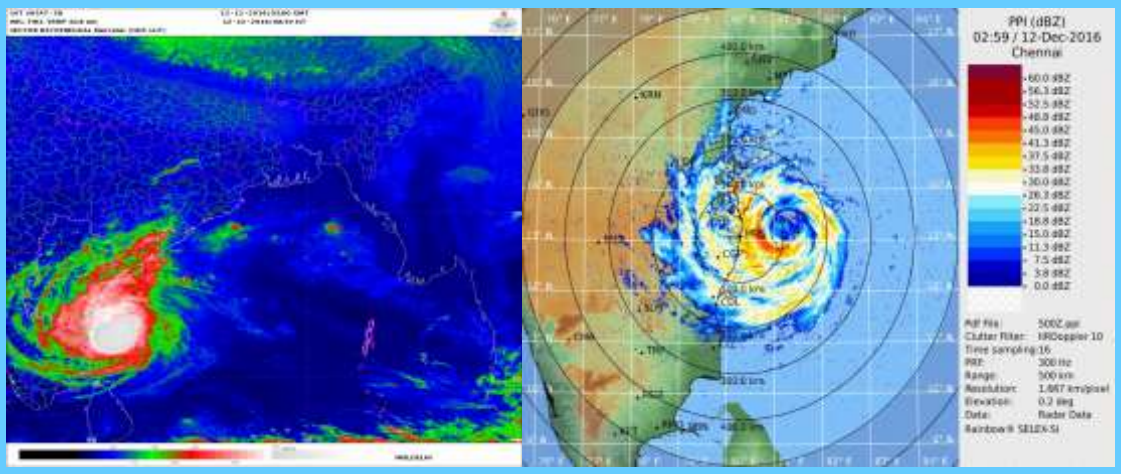
INDIA METEOROLOGICAL DEPARTMENT

Report No.: FDP/TCR/1/2016

Forecast Demonstration Project (FDP) for Improving Track, Intensity and Landfall of Bay of Bengal Tropical Cyclones: Implementation Report, 2016



Typical Satellite and Radar Imageries of Very Severe Cyclonic Storm Vardah

Cyclone Warning Division, New Delhi

August, 2017

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Preface

A programme has been evolved on prediction of track, intensity and landfall of tropical cyclone over north Indian ocean resulting in planning of the Forecast Demonstration Project (FDP) over Bay of Bengal since 2008 (15 October – 30 November). The programme is aimed to demonstrate the improvement in cyclogenesis, intensification and movement of cyclones over the north Indian Ocean (NIO) with enhanced observations over the data sparse region. The FDP on landfalling cyclones over the Bay of Bengal was conducted during 15th October to 20 December (against 15th October to 30 November) due to extended period of development of cyclogenesis over the NIO. The daily bulletin was prepared during the period and circulated to all concerned. This report deals with implementation of the programme, salient features of the systems developed, forecast performance, weather summaries issued and the lessons learnt during 15 October to 20 December, 2016.

The FDP helped in continuous monitoring of environmental conditions for cyclogenesis and monitoring of track, intensity and landfall of cyclonic disturbances over the region. Further, intense observation during IOP helped in better monitoring and prediction of cyclonic disturbances. The additional data collected during the FDP included enhanced Automatic Weather Station (AWS), High Wind Speed Recoder (HWSR) and Doppler Weather radar (DWR) network along the coast, eighteen activated buoy observations from the NIO, coastal AWS, ships and microwave imagery products. Also, an array of deterministic and probabilistic numerical weather prediction models was used for prediction purpose. Because of the above, the cyclone track and intensity forecast skills improved during the season resulting in significant check over damage to property and loss of lives. It also helped in strengthening the multi-institutional mechanism. Various lessons were also learnt during the campaign.

Many research and observational inputs were received from various national agencies including National Centre for Medium Range Weather Forecasting (NCMRWF), Indian Institute of Tropical Meteorology (IITM Pune), Indian Air Force, Indian Navy, Indian Institute of Technology-Bhubaneswar, Indian National Centre for Ocean Information Services (INCOIS), National Institute of Ocean Technology (NIOT), Space Application Centre, Indian Space Research Organisation (SAC-ISRO) which are highly appreciated and duly acknowledged. I would like to acknowlege Cyclone Warning Division and various other divisions of India Meteorological Department at Headquarter including Satellite, Radar and Numerical Weather Prediction Centre, and Information System and Services Division and Field Operation Centre, Chennai, Cyclone warning centres at Bhubaneswar & Visakhapatnam, Area Cyclone warning Centres at Kolkata & Chennai and all DWR stations as well as Meteorological observatories along the coast for their valuable inputs in monitoring and prediction of cyclonic disturbances over the region.

I place on record my sincere appreciation for Dr. M. Mohapatra and him team in RSMC, New Delhi for their valuable contribution in monitoring, predicting and warning services round the clock during the period with improved forecast skills which enhanced the confidence of disaster managers, media and general public in forecast by IMD and hence triggered suitable timely action leading minimum loss of lives and properties.

August 2017 **K.J. Ramesh**

Abstract

Major advancements happened globally in computational and observational capabilities in the recent past facilitated in better understanding of the inner structure of the cyclone and its mathematical representation. To incorporate these technical advancements into the operational cyclone forecast, a programme has been evolved on prediction of track, intensity and landfall of tropical cyclones over north Indian Ocean resulting in the planning of a Forecast Demonstration Project (FDP) over Bay of Bengal.

FDP programme is aimed at demonstrating the improvement in forecast of cyclogenesis, intensification and movement of cyclones over the north Indian Ocean with enhanced observations over the data sparse region and with output from numerical weather prediction (NWP) models. Several national institutions participated in the joint observational, communicational & NWP activities during FDP-2016. Following the success of previous FDP campaigns, a similar exercise was carried out in 2016, for the post monsoon cyclone season, with FDP starting from 15 October 2016. The campaign continued till 20th December, in view of continuance of development of cyclonic disturbances upto December. This report deals with implementation programme, salient features of the systems developed, forecast performance, weather summaries issued and the lessons learnt during the FDP-2016.

During the period there were 25 days of Intense Observation Period (IOP) in association with the (i) Cyclonic storm 'KYANT' over the Bay of Bengal, (ii) Depression over the Bay of Bengal, (iii) Cyclonic Storm “Nada” over the Bay of Bengal, (iv) Very Severe Cyclonic Storm ‘VARDAH’ over the Bay of Bengal, and (v) Depression over the Arabian Sea. With the enhanced observations and use of better range of deterministic and probabilistic numerical weather prediction models, the cyclone track and intensity forecast skills improved during the season resulting in significant check over damage to property and loss of lives. The seasonal average track forecast error was 85.4km, 164.4 km and 289.9 km, respectively for 24, 48 and 72hrs forecasts during post-monsoon season, 2016 against the past five years average error of 97.5, 146 and 183 km based on data of 2011-2015. The landfall point forecast error was 11 km, 155 km and 264 km for 24, 48 and 72 hrs lead period during postmonsoon season 2016 against the average of past five years of 56 km, 93 km and 106 km. The seasonal average absolute error (AE) in intensity forecast error has been 7.3 knots, 9.9 knots and 12.5 knots respectively for 24, 48 and 72 hrs lead period of forecast against the past five years average of 12, 17 and 18 knots. The operational track and landfall forecast errors were higher as all the cyclones during the season had recurving track. However, comparing with the average track forecast errorsd of recurving cyclones during past years, the error during 2016 was less. Also, intensity forecast errors were significantly less than long period average.

During the campaign various lessons were learnt, which will further help in better understanding of physical processes involved in cyclone monitoring & forecasting. To mention a few, we should have better availability of consumables and other logistic support for the coastal observatories and ships to ensure good collection of data, GPS-sonde based upper air observation, better data reception from the coastal stations of all WMO/ESCAP Panel countries on real time basis, improved buoy network, improved NWP models and Ensemble Prediction System (EPS) guidance with better data assimilation and computational abilities, objective analysis of various cyclogenesis, intensification and track forecast parameters by preparing a check list and threshold values of various NWP products.

Key words: Tropical cyclones, Bay of Bengal, Arabian Sea, Forecast Demonstration Project

CHAPTER–I

Introduction

1.1 Background

Extensive operational mode activities are in place involving a range of global Forecasting system (currently T-1534) and meso-scale (WRF/HWRF) models for generating short (up to 3 days in advance) and medium range (4-10 days in advance) forecast products for use in the prediction of tropical cyclone genesis, intensification, movement and landfall characteristics. Continuous assimilation of all available land based, ocean based and space based observations is carried out at the NCMRWF and IMD for Global models. Regional scale assimilation is also carried out at NCMRWF and IMD for generating most representative 3-D atmospheric fields for forcing the regional and meso-scale models.

Extensive performance evaluation and numerical experimentation studies carried out by the operational, R & D and academic groups on tropical cyclone forecasting over the Bay of Bengal and Arabian Sea indicates that though the cyclone forecasts have improved significantly in recent years due to modernisation programme of IMD and other intiatives of Ministry of Earth Sciences, there is still scope for further improvement. It is concluded that the tropical cyclone track and intensity forecast errors in 3-5 days scale can be further improved significantly. Also, it is strongly believed that the establishment of necessary aircraft probing of cyclone (APC) facility for generating data from the cyclone core environment can successfully address this critical data gap in cyclone intensity and track forecasting.

1.2. Key Scientific Objectives and Goals for FDP

The key objectives of the FDP are:

i) To demonstrate the ability of the Numerical Models using enhanced observation over the region including the measurements from the dropsonde's over the periphery of the cyclone and to assess overall accuracy limits in terms of the cyclone track, intensity and landfall for one to two Seasons.

ii) To incorporate modification into the models which could be specific to the Bay of Bengal based on the in-situ measurements and following the actual track through Satellite and Radar observations.

1.3. Programme

The FDP on landfalling tropical cyclones over the Bay of Bengal has been taken up by the IMD which aims to improve the skill of TC track & intensity prediction during 15 Oct.-30 Nov. since 2008. During this year's campaign **(15 Oct – 20 December 2016),** several national institutions participated for joint observational, communicational & NWP activities. In this Phase, there were in all 25 days of Intensive Observational Period (IOP) in association with the (i) Cyclonic storm 'KYANT' over the Bay of Bengal, (ii) Depression over the Bay of Bengal, (iii) Cyclonic Storm "Nada" over the Bay of Bengal, (iv) Very Severe Cyclonic Storm 'VARDAH' over the Bay of Bengal, and (v) Depression over the Arabian Sea. However, the aircraft probing could not be attempted in this phase of FDP due to various technical reasons.

The detailed implementation plan is presented in Chapter-II. The detailed implementation programme is presented in Chapter-III. The salient features of post monsoon cyclone Season 2016 are presented and discussed in Chapter-IV. Forecast performance during the season is presented in Chapter-V. The summary and conclusions as well as lessons learnt are presented in Chapter-VI. Daily weather summary and advisory issued during FDP-2016 are presented in Appendix-I.

CHAPTER–II

PROGRAMME IMPLEMENTATION PLAN FOR FDP-2016

Background

Currently in India, extensive operational mode activities are in place involving a range of global (GFS-IMD, NCMRWF), regional and meso-scale (WRF/HWRF) models for generating short (up to 3 days in advance) and medium range (4-7 days in advance) forecast products for use in the prediction of tropical cyclone genesis, intensification, movement and landfall characteristics. Continuous assimilation of all available land based, ocean based and space based observations is carried out at the NCMRWF. Regional scale assimilation is carried out at NCMRWF and IMD for generating most representative 3-D atmospheric fields for forcing the regional and meso-scale models.

Recent initiatives for FDP Planning

IMD is the nodal agency with respect to the implementation of FDP campaign. The programme started in 2008 based on the available observational, NWP and communication infrastructure in the absence of aircraft probing. It continued through 2016 with the upgradation of observational network and NWP modeling system. Based on the experience of these past phases of FDP, the implementation plan was modified from time to time.

Key Scientific Objectives and Goals for FDP-2016

i. To demonstrate the ability of the Numerical Models using enhanced observation over the region and to assess overall accuracy limits in terms of the cyclone track, intensity and landfall.
ii. To incorporate modification into the models which could be specific to the Bay of Bengal based on the in-situ measurements and following the actual track through Satellite and Radar observations.

Programme

The objectives of the programme will be met by conducting a joint observational communication and NWP effort by several institutes in the country during the period 15 Oct.-30 Nov., 2016. There will be Intensive Observational Phases (IOP) within this period tuning actual cyclone events. There will be a National Operational Centre (NOC) at New Delhi and a Field Operational Centre (FOC) at Chennai.

National Operational Centre (NOC):

The overall campaign will be monitored and guided by a Weather Monitoring and Advisory Group (WMAG) at National Weather Forecasting Centre (NWFC), IMD. In addition, communication conferencing and data exchange will be facilitated from this nodal cell. It will be called the NOC. The announcement of IOP will be made by NOC. (Contact: Dr. M. Mohapatra, Scientist-G and Head (Services), India Meteorological Department, e-mail mohapatraimd@gmail.com & cwdhq2008@gmail.com, Phone No. 011-24616051, 24652484, 24631913 Mobile: 9868623475, Fax No. 011-24623220.

Field Operational Centre (FOC):
The FOC, Chennai will work in unison with the NOC coordinating all activities of every institution during the IOP (Contact: Dr. S. Balachandran, Sc. F, Cyclone Warning Research Centre, RMC, Chennai, E-mail: balaimd@gmail.com, Phone No. 044-28276752, Fax No. 044-28276752)

Multi institutional initiative
The institutions involved in the program are as follows:-

1. India Meteorological Department (IMD)
2. National Centre for Medium Range Weather Forecasting (NCMRWF)
3. India Space Research Organisation (ISRO)
4. Indian Air Force (IAF)
5. INDIAN NAVY
6. Indian Institute of Technology (IIT) DELHI & BHUBNESWAR
7. National Institute of Ocean Technology (NIOT)
8. Indian National Centre for Ocean Information Services (INCOIS)

Targeted FDP Requirements for the FDP Campaign of October-November 2016
Observational program:

(I) AWS:
Operational meso-scale AWS network of IMD along the east coast of India available for FDP is shown below.

S. No.	State	Existing No. of AWS Stations
1	West Bengal	27
2	Odisha	38
3	Andhra Pradesh	24
4	Tamilnadu and Puducherry	35
5	Andaman & Nicobar	1
6	Lakshadweep	1
7	Kerala	15
8	Karnataka	25
9	Goa	3
10	Maharashtra	39
11	Gujarat, Daman & Diu and Dadra Nagar & Haveli	40
12	East coast + A&N Islands	125
13	West coast + Lakshadweep	123

The locations of the stations are shown in Fig.1

- DDGM (SI), Pune will ensure the real time transmission of data from AWS stations along east coast of India and additional 14 in the Northeast to DDGM (ISSD) Delhi in GTS mobile synop format. DDGM (SI) will submit status report by 1st October 2016 to Project Manager on the availability of such data.

- Data from PRWONAM and northeast India Meso-scale AWS network will be made available by ISRO from the MOSDAC server of SAC, Ahmedabad on real time (Fig.2).
- DDGM (Sat. Met) will make arrangements to download ISRO AWS data and relay it to NOC for operational and NWP application.
- AWS data from 10 stations commissioned (under STORM Project) by Kolkata University and Guwahati university will also be communicated to NOC. DDGM, RMC, Kolkata and Guwahati will coordinate and intimate the status to NOC and FOC by 1st October 2015.
- RMCs at Kolkata and Guwahati will work out modalities to collect and transmit data on real time basis from AWS network established under the storm programme by Kolkata University, Jadavpur University and Guwahati University by 1st October. The data will be transmitted through AMSS of respective RMC. FOC shall coordinate the exercise.

IMD AWS network over NE India is given below.

S. No.	State	Existing No. of AWS Stations
1	Assam	29
2	Meghalaya	7
3	Nagaland	10
4	Arunachal Pradesh	15
5	Tripura	4
6	Manipur	8
7	Mizoram	8
8	Sikkim	4

(II) Synoptic observation

- Synoptic observatories of IMD network (Fig.3 and Fig.4) over the peninsular/east India under the RMCs of Chennai and Kolkata shall report data on hourly basis, during IOP. During normal period of FDP, 3 hrly. SYNOP will be collected.
- RMC Kolkata and Chennai will ensure hourly observation and transmission through telephone/fax/e-mail of all synops of coastal stations during IOP to NOC and FOC. In addition, RMC Chennai shall organize transmission of such data through AMSS.
- RSMC, New Delhi will write to concerned WMO/ESCAP Panel member countries to ensure the availability of synoptic data from there respective region for the FDP period.
- FOC will also intimate the status of Cyclone Distress Mitigation Committee (CDMC) stations along east coast to NOC and ensure their functioning during FDP period.

(III) Buoys:

Real-time collection of hourly data from deep ocean and met-ocean buoy network over the Bay of Bengal from INCOIS Server will be ensured by DDGM (ISSD).

- NOC & FOC will utilize these data received through GTS/E-mail.
- INCOIS will ensure availability of additional marine surface pressure observation through E-mail to NOC & FOC

(IV) High wind speed recorder (HWSR)

There are twenty HWSRs along the coast of India in the operational conditions as mentioned below.

Digha	: West Bengal
Haldia	: West Bengal
Sagar Island	: West Bengal
Puri	: Odisha
Gopalpur	: Odisha
Balasore	: Odisha
Paradip	: Odisha
Visakhapatnam	: Andhra Pradesh
Machilipatnam	: Andhra Pradesh
Nellore	: Andhra Pradesh
Kalingapatnam	: Andhra Pradesh
Kakinada	: Tamil Nadu
Chennai	: Tamil Nadu
Karaikal	: Puducherry
Pune	: Maharashtra
Goa	: Goa
Veraval	: Gujarat
Dwarka	: Gujarat
Bhuj	: Gujarat
Naliya	: Gujarat

FOC, Chennai will ascertain the functioning of the HWSRs along the east coast. It will make arrangement for collection and dissemination of HWSR data on real time basis to NOC and NWP Division of IMD. It will also make arrangement for archival of this data. NWP Division of IMD and NCMRWF will try to ingest these data in NWP models. The performance of HWSRs during IOP period will be evaluated.

(V) Upper air

Augmentation of coastal/peninsular upper air measurements (Fig.5)

- Upper air RS/RW data from IMD stations (Guwahati, Kolkata, Port Blair, Bhubaneswar, Visakhapatnam, Machilipatnam, Hyderabad, Chennai, Karaikal, Minicoy/Amini Divi, Trivendrum) will be collected at least once(based on 0000 UTC) for normal days of FDP period. However, during the IOP phase of FDP, 12 hrly. data shall be collected. The flights terminating below 250 hPa are to be repeated.
- DDGM (UI), RMCs Kolkata, Chennai and Guwahati will take all necessary steps in support of FDP observational requirements. The readiness report should be sent to NOC by 1st October 2016.
- Additional GPS Sonde soundings will be taken at Balasore, Gopalpur, Kalingapatnam, Ongole/Bapatla and Pamban with the support of ISRO.
- DDGM, Chennai and DDGM (UI) shall liaise with VSSC, Trivendrum to ensure commissioning of equipment along with training to IMD staff to operate during the IOP phase of FDP. DDGM, Kolkata will depute suitable staff for Balasore and Gopalpur and remain in touch with RMC Chennai.
- Upper air GPS Sonde data from Indian Navy stations shall be made available by the DNOM HQs, Delhi through e-mail. DDGM (UI) shall liaise with DNOM and ensure real time data transfer for the FDP period.

- FOC may explore the availability of Upper air data from GPS Sonde network of ISRO at Gadanki, SHAR, Arakkonam, Kochi etc. for the IOP Phase of FDP. DDGM, Chennai shall liaise with VSSC, Trivendrum to ensure commissioning of equipment along with training to IMD staff to operate at these stations if agreed by ISRO during the IOP phase.
- Due arrangements are to be made by DDGM (UI) to receive all available Pilot Balloon data sets for the FDP 2016 period.
- Arrangements have to be made by DDGM (UI) to collect pilot balloon data from IAF. In case of becoming dark by 12UTC, IAF be advised to take the Pilot assent by 11UTC. Daily flight level winds as collected by IAF flights between Carnicobar and Tambaram are also to be received for FDP 2016 period. DDGM (UI) shall liaison with IAF to receive GTS coded data.
- Wind profiler support from the existing Gadanki and SHAR is to be activated so as to receive hourly profiles in the lower troposphere. FOC, Chennai will request ISRO (Principal Scientist) for organizing necessary observational support during FDP campaign. ISSD, IMD, New Delhi will identify nodal officers to workout real time data reception modalities in this regard.

(VI) DWR Support

DWR Support from 5 locations (Fig.6) at Kolkata, Visakhapatanm, Machillipatnam, SHAR and Chennai with uniform storm scanning strategy will be ensured prior to the FDP-2016. DDGM (UI) shall make due arrangements to receive the DWR data in real time to DDGM (ISSD) for the FDP 2016.

(VII) Satellite observations

DDGM (Sat Met) shall make all available satellite derived products (high resolution AMVs; rapid scan winds; OLR; ASCAT and WINDSAT winds; local HRPT Temperature and moisture profiles from INCOIS; GPS occultation data; MODIS moisture data; TMI; SSMI and AMSU data sets, Rapid products etc.) for its utilization by the global and regional data assimilation-forecast systems of IMD and NCMRWF during the FDP 2016 period. Satellite Division will issue special bulletin every three hourly about the cyclonic disturbance.

Telecommunication

1. DDGM (ISSD) shall take all necessary steps so as to receive the observational data at the NOC and FOC from all identified sources both from FDP partners and the regional countries (Bangladesh, Myanmar, Malaysia, Thailand, Indonesia and Sri Lanka) in real time. ISSD and NWP division shall continuously monitor the data reception at NWP/Telecom and ensure the timely data reception and onward transmission of data to NWP Division and NCMRWF throughout the FDP 2016 period.
2. IMD shall update FDP Web Page on IMD (linked at NCMRWF as well). The existing FDP e-mail group will be updated with full contact details). An FDP discussion group for the exchange of FDP related information among the FDP partners may be created. DDGM (ISSD), IT cell will take necessary action in this regard.

NWP analysis and prediction

1. NWP Division shall make all necessary arrangements for the generation of global and regional analyses fields by using special FDP 2016 data at 4 analysis times (00, 06,12,18 UTC) for the whole of FDP 2016 period. Arrangements are also to be made to

keep FDP 2016 analyses and forecast boundary fields upto 72hrs on ftp servers of NCMRWF and IMD for their utilization by FDP partners in India. Efforts will be made to bring out the Regional Model forecast within three hours of the observation time.

2. NWP Division, IMD shall workout arrangements to provide analyses fields of Unified model as well on the ftp servers at NCMRWF and IMD for the FDP 2016 period.

International Cooperation

Head RSMC, New Delhi shall inform the ESCAP Panel, SAARC and BIMSTEC countries about the FDP over the Bay of Bengal programme of India and solicit their cooperation in the real-time exchange of data (surface, upper air and special observations) for their utilization in the generation of most representative meso-scale analysis fields over the Bay of Bengal and its neighbourhood for generating improved quality of track, intensity and landfall of tropical cyclones.

FDP Operation Centre

Project Director will be assisted by a National FDP Operations Centre (NOC) at NWFC and a FDP Weather Monitoring and Advisory Group will be constituted to identify the IOP phases during FDP 2016 period.

FDP Weather Monitoring and Advisory Group (WMAG)

1. DGM Chairman
2. Head ,NCMRWF
3. Head Services
4. All members of FDP Project Team
5. Representatives from IAF, Indian Navy.

The WMAG shall meet thrice a week (Monday, Wednesday & Friday) at 1530 hrs. (including holidays) during the period 15 Oct.- 30 Nov., 2016 at India Meteorological Department to review the FDP activity regularly and decide on IOP declaration. Weather summaries and current information will be presented by Project Scientist, FDP. The weather summaries and information will be prepared daily and uploaded in the website along with circulation through e-mail like previous years.

Implementation Strategy

- Preparatory Phase for the

FDP-2016: 1-30 September 2016

(Actions to be completed as mentioned above)

- FDP-2016 Field Phase: 15 October to 30 November

(Actions to be completed as mentioned above)

- Intense Observational Phase (IOP): Identified by the NOC at NWFC in consultation with the Weather Monitoring and Advisory Group
- NOC: The NOC will be established at NWFC, New Delhi which will be responsible for entire co-ordination and declaration of IOP. The center will function independently. The usual operational activity of RSMC, New Delhi will be separate.
- FOC: Cyclone Warning Research Centre at RMC, Chennai shall function as the FOC and establish links with all FDP partners, notify all IOP phases to FDP partners, coordinate and update the status of observation collection and transmission from FDP partners from time to time. The RMCs at Kolkata and Guwahati; ACWCs at Kolkata and CWCs at Visakhapatnam and Bhubaneswar shall work in close liaison with FDP FOC

and NOC, NWFC, Delhi for smooth and efficient organization of FDP 2016 pilot observational campaign.

- FDP Data Centre: All special observations collected by the FDP project partners shall be archived along with meso-scale analysis and forecast fields at IMD and NCMRWF computing centres.
- Post Experiment Phase:

1. Preparation of weather summery data CD will be carried out by the project management team and NWP group of IMD.
2. Project management team shall plan and coordinate necessary R&D work involving not only FDP partners but also other academic and research groups in the country to maximize the utilization of FDP data for accomplishing the envisaged targets of the project.
3. An implementation report will be prepared at the end of FDP-2016. It will highlight societal issues along with the programme implementation, outcome and lessons learnt.
4. The daily rainfall data along the coast during landfall of a cyclone will be analysed to find out the diurnal variation of rainfall.
5. A report will be prepared at the end of FDP about the performance of Operational forecast system and various tools and techniques utilised in monitoring process.

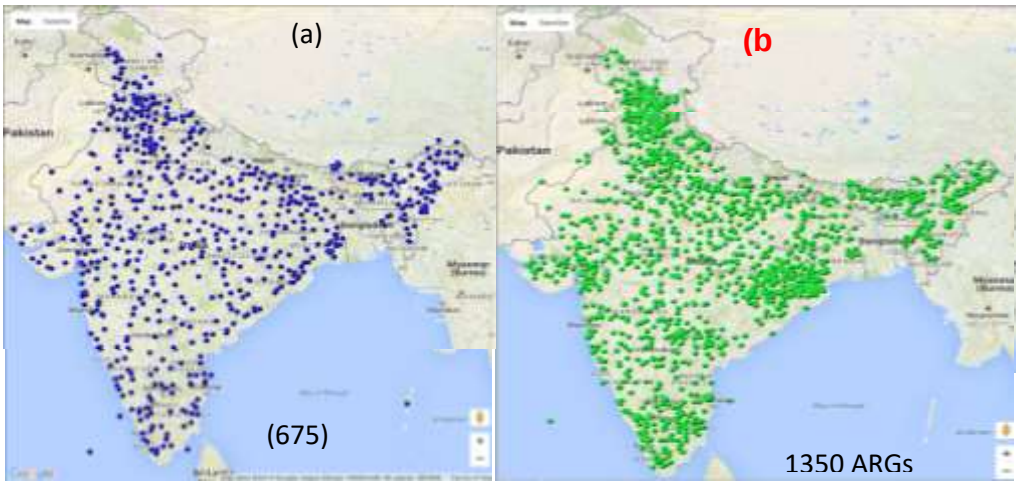


Fig.1(a). AWS and ARG Network of IMD

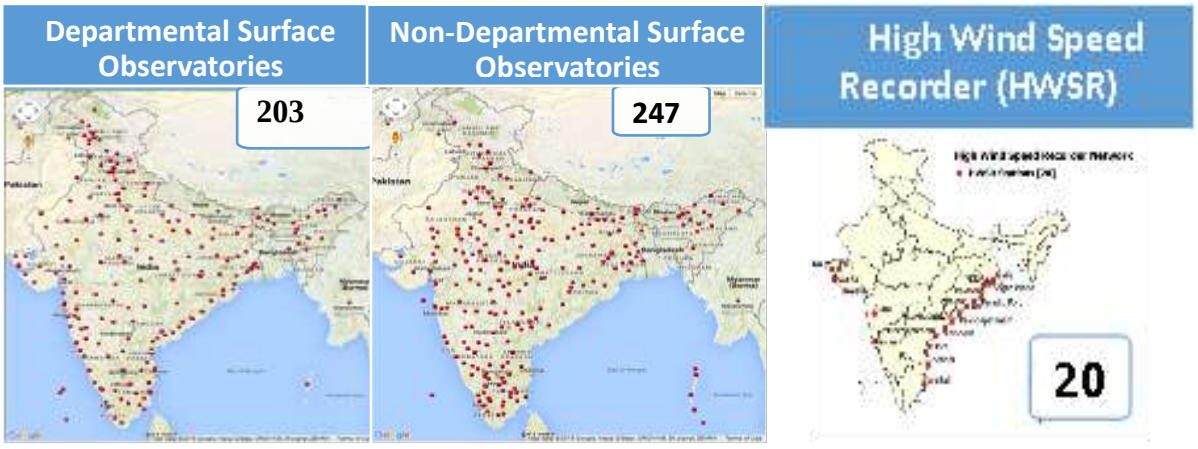


Fig.1(b) Observational Network of IMD

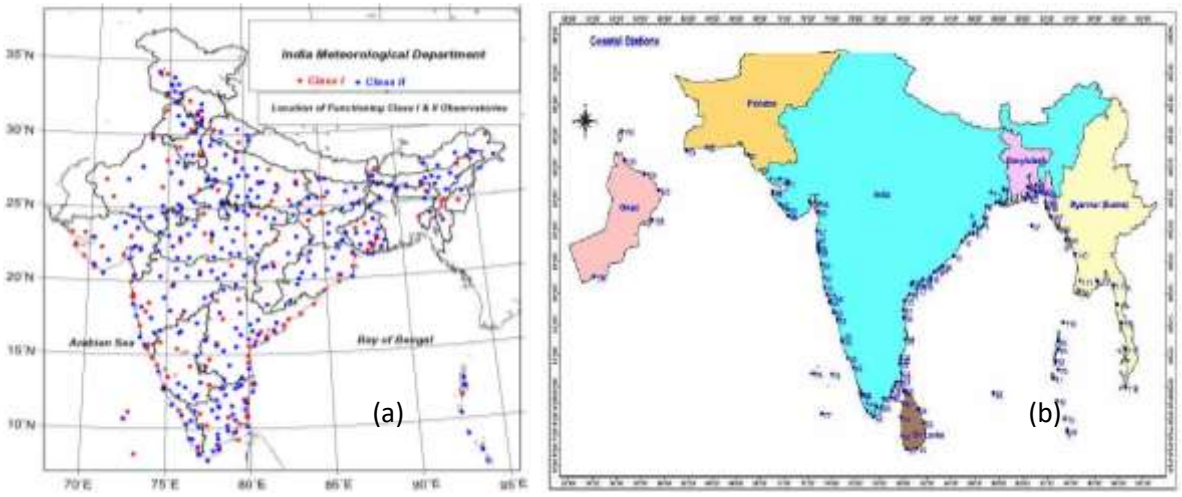


Fig.2. (a) Synoptic stations of IMD and (b) coastal synoptic stations of IMD

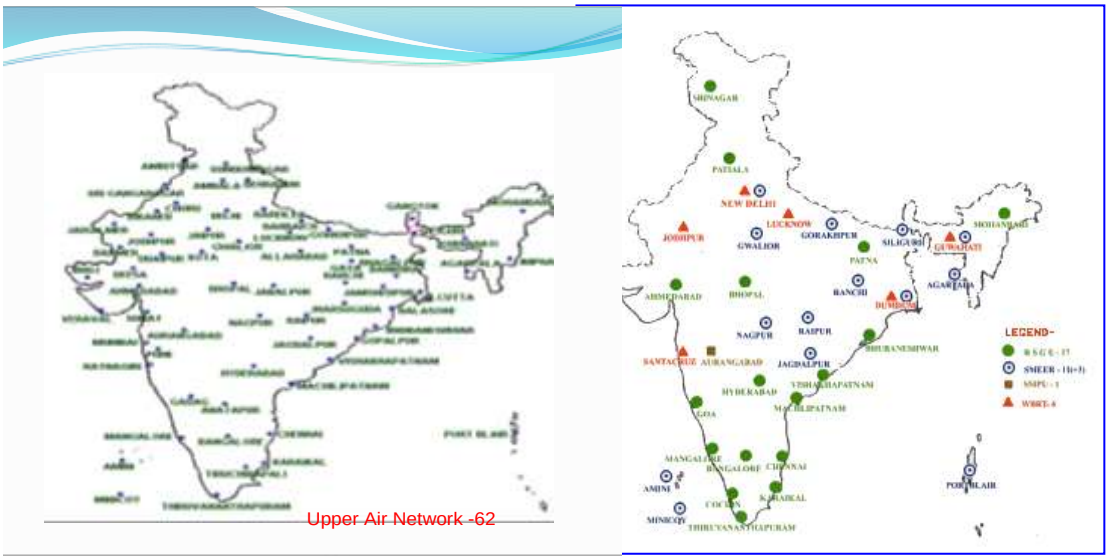


Fig.3 Pilot balloon and RS/RW network of IMD

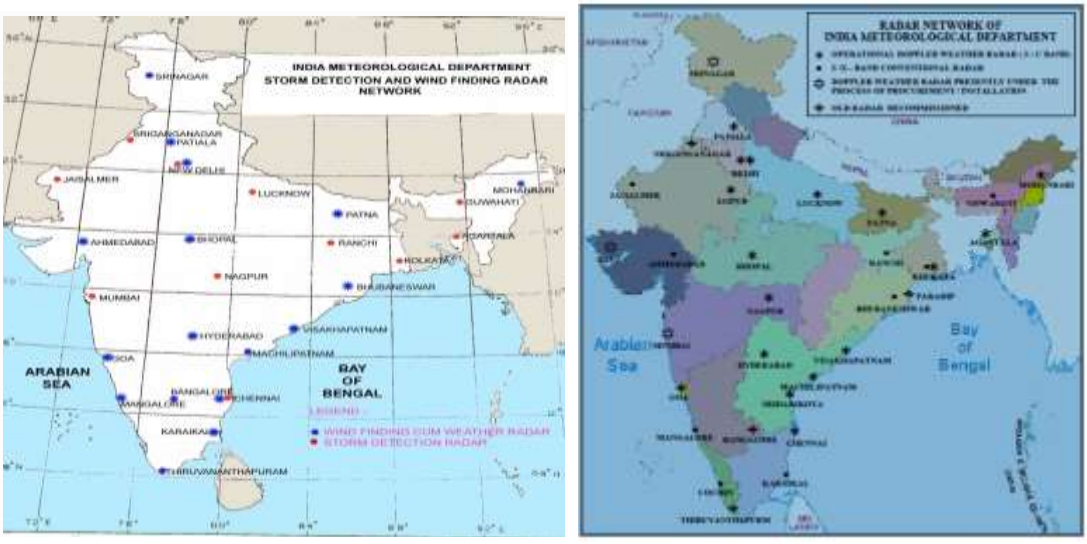


Fig.4. Cyclone detection radar network of IMD

Table 1. List of East Coast stations in India

Station	Index	Latitude	Longitude	Class	00Z	03Z	06Z	09Z	12Z	15Z	18Z	21Z
Kolkota(Alipore)	42807	22 32N	88 20E	I	X	X	X	X	X	X	X	X
Kolkota(DumDum)	42809	22 39N	88 20E	I	X	X	X	X	X	X	X	X
Diamond Harbour	42811	22 11N	88 12E		X	X	X	X	X	X	X	X
Canning	42812	22 15n	88 40 E		0	X	0	0	X	0	0	0
Midnapore	42803	22 25N	87 19E	IIb	0	X	0	0	X	0	0	0
Digha	42901	21 50N	87 47 E		X	X	X	X	X	X	X	X
Basirhat	42810				0	X	X	X	X	0	0	0
Contai	42900	21 47N	87 45E	IIb	0	X	0	0	X	0	0	0
Balasore	42895	21 31N	86 56E	I	0	X	X	X	X	X	0	0
Chandbali	42973	20 47N	86 44E	I	0	X	X	X	X	X	X	X
Cuttack	42970	20 28N	85 56E	IIb	0	X	0	0	X	0	0	0
Paradip	42976	20 18N	86 41E	IIa	0	X	0	0	X	0	0	0
Bubaneshwar	42971	20 15N	85 50E	I	X	X	X	X	X	X	X	X
Puri	43053	19 48N	85 49E	I	X	X	X	X	X	X	X	X
Gopalpur	43049	19 16N	84 53E	I	X	X	X	X	X	X	X	X
Kalingapatnam	43105	18 20N	84 08E	I	X	X	X	X	X	X	X	X
Vishakapatnam	43149	17 43N	83 14E	I	X	X	X	X	X	X	X	X
Kakinada	43189	16 57N	82 14E	I	X	X	X	X	X	X	X	X
Tuni	43147	17 21N	82 33E	I	X	X	X	X	X	X	X	X
Kavali	43243	14 54N	79 59E	I	X	X	X	X	X	X	X	X
Nidadavole	43184	16 50N	81 35E	IIb	0	X	0	X	X	0	0	0
Narsapur	43187	16 26N	81 42E	I	X	X	X	X	X	X	X	X
Gannavaram	43181	16 42N	80 48E	I	X	X	X	X	X	X	X	X
Machlipatnam	43185	16 12N	81 09E	I	X	X	X	X	X	X	X	X
Bapatla	43220	15 54N	80 28E	I	0	X	X	X	X	0	0	0
Ongole	43221	15 30N	80 05E	I	X	X	X	X	X	X	X	X
Nellore	43245	14 27N	79 59E	I	X	X	X	X	X	X	X	X
Minambakkam	43279	13 00N	80 12E	I	X	X	X	X	X	X	X	X
Pondicherry	43331	11 58N	79 49E	I	X	X	X	X	X	X	X	X
Cuddalore	43329	11 46N	79 46E	I	X	X	X	X	X	X	X	X
Karaikal	43346	10 55N	79 50E	I	X	X	X	X	X	X	X	X
Nagapattinam	43347	10 46N	79 51E	I	X	X	X	X	X	X	X	X
Vedaranyam	43349	10 22N	79 51E	IIb	0	X	0	0	X	0	0	0
Adiramapattinam	43348	10 20N	79 23E	I	X	X	X	X	X	X	X	X
Tondi	43361	09 44N	79 02E	I	X	X	X	X	X	X	X	X
Pamban	43363	09 16N	78 18E	I	X	X	X	X	X	X	X	X
Tuticorin	43379	08 45N	78 11E	I0	0	X	X	X	X	0	0	0
Palayamkottai	43376	08 44N	77 45E	IIb	0	X	0	0	X	0	0	0
Kanniyakumari	43377	08 05N	77 30E	IIa	0	X	X	0	X	0	0	0
Kondul	43385	07 13N	93 44E	IIb	0	X	0	0	X	0	0	0
Nancowri	43382	07 59N	93 32E	IIb	0	X	0	0	X	0	0	0
Carnicobar	43367	09 09N	92 49E	IIb	X	X	X	X	X	X	X	X
Hut bay	43364	10 35N	92 33E	IIb0	0	X	0	0	X	0	0	0
Portblair	43333	11 40N	92 43E	I	X	X	X	X	X	X	X	X
Longisland	43310	12 25N	92 56E	IIb	0	X	0	0	X	0	0	0
Mayabandar	43309	12 55N	92 55E	IIb	0	X	0	0	X	0	0	0

Table 2: List of Foreign Coastal stations

Station	Index	Latitude	Longitude	00Z	03Z	06Z	09Z	12Z	15Z	18Z	21Z
SRI LANKA											
Mannar	43413	08 59N	79 55E	X	X	X	X	X	X	X	X
Puttalam	43424	08 02N	79 50E	X	X	X	X	X	X	X	X
Galle	43495	06 02N	80 13E	X	X	X	X	X	0	X	0
Colombo	43466	06 54N	79 52E	X	X	X	X	X	X	X	X
Hambantota	43497	06 07N	81 08E	X	X	X	X	X	X	X	X
Batticloa	43436	07 43N	81 42E	X	X	X	X	X	X	X	X
Trincomalee	43418	08 35N	81 15E	X	X	X	X	X	X	X	X
Jaffna	43404	09 39N	88 01E	X	X	X	X	X	0	X	0
BANGLADESH											
Chandpur	41941	20 16N	90 42E	X	X	X	X	X	X	X	X
Barisal	41950	22 45N	90 22E	X	X	X	X	X	X	X	X
Majidcourt	41953	22 52N	91 06E	X	X	X	X	X	X	X	X
Patuakhali	41960	22 20N	90 20E	X	X	X	X	X	X	X	X
Hatia	41963	22 26N	91 06E	X	X	X	X	X	X	X	X
Sandwip	41964	22 29N	91 26E	X	X	X	X	X	X	X	X
Khepura	41984	21 59N	90 14E	X	X	X	X	X	X	X	X
Chittagong	41977	22 21N	91 49E	X	X	X	X	X	X	X	X
Cox'sBazzar	41992	21 26N	91 56E	X	X	X	X	X	X	X	X
Kutubdia	41989	21 49N	91 51E	X	X	X	X	X	X	X	X
Teknaf	41998	20 52N	92 18E	X	X	X	X	X	X	X	X
MYANMAR											
Sittwe	48062	20 08N	92 53E	X	X	X	X	X	0	X	0
Kyaukpyu	48071	19 25N	93 33E	X	X	X	X	X	0	X	0
Sandoway	48080	18 28N	94 21E	X	X	X	X	X	0	X	0
Pathein	48094	16 46N	94 46E	X	X	X	X	X	0	X	0
Yangon	48097	16 46N	96 10E	X	X	X	X	X	X	X	X
Moulmein	48103	16 30N	97 37E	X	X	X	X	X	0	X	0
Ye	48107	15 15N	97 52E	X	X	X	X	X	0	X	0
Dawei	48108	14 06N	98 13E	X	X	X	X	X	0	X	0
Mergui	48110	12 26N	98 36E	X	X	X	X	X	0	X	0
Bictoria Point	48112	09 58N	98 35E	X	X	X	X	X	0	X	0
THIALAND											
Phuket Airport	48565	08 07 N	98 19 E	X	X	X	X	X	X	X	X

Table 3 List of Co-operative Cyclone Reporting Network of Stations (Andhra Pradesh & ODISHA)

S. No	Station	District	Nearest Telegraphic Office	Distance From Station
Andhra Pradesh				
1	Palasa	Srikakulam	Palasa	2 km
2	Sompeta	Srikakulam	Sompeta	100 meters
3	Anakapalli	Vishakapatnam	Anakapalli	1.5 km
4	Rajamundry	East Godavari	Rajamundry	2.5 km
5	Yanam	East Godavari	Yanam	1.0 km
6	Razaole	East Godavari	Razaole	200 meters
7	Eluru	West Godavari	Eluru	1.0 km
8	Challapalli	Krishna	Challapalli	0.5 km
9	Avani Gadda	Krishna	Avani Gadda	200 meters
10	Nagayalanka	Krishna	Nagayalanka	1.0 km
11	Bantimalli	Krishna	Bantimalli	1.0 km
12	Kothapatnam	Prakasam	Kothapatnam	200 meters
13	Narasapuram	Nellore	Narasapuram	0.5 km
ODISHA				
1	Bhogral	Balasore	Bhogral	2Km
2	Basta	Balasore	Basta	1 Km
3	Bhadrak	Balasore	Bhadrak	2 Km
4	Bansara	Balasore	Bansara	2 Km
5	Rajkanika	Cuttack	Rajkanika	2 Km
6	Aul	Cuttack	Aul	2 Km
7	Rajnagar	Cuttack	Rajnagar	1 Km
8	Kendrapara	Cuttack	Kendrapara	2 Km
9	Mahakalpara	Cuttack	Mahakalpara	2 Km
10	Jagatsingpur	Cuttack	Jagatsingpur	1 Km
11	Ersama	Cuttack	Ersama	2 Km
12	Nimapara	Puri	Nimapara	0.5 Km
13	Brahmagiri	Puri	Brahmagiri	1 Km
14	Krishnaprasad	Puri	Krishnaprasad	0.5 Km
15	Chatrapur	Ganjam	Chatrapur	0.5 Km
16	Berhampur	Ganjam	Berhampur	3 Km

CHAPTER–III
IMPLEMENTATION OF FDP – 2016

3.1. Introduction

The objectives of the programme were met by conducting a joint observational communication and NWP effort by several institutes in the country during the period 15 Oct.-20 December 2016. There were in all 25 days of Intensive Observational Period (IOP).

The overall campaign was monitored and guided by a Weather Monitoring and Advisory Group (WMAG) at National Operation Centre (NOC) at RSMC, New Delhi in addition, communication conferencing and data exchange were facilitated from this nodal cell.

Field Operational Centre (FOC) worked at Regional Meteorological Centre, Chennai in unison with the NOC coordinating all activities of every institution during the IOP.

3.2. Observational programme

The observational programme was taken up as per the project implementation plan prepared by NOC. However, the buoy data with 12 such stations in Bay of Bengal was available during the campaign in 2016. IMD has augmented AWS network under its modernisation programme. The number of AWS/ Automatic Rain Gauge (ARG) stations in the country is around 675/1350. The AWS data including wind and pressure could very well help in monitoring the genesis, intensity, structure and movement of the landfalling cyclonic disturbances. Availability of hourly observations without an observer's need at the site helped immensely the monitoring and prediction of cyclonic disturbances. 39 GPS sonde stations helped in improving the initial conditions of the NWP models resulting in forecast also.

3.3. Operation Management

The announcement of IOP was made by NOC. Field Operational Centre (FOC) worked at Regional Meteorological Centre, Chennai in unison with the NOC coordinating all activities of every institution during the IOP.

The following methods were used for monitoring and forecasting of cyclonic disturbances**.**

3.3.1. Genesis:

Genesis parameters are evaluated in following steps to monitor the cyclogenesis.

Step 1 : SST, depth of 26°C isotherm and Ocean thermal energy

Step II : Conditional instability through a deep and moist atmospheric layer

Step III : Pre-existing disturbance

Step IV: Environmental conditions (vertical wind shear, low level vorticity, upper level divergence etc)

Step V: NWP and dynamical-statistical model forecasts for genesis

Based on synoptic, statistical, dynamical-statistical, NWP models guidance and Genesis Potential Parameter (GPP) of IMD & other sources, a consensus decision is taken on genesis of depression and its likely intensification into TC.

3.3.2. Determination of location of centre and intensity of cyclone

The location of the centre of the TC is determined based on (a) Synoptic, (b) Satellite (INSAT/METSAT/microwave) and (c) Radar observations. When the cyclone is far away from the coast and not within the radar range, satellite estimate gets more weight, though it is modified sometimes with availability of ship and buoy observations. When the cyclone comes

closer to the coast, radar estimate gets maximum preference followed by satellite. When cyclone is very close to coast or over the land surface, coastal observations get the highest preference followed by radar and satellite observations.

3.3.2.1. Synoptic technique

In synoptic technique, the centre of the system is determined by considering the centroid of the wind distribution at the surface level. In the pressure field, the location of lowest mean sea level pressure is considered as the centre of the system (IMD, 2003). The synoptic technique has got serious limitations over the open sea due to non-availability of sufficient observations. However, the AWS stations along coast are very useful as they provide hourly observations on real time basis (Bhatia et al, 2008). The coastal hourly observations help not only in correctly analyzing the location, but also in determining the landfall point and time and hence help in adverse weather warning. For intensity estimation, the available surface observations are taken into consideration to find out MSW and number of closed isobars at the interval of 2 hPa within a specified region around the system centre (IMD, 2003).

3.3.2.2. Satellite technique

In the initial stage (depression/deep depression), the centre is determined, from the centre of the low cloud lines (IMD, 2003). There are four types of cloud pattern (Dvorak, 1984) in TC. In case of shear pattern, when the convection lies away from the centre, centre is same as the centre of low cloud lines. As the system intensifies and acquires the banding pattern, the centre is determined from the banding feature using logarithmic spiral. In the central dense overcast (CDO) pattern, the centre of CDO is the centre of the system. In the eye pattern, the centre determination is easier and accurate as it is same as the centre of the eye of the cyclone.

The intensity classification by satellite technique is based on Dvorak's technique (Dvorak, 1984, Velden et al, 2006). The intensity of the tropical system is indicated by a code figure called T Number based on above pattern recognition technique. Another feature of the technique is the Current Intensity number (C.I.) which relates directly to the intensity (in term of wind speed) of the cyclone. The C.I. number may differ from the T number on some occasions to account for certain factors which are not directly related to cloud features. The empirical relationship between C.I .number and the MSW are given in Table.4 Col. 3 of the table gives the pressure depths (peripheral pressure minus central pressure in hPa) as applicable for Indian Sea area using the relation Vmax = 14.2 X SQRT (Pressure depth) following Mishra and Gupta (1976). As there is no aircraft reconnaissance in the NIO, Dvorak's technique has not been verified and also the pressure wind relationship not verified. Comparison of satellite based intensity and the best track estimates of IMD indicate a difference of about 0.5 T (Goyal et al, 2013). Recently the microwave imageries and brightness temperatures are also used to determine central pressure and MSW (Jha et al, 2013). However, this technique has not been validated over the NIO due to non-availability of aircraft reconnaissance.

Table 4. Maximum sustained wind speed (MSW) and pressure depth in relation to CI number

C.I. Number	*Max. Wind Speed (knots)*	*Pressure depth (in mb)*
1	25	2.0
1.5	25	3.0
2	30	4.5
2.5	35	6.1
3	45	10.0

3.5	55	15.0
4	65	20.9
4.5	77	29.4
5	90	40.2
5.5	102	51.6
6	115	65.6
6.5	127	80.0
7	140	97.2
7.5	155	119.1
8	170	143.3

3.3.2.3. Radar Techniques

The *eye* or the centre of the TC can be derived from a continuous and logical sequence of observations. The geometric centre of the echo-free area is reported as the *eye location*. If the wall cloud is not completely closed, it is still usually possible to derive an eye location with a high degree of confidence by sketching the smallest circle or oval that can be superimposed on the inner edge of the existing portion of the wall cloud. When the wall cloud is not developed fully but a centre of circulation is identifiable, then this feature is observed and reported similar to the eye. When the eye or centre is indistinct or outside the range or the radar beam overshoots the inner eyewall when it does not extend very high, spiral band overlays are used to estimate the location of the centre (IMD, 1976). Based on observed winds from DWR, the intensity can be determined (Raghavan, 2013). As radar based wind are not available at surface level, the wind observations from these techniques are converted to 10 meter wind using the suitable conversion technique like those used in case of aircraft reconnaissance technique in Atlantic.

The location estimation error has been about 55 km over the sea areas (Mohapatra et al, 2012a, Goyal et al, 2013). According to Elsberry (2003), the errors in determining the TC centre over the northwest Pacific Ocean can be upto 50 km by satellite fixes, 20-50 km by radar observations and by about 20 km by aircraft reconnaissance. The induction of DWR has reduces the error in fixing the centre of cyclones in radar range. The landfall point estimation error has reduced to about 25 km by 2010 mainly due to installation of coastal AWS. The average error in MSW estimation has reduced over the years. It could have been T0.5 (05-20 knots or 3-10 mps) with the introduction of Dvorak's classification of intensity since 1974.

3.3.3. Track and Intensity Forecast:

A variety of observational data have been used in India till 1960s to forecast the track intensity and landfall of TCs. Satellite era, since 1960s, added another feature. There has been rapid development in objective techniques since 1970s and especially in recent years for forecasting tracks and intensity of TCs in the NIO. To summarise, currently following methods are used by IMD for TC track and intensity forecasting.

i) Statistical technique(Analogue, Persistence, Climatology, Climatology and persistence(CLIPER)
ii) Synoptic technique – Empirical technique
iii) Satellite techniques- Empirical technique
iv) Radar techniques- Empirical technique
v) Numerical weather prediction (NWP) models

vi) Dynamical statistical models

In the synoptic method, prevailing environmental conditions like wind shear, low to upper level wind and other characteristics are considered. All these fields in the NWP model analyses and forecasts are also considered. The development of characteristic features in satellite and radar observations is also taken into consideration. While, the synoptic, statistical and satellite/radar guidances help in short range forecast (upto 12/24 hrs), the NWP guidance is mainly used for 24-120 hr forecasts. Consensus forecasts that gather all or part of the numerical forecast tracks and intensity and uses synoptic and statistical guidance are utilised to issue official forecast.

There are three types of NWP models for cyclone forecasts, viz., individual deterministic models, multi-model ensemble (MME) and single model ensemble prediction system (EPS). Also there are dynamical statistical models for the purpose of genesis and intensity prediction.

3.3.3.1. Individual deterministic model

- **Global Forecast System (GFS)**

The Global Forecast System (GFS), adopted from National Centre for Environmental Prediction (NCEP), at T1534 (~ 12 km in horizontal) resolution (incorporating Grid point Statistical Interpolation (GSI) scheme as the global data assimilation for the forecast up to 10 days) is implemented operationally at IMD, New Delhi. The model is run twice in a day (00 UTC and 12 UTC). The real-time outputs are made available to the national web site of IMD (http://www.rsmcnewdelhi.imd.gov.in/section/nhac/dynamic/nwp/welcome.htm).

- **Non-hydrostatic mesoscale modeling system WRFDA-WRF-ARW**

The mesoscale forecast system Weather Research and Forecast WRFDA (version 3.2) with 3DVAR data assimilation is being operated daily twice to generate mesoscale analysis at 9 km and 3 km horizontal resolutions using IMD GFS-T1534 analysis/forecast as first guess. Using initial and boundary conditions from the WRFDA, the WRF (ARW) is run for the forecast up to 3 days with double nested configuration and horizontal resolution of 9 km and 3 km and 38 Eta levels in the vertical. The model mother domain covers the area between lat. 25º S to 45º N long 40º E to 120º E and child covers whole India.

- **Hurricane WRF Model (HWRF)**

Recently under Indo-US joint collaborative program, IMD adapted Hurricane-WRF model for cyclone track and intensity forecast over NIO region. It has nested domain of 18 km and 2 km horizontal resolution and 42 vertical levels with outer domain covering the area of 800x800 and inner domain 60x60 with centre of the system adjusted to the centre of the observed cyclone. The model has special features such as vortex initialization, coupling with Ocean model to take into account the changes in SST during the model integration, tracker and diagnostic software to provide the graphic and text information on track and intensity prediction for real-time operational requirement. The model is run on real time twice a day based on 00, 06, 12 and 18 UTC initial conditions to provide 6 hourly track and intensity forecasts valid up to 120 hours. The model uses IMD GFS-T1534 analysis/forecast as first guess.

IMD is also working in collaboration with INCOIS, Hyderabad which is running the Ocean Models (POM)/Hybrid co-ordinate ocean model (HYCOM) to support in porting the Ocean Model with Indian Ocean climatology and real time data of SST over Indian Seas.

- **Other Models**

IMD also makes use of NWP products prepared by some other operational NWP Centres like, European Centre for Medium Range Weather Forecasting (ECMWF), GFS-USA, GFS-NCMRWF, Japan Meteorological Agency (JMA), United Kingdom Meteorological Office (UKMO), Global Tropical model, Meteo-France etc.

3.3.3.2. Multi-model ensemble (MME)

The MME technique (Kotal and Roy Bhowmik, 2011) is based on a statistical linear regression approach. The predictors selected for the ensemble technique are forecasts latitude and longitude positions at 12-hour interval up to 120-hour of five operational NWP models. The 12 hourly predicted cyclone tracks are then determined from the respective mean sea level pressure fields using a cyclone tracking software. A collective bias correction is applied in the MME by applying multiple linear regression based minimization principle for the member models WRF (ARW), QLM, GFS (IMD), GFS (NCEP), ECMWF and JMA (Fig.9). There is also facility in cyclone module of forecasters' work station to develop MME using equal weightage to individual model tracks available in cyclone module.

3.3.3.3. Ensemble prediction system (EPS)

As part of WMO Program to provide a guidance on cyclone forecasts in near real-time for the ESCAP/WMO Member Countries, IMD implemented JMA supported software for real-time forecast over NIO during 2011. The Ensemble and deterministic forecast products from ECMWF (50+1 Members), NCEP (20+1 Members), UKMO (23+1 Members) and MSC (20+1 Members) and JMA (20+1 Members) are available near real-time for NIO region. These Products includes: Deterministic and ensemble track forecasts, strike probability maps and strike probability of cities within the range of 120 kms 4 days in advance. The super-ensemble has also been developed based on above ensembles.

In India, NCMRWF runs the Global ensemble forecasting system (GEFS) configuration consisting of four cycles corresponding to 00Z, 06Z, 12Z 18Z and 10-day forecasts are made using the 00 UTC initial condition. A T190L28 control that is started with T574L64 analysis is run out to 10 days with 20 perturbed forecasts. The ensemble spread is a measure of the difference between the members and is represented by the standard deviation with respect to the ensemble mean. On average, small (high) spread indicates a high (low) forecast accuracy. The ensemble spread is flow-dependent and varies for different parameters. It usually increases with the forecast range, but there can be cases when the spread is larger at shorter forecast ranges than at longer.

3.3.3.4. Statistical Dynamical model for Cyclone genesis and Intensity Prediction

A genesis potential parameter (GPP), for the NIO has been developed (Kotal et al, 2013) as the product of four variables, namely vorticity at 850 hPa, middle tropospheric relative humidity, middle tropospheric instability, and the inverse of vertical wind shear. The GPP is operationally used for predicting cyclogenesis at their early development stages. The grid point analysis and forecast of the genesis parameter up to seven days are generated on real time. Region with GPP value equal or greater than 30 is found to be high potential zone for cyclogenesis.

A statistical-dynamical model (SCIP) (Kotal et al, 2008) has been implemented for real time forecasting of 12 hourly intensity upto 72 hours. The model parameters are derived based on model analysis fields of past cyclones. The parameters selected as predictors are Initial

storm intensity, intensity changes during past 12 hours, storm motion speed, initial storm latitude position, vertical wind shear averaged along the storm track, vorticity at 850 hPa, divergence at 200 hPa and SST. For the real-time forecasting, model parameters are derived based on the forecast fields of IMD GFS model.

3.3.3.5. Rapid Intensification (RI) Index

A rapid intensification index (RII) is developed for tropical cyclones over the Bay of Bengal (Kotal and Roy Bhowmik, 2013). The RII uses large-scale characteristics of tropical cyclones to estimate the probability of rapid intensification (RI) over the subsequent 24-h. The RI is defined as an increase of intensity 30 kt (15.4 ms^{-1}) during 24-h. The RII technique is developed by combining threshold (index) values of the eight variables for which statistically significant differences are found between the RI and non-RI cases. The variables are: Storm latitude position, previous 12-h intensity change, initial storm intensity, vorticity at 850 hPa, divergence at 200 hPa, vertical wind shear, lower tropospheric relative humidity, and storm motion speed. The probability of RI is found to increase from 0% to 100% when the total number of indices satisfied increases from zero to eight. The forecasts are made available in real time from 2013.

3.3.3.6. Decay of Intensity after the landfall

Tropical cyclones (TCs) are well known for their destructive potential and impact on human activities. The Super cyclone Orissa (1999) illustrated the need for the accurate prediction of inland effects of tropical cyclones. The super cyclone of Orissa maintained the intensity of cyclonic storm for about 30 hours after landfall. Because a dense population resides at or near the Indian coasts, the decay forecast has direct relevance to daily activities over a coastal zone (such as transportation, tourism, fishing, etc.) apart from disaster management. In view of this, the decay model (Roy Bhowmik et al. 2005) has been used for real time forecasting of decaying intensity (after landfall) of TCs.

3.3.4. Tropical Cyclone Module:

The Tropical Cyclone Module (TCM) installed in the SYNERGIE forecasting system has the facilities to serve the above purpose. The automation of the process has increased the efficiency of system, visibility of IMD and utility of warning products.
The TCM installed in this forecasting system has the following facilities.

- Analysis of all synoptic, satellite, radar and NWP model products for genesis, intensity and track monitoring and prediction
- Preparation of past and forecast tracks upto 120 hrs.
- Depiction of uncertainty in track forecast
- Structure forecasting (Forecast of wind in four geographical quadrants of cyclone)
- However all the data are not still available in TCM through Synergie. For better monitoring and prediction, additional help of ftp and websites is taken.

3.4. Daily Bulletin and IOP:

Daily bulletins were prepared based on the observations of 0300 UTC from 15th October to 20th December. Based on the consensus forecast, 25 days of IOP were declared during the period. The daily bulletins are placed at Appendix-I.

CHAPTER-IV

CYCLONIC ACTIVITIES OVER THE BAY OF BENGAL DURING FDP - 2016

4.1. Introduction

There were 5 cyclonic disturbances (depressions and cyclones) over the north Indian Ocean (NIO) and adjoining land regions during post monsoon season 2016 against the long period average (LPA) of 4.3 disturbances per year based on data of 1961-2015. Out of 5 CDs, 3 intensified into tropical cyclones against the normal frequency of 2.5 cyclones per year over north Indian Ocean (NIO) based on LPA for post monsoon season. It included 2 cyclonic storms (CS) and one very severe cyclonic storm (VSCS). These cyclones are:

a. ***Cyclonic storm, Kyant over Bay of Bengal (21-28 October)***
b. ***Cyclonic storm, Nada over the Bay of Bengal (29 November-02 December)***
c. ***Very severe cyclonic storm, Vardah (06-13 December)***

The salient features of cyclonic disturbances during FDP-2016 are as follows

- The cyclonic activity over the NIO was above normal during post-monsoon season, 2016. with the formation of 3 cyclones during the season against LPA of 2.5 cyclones over the NIO. The Arabian Sea activity was subdued, as there was only one depression in December with a life period of less than 48 hrs.
- All the cyclones had recurving tracks.
- The Cyclonic Storm (CS) Kyant developed on 21st October with the formation of a depression (D) over eastcentral Bay of Bengal (BOB). Initially, it moved east-northeastwards towards Myanmar coast and steadily intensified into a deep depression (DD) on 23rd morning. Thereafter, it changed its direction of movement and recurved west-northwestwards. It intensified into a CS in the morning of 25th over eastcentral BOB. Thereafter, it again changed its direction of movement and moved west-southwestwards towards westcentral BOB off Andhra Pradesh coast. It maintained its intensity till midnight of 26th and thereafter weakened gradually becoming DD in the early hours 27th and D in the same evening. It weakened into a well marked low pressure area over westcentral BOB off Andhra Pradesh coast in the morning of 28th.
- CS Nada formed from a depression formed over southeast BOB in the evening of 29th November. It moved initially northwestwards and intensified gradually into cyclonic storm (CS) “Nada” over southeast BoB in the morning of 30th. It maintained its intensity till the evening of 1st December while moving west-northwestwards. It weakened into a deep depression (DD) in the noon of 1st December and further into a depression in the same midnight. Continuing to move west-northwestwards, it crossed north Tamil Nadu coast near Nagapattinam (about 20 km south of Karaikal) during 0400-0500 hours IST of 2nd December. Continuing to move westwards, it further weakened into a well marked low pressure area over interior Tamil Nadu in the forenoon of 02nd Dec. 2016.
- The last cyclone, Vardah developed from a depression (D) over southeast Bay of Bengal (BOB) in the afternoon of 6th December. Moving northwestwards initially and northwards thereafter, it intensified into a deep depression (DD) in the midnight of 7th December, into a cyclonic storm (CS) “**VARDAH**” in the morning of 8th and into a severe cyclonic storm (SCS) in the midnight of 9th. It then moved west-northwestwards and intensified further into a very severe cyclonic storm (VSCS) over westcentral and adjoining south BOB in the evening of 10th December. It then moved nearly westwards and reached its peak intensity of about 130 kmph on 11th December evening and maintained the same intensity till noon of 12th December. It weakened into an SCS and crossed north Tamil Nadu coast near

Chennai during 1500-1700 hrs IST of 12th December 2016 with a wind speed of 100-110 kmph gusting to 120 kmph. After the landfall, the SCS moved west-southwestwards and weakened into a CS in the evening, into a DD in the midnight of 12th and into D in the early morning of 13th. Continuing its west-southwestwards movement, it weakened into a well marked low pressure area in the forenoon of 13th December.

- Thus there was only one landfalling cyclone (Vardah) over the BOB during post-monsoon season, 2016 against normal of 1.5 such cyclones per year based on long period average based on 1961-2015 during post monsoon season.
- Only one cyclone (Vardah) crossed India coast against the normal of about 1.1 such cyclones per year crossing Indian coast during post monsoon season.

The tracks of these disturbances are presented in Fig. 4.1.

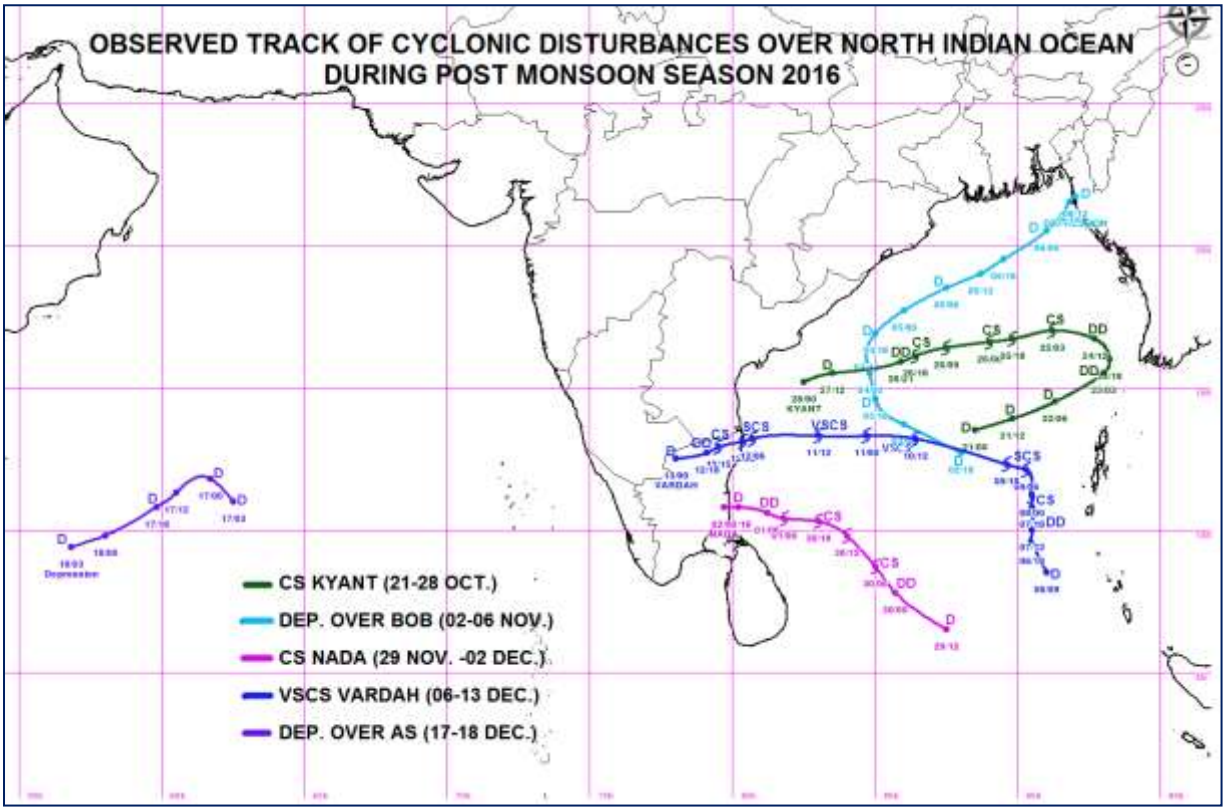


Figure 4.1: Tracks of cyclonic disturbances during post monsoon season 2016

Table 4.1: Brief statistics of cyclonic disturbances over NIO during post-monsoon season, 2016:

1.	Cyclonic Storm, KYANT, over Bay of Bengal (21 – 28 Oct 2016)
2.	Depression over Bay of Bengal (02-06 Nov, 2016)
3.	Cyclonic Storm, NADA, over Bay of Bengal (29 Nov- 02 Dec 2016)
4.	Very Severe Cyclonic Storm, VARDAH, over Bay of Bengal (06 – 13 Dec, 2016)
5.	Depression over Arabian Sea (17-18 Dec, 2016)

Table 4.2: Some Characteristic features of cyclonic disturbances formed over north Indian Ocean and adjoining region during 2016

S. No.	Cyclonic storm/ Depression	Date, Time& Place of genesis (Lat. N/long E)	Date, Time (UTC) Place (Lat./Long.) of Landfall	Estimated lowest central pressure, Time & Date (UTC) & Lat°N/long°E	Estimated Maximum wind speed (kt), Date & Time	Max T. No. Attained
1.	Cyclonic Storm, KYANT Over bay of Bengal (21st Oct – 27th Oct, 2016)	26th Oct 2016, 0000 UTC over eastcentral Bay of Bengal (13.5/88.5).	Weakened into a well-marked low pressure area over west central Bay of Bengal off Andhra Pradesh coast on 28th morning.	988 hPa at 0300 UTC on 25th Oct 2016 near (17.0/91.2)	40 knots at 0300 UTC on 25th Oct 2016	T 2.5
2.	Depression over the Bay of Bengal (2nd – 6th Nov. 2016)	2nd Nov 2016 at 1800 UTC over central and adjoining southeast Bay of Bengal (12.7/88.0).	Weakened into a well marked low pressure area over southeast Bangladesh & adjoining northeast Bay of Bengal and lay as a low pressure area over southeast Bangladesh and neighbourhood on 7thmorning.	996 hPa at 1800 UTC on 2nd Nov 2016 (12.7/88.0)	25 knots at 1800 UTC on 2nd Nov 2016.	T1.5
3.	Cyclonic Storm “Nada” over the Bay of Bengal (29th Nov. – 2nd Dec. 2016)	29th Nov 2016, 1200 UTC over southeast Bay of Bengal (6.5/87.5)	weakened into a well marked low pressure area over interior Tamil Nadu & neighbourhood on 2nd.	988 hPa at 0300 UTC 30th Nov, 2016 near (8.2/85.3)	40 knots at 0300 UTC 30th Nov, 2016	T 2.5

4.	Very Severe Cyclonic Storm 'VARDAH ' over the Bay of Bengal (6^{th} -13^{th} Dec. 2016).	06^{th} Dec 2016, 0900 UTC over southeast Bay of Bengal (8.5/91.0)	weakened into a Well marked low pressure area over north interior Tamil Nadu and adjoining south interior Karnataka at 0300 UTC of 13^{th} Dec 2016.	984 hPa at 1200 UTC 10^{th} Dec 2016 near (13.2/86.4)	65 knots at 1200 UTC 10^{th} Dec 2016	T 4.5
5.	Depression over Arabian sea (17-18 Dec 2016)	17^{th} Dec 2016 at 0300 UTC over southwest Arabian Sea near (11.0/62.5).	weakened into a well marked low pressure area over southwest Arabian Sea in the forenoon of 18^{th} Dec 2016	994 hPa at 0300 UTC 18^{th} Dec, 2016 near (9.4/56.8)	25 knots at 0300 UTC 17th Dec 2016.	T 1.5

4.1.1. Cyclonic storm 'KYANT' over the Bay of Bengal (21^{st} -27^{th} October 2016)

4.1.1.1 Introduction

The Cyclonic Storm (CS) Kyant developed on 21^{st} October with the formation of a depression (D) over eastcentral BoB (BOB). Initially, it moved east-northeastwards towards Myanmar coast and steadily intensified into a deep depression (DD) on 23^{rd} morning. Thereafter, it changed its direction of movement and recurved west-northwestwards. It intensified into a CS in the morning of 25^{th} over eastcentral BOB. Thereafter, it again changed its direction of movement and moved west-southwestwards towards westcentral BOB off Andhra Pradesh coast. It maintained its intensity till midnight of 26^{th} and thereafter weakened gradually becoming DD in the early hours 27^{th} and D in the same evening. It weakened into a well marked low pressure area over westcentral BOB off Andhra Pradesh coast in the morning of 28^{th}.

Unique/salient features of the system were:

- The track followed by the system was rare in nature as it experienced two recurvatures during its life period. First recurvature occurred in the evening of 23^{rd} before the intensification of system into CS and the other occurred in the afternoon of 25^{th} during the weakening phase.
- The recurvature was anticlockwise against the normal clockwise recurvature over the BOB. The last such recurvature over the BOB occurred in case of VSCS Madi (December, 2013).
- It was one of the longest track in recent years with life period of 7 days.
- While the rate of intensification was slow and steady taking about 4 days to become CS from the stage of depression, the rate of weakening was rapid as it reduced to a well marked low pressure area from the CS stage within 30 hours.

- ❖ The system weakened over the sea due to entrainment of dry and cold air from northwest India in association with anticyclonic circulation lying to the northwest of the system centre in middle and upper troposphere. The weakening occurred inspite of favourable (low-moderate) vertical wind shear over the storm region.
- ❖ The cyclone was monitored & predicted continuously since its inception by India Meteorological Department (IMD). At the genesis stage, the system was monitored mainly with satellite observations. Various national and international NWP models and dynamical-statistical models were utilized to predict the genesis, track and intensity of the cyclone. Tropical Cyclone Module, the digitized forecasting system of IMD was utilized for analysis and comparison of various models guidance, decision making process and warning product generation.
- ❖ Though the system was moving towards Myanmar, no landfall over Myanmar was predicted by IMD.
- ❖ No Cyclone Alert/Warning was issued for any coastal state of India.

4.1.1.2. Brief life history

4.1.1.2.1. Genesis

A low pressure area formed over East-central BoB and neighbourhood at 0300 UTC on 19th October. It became .well marked low pressure are over eastcentral BoB and adjoining southeast BoB at 0300 UTC on 20th. It concentrated into a Depression at 0000 UTC on 21st over central and adjoining southeast BoB near latitude 13.5^{0}N and longitude 88.5^{0}E. The best track parameters associated with the system are presented in Table 4.3 and the best track is presented in Fig.4.1.

Table 4.3 Best track positions and other parameters of the Cyclonic Storm, 'KYANT' over the BoB during 21-28 October, 2016

Date	Time (UTC)	Centre lat.^{0} N/ long.^{0} E	C.I. No.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
21st Oct.	0000	13.5/88.5	1.5	996	20	4	**D**
	0300	13.5/88.5	1.5	996	20	4	D
	0600	13.7/89.3	1.5	996	20	4	D
	1200	13.9/89.8	1.5	996	20	4	D
	1800	13.9/89.8	1.5	996	20	4	D
22nd Oct.	0000	13.9/90.0	1.5	996	20	4	D
	0300	14.0/90.5	1.5	996	20	4	D
	0600	14.5/91.3	1.5	996	20	4	D
	1200	14.9/92.0	1.5	996	20	4	D
	1800	15.2/92.5	1.5	996	20	4	D
23rd Oct.	0000	15.5/93.0	1.5	996	20	4	D
	0300	15.5/93.0	2.0	994	30	5	**DD**
	0600	15.5/93.0	2.0	994	30	5	DD
	1200	15.5/93.0	2.0	994	30	5	DD
	1800	16.0/93.2	2.0	994	30	5	DD
24th	0000	16.4/93.2	2.0	994	30	5	DD

Oct.	0300	16.4/93.2	2.0	994	30	5	DD
	0600	16.5/93.2	2.0	994	30	5	DD
	0900	16.6/92.7	2.0	994	30	5	DD
	1200	16.7/92.7	2.0	994	30	5	DD
	1800	16.8/92.3	2.0	994	30	5	DD
25th Oct.	0000	16.9/91.7	2.0	990	30	5	DD
	0300	17.0/91.2	2.5	988	40	8	**CS**
	0600	17.1/91.9	2.5	988	40	8	CS
	0900	16.8/90.5	2.5	988	40	8	CS
	1200	16.8/90.5	2.5	988	40	8	CS
	1500	16.7/90.2	2.5	988	40	8	CS
	1800	16.6/89.8	2.5	988	40	8	CS
	2100	16.5/89.6	2.5	988	40	8	CS
26th Oct.	0000	16.6/89.0	2.5	988	40	8	CS
	0300	16.6/88.5	2.5	988	40	8	CS
	0600	16.5/88.0	2.5	988	40	8	CS
	0900	16.3/87.5	2.5	988	40	8	CS
	1200	16.3/87.0	2.5	988	40	8	CS
	1500	15.9/86.9	2.0	988	40	8	CS
	2100	15.9/85.9	2.0	994	35	7	**DD**
27th Oct.	0000	15.7/85.5	2.0	994	35	7	DD
	0300	15.3/85.1	2.0	994	35	7	DD
	0600	15.5/84.5	2.0	994	35	7	DD
	0900	15.3/84.5	2.0	998	35	7	DD
	1200	15.5/83.5	2.0	998	35	5	**D**
	1800	15.3/83.0	2.0	998	35	5	D
	Weakened into a well-marked low pressure area over west central Bay of Bengal off Andhra Pradesh coast on 28th morning.						

4.1.1.2.2. Intensification and Movement

Initially, it moved east-northeastwards towards Myanmar coast and steadily intensified into a deep depression (DD) on 23rd morning and lay centered at 0300 UTC of 23rd October over eastcentral BoB near latitude 15.5^{0}N and longitude 93.0^{0}E. It remained practically stationary at 1200 UTC of 23rd. It then recurved gradually in anti-clockwise direction and lay centered at 0300 UTC of 24th over eastcentral BoB near latitude 16.4^{0}N and longitude 93.2^{0}E. It then moved west-northwestwards and lay centered at 1200 UTC of 24th October near latitude 16.7^{0}N and longitude 92.7^{0}E. It further moved west-northwestwards and intensified into a Cyclonic Storm 'KYANT' and lay centered at 0300 UTC of 25th near latitude 17.0^{0}N and latitude 91.2^{0}E. It again recurved, moved west-southwestwards and lay centered at 1200 UTC of 25th over eastcentral BoB near latitude 16.8^{0}N and longitude 90.5^{0}E. It moved further west-southwestwards weakened into a DD and lay centered at 0000 UTC of 27th over westcentral BoB near latitude 15.7^{0}N and longitude 85.5^{0}E about 400 km south of Gopalpur. It moved further west-southwestwards and weakened into a Depression and lay centered at 1200 UTC of 27th over westcentral BoB near latitude 15.5^{0}N and longitude 83.5^{0}E. Continuing to move west-southwestwards, it weakened into a well marked low pressure area over westcentral BoB off Andhra Pradesh coast at 0000 UTC of 28th October. The total perceptible water imageries (TPW) during 21st to 27th October 2016 are presented in Fig. 4.2. It indicates that due to cross equatorial, flow warm and moist air continued to converge around the system centre till 25th. On

26th, it gradually decreased and it further decreased on 27th as the system moved west-southwestwards and came under the influence of the dry air incursion from the northwest in association with the anticyclone to the northwest of the system centre leading to weakening of the system over westcentral BoB.

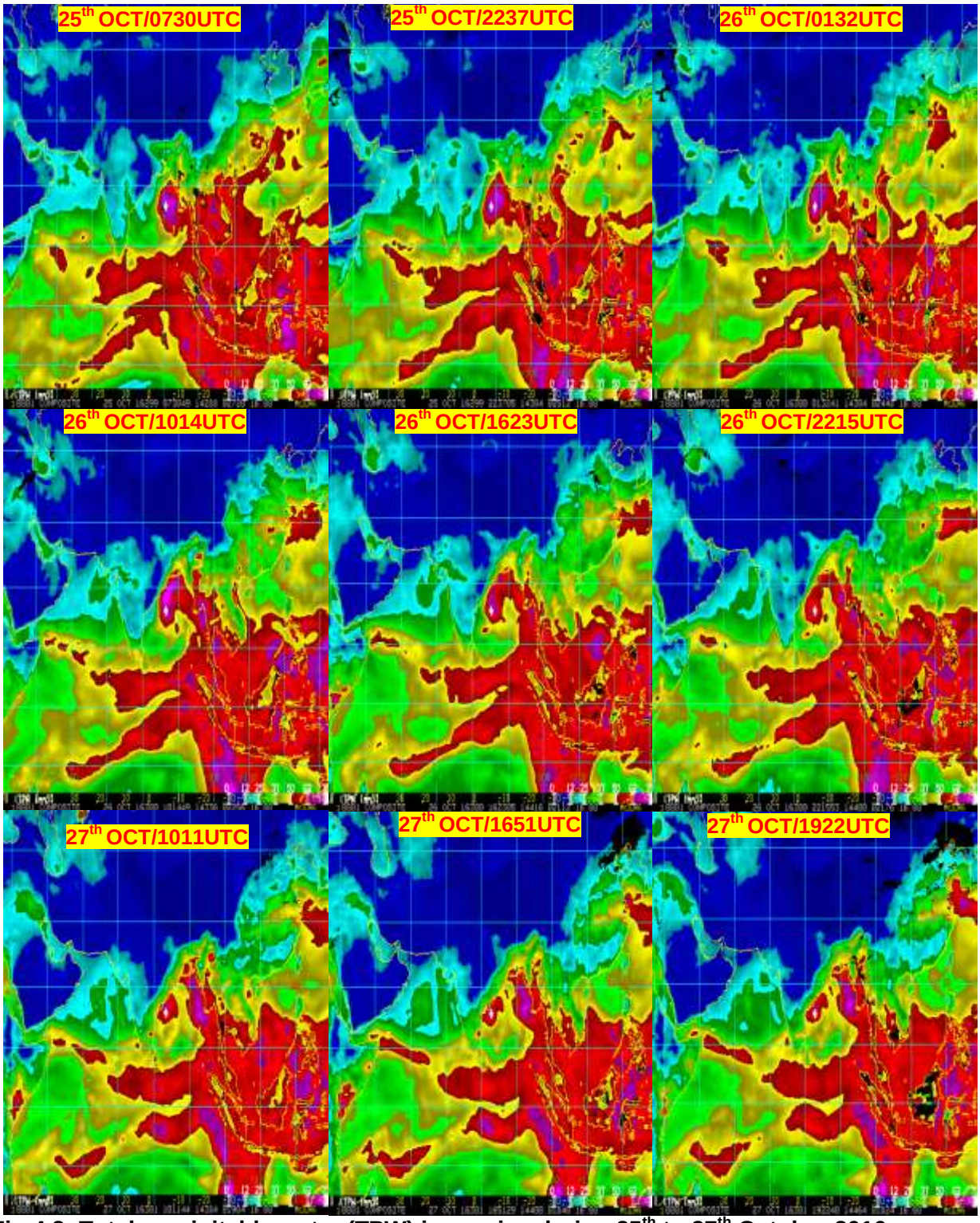


Fig.4.2: Total precipitable water (TPW) imageries during 25th to 27th October 2016

12 hourly translational speed and direction of movement is presented in Fig.4.3.

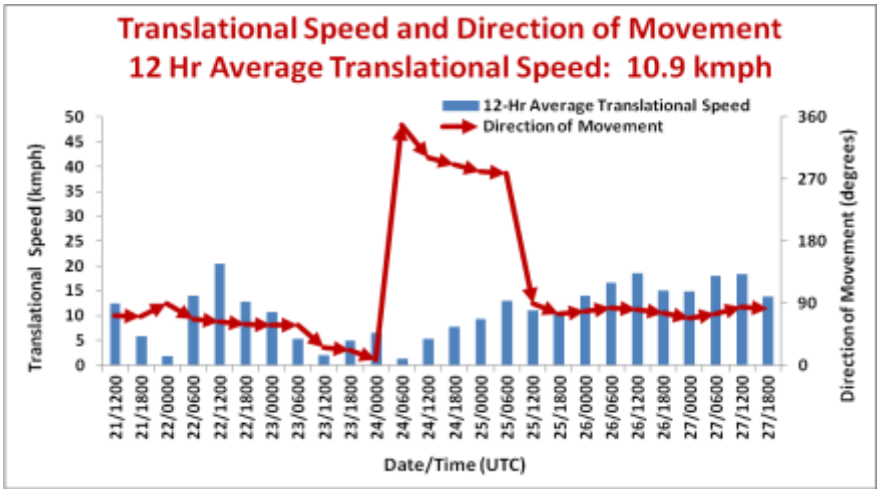


Fig.4.3 Twelve hourly average translational speed (kmph) and direction of movement in association with CS Kyant

It indicates that the system followed a rare track. It experienced two recurvatures during its life period. Initially it moved northeastwards to east-northeastwards till 1800 UTC of 23rd. It experienced northwards recurvature from the evening of 23rd before the intensification of system into CS. From 0600 UTC of 24th, it moved west-northwestwards. It again experienced recurvature in track from 0600 UTC of 25th and moved southwestwards during the weakening phase.

The Wind shear and wind speed in the middle and deep layer around the system during 24th to 30th October, 2016 are presented in Fig. 4.4.

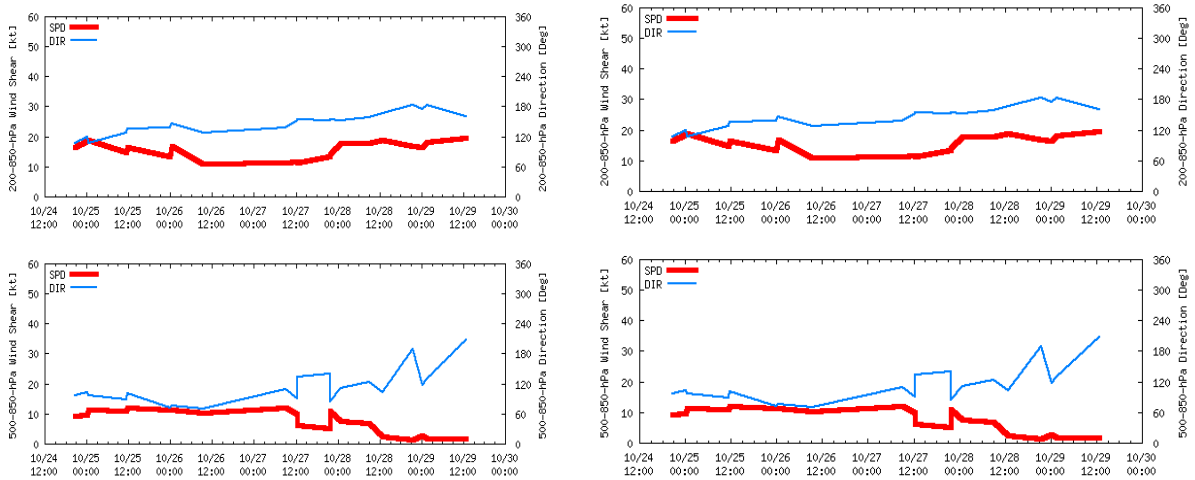


Fig.4.4: Wind shear and wind speed in the middle and deep layer around the system during 24th to 30th October, 2016.

4.1.1.2.3. Maximum Sustained Surface Wind speed and estimated central pressure:

The lowest estimated central pressure and the maximum sustained wind speed are presented in Fig.4.5. The lowest estimated central pressure was 996 hPa. The estimated maximum sustained surface wind speed (MSW) was 40 knots during 0000 UTC of 26th to 1500 UTC of 26th October. The system weakened over the sea due to entrainment of dry and cold air from northwest India in association with anticyclonic circulation lying to the northwest of the system centre in middle and upper troposphere. The weakening occurred inspite of favourable (low-moderate) vertical wind shear over the storm region. There was no rapid intensification of

the system as it intensified from depression to cyclonic storm in about 96 hours. However, it weakened rapidly from CS to well marked low pressure area in 30 hours.

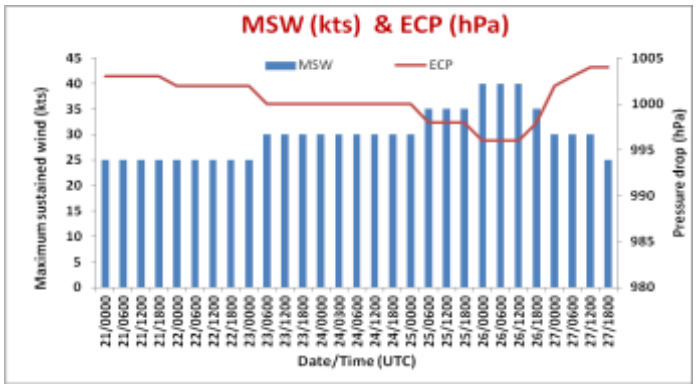


Fig.4.5 Lowest estimated central pressure and the maximum sustained wind speed

4.1.1.2.4. Structure

Sectorwise wind distribution around the system centre is presented in Fig.4.6. It depicts that maximum winds were observed in northwest and northeast sector. Sectorwise wind distribution of CS Kyant also indicates that the size increased gradually becoming maximum on 26th forenoon. The system maintained its size till the evening of 26th and then it decreased sharply from 26th midnight.

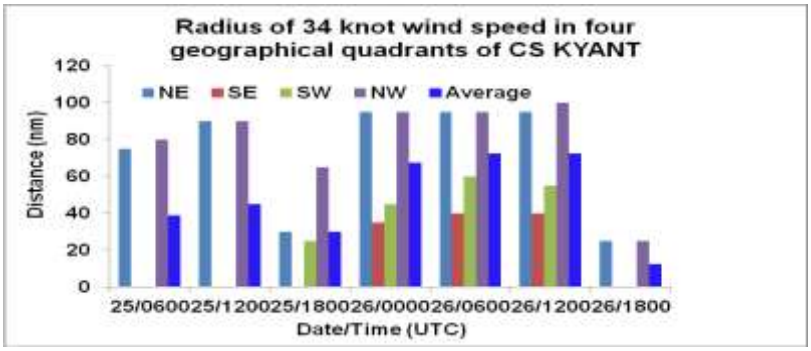


Fig.4.6: (a) Sectorwise wind distribution of CS, Kyant.

4.1.1.2.5. Climatological aspects

Considering the area of genesis (+/- 2^0 around the genesis point), the cliamtological tracks of the TCs during 1891-2015 are presented in Fig.4.7. It indicates that climatologically, about one third of the cyclonic disturbances developing over this region moved westwards/northwestwards and crossed Andhra Pradesh/ north Tamil Nadu coast whereas two third moved towards Bangladesh/Myanmar coasts.

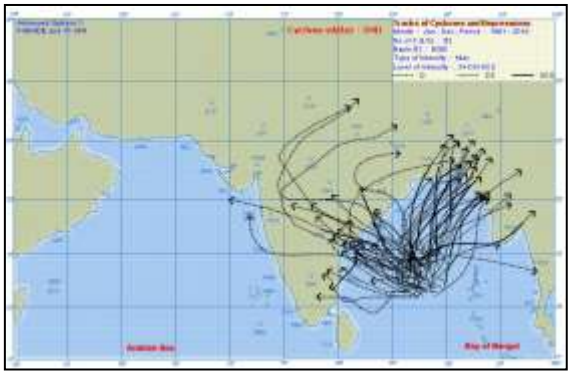


Fig. 4.7 Climatological tracks of TCs forming within +/- 2^0 around the genesis point during 1891-2015.

4.1.1.3. Features observed through Satellite

Satellite monitoring of the system was mainly done by using half hourly Kalpana-1 and INSAT-3D imageries. Satellite imageries of international geostationary satellites Meteosat-7 & MTSAT and microwave & high resolution images of polar orbiting satellites DMSP, NOAA series, TRMM, Metops were also considered for monitoring the system. Typical satellite imageries are presented in Fig. 4.8.

4.1.1.3.1 INSAT-3D features

At 0000 UTC of 21st October, the intensity of the system was T 1.5. Associated broken low and medium clouds embedded with intense to very intense convection lie over central and adjoining south BoB around the system centre. The lowest cloud top temperature (CTT) was about -75^{0}C. At 0300 UTC of 22nd, the convection showed shear pattern. The convective clouds were sheared towards southwest. Intensity of the system was T 1.5. Associated broken low and medium clouds embedded with intense to very intense convection lie over BoB between 12.0^{0}N to 17.0^{0}N and longitude 84.5^{0}E to 90.5^{0}E. The lowest CTT was about -80^0 C. At 0300 UTC of 23rd, the convective clouds were sheared towards west. The intensity of the system was T 2.0. Associated broken low and medium clouds embedded with intense to very intense convection lie over BoB between 12.0^{0}N to 17.0^{0}N and longitude 83.5^{0}E to 92.0^{0}E. The lowest CTT was about -85^0 C.

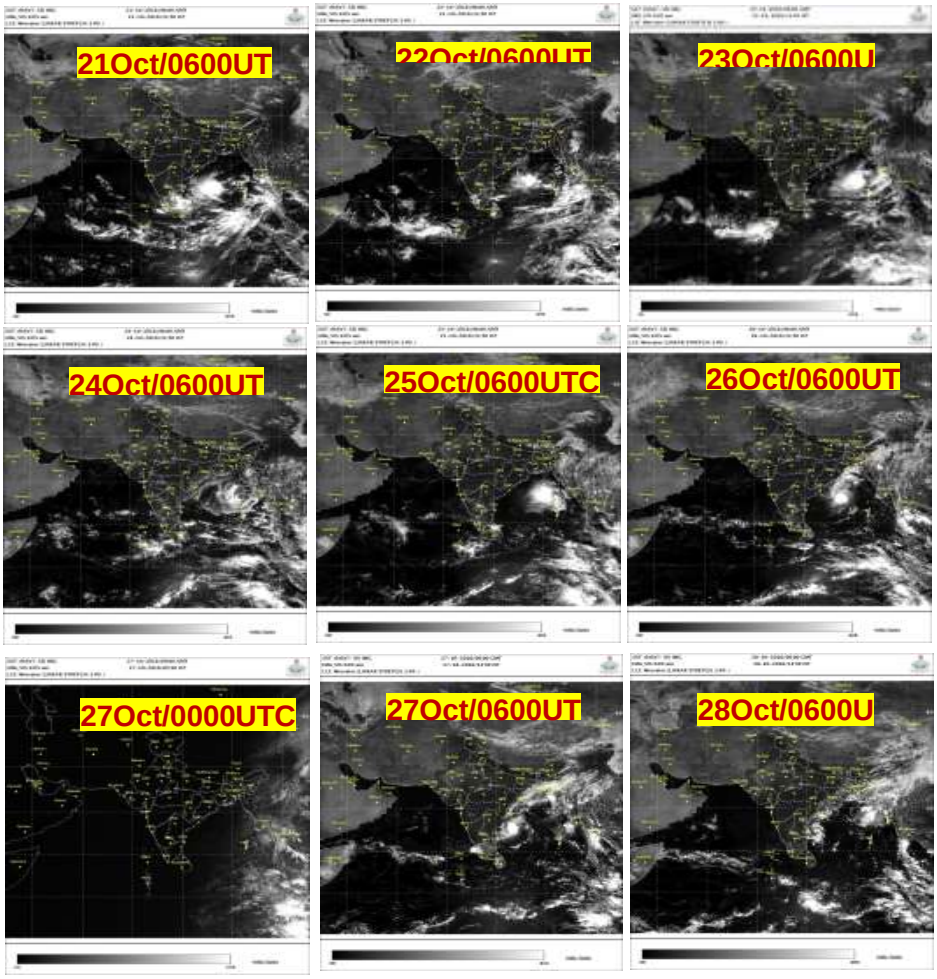


Fig.4.8 (a): INSAT-3D Visible imageries of CS Kyant based on 0600 UTC of 21-28 Oct. 2016

At 0300 UTC of 24th, the convective clouds were sheared towards west. Intensity of the system was T 2.0. Associated broken low/medium clouds with embedded intense to very intense convectioin lie over BoB between latitude 14.0^{0}N to 20.5^{0}N and longitude 86.5^{0}E to 93.0^{0}E and the lowest CTT was about -80^0 C. At 0300 UTC of 25th, the convective clouds were organised in CDO pattern. Intensity of the system was T 2.5. Broken low and medium clouds with embedded intense to very intense convectioin lie over BoB between latitude 13.0^{0}N to 19.8^{0}N and longitude 86.5^{0}E to 94.0^{0}E. The lowest CTT was about -90^0 C. At 0300 UTC of 26th, the convective clouds were organised in CDO pattern. The intensity of the system was T 2.5. Broken low and medium clouds with embedded intense to very intense convectioin lie over BoB between latitude 14.0^{0}N to 20.0^{0}N and longitude 85.0^{0}E to 90.0^{0}E. The lowest cloud top temperature CTT was about -90^0 C.

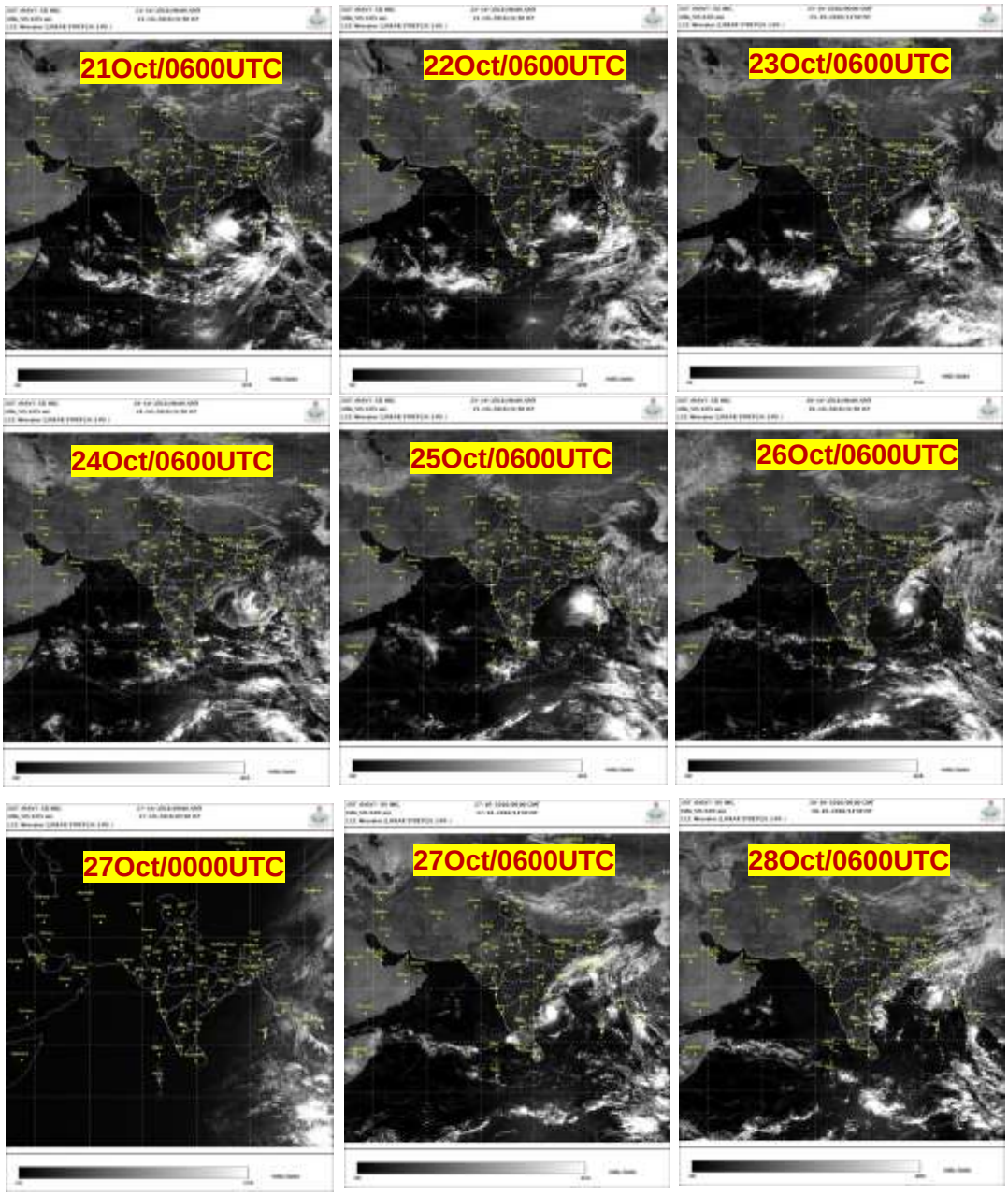


Fig.4.8 (b). INSAT-3D IR imageries of CS, Kyant based on 0600 UTC of 21-28 Oct. 2016

At 1800 UTC of 26th, the intensity of the system was T 2.5. Broken low and medium clouds with embedded moderate to intense convectioin lie over BoB between latitude 13.5^{0}N to 20.0^{0}N and longitude 82.0^{0}E to 88.0^{0}E. The lowest CTT was about -70^0 C. At 2100 UTC of 26th, the intensity of the system was T 2.0. Associated broken low and medium clouds with embedded moderate to intense convectioin lie over BoB between latitude 13.5^{0}N to 19.5^{0}N and west of longitude 87.0^{0}E. The lowest CTT was about -85^0 C. At 0000 UTC of 28th, the intensity of the system was T 1.0 the convection continued to show disorganization and also there was reduction in depth of convection. Scattered low and medium clouds with embedded moderate to intense convectioin lie over BoB between latitude 13.0^{0}N to 16.0^{0}N and longitude 81.0^0 E to longitude 83.5^{0}E. The lowest CTT was about -64^{0}C.

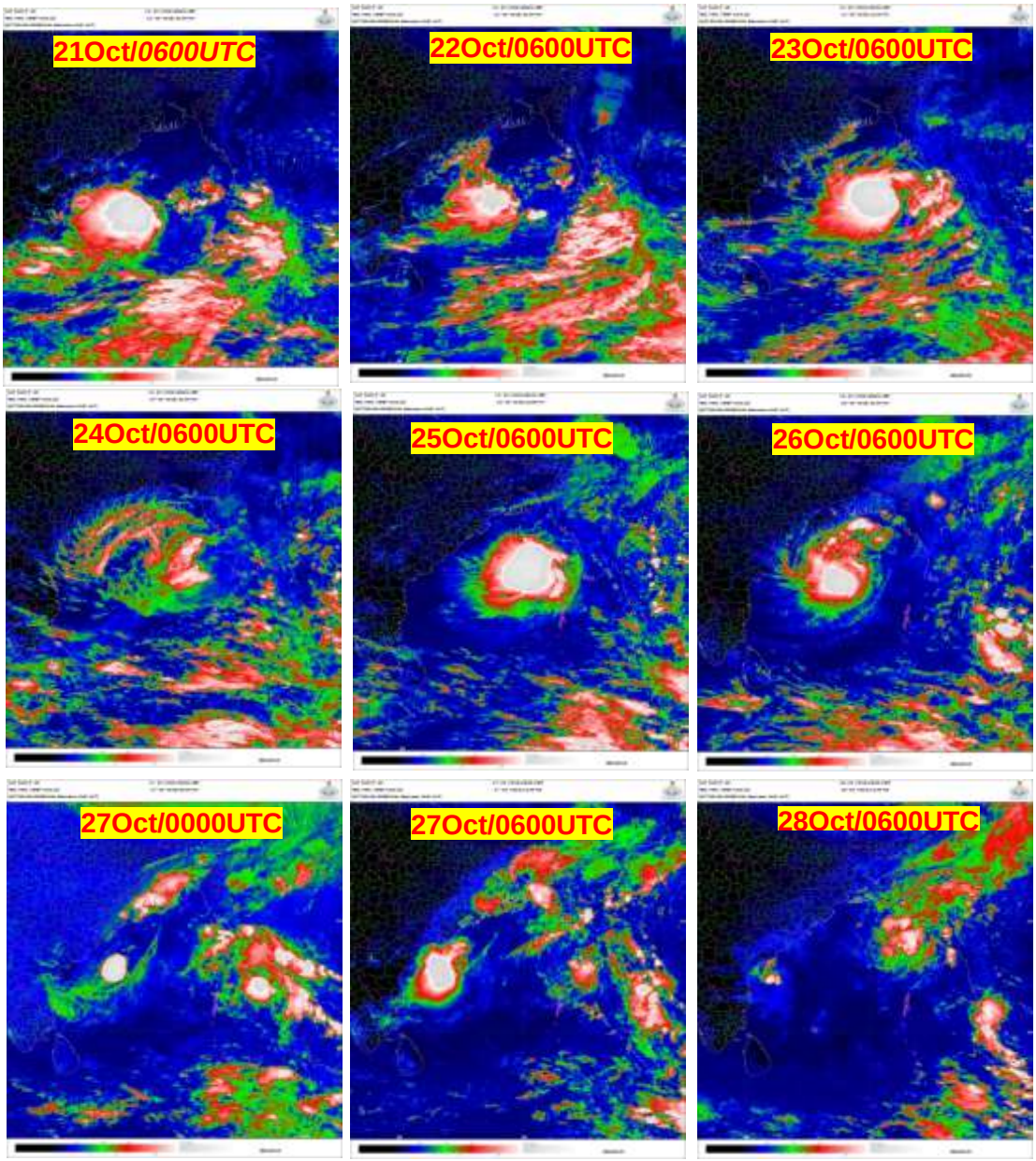


Fig.4.8 (c). Enhanced colored IR imageries of CS, Kyant based on 0600 UTC of 21-28 Oct. 2016

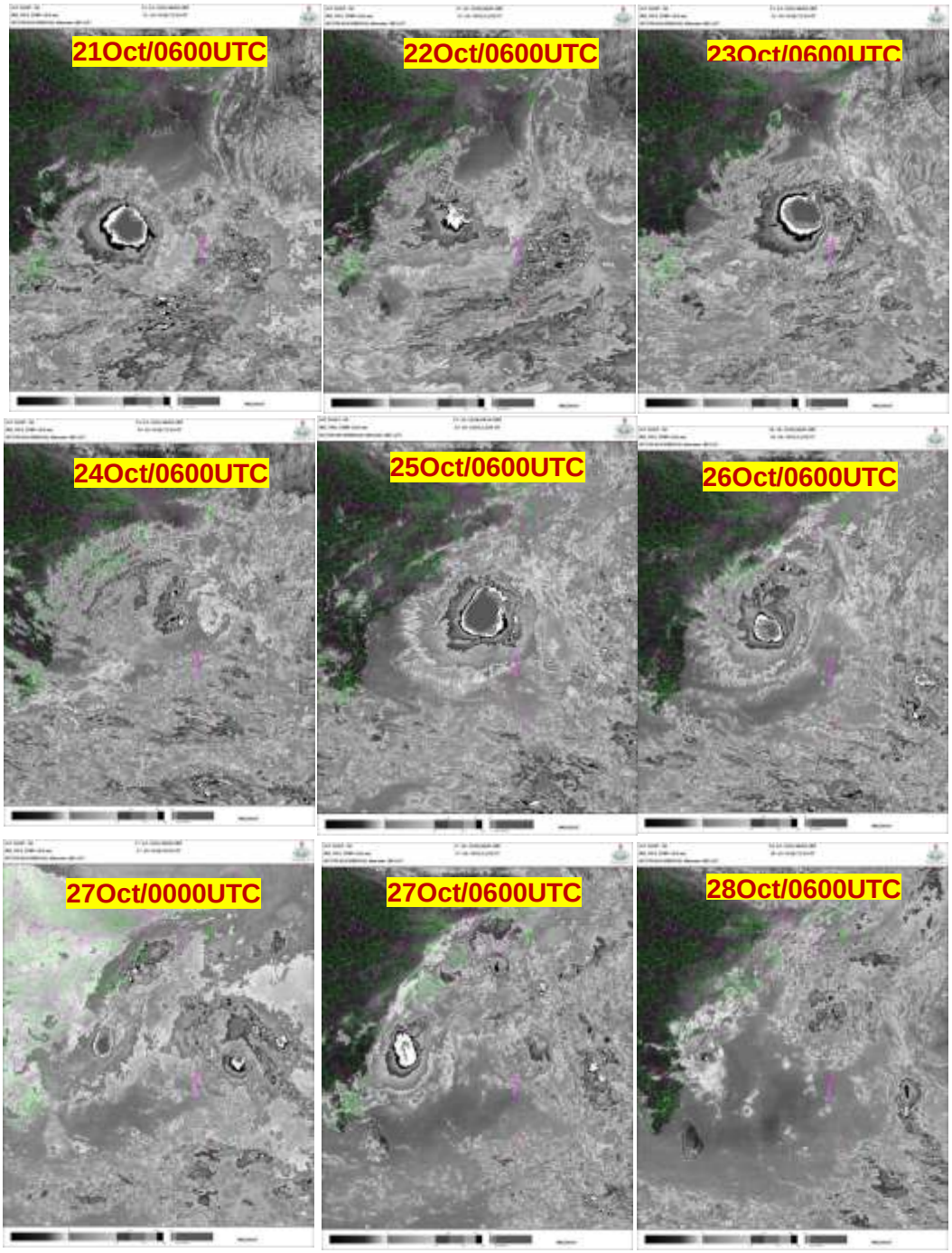


Fig.4.8 (d). Cloud top brightness temperature imageries of CS, Kyant based on 0600 UTC of 21-28 Oct. 2016

4.1.1.3.2 Microwave features

The microwave imageries of the CS Kyant covering its life period from 21st - 28th Oct 2016 are presented in Fig.4.8 (e). These imageries helped in understanding the internal structure of the system and better estimation of location of the system. It could indicate the region of intense convection and hence the rainfall. The microwave imageries indicate that the

convection was concentrated in the southwest sector till morning of 22nd. Thereafter, it shifted to northwest sector with increase in spatial spread from afternoon of 22nd. It got more organised from 23rd October with convection concentrating in southwest and northwest sector. Similar conditions continued till 25th morning. Convection got organised with appearance of curved convective band pattern from 22nd. It gradually became more organized and showed central dense overcast (CDO) pattern on 25th evening. Thereafter, from 26th onwards, the convection started disorganising and the system weakened into a well marked low pressure area in the early morning of 28th October.

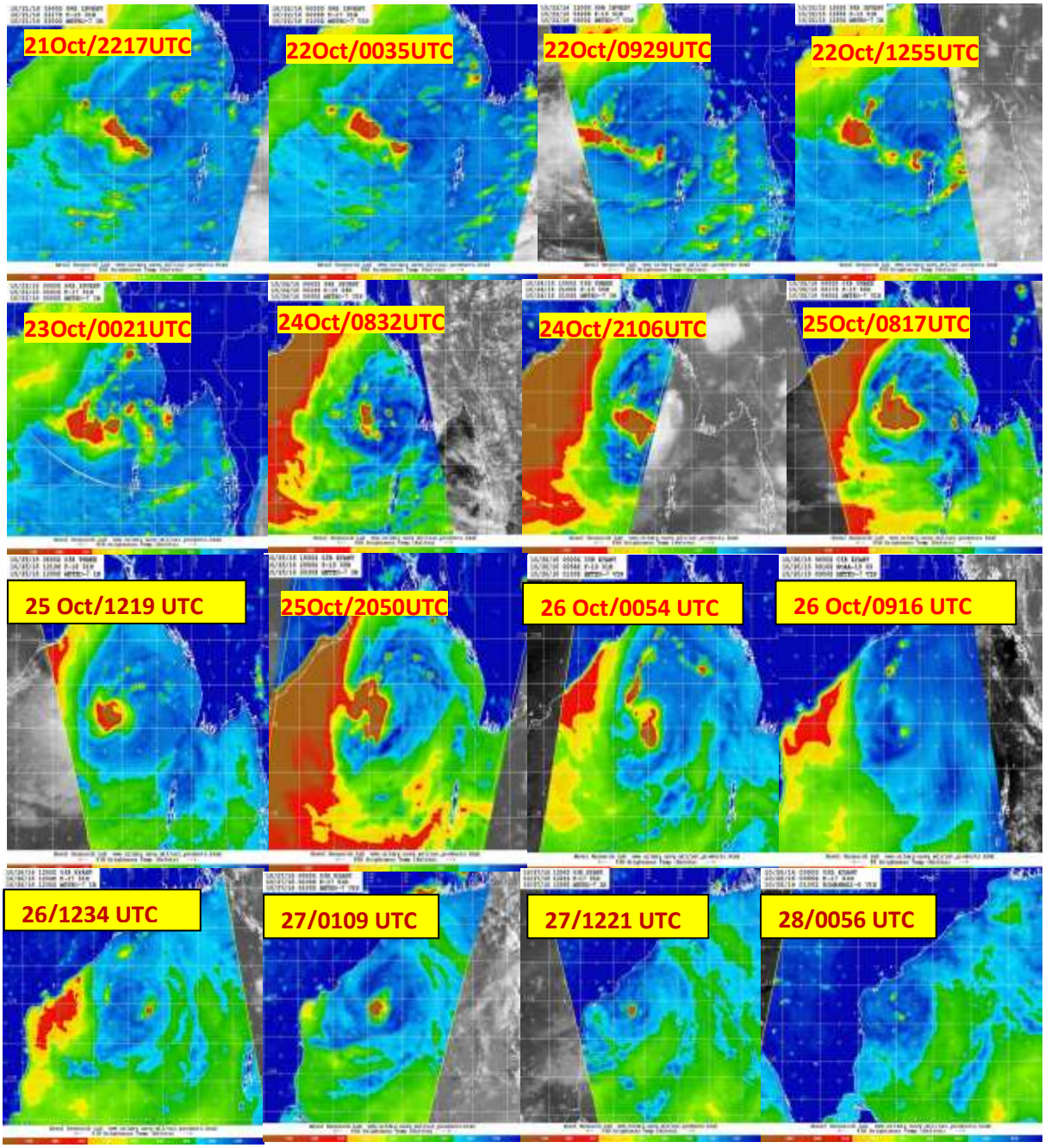


Fig.4.8(e). Microwave imageries of CS, Kyant based during 21st to 28th October

4.1.1.4. Dynamical features

IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels are presented in Fig.4.9. At 0000 UTC of 21st October, the system was centered near 13.5^{0}N/88.5^{0}E. IMD-GFS analysis field of MSLP indicated development of depression over eastcentral BoB near 14.5^{0}N/89.5^{0}E. Winds at 850 hPa levels showed cross equatorial inflow of warm moist air from southeast sector into the system. Winds at 200 hPa levels indicated ridge running along 21.0^{0}N in association with anticyclonic circulation lying to the northeast of system centre. However, the system was steered east-northeastwards under the influence of lower to middle level winds.

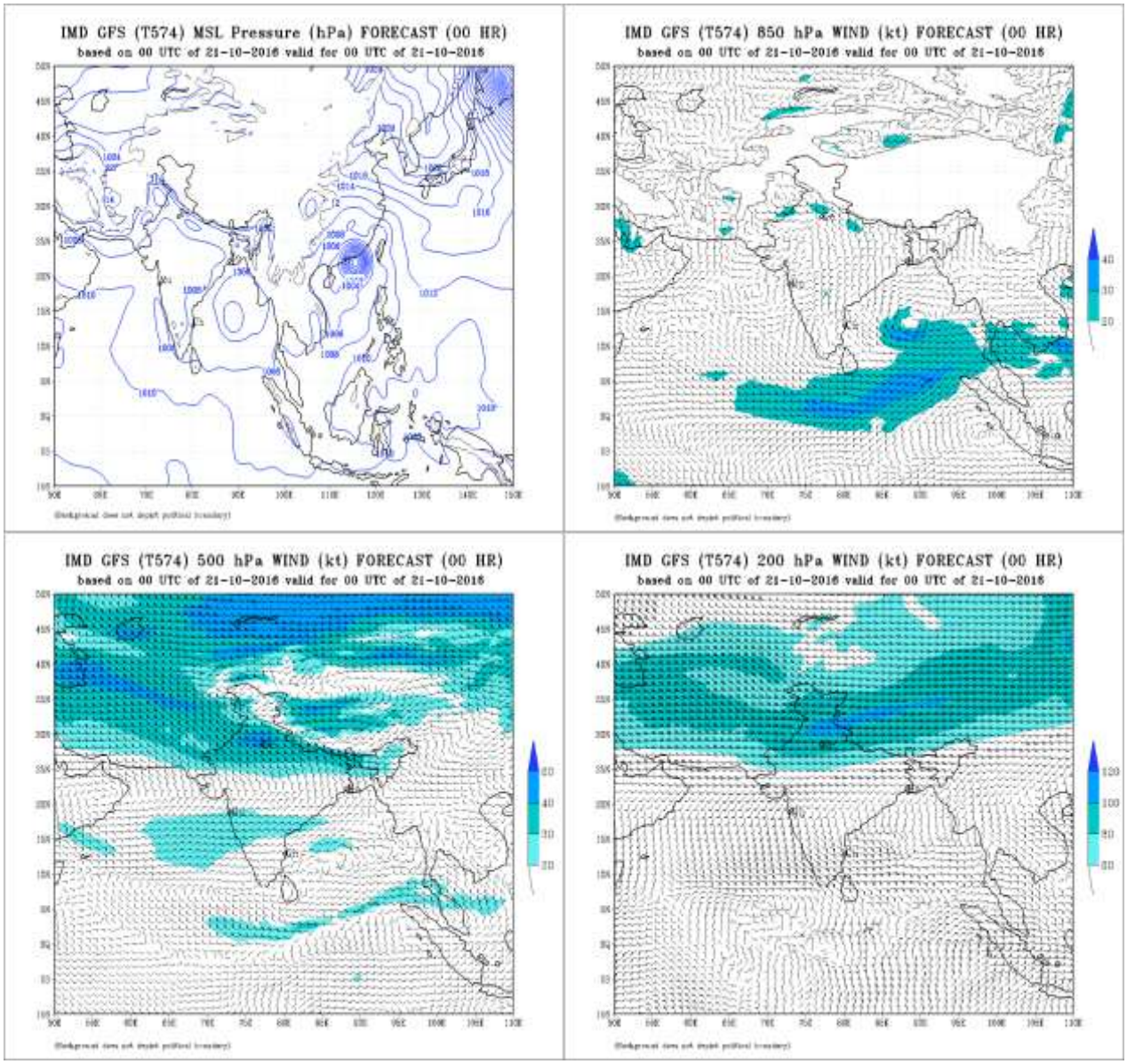


Fig. 4.9 (a): IMD GFS MSLP and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 21st Oct 2016

At 0000 UTC of 22nd October, the system was centered near 13.9^{0}N/90.0^{0}E. IMD-GFS analysis field of MSLP indicated depression over eastcentral BoB near 15.0^{0}N/90.0^{0}E. Winds at 850 hPa levels showed cross equatorial inflow of warm moist air from southeast sector into the system. Winds at 200 hPa levels indicated ridge running along 19.0^{0}N in association with anticyclonic circulation lying to the northeast of system centre. Middle and lower level winds showed steering of system northeastwards towards Myanmar coast.

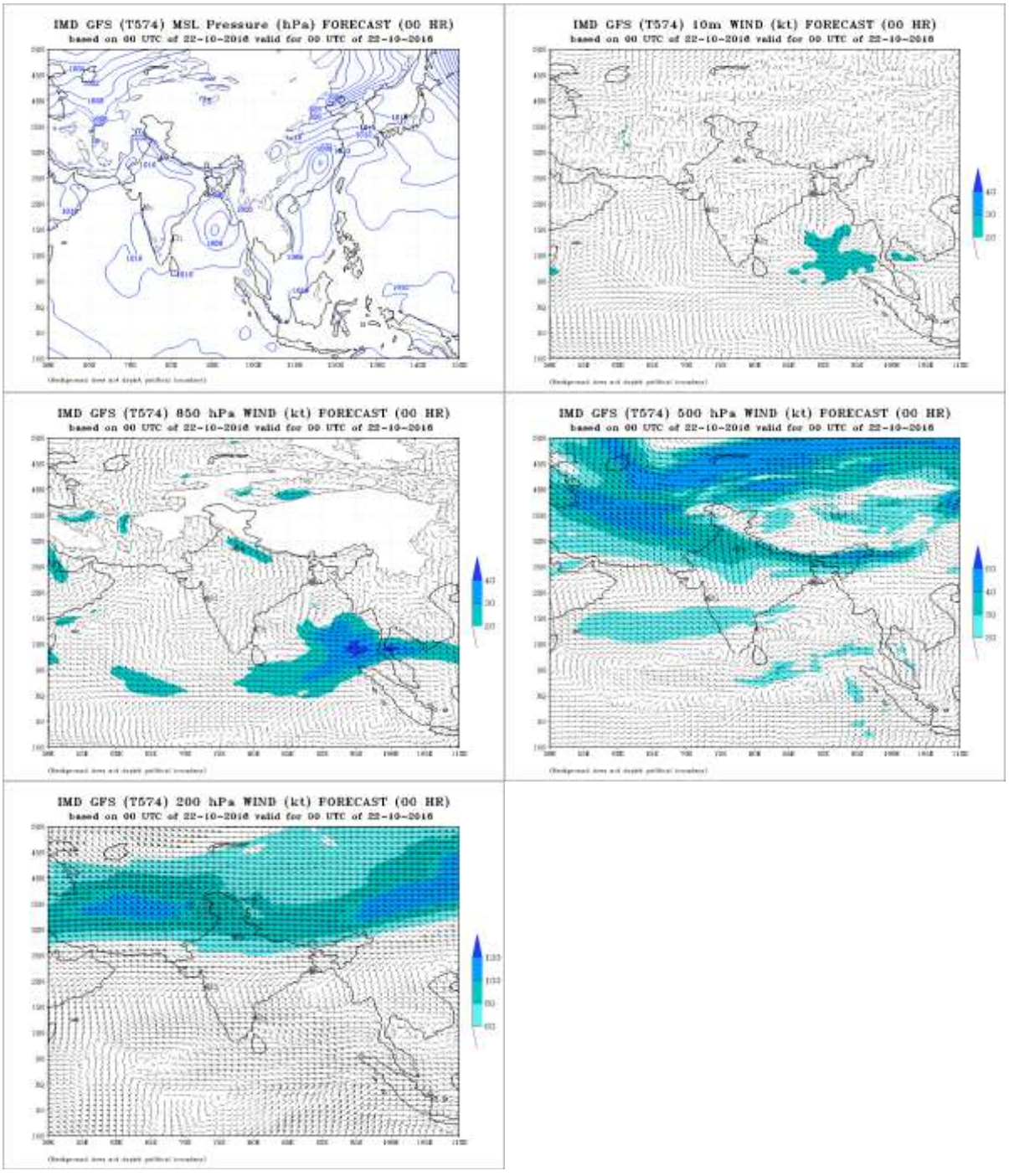


Fig. 4.9 (b): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 22nd Oct 2016

At 0000 UTC of 23rdOctober, the system was centered near 15.5^{0}N/93.0^{0}E. IMD-GFS analysis field of MSLP indicated intensification of system into a deep depression over eastcentral BoB near 15.5^{0}N/93.0^{0}E. Winds at 850 hPa levels showed cross equatorial inflow of warm moist air from southeast sector into the system. Circulation was extending upto 500 hPa levels. Winds at 200 hPa levels indicated ridge running along 19.0^{0}N in association with anticyclonic circulation lying over Myanmar coast. Middle and lower level winds showed steering of system northeastwards and then northwards.

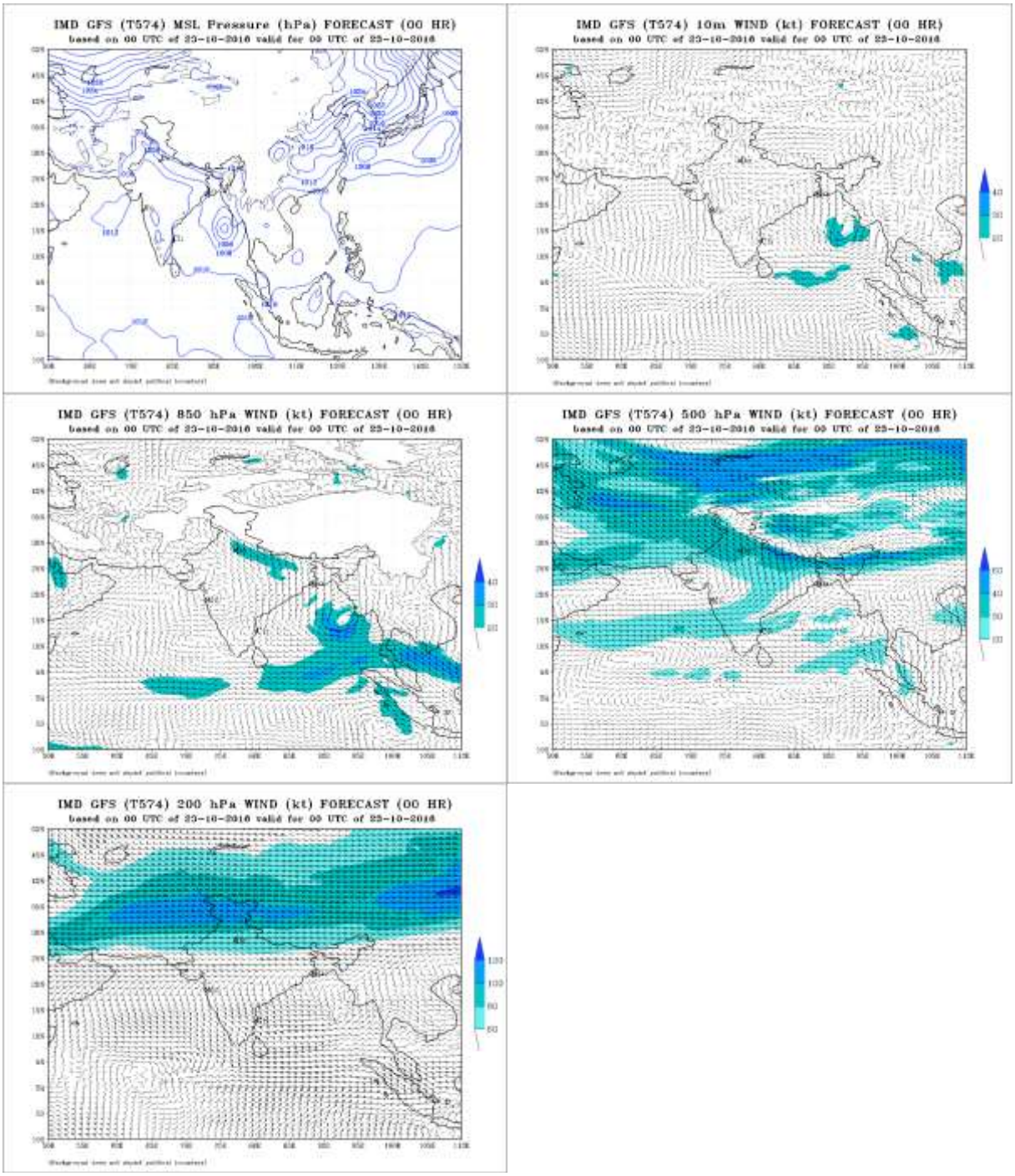


Fig. 4.9(c): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 23rd Oct 2016

At 0000 UTC of 24th October, the system as DD was centered near 16.4^{0}N/93.2^{0}E. IMD-GFS MSLP analysis field showed signs of slight weakening of the system against the intensification into DD and it was located near 16.0^{0}N/92.0^{0}E. Wind field at 850 and 500 hPa levels showed similar features. As the system intensified, the steering level changed from lower-middle levels to middle-upper levels. Thus the system commenced to be steered by middle and upper level winds and hence started moving northwestwards from 24th.

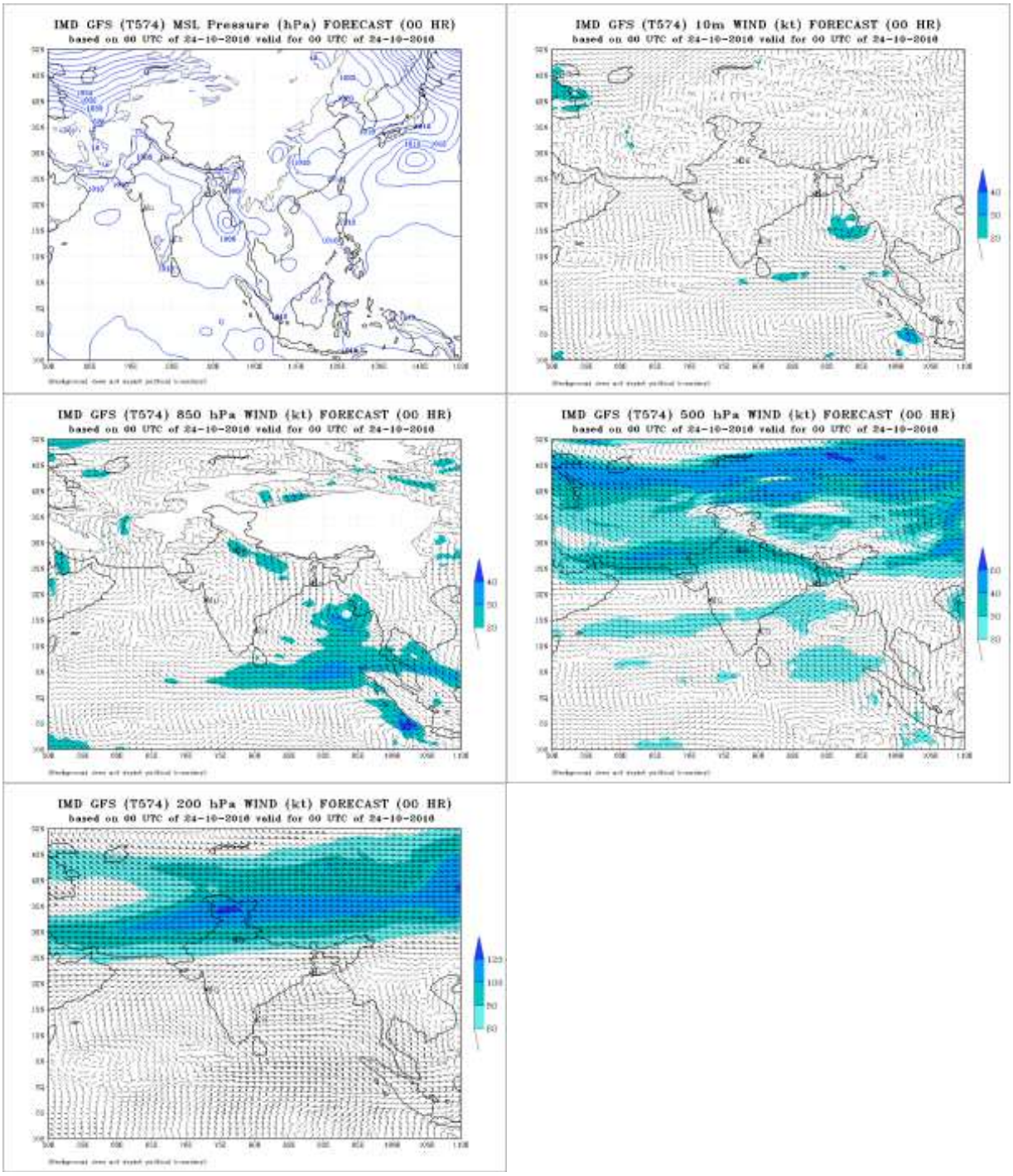


Fig. 4.9 (d): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 24th Oct 2016

At 0000 UTC of 25th October, the system further intensified into CS and was centered near 16.9^{0}N/91.7^{0}E. On the other hand, IMD-GFS MSLP analysis field showed no further intensification of the system and it was located near 16.0^{0}N/91.0^{0}E. Wind field at 850 and 500 hPa levels showed similar features. Thus the system continued to be steered by middle and upper level winds and hence moved west-northwestwards on 25th.

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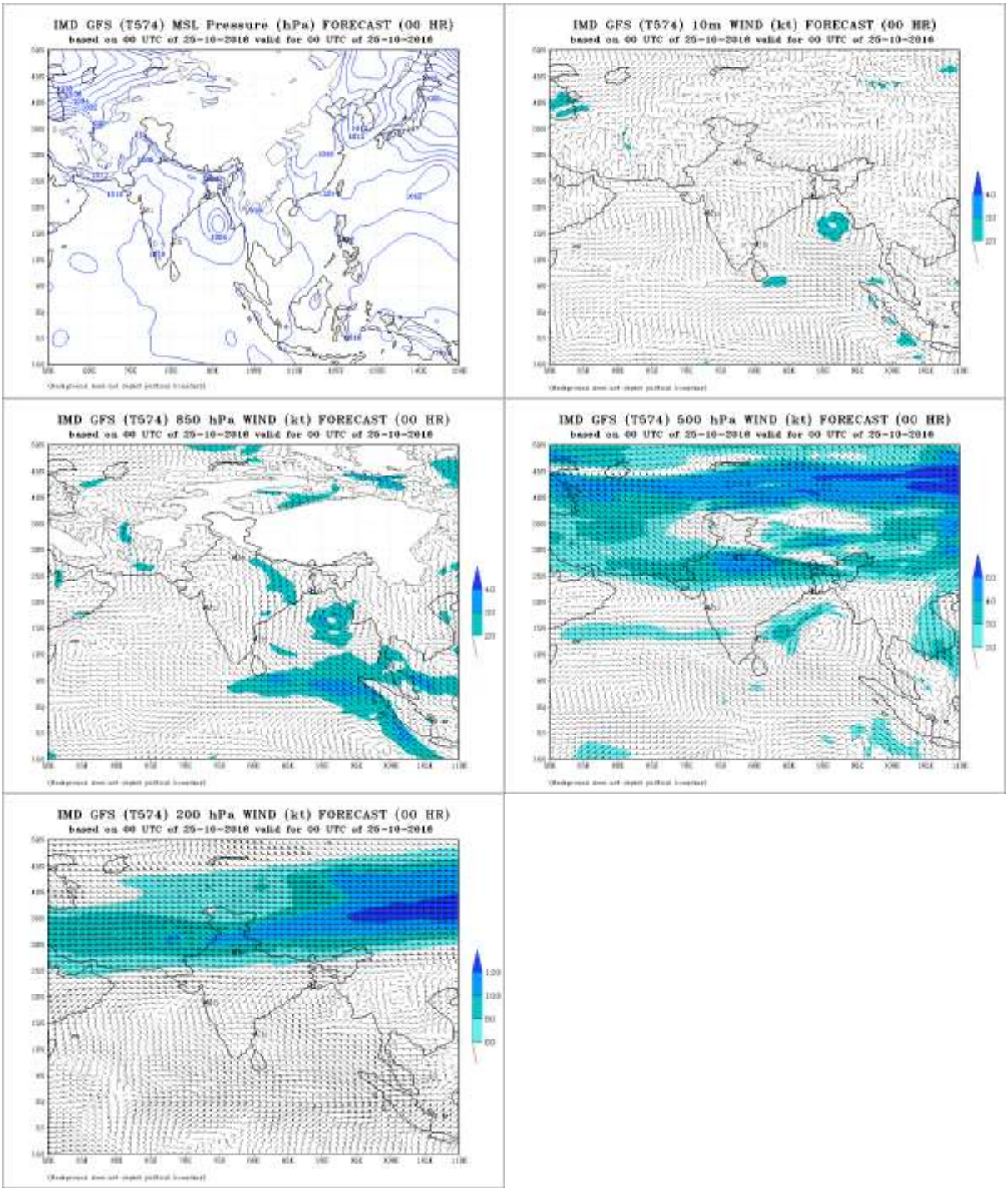


Fig. 4.9 (e): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 25th Oct 2016

At 0000 UTC of 26th October, the system as cyclonic storm was centered near 16.6^{0}N/89.0^{0}E. IMD-GFS MSLP analysis field showed intensification of the system into cyclonic storm near 17.0^{0}N/89.0^{0}E showing west-northwestwards movement. Wind field at 850, 500 and 200 hPa levels showed similar features. The model could not capture west-southwestward movement. Actually anticyclonic circulation at middle levels was lying to the northwest of system centre which steered the system west-southwestwards.

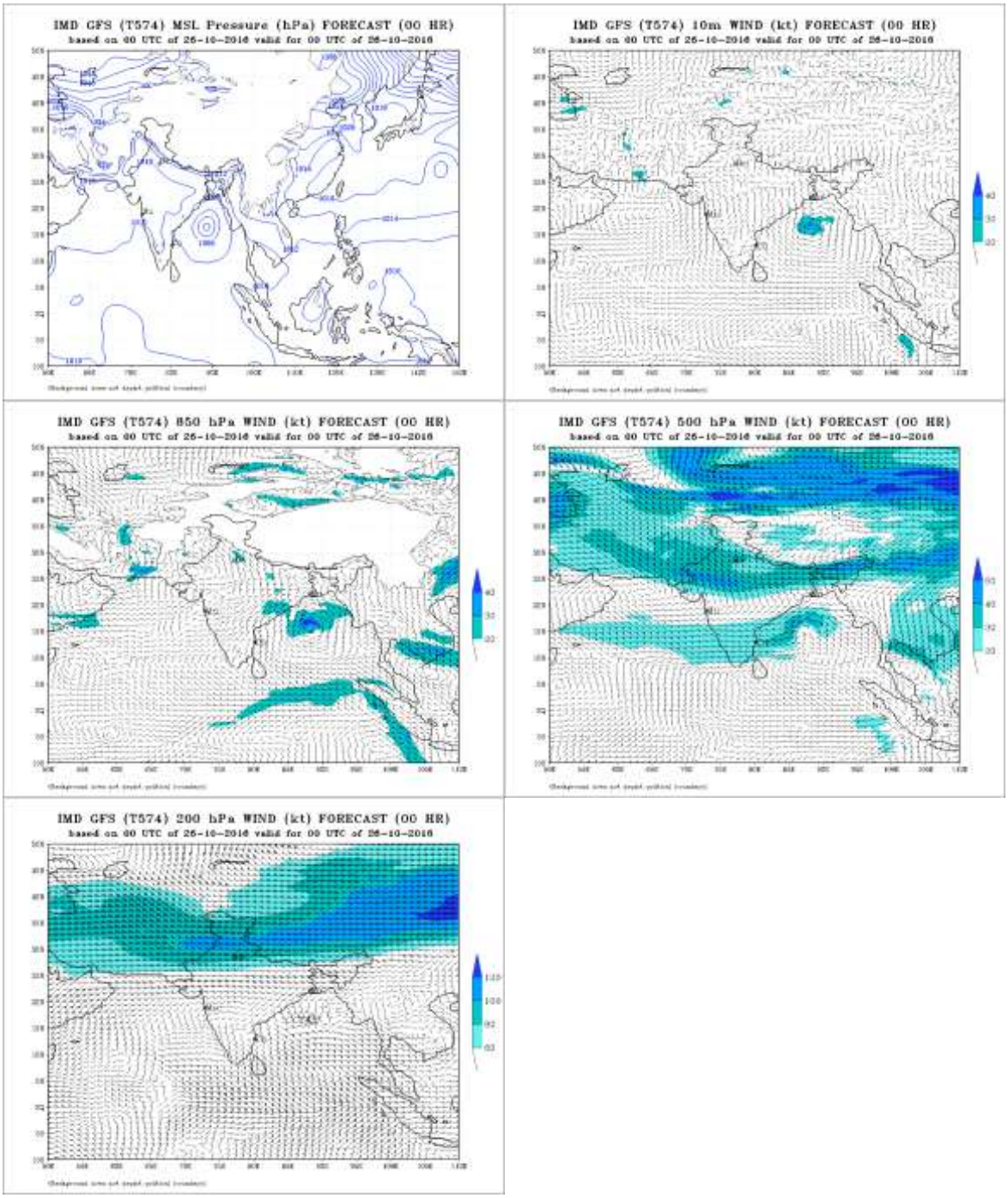


Fig. 4.9 (f): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 26th Oct 2016

At 0000 UTC of 27th October, the system which weakened into a DD at 2100 UTC of 26th October 2017 was centered near 15.7^{0}N/85.5^{0}E. IMD-GFS MSLP analysis field showed weakening of the system into a low pressure area near 15.5^{0}N/85.0^{0}E showing west-southwestwards movement. The wind fields showed a feeble circulation extending upto 850 hPa only.

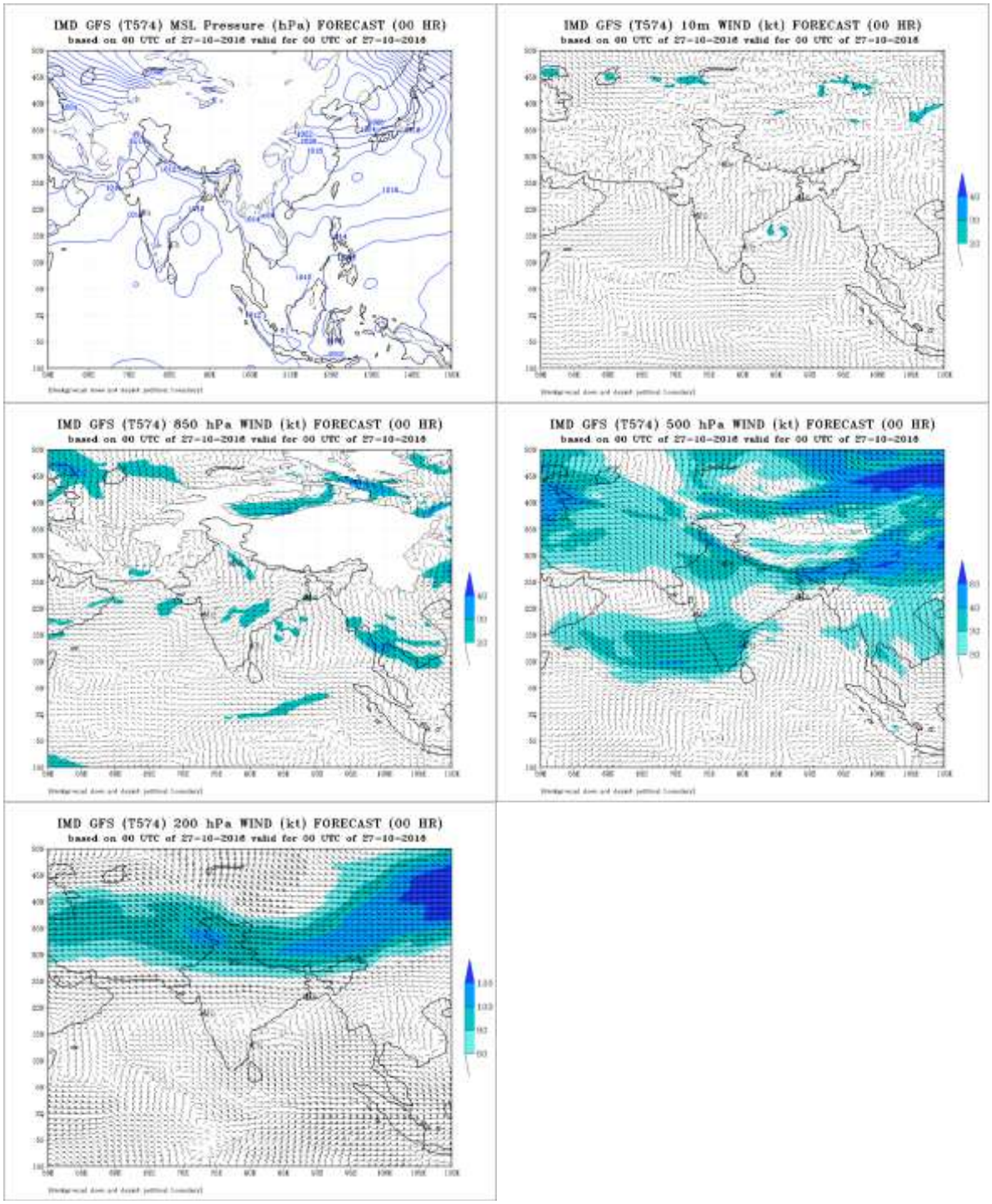


Fig. 4.9 (g): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 27th Oct 2016

At 0000 UTC of 28th October, the system lay as a well marked low over Westcentral Bay. IMD-GFS MSLP analysis field showed weakening of the system into a low pressure area near 12.5^{0}N/82.5^{0}E showing west-southwestwards movement. The wind fields showed a feeble circulation extending upto 850 hPa only and weakening of the system over southwest and adjoining westcentral BoB off north Tamilnadu and south Andhra Pradesh coasts.

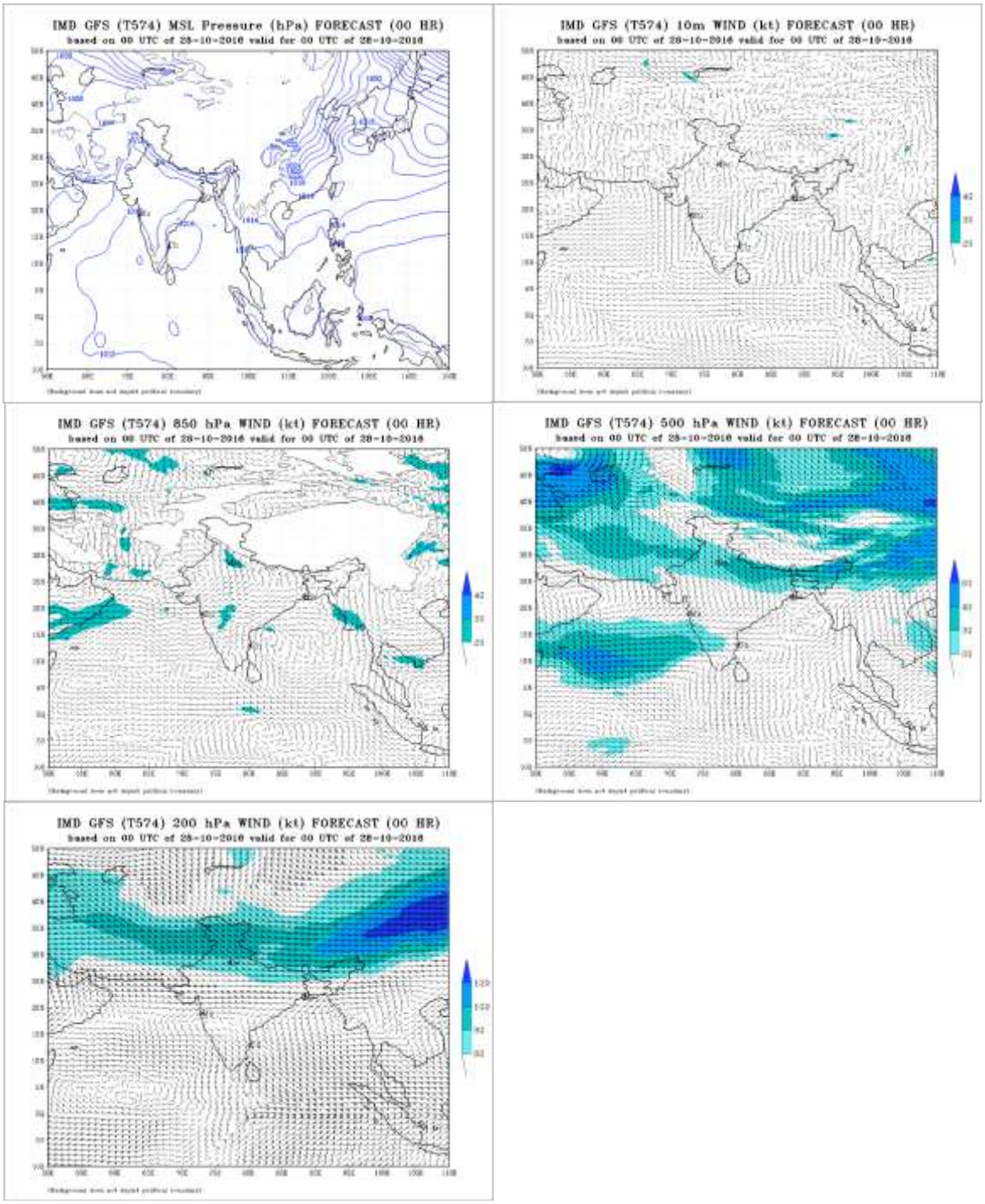


Fig. 4.9 (h): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 28th Oct 2016

4.1.1.5. Realized Weather:

4.1.1.5.1 Rainfall:

Based on IMD-NCMRWF GPM merged gauge rainfall data, rainfall associated with the system is depicted in Fig 2.6.9. The system caused heavy to very rainfall over eastcentral BoB during. 21st-26th October. On 27th October it caused heavy rainfall over westcentral and adjoining eastcentral BoB. On 28th October, the system caused heavy rainfall over westcentral BoB off south Andhra Pradesh coast.

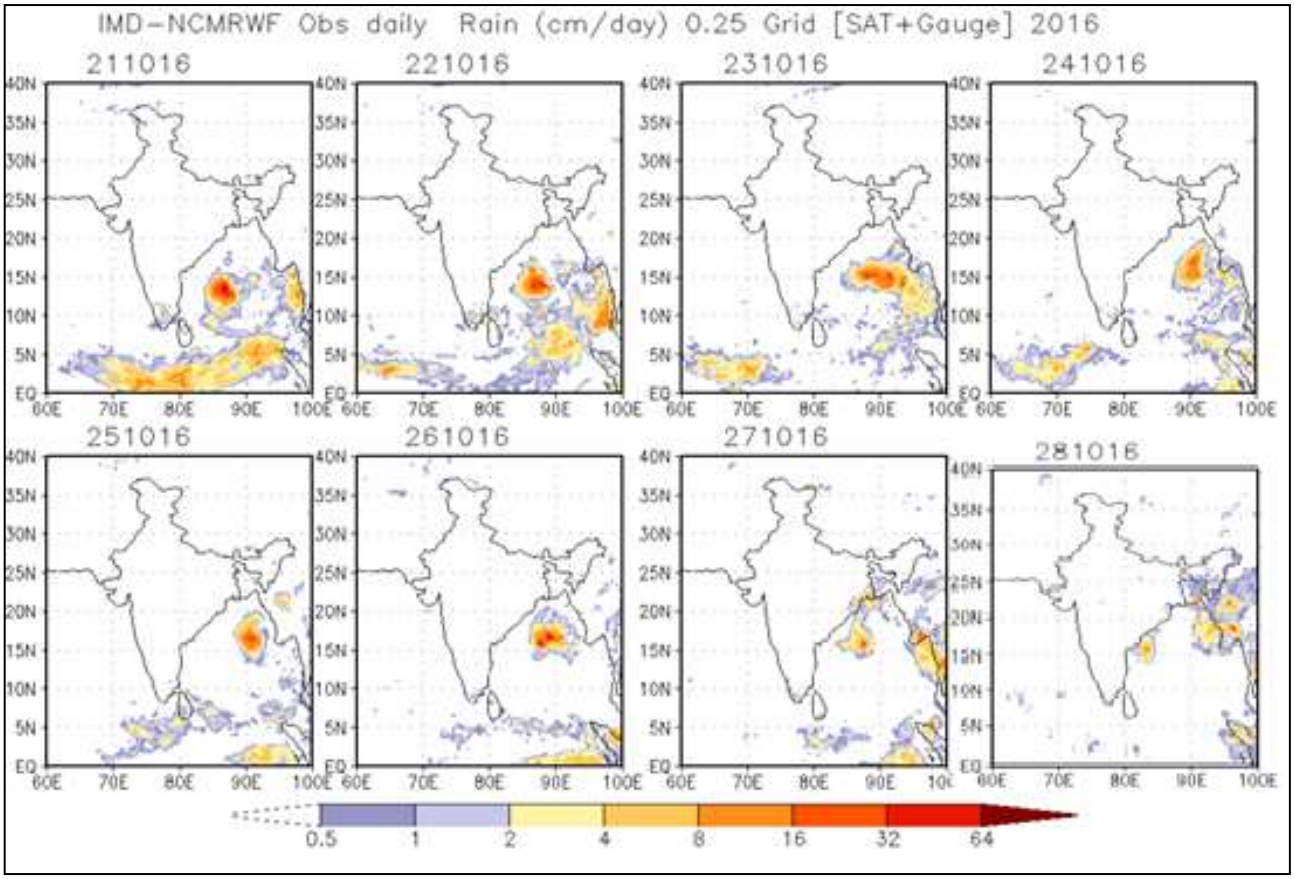


Fig. 4.10: IMD-NCMRWF GPM merged gauge rainfall during 21st-28th October.

4.1.1.6. Damage:

As cyclone Kyant weakened over sea, no damage was reported due to this system.

4.1.2. Depression over the Bay of Bengal (2nd – 6th Nov. 2016)

4.1.2.1. Introduction

A low pressure area developed over south Andaman Sea and neighbouhood in the morning of 1st November 2016. Moving northwestwards, it lay as a well marked low pressure area over region in the morning of 2nd. It further moved northwestwards and concentrated into a depression (D) in the midnight of 2nd and lay centered over central and adjoining southeast BoB at 1800 UTC of 2nd near latitude 12.7^{0}N and longitude 88.0^{0}E. It moved initially west-northwestwards and then northwestwards to westcentral BOB till the evening of 4th November. Thereafter, it recurved east-northeastwards and reached southeast Bangladesh coast close to Kutubdia in the afternoon of 6th near latitude 21.6^{0}N and longitude 91.9^{0}E. It weakened into a well marked low pressure area over southeast Bangladesh and adjoining northeast BOB in the evening of 6th.

The salient features of the system are as follows.

i. It was second consecutive recurving system in the post-monsoon season (October-December, 2016) after cyclonic storm (CS) 'Kyant'. While CS 'Kyant' had anticlockwise recurvature, this depression had clockwise recurvature.
ii. It also dissipated near the coast under the influence of high vertical wind shear, dry air incursion into the system from northwest and low ocean heat content over north BOB.
iii. After recurvature from 4th midnight, the system moved faster with a speed of 25 kmph in east-northeast direction till 6th morning. The faster movement was due to the trough in westerlies prevailing in the middle tropospheric levels which was mainly steering the system.
iv. Lowest estimated central pressure (ECP) was 1000 hPa with a pressure drop of 4 hPa.
v. The depression travelled a distance of about 1610 km during its life period.
vi. The life period of depression was 90 hours.
vii. Genesis of depression over southeast BOB was predicted 72 hours in advance (on 30th October itself).
viii. Though the system was moving towards east coast of India till 4th midnight, no Cyclone Warning/Alert was issued for any coastal state of India due to accurate prediction of its track towards Bangladesh.
ix. The movement of system towards Bangladesh coast was predicted well in advance from the first Bulletin (84 hours in advance of reahing Bangladesh coast).
x. IMD issued regular bulletins to WMO/ESCAP Panel member countries, National & State Disaster Management Agencies, general public, media and social networking sites since inception of the system over BOB.

Brief life history, characteristic features and associated weather along with performance of NWP and operational forecast of IMD are presented and discussed in following sections.

4.1.2.2. Monitoring of Depression

The depression was monitored & predicted continuously since its inception by IMD. The best track parameters of the systems are presented in Table 4.4 and the best track is presented in Fig.4.1**.** Throughout its life cycle, the system was monitored mainly with satellite, buoy, ship and coastal observations. Various national and international NWP models and dynamical-statistical models including IMD's and NCMRWF's global and meso-scale models, dynamical

statistical models for genesis and intensity were utilized to predict the genesis, track and intensity of the system. Tropical Cyclone Module, the digitized forecasting system of IMD was utilized for analysis and comparison of various models guidance, decision making process and warning product generation. Typical INSAT 3D imageries are presented in Fig. 4.11

4.1.2.3 Brief life history

4.1.2.3.1. Genesis

In association with active inter-tropical convergence zone (ITCZ), a low pressure area formed over south Andaman Sea and neighbourhood at 0300 UTC of 1st November. It persisted over the area and became a well marked low pressure area at 0300 UTC of 2nd. On 2nd November, the large scale dynamical and thermodynamical features became gradually favourable. At 1800 UTC of 2nd, the vertical wind shear was 10-20 kts (moderate), upper level divergence was $40x10^{-5}$ s^{-1}, lower level convergence was $15x10^{-5}$ s^{-1} and relative vorticity at 850 hPa was around $150x10^{-6}$ s^{-1}. Sea surface temperature was 29-30^{0}C. The ocean thermal energy was about 60- 80 KJ/cm^2 around the system centre over central BOB. According to satellite imagery, a low level cyclonic circulation lay over south Andaman Sea and adjoining southeast BOB on 1st and it became a vortex with T1.0 at 0300 UTC of 02 Nov. 2016 over the southeast BOB. The associated convection gradually organized on 2nd. Broken low/medium clouds with embedded intense to very intense convectioin lay over BOB between latitude 12.0^{0}N to 20.0^{0}N and longitude 83.0^{0}E to longitude 90.0^{0}E at 1800 UTC of 2nd. Intensity of system was T 1.5 at 1800 UTC of 2nd. The convection showed banding pattern at the time of genesis, covering 0.3 in logarithmic spiral. The lowest cloud top temperature was about -85^0 C Under these favourable conditions, the system concentrated into a depression and lay centered at 1500 UTC of 2nd Nov. 2016 over central and adjoining southeast BOB near latitude 12.7^{0}N and longitude 88.0^{0}E.

Table 4.4: Best track positions and other parameters of the depression over BOB during 02-06 November, 2016

Date	Time (UTC)	Centre lat.^{0} N/ long.^{0} E	C.I. No.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
2nd Nov.	1500	12.8/88.2	1.5	996	20	4	D
3rd Nov.	0300	13.5/86.5	1.5	996	20	4	D
	1200	14.2/85.5	1.5	996	20	4	D
4th Nov.	0000	15.5/85.0	1.5	996	20	4	D
	0300	16.0/84.7	1.5	996	20	4	D
	1200	16.3/84.7	1.5	996	20	4	D
5th Nov.	0300	18.5/87.5	1.5	996	20	4	D
	1200	19.0/88.7	1.5	996	20	4	D
6th Nov.	0300	21.0/91.5	1.5	996	20	4	D
	1200	Moved northeastwards and crossed southeast Bangladesh coast near longitude 92.0°E					
7th Nov.	0000	Weakened into a well marked low pressure area over southeast Bangladesh & adjoining northeast Bay of Bengal and lay as a low pressure area over southeast Bangladesh and neighbourhood on 7th morning.					

4.1.2.3.2. Intensification

At 0300 UTC of 4th, the depression lay over westcentral BOB. The upper tropospheric ridge ran along 17.0^0 N. Winds were southeasterly over the region of the depression. The vertical wind shear increased during past 24 hours and was about 15-25 kts (moderate to high) around the system centre. It was increasing towards north and west, becoming more than 30 knots to the north of 18^0N. The upper level divergence was about $20x10^{-5}$ s^{-1}, the lower level convergence was about $15x10^{-5}$ s^{-1} around the system centre and the relative vorticity was around $150x10^{-6}$ s^{-1}. MJO Index was in phase 4 with amplitude more than 1.

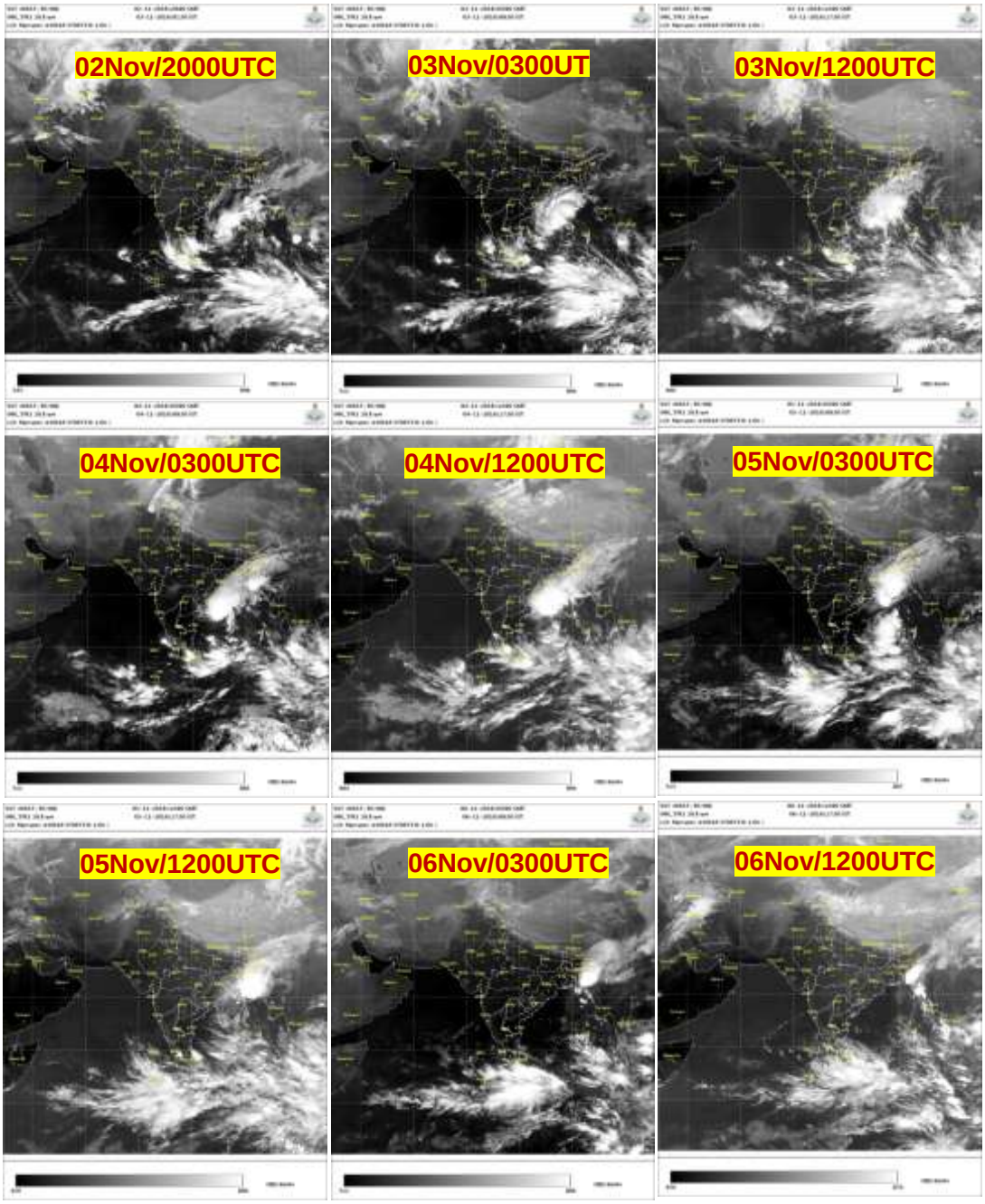


Fig.4.11 (a) Typical INSAT-3D IR imageries during 02-06 Nov 2016

Sea surface temperature was 29-30^{0}C and the ocean thermal energy was about 60- 80 KJ/cm^2 around the system centre over westcentral BOB. Though the thermodynamical parameters, lower vorticity and upper level divergence were favourable, the system did not intensify due to high vertical wind shear. Similar condition continued throughout its life. However, from 5th onwards, the convection continued to show curved banding pattern with the bands approaching the centre from northeast till 5th Nov. 2016. At 0300 UTC of 5th, the depression lay over westcentral and adjoining northwest BOB. The intensity of the system was T 1.5. The lowest cloud top temperature was about -91.0^0 C. Convection got disorganised in past 24 hours due to dry air incursion from southwest sector at middle level. The incursion of warm moist air to the core of system also decreased gradually. The sea surface temperature was 29-30^{0}C.

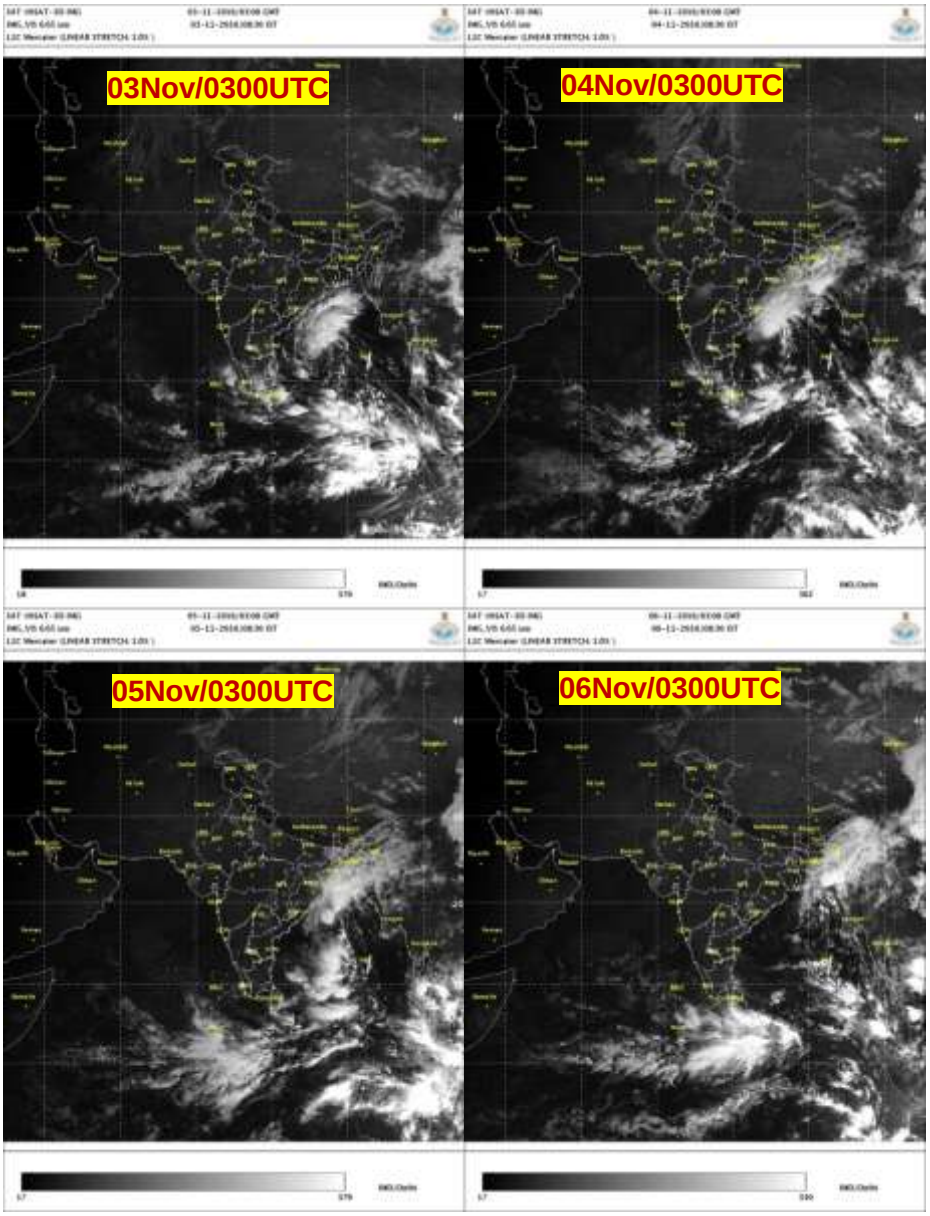


Fig. 4.11 (b) Typical INSAT-3D visible imageries at 0300 UTC of 02-06 Nov 2016

The ocean thermal energy was about 60- 80 KJ/cm^2 around the system centre over westcentral BOB becoming less than 50 KJ/cm^2 over north BOB. As the system moved northeastwards, it experienced more unfavourable conditions. At 0300 UTC of 6th, the intensity of the system was C.I.1.5. Associated broken low/medium clouds with embedded moderate to intense convectioin lay over northeast BOB, east Bangladesh, Tripura, Manipur and intense to very intense convection lay over Mizoram & adjoining Myanmar.

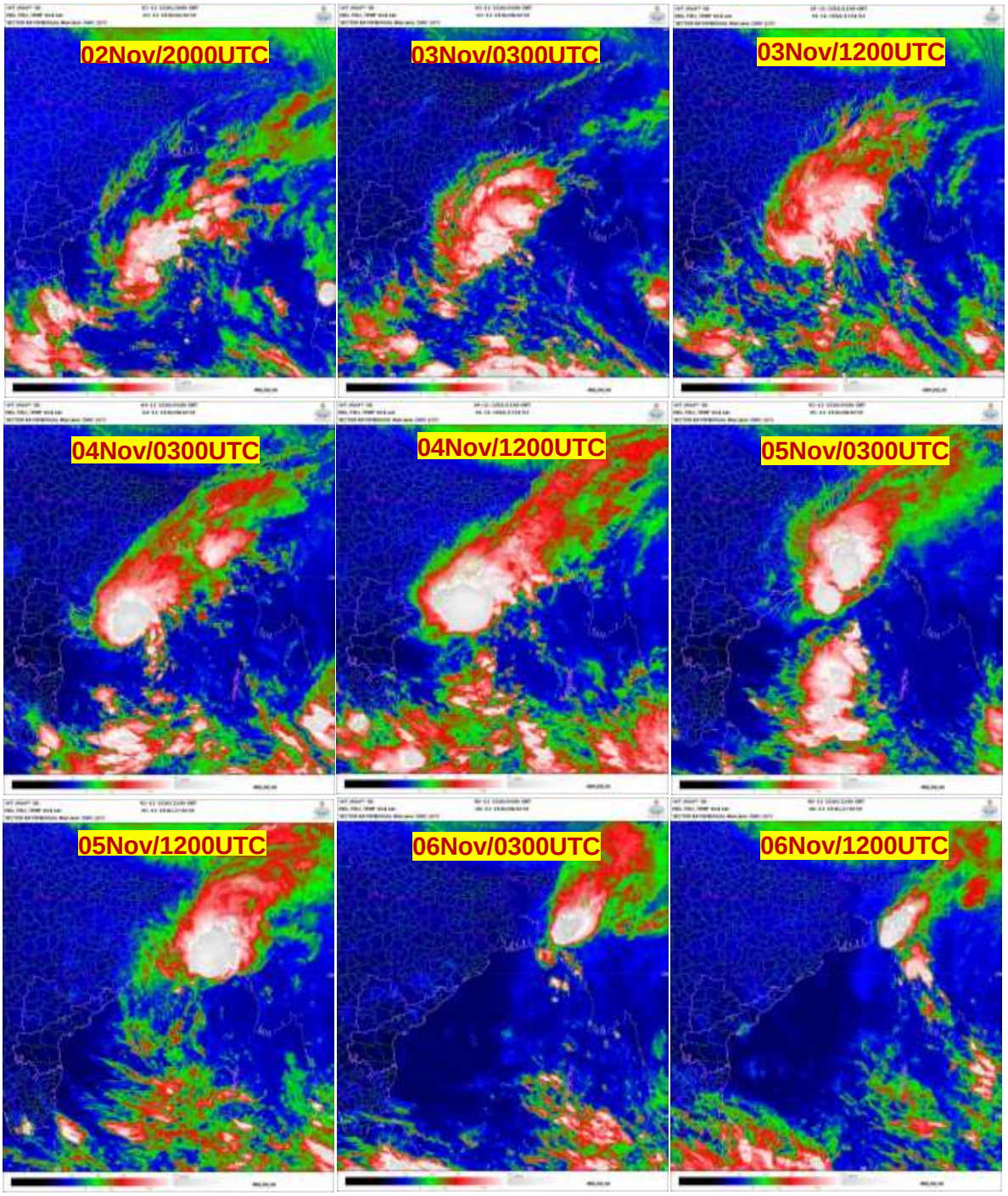


Fig. 4.11.(c) Typical INSAT-3D enhanced colored imageries during 02-06 Nov 2016

The convection showed further disorganisation in past 12 hours. The vertical wind shear was about 20-30 kts (high) around the system centre. The upper level divergence was about $5x10^{-5}$ s^{-1} near the system centre, the lower level convergence was about $20x10^{-5}$ s^{-1} to the northeast of the system centre.The relative vorticity was around $100x10^{-6}$ s^{-1}. Sea surface temperature was $29\text{-}30^{0}$ C and the ocean thermal energy was less than 50 KJ/cm^2 over north BOB. Under these prevailing conditions, the system moved northeastwards and gradually weakened into a well marked low pressure area at 0900 UTC of 6th over southeast Bangladesh and adjoining northeast BOB.

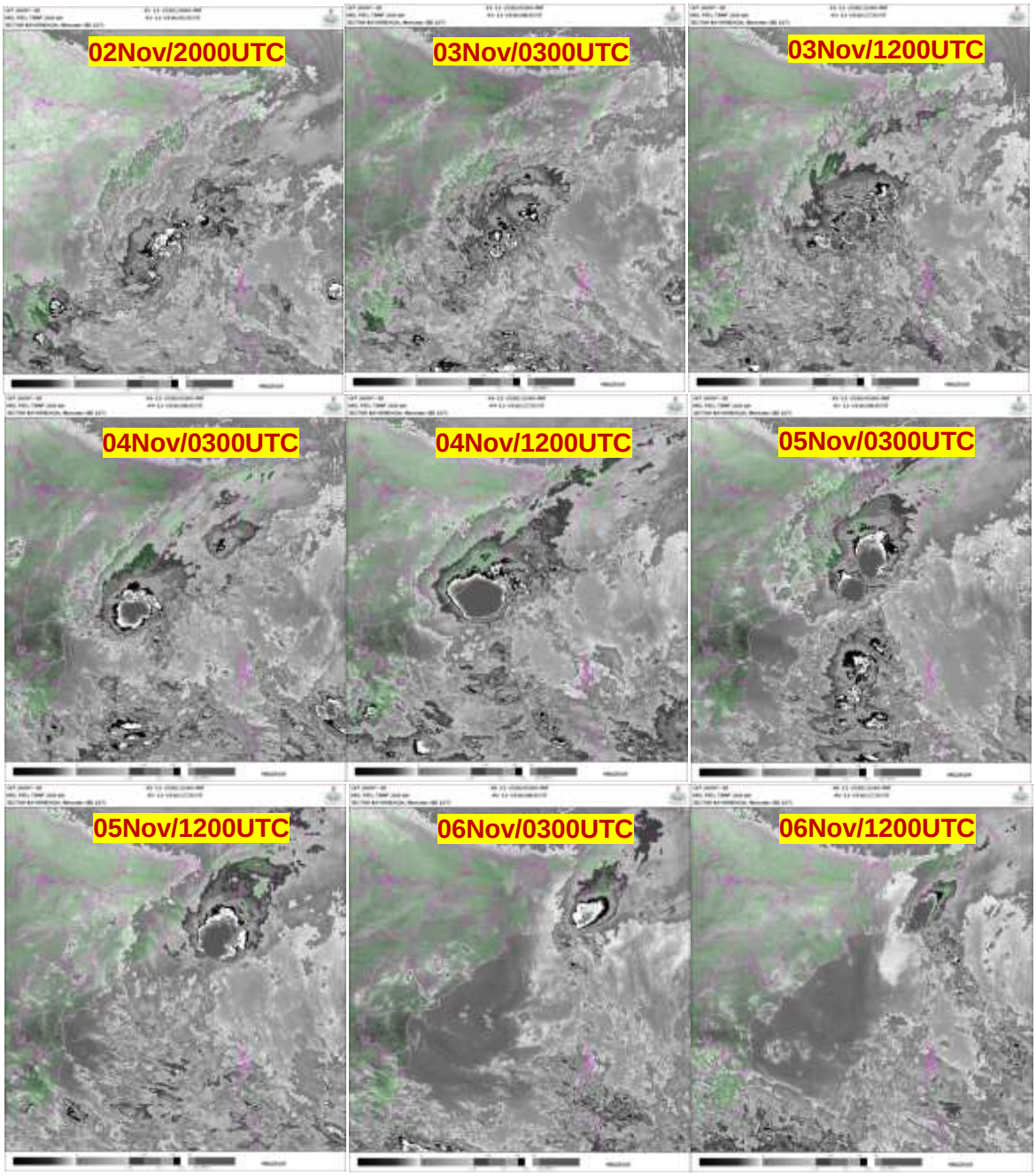


Fig. 4.11.(d) Typical INSAT-3D cloud top brightness temperature imageries during 02-06 Nov 2016

The water vapour imageries and total precipitable imageries during 2nd to 6th Nov are presented in Fig. 4.12 and Fig. 4.13 respectively.

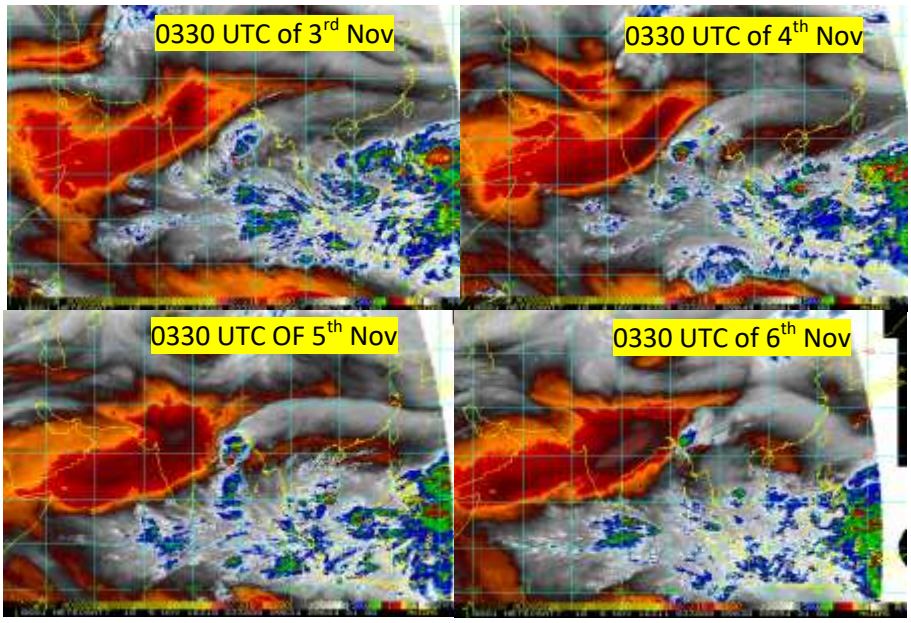


Fig.4.12 Water Vapour Imagery during 3rd to 6th November 2016

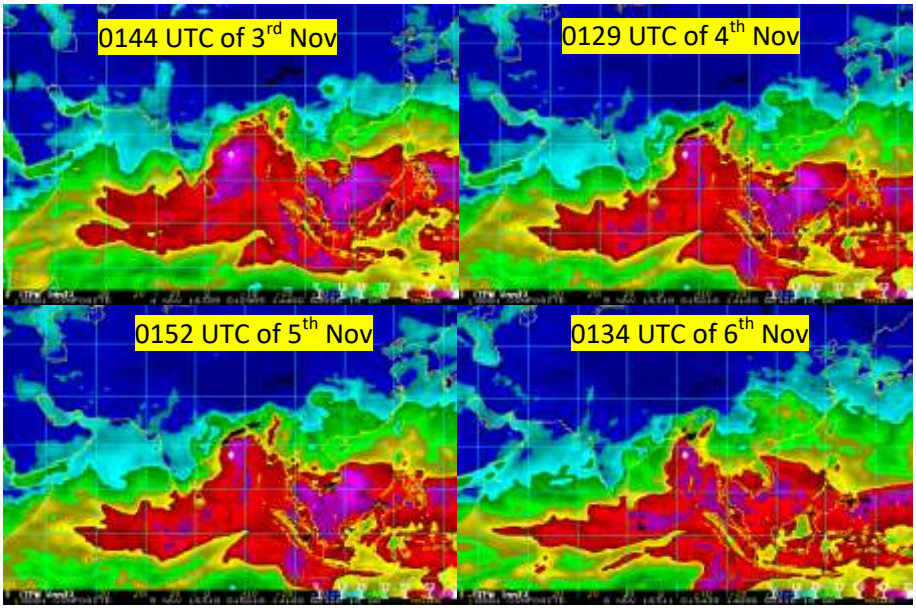


Fig.4.13 Total Precipitable Water Vapour Imagery during 3rd to 6th November 2016

4.1.2.3.3 Speed and direction of Movement

At 0300 UTC of 3rd, the upper tropospheric ridge ran along 16.0^{0}N and the system was to the south of ridge. The prevailing winds in upper level were east-southeasterly and southeasterly near the system. Under its influence, the system moved west-northwestwards to northwestwards till 1800 UTC of 3rd. Thereafter the system recurved nearly northwards till 1200

UTC of 4th as it came very close to the ridge during this period and the upper level winds were nearly southerly. From 1800 UTC of 4th, the system transitioned to the north of ridge and recurved northeastwards under the influence of southwesterly winds in upper level under the influence of mid-latitude trough in westerlies. A trough in mid-tropospheric westerlies ran along 80.0^0E and to the north of 17.0^0N till 0000 UTC of 5th November. This helped in steering the system northeastwards from 1800 UTC of 4th. Initially the system moved with an average speed of 10-15 kmph. At 0300 UTC of 5th, the trough in mid-latitude westerlies ran along 86.0^0E and to the north of 20.0^0N and under its influence, the system moved faster with an average speed of 25 kmph. The system slowed down after 0600 UTC of 6th and moved with an average speed of 5 kmph when it reached near the coast due to gradual weakening of the system. The system had a track length of about 1610 km during its life period. The wind speed in middle and deep layer around the system centre is presented in Fig.4.14 (a).

The 12 hrs translational speed and direction of the system are shown in Fig.4.14 (b). It indicates that the system moved initially west-northwestwards, then recurved gradually and finally moved east-northeastwards. The translational speed gradually decreased becoming minimum around 1200 UTC of 4th Nov. and then increased gradually as it moved northeastwards under the influence of the mid-latitude westerly trough. Fig. **4.14**(a) indicate that the depression was steered by 200-850 hPa mean layer wind

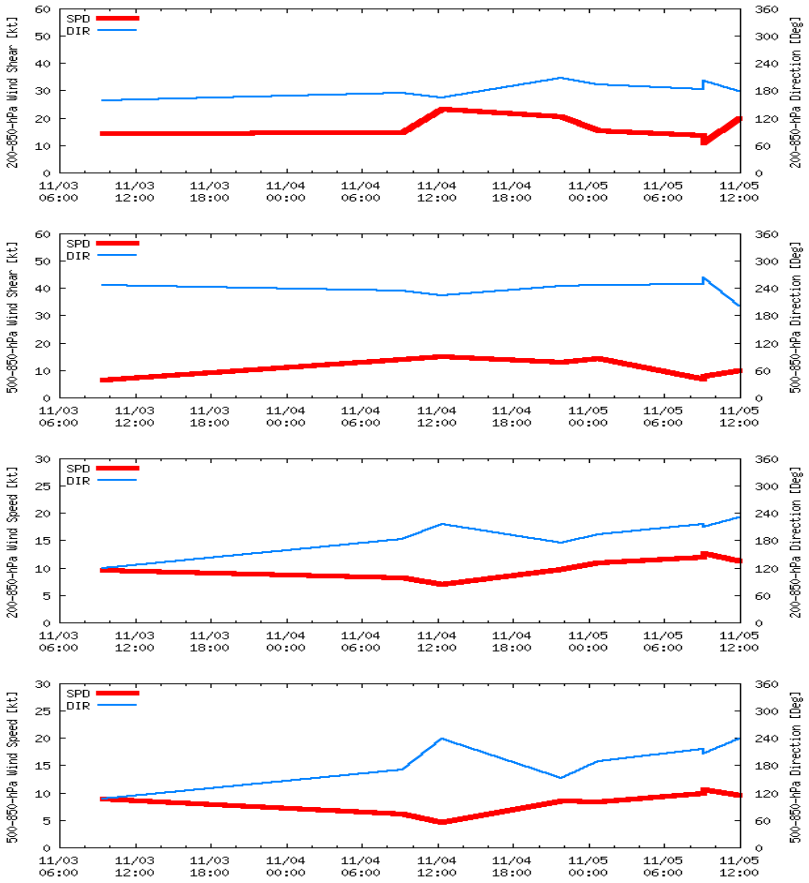


Fig.4.14(a)Wind shear (i) between 850 and 200 hPa levels & (ii) between 850 and 500 hPa levels and mean wind speed & direction within 850 to 500 hPa levels and 850 to 200 hPa levels around the system during 3rd to 6th Nov.

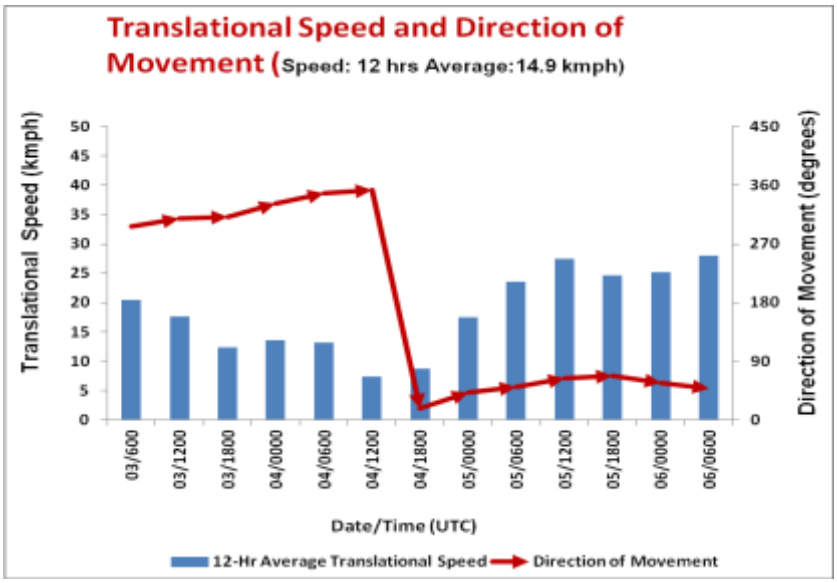


Fig.4.14 (b). 12 hrly average translational speed and direction of depression (3-6 Nov. 2016).

4.1.2.3.4. Climatological aspects

Considering the area of genesis (+/- 2^0 around the genesis point), the cliamtological tracks of the cyclonic disturbances during 1891-2015 are presented in Fig.4.15. It indicates that climatologically, only 20% of the tracks recurved towards northeast and remaining moved northwestwards. All the systems generating over this 2^0x2^0 block dissipated over the Sea. Out of five systems, two intensified into cyclonic storms.

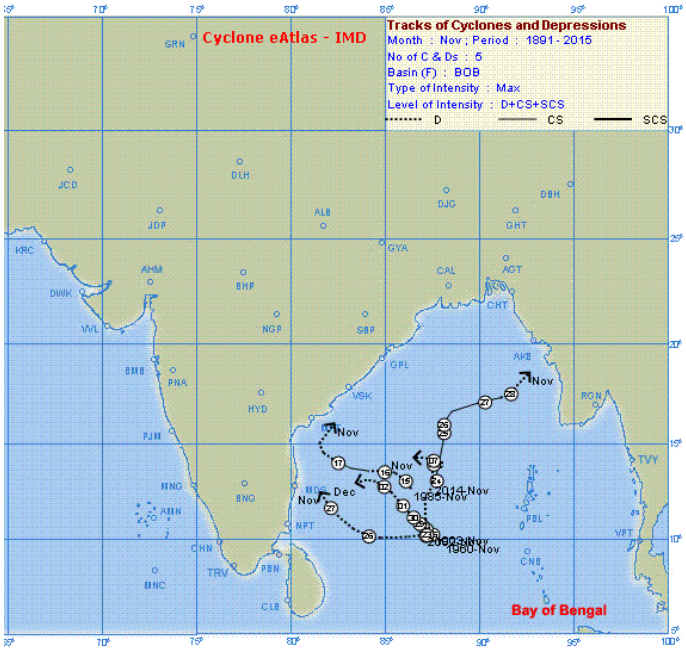


Fig 4.15. Climatological tracks of TCs forming within +/- 2^0 around the genesis point during 1891-2015.

4.1.2.3.5 Dynamical features

IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels are presented in Fig. 4.16. IMD GFS analysis based on 0000 UTC of 2nd Nov., picked up development of a low over southeast BOB with circulation extending upto mid-tropospheric level. At 200 hPa, a ridge ran along lat. 15^0N. IMD GFS analysis based on 0000 UTC of 3rd Nov., indicated west-northwestward movement of the system with intensification into a depression over southwest BOB extending upto mid-tropospheric level. IMD GFS analysis based on 0000 UTC of 4th Nov., indicated northward movement of the system with further intensification over westcentral BOB extending upto mid-tropospheric level. A trough in mid-tropospheric level ran along long. 80^0E to the north of 15^0N, suggesting the recurvature of the system to northeastwards.

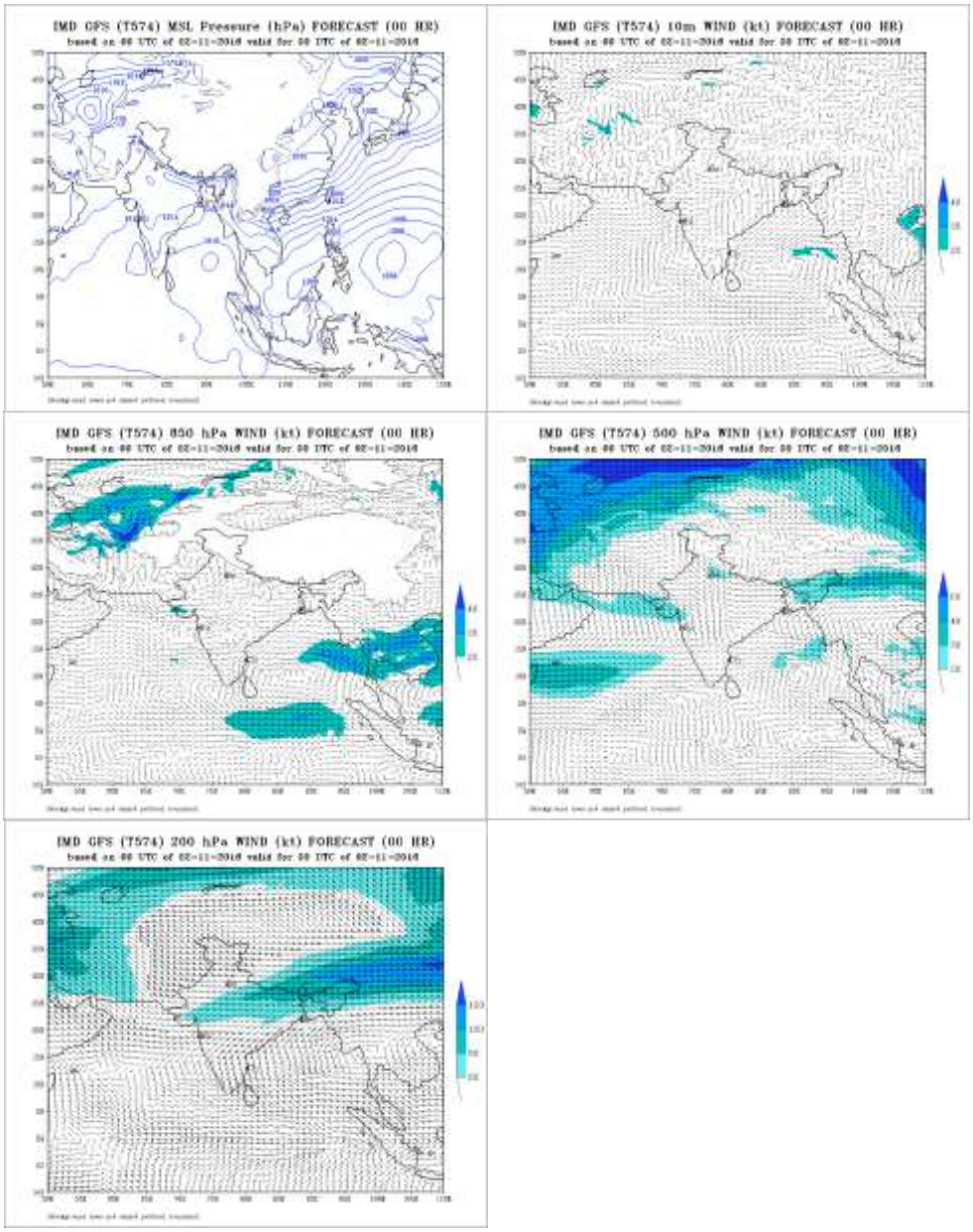


Fig. 4.16. (a): IMD GFS analysis of MSLP, 10m wind and winds at 850, 500 & 200 hPa levels based on 0000 UTC of 2nd November

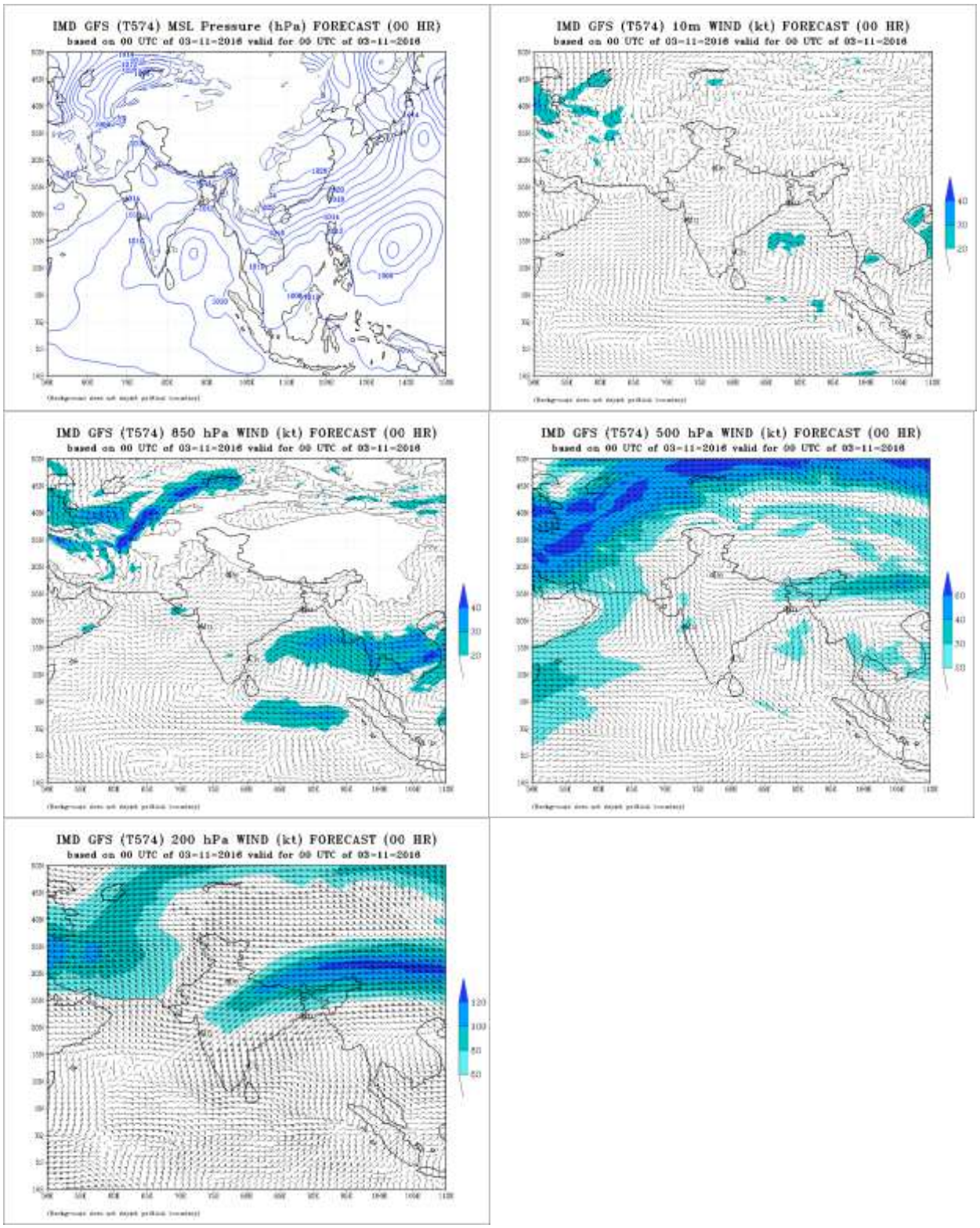


Fig. 4.16.(b) IMD GFS analysis of MSLP, 10m wind and winds at 850, 500 & 200 hPa levels based on 0000 UTC of 3rd November

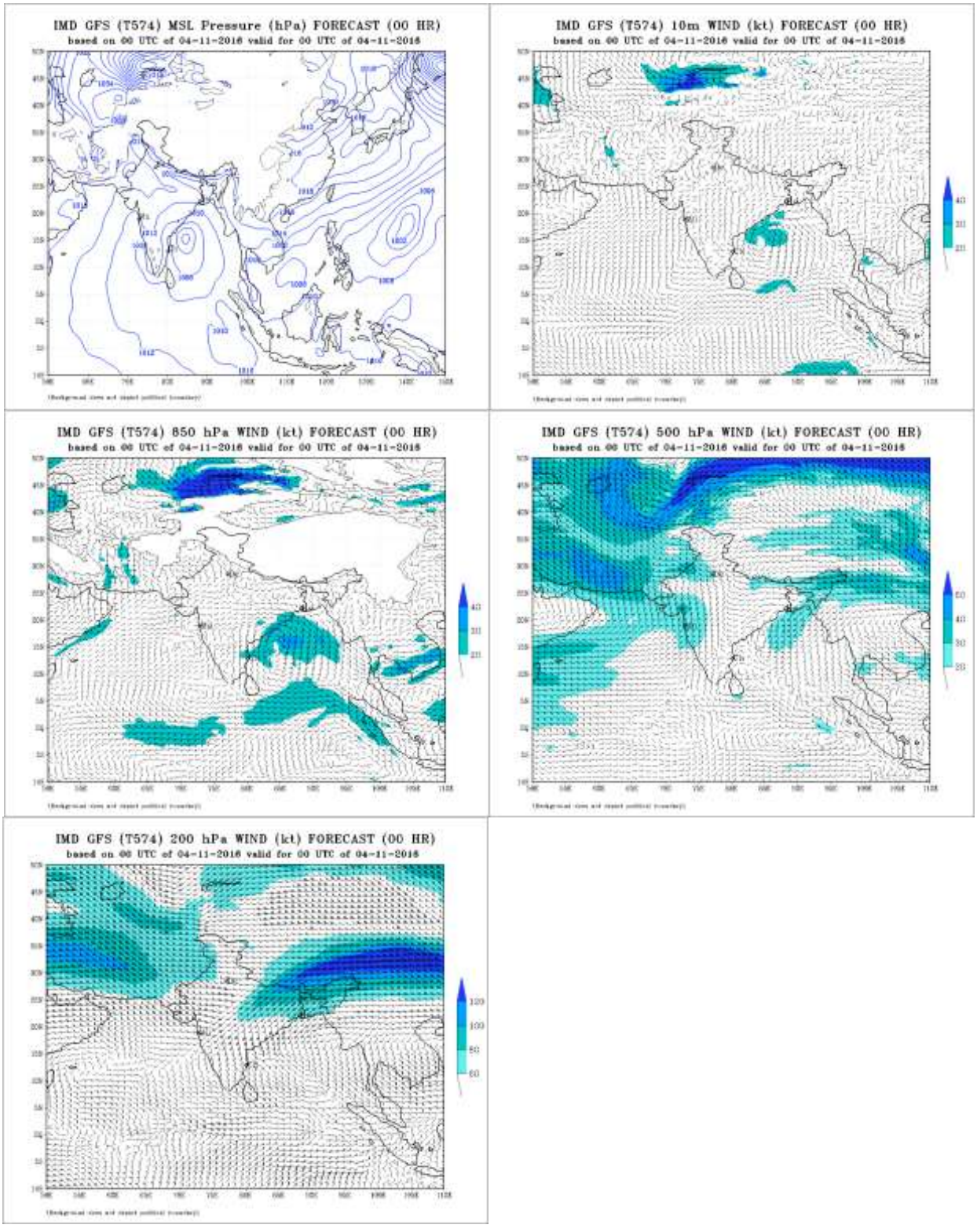


Fig. 4.16(c) IMD GFS analysis of MSLP, 10m wind and winds at 850 and 500 hPa levels based on 0000 UTC of 4th November

IMD GFS analysis based on 0000 UTC of 5th Nov., indicated east-northeastward recurvature of the system over westcentral BOB under the influence of the trough in westerly running along 85^0E to the north of 15^0N.

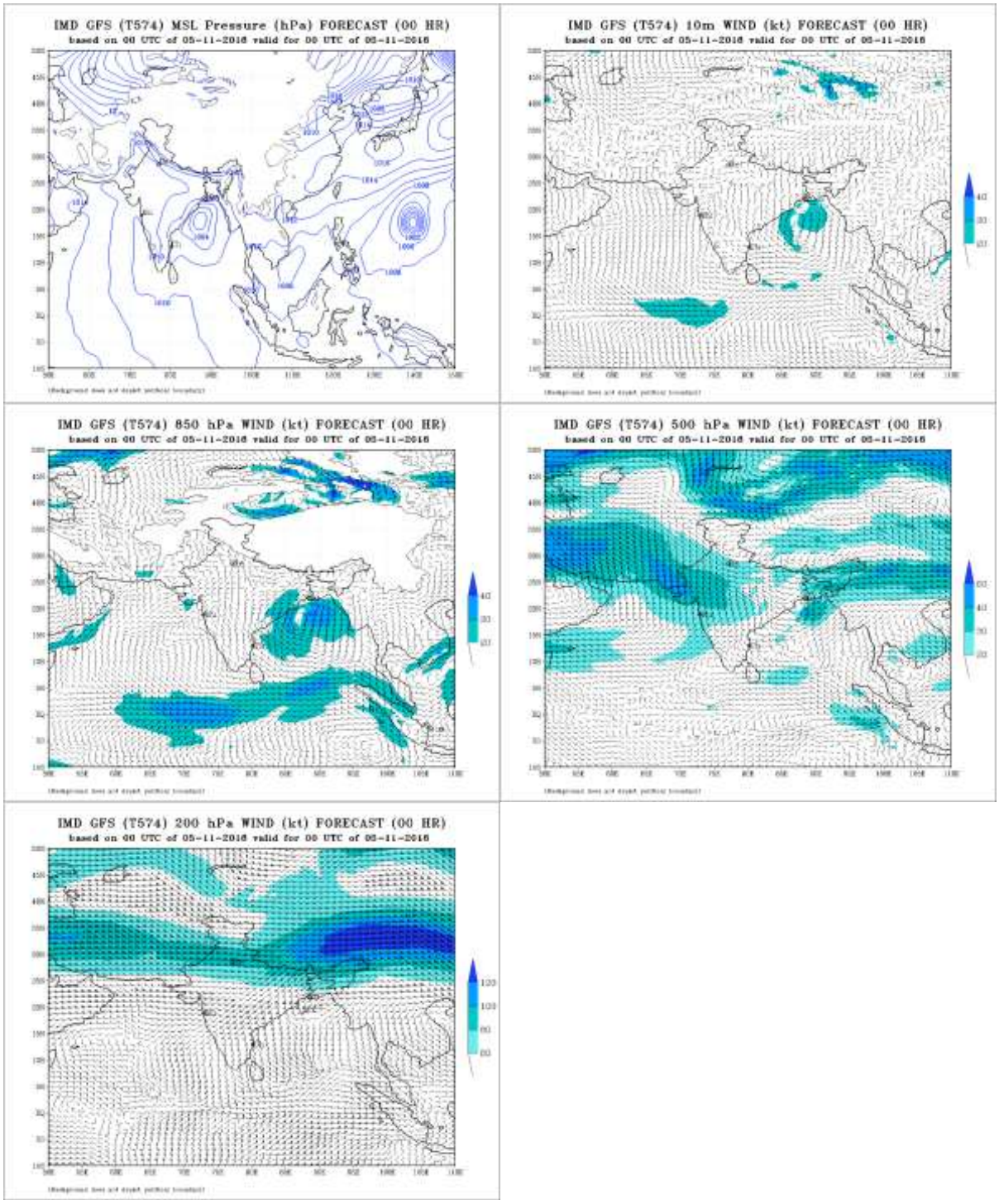


Fig. 4.16(d) IMD GFS analysis of MSLP, 10m wind and winds at 850 and 500 hPa levels based on 0000 UTC of 5th November

IMD GFS analysis based on 0000 UTC of 6th Nov indicated weakening of the system over northeast BOB.

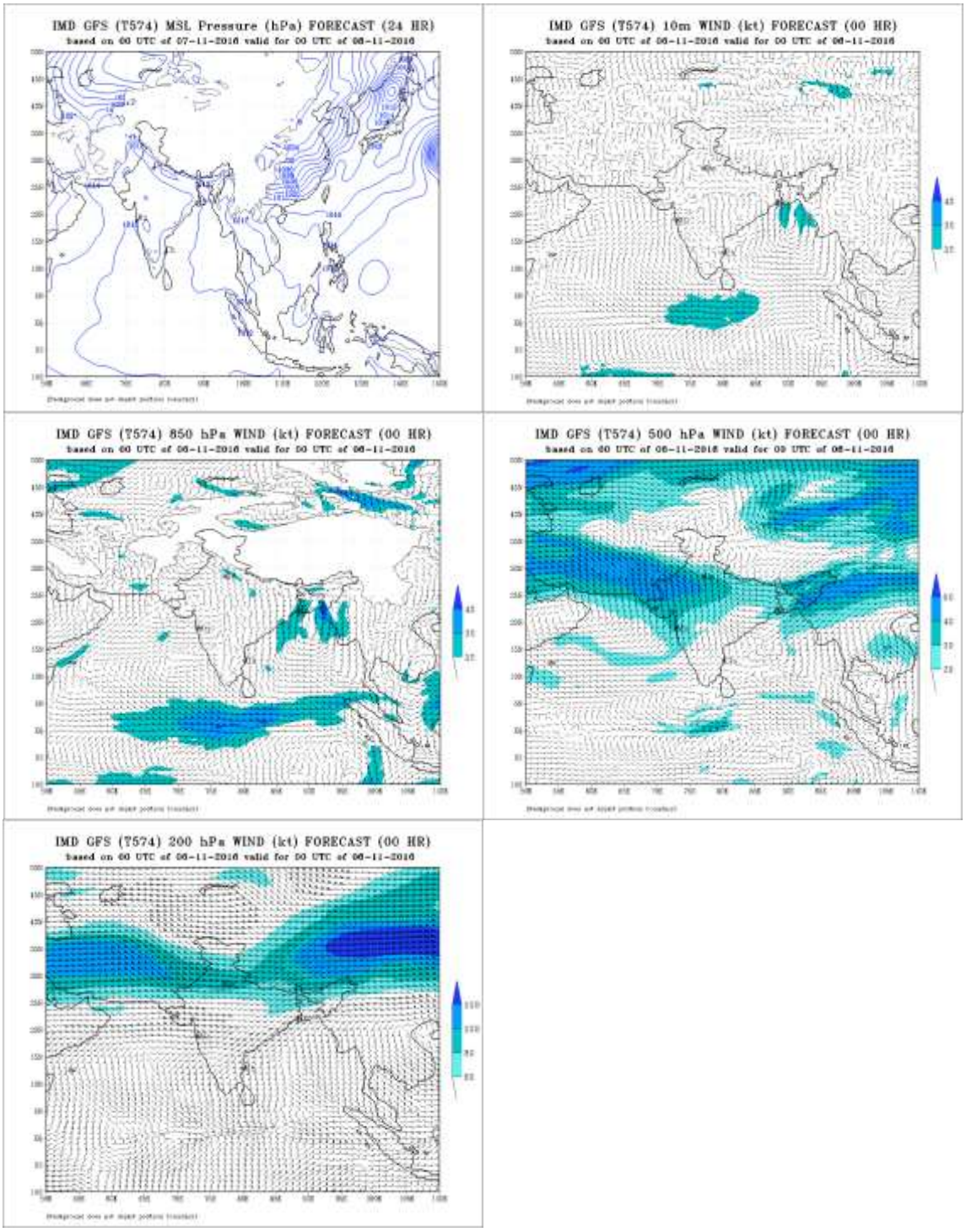


Fig. 4.16. (e) IMD GFS analysis of MSLP, 10m wind and winds at 850 and 500 hPa levels based on 0000 UTC of 6th November

Thus the IMD-GFS model could detect the genesis, track and weakening over the sea.

4.1.2.4. Realized Weather:

4.1.2.4.1 Rainfall:

Even though the system did not cross the Indian coast, the sheared convective cloud mass caused rainfall at many places with isolated heavy rainfall over north coastal Andhra Pradesh, coastal Odisha, coastal West Bengal, south Assam, Tripura and Mizoram for one day each. The depression also caused widespread rainfall with isolated heavy to very heavy falls over Bangladesh on 6th. Realized rainfall ≥ 7cm over Assam, Meghalaya, Nagaland, Manipur, Mizoram, Tripura, Gangetic West Bengal, Odisha and Puducherry during 4th-7th November is presented below:

4 Nov. 2016:

Gangetic West Bengal: Contai-7

Puducherry: Kangeyam-7, Rameswaram-7

5 Nov. 2016:

Assam : Karimganj-9, ,

Odisha: Tirtol and Paradip-10 each, Marsaghai -9, Astaranga-8, Derabisi,Chandbali, Garadapur-8 each, Balikuda, Kendrapara, Kujanga and Rajkanika-7

6 Nov. 2016:

Assam & Meghalaya: B.P Ghat-9 and Karimganj-9 each, Halflong-7

Nagaland, Manipur, Mizoram & Tripura: Arundhutinagar-13, Khowai-12, Agartala Airport, Kailashahar Airport-12 each, Kamalpur-11, Bishalgarh-11, Udaipur, Gokulpur-10 each, Belonia, Sonamura-9 each, Sabroom-8, Aizwal-7

7 Nov. 2016:

Assam & Meghalaya: B.P.Ghat-13, Halflong-10, Karimganj-8, Lumding-7

Nagaland, Manipur, Mizoram & Tripura: Gokulpur, Udaipur, Amarpur, Bishalgarh-11 each, Khowai-10, Wokha, Kailashahar airport, Belonia-8 each, Chhamonu, Jharnapani-7

4.1.2.5. Damage due to system

No damage was reported by any coastal state of India and Bangladesh.

4.1.3. Cyclonic Storm "Nada" over the Bay of Bengal (29th Nov. – 2nd Dec. 2016)

4.1.3.1 Introduction

A depression formed over southeast BOB in the evening of 29th November. It moved initially northwestwards and intensified gradually into cyclonic storm (CS) "Nada" over southeast BoB in the morning of 30th. It maintained its intensity till the evening of 1st December while moving west-northwestwards. It weakened into a deep depression (DD) in the noon of 1st December and further into a depression in the same midnight. Continuing to move west-northwestwards, it crossed north Tamil Nadu coast near Nagapattinam (about 20 km south of Karaikal) during 0400-0500 hours IST of 2nd December. Continuing to move westwards, it further weakened into a well marked low pressure area over interior Tamil Nadu in the forenoon of 02nd Dec. 2016. The best track parameters of the system are presented in Table 4.5 and the best track in Fig.4.1.

Salient features of the system:

(i) It was the second CS over BOB during post monsoon season.
(ii) It also weakened over sea under the influence of high vertical wind shear, low sea surface temperature and low ocean heat content over southwest BoB off Tamilnadu coast.

4.1.3.2. Brief life history

4.1.3.2.1. Genesis

A low pressure area lay over southeast Bay of Bengal at 0300UTC of 28th November 2016. It became a well-marked low pressure area over southeast Bay of Bengal at 0300UTC of 29th November 2016.At 0300UTC of 29th, the sea surface temperature was 29˚C, Ocean thermal energy was 80-100KJ/cm^2, low level convergence was 30 x 10^{-5} second^{-1}, upper level divergence was about 30x10^{-5} second^{-1}, the low level relative vorticity was about (100-120) x10^{-6} second^{-1}, vertical wind shear of horizontal wind was moderate (10-20 knots). Upper tropospheric ridge lay along 14.0˚N. Considering large scale features, Madden Julian Oscillation was also favourable and lay in Phase-3 with amplitude about 1. Under these favourable conditions, the well-marked low concentrated into a **depression (D)** and lay centered at 1200 UTC of 29h over southeast BoB near latitude 6.5^{0}N and longitude 87.5^{0}E.

4.1.3.2.2. Intensification and Movement

The depression over southeast Bay of Bengal moved west-northwestwards with a speed about 15 kmph, intensified into a **deep depression** and lay centred at 0000 UTC of 30th November, 2016 near latitude 7.8ºN and longitude 85.E. At 0300 UTC of 30th November, 2016, the sea surface temperature was around 29˚C near the system centre and 28˚C near north Tamilnadu coast, Ocean thermal energy was about (80-100) KJ/cm^2 around system centre and it decreased towards southwest Bay of Bengal becoming less than 50 KJ/cm^2 near north Tamilnadu coast. The low level convergence was (50 x 10^{-5} second^{-1}), upper level divergence was around (40x10^{-5} second^{-1}) in southwest sector of deep depression and low level relative vorticity was 150x10^{-6} second^{-1} near the system centre. The vertical wind shear of horizontal wind was moderate (10-20 knots) around the system centre and increased towards southwest

Bay of Bengal near Shri Lanka & Tamilnadu coast. The Madden Julian oscillation (MJO) index was in phase 3 with amplitude <1. It continued in phase 3 and then in phase 2 for next 3-4 days. All the above environmental parameters were favourable for further intensification. The upper tropospheric ridge lay along 14.0^0 N and hence the east-southeasterly winds prevailed over the region of deep depression in middle and upper tropospheric levels. It steered the system west-northwestwards. Under these conditions, the deep depression moved northwestwards and intensified into a cyclonic storm, "Nada" over southwest & adjoining southeast Bay of Bengal and lay centred at 0300 UTC of 30th November, 2016 near latitude 8.2ºN and longitude 85.3ºE. The cyclonic storm "Nada" over southwest Bay of Bengal moved west-northwestwards and maintained its cyclonic storm intensity till forenoon of 01st Dec. As it moved close to coast, it encountered the colder sea surface, lower Ocean thermal energy (< 50 KJ/cm^2) and also the dry air incursion from the northwest in association with an anticyclone lying to the northwest of the system centre. As a result, while moving west-northwestwards, it weakened into a deep depression and lay centred at 0600 UTC of 1st December, 2016 near latitude 10.6ºN and longitude 81.2ºE over southwest Bay of Bengal. The intensity of the system reduced further and it weakened into a depression at 1800 UTC of 1st December, 2016 over southwest Bay of Bengal. Moving westward, it crossed north Tamilnadu coast near Nagapattinam (about 20 km south of Karaikal) between 2230 and 2330 UTC of 1st December, 2016 and further weakened into a low pressure-area and layover Interior Tamilnadu and neighbourhood at 0300 UTC of 2nd December, 2016. To illustrate the impact of the dry air incursion, the total precipitatble water (TPW) imageries during the life period of the storm are shown in Fig. 4.17.

Table 4.5: Best track positions and other parameters of the Cyclonic Storm, 'NADA' over the Bay of Bengal during 29 November to 02 December, 2016

Date	Time (UTC)	Centre lat.^{0} N/ long.^{0} E	C.I. No.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
29th Nov.	1200	6.5/87.5	1.5	996	20	4	D
	1500	6.8/87.1	1.5	996	20	4	D
	1800	6.8/87.1	1.5	996	20	4	D
	2100	7.6/86.5	2.0	996	20	4	D
30th Nov.	0000	7.8/85.7	2.0	994	30	5	DD
	0300	8.2/85.3	2.5	988	40	8	CS
	0600	8.7/85.0	2.5	988	40	8	CS
	0900	9.5/84.5	2.5	988	40	8	CS
	1200	9.8/84.0	2.5	988	40	8	CS
	1500	9.9/83.5	2.5	988	40	8	CS
	1800	10.0/83.0	2.5	988	40	8	CS
1st Dec	0000	10.1/42.0	2.0	988	40	8	CS
	0300	10.4/81.7	2.0	988	40	8	CS
	0600	10.4/81.2	1.5	994	30	5	DD
	0900	10.6/81.1	1.5	994	30	5	DD
	1200	10.7/80.7	1.5	994	30	5	DD

	1500	10.8/80.5	1.5	994	30	4	DD
	1800	11.0/80.4	1.5	996	20	4	D
	2100	11.0/80.0	1.5	996	20	4	D
	Crossed north Tamil Nadu coast near Nagapattinam (about 20 kms south of Karaikal) between 2230 & 2330 UTC of 1st December						
2nd Dec.	0000	11.0/79.9	-	996	20	4	D
	0300	10.8/79.9	-	996	20	4	
	It further weakened into a well marked low pressure area over interior Tamil Nadu & neighbourhood on 2nd December						

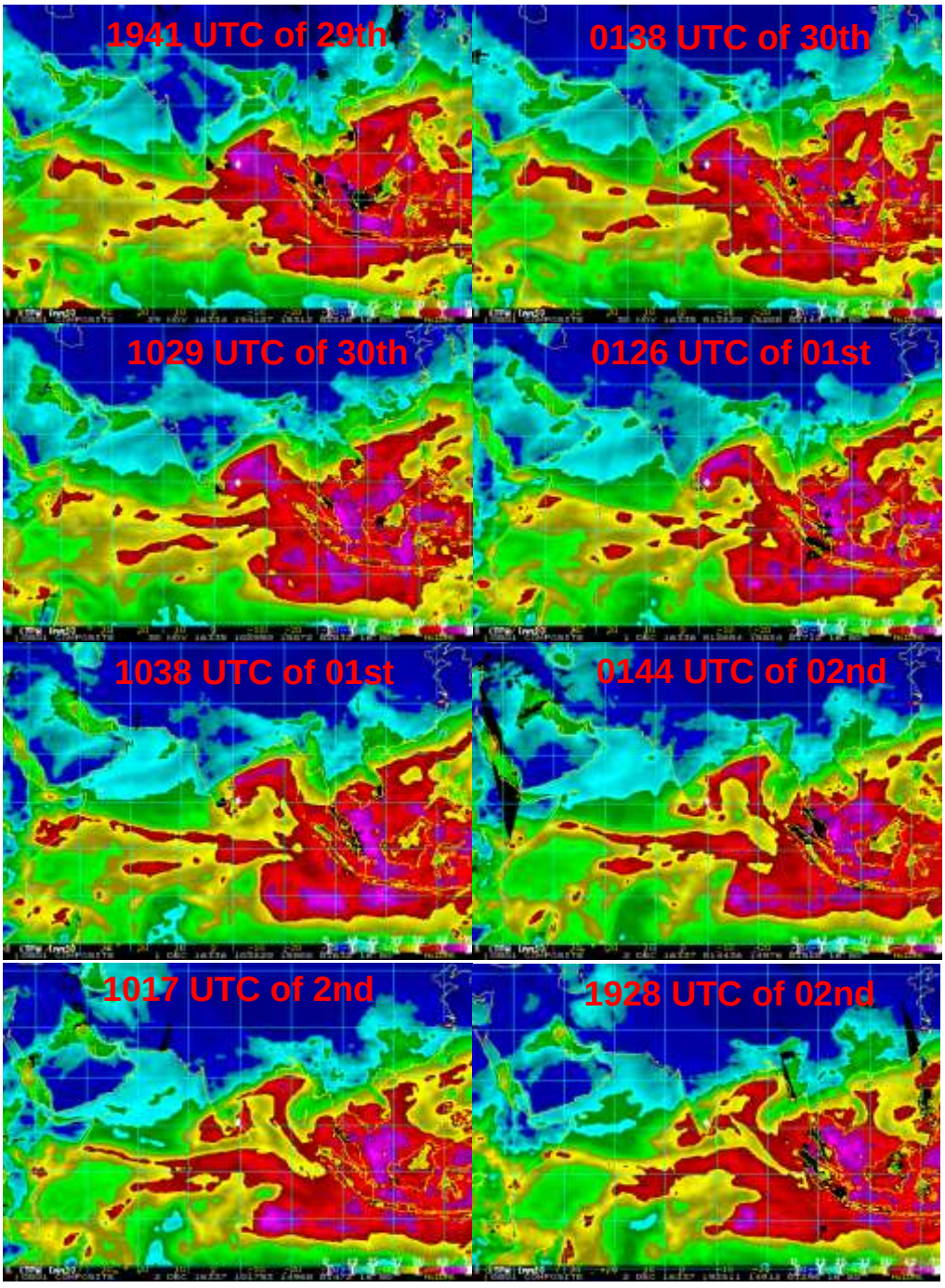


Fig. 4.17 Total precipitable water imageries during 29th Nov to 02 Dec 2016

The environmental wind shear between 200-850 hPa and 500-850 hPa is presented in Fig.4.18.

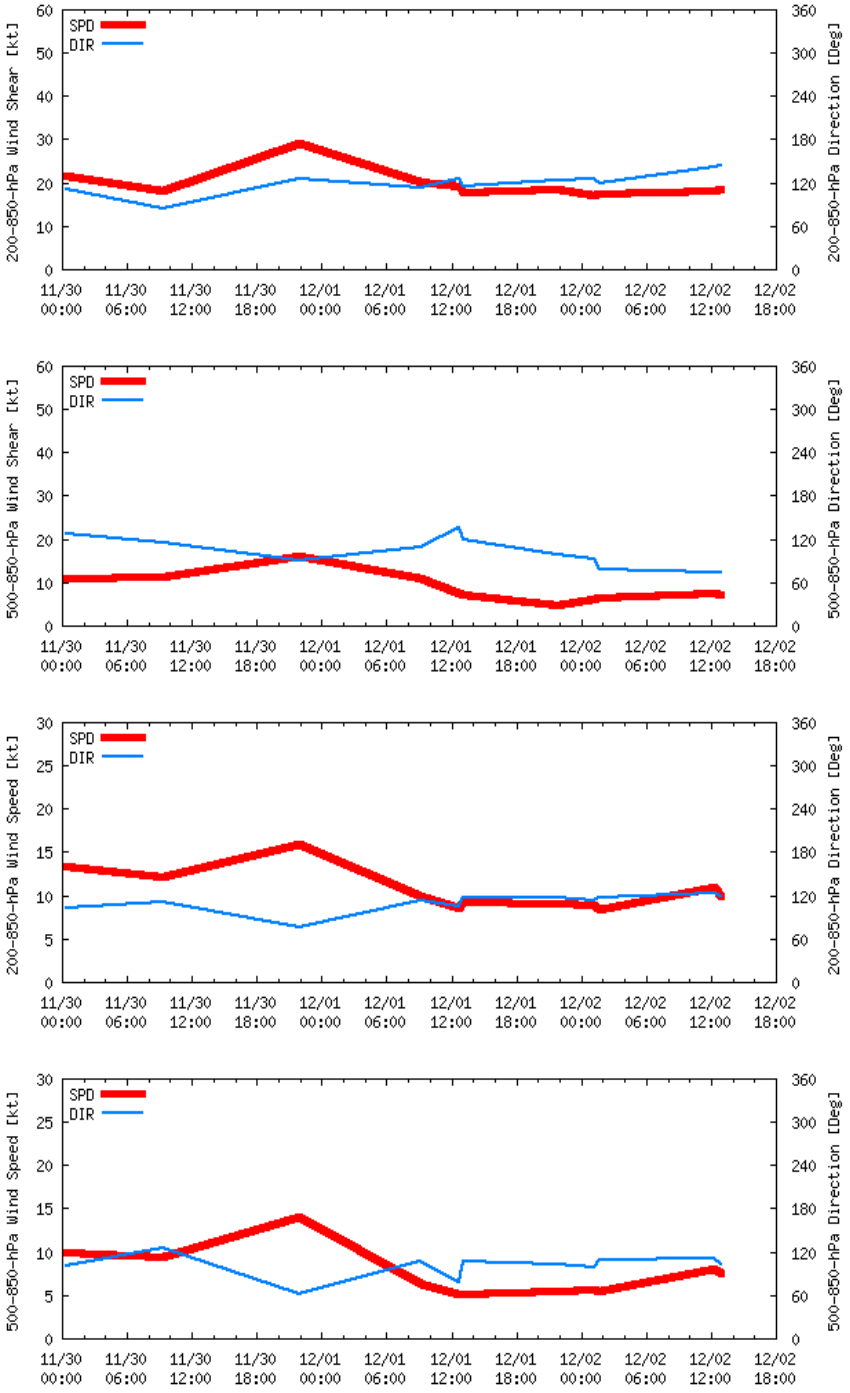


Fig. 4.18. Wind shear and wind speed in the middle and deep layer around the system during 29th November to 02nd December.

It indicates that the vertical wind shear was between 20-25 knots during genesis and intensification stage and then remained around 20 knots during cyclonic storm stage. During the period of dissipation it gradually increased and was about 20-25 knots. The vertical wind shear between lower and middle level (500-850 hPa level) also decreased during genesis and intensification stage and then increased during cyclonic storm stage. However unlike the vertical wind shear between upper and lower level, the vertical wind shear between lower and middle

level decreased during weakening stage, becoming about 15-20 knots. Thus the vertical wind shear between upper and lower level played a major role in genesis and intensification/weakening of CS Nada. The mean wind speed and direction between 200-850 hPa and 500-850 hPa are presented in Fig. 4.19. It indicates that the mean wind speed between 200-850 hPa was about 10-15 knots during genesis and intensification stage. It then weakened into about 10 knots during weakening of the system. The direction of the wind was nearly 1200 indicating west-northwestwards movement. Considering the mean wind speed between 500-850hPa levels, it was initially about 10 knots at the time of genesis and increased to about 15 knots during intensification of the system. Thereafter, it decreased becoming 5-7 knots during weakening stage of the system. The direction of the mean wind was about 120^0 throughout the life period indicating west-northwestwards movement of the system. Comparing with the actual direction of movement and translational speed (Fig. 4.19), the mean wind speed between 200 and 850 hPa levels was identical with the actual translational speed. However, the directions of movement were not in agreement with each other.

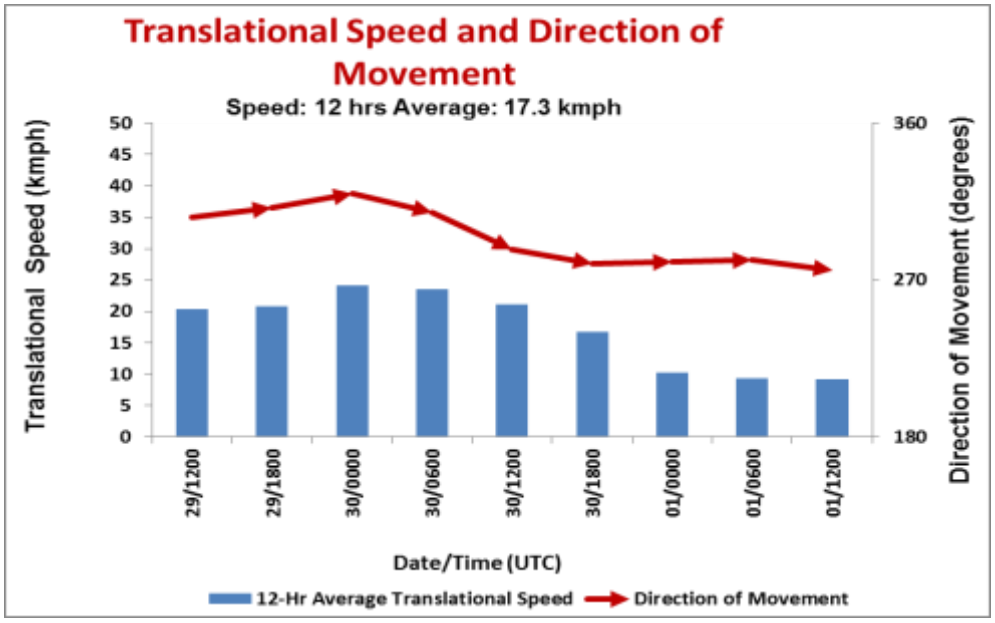


Fig. 4.19 Twelve hourly average translational speed (kmph) and direction of movement in association with CS Nada

4.1.3.2.3. Maximum Sustained Surface Wind speed and estimated central pressure:

The lowest estimated central pressure and the maximum sustained wind speed are presented in Fig.4.20. The lowest estimated central pressure had been 1000 hPa. The estimated maximum sustained surface wind speed (MSW) was 40 knots during 1200 UTC of 30^{th} to 2100 UTC of 30^{th} November. At the time of landfall, the ECP was 1006 hPa and MSW was 25 knots (Depression). The figure also indicates that the system did not intensify much despite its long journey over sea mainly because of unfavourable sea condition and dry air incursion from northwest. There was no rapid intensification and rapid weakening of the system throughout its life cycle.

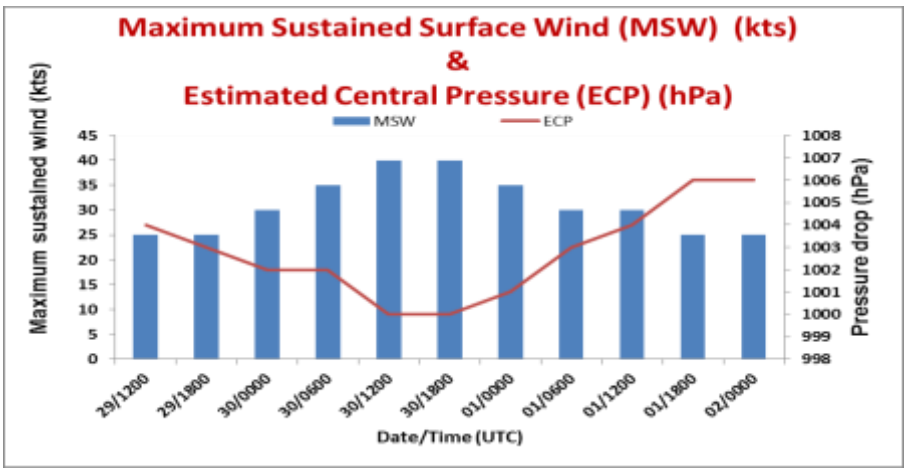


Fig. 4.20 Lowest estimated central pressure and the maximum sustained wind speed

4.1.3.2.4. Climatological aspects

Considering the area of genesis (+/- 2^0 around the genesis point), the climatological tracks of the TCs during 1891-2015 is presented in Fig.4.21. It indicates that climatologically, out of 28, only four systems recurved northeastwards and remaining moved wet-northwest/ northwestwards. Similarly out of 28, 17 systems intensified into cyclonic storm or higher intensity category.

Most of the system moving northwest/west-northwestwards crossed Tamil Nadu or Sri Lanka coast. Hence the track of Nada was nearly climatological in nature.

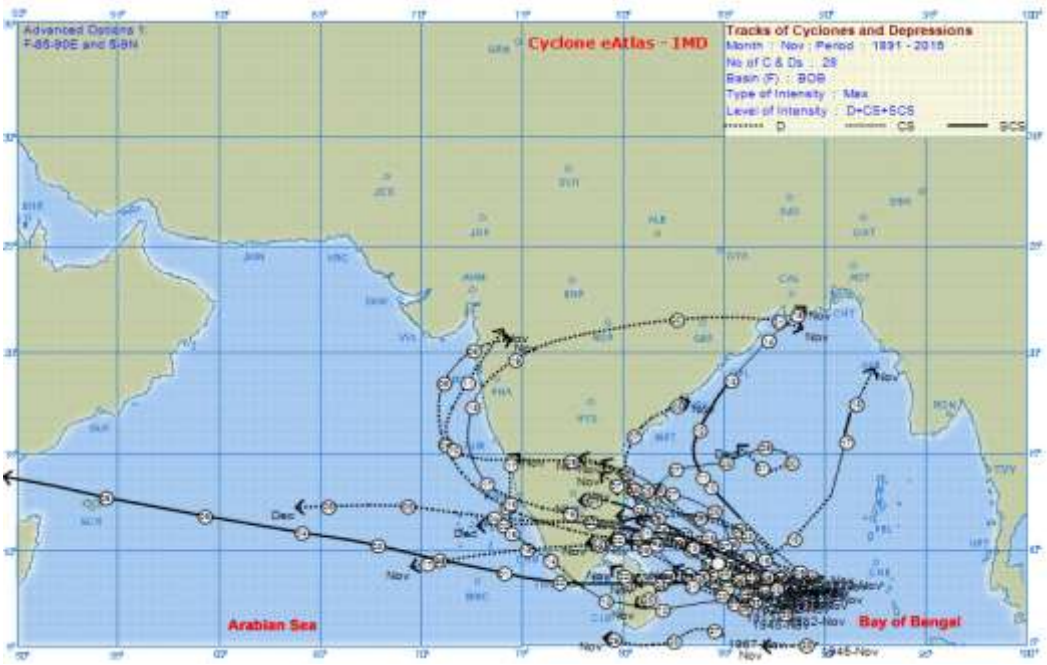


Fig. 4.21 Climatological tracks of TCs forming within +/- 2^0 around the genesis point during 1891-2015.

4.1.3.3. Features observed through satellite and Radar

4.1.3.3.1. Features observed through satellite

Satellite monitoring of the system was mainly done by using half hourly Kalpana-1 and INSAT-3D imageries. Satellite imageries of international geostationary satellites Meteosat-7 & MTSAT and microwave & high resolution images of polar orbiting satellites DMSP, NOAA series, TRMM, Metops were also considered. Typical INSAT-3D enhanced coloured imageries, grey scale enhanced imageries, IR imageries and visible imageries are presented in Fig. 4.22.

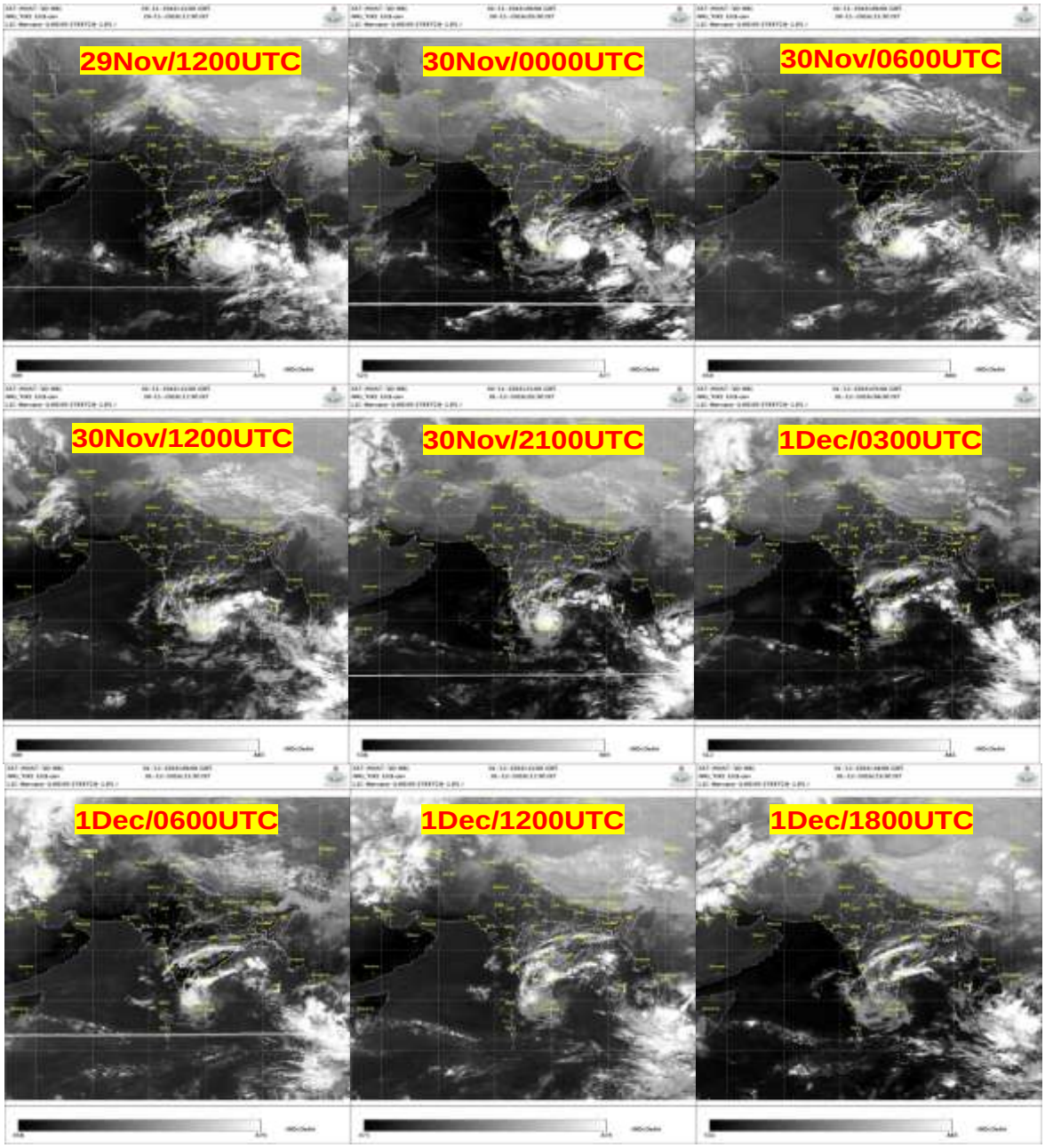


Fig. 4.22 (a) INSAT-3D IR imageries based on during 29 Nov – 02 Dec, 2016

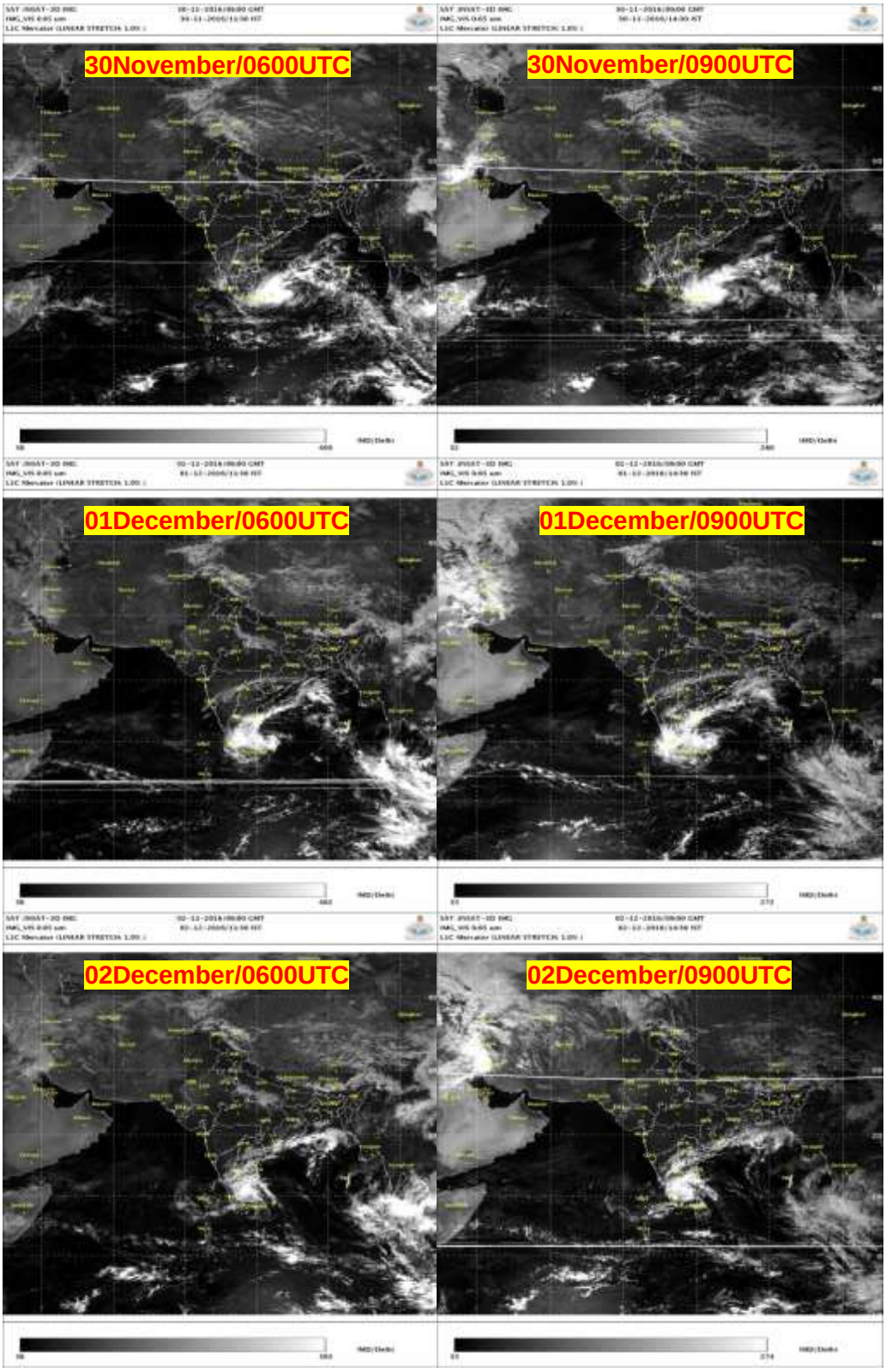


Fig. 4.22 (b) INSAT-3D IR imageries based on during 29 Nov – 02 Dec, 2016

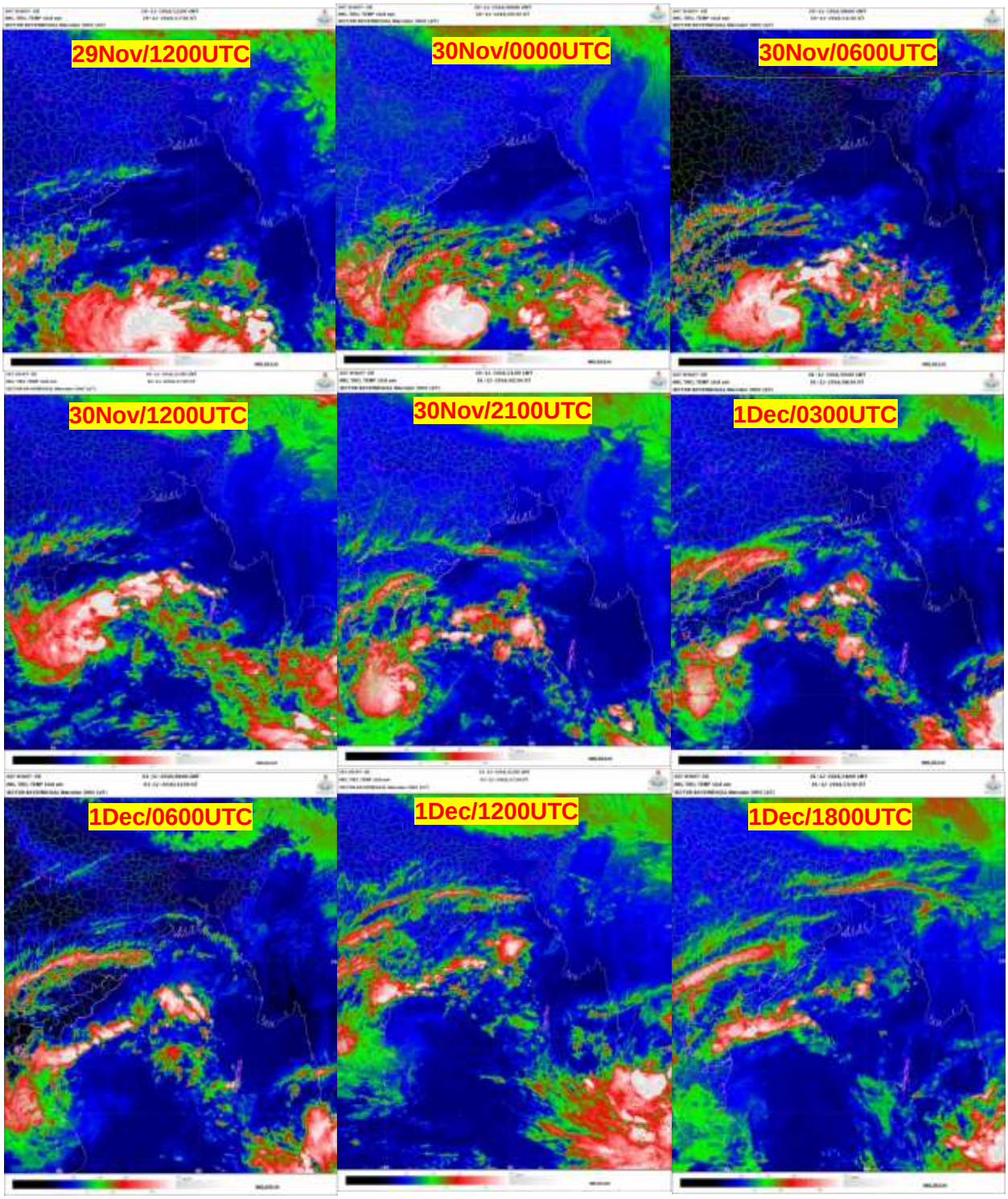


Fig. 4.22 (c) INSAT-3D enhanced colored imageries based on during 29 Nov – 02 Dec, 2016

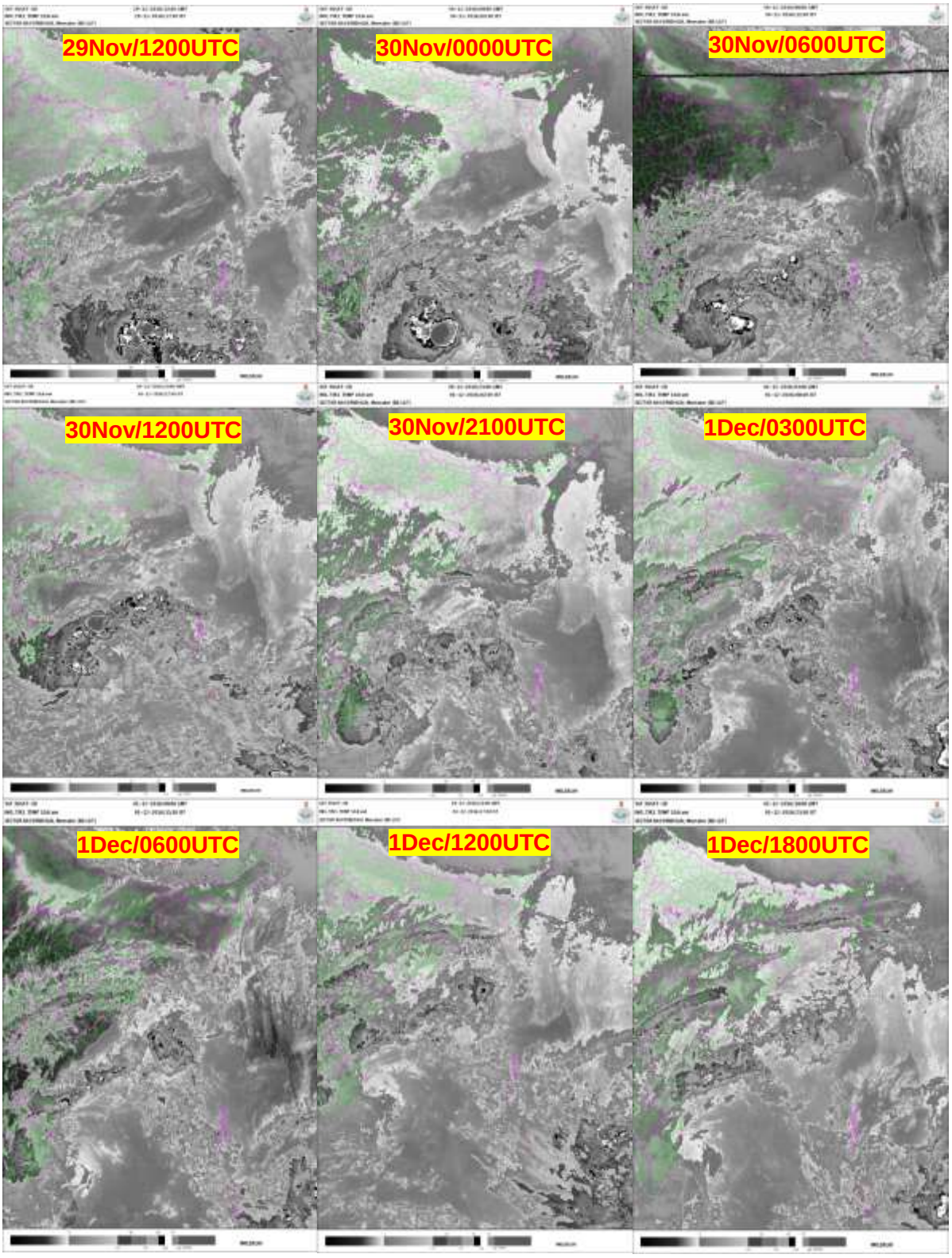


Fig. 4.22 (d): INSAT-3D enhanced grey scale imageries during 29 Nov – 02 Dec, 2016

4.1.3.3.2. Features observed through Radar

As the system was tracked by DWR Karaikal Radar imageries during 29th November-02nd December are presented in Fig. 4.23. The radar imageries helped in detecting the centre of the cyclone accurately, as it could find the spiral band pattern. It also helped in estimating intensity in terms of radial wind observations and the reflectivity of clouds.

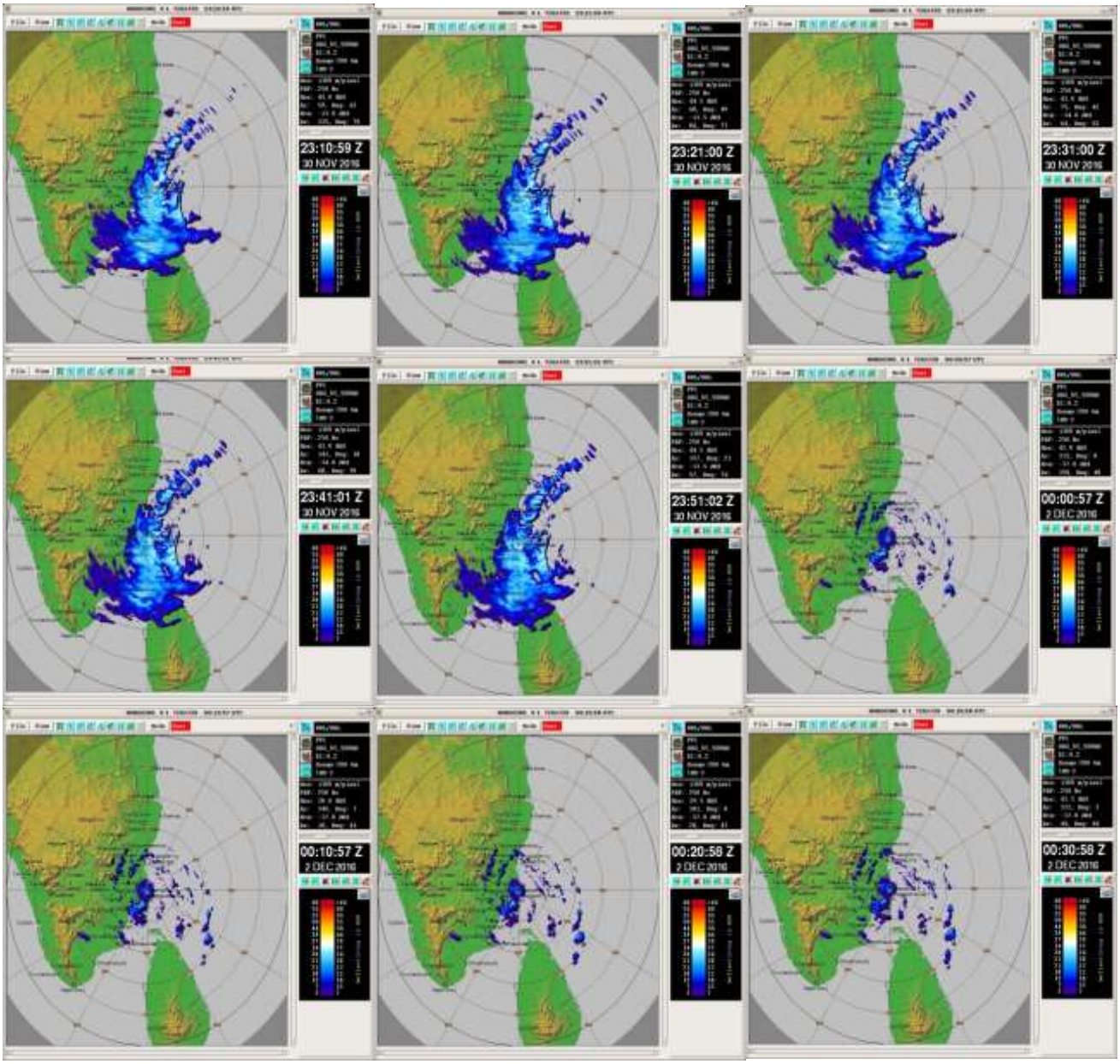


Fig. 4.23 (a): Plan Position Indicator (PPI) (dBZ) imageries from DWR Karaikal at 2310,

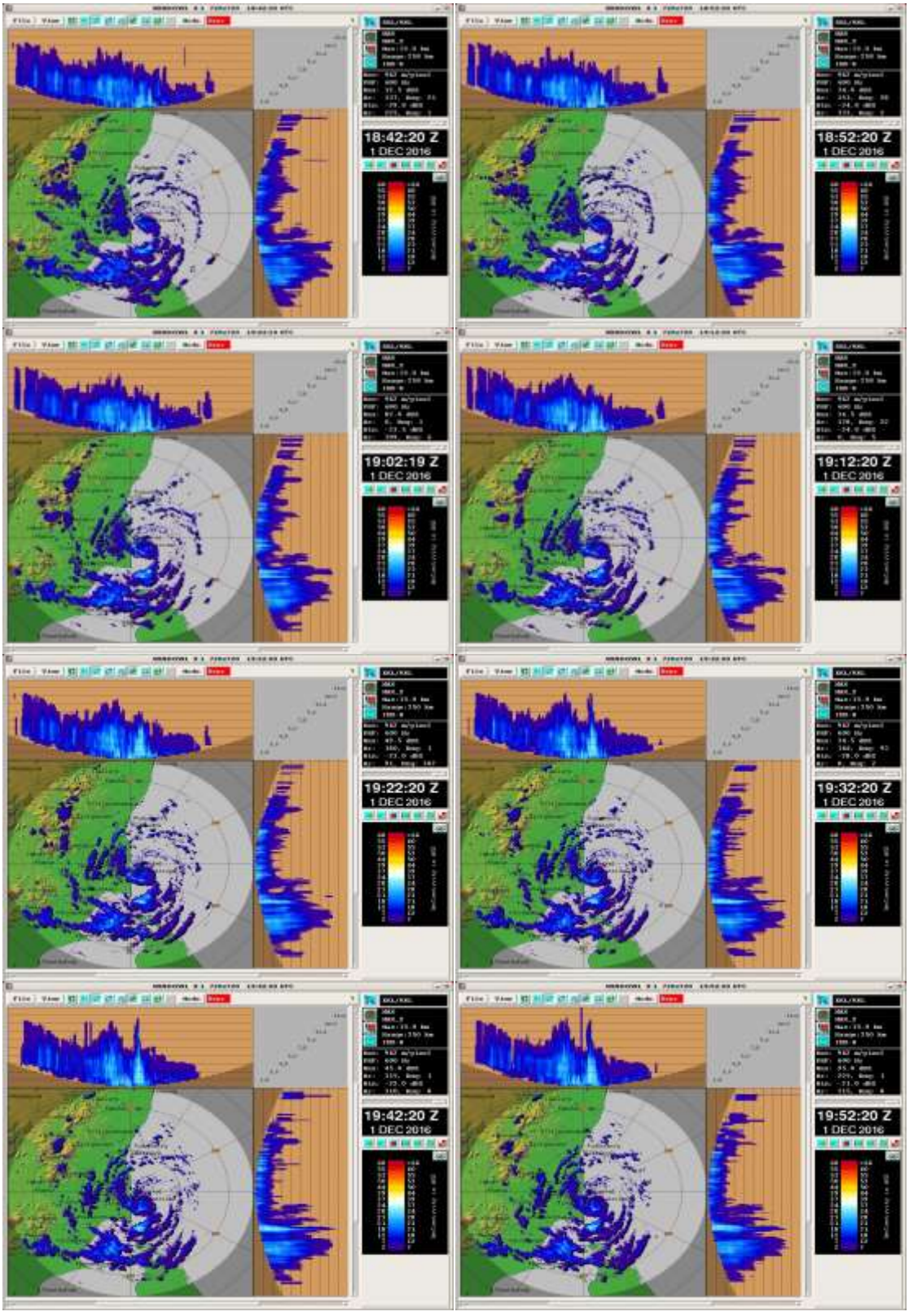


Fig. 4.23 (b): Max(dBZ) imageries from DWR Karaikal at 1842, 1852, 1902, 1912, 1922, 1932, 1942 and 1952 UTC of 1st December 2016.

4.1.3.4. Dynamical features

IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels are presented in Fig. 4.24. GFS (T574) could simulate the genesis of the system and the associated circulation features during the life period of CS Nada.

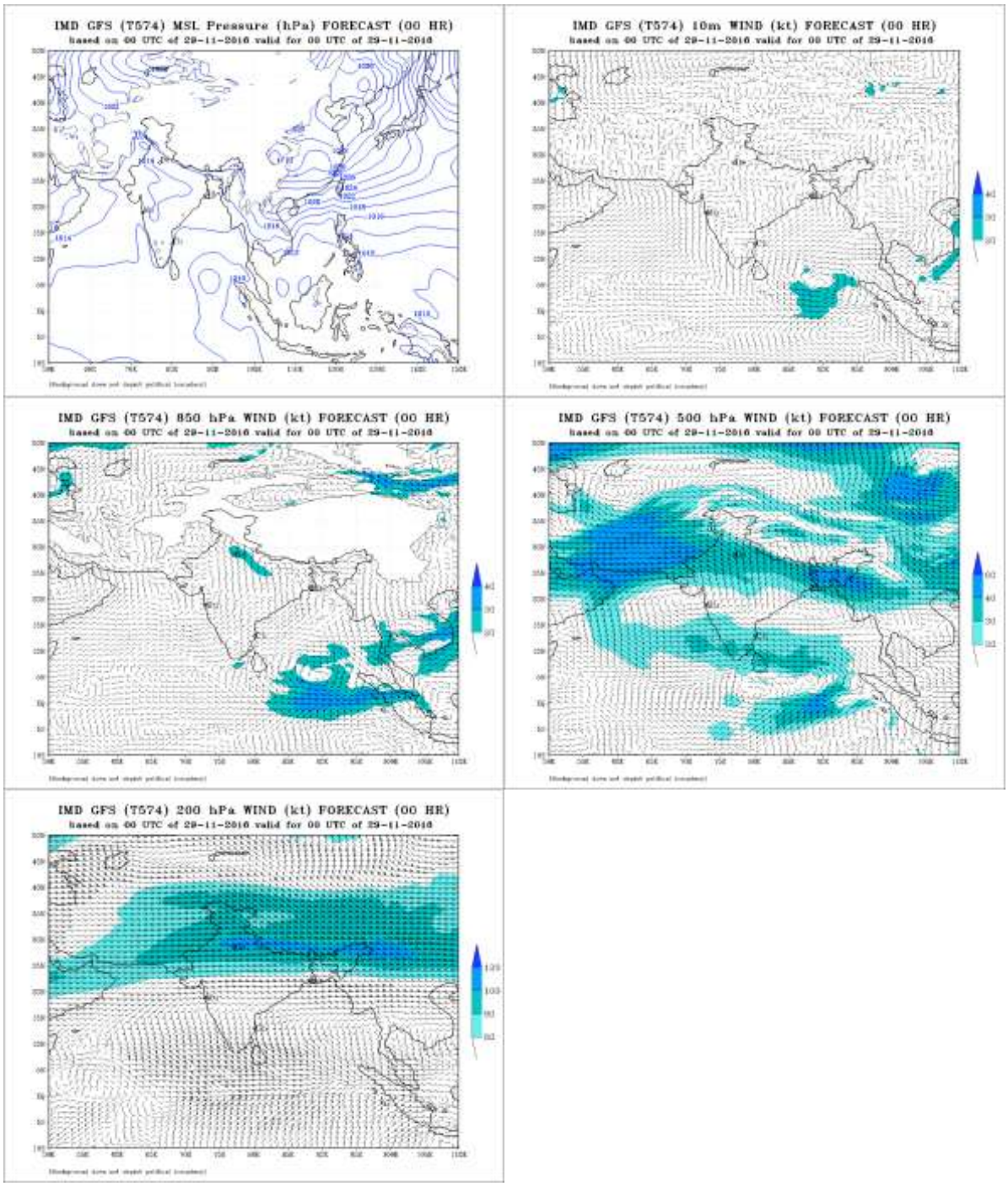


Fig. 4.24 (a): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 29th November 2016

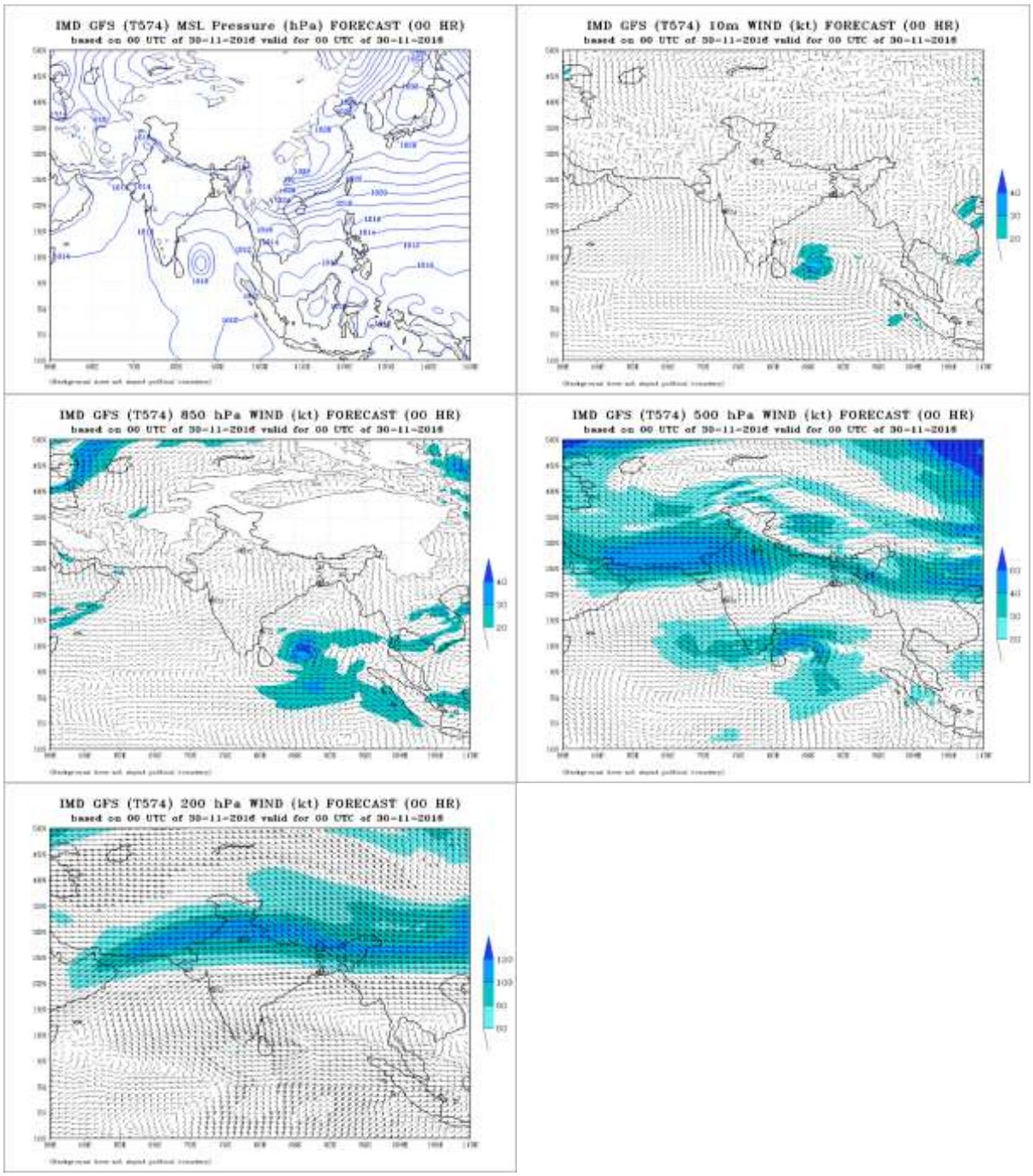


Fig. 4.24 (b): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 30th November 2016

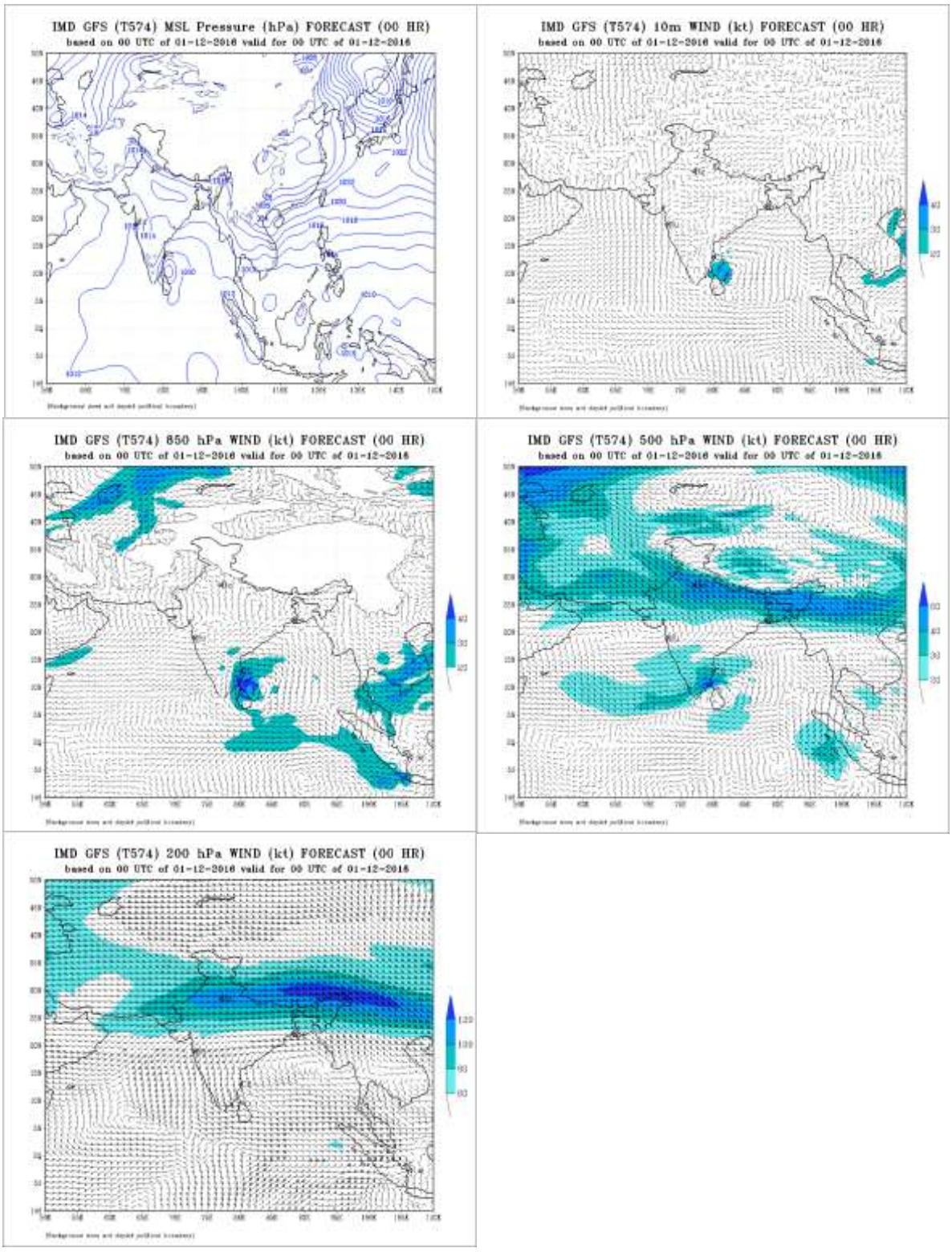


Fig. 4.24 (c): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 01st December 2016

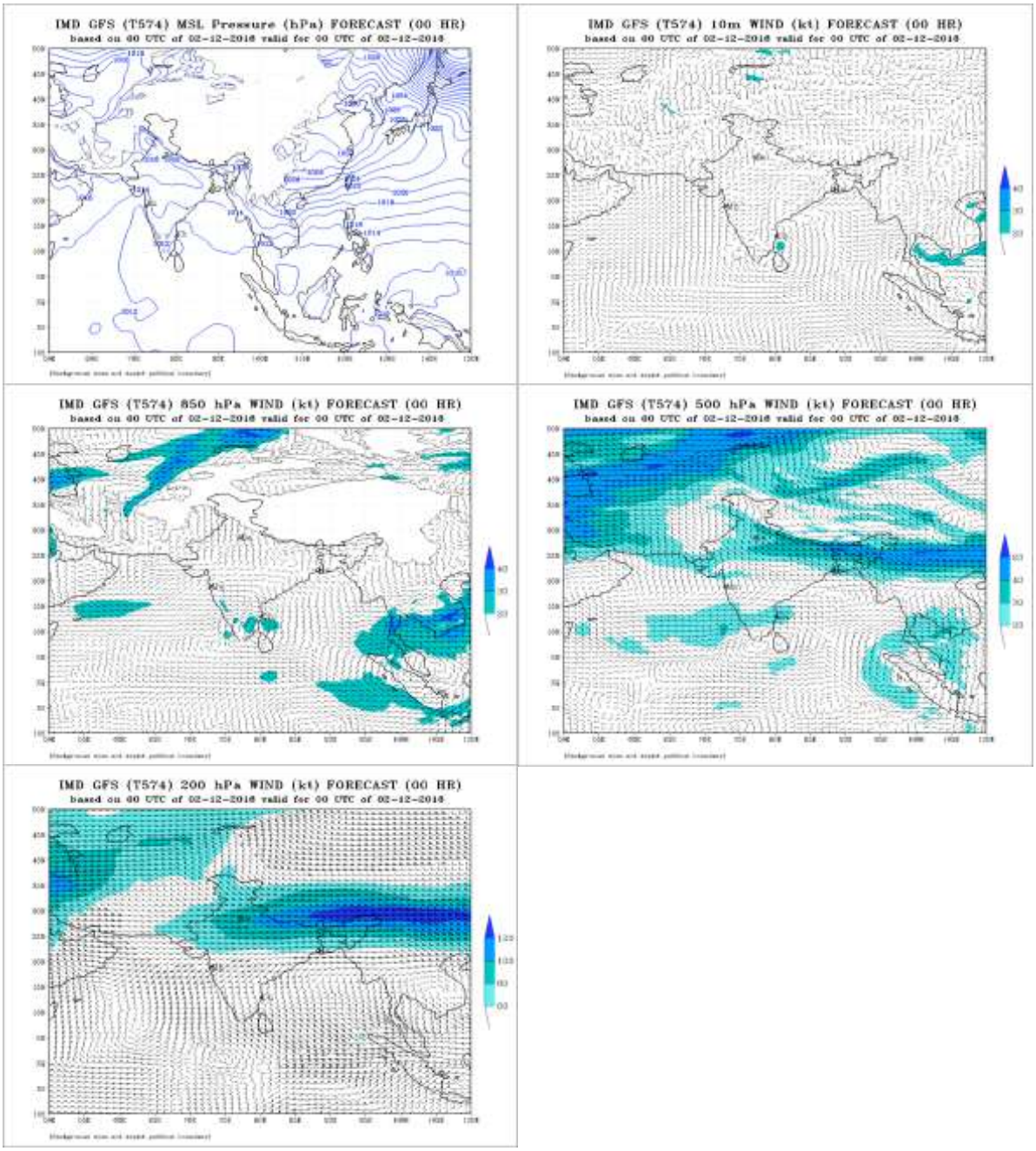


Fig. 4.24 (d): IMD GFS MSLP, 10 m wind and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 02nd December 2016

4.1.3.5. Realized Weather:

Rainfall:

Rainfall associated with the system is depicted in Fig 4.25. based on IMD-NCMRWF GPM merged gauge rainfall data. The chief amounts (7 cm or more) of 24 hrs accumulated rainfall ending at 0830 hrs IST of date are given below:

2nd December

Coastal Andhra Pradesh: Gudur-9

Tamilnadu & Puducherry : Mahabalipuram-11

3r[d] December

Tamilnadu & Puducherry: Kalpakkam And Virudhnagar-8, Madurai Airport, Chennai Airport, Sivakasi, Tirupavnam, Tiruttani, Kancheepuram, Chengalpattu, Metupatti and Tirumangalam-7 each

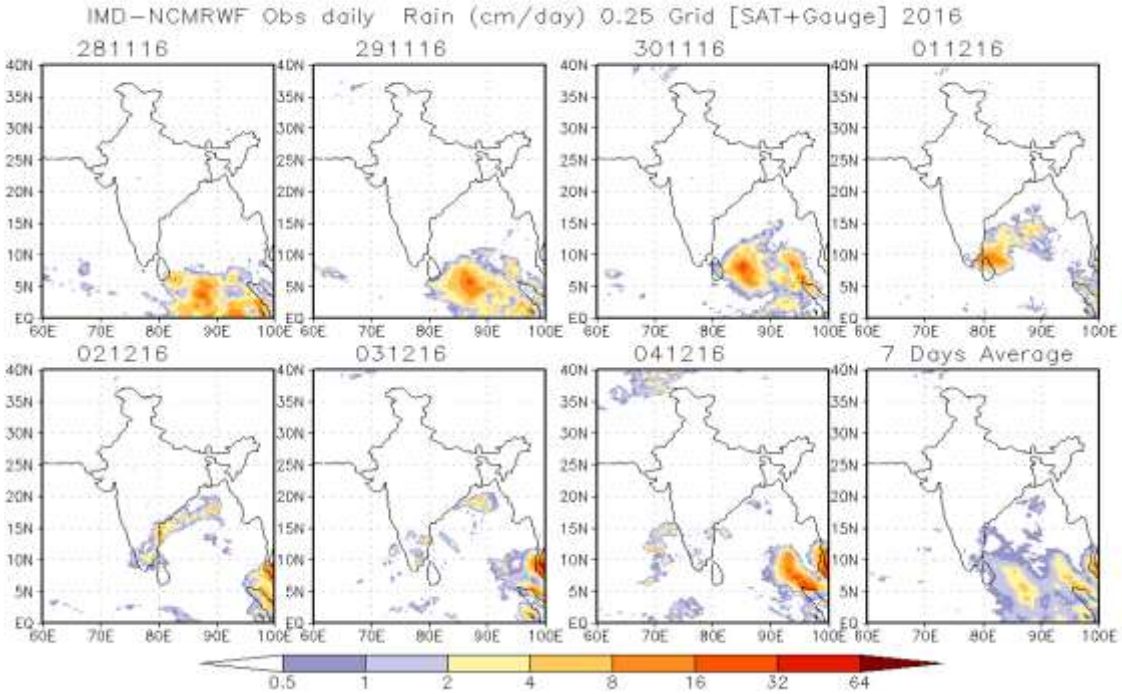


Fig.4.25. IMD-NCMRWF GPM merged gauge rainfall in association with CS, Nada

4.1.3.6. Damage due to CS Nada

No damage was reported as cyclone Nada weakened over sea and crossed coast as a depression.

4.1.4. Very Severe Cyclonic Storm 'VARDAH' over the Bay of Bengal (6^{th} -13^{th} Dec. 2016)

4.1.4.1. Introduction

A low pressure area developed over south Andaman Sea & adjoining Sumatra in the morning of 4^{th} December. It lay as a well marked low pressure area in the night of 5^{th} over south Andaman Sea and adjoining southeast Bay of Bengal (BoB). Moving westwards, it concentrated into a depression (D) over southeast BOB in the afternoon of 6^{th} December. Moving northwestwards initially and northwards thereafter, it intensified into a deep depression (DD) in the midnight of 7^{th} December, into a cyclonic storm (CS) "**VARDAH**" in the morning of 8^{th} and into a severe cyclonic storm (SCS) in the midnight of 9^{th}. It then moved west-northwestwards and intensified further into a very severe cyclonic storm (VSCS) over westcentral and adjoining south BOB in the evening of 10^{th} December. It then moved nearly westwards and reached its peak intensity of about 130 kmph on 11^{th} December evening and maintained the same intensity till noon of 12^{th} December. It weakened into an SCS at the time of landfall and crossed north Tamil Nadu coast near Chennai during 1500-1700 hrs IST of 12^{th} December 2016 with a wind speed of 110 kmph gusting to 125 kmph. After the landfall, the SCS moved west-southwestwards and weakened into a CS in the evening, into a DD in the midnight of 12^{th} and into D in the early morning of 13^{th}. Continuing its west-southwestwards movement, it weakened into a well marked low pressure area in the forenoon of 13^{th} December.

The salient features of the system are as follows.

- It was the first severe cyclonic storm of the year 2016.
- Vardah was the fourth consecutive cyclone with recurving track after cyclones Roanu, Kyant and Nada during the year, as it changed its track from initial northwards movement to west-northwestwards and then west-southwestwards after landfall.
- Unlike the previous two cyclones in the post-monsoon season, it crossed the coast with the cyclone intensity.
- The peak maximum sustained wind speed of the cyclone was 130 kmph gusting to 145 kmph over westcentral BOB.
- The life period of cyclone was 159 hours (6.6 days) against the normal of 4.7 days over north Indian Ocean during post-monsoon season for VSCS category.
- The track length of the cyclone was 1795 km.
- The 12 hour average translational speed of the cyclone was 5.2 kmph against normal of 13 kmph over BOB for post-monsoon season. However, prior to landfall, the cyclone moved with a speed of about 15-20 kmph.
- Lowest estimated central pressure (ECP) was 975.6 hPa with a pressure drop of 26 hPa.
- The Accumulated Cyclone Energy (ACE) which is a measure of damage potential was about 5.99×10^4 $knot^2$.
- The Power Dissipation Index which is a measure of loss due to a CS was 3.61×10^6 $knot^3$.
- There was rapid weakening of the system from 0600 to 1800 UTC of 12^{th} Dec as the maximum sustained wind speed decreased from 70 knots to 30 knots during this period.
- During genesis stage cyclone Vardah caused heavy to very heavy rainfall over Andaman & Nicobar Islands and squally wind speed reaching 50-60 kmph prevailed along and off Andaman & Nicobar Islands.

- ❖ It caused heavy to very heavy rainfall at many places with isolated extremely heavy rainfall over Chennai, Thiruvallur, Kanchipuram districts of Tamil Nadu and heavy to very heavy rainfall at a few places over Nellore district of Andhra Pradesh The maximum gale wind of about 11-110 kmph gusting to 120 kmph has been reported in these districts.
- ❖ The maximum storm surge of about 1 meter inundated low lying areas of Chennai, Thiruvallur districts of Tamil Nadu and Nellore district of Andhra Pradesh at the time of landfall.

4.1.4.2. Brief life history

4.1.4.2.1. Genesis

Under the influence of an upper air cyclonic circulation over northern parts of Sumatra & adjoining south Andaman Sea, a low pressure area formed over south Andaman Sea & adjoining Sumatra extending upto mid-tropospheric levels at 0300 UTC of 4th December. Moving west-northwestwards, it lay as a well marked low pressure area in the night of 5th over south Andaman Sea and adjoining southeast BoB. At 0900 UTC of 6th, the sea surface temperature (SST) was around 28-29˚C. The Ocean heat content was about 100-120 KJ/cm^2 over the well marked low pressure area. The low level convergence was about 20x10^{-5} second$^{-1,}$ the upper level divergence was around 30x10^{-5} second^{-1} and the low level relative vorticity was about 100x10^{-6} second^{-1} to the southwest of the system. The vertical wind shear of horizontal wind was moderate (5-15 knots) around the system centre and was increasing towards northwest and westcentral BoB. The Madden Julian Oscillation (MJO) index was in phase 2 with amplitude <1. The upper tropospheric ridge lay along 13^{0}N and east-southeasterly winds prevailed over the region of low pressure area in middle and upper tropospheric levels. Under these favourable environmental conditions, the well marked low pressure area over southeast BoB and adjoining south Andaman Sea moved west-northwestwards and concentrated into a depression (D) and lay centred at 0900 UTC of 6th over southeast BoB near latitude 8.5ºN and longitude 91.0ºE.

4.1.4.2.2. Intensification

At 1800 UTC of 7th, SST was around 28-29˚C, the ocean heat content was about 70-80 KJ/cm^2 over the depression. The low level convergence was about 20x10^{-5} second^{-1} to the east-northeast of the system centre, the upper level divergence was around 40x10^{-5} second^{-1} to the northeast and the low level relative vorticity was about 150x10^{-6} second^{-1} to the southeast of the system centre. The vertical wind shear of horizontal wind was moderate (10-20 knots) around the system centre and was increasing towards northwest and westcentral BoB. The MJO index lay in phase 2 with amplitude 1. Under these favourable environmental conditions, the system moved northwestwards initially & then northwards and concentrated into a deep depression **(DD)** at 1800 UTC of 7th over southeast BoB near latitude 10.8ºN and longitude 90.5ºE. At 0000 UTC of 8th, similar conditions prevailed and moving northwards, the system intensified into a cyclonic storm **(CS)** over southeast BoB near latitude 11.2ºN and longitude 90.5ºE. At 0000 UTC of 9th, similar thermal conditions prevailed. The low level convergence was about 20x10^{-5} second^{-1} to the east-northeast of the system centre, the upper level divergence was around 10x10^{-5} second^{-1} around the system centre and the low level relative vorticity increased to about 250x10^{-6} second^{-1} to the southeast of the system centre. The vertical wind shear of horizontal wind was high (20-25 knots) around the system centre. The MJO index lay in phase 2 with amplitude 1. Under these environmental parameters, the system moved nearly northwards,

intensified gradually and lay over southeast BoB near latitude 12.1ºN and longitude 90.4ºE. At 1800 UTC of 9th, the SST was around 28-29˚C, the ocean heat content was about 70-80 KJ/cm^2 over the system. The low level convergence was about 50x10^{-5} second^{-1} at system centre, the upper level divergence was around 30x10^{-5} second^{-1} to west of the system centre and the low level relative vorticity was about 250x10^{-6} second^{-1} to the south of the system centre. The vertical wind shear of horizontal wind was high (20-25 knots) around the system centre. The MJO index lay in phase 2 with amplitude less than 1. Under these favourable environmental parameters, CS Vardah moved west-northwestwards and intensified into a severe cyclonic storm **(SCS)** over southeast BoB near latitude 12.3ºN and longitude 89.6ºE. At 1200 UTC of 10th, similar thermodynamical and large scale environmental conditions prevailed and the system moving west-northwestwards, concentrated into a very severe cyclonic storm **(VSCS)** and lay centered over westcentral and adjoining south BoB near latitude 13.2ºN and longitude 86.4ºE. At 0000 UTC of 11th, the low level convergence was about 40x10^{-5} second^{-1} to the southwest of the system centre, the upper level divergence was around 30x10^{-5} second^{-1} to southwest of the system centre. the low level relative vorticity was about 250x10^{-6} second^{-1} to the south-southwest of the system centre. The vertical wind shear of horizontal wind was high (20-25 knots) around the system centre. The system intensified slightly and lay centered over westcentral and adjoining southwest BoB near latitude 13.3ºN and longitude 84.7ºE. The system continued its near westward journey, and at 0900 UTC of 12th, weakened slightly due to land interactions, lower SST about 26˚C, lower Ocean thermal energy less than 50 KJ/cm^2 and high vertical wind shear (20-25 knots) over westcentral & adjoining southwest BoB. Moving westwards, the system crossed north Tamil Nadu coast close to Chennai near 13.13^{0}N/80.3^{0}E during 0930-1130 UTC of 12th. Moving west-southwestwards, the system weakened into a CS over north Tamil Nadu near latitude 12.9ºN and longitude 79.5ºE at 1500 UTC of 12th, into a DD over north interior Tamil Nadu near latitude 12.7ºN and longitude 79.1ºE at 1800 UTC of 12th. It further weakened into a depression over north interior Tamil Nadu near at 0000 UTC of 13th and into a well marked low pressure area at 0300 UTC of 13th over north interior Tamil Nadu and adjoining south interior Karnataka.

Table 4.6: Best track positions and other parameters of the Very Severe Cyclonic Storm, 'Vardah' over the Bay of Bengal during 06-13 December, 2016

Date	Time (UTC)	Centre lat.^{0} N/ long.^{0} E	C.I. NO.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
06/12/2016	0900	8.5/91.0	1.5	1002	25	3	**D**
	1200	8.5/90.5	1.5	1002	25	3	D
	1800	9.5/90.5	1.5	1002	25	3	D
07/12/2016	0000	9.8/90.5	1.5	1002	25	4	D
	0300	9.8/90.5	1.5	1002	25	4	D
	0600	9.8/90.5	1.5	1002	25	4	D
	1200	10.0/90.5	1.5	1002	25	4	D
	1800	10.8/90.5	2.0	1000	30	5	**DD**
08/12/2016	0000	11.2/90.5	2.5	998	35	6	**CS**
	0300	11.5/90.5	2.5	998	35	7	CS

	0600	11.5/90.5	2.5	998	35	7	CS
	0900	11.5/90.5	2.5	998	35	7	CS
	1200	11.7/90.5	2.5	997	40	8	CS
	1500	11.7/90.5	2.5	997	40	8	CS
	1800	11.8/90.5	2.5	997	40	8	CS
	2100	12.0/90.5	2.5	997	40	8	CS
09/12/2016	0000	12.0/90.4	3.0	996	45	10	CS
	0300	12.1/90.4	3.0	996	45	10	CS
	0600	12.1/90.3	3.0	996	45	10	CS
	0900	12.2/90.3	3.0	996	45	10	CS
	1200	12.2/90.0	3.0	996	45	10	CS
	1500	12.2/89.9	3.0	994	45	12	CS
	1800	12.3/89.6	3.0	992	50	14	**SCS**
	2100	12.5/89.0	3.5	990	55	16	SCS
1012/2016	0000	12.6/88.4	3.5	990	55	16	SCS
	0300	12.7/88.0	3.5	990	55	16	SCS
	0600	13.0/87.4	3.5	990	55	16	SCS
	0900	13.1/86.8	3.5	988	60	18	SCS
	1200	13.2/86.4	4.0	984	65	22	**VSCS**
	1500	13.3/85.9	4.0	984	65	22	VSCS
	1800	13.3/85.3	4.0	984	65	22	VSCS
	2100	13.3/85.0	4.0	982	65	22	VSCS
11/12/2016	0000	13.3/84.7	4.0	980	70	24	VSCS
	0300	13.1/84.3	4.0	980	70	24	VSCS
	0600	13.1/83.7	4.0	980	70	24	VSCS
	0900	13.1/83.3	4.0	980	70	24	VSCS
	1200	13.3/83.0	4.0	980	70	24	VSCS
	1500	13.3/82.5	4.0	980	70	24	VSCS
	1800	13.1/82.3	4.0	980	70	24	VSCS
	2100	13.2/81.9	4.0	978	70	26	VSCS
12/12/2016	0000	13.2/81.6	4.0	975	70	26	VSCS
	0300	13.2/81.2	4.0	975	70	26	VSCS
	0600	13.2/80.7	4.0	975	70	26	VSCS
	0900	13.1/80.3	3.5	975	60	26	**SCS**
	Crossed North Tamil Nadu coast close to Chennai near 13.13^{0}N/80.3^{0}E during 0930-1130 UTC						
	1200	13.0/79.9	3.5	984	50	18	SCS
	1500	12.9/79.5	3.0	994	40	10	**CS**
	1800	12.7/79.1	2.0	1002	30	5	**DD**
13/12/2016	0000	12.5/78.0	1.5	1003	20	3	**D**
13/12/2016	0300	**Well Marked Low Pressure Area over north interior Tamil Nadu and south Interior Karnataka**					

The total precipitable water imageries (TPW) during 06th to 13th December are presented in Fig.4.26. These imageries indicate gradual incursion of cold, dry air from northwest into the

system cutting off supply of cross equatorial moist air into the system on 12th completely. It led to rapid weakening of the system after landfall. The best track parameters of the system are presented in Table 4.6 and the best track in Fig.4.1.

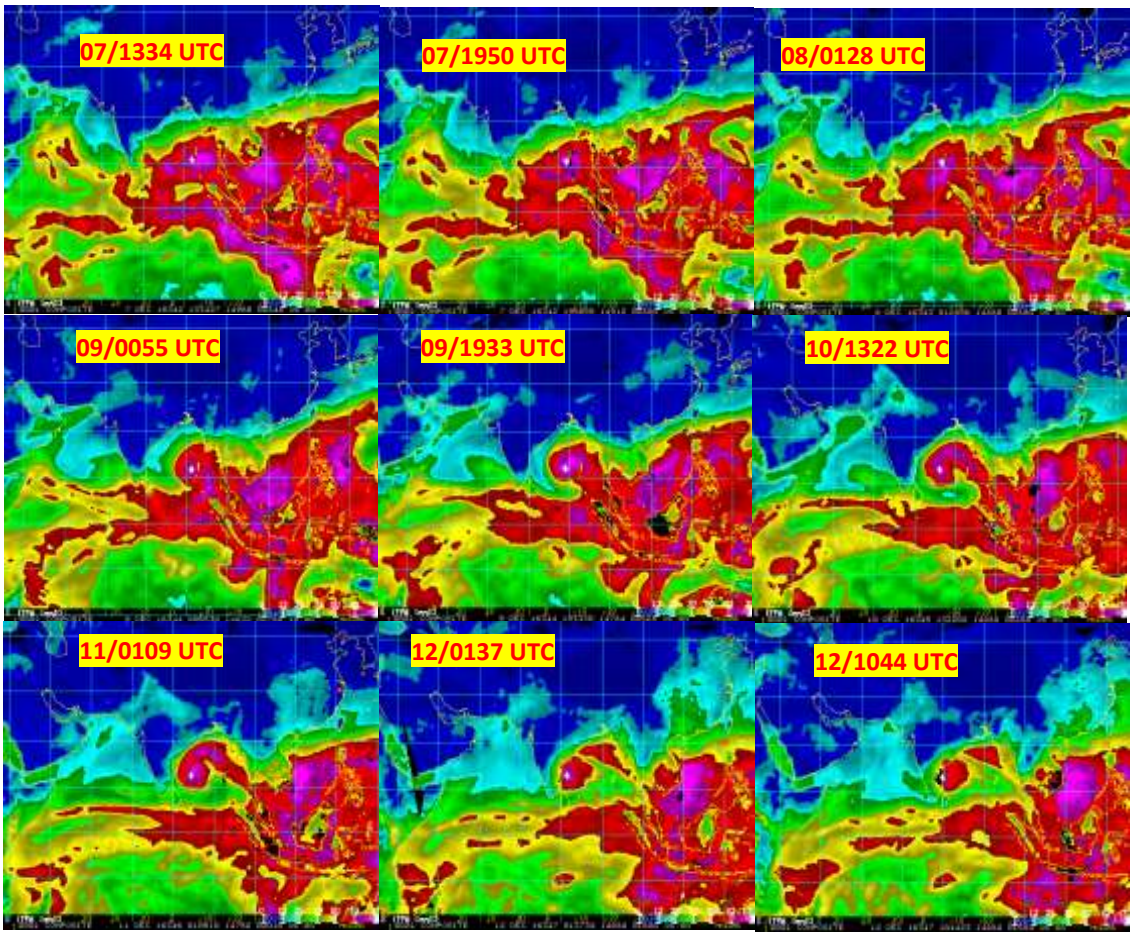


Fig. 4.26: Total Precipitable Water Imageries during 6th – 13th December, 2016

4.1.4.2.3 Movement

VSCS Vardah moved initially northwestwards and then northwards till midnight of 8th December. It then recurved and moved west-northwestwards till 0900 UTC of 12th and west-southwestwards after landfall close to Chennai coast. The wind speed in middle and deep layer around the system centre is presented in Fig. 4.27. The six hourly movement of VSCS Vardah is presented in Fig. 4.28. The system had a track length of about 1795 km during its life period. It indicates that from 18th onwards, the middle to upper level steering flow was supporting the above direction and speed of movement. The west-southwesterly movement after the landfall was in association with an anti-cyclonic circulation lying to the northwest of the system centre. The initial slow northerly movement of the system was in association with the upper tropospheric ridge which lay very close to the north of the system centre. Under the influence of middle and upper tropospheric trough, the wind shear around the system between 200 and 850 hPa levels also increased rapidly on 20th and 21st. As the wind shear was east-southeasterly, the convective cloud mass was sheared towards west-northwestwards of the system centre till 20th.

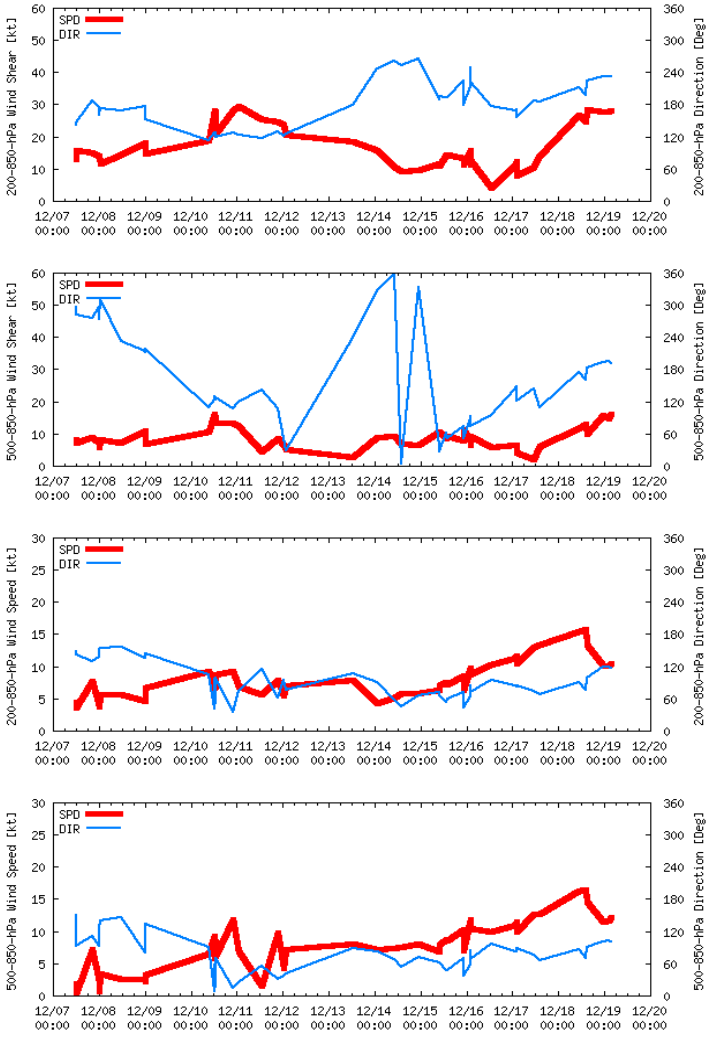


Fig.4.27. Wind shear and wind speed in the middle and deep layer around the system during 06th to 13th December 2016.

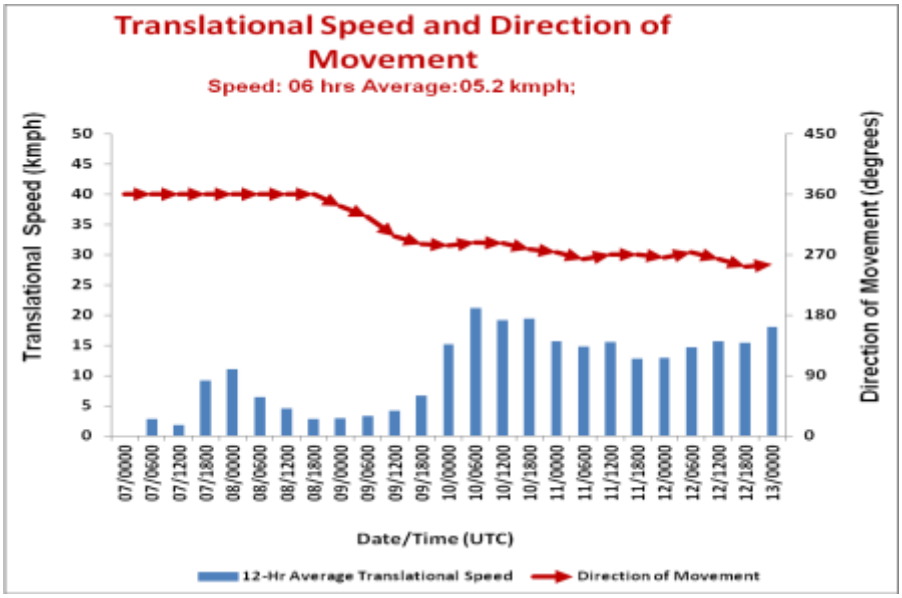


Fig.4.28 Twelve hourly average translational speed (kmph) and direction of movement in association with VSCS Vardah

4.1.4.2.4. Landfall point and time

The plot of hourly observations is presented in Fig. 4.29 during 0600-1200 UTC of 12th December. Veering of winds over NBK from northwesterly (0900 UTC) to southeasterly (1100 UTC) with calm winds at 1000 UTC indicating that the system has passed over NBK at 1000 UTC of 12th. Light winds over MBK at 1100 UTC and backing of winds from southwesterly at 1000 UTC to southeasterly at 1200 UTC suggest that the system passed over MBK at 1100 UTC.

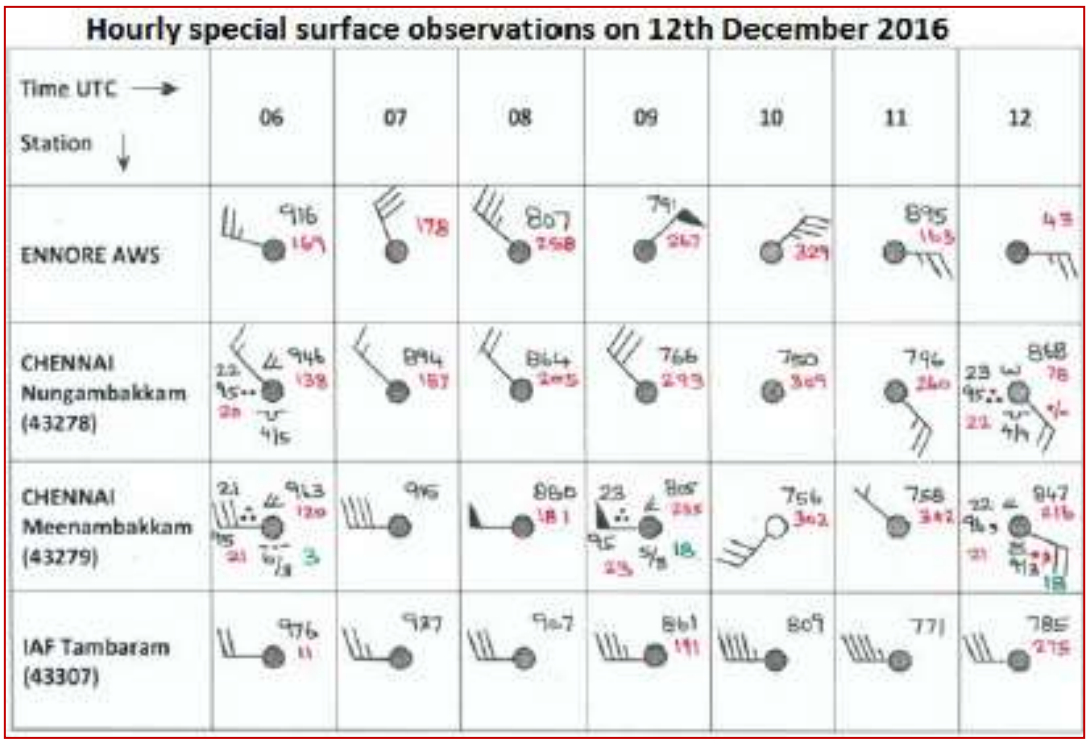


Fig.4.29: Hourly synoptic observations during 0600 -1200 UTC of 12th December, 2016

4.1.4.2.5. Maximum Sustained Surface Wind speed and estimated central pressure:

The lowest estimated central pressure and the maximum sustained wind speed are presented in Fig. 4.30. The lowest estimated central pressure had been 976 hPa. The reported lowest mean sea level pressure has been 975.6 hPa recorded over Chennai at the time of landfall. The estimated maximum sustained surface wind speed (MSW) was 70 knots during 0000 UTC of 11th to 0600 UTC of 12th December. At the time of landfall, the ECP was 976 hPa and MSW was 60 knots (severe cyclonic storm). The ECP and Vmax graph indicate that the system intensified gradually till 0000 UTC of 11th, maintained its intensity till 0600 UTC of 12th and started weakening rapidly after landfall. There was rapid weakening of the system from 0600 to 1800 UTC of 12th Dec as the maximum sustained wind speed decreased from 70 knots to 30 knots during this period.

The hourly MSLP as recorded by Nungambakkam (NBK) (Chennai city) and Meenambakkam (MBK) (Chennai airport) is shown in Fig. 4.31 (a) which clearly indicates that the pressure fell gradually from 11th onwards. The minimum MSLP of 975 hPa and 975.6 hPa was recorded at NBK and MBK respectively at 1000 UTC. The lowest MSLP of 975.0 and 974.0 hPa has been recorded by the barograph at NBK and MBK respectively. At that time, the

outermost pressure was 1002 hPa. Hence the pressure drop was 26-28 hPa at different stations in Chennai. Considering other stations surrounding Chennai, as shown in Table **4.7**, it is found that the lowest MSLP of 974.0 hPa was recorded over Chennai Airport at 1030 UTC. It indicates the cyclone Vardah crossed Tamil Nadu coast near Chennai around 1030 UTC.

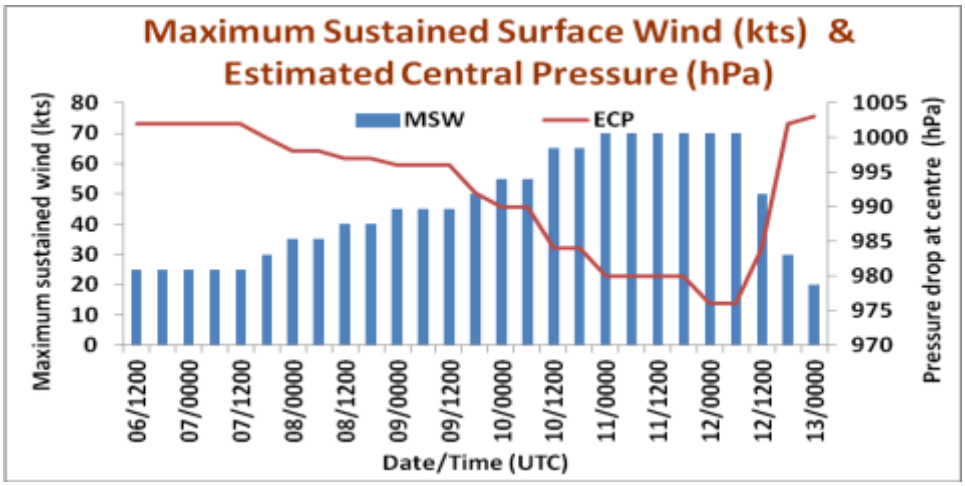


Fig.4.30 Lowest estimated central pressure and the maximum sustained wind speed

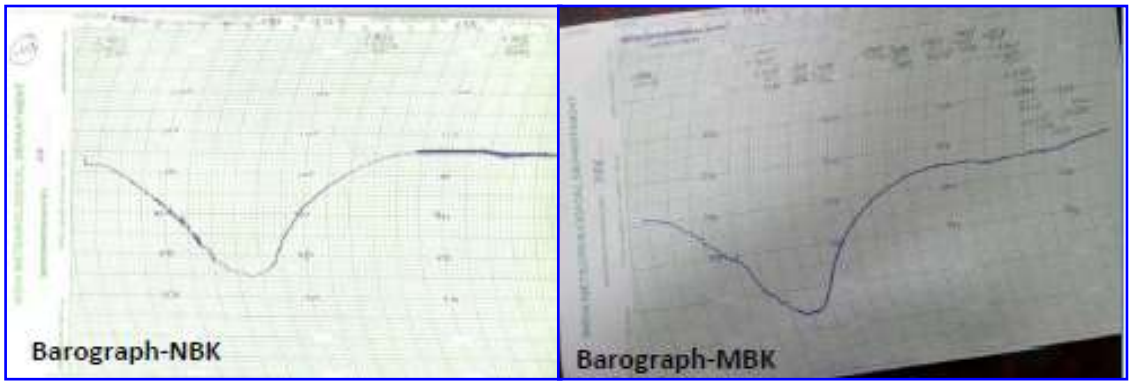


Fig.4.31 (a): Barograph recordings at NBK and MBK on 12th December 2016

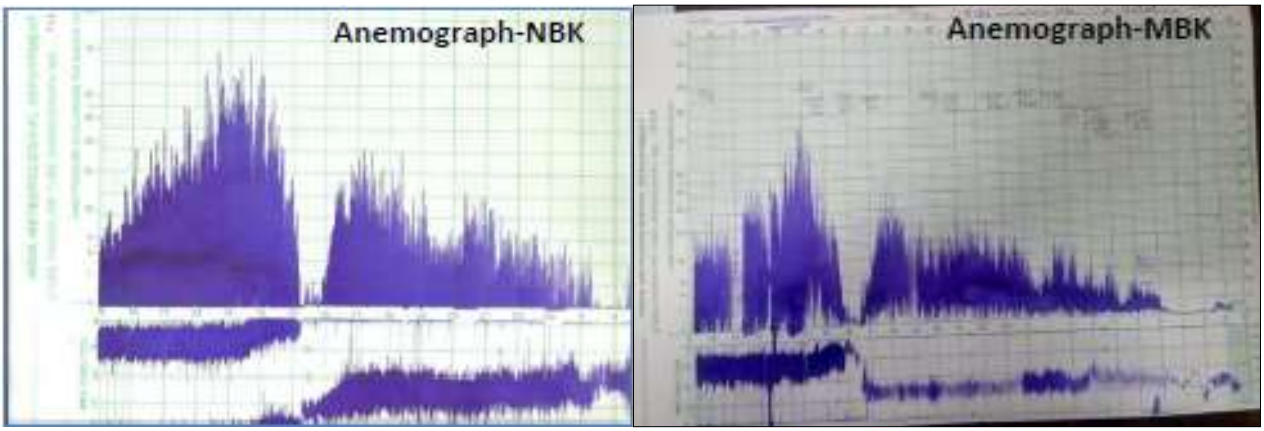


Fig.4.31 (b): Anemograph recordings at NBK and MBK.

4.1.4.2.6. MSW based on pressure wind relationship:

The pressure drop at the centre was 28 hPa with lowest MSLP of 974 hPa over Chennai Airport (MBK) and the outermost pressure in the cyclone was 1002hPa. According to Mishra and Gupta formula, the MSW=14.2*SQRT (pressure drop) = 14.2*SQRT (28) = 75 knots. (139 kmph)

Table 4.7: Observational data recorded by manned observatories and AWS

Station/(lat./long.)	Lowest MSLP (hPa) and time of occurrence (UTC)	Wind Speed (kts/kmph) and time of occurrence (UTC)	Wind Direction (degree) and time of occurrence (UTC)
*Chennai (NBK)/ (13.1N/80.2E) (Manned)	975.0 at 1000 UTC	30 kts (56 kmph) at 0900 UTC	315
*Chennai (MBK)/ (12.98N/80.18E) (Manned)	975.6 at 1000 UTC	50kts (93 kmph) at 0900 UTC	270
*Chennai (NBK)/ (13.1N/80.2E) (AWS)	977 at 1000 UTC	11kts (20 kmph) at 0800 UTC	340
*Ennore Port/ (13.2N/80.3E) (AWS)	979.1 at 0900 UTC	48kts (89 kmph) at 0900 UTC	10
*Madhavaram Agro/ (13.2N/80.2E) (AWS)	977.3 at 1000 UTC	25kts (46 kmph) at 0800 UTC	350
*MBK-ISRO/ (13.0N/80.2E) (AWS)	978 at 1000 UTC	13kts (24 kmph) at 0700 UTC	200
**Chennai (NBK)/ (13.1N/80.2E) (Barograph)	975.0 at 1000 UTC	61 kts (114 kmph) at 0710 UTC	330
**Chennai (MBK)/ (12.98N/80.18E) (Barograph)	974.0 at 1030 UTC	65 kts 122 kmph during 0815-0820 UTC	315

***-3-minute average MSW, **-Instantaneous wind**

4.1.4.2.7. MSW over Chennai as measured by HWSR:

According to HWSR located at the ACWC, IMD, Chennai, one -minute average MSW was about 57.7 knots (107kmph) at 0800 UTC (1330 hours IST) (Fig.4.32).

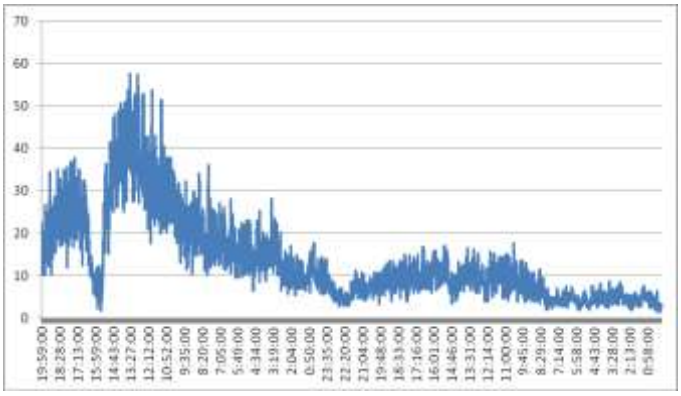


Fig.4.32: Wind speed recorded by HWSR Chennai on 12 October 2016

4.1.4.2.8. MSW based on observation by the DIWE, AWS and manned observatories:

From Table 4.7, the 3 minute maximum sustained surface wind of 50 knots has been reported by NBK followed by 48 knots by Ennore port. The Ennore port lies to the north of NBK at about 15 km. Hence it lay over the maximum wind region wnen the cyclone was crossing Chennai city. The maximum wnd in gustiness has been reported as 122 kmph over MBK followed by 114 kmph over NBK. The distance Indicator of Wind Equipment (DIWE) at NBK reported MSW of 87.6 knots at 0820 UTC (1350 IST) of 12th December. However, there is tunneling effect in the Chennai airport leading to this higher wind speed. ISRO, Sriharikota wind measuring tower reported 99 kmph winds in gustiness at 0900 UTC.

The concurrent MSW at 1000 and 1030 UTC of 12th Dec. over NBK and MBK has been examined and is presented in Table 4.8 (a). As VSCS, Vardah crossed coast over Chennai and moved west-southwestwards recording lowest MSLP over NBK at 1000 UTC and over MBK at 1030 UTC are presented in Table 4.8.(b).

Table 4.8 (a): Concurrent wind data during 1000 to 1030 UTC on 12th December

S. N.	Concurrent wind	1000 UTC (1530 IST)	1030 UTC (1600 IST)
1.	Manual (NBK)	Calm	---
2.	Manual (MBK)	30 kt	---
3.	Anemograph(NBK)	4 kmph (2 kt) /Ely	10 kmph / Ely
4.	Anemograph(MBK)	68 kmph (36.7 kt) / NWly	4 kmph / NNWly
5.	HWSR (NBK)	14.4 kt / NWly (Peak: 26.5 kt, NWly)	14.9 kt / NWly (Peak: 27.5 kt, WNWly)
6.	AWS (NBK)	11 kt / NWly	---
7.	AWS (Ennore Port)	37 kt / NEly	---
8.	Radar wind (surface)	28.8 m/s (55.8 kt)	**---**
9.	Runway-12 DWI	40.8 kt / NWly	6.5 kt / NNWly
10.	Runway-25 DWI	Not recorded due to power failure	
11.	Tambaram IAF	45 kt / W ly	---

Table 4.8 (b): MSLP data during 1000 to 1030 UTC on 12th December

S. N.	Source	Time (UTC)	Minimum MSLP (hPa)
1.	Barograph (NBK)	1000 UTC (1530 IST)	975
2.	Barograph (MBK)	1030 UTC (1600 IST)	974

4.1.4.2.9. MSW over Chennai based on radar:

The hourly radar observations from DWR Chennai are presented in Table 4.9. As per Radar observations, maximum radial velocity of 51 m/s was recorded at 0500 UTC of 12th December in the direction of 103^0 at a distance of 67 km at a height of 493 m above station level. As per the standard procedure the radial velocity has been converted to surface wind. Utilizing the mean wind speed profile, based on dropsonde observations over Atlantic Ocean in the eyewall region of cyclones, radar based radial wind observations at a given height has been converted initially into wind at 700 hPa level and then at surafce level. The wind is first converted to 700 hPa level as the WC-130J flies at this level and dropsonde is released into the cyclone field from this level. A suitable conversion factor for changing the radar wind at a given height to the 700 hPa level has been used based on Franklin etal, 2000 and Powel & Black (1990).

Table 4.9: DWR Chennai observations on 12th December

Date/ Time (UTC)	Radial Velocity (m/s)	Azimuth (deg)	Range (deg)	Height (km)	Conversion Factor	W_{700} (m/s)	W_{10m} W_{700}x 0.73) (m/s)(kt) @1	W_{10m} (Outer Vortex) W_{700}x 0.78) (m/s) (kts) @2	W_{10m} (Eye Wall) W_{700}x 0.91 (m/s) (kts) @3	Remarks
12/0300	49.0	100.5	104.8	0.15	1.13	43.6	33.8 (65)	34.0 (66.0)	39.7 (77.0)	-
12/0400	48.0	56.2	88.3	0.05	1.05	45.71	35.66 (70)	35.7 (69.2)	41.6 (80.7)	-
12/0500	51.0	103.5	67.3	0.493	1.21	42.15	32.88 (65)	32.9 (63.8)	38.4 (74.4)	-
12/0530	48.5	37.3	44.2	0.32	1.20	36.9	28.81 (60)	28.8 (55.8)	33.6 (65.1)	-
12/0650	37.67	8.5	40.0	0.0	-	-	-	-		Erroneous -ground clutters
12/0800	42.47	8.6	28.2	0.2	1.15	36.9	28.80 (60)	28.8 (55.8)	33.6 (65.1)	-
12/0900	22.9	234	22.8	0.16	1.13	20.27	15.81 (30)	15.8	18.4	Not acceptabl

								(30.7)	(35.8)	e -over land
12/1000	28.8	230.6	30.3	0.0	-	-	-	-		Erroneous - Ground clutters
12/1100	29.9	187.1	26.6	0.19	1.15	26.0	20.3 (40)	20.3 (39.3)	39.3 (45.9)	-

@1: Powell and Black estimate (1990), @2: Franklin et al estimate (for winds in outer vortex) and @3: Franklin et al estimate (for winds in eye wall region)

4.1.4.2.10. Satellite based MSW over Chennai:

According to interpretation of satellite imageries, as per Dvorak technique by the IMD, the tropical cyclone intensity was T 4.0 on intensity scale. T4.0 corresponds to an MSW of about 65 knots (122 kmph). According to NOAA satellite estimates, the T number was 4.5 at 0230 UTC and 0830 UTC of 12th December, which was less than that estimated at 2030 UTC of 11th December (T5.0). It thus indicated the weakening trend of the cyclone while moving towards land on 12th December.

4.1.4.2.11. Best estimated wind speed at the time of landfall

Comprehensive analysis of all the observations is presented in Table 4.1. Considering all the inputs available based on surface synoptic observations, AWS, HWSR of IMD, wind profiler of SHAR, Sriharikota, Radar observations from DWR Chennai and satellite based observations, it is seen that the landfall occurred near Chennai city (NBK) and hence the MSW observed near the coast i.e. near NBK has been taken into consideration to estimate the intensity at the time of landfall. MBK which lies about 15 km to the southwest of NBK experienced the centre of the cyclone with lowest MSLP at 1030 UTC as compared to lowest pressure recorded at 1000 UTC by NBK. It is due to the fact that the cyclone moved west-southwest after landfall. Thus considering the MSW recorded over NBK and adjoining areas along the coast, MSW of 61 kts has been recorded over NBK (Table 4.8). HWSR Chennai reported MSW of 57.7 kts. Considering the Radar observations taken at different heights, the MSW of 55-65 kts are estimated to be at the surface level based on various conversion factors utilised to convert the wind from a certain height to surface level (10m) (Table 4.9). According to Mishra and Gupta formula, with lowest pressure of 974.0 hPa, the estimated MSW is found to be 75 kts which is not in agreement with actual observations of MSW. Hence this estimate has not been taken into consideration. Analysis of all the observations is presented in Table 4.10.

The observation from DIWE at MBK has not been considered as there is increased mean wind speed due to tunneling effect in the airport. Further, after the landfall there can be location specific modifications/ changes in the MSW due to variation in land use. **Considering all these observations and estimates, it has been concluded that the MSW associated with VSCS Vardah at the time of landfall was 60 kts.**

Table 4.10: Analysis of all observations on 12th December

Station/(lat./long.)	Lowest MSLP (hPa) and time of occurrence (UTC)	Wind Speed (kts/kmph) and time of occurrence (UTC)
*Chennai (NBK)/ (13.1N/80.2E) (Manned)	975.0 at 1000 UTC	30 kts (56 kmph) at 0900 UTC
*Chennai (MBK)/ (12.98N/80.18E) (Manned)	975.6 at 1000 UTC	50kts (93 kmph) at 0900 UTC
*Chennai (NBK)/ (13.1N/80.2E) (AWS)	977 at 1000 UTC	11kts (20 kmph) at 0800 UTC
*Ennore Port/ (13.2N/80.3E) (AWS)	979.1 at 0900 UTC	48kts (89 kmph) at 0900 UTC
*MBK-ISRO/ (13.0N/80.2E) (AWS)	978 at 1000 UTC	13kts (24 kmph) at 0700 UTC
**Chennai (NBK)/ (13.1N/80.2E) (Barograph)	975.0 at 1000 UTC	61 kts (114 kmph) at 0710 UTC
**Chennai (MBK)/ (12.98N/80.18E) (Barograph)	974.0 at 1030 UTC	65 kts (122 kmph) during 0815-0820 UTC
Mishra and Gupta Formula	-	75 kts (139 kmph) at 0900 UTC
HWSR, IMD Chennai	-	57.7 kts (107 kph) at 0800 UTC
DIWE, NBK	-	87.6 kts at 0820 UTC
ISRO SHAR wind tower	-	54 kts (99 kmph) in gustiness at 0900 UTC
IMD, Satellite	-	T 4.0 at 0900 UTC(65 kts/122 kmph)
NOAA	-	T 4.5 (77 kts/143 kmph) at 0230 UTC & 0830 UTC
Radar (@1)	-	60 kts (111 kmph) at 0530 UTC
Radar (@2)	-	56 kts (104 kmph) at 0530 UTC (in outer vortex)
Radar (@3)	-	65 kts (120 kmph) at 0530 UTC (in eyewall region)

*-3-minute average MSW, **-Instantaneous wind, @1: Powell and Black estimate (1990), @2: Franklin et al estimate (for winds in outer vortex) and @3: Franklin et al estimate (for winds in eye wall region).

4.1.4.3. Climatological aspects

Considering the area of genesis (+/- 2^0 around the genesis point), the cliamtological tracks of the TCs (SCS and above) during 1891-2015 are presented in Fig.4.33.

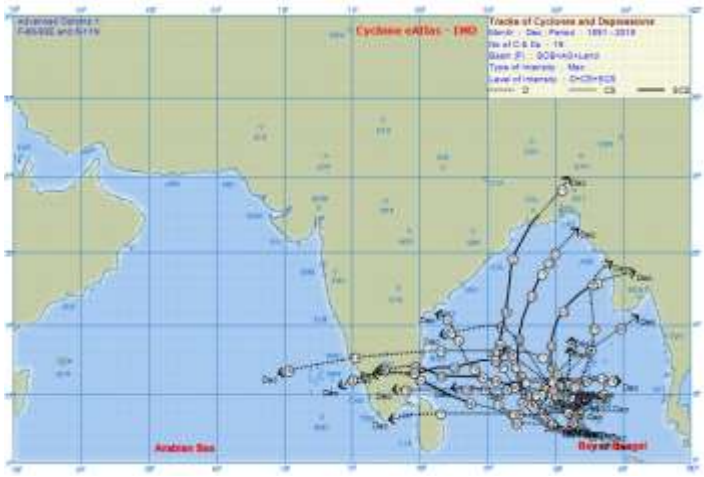


Fig 4.33. Climatological tracks of TCs (SCS and above) forming within +/- 2^0 around the genesis point during 1891-2015

It indicates that climatologically, out of 19 cyclonic disturbances (depression and above), about half of them moved towards Tamil Nadu/ south Andhra Pradesh coast. All these system crossed Tamil Nadu coast. Those which approach Andhra Pradesh coast weakened over the Sea.

4.1.4.4. Features observed through satellite and Radar

Satellite monitoring of the system was mainly done by using half hourly Kalpana-1 and INSAT-3D imageries. Satellite imageries of international geostationary satellites Meteosat-7 & MTSAT and microwave & high resolution images of polar orbiting satellites DMSP, NOAA series, TRMM, Metops were also considered.

4.1.4.4.1. INSAT-3D features

Typical INSAT-3D visible/IR imageries enhanced colored imageries and cloud top brightness tempearture imageries are presented in Fig.4.34. Intensity estimation using Dvorak's technique suggested that the system attained the intensity of T 1.5 on 0900 UTC of 6th. The cloud pattern was curved band type. Convection wrapped around western half of cyclonic circulation. Minimum Cloud Top Temperature (CTT) was minus 85.0^0C. Associated broken low and medium clouds with embedded intense to very intense convection lay over Andaman & Nicobar Islands and adjoining Andaman Sea & southeast BoB. At 1800 UTC of 7th, well defined banding features were seen. Banding wrapped 7 on log 10 spiral. The system attained the intensity of T2.0. Minimum CTT was minus 92.0^0C. Associated broken low and medium clouds with embedded intense to very intense convection lay over southeast and adjoining eastcentral BoB, western parts of Andaman Sea & Bay Islands. At 0000 UTC of 8th, the system intensified to T2.5. Convection showed central dense overcast (CDO) pattern. Minimum CTT was minus 93.0^0C. Associated broken low and medium clouds with embedded intense to very intense convection lay over southeast and adjoining eastcentral BoB, western parts of Andaman Sea & Bay islands. At 0000 UTC of 9th, the system attained the intensity of T 3.0. Convection showed CDO pattern. Minimum CTT was minus 93.0^0C. Associated broken low and medium clouds with embedded intense to very intense convection lay over southeast and adjoining eastcentral BoB. At 1800 UTC of 9th, the system intensified to T 3.5. Convection showed CDO pattern. Minimum CTT was minus 93.0^0C. Associated broken low and medium clouds with embedded intense to very intense convection lay over southeast and adjoining eastcentral BoB between 9.5^0N &

15.0^{0}N and longitude 86.0^{0}E & 90.0^{0}E. At 1200 UTC of 10th, the system intensified to T4.0. Convection showed curved band pattern with embedded CDO. Minimum CTT was minus 93.0^{0}C.

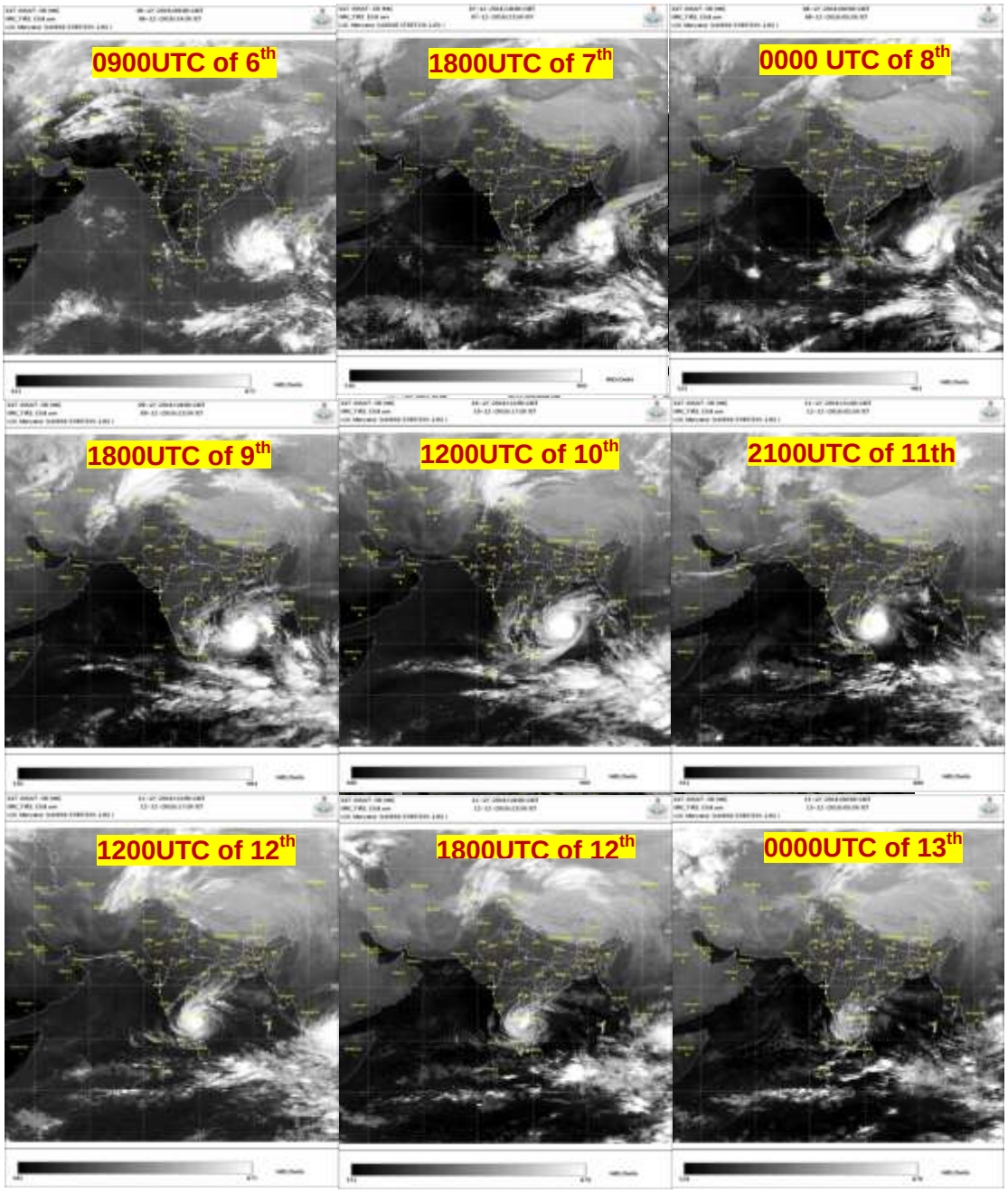


Fig. 4.34 (a): INSAT-3D IR imageries during life cycle of VSCS Vardah (06-13 December, 2016)

Associated broken low and medium clouds with embedded intense to very intense convection lay over central BoB between 10.9^{0}N & 15.6^0 N and longitude 83.0^{0}E & 87.7^0 E. At 0000 UTC of 11th, the intensity of the system was T 4.0. Convection showed curved band pattern with embedded irregular CDO. Minimum CTT was minus 92.0^{0}C. Associated broken low and

medium clouds with embedded intense to very intense convection lay over BoB between 10.0^{0}N & 16.0^{0}N and longitude 80.5^{0}E & 86.0^{0}E. At 0900 UTC of 12th, intensity of the system was T4.0. Cloud convection showed CDO pattern. Minimum CTT was minus 82.0^{0}C. Associated broken low and medium clouds with embedded intense to very intense convection lay over BoB between 11.0^{0}N & 15.0^{0}N, west of longitude 82^{0}E, south coastal Andhra Pradesh adjoining Rayalaseema and north coastal Tamil Nadu.

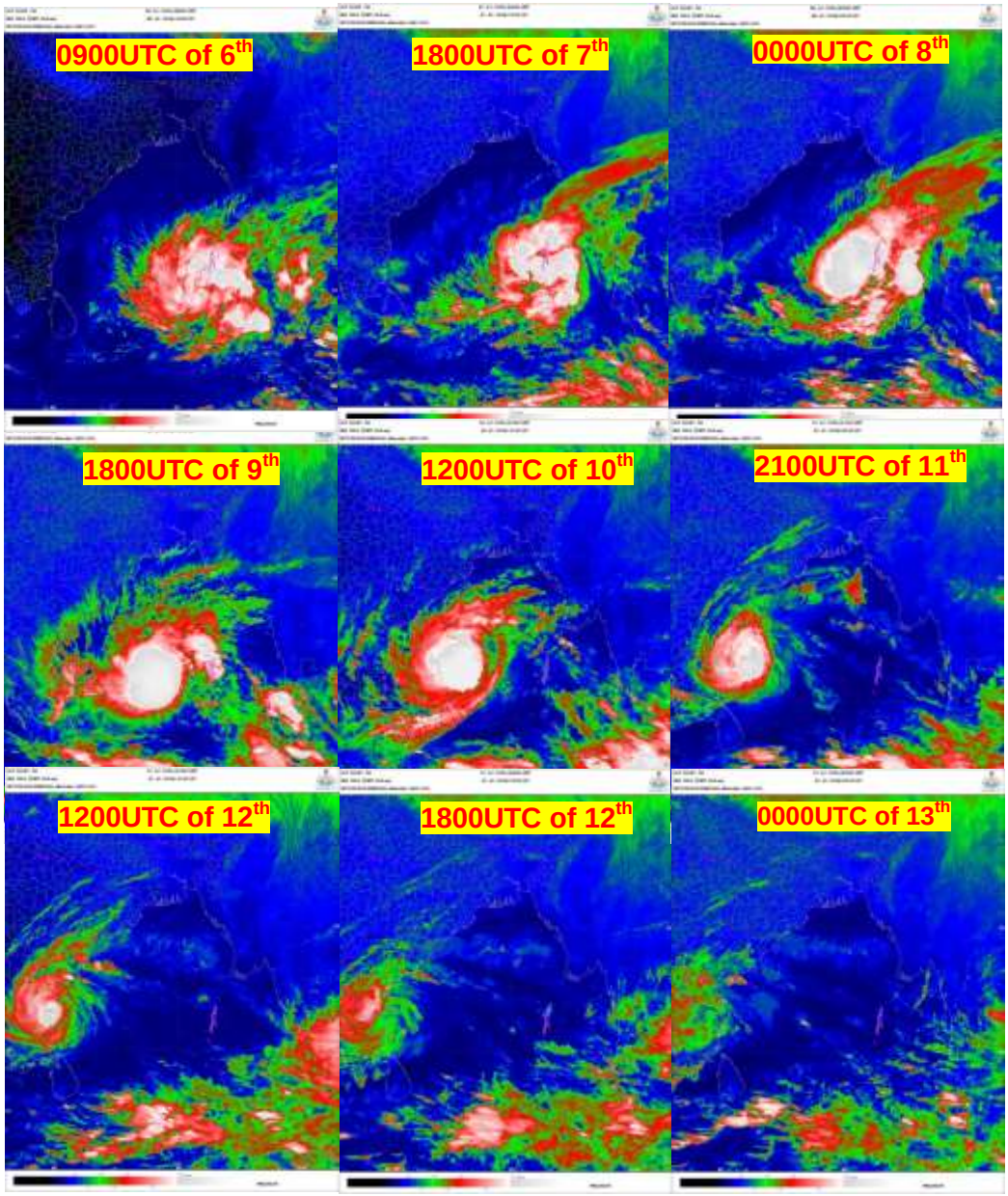


Fig. 4.34 (b): INSAT-3D enhanced colored imageries during life cycle of VSCS Vardah (06-13 December, 2016)

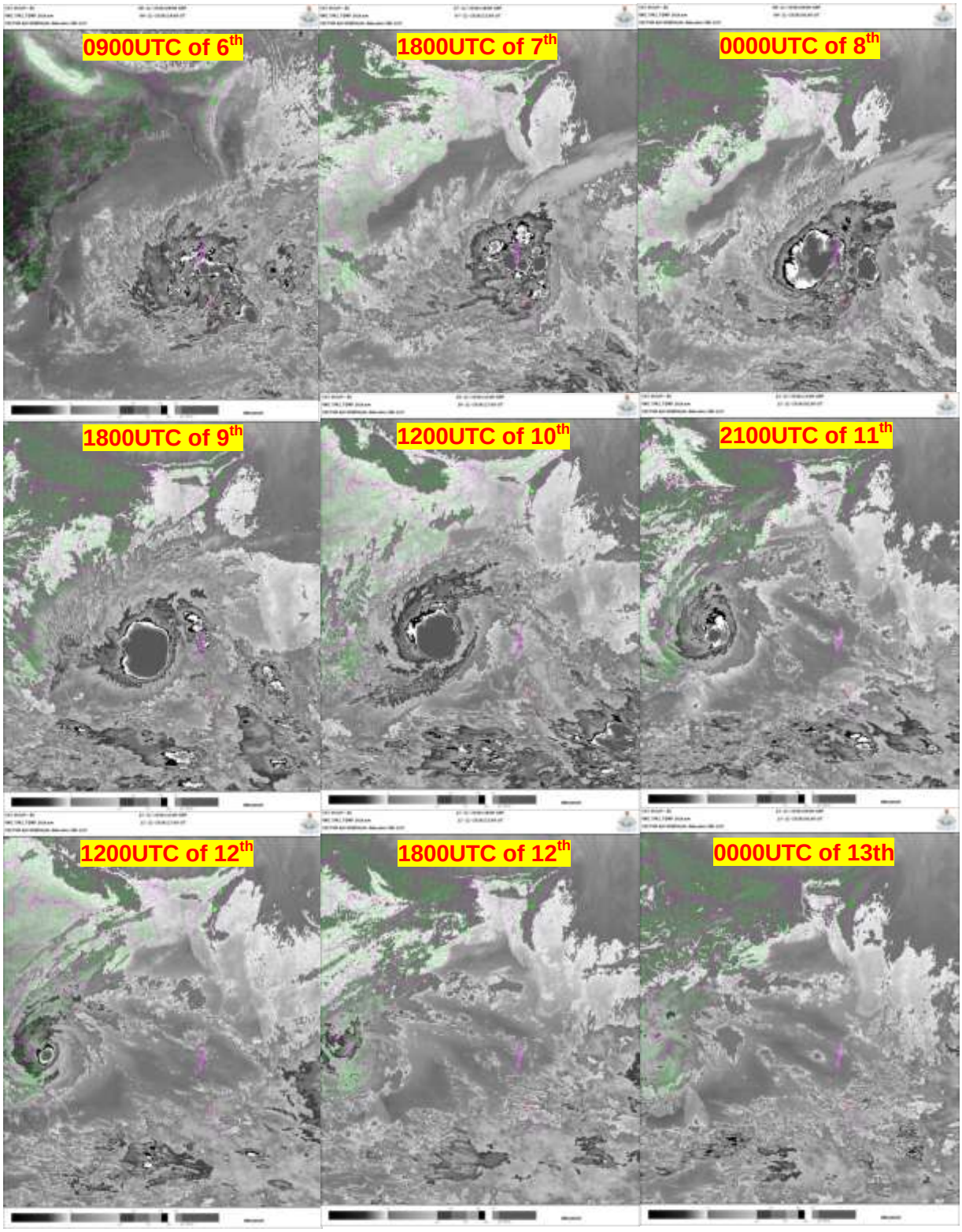
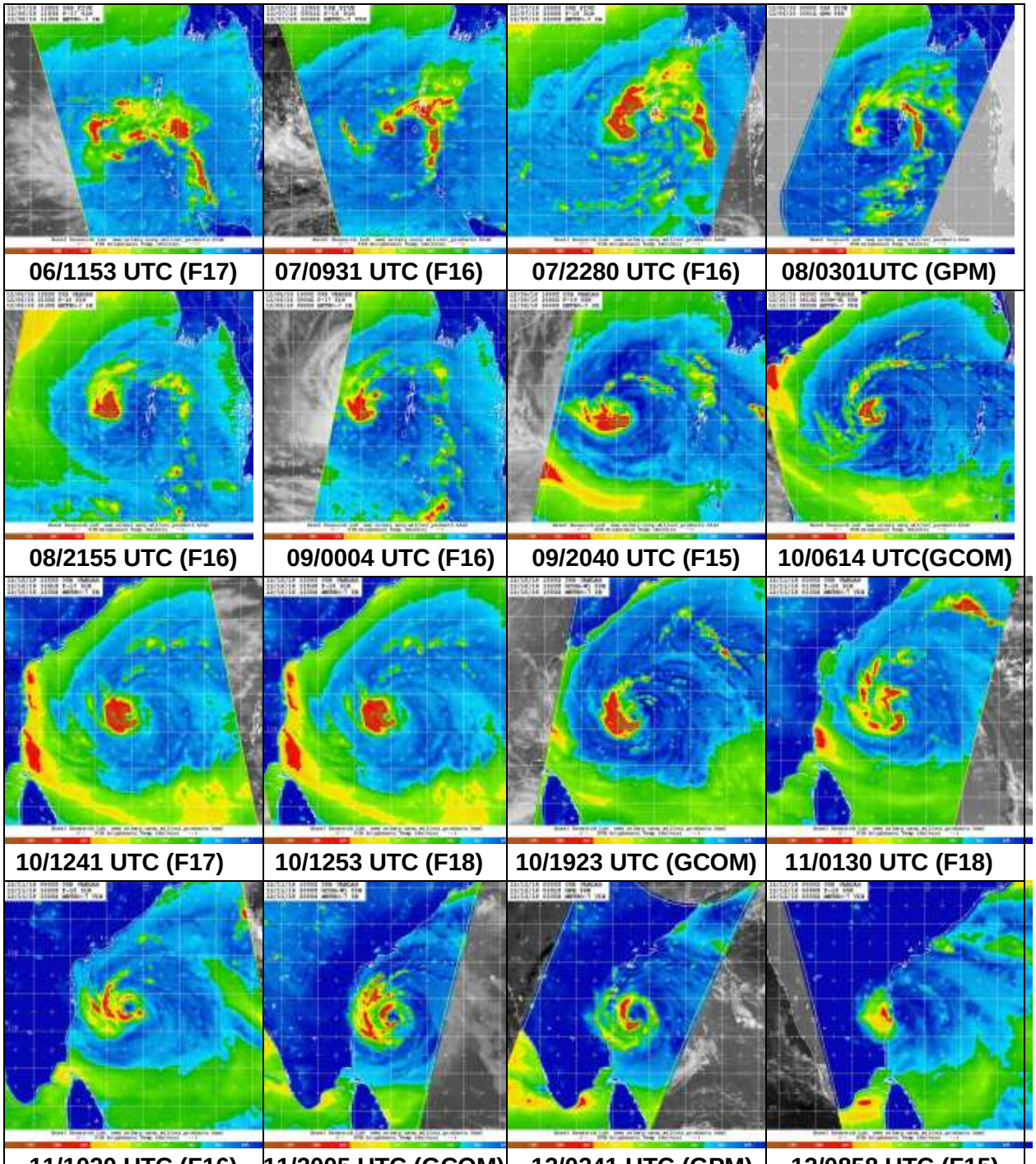


Fig. 4.34 (c): INSAT-3D cloud top brightness temperature imageries during life cycle of VSCS Vardah (06-13 December, 2016)

4.1.4.4.2 Microwave features

F-15, F-16, F-17, GPM and GCOM-W1 microwave imageries of the VSCS Vardah covering its life period from 06th to 13th December 2016 are presented in Fig. 4.35. These imageries helped in understanding the internal structure of the system and better estimation of

location of the system. It could indicate the region of intense convection and hence the rainfall. It also helped in understanding the large scale diurnal variation of the system.



06/1153 UTC (F17)	07/0931 UTC (F16)	07/2280 UTC (F16)	08/0301UTC (GPM)
08/2155 UTC (F16)	09/0004 UTC (F16)	09/2040 UTC (F15)	10/0614 UTC(GCOM)
10/1241 UTC (F17)	10/1253 UTC (F18)	10/1923 UTC (GCOM)	11/0130 UTC (F18)
11/1020 UTC (F16)	11/2005 UTC (GCOM)	12/0241 UTC (GPM)	12/0858 UTC (F15)

Fig. 4.35: Microwave imageries during life cycle of VSCS Vardah (06th- 13th Dec., 2016)

4.1.4.4.3. Features observed through Radar

As the system was moving along the east coast, it was tracked by DWR Chennai and Machillipatnama Typical Radar imageries from DWR Chennai on 12th December are presented in Fig. 4.36.

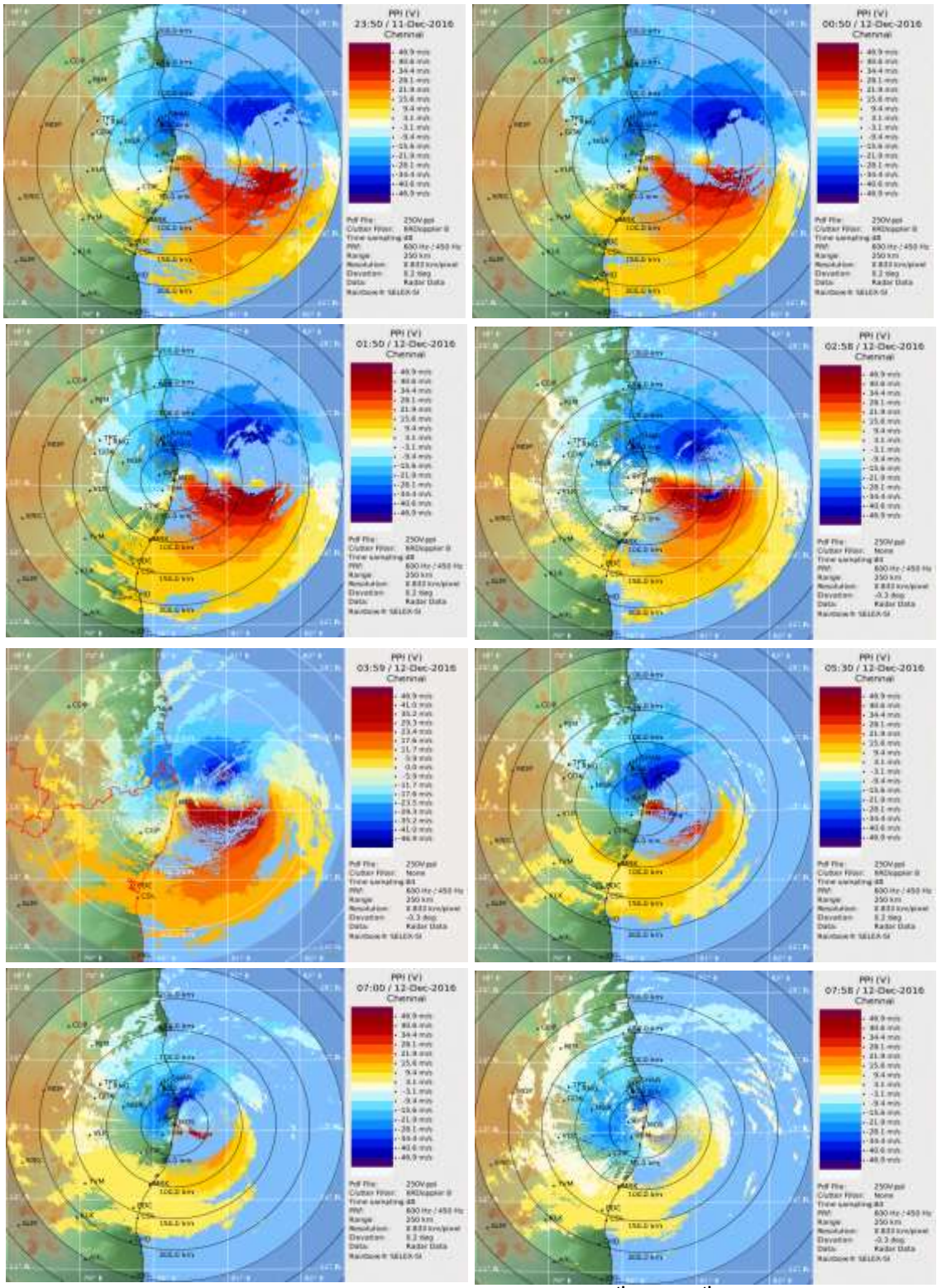


Fig. 4.36 (a): Typical PPI (V) imageries during 11th & 12th December from DWR Chennai

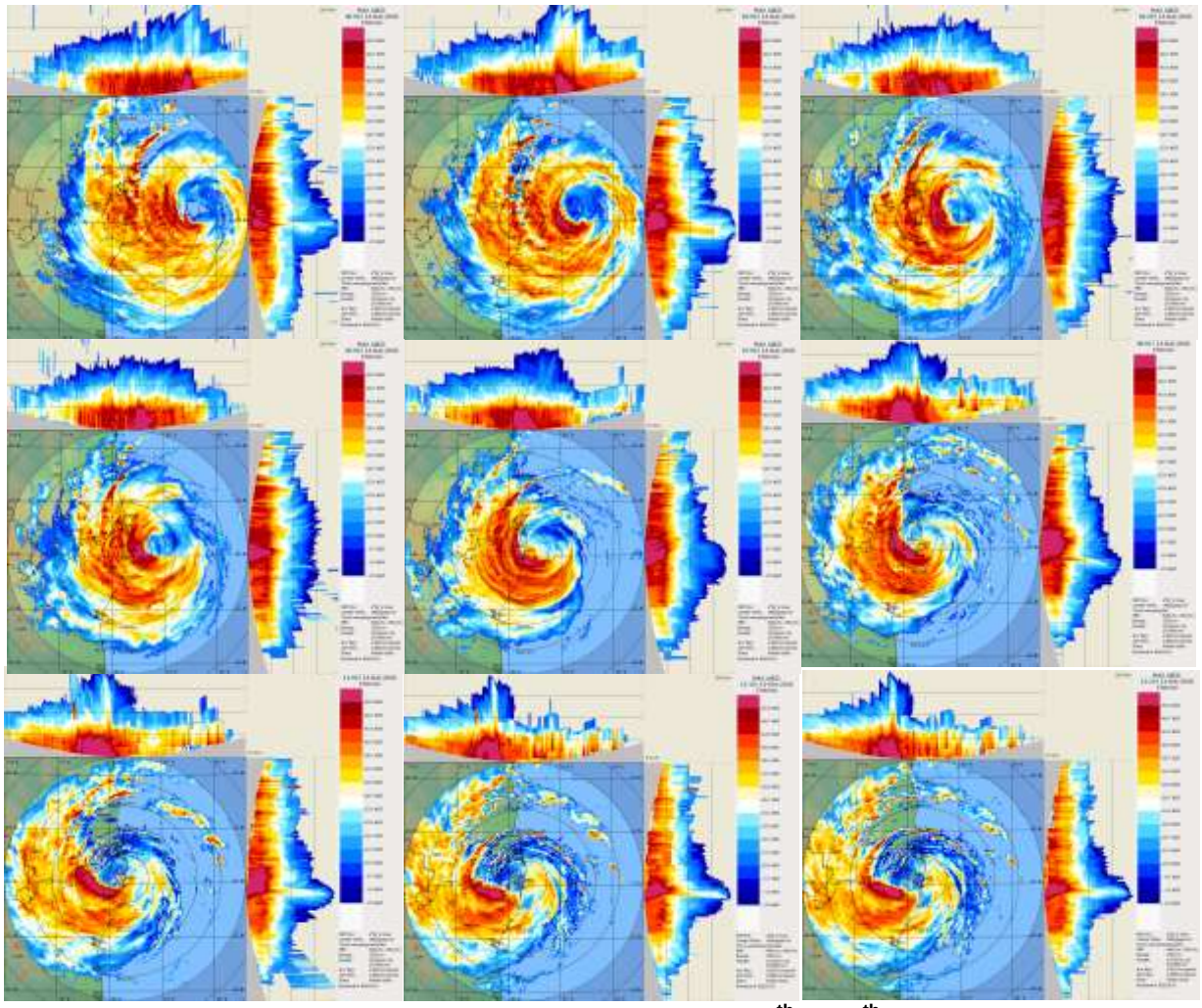


Fig. 4.36 (b): Typical MAX (dBZ) imageries during 11th & 12th December from DWR Chennai

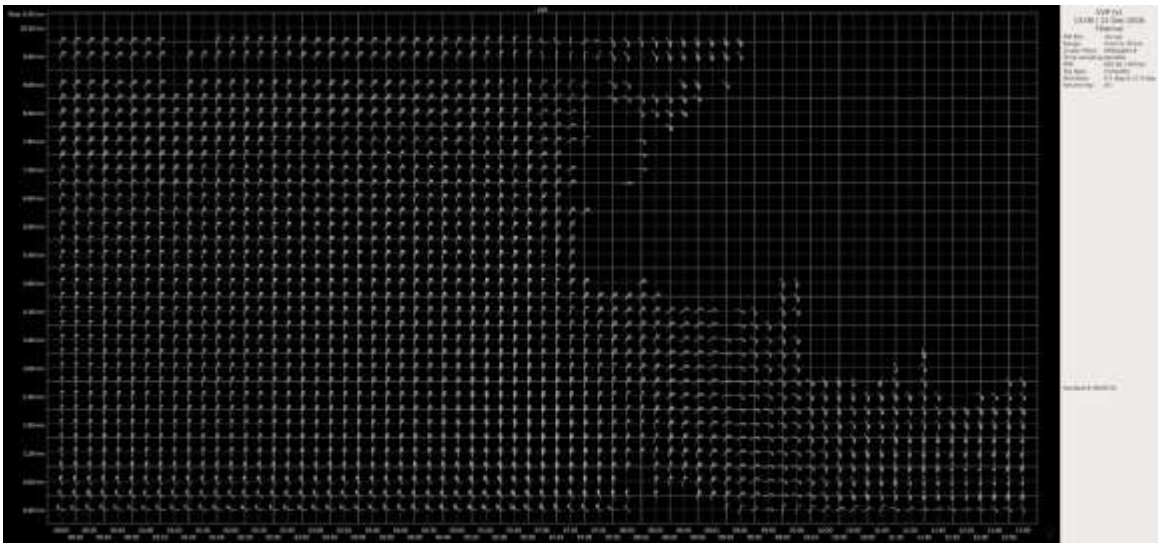


Fig. 4.36 (c): Vertical Velocity Profile (VVP(V)) at Chennai during on 12th December from DWR Chennai

4.1.4.5. Dynamical features

IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels are presented in Fig. 4.37. GFS (T574) could simulate the genesis of the system and the associated circulation features during the life period of VSCS Vardah.

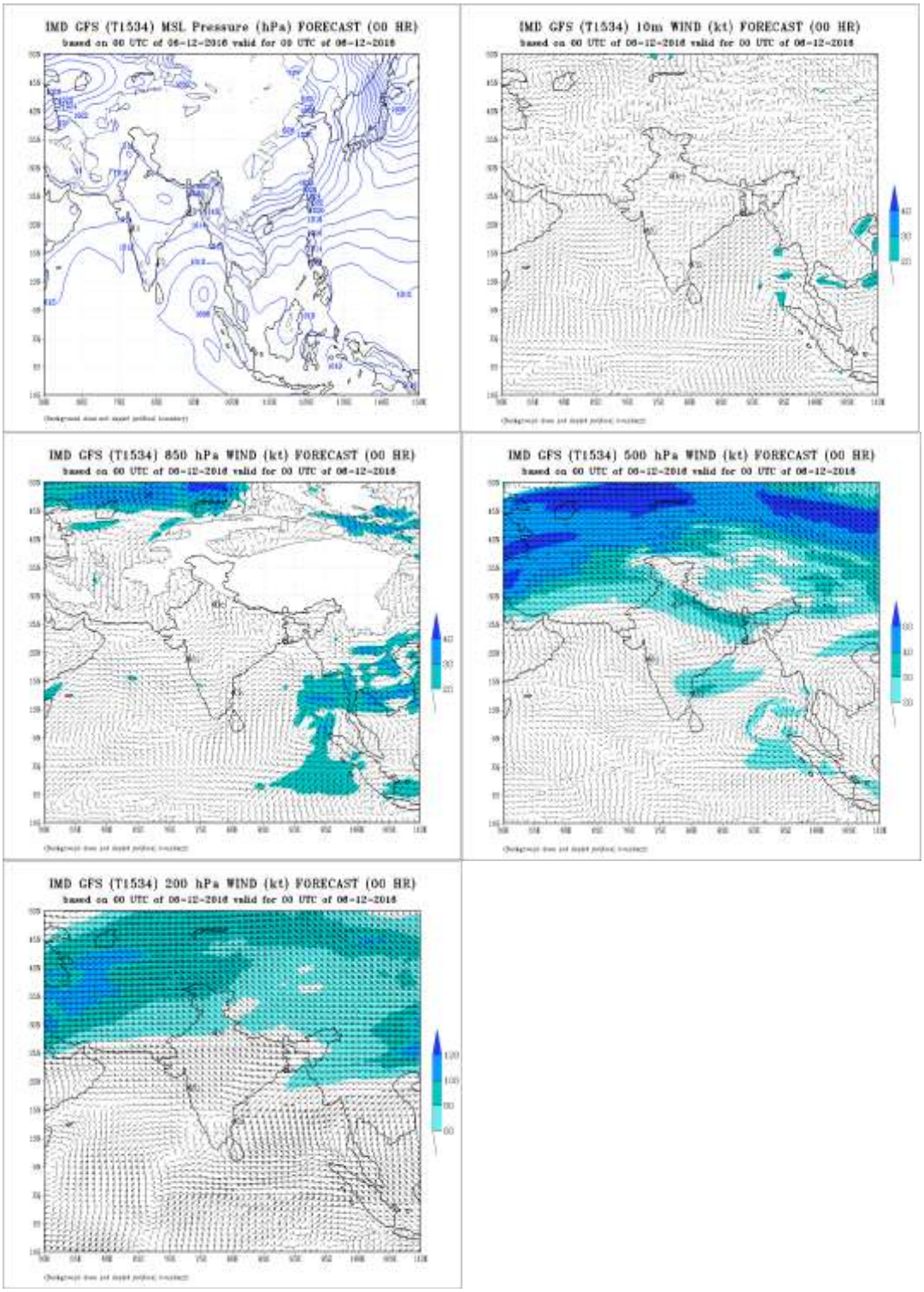


Fig. 4.37 (a): IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 6th December

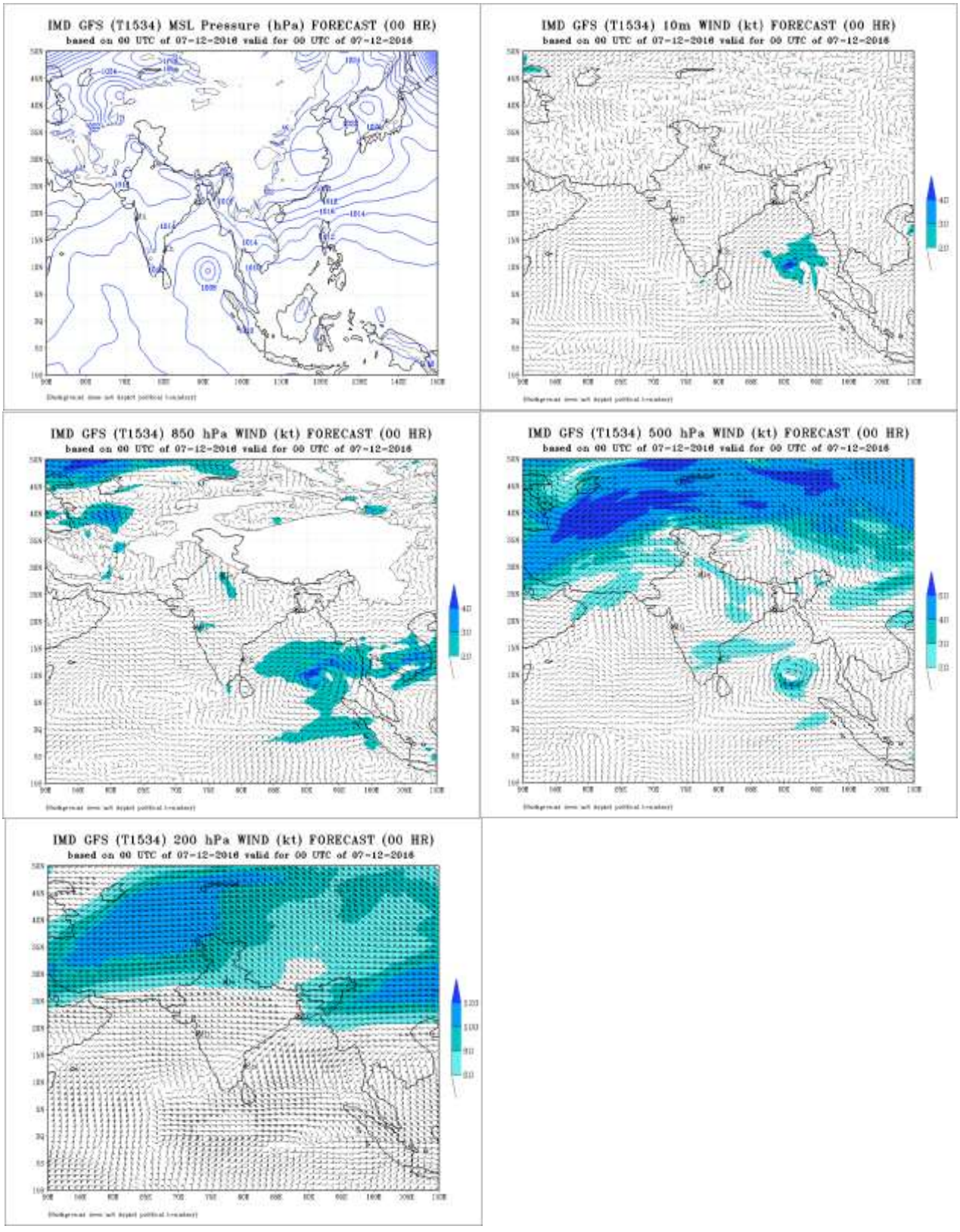


Fig. 4.37 (b): IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 7th December

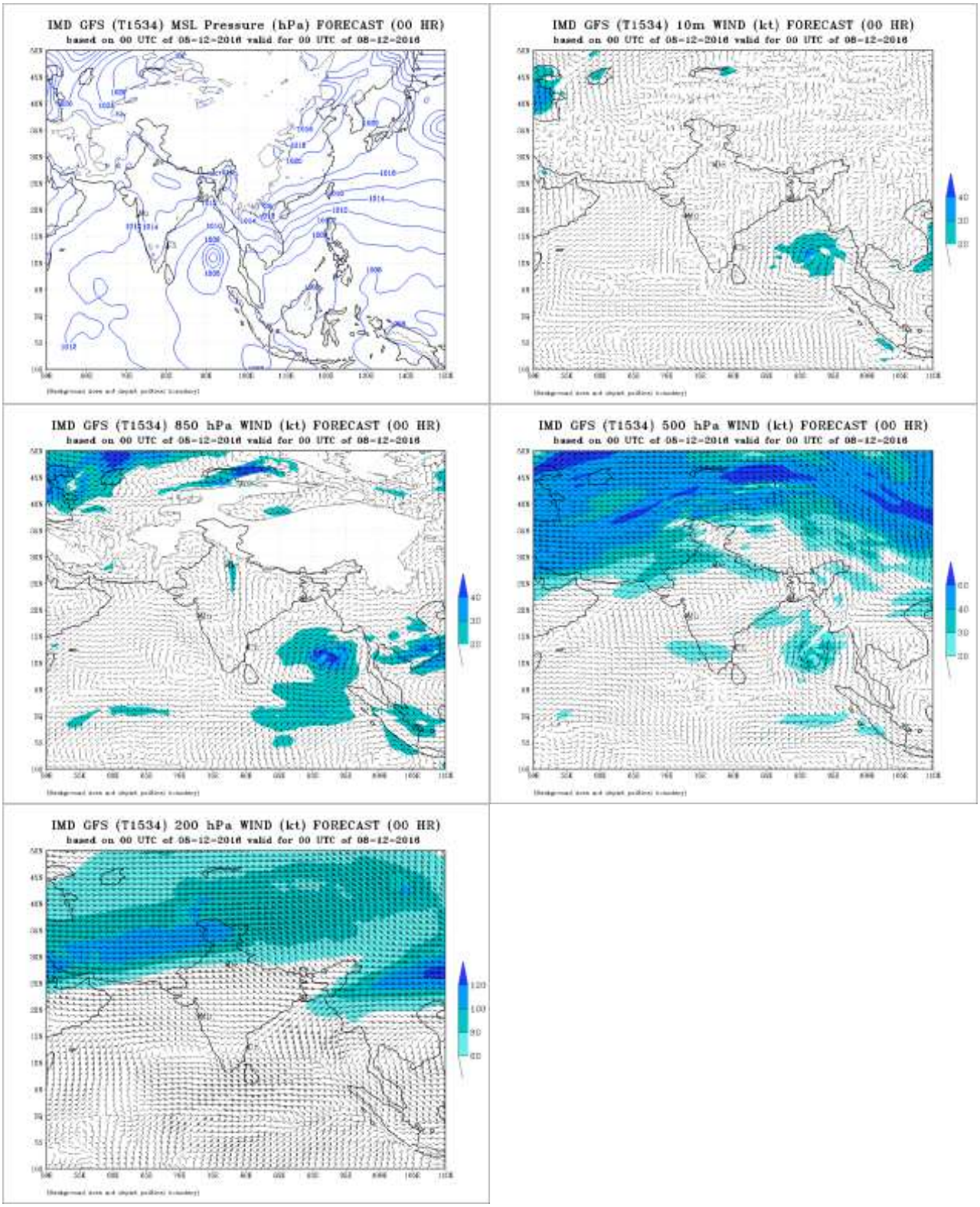


Fig. 4.37 (c): IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 8th December

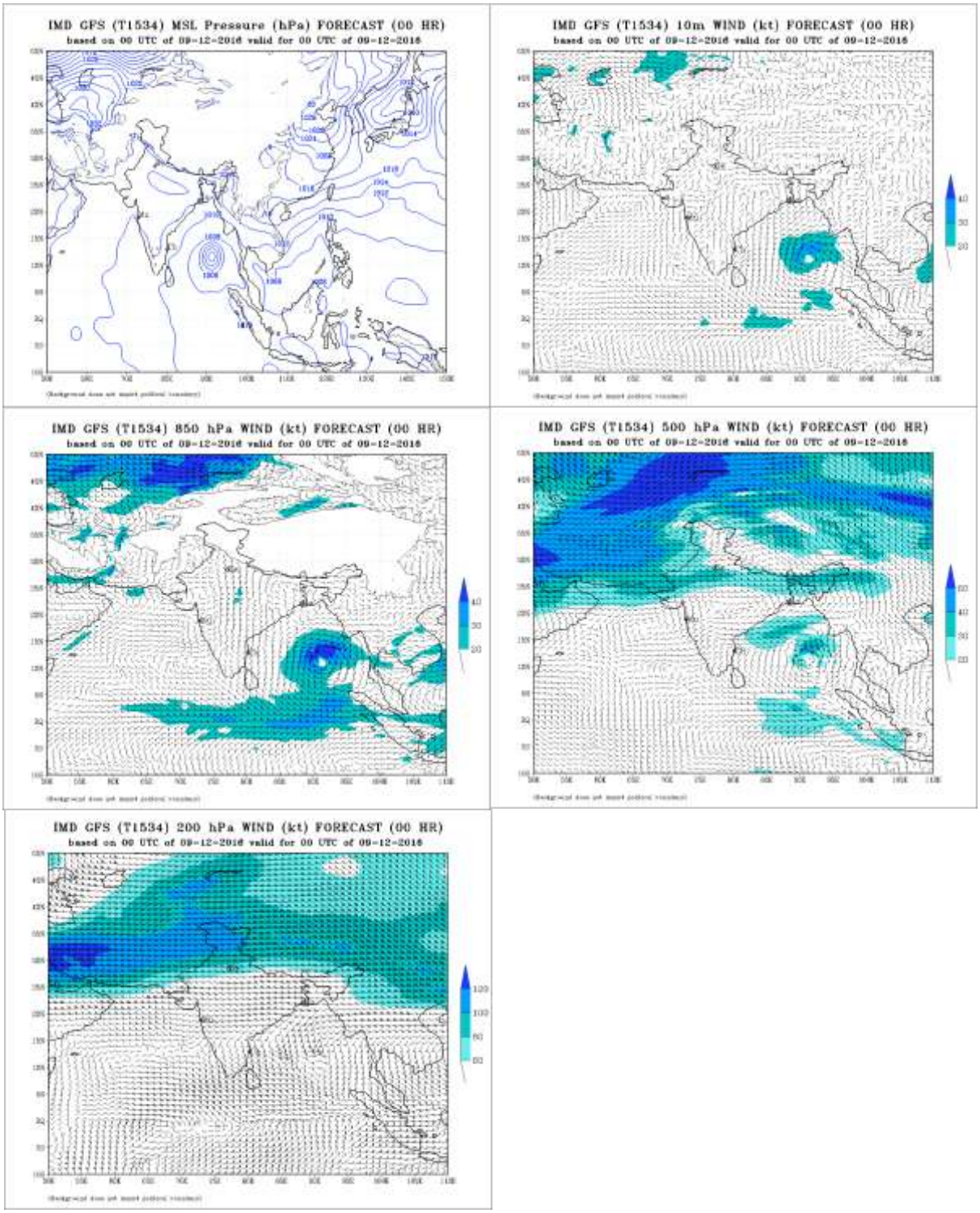


Fig. 4.37 (d): IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 9th December

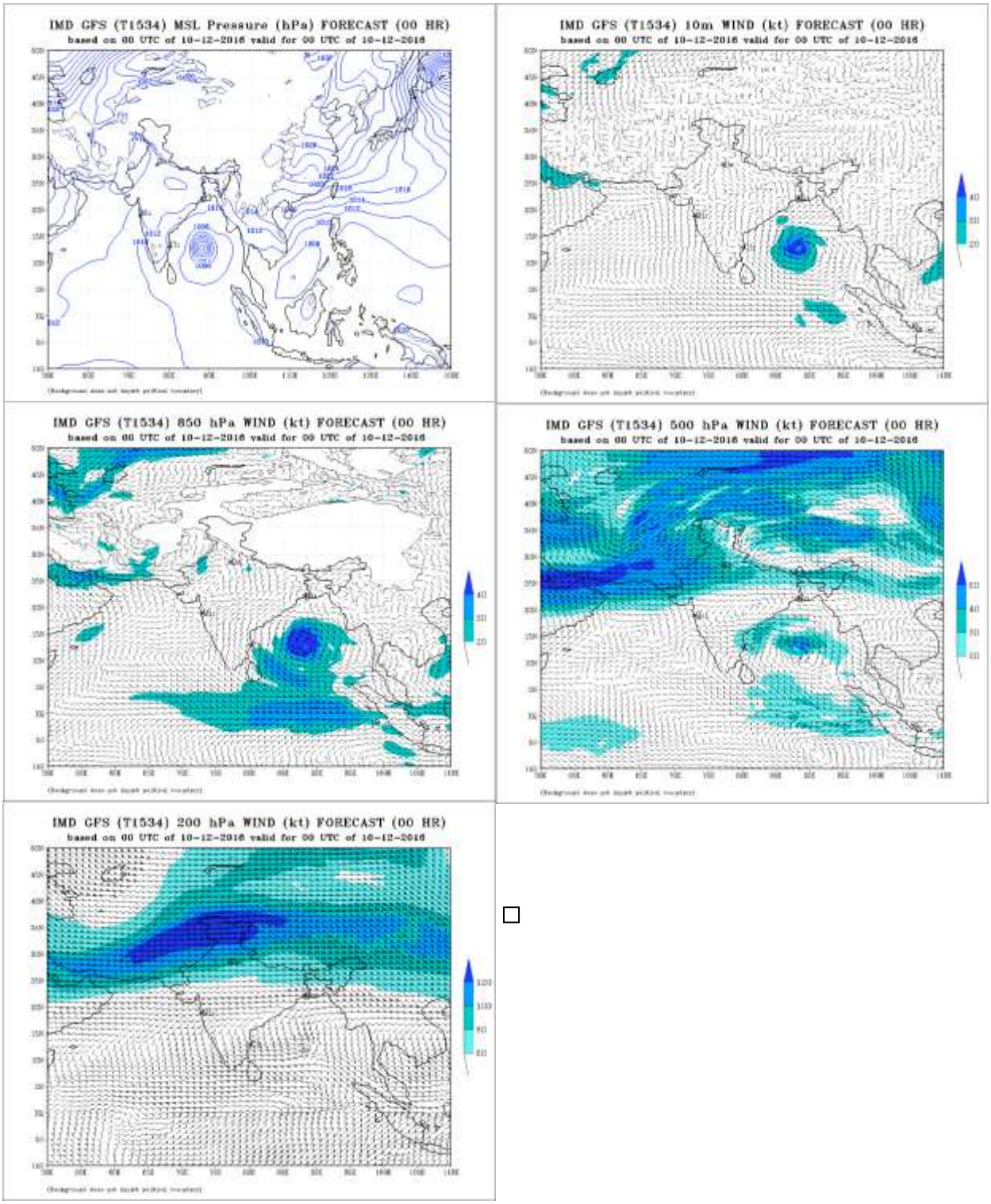


Fig. 4.37 (e): IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 10th December

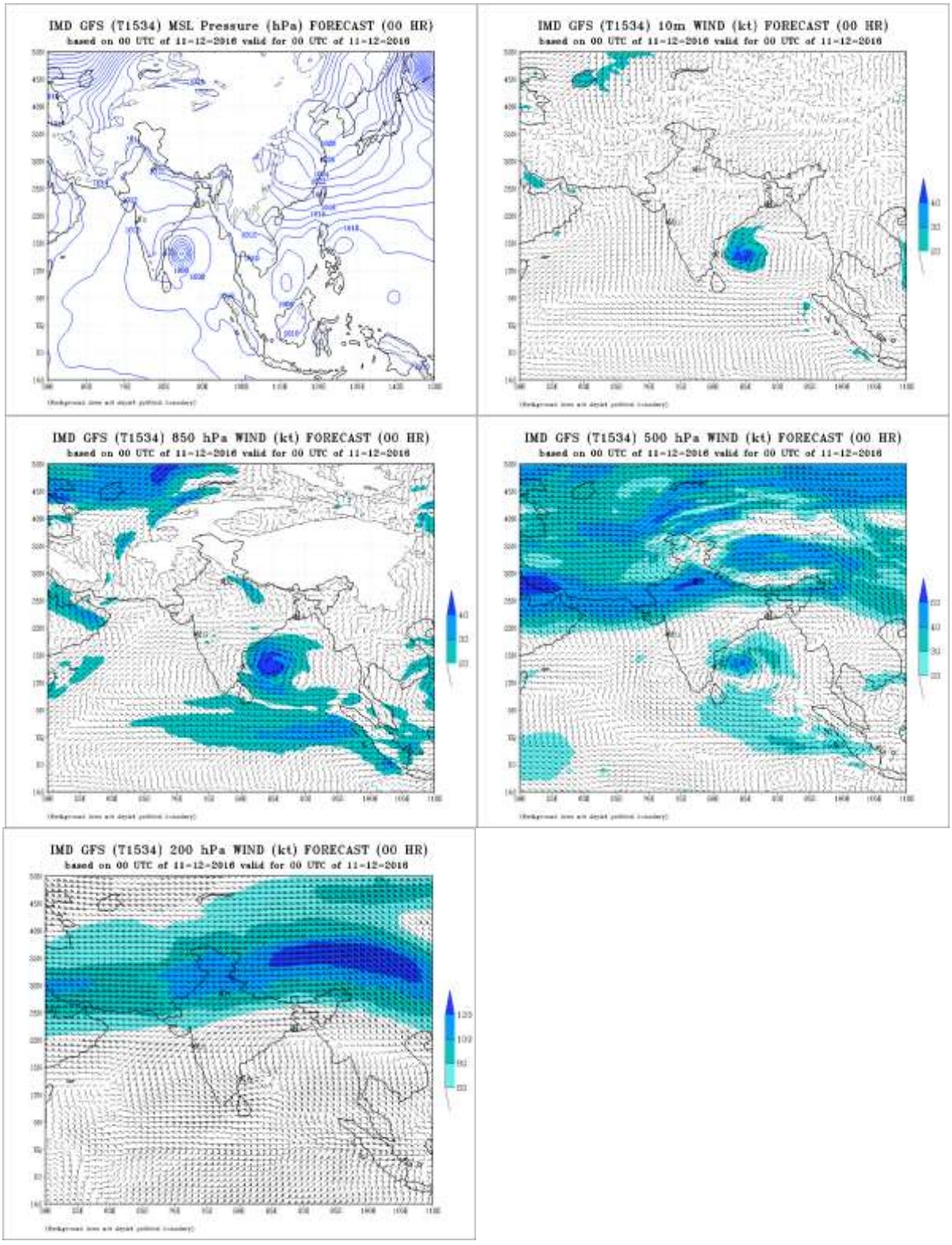


Fig. 4.37 (f): IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 11th December

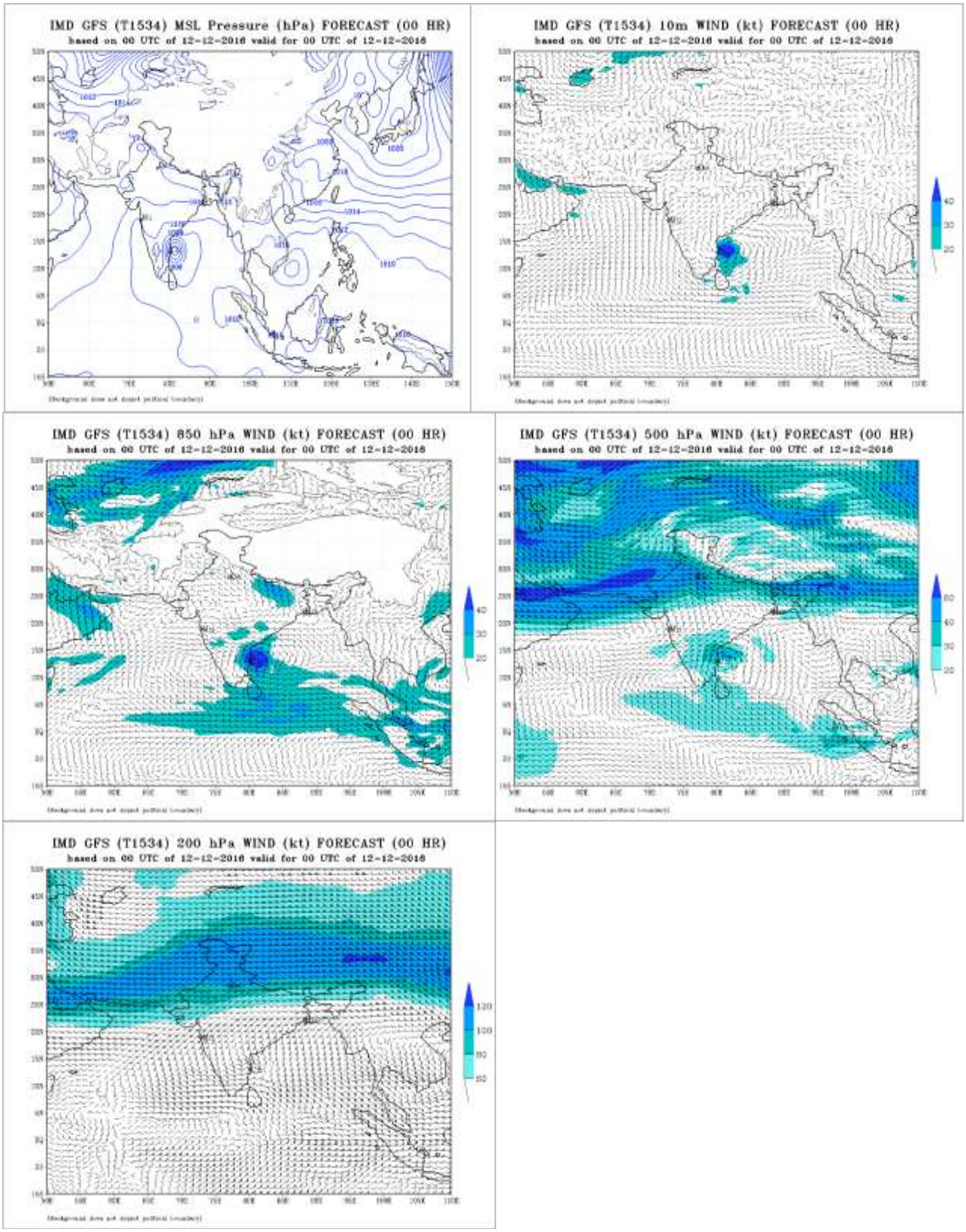


Fig. 4.37 (g): IMD GFS (T574) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 12th December

4.1.4.6 Realized Weather:

4.1.4.6.1 Rainfall:

Light to moderate rainfall at most places with heavy to very heavy falls at a few places over Andaman Islands and heavy rainfall at isolated places over Nicobar Islands were predicted during 7th -8th. Rainfall at most places with isolated heavy to very heavy falls over south coastal Andhra Pradesh, Rayalaseema, north coastal Tamil Nadu and Puducherry were predicted on 13th. Heavy to very heavy rainfall (7-19 cm) at a few places and isolated extremely heavy rainfall (≥ 20 cm) very likely over Chennai, Thiruvallur and Kanchipuram districts of Tamil Nadu and Nellore and Prakasam districts of Andhra Pradesh on 12th.

Heavy rainfall occurred at many places with very heavy falls at few places and isolated extremely heavy rainfall over Chennai, Kancheepuram, Tiruvallur, and Villupraum districts of Tamil Nadu. Heavy to very heavy rainfall occurred at a few places over Vellore, Krishnagiri, Tiruvannamalai districts of Tamil Nadu, Nellore district of coastal Andhra Pradesh and Chittor, Anantapuram & Cuddapah districts of Rayalaseema on 12th December. During genesis stage cyclone Vardah caused heavy to very heavy rainfall at a few places over Hut Bay, Maya Bandar, IAF Car Nicobar on 7th December and rainfall at many places with isolated extremely heavy rainfall occurred over Long Island, Port Blair of Andaman & Nicobar Islands on 8th December.

(Heavy rainfall distribution: Isolated places : <25%, A few places: 26-50%, Many places : 51-75%, Most places: 76-100% of total stations in the region;
Heavy rain : 64.5 – 115.5 mm, Very heavy rain: 115.6 – 200.4 mm, Extremely heavy rain: 200.5 mm or more).

Realized 24 hrs accumulated rainfall (≥7cm) ending at 0830 hrs IST of date due to the cyclone is presented below:

07.12.2016

ANDAMAN & NICOBAR ISLANDS: Hut Bay-17, Port Blair-12, Maya Bandar-9, IAF Carnicobar-7

08.12.2016

ANDAMAN & NICOBAR ISLANDS: Long Island-23, Port Blair-21, IAF Carnicobar-7

13.12.2016

Tamil Nadu:

Satyabama University (Kancheepuram)-38, Kattukuppam (Kancheepuram)-34, Kancheepuram (Kancheepuram)-28, Kalavai (Vellore)-23, Poonamallee (Tiruvallur)-22, Chembarabakkam (Tiruvallur)-21, Meenambakkam-20, Sriperumbudur (Kancheepuram)-17, Chembarambakkam (Tiruvallur)-16, Yercaud (Salem)-15, Alangayam (Vellore)-15, Tambaram (Kancheepuram)-14, Nugampakam-12, Vellore-11, Melalathur (Vellore)-9, Tirppattur-8, Poondi (Tiruvallur)-9, Mahabalipuram (Kancheepuram), Uthiramerur (Kancheepuram), Tirupattur (Vellore), Maduranthagam (Kancheepuram), Krishnagiri (Krishnagiri), Shoolagiri (Krishnagiri), Hosur (Krishnagiri), Vandavasi (Tiruvannamalai), Marakkanam (Villupraum), Vaniaymbadi (Vellore), Gudiyatham (Vellore) and Cheyyur (Kancheepuram) -7 each

Coastal Andhra Pradesh:

Atmakur (Nellore) 13, Vinjamur (Nellore) 12, Udayagiri (Nellore) 11, Sullurpeta (Nellore) 9, Kandukur (Prakasam) 9, Kavali (Nellore) 8, Nellore (Nellore) 8, Veligandla (Prakasam) 8, Rapur (Nellore) 7, Gudur (Nellore) 7, Venkatagiri (Nellore) 7, Shar (Nellore) 7

Rayalaseema:

Tirumalla (Chittor) 15, Puttur (Chittoor) 14, Nagari (Chittoor) 12, Chittoor 10, Kodur (Cuddapah) 10, Satyavedu (Chittoor) 10, Venkatagiri Kota (Chittoor) 9, Palasamudram (Chittoor) 9, Nambulipulikunta (Anantapuram) 7, Thottambedu (Chittoor) 7, Tirupati Aero (Chittoor) 7, Atlur (Cuddapah) 7, Rajamet (Cuddapah) 7, Mandapalle (Chittoor) 7, Kuppam (Chittoor) 7, Pakala (Chittoor) 7, Sambepalle (Cuddapah) 7, Royachoti (Cuddapah) 7. Rainfall associated with the system is depicted in Fig 2.9.14 based on IMD-NCMRWF GPM merged gauge rainfall data.

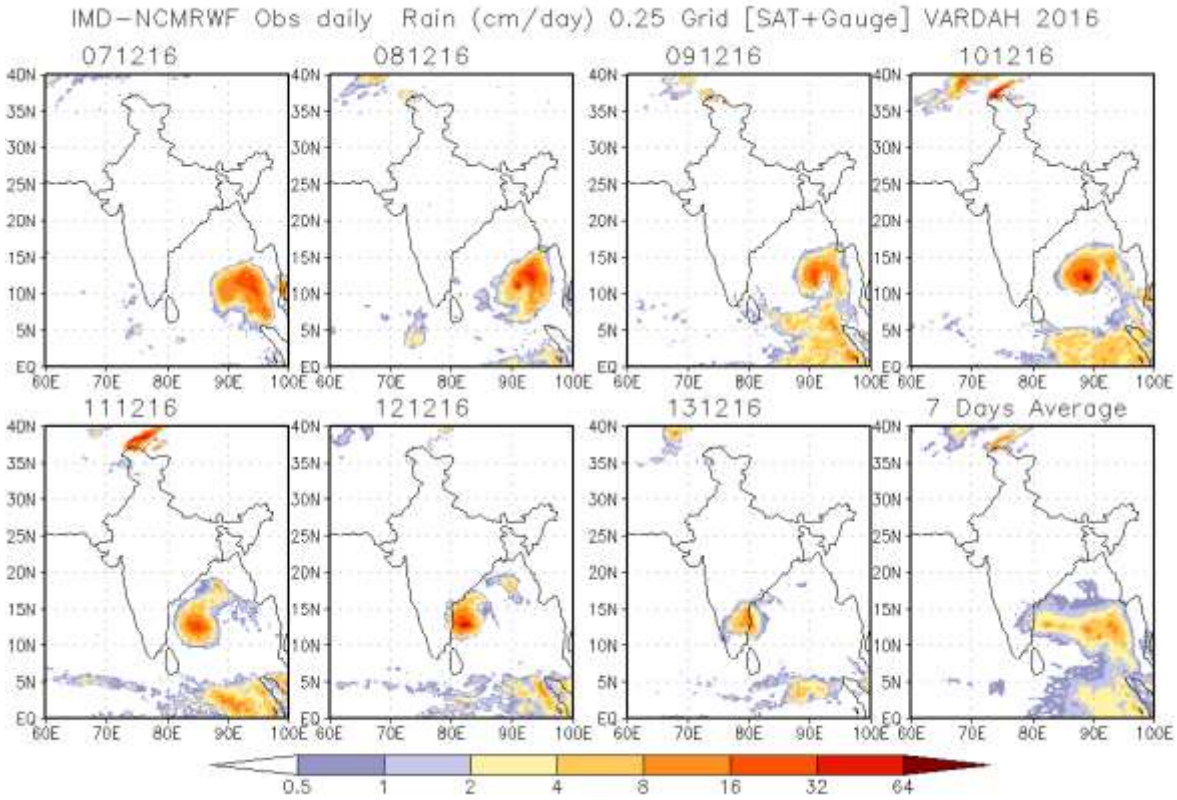


Fig.4.38: IMD-NCMRWF GPM merged gauge rainfall during 7th – 13th and 7 days average rainfall (cm/day)

On 7th & 8th, heavy to very heavy rainfall was observed over south Andaman Sea and adjoining southeast BoB to the northeast of system centre. On 9th the region of heavy to very heavy rainfall shifted from northeast to northwest sector. On 10th, 32 cm rainfall was observed in southeast BOB over the entire region around the centre. On 11th, 16-32 cm rainfall was observed over southwest BoB. On 12th, around 30 cm rainfall was observed in the right forward sector of the system near north Tamil Nadu and adjoining south Andhra Pradesh. On 13th, 4-8 cm rainfall was observed over north interior Tamil Nadu and south interior Karnataka. 7 days average rainfall plot indicate that during initial stage 4-8 cm average rainfall was observed over south Andaman Sea and southeast BoB within 10-14°N. However, in the later part of the week, 2-4 cm rainfall was observed between 10-14°N over southwest BoB.

4.1.4.7. Damage due to VSCS Vardah

Andaman Islands

As per media report, Cyclone Vardah wreaked havoc in the remote islands of Andaman like Diglipur, Rangat and Billyground that witnessed a flood-like situation due to torrential rains. Landslides were reported along the Andaman Trunk Road, while several houses and crops have been damaged in areas located in the northern and central Andaman. There was no power in several areas for two days due to the snapping of power cables. More than 1,400 tourists were stranded on the Havelock and Neil Islands of the Archipelago. However, no casualty was reported from Andaman & Nicobar Islands.

Tamil Nadu

Loss of Human Lives

The cyclone prompted India's largest evacuation in 2 years of 16000 people. 24 deaths related to the cyclone have been reported in the state of Tamil Nadu.

Infrastructure damage

Cyclone Vardah caused colossal damage to infrastructure like roads, bridges, reservoirs, tanks, drinking water supply, school & public health buildings, electrical installations, habitats such as huts & houses, crops, cattle losses. The state Government estimated the damage to the tune of Rs 22,573 crores (The Hindu dated the 28th December, 2016).

Crop damage

Severe Crop damages occurred in Tiruvallur, Kanchipuram, Vellore and Tiruvannamalai districts of north Tamil Nadu. There was damage to paddy, groundnut, blackgram, greengram and coconut causing a loss of nearly 33 % in these districts in an area of 34206.13 Hectare. The estimated loss of Agriculture produce valued Rs. 35571 Crore. The detailed loss is given in Table 4.11:

Table 4.11: Loss due to VSCS Vardah

S.No.	Crop	Total Area damaged in Hectares	Production Loss (MT)	Avg. Market Price/MT (Rs.)	Value of the produce Lost (Rs. in crores)
1.	Paddy	33980.86	220876	16000	35340.09
2.	Millets	58.44	2507	15000	37.60614
3.	Pulses	41.8	314	80000	25.08
4.	Sugarcane	44.82	41683	2300	95.86998
5.	Oilseeds	63.06	145	50000	72.519
6.	Perennial crops Coconut	16.62	-	-	0.20775
	Total	34206.10	22547		35571.37287

District wise Details of Area affected by Cyclone "Vardah"

(a) Tiruvallur:

Due to Cyclone Vardah, the Paddy crop cultivated in Tiruvallur district was severely affected in 11 blocks. Out of the total area (87000 Hectare) cultivated in the district, 45518 Hectare Paddy was severely affected. In this 32241 Hectare Paddy was affected with >33% crop damage. And

also 16.62 Hectare Coconut was also affected. The trees were totally uprooted from the field. Totally 32257.62 Hectare area was affected with >33% crop damage which includes 2700.40 Hectare area of SF/MF and 5237 Hectare of Other farmers. 37370 farmers were affected due to this Vardah cyclone.

The total Assistance sought for Tiruvallur district is Rs.4355.53 lakhs @ Rs.13500/ Hectare to Paddy crop and Rs.18000/ Hectare to Coconut crop.

(b) Kanchipuram:

Due to Cyclone Vardah, the crops viz., Paddy, Ground nut and Pulses crops cultivated in Kanchipuram district were severely affected in 13 blocks. Out of the total area cultivated (49500 Hectare) in the district, 6002.20 Hectare area under agricultural crops was severely affected. In this, Paddy --1625.70 Hectare, Ground nut --54 Hectare and Pulses --35 Hectare were affected with >33% crop damage. In total 1714.70 Hectare area was affected with >33% crop damage which includes 1679.20 Hectare area of SF/MF and 35.50 Hectare of other farmers. 2398 farmers were affected due to this Vardah cyclone.

The total Assistance sought for Kanchipuram district is Rs.231.483 lakhs@ Rs.13500/ Hectare to annual crops.

(c) Vellore:

The crops viz., Paddy, Millets, Ground nut Pulses and Sugarcane crops cultivated in Vellore district were severely affected in 15 blocks. Out of the total area (1, 24, 800 Hectare) cultivated in the district, 780.12 Hectare agricultural crops were severely affected. Due to cyclone Vardah, Paddy --101.16 Hectare, Millets --58.44 Hectare, Groundnut --9.06 Hectare, Pulses -- 6.8 Hectare, Sugarcane -- 44.82 Hectare and Coconut -- 0.53 Hectare were affected with >33% crop damage. In total 220.81 Hectare area was affected with >33% crop damage which was belonging to SF/MF only. 498 farmers were affected due to this Vardah cyclone.

The total Assistance sought for this affected area of Vellore district is Rs.29.81 lakhs @ Rs.13500/ Hectare to annual crops.

(d) Tiruvannamalai:

Due to Cyclone Vardah, the Paddy and Sugarcane crops cultivated were severely affected in Arani block of in Tiruvannamalai district. Out of the total area cultivated under Paddy (57300 Hectare) in the district, 139 Hectare area was severely affected. In this, 13 Hectare Paddy area cultivated by 48 numbers of SF/MF was affected with >33% crop damage.

The total Assistance sought for Tiruvannamalai district is Rs.1.76 lakhs @ Rs.13500/ Hectare to Paddy crop.

Andhra Pradesh

Loss of Human Lives

Two persons were killed in Chittoor district of Andhra Pradesh due to cyclone Vardah as heavy rains lashed the region (NDTV, 13th December, 2016).



Fig. 4.39 (a): Uprooted Poles and Trees in Chennai City (Business Line, 12th December)



Fig. 4.39(b): Blown away profiler wind damaged banana plantation in Vellore sheets at district VGP Theme Park



Fig. 4.39 (c): Flying car in Chennai City Storm Surge near Chennai Coast



Fig. 4.39 (d): Heavy Rainfall over Chennai

4.1.5. Depression over the Arabian Sea (17th-18th December 2016)

4.1.5.1 Introduction

The remnant of the very severe cyclonic storm (VSCS), Vardah (06-13 Nov. 2016), which crossed Tamil Nadu coast near Chennai on 12th December 2016 emerged into southeast Arabian Sea as a low pressure area on 14th December. It moved gradually westwards and became well marked over southeast and adjoining southwest Arabian Sea on 16th December. It concentrated into a depression (D) and lay centered at 0300 UTC of 17th over southwest Arabian Sea near latitude 11.0^0N and longitude 62.5^0E. It moved west-southwestwards and lay over southwest Arabian Sea near latitude 09.4^0N and longitude 56.8^0E at 0300 UTC of 18th December 2016. Under the influence of the unfavourable environmental conditions like colder sea surface temperature (SST) and Ocean thermal energy over the southwest Arabian Sea, it weakened into a well marked low pressure area at 0900 UTC of 18th December 2016. The salient features of the system are as follows.

(iii) It was the only cyclonic disturbance over the Arabian Sea during the post-monsoon season of 2016. Thus the cyclonic activity over the Arabian Sea has been below normal during post-monsoon season, 2016.

(iv) It developed from the remnant of the VSCS, Vardah over the Bay of Bengal

(v) It moved west-southwestwards and dissipated over the sea

Brief life history, characteristic features and associated weather along with performance of NWP and operational forecast of IMD are presented and discussed in following sections.

4.1.5.2. Monitoring of Depression

The depression was monitored & predicted continuously since its inception by IMD. The best track parameters of the systems are presented in Table 4.12 and the best track in Fig.4.1**.** Throughout its life cycle, the system was monitored mainly with satellite, buoys and ships coastal observations. Various national and international NWP models and dynamical-statistical models including IMD's and NCMRWF's global and meso-scale models, dynamical statistical models for genesis and intensity were utilized to predict the genesis, track and intensity of the system.

4.1.5.3 Brief life history

4.1.5.3.1. Genesis

The remnant of the very severe cyclonic storm (VSCS), Vardah (06-13 Nov. 2016), which crossed Tamil Nadu coast near Chennai on 12th December 2016 emerged into southeast Arabian Sea as a low pressure area on 14th December. It moved gradually westwards and became well marked over southeast and adjoining southwest Arabian Sea on 16th December. It concentrated into a depression (D) and lay centered at 0300 UTC of 17th over southwest Arabian Sea near latitude 11.0^0N and longitude 62.5^0E. The best track parameters are presented in Table 4.12 and the best track is presented in Fig.4.1.

On 16th and 17th December, the large scale dynamical and thermodynamical features became gradually favourable. At 0300 UTC of 17th, the vertical wind shear was 15-20 kts (moderate), upper level divergence was (5-10)x10^{-5} s^{-1}, lower level convergence was (5-10)x10^{-5} s^{-1} and relative vorticity at 850 hPa was around 80x10^{-6} s^{-1}. Sea surface temperature was 26-28^{0}C. The ocean thermal energy was about 60- 80 KJ/cm^2 around the system centre over central BOB. According to satellite imagery, a low level cyclonic circulation lay over southeast Arabian Sea on 14th and 15th Dec. and it became a vortex with T1.0 at 1200 UTC of 16th Dec. 2016 over the southeast Arabian Sea. The associated convection gradually organized on 17th. Broken low/medium clouds with embedded intense to very intense convectioin lay over Arabian Sea between latitude 8.5^{0}N to 12.5^{0}N and longitude 58.5^{0}E to longitude 64.5^{0}E at 0300 UTC of 17th. Intensity of system was T 1.5. The convection showed banding pattern at the time of genesis, covering 0.3 in logarithmic spiral. The lowest cloud top temperature was about -85^0 C. The estimated central pressure was 1006 hPa and maximum sustained wind speed of 25 knots.

4.1.5.3.2. Intensification and movement

The upper tropospheric ridge ran along latitude 16^{0}N At 0300 UTC of 17th. Hence the depression centre lay far to the south of the ridge and was thus steered initially westwards and then west-southwestwards. The west-southwestward movement was mainly triggered by the anti-cyclonic circulation lying to the northwest of the system centre over the Arabia-Africa. As the system moves west-southwestwards, it experienced colder water and lower Ocean thermal energy leading to weakening of the system into a well marked low pressure area at 0600 UTC of 18th December. Under the above mentioned anti-cyclonic circulation, there was also intrusion of dry and cold air to the core of depression, which helped in weakening of the system.

Table 4.12 Best track positions and other parameters of the depression over the Arabian Sea (17th-18th December 2016)

Date	Time (UTC)	Centre lat.^{0} N/ long.^{0} E	C.I. NO.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
17th Dec.	0300	11.0 / 62.5	1.5	998	25	3	D
	0600	11.8/61.7	1.5	998	25	3	D
	0900	10.6/61.2	1.5	998	25	3	D
	1200	10.4 / 60.5	1.5	998	25	3	D
	1500	10.0/59.8	1.5	998	25	3	D
	1800	10.8/59.8	1.5	998	25	3	D
	2100	9.8/58.8	1.5	998	25	3	D
18th	0000	9.4/58.0	1.5	996	25	3	D

Dec.	0300	9.4/56.8	1.5	994	20	3	D
	Weakened into a well marked low pressure area over southwest Arabian Sea in the forenoon of 18th						

Typical INSAT 3D imageries are presented in Fig.4.40. The water vapour imageries in association with the system are presented in Fig. 4.41 respectively.

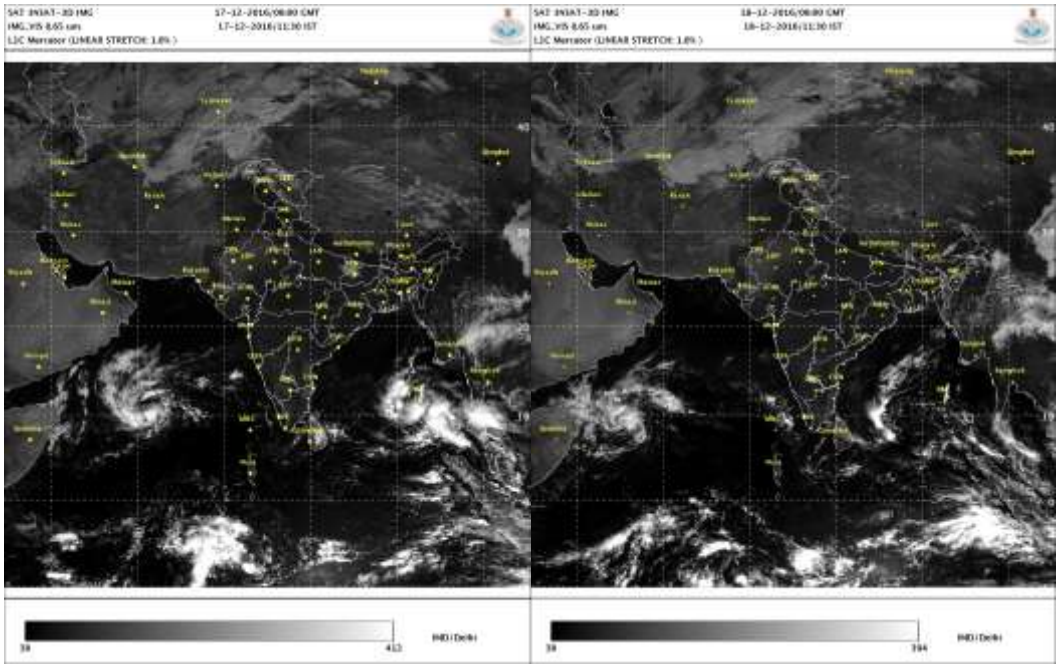


Fig.4.40(a): Typical INSAT-3D visible imageries at 0600 UTC of 17-18 Dec. 2016

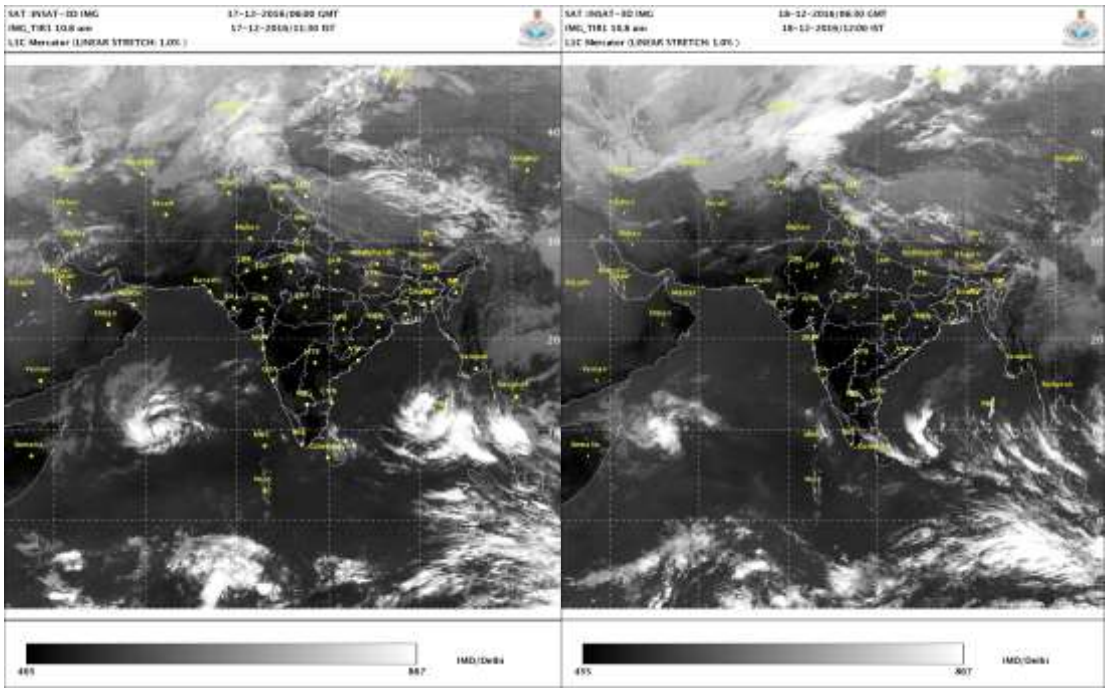


Fig. 4.40(b) Typical INSAT-3D visible imageries at 0300 UTC of 02-06 Nov 2016

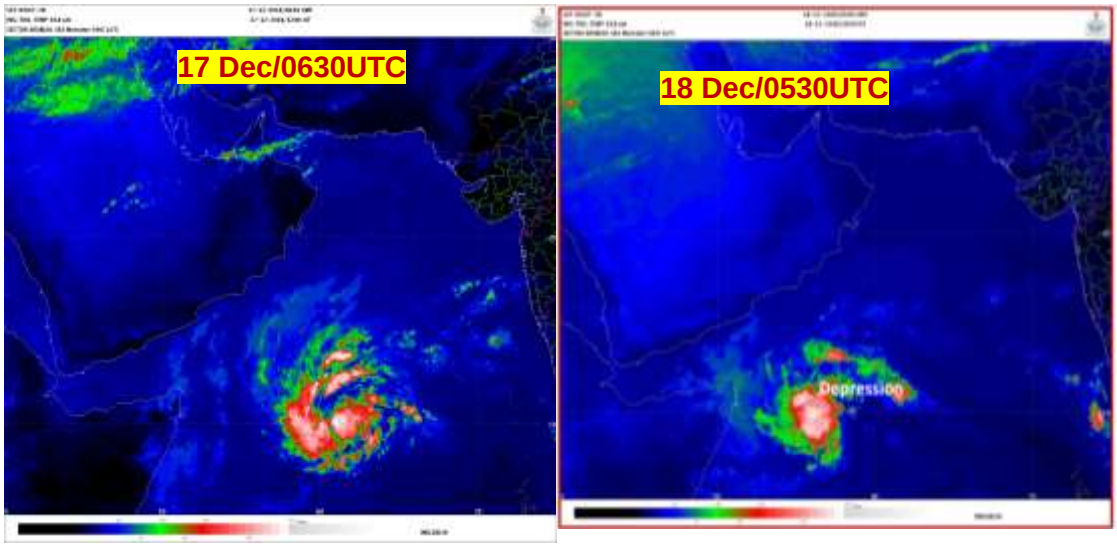


Fig. 4.40(c): Typical INSAT-3D enhanced colored imageries during 02-06 Nov 2016

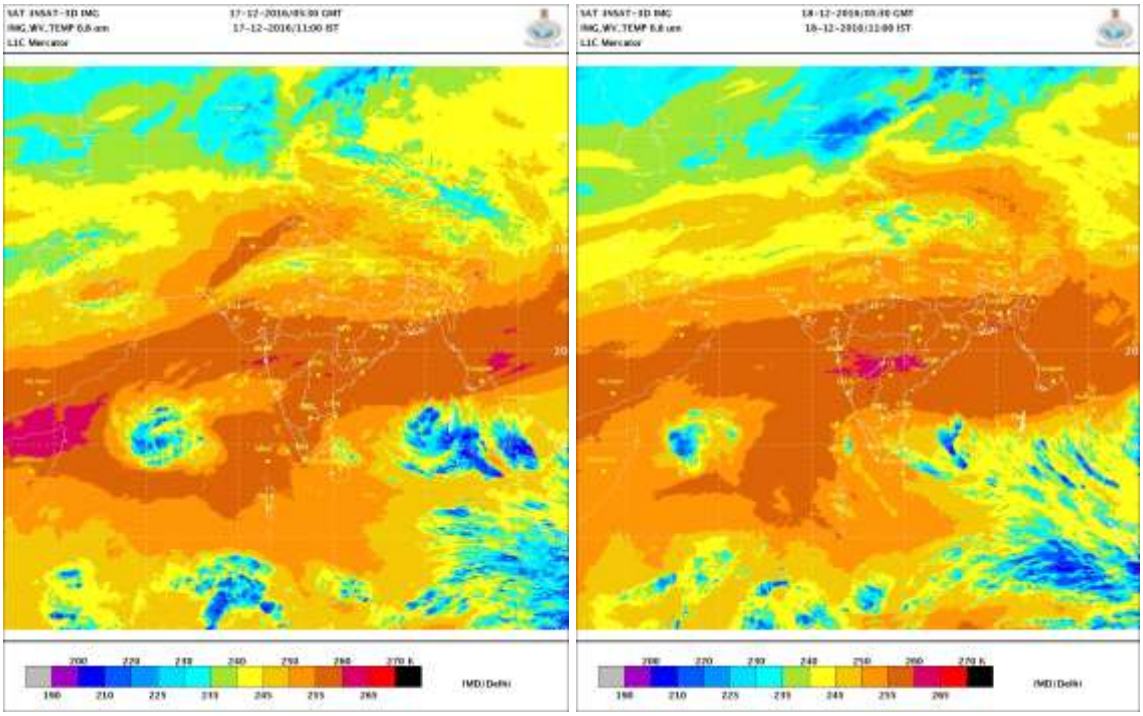


Fig. 4.40 (d): Typical INSAT-3D water vapour temprature imageries during 02-06 Nov 2016

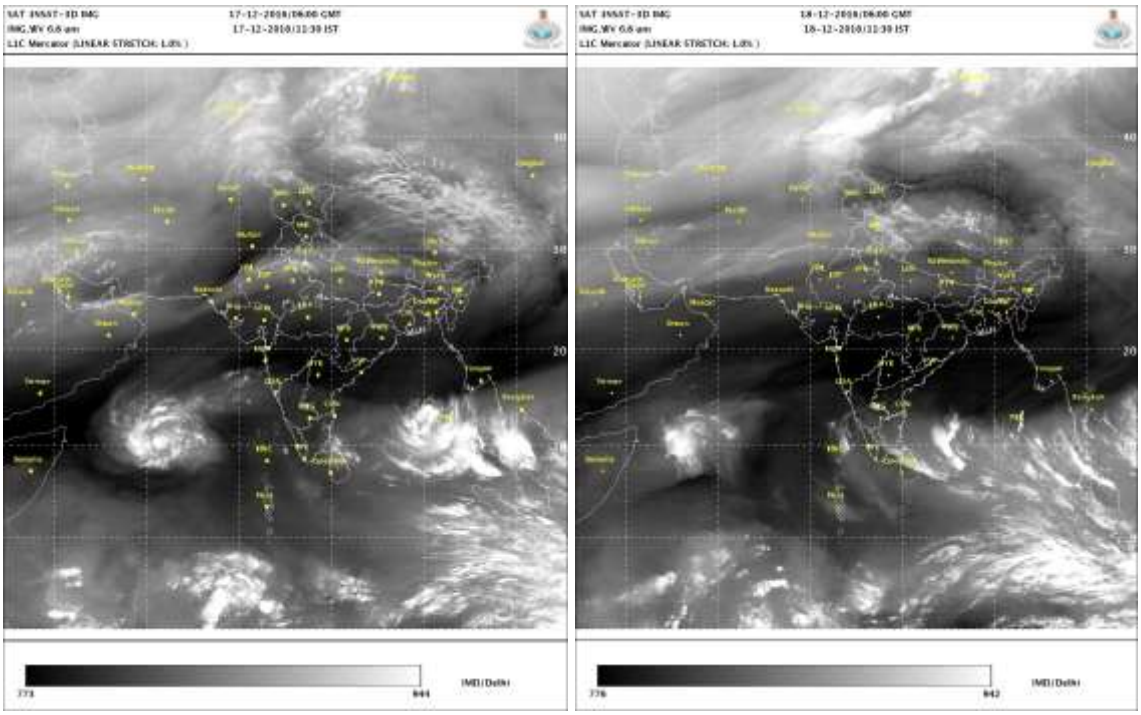


Fig. 4.40.(e) Water Vapour and brightness temperature Imageries at 0600 UTC of 17-18 December 2016

4.1.5.4. Climatological aspects

Considering the area of genesis (+/- 2^0 around the genesis point), the cliamtological tracks of the cyclonic disturbances during 1891-2015 are presented in Fig.4.41. It indicates that climatologically, most of the tdisturbances moved west-northwestwards or northwestwards. However, there were three disturbances that moved northeastwards. Out of nine systems, five have developed into cyclonic storms or higher intensity.

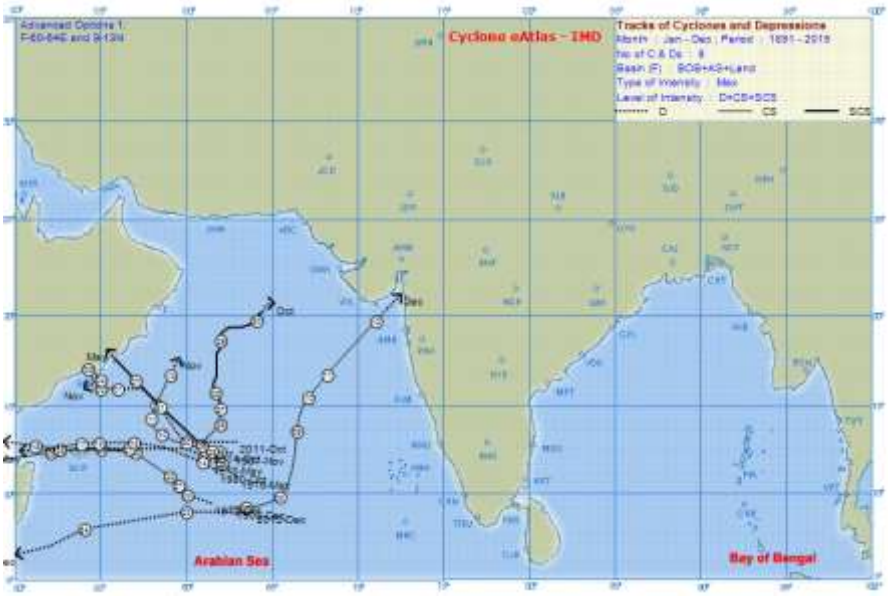


Fig. 4.41. Climatological tracks of cyclonic disturbances formed within +/- 2^0 around the genesis point during 1891-2015.

4.1.5.5 Dynamical features

IMD GFS (T1534) mean sea level pressure (MSLP), winds at 850, 500 and 200 hPa levels are presented in Fig.4.42. IMD GFS analysis could detect the formation of low pressure system with underestimation of intensity. Also it could detect higher wind in the northern sector under the influence of the northeast monsoon condition. It also detected west-southwestward movement of the system towards north Somalia coast.

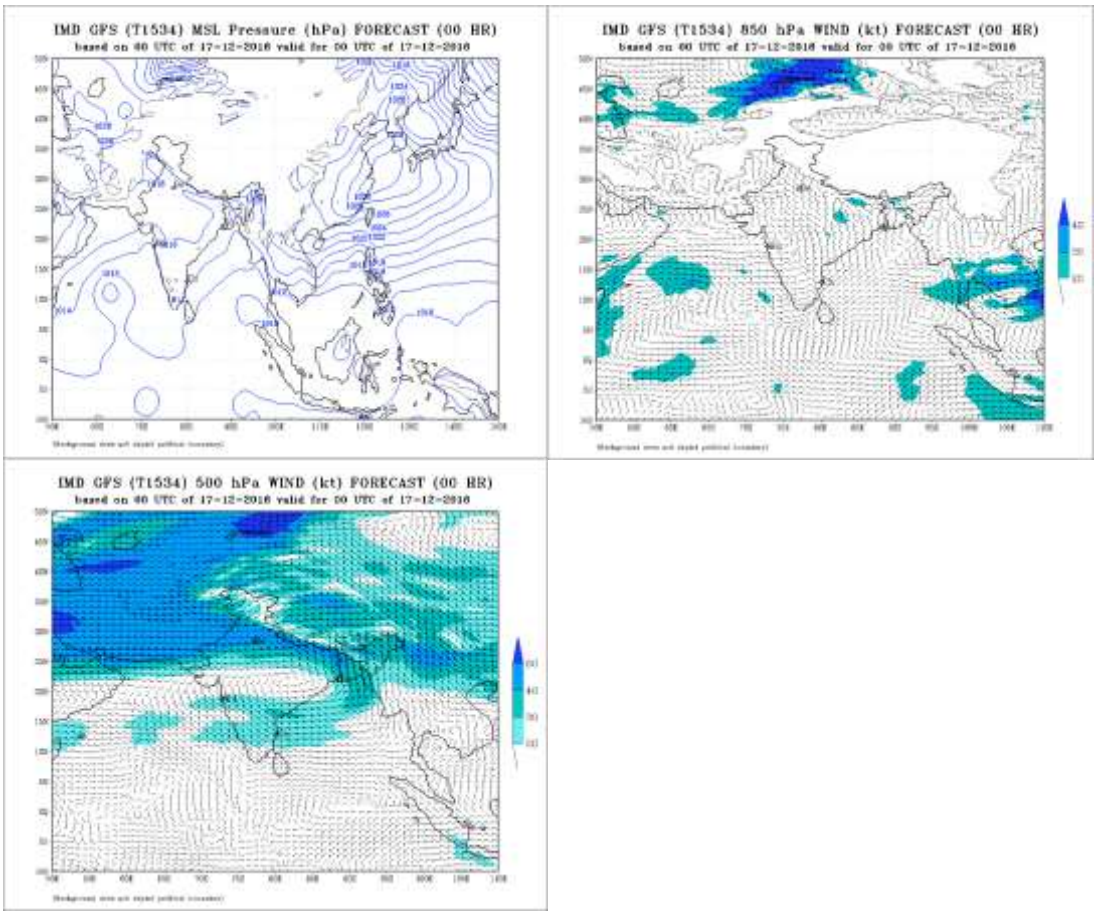


Fig. 4.42(a): IMD GFS (1534) analysis of MSLP and winds at 850 and 500 hPa levels based on 0000 UTC of 17th December 2016.

(675)

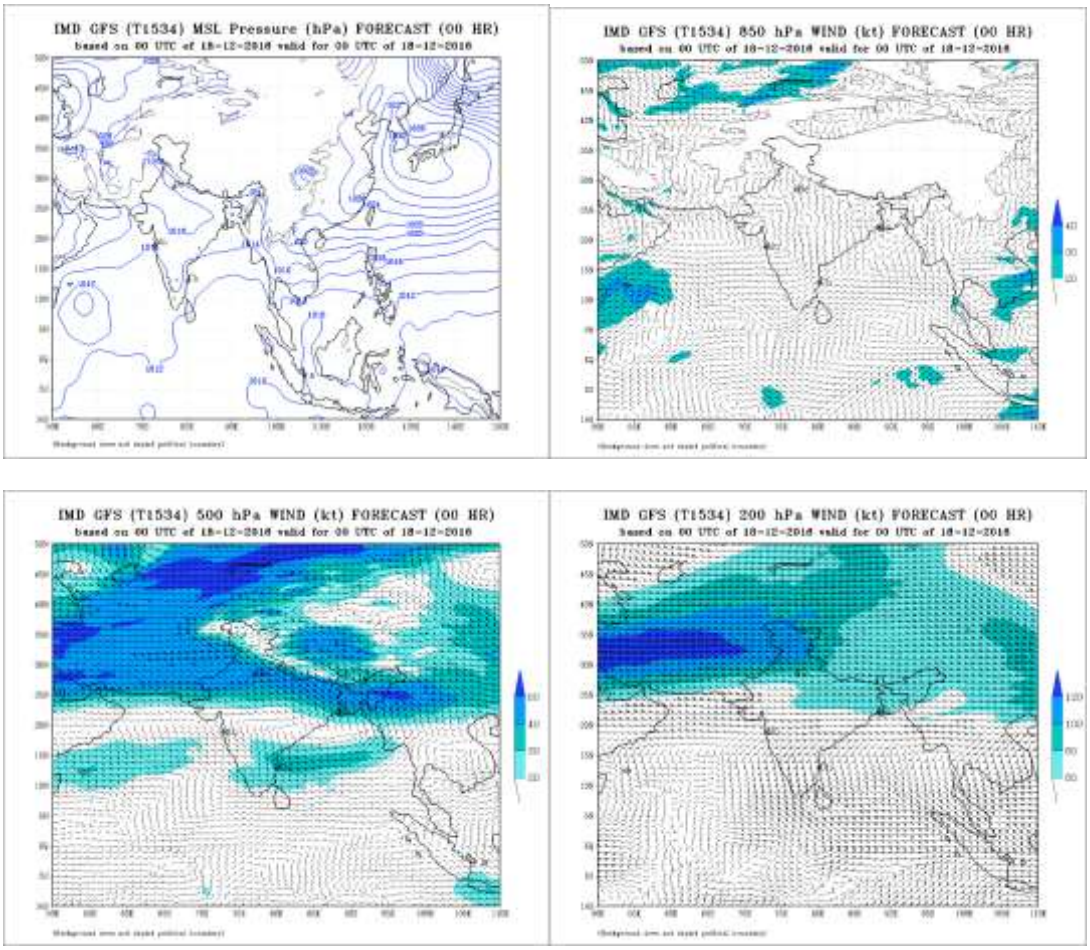


Fig. 4.42(b): IMD GFS (1534) analysis of MSLP and winds at 850, 500 and 200 hPa levels based on 0000 UTC of 18th December 2016.

4.1.5.6 Realized Weather:

There was no adverse weather along west coast of India and Lakshadweep area as the depression formed over southwest Arabian Sea and moved west-southwestwards towards Somalia coast. No adverse weather has also been report by Yemen and Somalia due to this system.

4.1.5.7 Damage due to system

No damage has been reported due to this system

CHAPTER-V

Forecast Performance during Post Monsoon Season 2016

5.1 Performance of Numerical Weather Prediction Models:

5.1.1. Introduction:

India Meteorological Department (IMD) operationally runs two regional models, WRF and HWRF for short-range prediction and one Global model T1534L64 for medium range prediction (10 days). The WRF-Var model is run at the horizontal resolution of 9 km and 3 km with 45 Eta levels in the vertical and the integration is carried up to 72 hours over three domains covering the area between lat. 23^0 S to 46^0 N long 40^0 E to 120^0 E. Initial and boundary conditions are obtained from the IMD Global Forecast System (IMD-GFS) at the resolution of 9 km. The boundary conditions are updated at every six hours interval. The HWRF model (resolution 27 km, 9 km and 3 km) is used for cyclone track prediction in case of cyclone situation in the north Indian Ocean. IMD also makes use of NWP products prepared by some other operational NWP Centres like, ECMWF (European Centre for Medium Range Weather Forecasting), GFS (NCEP), UKMO (UKMet), JMA (Japan Meteorological Agency). Ensemble prediction system (EPS) has been implemented at the NWP Division of the IMD HQ for operational forecasting of cyclones.

In addition to the above NWP models, IMD also run operationally "NWP based Objective Cyclone Prediction System (CPS)". The method comprises of five forecast components, namely (a) Cyclone Genesis Potential Parameter (GPP), (b) Multi-Model Ensemble (MME) technique for cyclone track prediction, (c) Cyclone intensity prediction, (d) Rapid intensification and (e) Prediction of decay in intensity after the landfall. Genesis potential parameter (GPP) is used for predicting potential of cyclogenesis and forecast for potential cyclogenesis zone. The multi-model ensemble (MME) for predicting the track (at 12h interval up to 120h) of tropical cyclones for the Indian Seas is developed applying multiple linear regression technique using the member models IMD-GFS, GFS (NCEP), ECMWF, UKMO and JMA. The SCIP model is used for 12 hourly intensity predictions up to 120-h and a rapid intensification index (RII) is developed and implemented for the probability forecast of rapid intensification (RI). Decay model is used for prediction of intensity after landfall. In this report performance of the individual models, MME forecasts, SCIP, GPP, RII and Decay model for cyclones during 2016 are presented and discussed.

Global models are also run at NCMRWF. These include unified model (NCUM) adapted from UK Meteorological Office. Apart from the observations that are used in the earlier system, the new observations assimilated at NCMRWF include (i) Precipitation rates from SSM/I and TRMM (ii) GPSRO occultation (iii) AIRS and AMSRE radiances (iv) MODIS winds. Additionally ASCAT ocean surface winds and INSAT-3D AMVs are also assimilated. NCUM (N768/L70) model features a horizontal resolution of 17km and 70 vertical levels. It uses 4D-Var assimilation and features no cyclone initialization/relocation. NCUM is a grid point model which has a Non-hydrostatic dynamics with a deep atmosphere suitable for all scales. It has semi-implicit time integration with 3D semi-Lagrangian advection, terrain following height coordinates and high order advection. It features mass-flux for shallow convection with convective momentum transport, non-local mixing and entrainment for boundary layer. NCMRWF Ensemble Prediction System (NEPS) is a global medium range probabilistic forecasting system adapted from UK MET Office. The configuration consists of four cycles of assimilation corresponding to 00Z, 06Z, 12Z 18Z and 10-day forecasts are made using the 00Z initial condition. The N400L70 forecast model consists of 800x600 grid points on the horizontal

surface and has 70 vertical levels. Horizontal resolution of the model is approximately 33 km in the mid-latitudes. The 10 day control forecast run starts with N768L70 analysis of the deterministic assimilation forecast system and 44 ensemble members start from different perturbed initial conditions consistent with the uncertainty in initial conditions. The initial perturbations are generated using Ensemble Transform Kalman Filter (ETKF) method (Bishop et al., 2001).

An important component common to both the deterministic and ensemble model is that they do not use any TC relocation in the analysis.

The performance of various NWP models for the cyclonic storms developing over NIO region during post monsoon season is presented in Sec. 5.1.2 to 5.1.4

1.1.2. Cyclonic storm KYANT over the Bay of Bengal during 21-28 October 2016

1.1.2.1. Track prediction by various NWP models

Track prediction by various NWP models is presented in Fig. **5.1**. Based on initial conditions of 0000 UTC of 21st, all the models were unanimously predicting anticlockwise recurving track and weakening over sea except WRF-VAR model which predicted northeastward movement with weakening over eastcentral BoB. Most of the models were predicting west-northwestwards recurvature from 23rd night. Only UKMO and NCUM predicted west-southwestwards recurvature from 25th afternoon onwards.

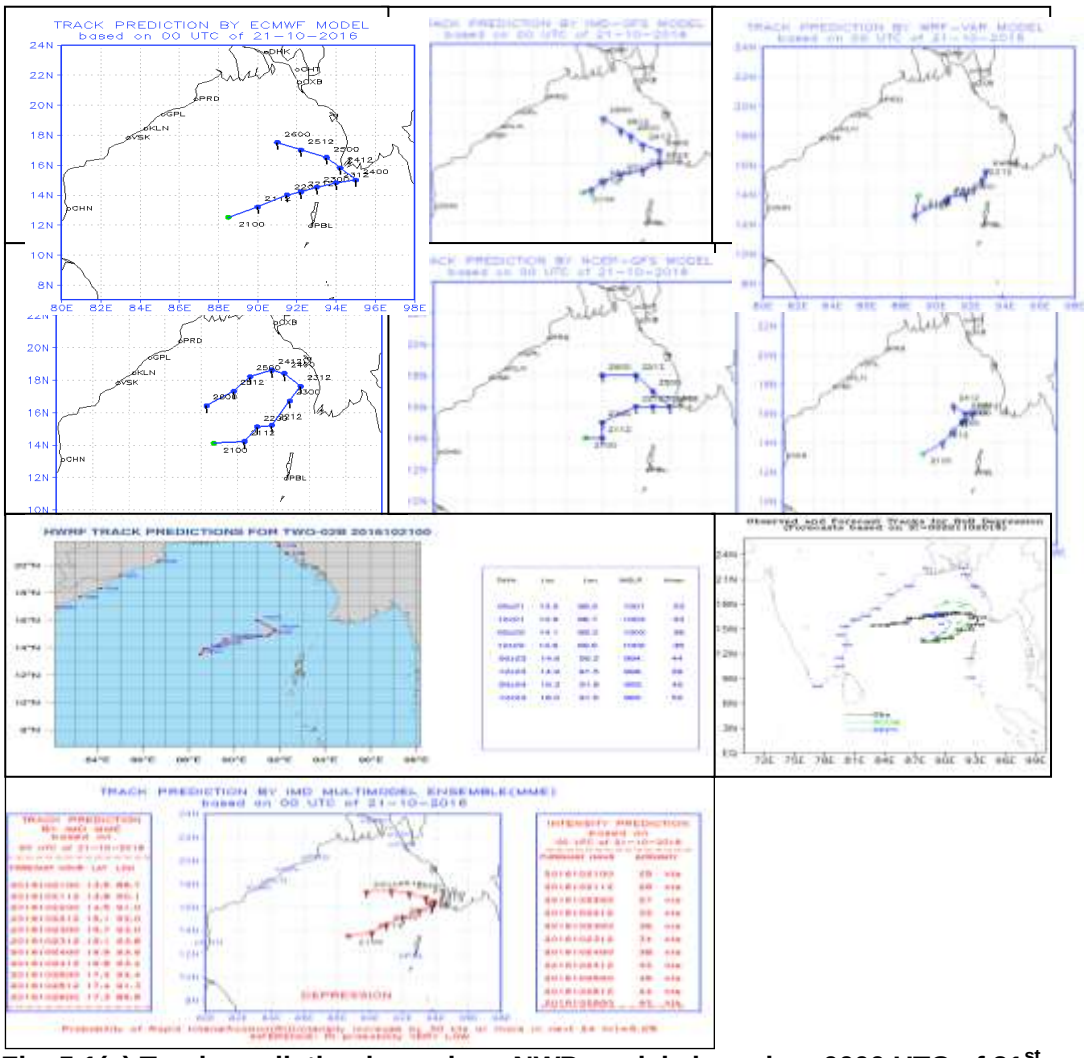


Fig. 5.1(a) Track prediction by various NWP models based on 0000 UTC of 21st October, 2016.

Based on initial conditions of 0000 UTC of 22nd, all the models were unanimously predicting anticlockwise recurving track. However, IMD-GFS, NCEP-GFS and WRF-VAR were predicting landfall over Myanmar coast and re-emergence in eastcentral BoB with IMD-GFS showing second landfall over Bangladesh. HWRF predicted landfall over north Andhra Pradesh. Other models were predicting weakening over sea. There was large divergence in track prediction by various models. Only UKMO and NCUM predicted west-southwestwards recurvature from 25th afternoon onwards.

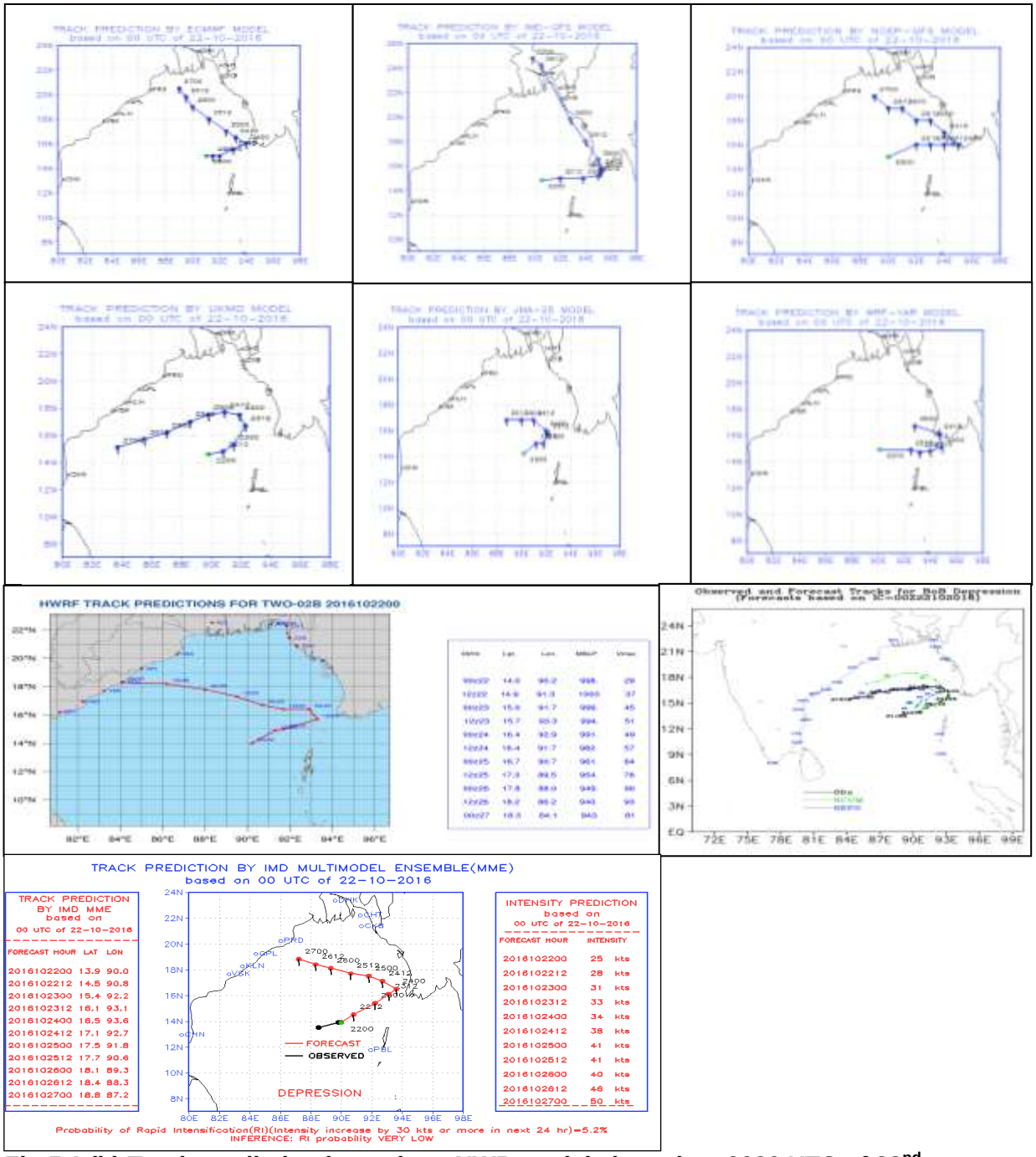


Fig.5.1 (b) Track prediction by various NWP models based on 0000 UTC of 22nd October. 2016.

Based on initial conditions of 0000 UTC of 23rd, only JMA, UKMO and NCUM were predicting weakening over westcentral BoB. The landfall point prediction by other models varied from Odisha to Bangladesh. There was large divergence in track prediction by various models. Only UKMO and NCUM predicted west-southwestwards recurvature from 25th night onwards. IMD-GFS, NCEP-GFS, IMD-HWRF and MME predicted even north/northeastward recurvature.

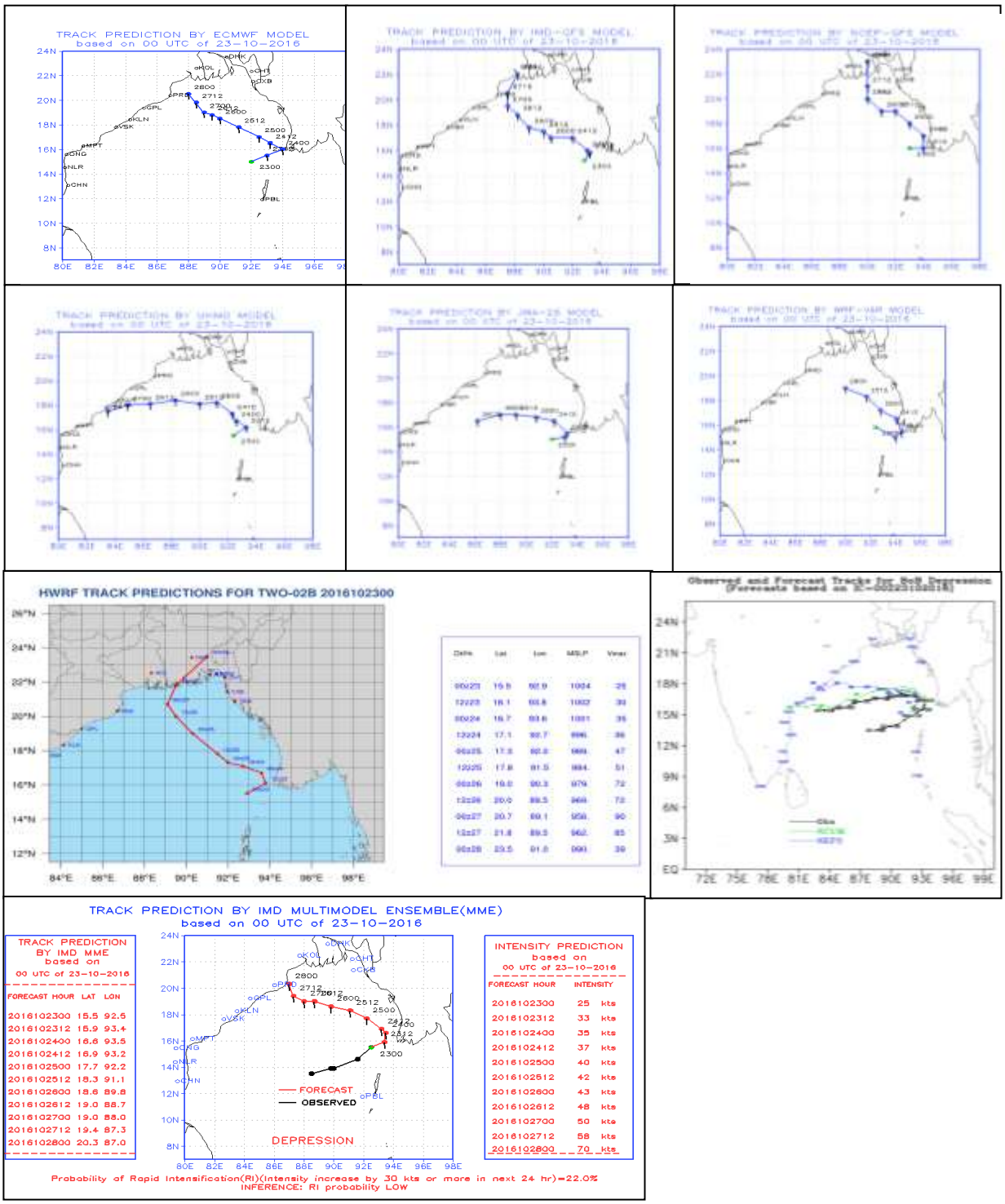


Fig. 5.1 (c) Track prediction by various NWP models based on 0000 UTC of 23rd October, 2016.

Based on initial conditions of 0000 UTC of 24th except UKMO and IMD GFS, all other models were predicting weakening over westcentral BoB. There was large divergence in track prediction by various models. Only UKMO, JMA, WRF-VAR and NCUM predicted west-southwestwards recurvature. IMD-GFS and IMD-HWRF predicted even north/northeastward recurvature.There was large divergence in track prediction by various models.

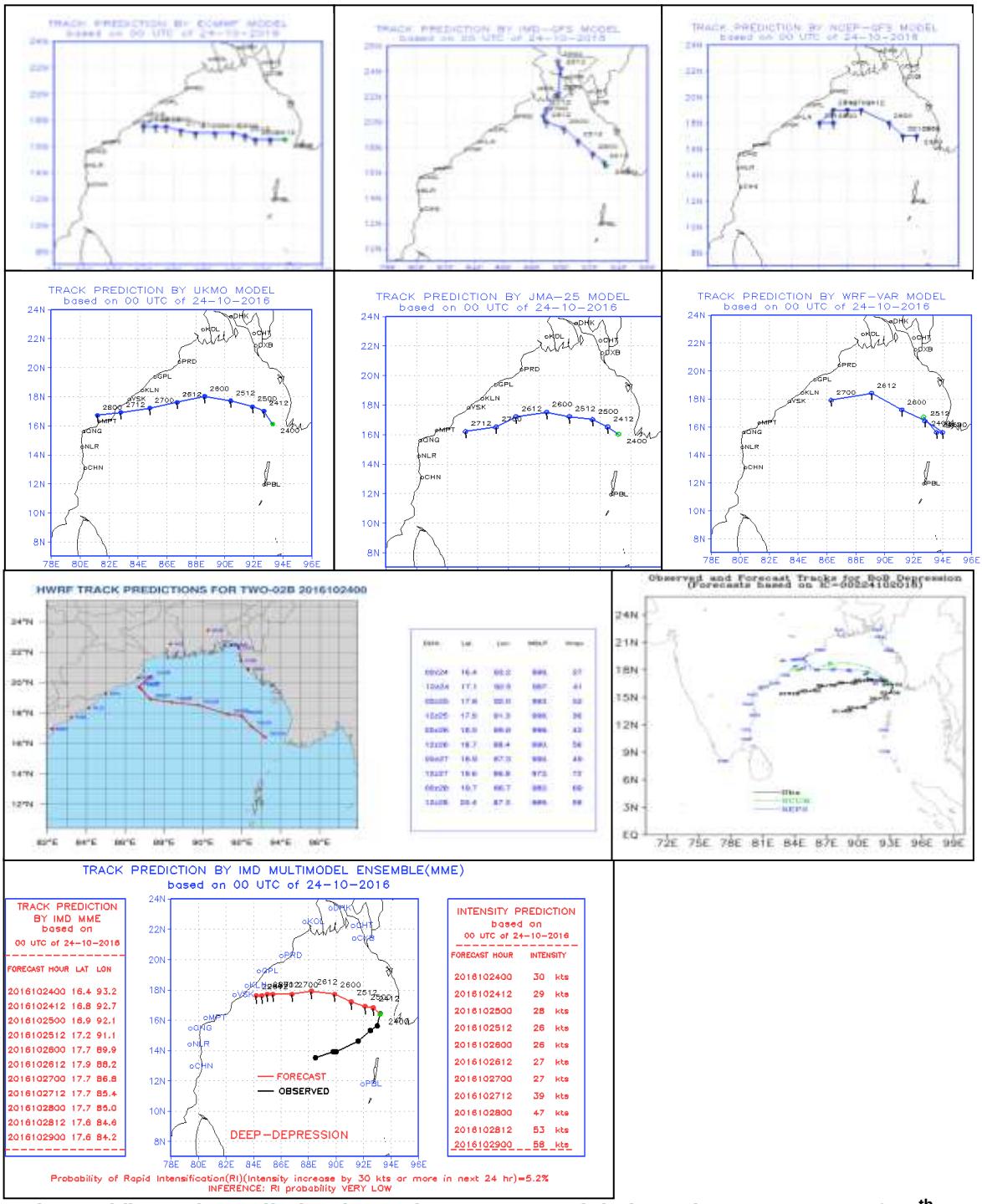


Fig.5.1 (d) Track prediction by various NWP models based on 0000 UTC of 24th October, 2016.

Based on initial conditions of 0000 UTC of 25th except WRF-VAR, all other models were predicting weakening over westcentral BoB. There was large divergence in model guidance w.r.t. track and time of west-southwestwards recurvature. UKMO, ECMWF, MME, JMA and HWRF were predicting west-southwestwards movement of the system.

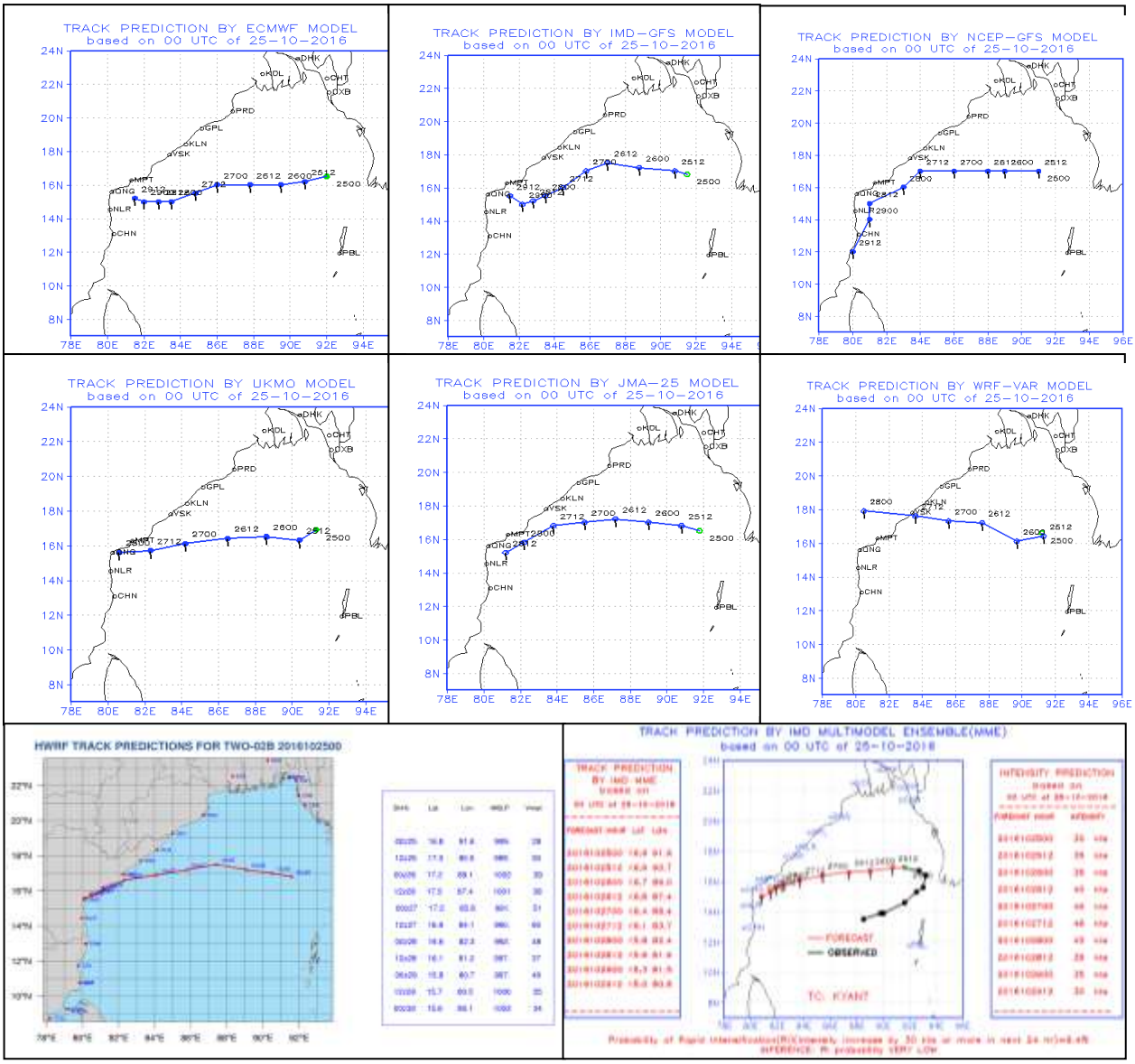


Fig.5.1 (e) Track prediction by various NWP models based on 0000 UTC of 25th october, 2016.

Based on initial conditions of 0000 UTC of 26th except WRF-VAR and HWRF, all other models were predicting weakening over westcentral BoB. Many models here predicted west-southwestwards towards south Andhra Pradesh coast.

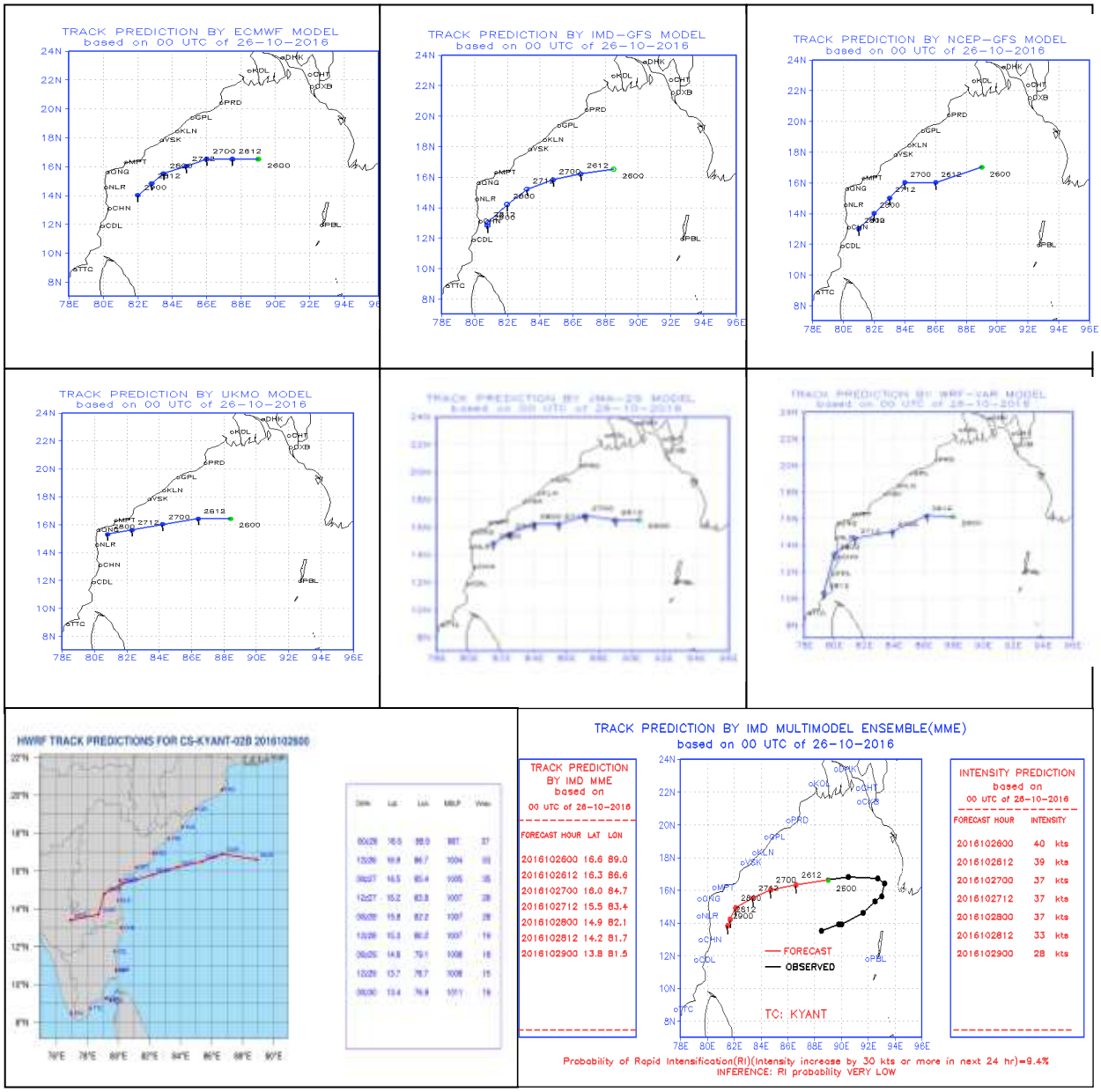


Fig. 5.1 (f) Track prediction by various NWP models based on 0000 UTC of 26th October, 2016.

Based on initial conditions of 0000 UTC of 27th except UKMO and WRF-VAR, all other models were predicting weakening over westcentral BoB and most models showed west-southwestward movement towards south Andhra Pradesh coast..

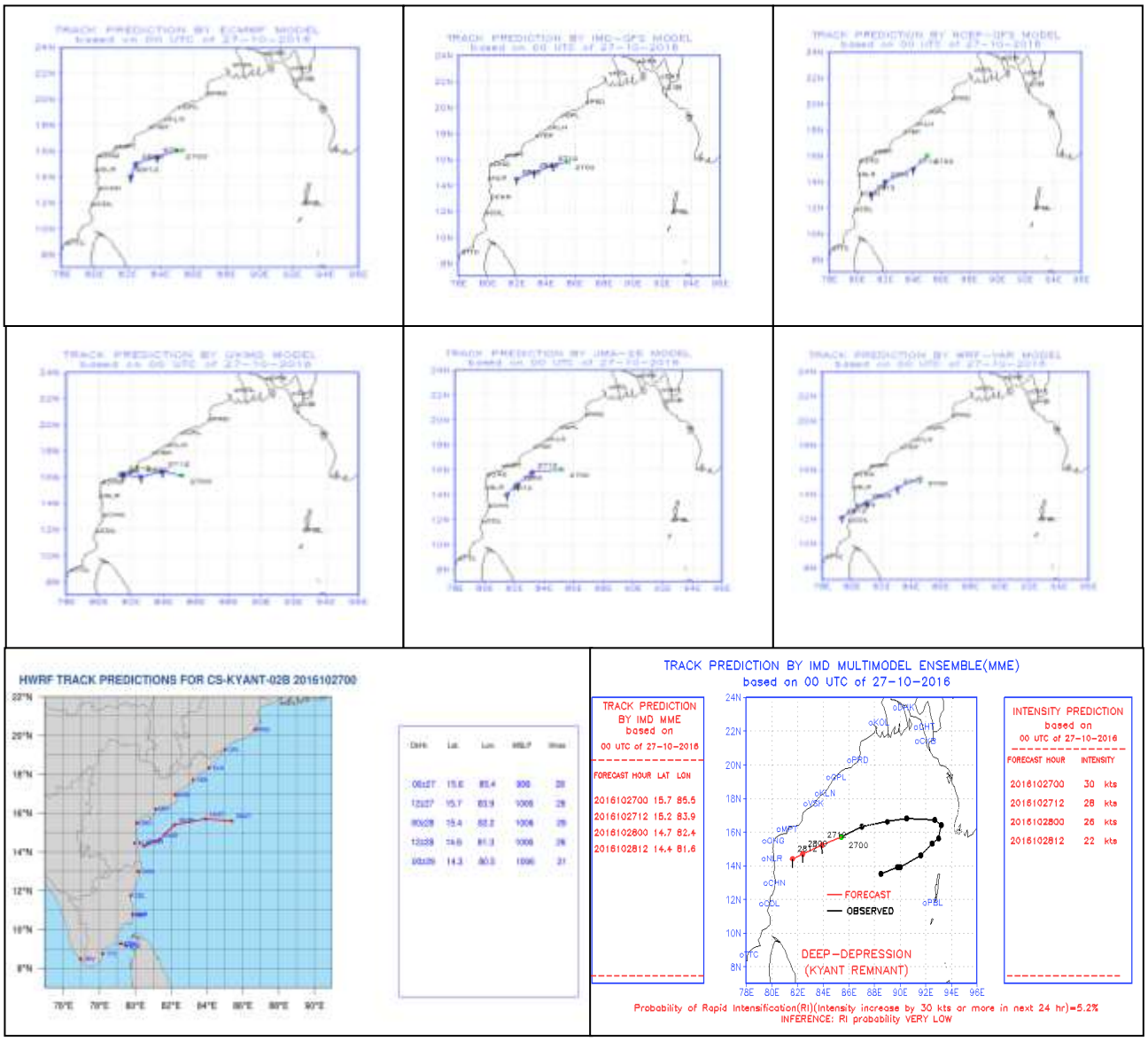


Fig.5.1 (g) Track prediction by various NWP models based on 0000 UTC of 27th October, 2016.

Hence to conclude, since beginning most of the models were predicting anticlockwise recurving track and weakening over westcentral BoB. From 26th morning, most of the models suggested weakening over westcentral BoB off Andhra Pradesh coast. Overall UKMO and NCUM models performed better.

5.1.2.2. Ensemble track and Strike Probability forecast

The forecast based on ensemble members predicted 20-40% probability of landfall over south Andhra. The probabilistic and deterministic track forecast by National Centre for Environment Prediction (NCEP), Meteorological Service, Canada (MSC), UK Meteorological Office (UKMO) and consolidated forecast by these centres based on initial conditions of 1200 UTC of 25th and 26th October are presented in Fig. 5.2 (a-b). Based on 1200 UTC of 25th initial conditions (Fig.5.2a), both MSC and NCEP predicted 20-40% strike probability over south Andhra Pradesh and adjoining north Tamil Nadu. Individual deterministic tracks predictions of MSC group were wide spread showing landfall varying from south Odisha to south Andhra Pradesh coasts. NCEP members narrowed over south Andhra Pradesh coast. All members ensemble showed 20-40% strike probability over south Andhra Pradesh coast.

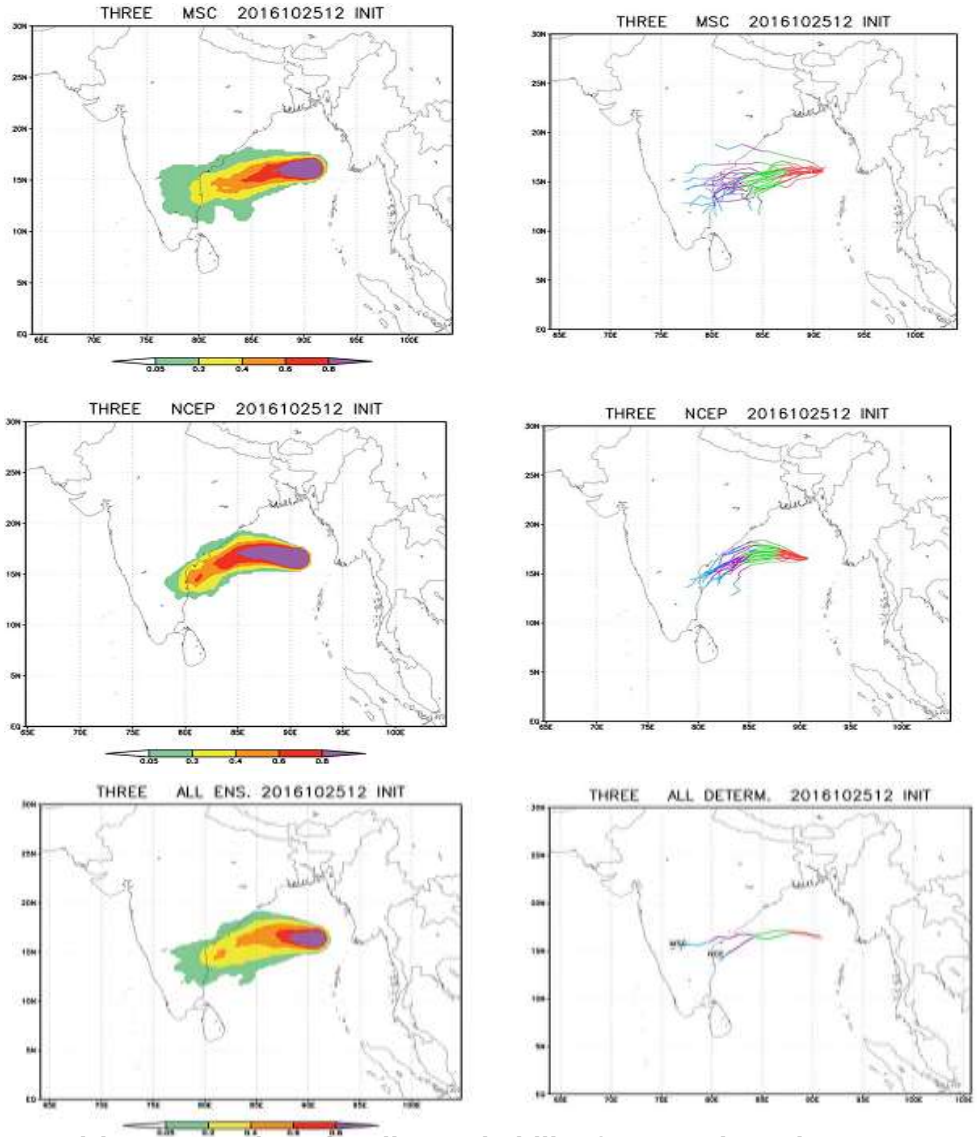


Fig. 5.2(a): EPS track and strike probability forecast based on 1200 UTC of 25th October 2016.

Based on the initial conditions of 1200 UTC of 26th October (Fig.5.2b) ensemble of MSC and UKMO members predicted 20-40% and 40-60% strike probability over south Andhra Pradesh and adjoining north Tamil Nadu. Ensemble of NCEP members predicted > 80% strike probability over north Tamil Nadu and adjoining south Andhra Pradesh. All members ensemble showed 20-40% strike probability over south Andhra Pradesh and adjoining north Tamil Nadu coast.

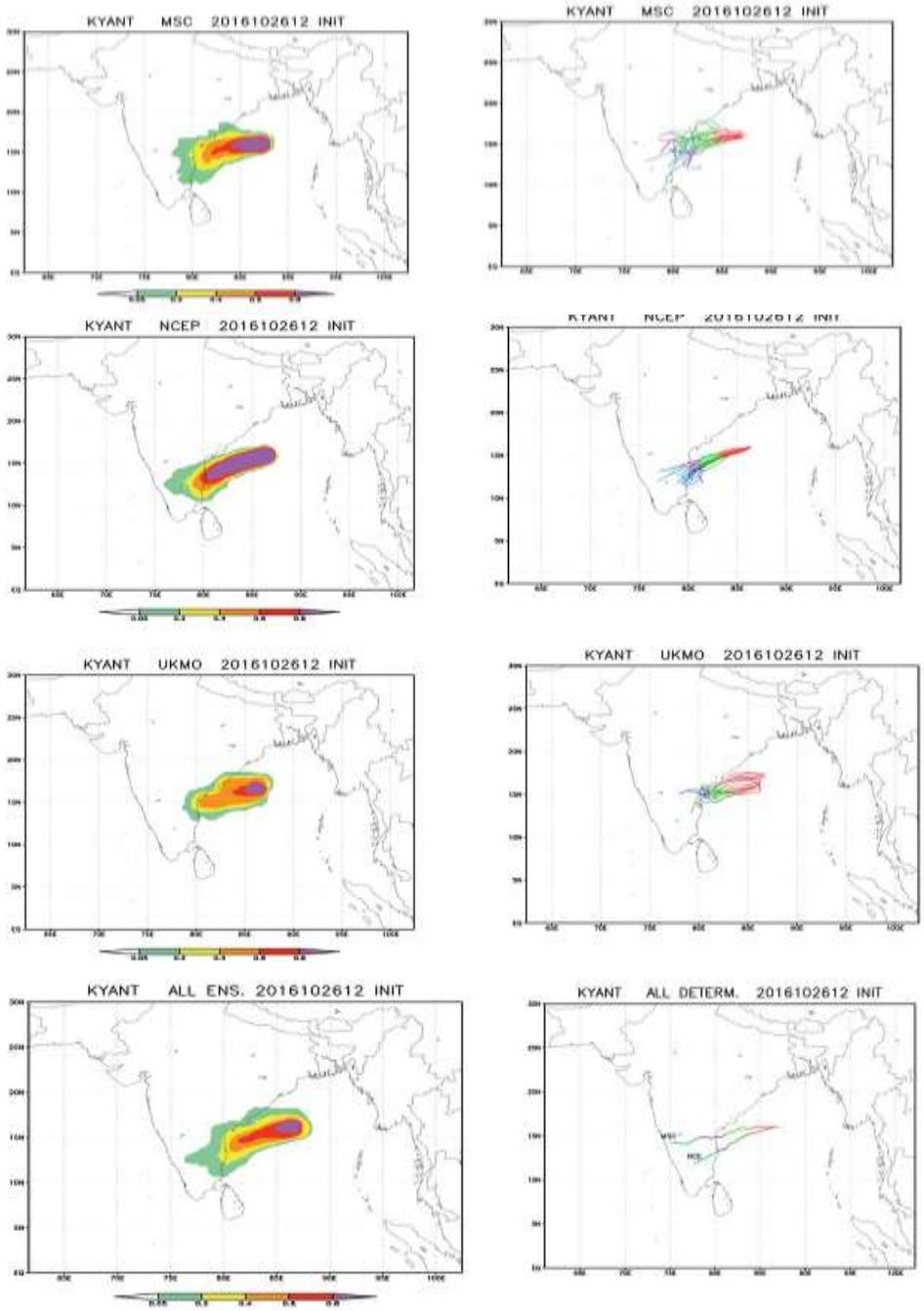


Fig. 5.2 (b): EPS track and strike probability forecast based on 1200 UTC of 26th October 2016.

5.1.2.3. Track and Intensity Forecast Errors by various Models:

The average track forecast errors (Direct Position Error) in km at different lead period (hr) of various models are presented in Table 5.1. The average cross track errors (CTE) and along track errors (ATE) are presented in Table 5.2 (a-b). From the verification of the forecast guidance available from various NWP models, it is found that the average track forecast errors

of IMD-MME were significantly less for all lead periods. Cross track errors contributed towards the DPE as the system had anticlockwise recurving track.

Table-5.1. Average track forecast errors (Direct Position Error (DPE)) in km (Number of forecasts verified is given in the parentheses)

Model	Lead time									
	12 hr	**24 hr**	**36 hr**	**48 hr**	**60 hr**	**72 hr**	**84hr**	**96hr**	**108hr**	**120hr**
IMD-GFS	41(9)	74(8)	119(7)	165(6)	201(5)	295(4)	400(4)	370(3)	604(3)	701(2)
IMD-WRF	115(9)	140(8)	174(7)	194(6)	214(5)	190(4)	-	-	-	-
JMA	68(9)	101(8)	96(7)	115(6)	131(5)	132(4)	129(4)	-	-	-
NCEP	72(9)	98(8)	127(7)	155(6)	214(5)	268(4)	354(4)	384(3)	519(3)	396(2)
UKMO	76(9)	104(8)	92(7)	147(6)	172(5)	210(4)	202(4)	220(3)	161(3)	141(2)
ECMWF	53(9)	109(8)	76(7)	96(6)	133(5)	207(4)	272(4)	335(3)	455(3)	442(2)
IMD-HWRF	41(23)	81(20)	104(18)	153(16)	212(14)	330(12)	407(10)	513(8)	473(6)	475(3)
IMD-MME	48(9)	62(8)	52(7)	77(6)	118(5)	161(4)	208(4)	235(3)	321(3)	252(2)
NCUM	83(13)	118(14)	139(13)	147(13)	140(13)	165(12)	188(13)	202(12)	209(11)	205(8)
NEPS	58(5)	124(6)	155(6)	187(5)	200(5)	216(4)	231(4)	251(3)	137(3)	109(2)

Table-5.2 a. Average cross-track forecast errors (CTE) in km

Model	Lead time									
	12 hr	**24 hr**	**36 hr**	**48 hr**	**60 hr**	**72 hr**	**84hr**	**96hr**	**108hr**	**120hr**
IMD-GFS	30	54	90	137	149	243	310	327	488	594
IMD-WRF	86	79	71	120	181	173	-	-	-	
JMA	49	40	56	79	99	73	88	-	-	
NCEP	60	66	78	125	163	198	269	290	372	331
UKMO	54	55	66	115	134	195	194	215	154	102
ECMWF	44	51	36	59	82	164	173	244	363	414
IMD-HWRF	11	24	51	105	168	213	268	320	308	325
IMD-MME	28	32	40	65	88	124	145	163	247	229

Table-5.2b. Average along-track forecast errors (ATE) in km

Model	Lead time									
	12 hr	**24 hr**	**36 hr**	**48 hr**	**60 hr**	**72 hr**	**84hr**	**96hr**	**108hr**	**120hr**
IMD-GFS	17	43	63	81	116	156	233	163	291	156
IMD-WRF	52	97	137	124	98	63	-	-	-	
JMA	27	84	61	73	79	91	72	-	-	
NCEP	25	62	81	79	109	164	221	250	310	166
UKMO	32	77	44	69	88	70	54	44	30	94
ECMWF	19	83	59	67	82	102	191	226	226	136
IMD-HWRF	25	41	56	151	244	313	415	466	457	453
IMD-MME	28	51	30	35	62	79	131	160	180	64

The intensity forecast errors of IMD-SCIP model and HWRF model are presented in Table 5.3. For lead period beyond 60 hours errors were higher in case of HWRF as the model could not pick up rapid weakening of the system. The probability of rapid intensification (RI) index of IMD is shown in Table 5.4.

Table 5.3: Intensity forecast errors by IMD SCIP and IMD-HWRF models

Lead time	12 hr	24 hr	36 hr	48 hr	60 hr	72 hr	84hr	96hr	108hr	120hr
IMD-SCIP (AAE)	1.9 (9)	4.0 (8)	5.7 (7)	11.3 (6)	9.6 (5)	6.3 (4)	8.8 (4)	11.7 (3)	14.3 (3)	11.0 (2)
IMD-SCIP (RMSE)	2.4	4.5	6.4	12.2	10.5	7.1	9.0	14.4	17.3	14.2
IMD-HWRF (AAE)	7.9 (23)	8.5 (20)	9.4 (18)	12.1 (16)	22.5 (14)	29.1 (12)	35.9 (10)	36.0 (8)	44.5 (6)	39.6 (3)
IMD-HWRF (RMSE)	9.9	11.3	12.7	14.1	25.9	30.5	37.8	43.8	48.0	45.6

Table 5.4: Probability of Rapid intensification

Forecast based on	Probability of RI predicted	Chances of occurrence predicted	Intensity changes(kt) occurred in 24h
00UTC/21.10.2016	5.2 %	Very low	2
00UTC/22.10.2016	5.2 %	Very low	6
00UTC/23.10.2016	22 %	Low	5
00UTC/24.10.2016	5.2 %	Very low	-2
00UTC/25.10.2016	9.4 %	Very low	-4
12UTC/25.10.2016	5.2 %	Very low	-5
00UTC/26.10.2016	9.4 %	Very low	7
12UTC/26.10.2016	5.2 %	Very low	-1

5.1.3. Depression over the Bay of Bengal during 2-6 November 2016

5.1.3.1. Grid point analysis and forecast of GPP

Prediction of cyclogenesis (Genesis Potential Parameter (GPP)) for the system

Figure 5.3 (a-f) shows the predicted zone of cyclogenesis. Grid point analysis and forecasts of GPP indicate the formation of cyclone over southwest BOB 120 hrs before its formation. Hence, it showed over estimation of intensity. Since all low pressure systems do not intensify into cyclones, it is important to identify the potential of intensification (into cyclone) of a low pressure system at the early stages (T No. 1.0, 1.5, 2.0) of development. Conditions for: (i) Developed system: Threshold value of average GPP ≥ 8.0 and (ii) Non-developed system: Threshold value of GPP < 8.0. The analysis and forecasts of GPP showed that GPP ≥ 8.0 (threshold value for intensification into cyclone) based on 00 UTC of 1st November and 2nd November 2016 indicated its potential to intensify into a cyclone (over estimated) at early stages of development (Fig.5.4. However, the updated analysis and forecasts of GPP based on 00 UTC of 2nd November to 5th November 2016 showed weakening of the system. GPP indicated weakening of the system from 5th November onwards based on initial conditions of 3rd, 4th and 5th November.

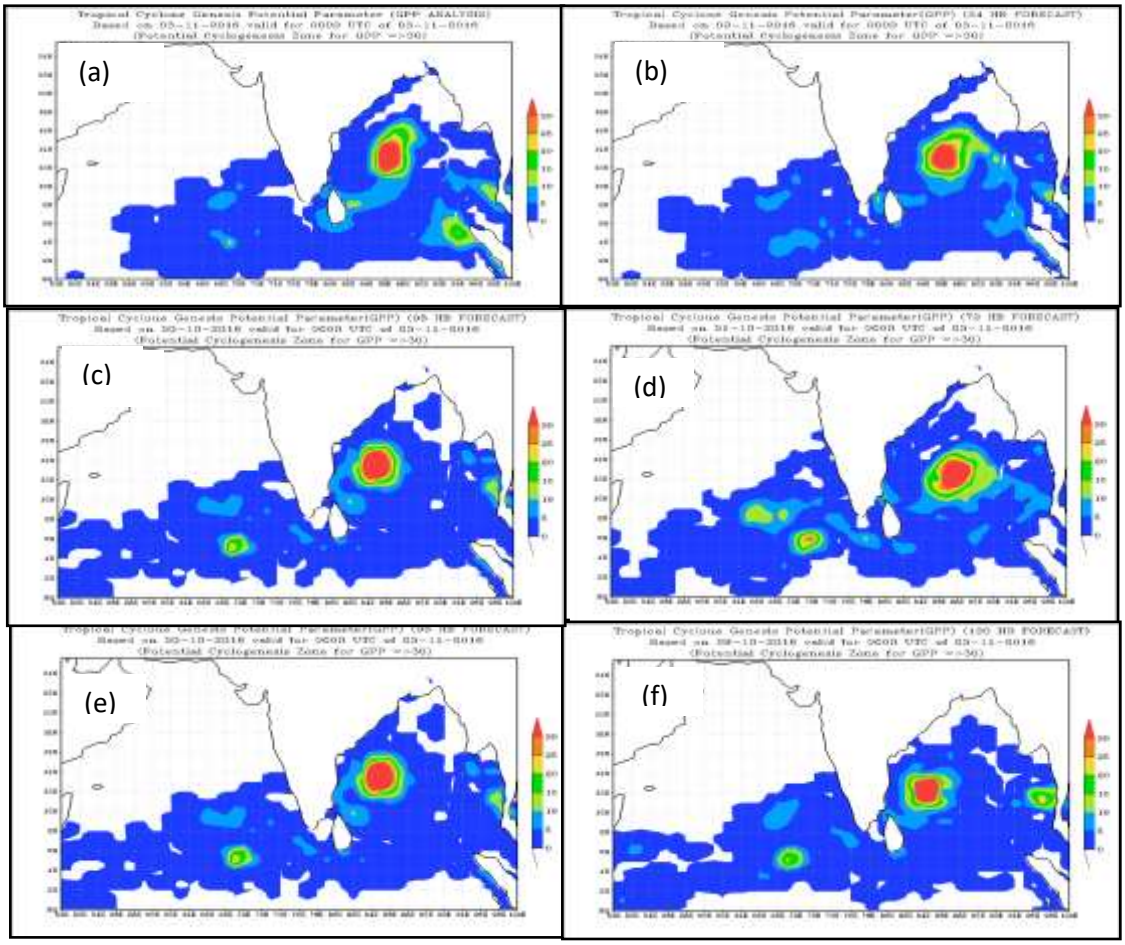


Fig.5.3 (a-f): Predicted zone of cyclogenesis based on 0000 UTC of 29th Oct. to 3rd Nov. for 0000 UTC of 3rd Nov2016.

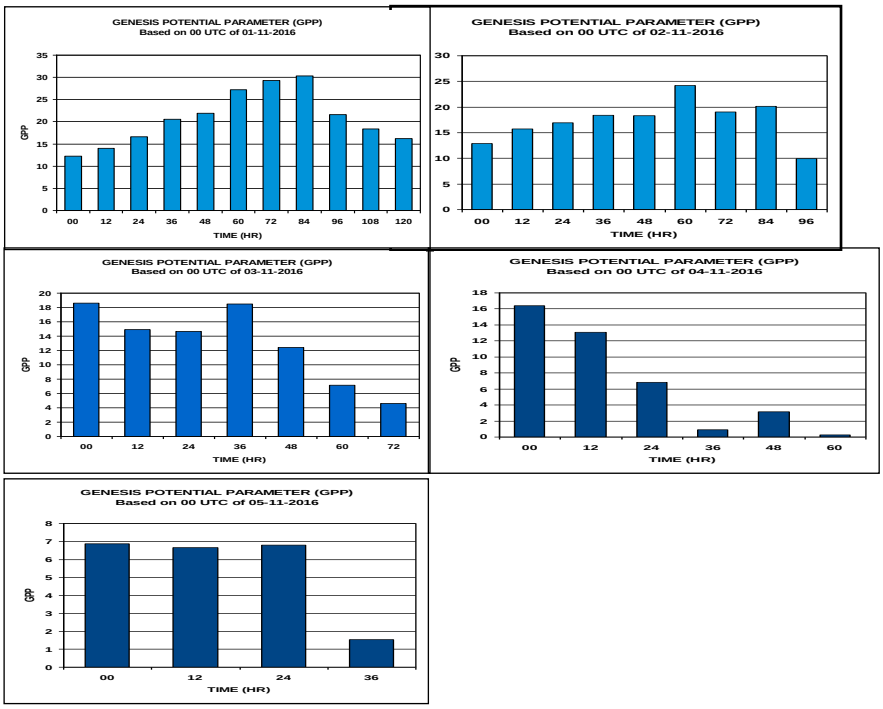


Fig. 5.4 (contd.) Area average analysis and forecasts based on 3rd- 5th Nov 2016

5.1.3.2 Track prediction by NWP models

Track prediction by various NWP models is presented in Fig. 5.5. Based on initial conditions of 0000 UTC of 3rd Nov, IMD GFS, WRF-VAR, ECMWF and JMA showed dissipation over sea. NCEP GFS and HWRF predicted northward recurvature and landfall over southwest Bangladesh. UKMO (at 0900 UTC of 6th Nov.) and MME predicted landfall over southeast Bangladesh near Chittagong (at 0000 UTC of 7th Nov.). In addition JMA and WRF predicted looping tracks. Most of the models predicted northeastwards recurvature.

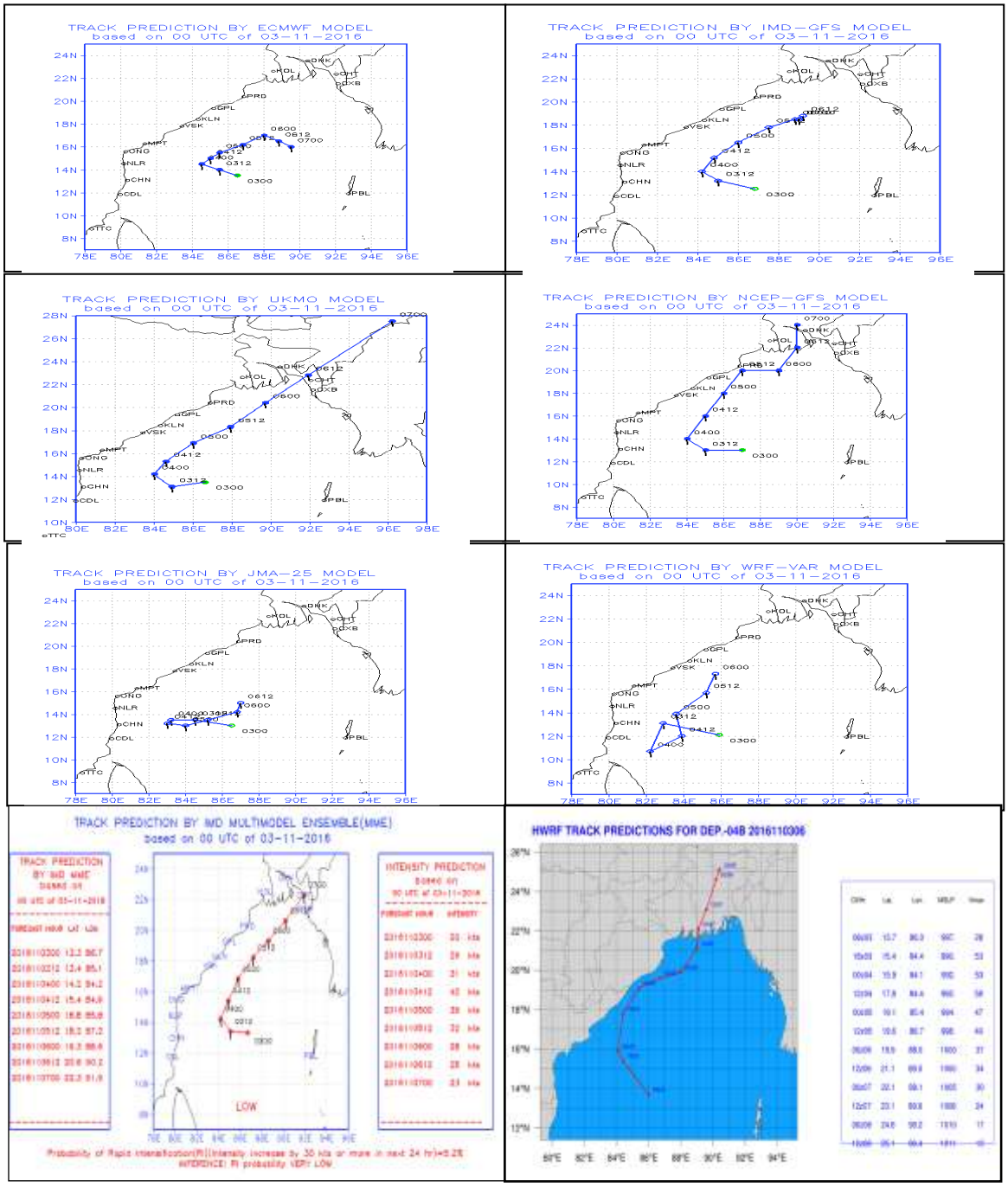


Fig. 5.5 (a). Track prediction by NWP models based on 0000 UTC of 3rd Nov. 2016

Based on initial conditions of 0000 UTC of 4th Nov ECMWF, WRF-VAR and JMA showed dissipation over sea. NCEP GFS, MME and HWRF predicted northward recurvature and landfall over southwest Bangladesh. UKMO (at 1800 UTC of 6th Nov.) over southeast Bangladesh. Most of the models suggested movement of cyclone close to east coast of India, northeast recurvature and landfall over Bangladesh. WRF predicted looping track.

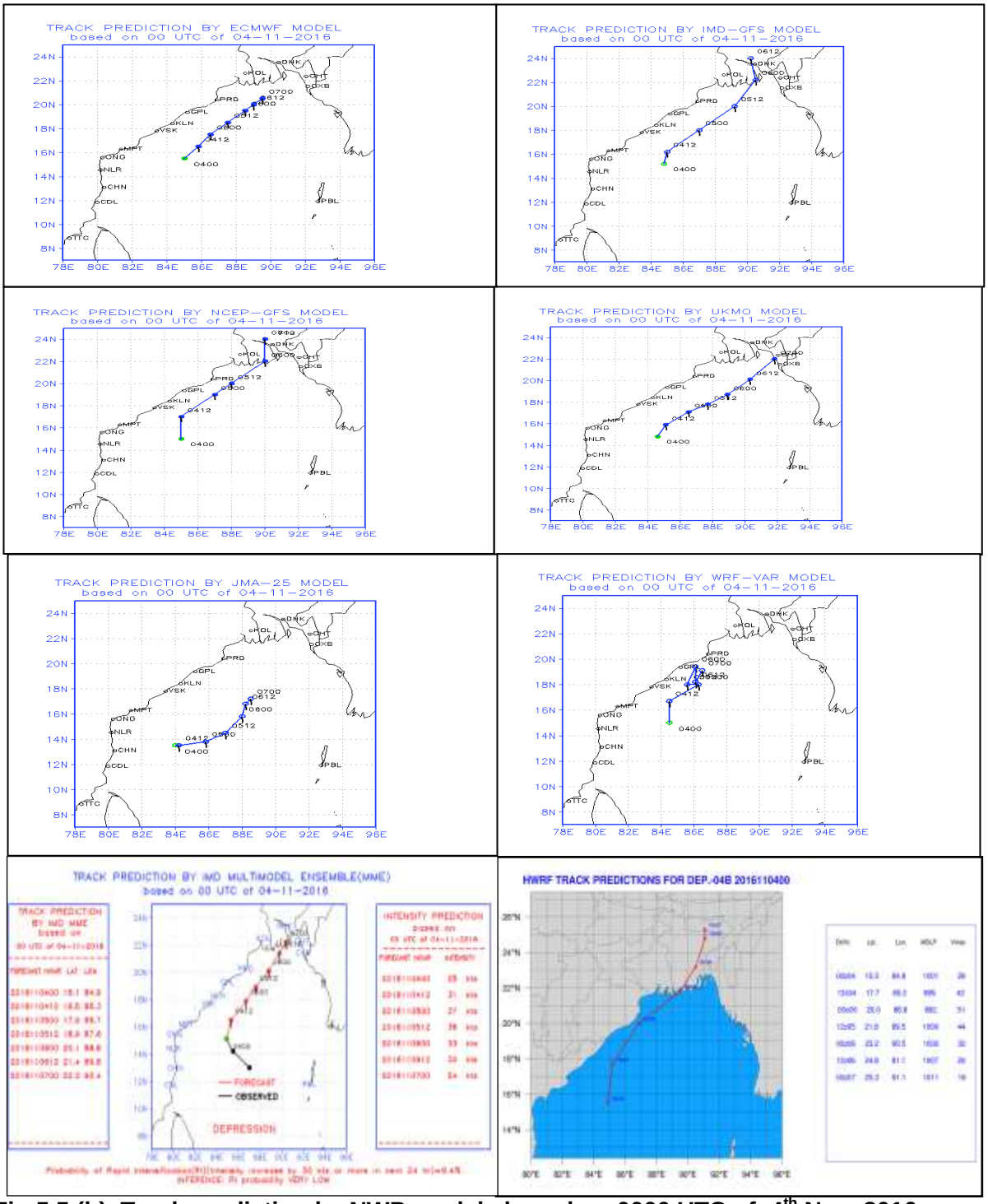


Fig.5.5 (b). Track prediction by NWP models based on 0000 UTC of 4th Nov. 2016

Based on initial conditions of 0000 UTC of 5th Nov, ECMWF, UKMO, WRF-VAR and JMA showed dissipation over sea. All others including NCEP GFS, UKMO, MME and HWRF predicted northward recurvature and landfall over southwest Bangladesh.

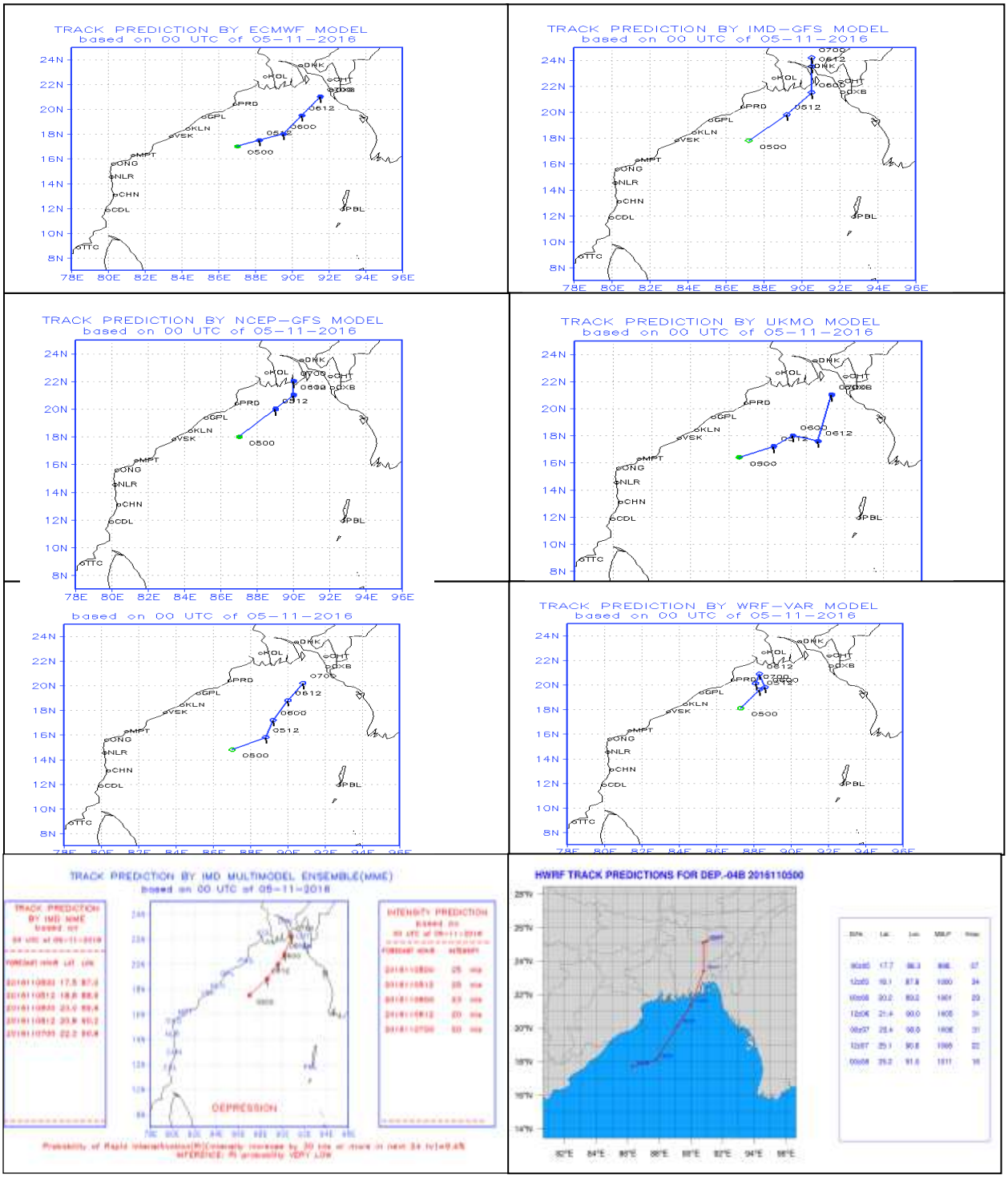


Fig. 5.5(c). Track prediction by NWP models based on 0000 UTC of 5th Nov.

5.1.3.3 Ensemble Prediction System

The probabilistic and deterministic track forecast by Meteorological service Canada (MSC), National Centre for Environment Prediction (NCEP) and consolidated forecast by both centres based on initial conditions of 1200 UTC of 4th Nov. are presented in Fig. 5.6. MSC predicted 5-20% strike probability over Bangladesh and NCEP members showed 40-60% strike probability over Bangladesh. All members predicted 20-40 % strike probability over Bangladesh. Individual deterministic tracks by MSC showed large variation and those by NCEP showed landfall over Bangladesh.

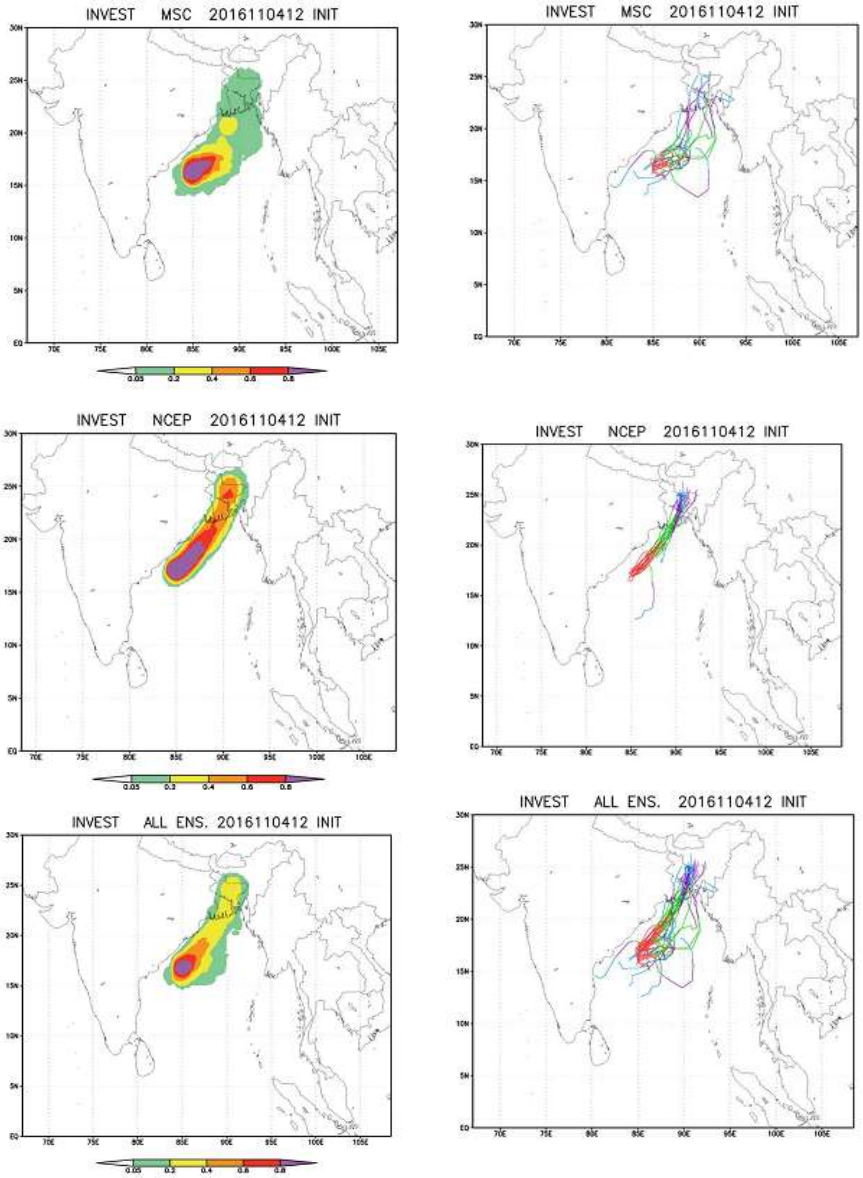


Fig. 5.6 (a): EPS track and strike probability forecast based on 1200 UTC of 4th Nov. 2016

Based on initial conditions of 1200 UTC of 5th Nov., MSC predicted 5-20% strike probability of landfall over Bangladesh. NCEP and all members did not pick up this system. Individual deterministic tracks showed landfall over Bangladesh.

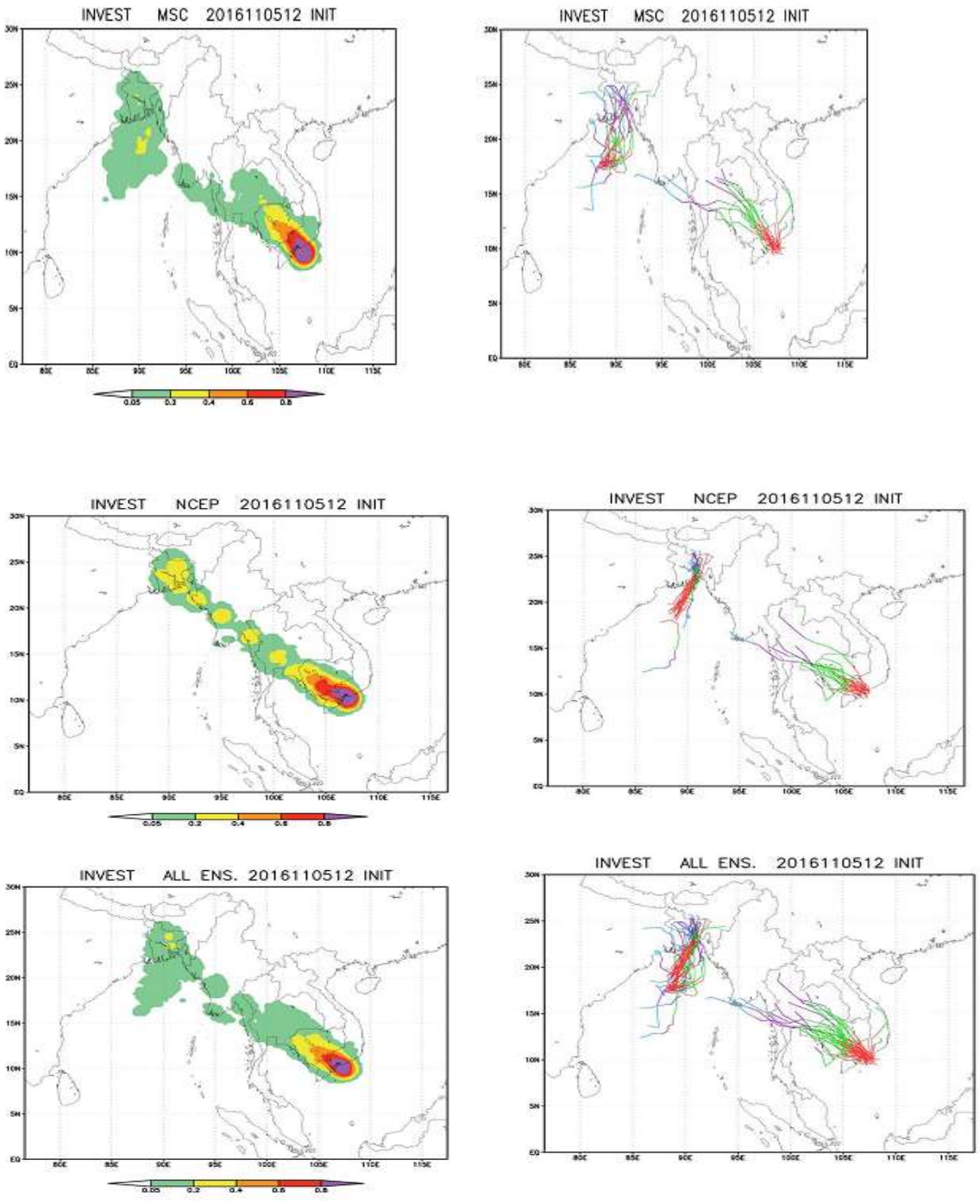


Fig. 5.6 (b): EPS track and strike probability forecast based on 1200 UTC of 5th Nov. 2016

5.1.4. Cyclonic Storm NADA over Bay of Bengal during 29 November to 02 December, 2016

5.1.4.1. Grid point analysis and forecast of GPP

The predicted zone of cyclogenesis during 26th to 30th Nov. and area average analysis of GPP based on 0000 UTC of 29th & 30th Nov. are presented in Fig. 5.7. & 5.8 respectively. Grid point analysis and forecasts of GPP could indicate the cyclogenesis zone over south west Bay of Bengal 120 hrs before its formation (Fig.5.7).

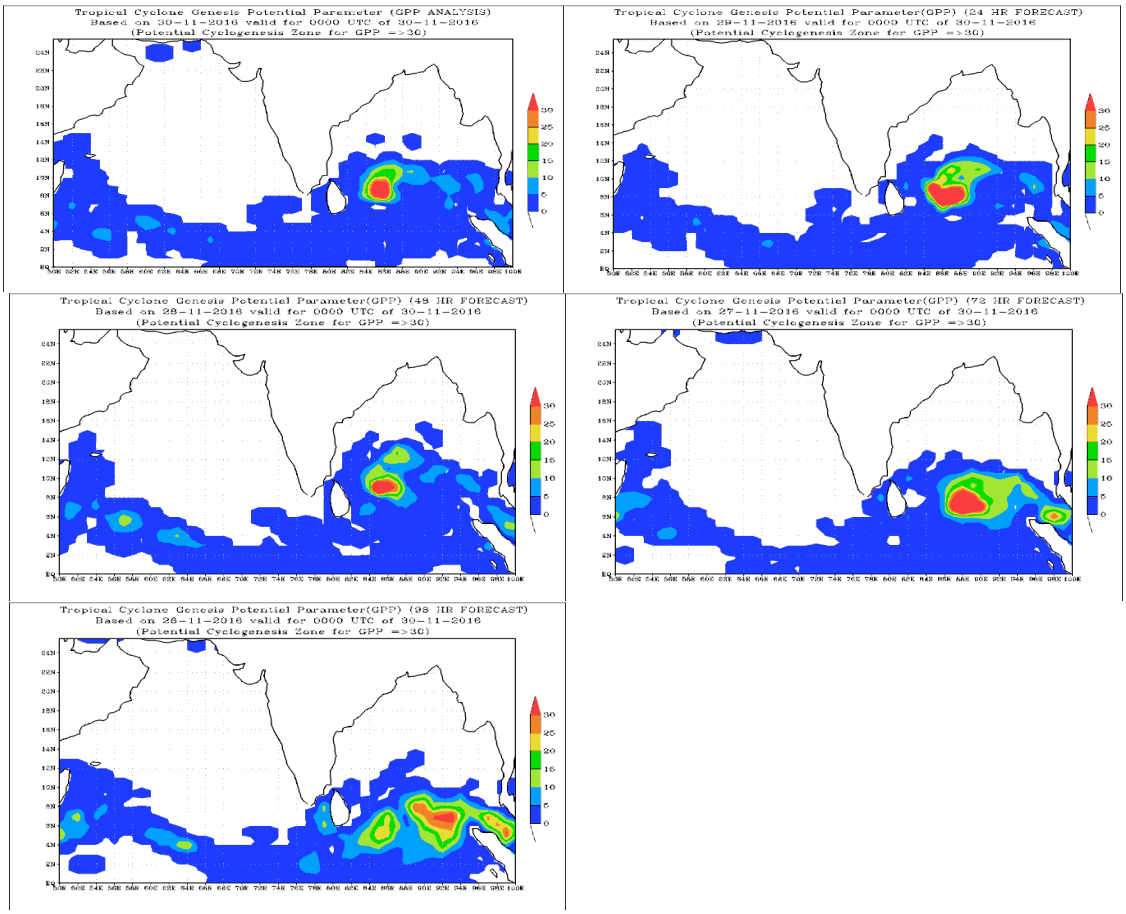


Fig. 5.7: Predicted zone of cyclogenesis based on 0000 UTC of 26th to 30thNovember 2016.

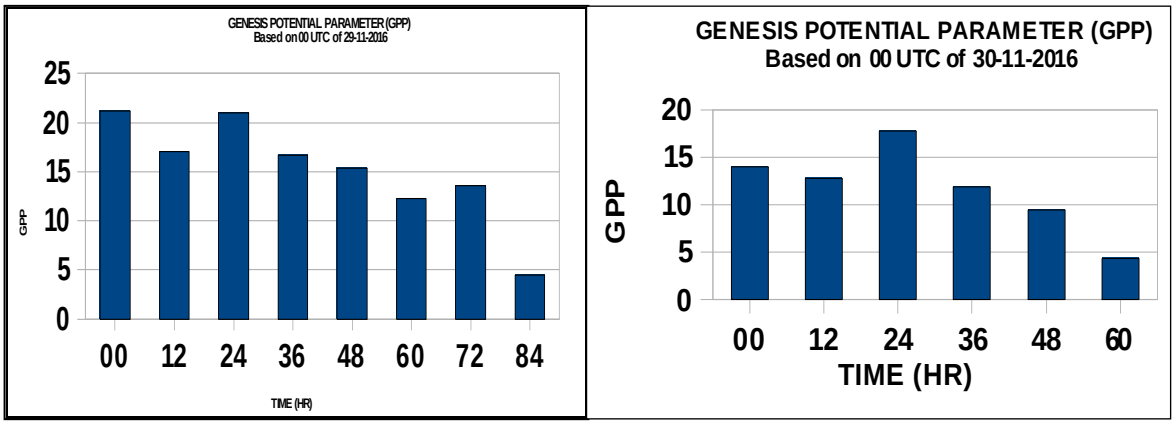


Fig.5.8: Area average analysis and forecasts of GPP based on 0000 UTC of 29th and 30th November 2016

5.1.4.2 Track prediction by NWP models

Track prediction by various NWP models is presented in Fig.5.9. Based on initial conditions of 0000 UTC of 30th November, all models except WRF-Var and HWRF indicated landfall near Karaikal/ Nagapattinam.

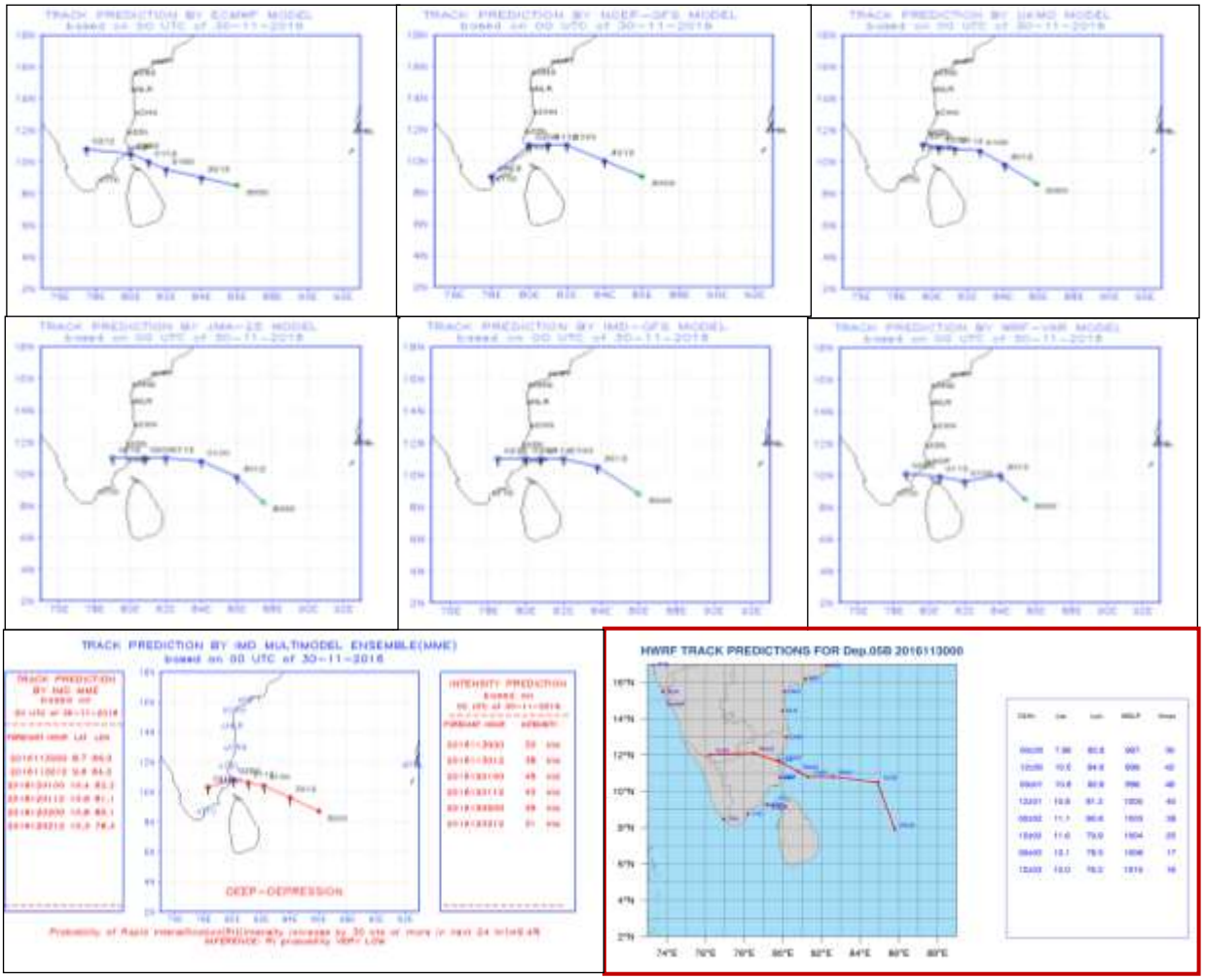


Fig. 5.9 (a): Track forecast based on initial conditions of 0000 UTC of 30th November

Based on initial conditions of 0000 UTC of 1st December, all models predicted landfall near Nagapattinam or Karaikal except ECMWF and WRF-Var models. Observed track and forecast track based on different initial conditions is presented in Fig. 5.9 (b).

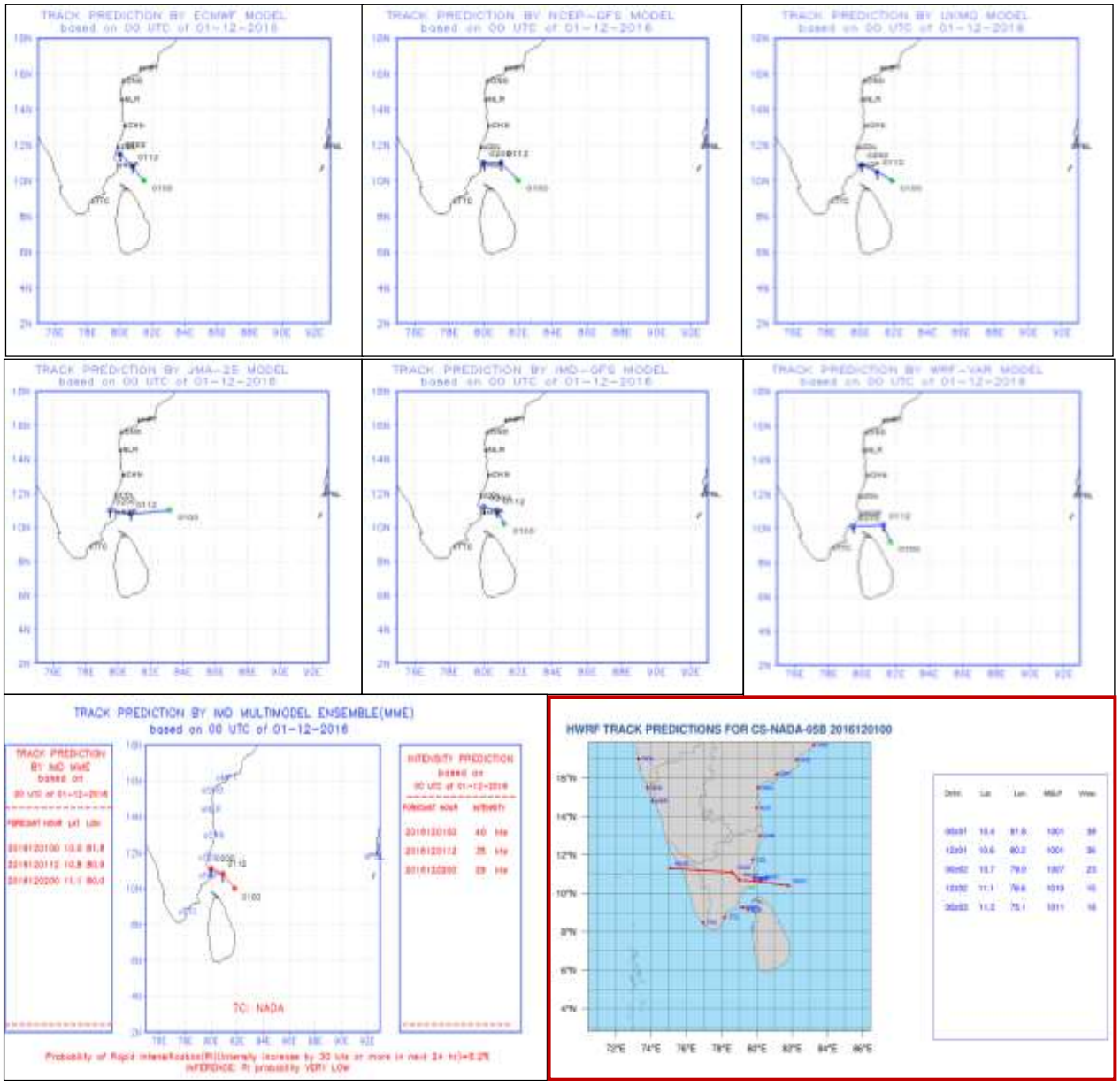


Fig. 5.9 (b): Track forecast based on initial conditions of 0000 UTC of 1st December

5.1.4.3 Ensemble Prediction System

The probabilistic and deterministic track forecast by Meteorological Service, Canada (MSC), National Centre for Environment Prediction (NCEP) and UK Meteorological Office (UKMO) and consolidated forecast by these centres based on initial conditions of 0000 & 1200 UTC of 1st December are presented in Fig. 5.10.

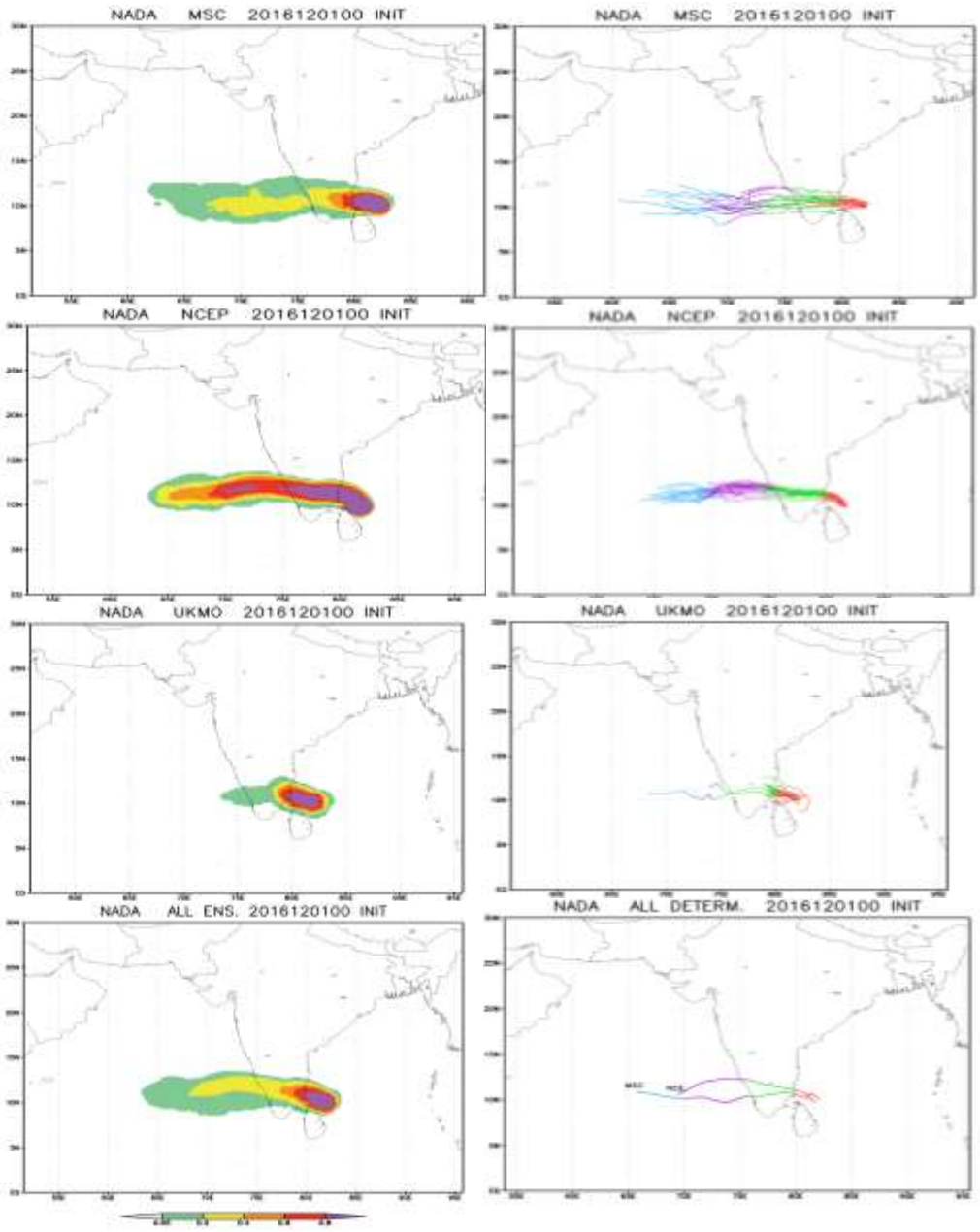


Fig. 5.10 (a): EPS track and strike probability forecast based on 0000 UTC of 01 December

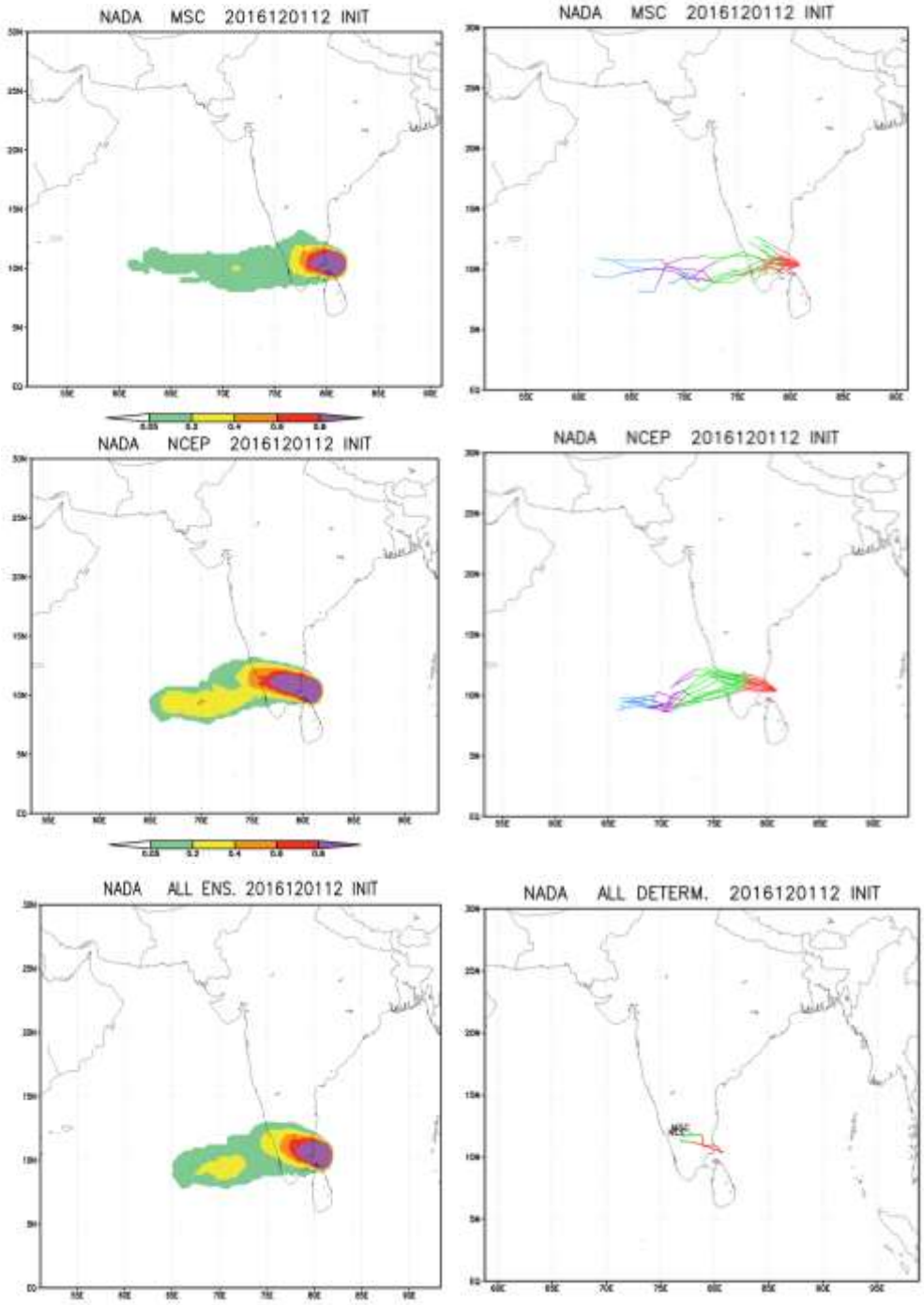


Fig. 5.10 (b): EPS track and strike probability forecast based on 1200 UTC of 01 December

1.1.4.4. Average track forecast errors:

The average track forecast errors of different models are presented in Table .5.5-5.7. The landfall point and time forecast errors of different models are shown in Table 5.8 and 5.9 respectively. ECMWF and UKMO had better landfall point forecast among different deterministic models. The landfall time error was minimum in case of ECMWF model compared to other deterministic models. The performance was also better for IMD GFS model for 48 hrs forecasts.

Table 5.5. Average track forecast errors (Direct Position Error (DPE)) in km (Number of forecasts verified is given in the parentheses)

Lead time→	12 hr	24 hr	36 hr	48 hr
IMD-GFS	53(3)	59(3)	44(2)	35(1)
IMD-WRF	56(3)	106(3)	106(2)	139(1)
JMA	143(3)	119(3)	99(2)	117(1)
NCEP	43(3)	80(3)	95(2)	35(1)
UKMO	43(3)	69(3)	64(2)	72(1)
ECMWF	58(3)	76(3)	54(2)	43(1)
IMD-HWRF	69(7)	69(5)	65(3)	119(1)
IMD-MME	34(3)	51(3)	55(2)	38(1)

Table 5.6. Average cross-track forecast errors (CTE) in km

Lead time→	12 hr	24 hr	36 hr	48 hr
IMD-GFS	27	51	42	32
IMD-WRF	34	94	101	121
JMA	97	84	75	71
NCEP	33	51	60	32
UKMO	19	36	33	42
ECMWF	37	62	36	18
IMD-HWRF	45	40	41	81
IMD-MME	16	23	24	17

Table 5.7. Average along-track forecast errors (ATE) in km

Lead time→	12 hr	24 hr	36 hr	48 hr
IMD-GFS	40	26	12	14
IMD-WRF	43	38	29	68
JMA	103	82	61	92
NCEP	27	55	67	14
UKMO	38	56	54	58
ECMWF	45	37	39	39
IMD-HWRF	43	49	49	87
IMD-MME	29	43	48	34

Table 5.8: Landfall point forecast errors (km) of NWP Models at different lead time (hour)

Forecast Lead time→ (hour)	23 hr	35 hr	47 hr
Based on→	**01Dec/00z**	**30 Nov/12z**	**30 Nov/00z**
IMD-GFS	-	65	30
IMD-WRF	-	122	129
JMA	30	65	30

NCEP	-	40	39
UKMO	-	12	39
ECMWF	-	12	30
IMD-HWRF	17	119	106
IMD-MME	40	30	12

Landfall Point Error: Landfall Forecast Point- Actual Landfall Point

-: No forecast issued

Table 5.9. Landfall time forecast errors (hour) at different lead time (hr)

Forecast Lead Time (hour) →	**23 hr**	**35 hr**	**47 hr**
Based on→	**01Dec/00z**	**30 Nov/12z**	**30 Nov/00z**
IMD-GFS	-	+3	+2
IMD-WRF	-	+2	-2
JMA	-2	+3	+8
NCEP	-	+8	+2
UKMO	-	+6	+8
ECMWF	-	-2	+2
IMD-HWRF	-9	+13	+14
IMD-MME	+1	+6	+1

Landfall Time Error: Landfall Forecast Time- Actual Landfall Time

- : No forecast issued

('+' indicates delay landfall, '-' indicates early landfall)

1.1.4.5. Intensity prediction

The intensity forecasts of IMD-SCIP model and HWRF model are shown in Table 5.10. The errors were relatively higher in case of HWRF. The probability of rapid intensification (RI) index of IMD is shown in Table 5.11. It correctly predicted no RI for cyclone, Nada.

Table 5.10: Average absolute errors (AAE) and Root Mean Square (RMSE) errors in knots of HWRF Model (Number of forecasts verified is given in the parentheses)

Lead time →	**12 hr**	**24 hr**	**36 hr**
IMD-HWRF (AAE)	6.0 (7)	9.0 (5)	9.6 (3)
IMD-HWRF (RMSE)	7.4 (7)	10.4 (5)	10.7 (3)

( ) : No of forecasts verified

Table 5.11: Probability of Rapid intensification

Forecast based on	**Probability of RI predicted**	**Chances of occurrence predicted**	**Intensity changes(kt) occurred in 24h**
00UTC/30.11.2016	9.4 %	VERY LOW	5
12UTC/30.11.2016	9.4 %	VERY LOW	-10
00UTC/01.12.2016	5.2 %	VERY LOW	-10

5.1.5. Cyclonic storm VARDAH over the Bay of Bengal during 06-13 December 2016

5.1.5.1. Grid point analysis and forecast of GPP Prediction of cyclogenesis (Genesis Potential Parameter (GPP)) for Vardah

Figure 5.11 shows the predicted zone of cyclogenesis. Grid point analysis and forecasts of GPP correctly predicted the cyclogenesis zone over southwest Bay of Bengal 96 hrs before its formation.

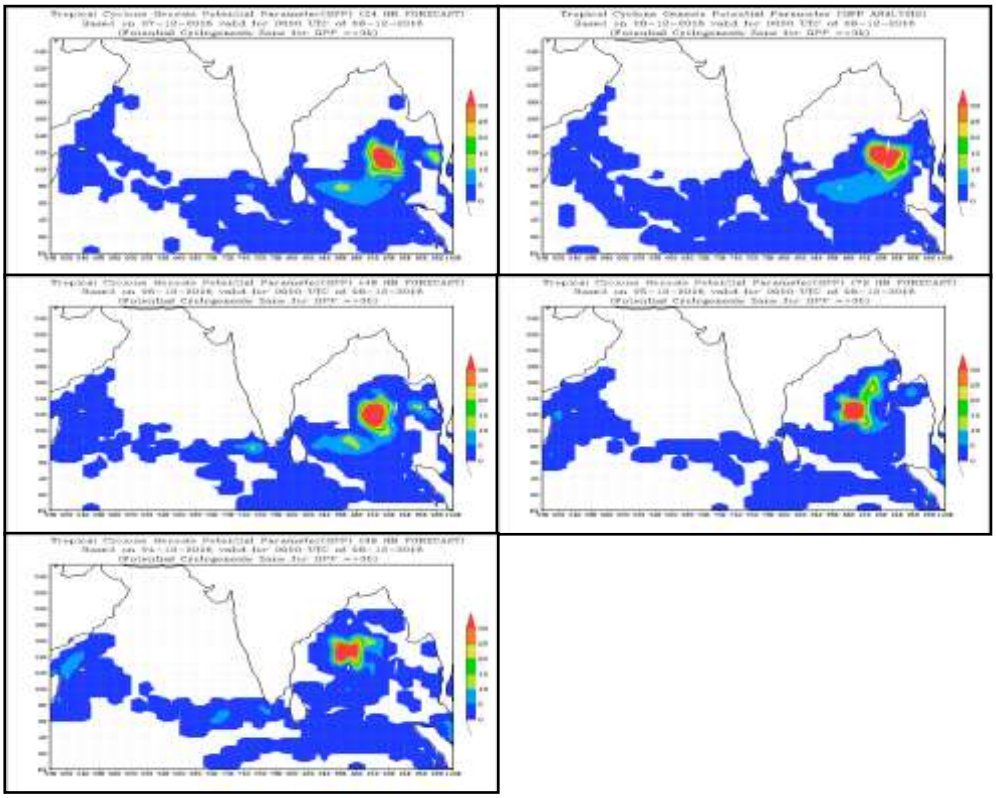


Fig. 5.11: Predicted zone of cyclogenesis based on 0000 UTC of 6th, 5th and 4th December for 8th December 2016

The forecasts of average GPP (Fig. 5.12) also showed potential to intensify into a cyclone at early stages of development (T.No. 1.0, 1.5, 2.0).

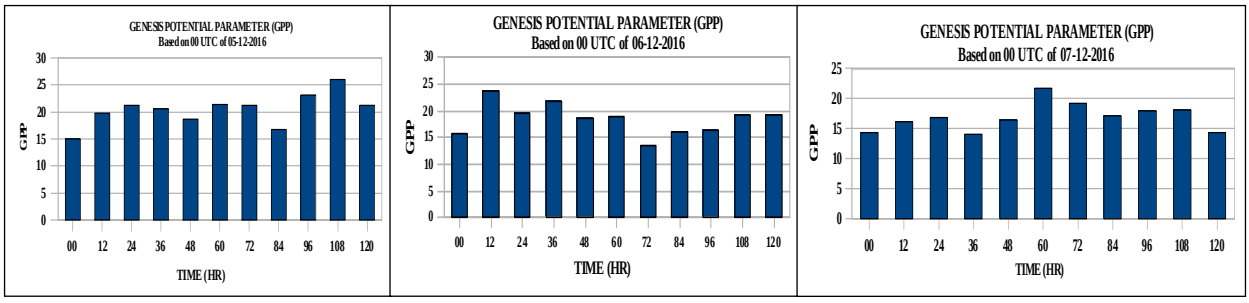


Fig. 5.12: Area average analysis and forecasts of GPP based on 0000 UTC of 5th -7th December, 2016

5.1.5.2 Track prediction by NWP models

Track prediction by various NWP models is presented in Fig.5.13 . Based on initial conditions of 0000 UTC of 7th December, ECMWF, WRF-VAR, UKMO, JMA, MME and HWRF showed dissipation over sea. Only NCEP-GFS and IMD GFS were showing landfall of system over south Andhra Pradesh between Ongole and Machillipatnam in the early hours of 12th. All models were showing anticlockwise recurving track.

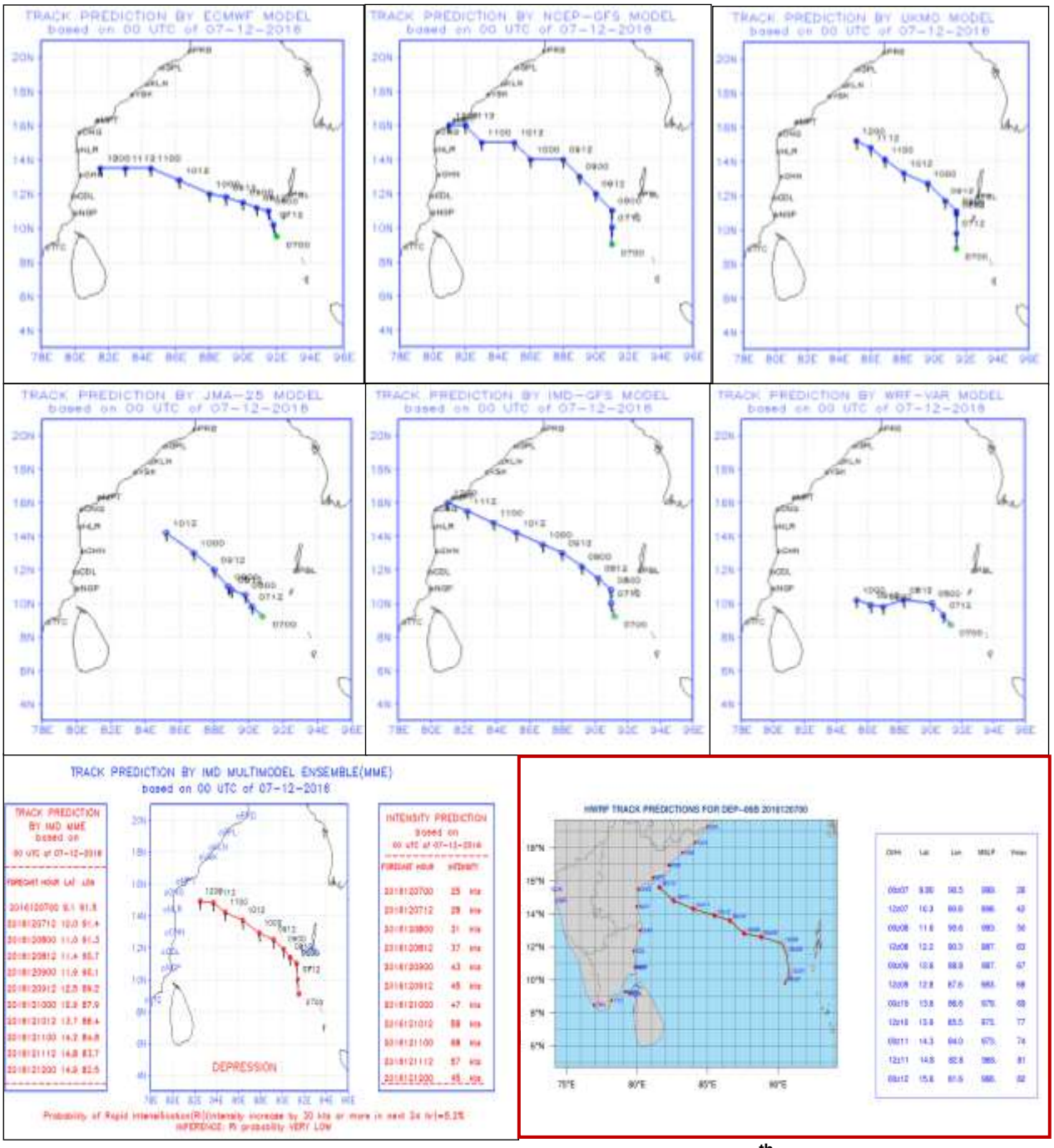


Fig. 5.13(a): NWP model track forecast based on 0000 UTC of 07th December 2016

HWRF predicted weakening over the sea. All other models predicted landfall between Nellore to Machillipatnam. Time of landfall also varied from early hours of 12th to early hours of 13th. All models unanimously predicted anticlockwise recurving track.

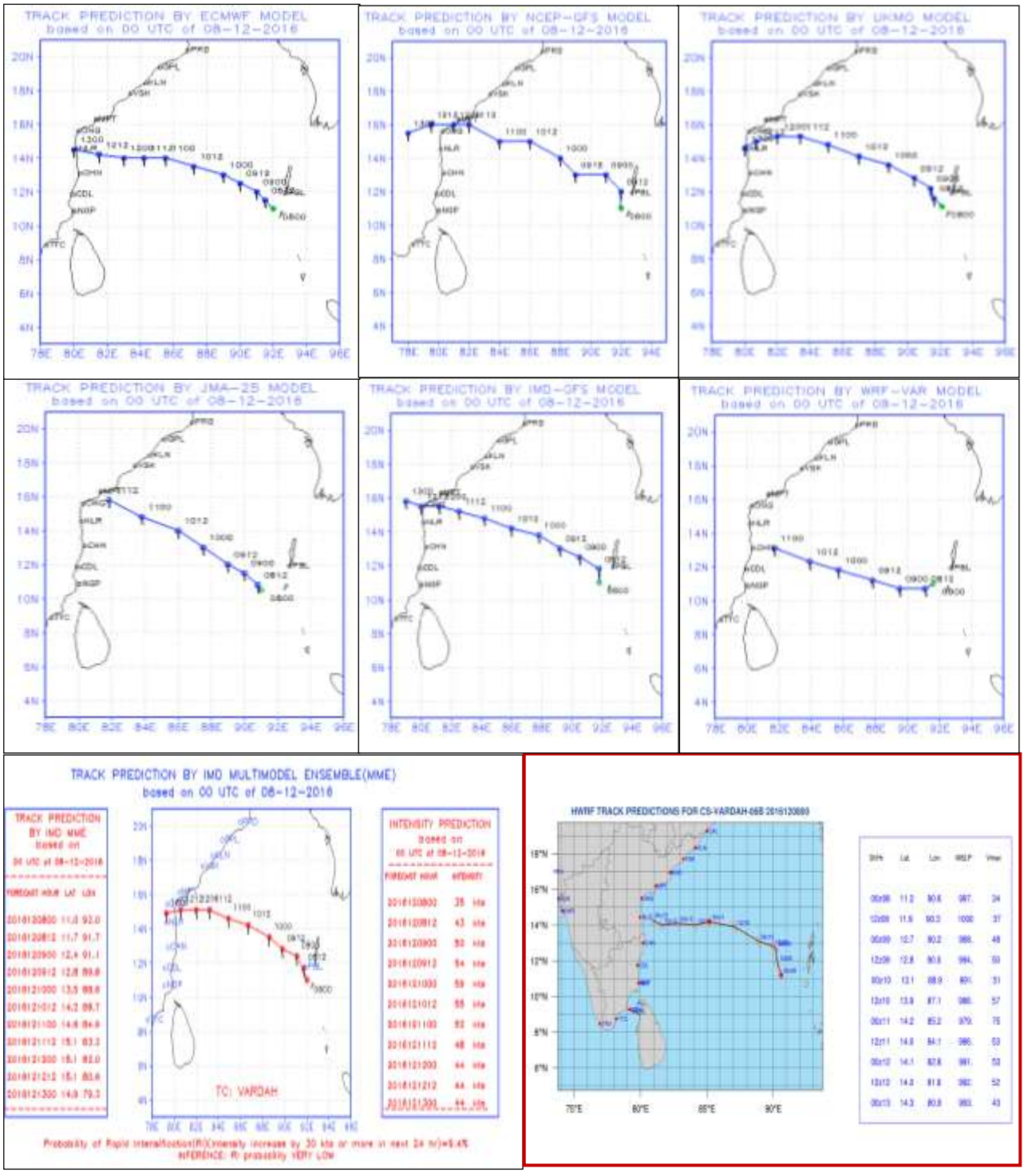


Fig. 5.13 (b): NWP model track forecast based on 0000 UTC of 8th December

Based on initial conditions of 0000 UTC of 9th, JMA and WRF-VAR predicted weakening over the sea. All other models predicted landfall over south Andhra Pradesh between Nellore to Machillipatnam. Time of landfall also varied from 1200 UTC of 12th to 0000 UTC of 13th. All models unanimously predicted anticlockwise recurving track.

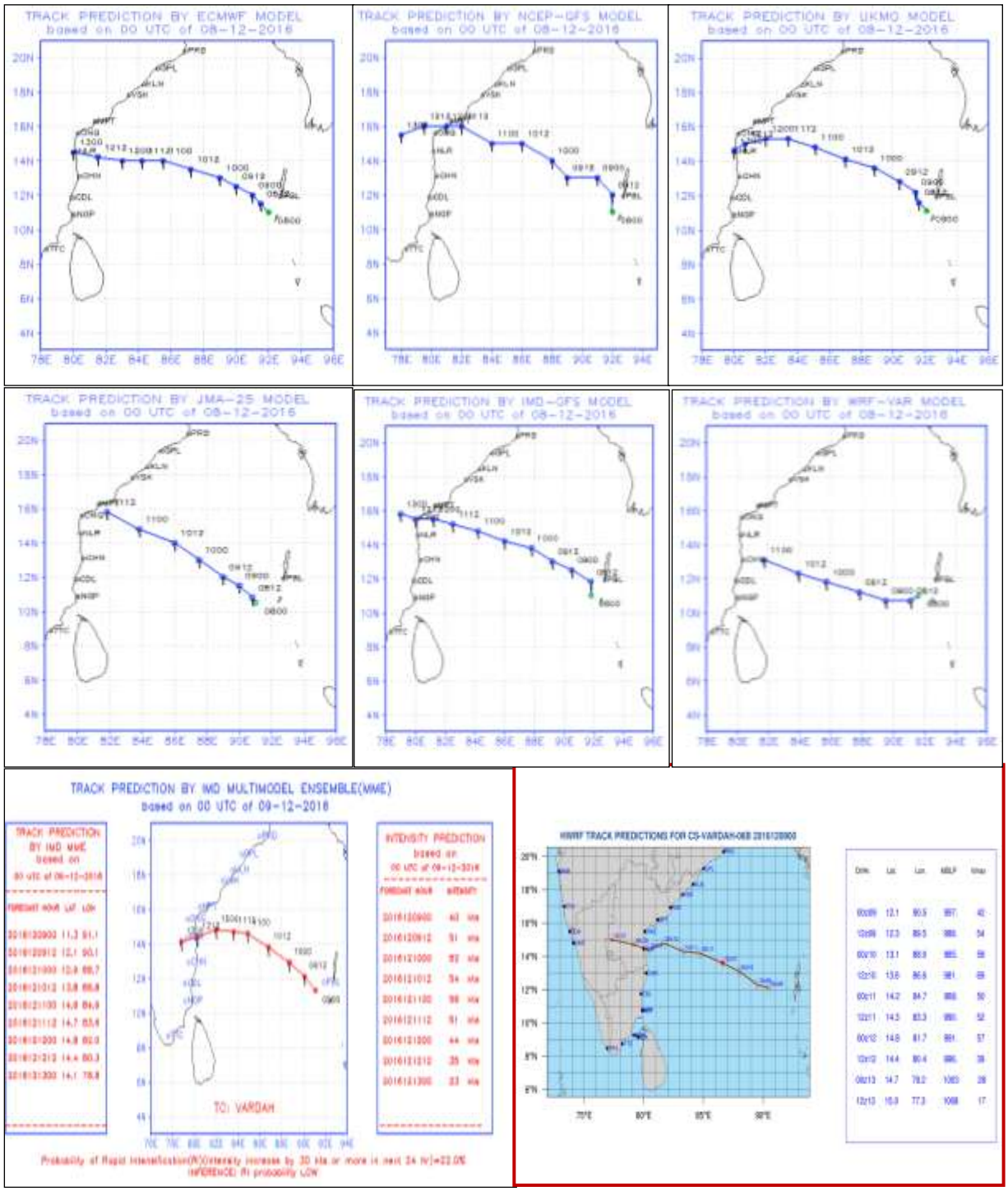


Fig. 5.13 (c): NWP model track forecast based on 0000 UTC of 9th December

Based on initial conditions of 0000 UTC of 10th December, all models predicted landfall between Chennai and Nellore. NCEP-GFS predicted landfall close to Chennai.

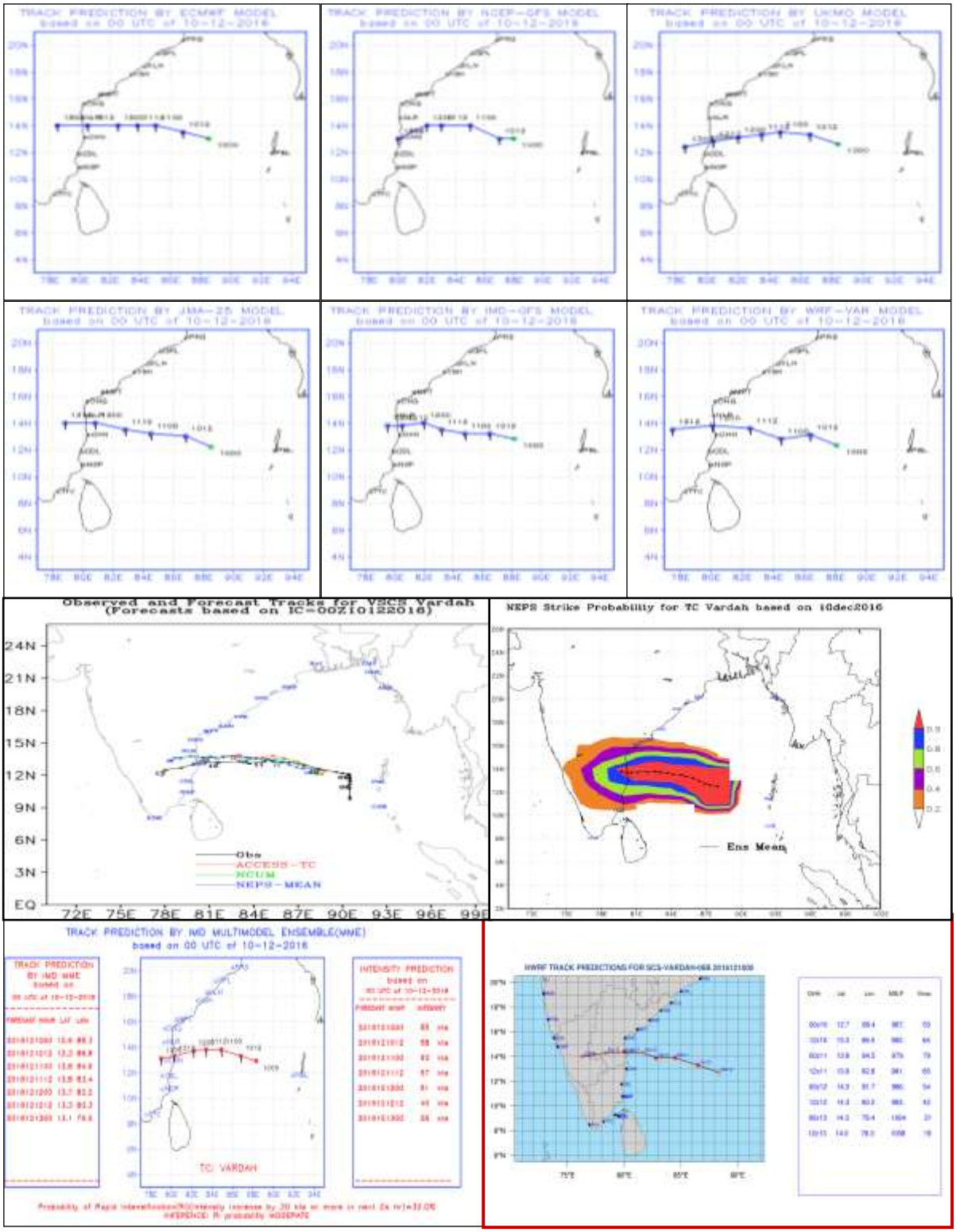


Fig. 5.13 (d): NWP model track forecast based on 0000 UTC of 10th December

Based on initial conditions of 0000 UTC of 11th December, most of the models predicted landfall over Chennai. JMA, WRF-VAR and HWRF were predicting landfall north/south of Chennai. Predicted time of landfall was around evening of 12th.

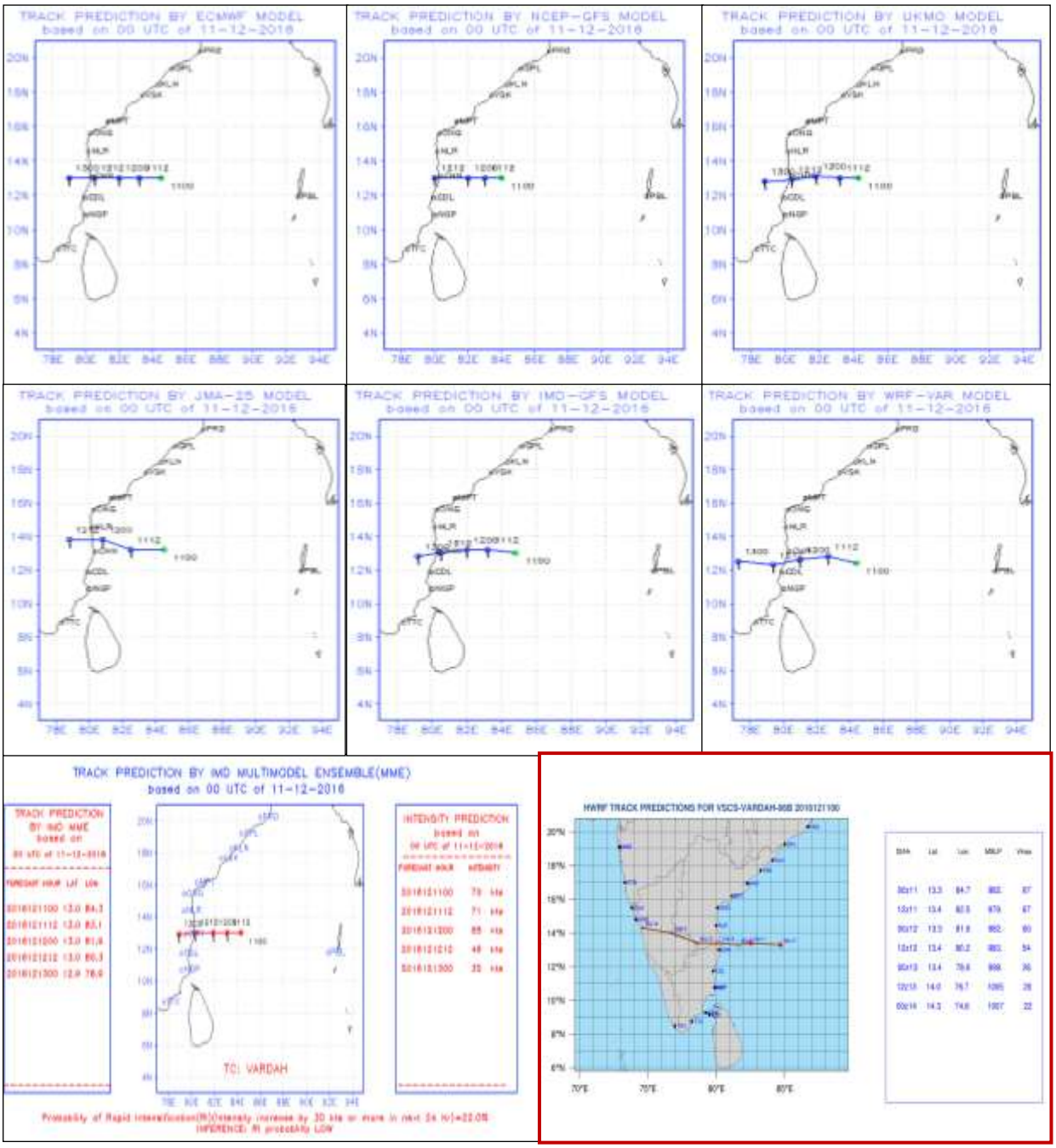


Fig. 5.13 (e): NWP model track forecast based on 0000 UTC of 11th December 2016

Based on initial conditions of 0000 UTC of 12th December, all models unanimously showed landfall over Chennai around evening of 12th. HWRF also predicted emergence of Vardah over eastcentral Arabian Sea as a depression.

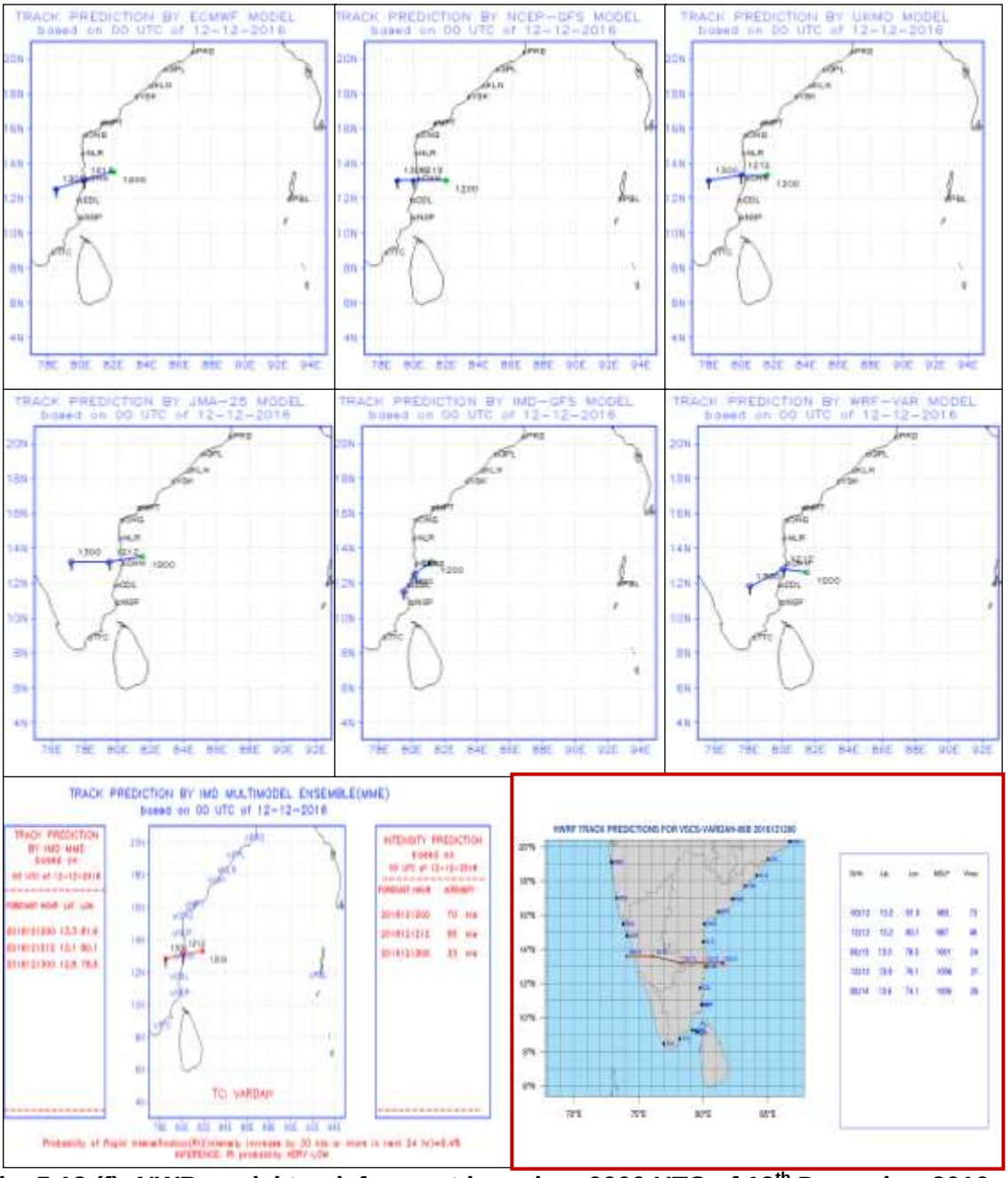


Fig. 5.13 (f): NWP model track forecast based on 0000 UTC of 12th December 2016

Hence to conclude, most of the models predicted anticlockwise recurving track and landfall between north Tamil Nadu and south Chennai. From 10th onwards most of the models were predicting landfall close to Chennai around evening of 12th. HWRF also predicted emergence of system over eastcentral AS.

5.1.5.3 Ensemble Prediction System

The probabilistic and deterministic track forecast by National Centre for Environment Prediction (NCEP) and UK Meteorological Office (UKMO) and consolidated forecast by these centres based on initial conditions of 1200 UTC of 8th December are presented in Fig. 5.14 (a). UKMO predicted 20-40% and 5-20 % strike probability over north Tamil Nadu close to Chennai and south Andhra Pradesh respectively. NCEP members showed 60-80% strike probability over south Andhra Pradesh coast. All members ensemble showed 20-40% strike probability over south Andhra Pradesh coast and 5-20% over north Tamil Nadu.

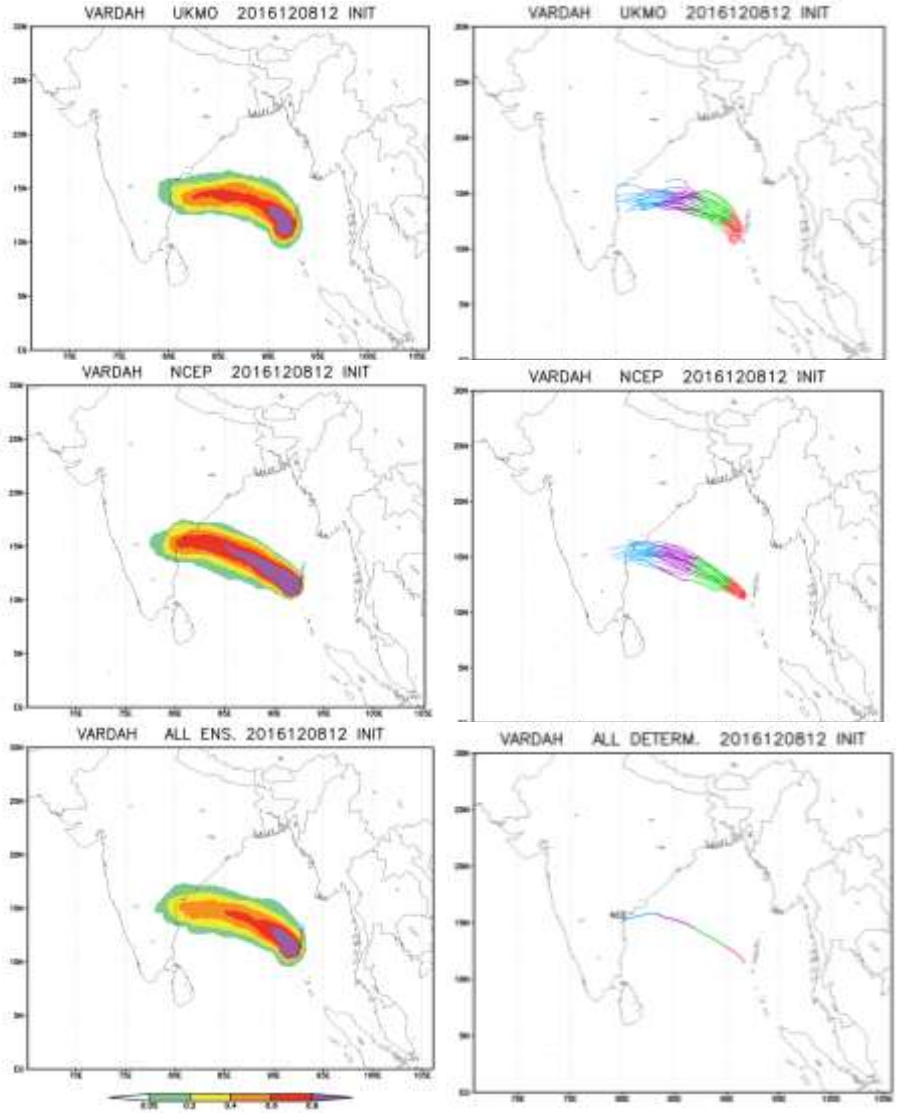


Fig. 5.14 (a): EPS track and strike probability forecast based on 1200 UTC of 8th December 2016

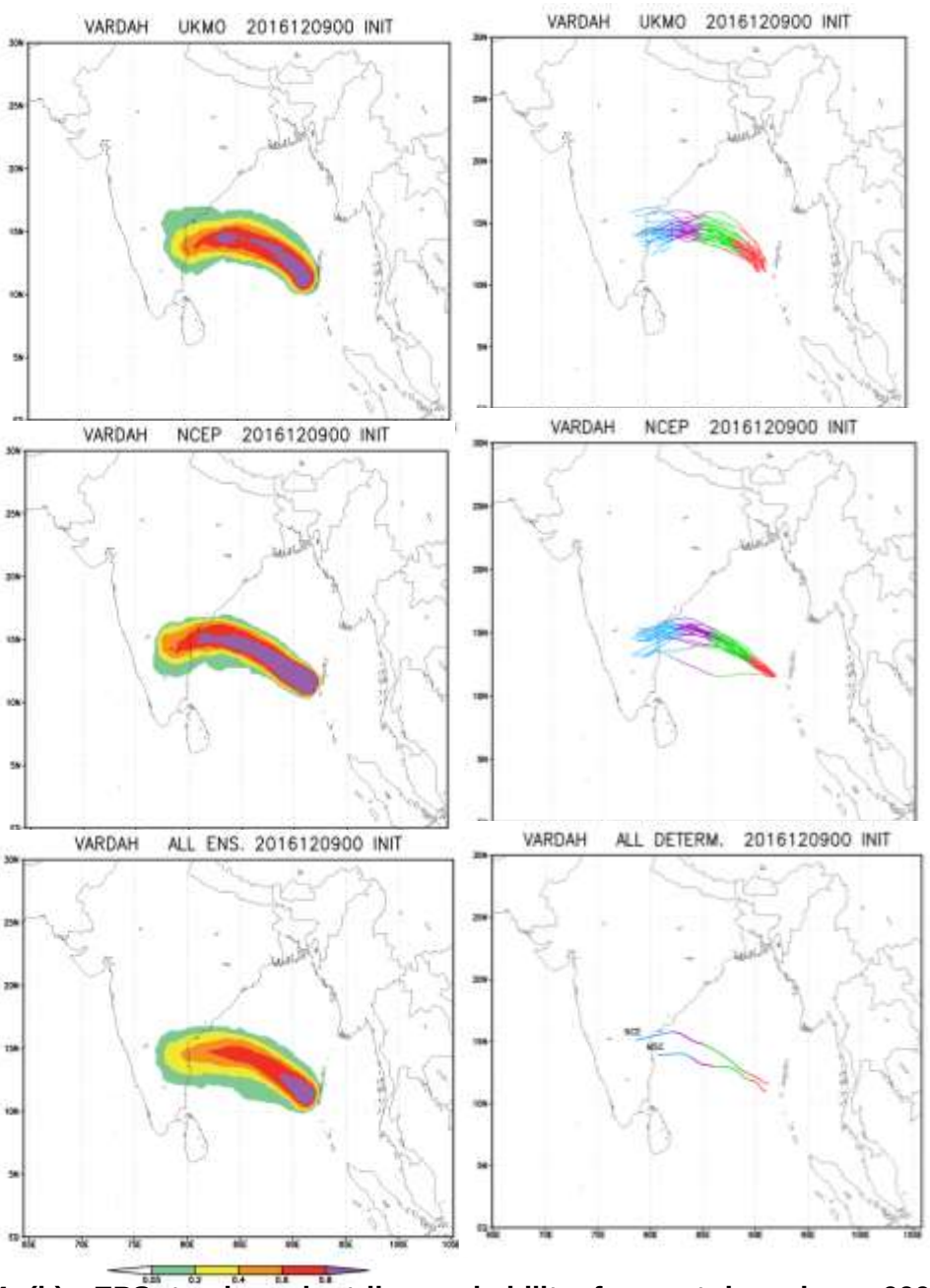


Fig. 5.14 (b): EPS track and strike probability forecast based on 0000 UTC of 9th December 2016

UKMO and NCEP probabilistic and deterministic tracks based on 0000 UTC of 9th December are presented in Fig. 5.14 (b). UKMO ensemble members predicted 40-60 % strike probability over north Tamil Nadu close to Chennai. However, NCEP ensemble members predicted 60-80 % strike probability over south Andhra Pradesh coast. All ensemble members were predicting 40-60 % strike probability over south Andhra Pradesh coast.

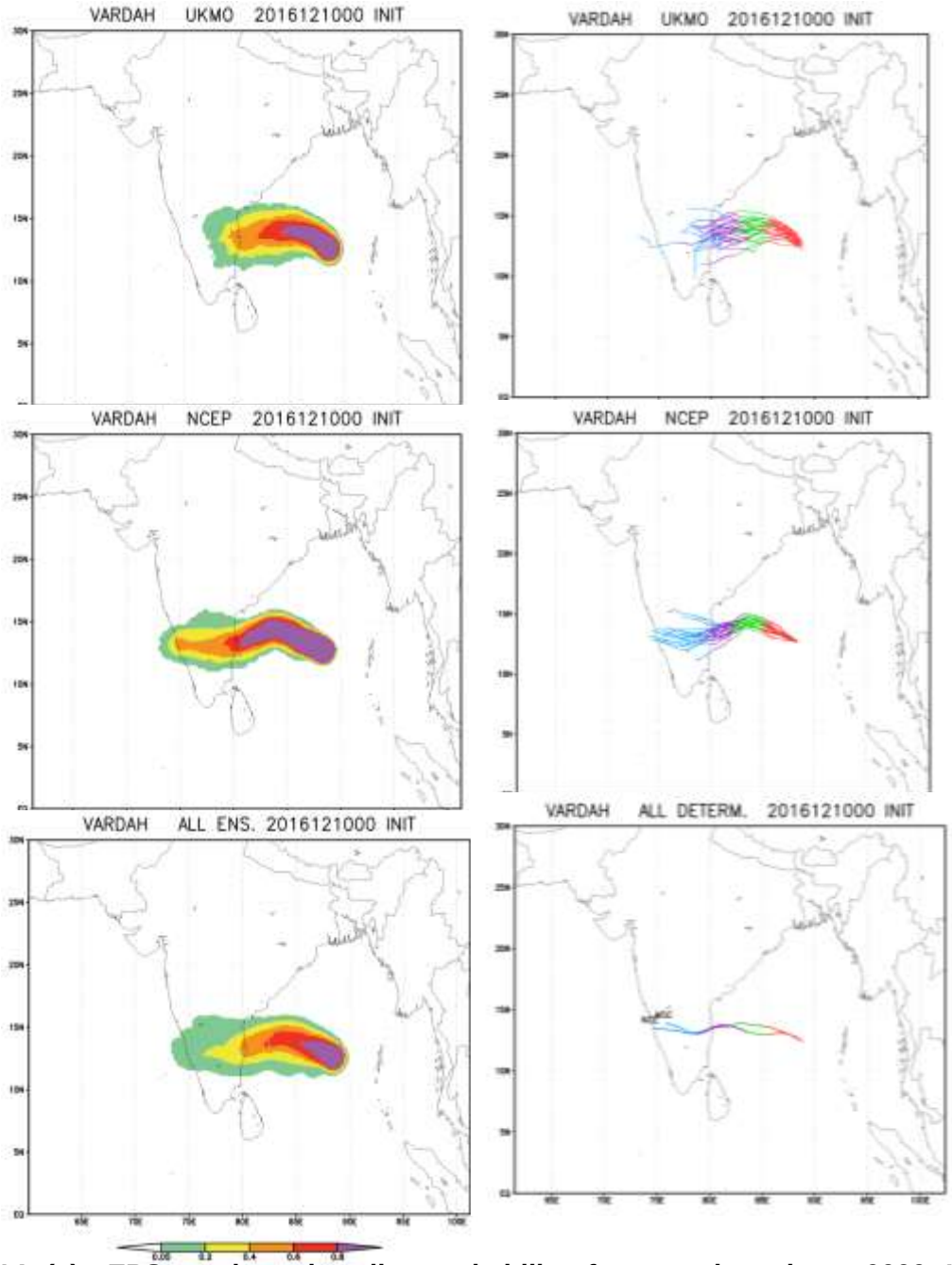


Fig. 5.14 (c): EPS track and strike probability forecast based on 0000 UTC of 10th December 2016

UKMO and NCEP probabilistic and deterministic tracks based on 0000 UTC of 10th are presented in Fig. 5.14 (c). Ensembles from UKMO predicted 40-60 % strike probability over north Tamil Nadu. Ensembles from NCEP predicted 60-80 % strike probability over north Tamil Nadu. All ensemble members were predicting 40-60 % strike probability over north Tamil Nadu.

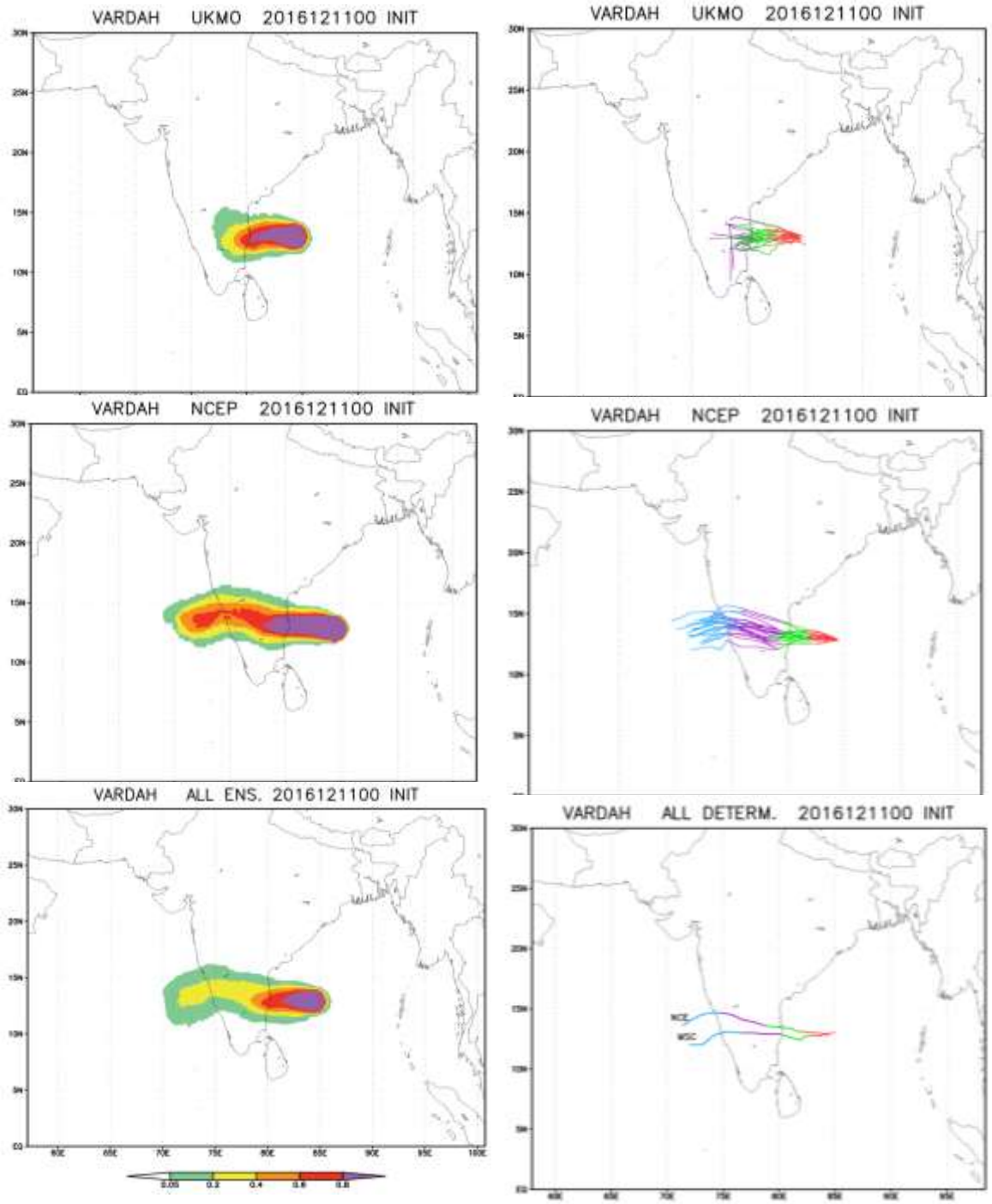


Fig. 5.14 (d): EPS track and strike probability forecast based on 0000 UTC of 11th December 2016

Based on initial conditions of 0000 UTC of 11th (Fig. 5.14 (d)), both UKMO and NCEP members showed >80% strike probability over north Tamil Nadu close to Chennai. All ensemble members were predicting 60-80 % strike probability over north Tamil Nadu close to Chennai.

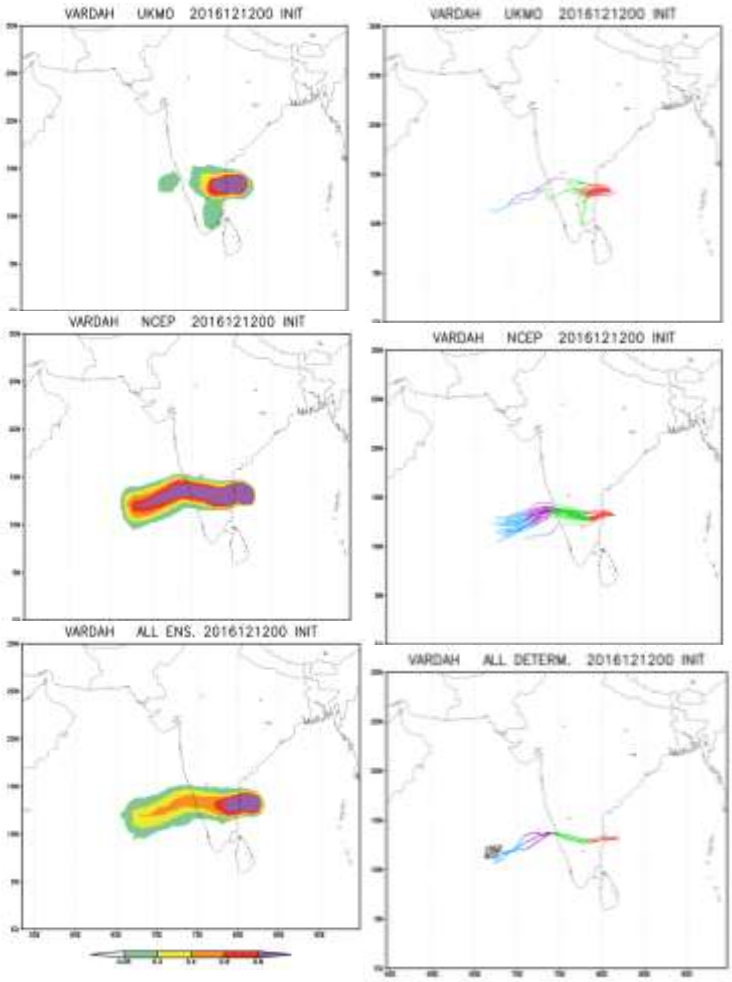


Fig. 5.14 (e): EPS track and strike probability forecast based on 0000 UTC of 12th December 2016

Based on initial conditions of 0000 UTC of 12th (Fig.5.14 (e)) UKMO, NCEP and all ensemble members showed >80% strike probability over north Tamil Nadu close to Chennai.

Overall forecast by NCEP members was closer to observed landfall point as compared to UKMO members.

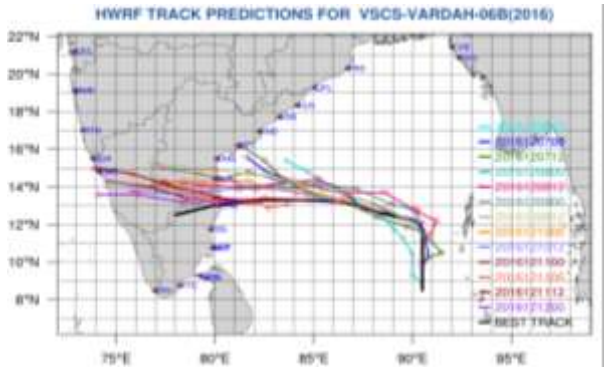


Fig. 5.15: Observed track and track forecast by HWRF based on initial conditions during 1200 UTC of 6th to 12th December

It is seen that HWRF could predict accurately anticlockwise recurvature of the system. HWRF predicted landfall between Chennai and Nellore. HWRF could also predict emergence of system over eastcentral AS.

5.1.5.4 Track and intensity forecast errors by various NWP Models

The average track forecast errors (Direct Position Error) in km at different lead period (hr) of various models are presented in Table 5.12. The average cross track errors (CTE) and along track errors (ATE) are presented in Table 5.13 (a-b). From the verification of the forecast guidance available from various NWP models, it is found that the average track forecast errors of UKMO were significantly less for all lead periods. Average track errors of IMD-MME were the least for 24 and 48 hours lead period.

Table 5.12. Average track forecast errors (Direct Position Error (DPE)) in km

Lead time	12 hr	24 hr	36 hr	48 hr	60 hr	72 hr	84hr	96hr	108hr	120hr
IMD-GFS	61(10)	76(10)	86(9)	115(8)	153(7)	195(6)	210(5)	239(4)	269(2)	350(2)
IMD-WRF	71(10)	109(10)	136(9)	190(8)	284(6)	325(4)	***	***	***	***
JMA	65(10)	76(10)	100(8)	140(7)	196(6)	261(5)	303(4)	***	***	***
NCEP	60(10)	87(10)	112(9)	170(8)	199(7)	266(6)	270(5)	248(4)	327(2)	326(2)
UKMO	67(10)	72(10)	100(9)	119(8)	130(7)	162(6)	205(5)	203(4)	301(2)	378(2)
ECMWF	58(10)	63(10)	83(9)	103(8)	116(7)	138(6)	143(5)	146(4)	120(2)	172(2)
IMD-HWRF	58(25)	64(23)	97(21)	144(19)	175(17)	179(15)	183(13)	201(11)	224(9)	316(7)
IMD-MME	55(10)	67(10)	88(9)	112(8)	132(7)	155(6)	177(5)	170(4)	214(2)	257(2)
NCUM	170	231	313	313	311	274	252			
ACCESS-TC	67	92	128	151	175	228	-			
NEPS-Mean	111	167	193	254	226	274	261			

( ): Number of forecasts verified; -: No forecast issued

Table 5.13 (a). Average cross-track forecast errors (CTE) in km

Lead time →	12 hr	24 hr	36 hr	48 hr	60 hr	72 hr	84hr	96hr	108hr	120hr
IMD-GFS	55	31	31	80	117	147	158	202	231	322
IMD-WRF	43	82	117	137	170	176	***	***	***	***
JMA	44	47	72	94	149	190	200	***	***	***
NCEP	49	54	68	136	139	192	205	188	276	301
UKMO	56	64	74	91	104	139	181	187	260	296
ECMWF	52	45	41	67	87	115	110	115	89	134
IMD-HWRF	45	43	41	91	107	138	111	126	147	215
IMD-MME	49	51	52	86	103	130	160	163	213	244

Table 5.13 (b). Average along-track forecast errors (ATE) in km

Lead time →	12 hr	24 hr	36 hr	48 hr	60 hr	72 hr	84hr	96hr	108hr	120hr
IMD-GFS	13	63	73	62	85	112	102	108	105	123
IMD-WRF	46	59	54	121	198	209	***	***	***	***
JMA	37	57	62	97	115	177	209	***	***	***
NCEP	22	57	68	70	117	134	132	121	157	98
UKMO	29	23	50	59	58	60	71	60	137	235
ECMWF	18	36	65	63	59	64	80	69	80	109
IMD-HWRF	53	51	88	112	138	113	145	156	172	234
IMD-MME	16	36	56	51	59	63	58	36	20	71

Above tables show that DPE was largely contributed by ATE, that is errors in speed of movement of the storm, whereas CTE shows that forecast tracks were close to the observed track.: No forecast issued

Landfall point and time forecast errors are presented in Table 5.14 and 5.15.

Table 5.14: Landfall point forecast errors (km) of NWP Models at different lead time (hour)

Forecast Lead Time (hour) →	10:30	22:30	34:30	46:30	58:30	70:30	82:30	106:30	130:30
Based on	**12Dec /00z**	**11Dec /12z**	**11 Dec /00z**	**10Dec /12z**	**10Dec /00z**	**09Dec /12z**	**09Dec /00z**	**08Dec /00z**	**07Dec /00z**
IMD-GFS	77	11	13	19	64	110	198	264	328
IMD-WRF	41	137	52	43	77	187	74	**	**
JMA	37	13	75	86	97	265	209	**	**
NCEP	22	18	13	18	18	209	209	328	328
UKMO	22	22	18	41	37	143	176	175	**
ECMWF	26	22	13	13	97	75	41	156	**
IMD-HWRF	8	30	30	75	130	198	153	**	**
IMD-MME	11	13	14	11	19	119	119	143	208

Landfall Point Error: Landfall Forecast Point- Actual Landfall Point, **: No forecast issued

24hr landfall point forecast error was the least by IMD GFS followed by JMA & IMD-MME and NCEP GFS. 48 hr landfall point forecast error was the least by IMD MME followed by ECMWF and NCEP GFS.

Table-5.15. Landfall time forecast errors (hour) at different lead time (hr)
('+' indicates delay landfall, '-' indicates early landfall)

Forecast Lead Time (hours) →	**10:30 hr**	**22:30 hr**	**34:30 hr**	**46:30 hr**	**58:30 hr**	**70:30 hr**	**82:30 hr**	**106:30 hr**	**130:30 hr**
Based on	**12Dec /00z**	**11Dec /12z**	**11 Dec /00z**	**10Dec /12z**	**10Dec /00z**	**09Dec /12z**	**09Dec /00z**	**08Dec /00z**	**07Dec /00z**
IMD-GFS	+01:30	+14:30	+03:30	+07:30	+04:30	+03:30	+00:30	+00:30	-10:30
IMD-WRF	+01:30	+07:30	-02:30	-02:30	-10:30	-10:30	-13:30	***	***
JMA	-02:30	-05:30	-06:30	-05:30	-05:30	+01:30	-10:30	***	***
NCEP	-00:30	+10:30	-00:30	+10:30	+11:30	+13:30	+00:30	-10:30	-10:30
UKMO	+01:30	+03:30	+02:30	+02:30	+01:30	+09:30	+01:30	+12:30	***
ECMWF	+01:30	+06:30	+03:30	+06:30	+03:30	+08:30	+06:30	+12:00	***
IMD-HWRF	+00:30	+04:30	+00:30	+04:30	+01:30	+01:30	+02:30	***	***
IMD-MME	+01:30	+06:30	+01:30	+06:30	+01:30	+08:30	+01:30	+00:30	+05:30

Landfall Time Error: Landfall Forecast Time- Actual Landfall Time

- : No forecast issued

The intensity forecast s of IMD-SCIP model and HWRF model are shown in Table 5.16. The errors were relatively higher in case of HWRF. The probability of rapid intensification (RI) index of IMD is shown in Table 5.17. It correctly predicted no RI for cyclone, Vardah.

Table 5.16: Average absolute errors (AAE) and Root Mean Square (RMSE) errors in knots of SCIP model (Number of forecasts verified is given in the parentheses)

Lead time →	**12 hr**	**24 hr**	**36 hr**	**48 hr**	**60 hr**	**72 hr**	**84hr**	**96hr**	**108hr**	**120hr**
IMD-SCIP (AAE)	4.2 (10)	6.2 (9)	8.9 (8)	10.6 (7)	10.0 (6)	16.2 (5)	18.0 (4)	17.3 (3)	9.5 (2)	25 (1)
IMD-HWRF (AAE)	7.5 (25)	9.4 (23)	11.0 (21)	15.5 (19)	12.2 (17)	13.6 (15)	14.5 (13)	12.5 (11)	11.0 (9)	14.4 (7)
IMD-SCIP (RMSE)	5.0	7.3	11.0	14.1	14.4	17.2	19.6	20.5	10.1	25.0
IMD-HWRF (RMSE)	8.8 (25)	11.2 (23)	13.7 (21)	17.8 (19)	15.2 (17)	15.8 (15)	16.4 (13)	15.2 (11)	12.8 (9)	17.8 (7)

( ) : No of forecasts verified

Table 5.17: Probability of Rapid intensification

Forecast based on Time (UTC)/Date	Probability of RI predicted	Chances of occurrence predicted	Intensity changes(kt) occurred in 24h
00/07.12.2016	5.2 %	VERY LOW	10
00/08.12.2016	9.4 %	VERY LOW	10
12/08.12.2016	9.4 %	VERY LOW	5
00/09.12.2016	22.0 %	LOW	10
12/09.12.2016	22.0 %	LOW	20
00/10.12.2016	32.0 %	MODERATE	15
12/10.12.2016	22.0 %	LOW	5
00/11.12.2016	22.0 %	LOW	0
12/11.12.2016	9.4%	VERY LOW	-20

5.2. Operational Forecast Performance during post monsoon season

5.2.1. Performance during cyclonic storms

5.2.1.1. Cyclonic Storm (CS) KYANT over the Bay of Bengal (21-28 October 2016)

5.2.1.1.1 Operational Genesis forecast

(i) IMD first predicted genesis of depression over southwest BoB on 21st October based on the observations of 0300 UTC of 19th October.

(ii) Depression formed at 0000 UTC of 21st October. At 0000 UTC of 20th October, IMD predicted genesis with fair (26-50%) probability on 21st .

5.2.1.1.2. Operational track forecast error and skill

The operational average track forecast errors and skills (compared to climatological and persistence (CLIPER) forecasts) are shown in Table 5.18.

The track forecast errors for 24, 48 and 72 hours lead period have been 80, 200 and 422 km against the long period average (LPA) of 98, 146 and 183 km respectively. The track forecast errors have been higher than the LPA for lead period beyond 48 hours mainly due to recurving track. However, the skill in operational track forecast compared to CLIPER forecast has been higher than long period average for all lead periods.

Table 5.18: Average Track forecast error in association with CS KYANT

Lead Period (hrs)	N	Average track forecast error (km)	Skill (%)	LPA (2011-15)	
				Track forecast error (km)	Skill (%)
12	17	51.3	61.7	59.1	41.4
24	15	80.2	75.5	97.5	48.5
36	13	122.8	79.1	120.0	58.1
48	11	200.8	77.3	145.5	62.7
60	09	289.8	75.5	160.4	67.8
72	07	422.8	72.1	183.2	69.3
84	05	486.9	73.5	204.0	71.3
96	03	553.2	73.4	239.6	70.4

N: No. of observations verified, LPA: Long Period Average (2011-15)

5.2.1.1.3 Operational Intensity forecast error and skill

The operational intensity forecast errors and skill compared to persistence forecast in terms of absolute error (AE) and root mean square error (RMSE) are presented in Table 5.19.

Table 5.19: Average Intensity forecast error in association with CS KYANT

Lead Period (hrs)	N	Average Intensity Error (kts)		LPA Intensity forecast Error (kts) (2011-15)		Gain in Skill (%) against Persistence		LPA Gain in Skill (%) against Persistence (2011-15)	
		AE	RMSE	AE	RMSE	AE	RMSE	AE	RMSE
12	17	2.9	4.2	7.1	9.4	23.6	20.4	20.9	27.9
24	15	5.6	7.9	11.5	14.9	19.3	15.8	36.4	40.1
36	13	9.3	11.2	14.8	19.2	29.1	26.3	49.4	52.0
48	11	9.2	11.4	16.9	21.6	22.4	18.6	55.8	59.6
60	09	10.0	11.1	17.6	22.0	6.1	27.2	62.3	67.0
72	07	13.1	14.4	17.6	22.1	-83.2	-0.4	67.3	72.0
84	05	20.3	21.8	20.0	27.3	-44.8	-5.2	73.4	76.4
96	03	30.2	30.9	18.0	21.8	-6.7	5.6	79.5	82.0

N: No. of observations verified; AE: Absolute Error; RMSE: Root Mean Square Error, LPA: Long Period Average (2011-15).

The operational AE in intensity forecast has been significantly less than LPA as it was about 6, 9 and 13 knots against LPA of 12, 17 and 18 knots for 24, 48 and 72 hours lead period. Similarly, operational RMSE in intensity forecast has been about 8, 11 and 14 knots against LPA of 15, 22 and 22 knots for 24, 48 and 72 hours lead period respectively. The skill in intensity forecast with reference to AE is about 19%, 22% and -83% against the LPA of 36%, 56% and 67% respectively for 24, 48 and 72 hours lead period. The skill was negative for lead period beyond 72 hours as the system rapidly weakened which could not be predicted accurately.

5.2.1.2. Cyclonic Storm (CS) NADA over the Bay of Bengal (29 November -02 December 2016)

5.2.1.2.1 Operational Genesis forecast

IMD first predicted genesis of depression over southeast Bay of Bengal (BoB) on 29th November based on the observations of 0000 hours IST of 27th November.

5.2.1.2.2. Operational landfall forecast error and skill

The operational landfall forecast errors and skill are presented in Table 5.20. The point and time of landfall over Tamil Nadu coast was also predicted accurately with 24 hr landfall point forecast error of about 28 km and landfall time forecast error of about 4 hrs (Table 5.21).

Table 5.20: Landfall Point and Time Error in association with CS Nada

Lead Period (hrs)	Base Time	Landfall Point (degrees)		Landfall Time (hours)		Operational Error		LPA error (2011-15)	
		Forecast	Actual	Forecast	Actual	LPE (km)	LTE (hours)	LPE (km)	LTE (hours)
12	01/1200	10.9/79.9	10.75/79.9	01/2000	01/2300	17	3.0	36.5	2.5
4	01/0000	11.0/79.9	10.75/79.9	01/1800	01/2300	28	5.0	56.3	4.2
36	30/1200	11.3/79.9	10.75/79.9	01/2200	01/2300	61	1.0	60.6	4.7
48	30/0000	11.4/79.9	10.75/79.9	01/2100	01/2300	72	2.0	93.5	4.7

The LPA error is based on 12, 24,…72 hours lead period.

LPE: Landfall Point Error, LTE: Landfall Time Error, LPA: Long Period Average,

LPE= Forecast Landfall Point-Actual Landfall Point

LTE= Forecast Landfall Time-Actual Landfall Time

5.2.1.2.3. Operational track forecast error and skill

The operational average track forecast errors and skills (compared to climatological and persistence (CLIPER) forecasts) are shown in Table 5.21. The 24 hr track forecast error & skill were 68.9 km & 63.4% against long period average (2011-15) of 97.5 km & 48.5%.

Table 5.21: Average Track forecast error and skill in association with CS Nada

Lead Period (hrs)	N	Average track forecast error (km)	Skill (%)	LPA (2011-15)	
				Track forecast error (km)	Skill (%)
12	7	63.7	27.1	59.1	41.4
24	5	68.9	63.4	97.5	48.5
36	3	54.9	80.1	120.0	58.1
48	1	98.4	65.8	145.5	62.7

N: No. of observations verified, LPA: Long Period Average

5.2.1.2.4 Operational Intensity forecast error and skill

The operational intensity forecast errors and skill compared to persistence forecast in terms of absolute error (AE) and root mean square error (RMSE) are presented in Table 5.22. The operational AE and RMSE in intensity forecast has been significantly less than LPA for 24 and 48 hours lead period. The skill in intensity forecast with reference to AE and RMSE is also higher than LPA for these lead periods.

Table 5.22: Average Intensity forecast error in association with CS Nada

Lead Period (hrs)	N	Average Intensity Error (kts)		LPA Intensity forecast Error (kts) (2011-15)		Gain in Skill (%) against Persistence		LPA Gain in Skill (%) against Persistence (2011-15)	
		AE	RMSE	AE	RMSE	AE	RMSE	AE	RMSE
12	7	3.8	5.0	7.1	9.4	40.6	42.4	20.9	27.9
24	5	8.6	9.7	11.5	14.9	49.6	53.6	36.4	40.1
36	3	12.1	12.5	14.8	19.2	63.7	65.0	49.4	52.0
48	1	10.1	10.1	16.9	21.6	59.5	59.5	55.8	59.6

N: No. of observations verified; AE: Absolute Error; RMSE: Root Mean Square Error, LPA: Long Period Average (2011-15). There was no track forecast verification for 96-120 hours due to short track of the CS.

5.2.1.3. Very Severe Cyclonic Storm, 'VARDAH' over the Bay of Bengal (06-13 December 2016)

5.2.1.3.1 Operational Genesis forecast

- The first information regarding genesis of depression over southeast BOB on 6th December was issued by RSMC New Delhi on 3rd December with probability of 51-75%.
- The first bulletin indicating the landfall of cyclone between Ongole and Chennai by afternoon/evening of 12th December was issued based on 1730 hours IST observations of 10th (48 hours prior to landfall).
- The bulletin indicating landfall of cyclone close to Chennai around afternoon of 12th December was issued based on 0530 hours IST observations of 11th (36 hours prior to landfall).

5.2.1.3.2 Operational landfall forecast error and skill

The operational landfall forecast errors and skill are presented in Table 5.23. The landfall point error (LPE) has been about 11, 154 and 264 km against long period average (LPA) based on 2011-15 of 56, 94 and 106 km for 24, 48 and 72 hours lead period respectively. For 12 hour lead period, the landfall point error was almost zero. The LPE has been significantly lower than the LPA for 24 hours lead period and comparable to LPA for 48 and 72 hours lead period. The landfall time error (LTE) has been 5.0, 6.0 and 4.5 hours against the LPA of 4.2, 4.7 and 2.4 hours for 24, 48 and 72 hours lead period respectively. An example of forecast track along with cone of uncertainty and quadrant wind distribution around the centre of cyclone issued on 0000 UTC of 11th December and observed track is presented in Fig.5.16.

Table 5.23: Landfall Point and Time Error in association with VSCS Vardah

Lead Period (hrs)	Base Time	Landfall Point (^{0}N/^{0}E)		Landfall Time (hours)		Operational Error		LPA error (2011-15)	
		Forecast	Actual	Forecast	Actual	LPE (km)	LTE (hours)	LPE (km)	LTE (hours)
12	11/1800	13.1/80.3	13.1/80.3	12/1000	12/1030	0	0.5	36.5	2.5
24	11/0600	13.0/80.3	13.1/80.3	12/0530	12/1030	11	5.0	56.3	4.2
36	10/1800	13.7/80.3	13.13/80.3	12/0700	12/1030	66	3.5	60.6	4.7
48	10/0600	14.5/80.2	13.1/80.3	12/0530	12/1030	154	6.0	93.5	4.7
60	09/1800	14.6/80.2	13.1/80.3	12/1230	12/1030	165	2.0	95.2	3.9
72	09/0600	15.5/80.2	13.1/80.3	12/1500	12/1030	264	4.5	105.7	2.4

LPE: Landfall Point Error, LTE: Landfall Time Error, LPA: Long Period Average,
LPE= Forecast Landfall Point-Actual Landfall Point,
LTE= Forecast Landfall Time-Actual Landfall Time

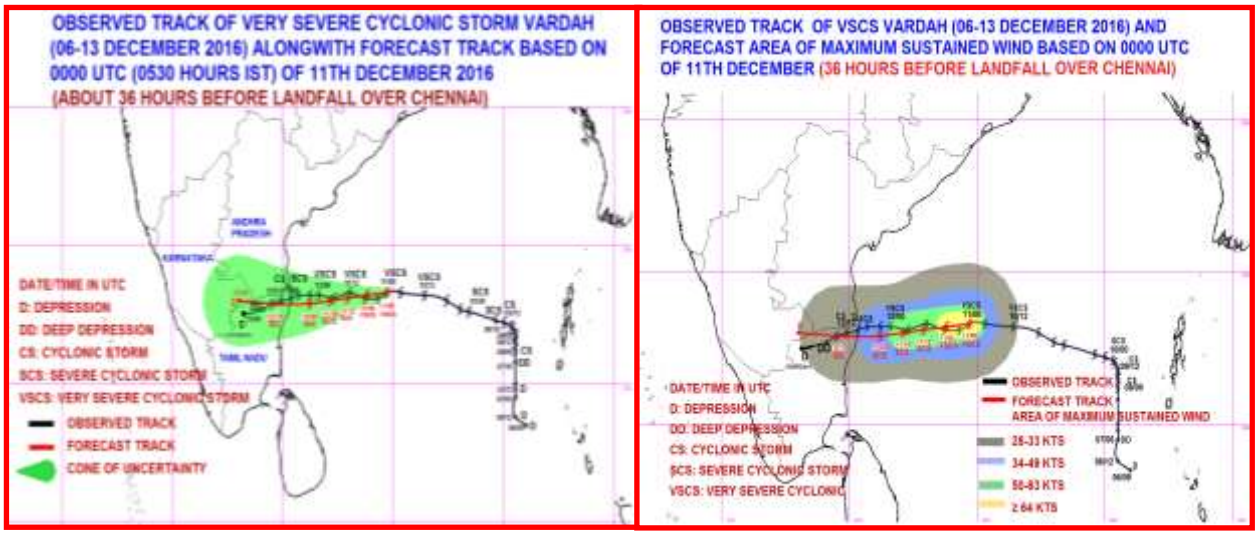


Fig.5.16: Observed track of VSCS Vardah (06-13 Dec, 2016) and forecast track based on 0000 UTC of 11th Dec alongwith (a) Cone of uncertainty and (b) Quadrant wind distribution

5.2.1.3.3 Operational track forecast error and skill

The operational average track forecast errors and skills (compared to climatological and persistence (CLIPER) forecasts) are shown in Table 5.24. The track forecast errors for 24, 48 and 72 hours lead period have been 94, 141 and 197 km against the long period average (LPA) of 98, 146 and 183 km respectively. The track forecast errors were less than the LPA for all 24 & 48 hours lead periods despite the fact that Vardah followed a recurving track. For 72 hours lead period, it was slightly more than LPA. However, the skill in operational track forecast compared to CLIPER forecast has been higher than long period average for all lead periods.

Table 5.24: Average Track forecast error in association with VSCS VARDAH

Lead Period (hrs)	N	Average track forecast error (km)	Skill (%)	LPA (2011-15)	
				Track forecast error (km)	Skill (%)
12	20	48.6	56.0	59.1	41.4
24	18	94.4	61.4	97.5	48.5
36	16	117.7	70.1	120.0	58.1
48	14	140.6	74.6	145.5	62.7
60	12	172.7	75.6	160.4	67.8
72	10	196.8	76.1	183.2	69.3
84	08	233.4	71.7	-	-
96	6	292.6	73.0	-	-
108	4	344.1	72.1	-	-
120	2	438.3	70.4	-	-

N: No. of observations verified, LPA: Long Period Average (2011-15) LPA not available for 84-120 hr forecasts, as this forecast was introduced from 2013 only.

5.2.1.3.4 Operational Intensity forecast error and skill

The operational intensity forecast errors and skill compared to persistence forecast in terms of absolute error (AE) and root mean square error (RMSE) are presented in Table 5.25.

Table 5.25: Average Intensity forecast error in association with VSCS VARDAH

Lead Period (hrs)	N	Average Intensity Error (kts)		Skill (%) in intensity forecast		LPA Intensity forecast Error (kts) (2011-15)	
		AE	RMSE	AE	RMSE	AE	RMSE
12	20	4.9	6.0	7.6	44.0	7.1	9.5
24	18	8.4	10.5	20.7	39.0	11.5	15.1
36	16	9.1	10.8	35.1	52.6	14.8	19.6
48	14	10.5	12.7	41.1	60.1	16.9	22.1
60	12	10.6	13.2	42.1	59.7	17.7	22.6
72	10	12.1	13.2	36.5	54.2	17.6	22.5
84	08	12.7	15.0	38.6	49.0	-	-
96	6	12.6	14.4	54.3	47.7	-	-
108	4	9.5	13.1	82.3	78.7	-	-
120	2	5.0	5.0	93.9	94.3	-	-

N: No. of observations verified; AE: Absolute Error; RMSE: Root Mean Square Error, LPA: Long Period Average (2011-15). LPA not available for 84-120 hr forecasts, as this forecast was introduced from 2013 only.

The operational AE in intensity forecast has been significantly less than LPA as it was about 8.4, 10.5 and 12.1 knots against LPA of 11.5, 16.9 and 17.6 knots for 24, 48 and 72 hours lead period. Similarly, operational RMSE in intensity forecast has been about 10.5, 12.7 and 13.2 knots against LPA of 15.1, 22.1 and 22.5 knots for 24, 48 and 72 hours lead period respectively. The skill in intensity forecast with reference to AE is about 36%, 82% and 73% against the LPA of 36%, 56% and 67% respectively for 24, 48 and 72 hours lead period.

5.2.2.2. Seasonal Forecast Performance during post monsoon season 2016:

5.2.2.2.1. Track Forecast

Seasonal average track forecast error is calculated by considering the track forecast errors of all the cyclones during the year. The mean error of each cyclone is weighted by number of forecasts verified to calculate the seasonal average track forecast errors as mentioned below. This is calculated for 12, 24, 36, 48, 60, 72, 84, 96, 108, 120 hr forecasts.

Seasonal average track forecast error= (n1*E1+n2*E2+n3*E3+....)/(n1+n2+n3+...)

where n1, n2, n3... are number of six hrly forecasts verified for cyclone 1, 2, 3. and E1, E2, E3... are the average track forecast errors for cyclone n1, n2, n3.

Similarly, seasonal average CLIPER model based track forecast errors are calculated. Subsequently, skill is calculated for a given cyclone by comparing the six hourly operational track forecast errors with track forecast errors of a reference model.

Track forecast skill (%) = (CLIPER track forecast error-Operational track forecast error)/
CLIPER track forecast error*100

The seasonal average track forecast error (Fig.5.17) has been 85.4km, 164.4 km and 289.9 km, respectively for 24, 48 and 72hrs against the past five year average error of 97.5, 146

and 183 km based on data of 2011-2015. The operational error has been higher, as all the cyclones during the season had recurving track.

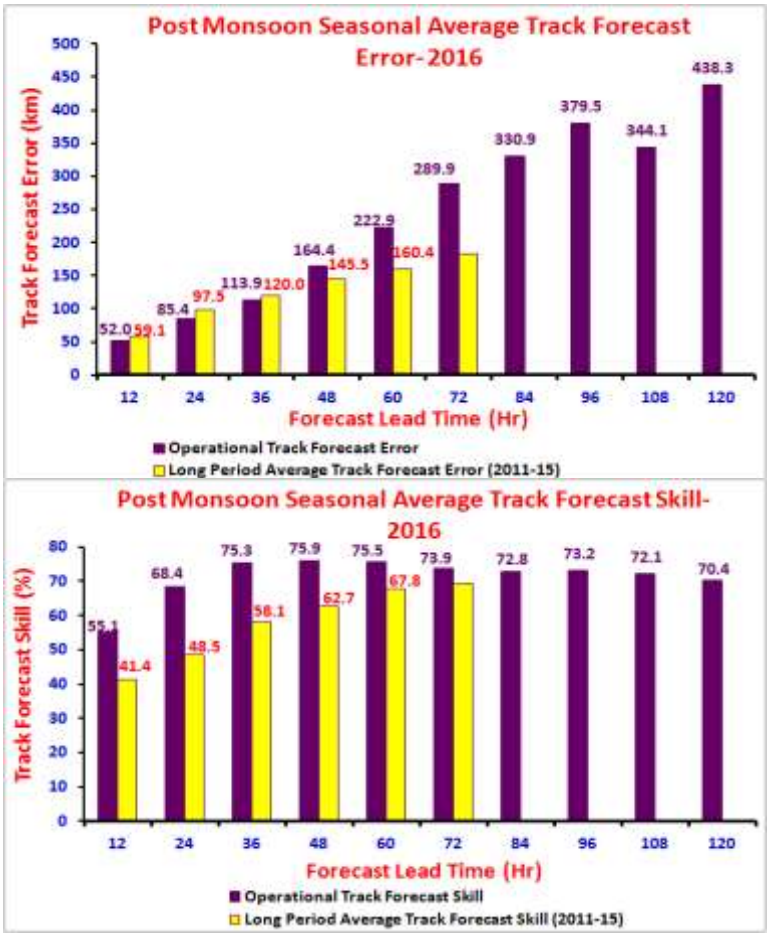


Fig.5.17. Seasonal average (a) track forecast error (km) and (b) track forecast skill against the climatology and persistence forecast as compared to that during 2011-2015

However comparing the average error of recurving tracks (Mohapatra et al, 2013), the error during 2016 has been significantly less. It is reflected in the assessment of track forecast skill during 2016 (Fig.5.17). The track forest skills compared to climatology and persistence forecast are 68%, 76% and 74% respectively for the 24, 48 and 72 hrs lead period which is much higher than long period average of 2011-2015 (49%,63% & 69% respectively). During 2016, CLIPER errors were more than official errors for all lead periods. CLIPER is a measure of the forecast difficulty level for a basin. As all the tracks were of recurving nature, the official errors were more as compared to long period average.

5.2.2.2.2 Landfall Forecast

The seasonal average landfall forecast error is average landfall forecast error of all the landfalling cyclones in a year. It is calculated for 12, 24, 36, 48, 60 and 72 hours lead period w.r.t. position and time respectively. The landfall point forecast error is 11 km, 155 km and 264 km for 24, 48 and 72 hrs lead period during postmonsoon season 2016 against the average of past five years of 56 km, 93 km and 106 km during 2011-2015 (Fig.5.18). The landfall time forecast error has been 5, 6 and 4.5 hrs for 24, 48 and 72 hrs lead period during 2016 against the average of past five years of 4.2, 4.7, 1.8 hrs during 2011-2015 (Fig.5.18). Due to recurving nature of the track, the landfall error like the track error has been relatively higher in 2016.

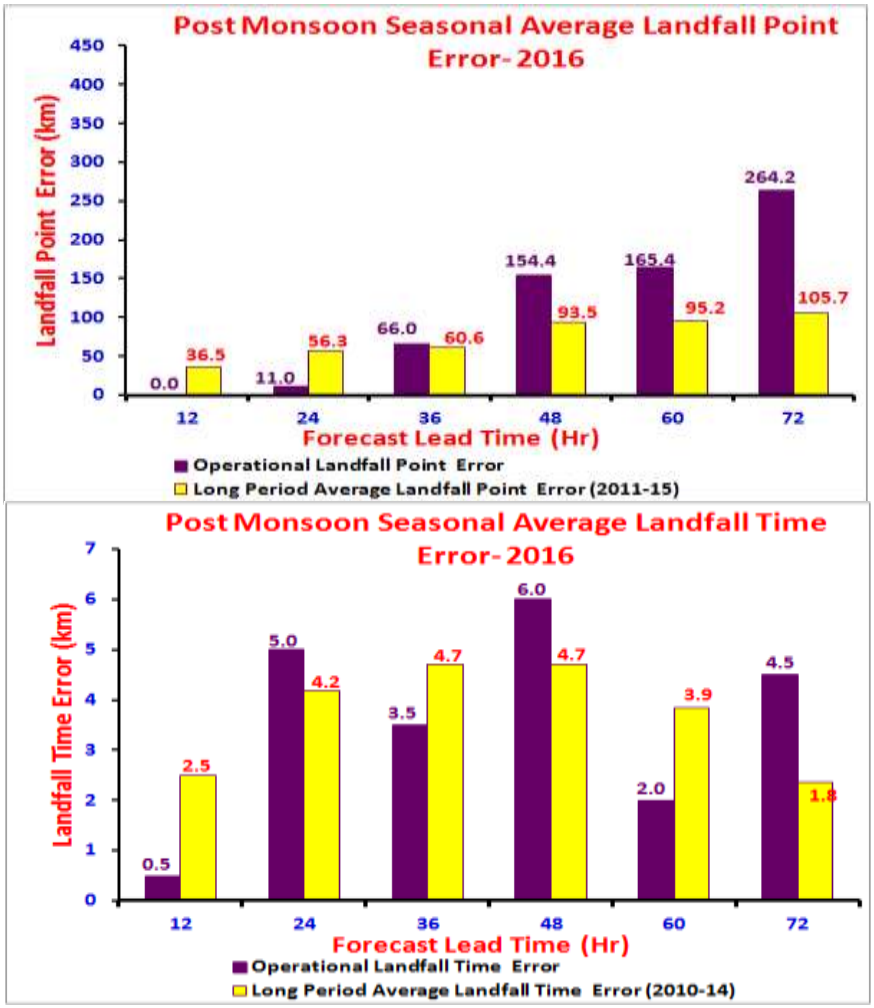


Fig.5.18. Seasonal average (a) landfall point forecast error (km) and (b) landfall time error as compared to that during 2011-2015

5.2.2.2.3 Intensity Forecast

The seasonal average intensity forecast error based on AE is the weighted mean of the absolute error for each cyclone. Similarly, the saesonal average error is calculated by persistence method. Based on these two errors, the intensity forecast skill with reference to absolute error is calculated. Errors and skills are calculated for 12, 24, 36, 48, 60, 72, 84, 96, 108 and 120 hour forecasts.

The average intensity forecast error based on RMSE is calculated by taking square root of the average of squared error between the forecast and observed intensity values for 12, 24, 36, 48, 60, 72, 84, 96, 108 and 120 hours forecast period for every six hourly forecast. Similarly, RMSE error based on persistence is calculated and hence the skill.

The seasonal average absolute error (AE) and root, mean square error (RMSE) in intensity forecast is presented in (Fig.5.19)

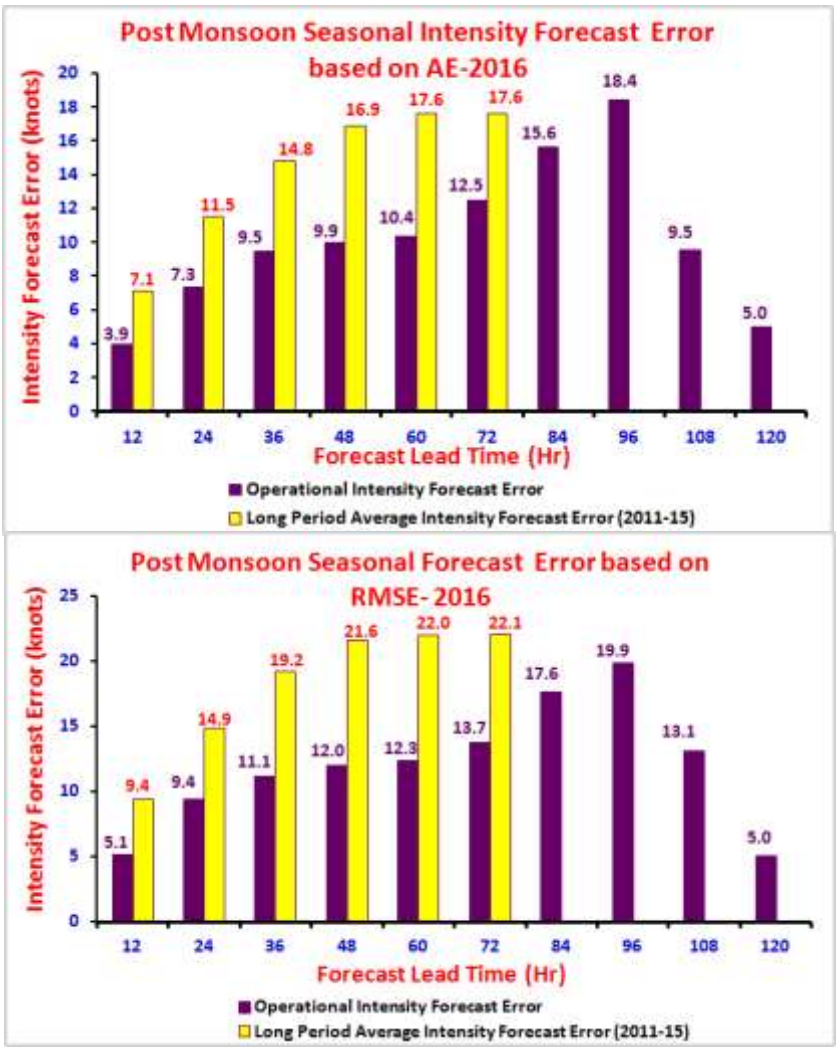


Fig.5.19. Seasonal average (a) absolute error (AE) and (b) root mean square error (RMSE) of intensity (wind) forecast as compared to that during 2011-2015

The seasonal average absolute error (AE) in intensity forecast error (Fig.5.19) has been 7.3 knots, 9.9 knots and 12.5 knots respectively for 24, 48 and 72 hrs lead period of forecast against the past five year average of 12, 17 and 18 knots. The seasonal average root mean square error (RMSE) in intensity forecast error (Fig.5.19) has been 9.4 nautical miles per hour (knots), 12 knots and 13.7 knots respectively for 24, 48 and 72 hrs lead period of forecast against the past five year average of 15, 22 and 22 knots. The skill in terms of AE compared to persistence forecast (Fig.5.20) was 28.4%, 37.9% and 20.4% as compared to long period average (2011-15) of 36.4, 55.8 and 67.3 for 24, 48 and 72 hours lead period. The skill in terms of RMSE compared to persistence forecast (Fig.5.20) was 38.3%, 50.4% and 42.9% as compared to long period average (2011-15) of 40, 60 and 72 for 24, 48 and 72 hours lead period.

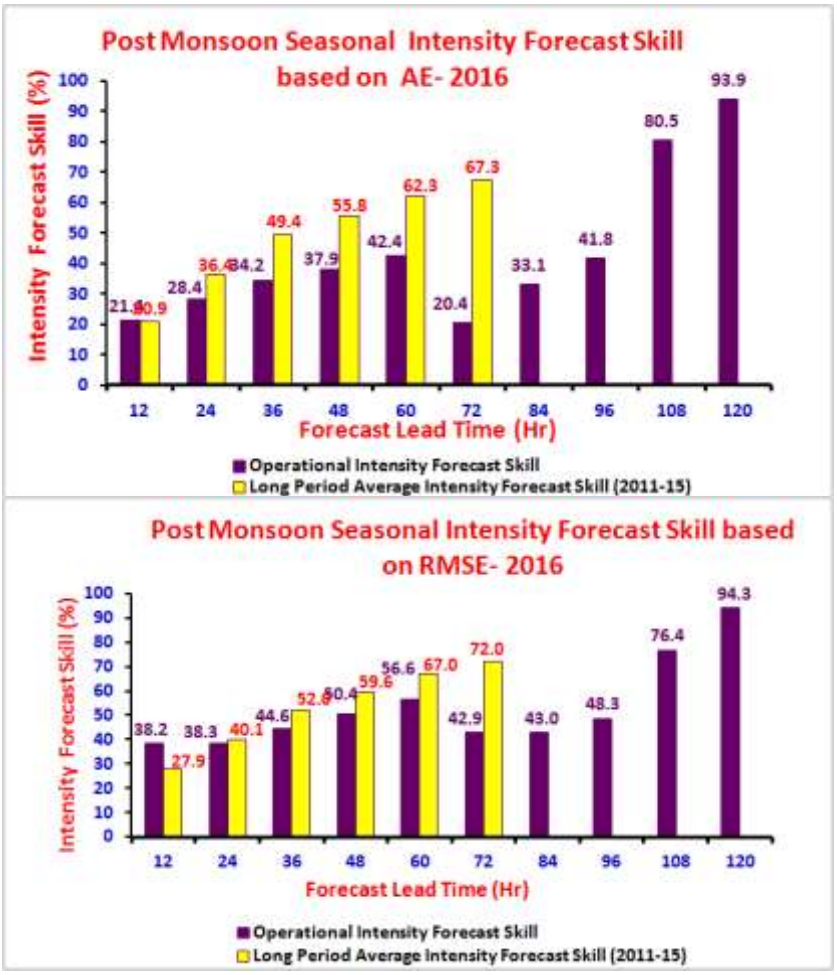


Fig.5.20. Seasonal average skill based on (a) absolute error (AE) and (b) root mean square error (RMSE) of intensity (wind) forecast as compared to that during 2011-2015

CHAPTER-VI

Summary, Conclusions and Lessons Learnt

The Pilot Phase of FDP on landfalling cyclones over the Bay of Bengal was conducted during 15th October to 20th December 2016 as per the implementation plan. IOP was declared for 25 days during the FDP period in association with (a) Cyclonic storm 'KYANT' over the Bay of Bengal during Oct 21st -27th (b) Depression over the Bay of Bengal during Nov 2nd – 6th (c) Cyclonic Storm “Nada” over the Bay of Bengal during Nov 29th – Dec 2nd (d) Very Severe Cyclonic Storm ‘VARDAH’ over the Bay of Bengal (6th -13th Dec 2016) and (e) Depression over the Arabian Sea (17th -18th December 2016).The daily bulletin was prepared during the period and circulated to all concerned.

The FDP helped in continuous monitoring of environmental conditions for cyclogenesis and monitoring of track, intensity and landfall of cyclonic disturbances over the region. Further, intense observation during IOP helped in better monitoring and prediction of cyclonic disturbances. The additional data collected during the FDP included enhanced Automatic Weather Station (AWS), High Wind Speed Recorder (HWSR) and Doppler Weather radar (DWR) network along the coast, eighteen activated buoy observations from the NIO, coastal AWS, ships and microwave imagery products. Also, an array of deterministic and probabilistic numerical weather prediction models was used for prediction purpose.

Because of above, the cyclone track forecast errors reduced in 2016 compared to previous FDP campaign. It helped in refining the Standard Operation Procedure and strengthening the multi-institutional mechanism. The seasonal average track forecast error was 85.4km, 164.4 km and 289.9 km, respectively for 24, 48 and 72hrs forecasts during post-monsoon season, 2016 against the past five years average error of 97.5, 146 and 183 km based on data of 2011-2015. The landfall point forecast error was 11 km, 155 km and 264 km for 24, 48 and 72 hrs lead period during post-monsoon season 2016 against the average of past five years of 56 km, 93 km and 106 km. The seasonal average absolute error (AE) in intensity forecast error has been 7.3 knots, 9.9 knots and 12.5 knots respectively for 24, 48 and 72 hrs lead period of forecast against the past five years average of 12, 17 and 18 knots. The operational track and landfall forecast errors were higher as all the cyclones during the season had recurving track. However, comparing with the average track forecast errors of recurving cyclones during past years, the error during 2016 was less. Also, intensity forecast errors were significantly less than long period average.

Following conclusions were made or lessons learnt during the FDP campaign 2016:

(a) Observational features

- Buoy data were very useful for validating the scatterometer based sea surface wind and intensity examination though they were scanty. Buoy observation is highly informative for synoptic analyses and ocean surface wind information. As such number of buoys may be enhanced over entire north Indian Ocean.
- Conventional ship observations under IVOF scheme are very less. Hence deployment of special cruise could have been very useful for cyclone forecast. In spite of attempts, it could not be organized during 2016 also. Attempt should be made for future campaign.

- Structured satellite bulletins like that issued by other international centres was introduced in 2016. It was very helpful for better utilization of statellite advisories. Satmet division of IMD should issue such bulletin regularly and uploaded in website.
- The surface wind data from ScatSat was available from cyclone Vardah onwards. Attempt should be made to make the product available in RSMC and IMD website. These data are very helpful for monitoring and predicting purpose in the data sparse region of north Indian Ocean..

(b) Diagnosis:

- On the average, the genesis of depression took place in association with lower level vorticity at 850 hPa level of about $100X10^{-6}s^{-1}$, lower level convergence at 850 hPa level of about $20X10^{-5}s^{-1}$, upper level divergence of about $20X10^{-5}s^{-1}$ and vertical wind shear of less than 20 knots, SST more than $50KJ/cm^{-2}$ and ocean thermal energy more than 100 KJ/cm^2. The intensification into cyclonic storm stage took place with low to moderate vertical wind shear (< 20 knots), upper level divergence of $40X10^{-5}s^{-1}$, lower level convergence of about of $40X10^{-5}s^{-1}$ and relative vorticity of about of $150X10^{-6}s^{-1}$.
    - Diurnal cycle of convection does influence cyclonic disturbance and hence this aspect is required to be monitored and examined in detail. Satellite division of IMD and others may carry out studies on these aspects.

(c) Model performance

- While the performance of grid point average GPP was better in predicting genesis of cyclones at the state of T 1.0, 1.5 or 2.0, there was over warning by grid point GPP for genesis prediction. Hence, there is need for bias correction in the grid point based GPP for cyclogenesis forecast.
- Further the performance of the NWP models varied from system to system. The average track forecast error was the minimum for MME for all forecast times. Among the deterministic models, the 24 hr track forecast error was the minimum for IMD (GFS) and HWRF followed by NCEP (GFS), UKMO, ECMWF (all less than 100 km). Similarly, 48 hr forecast error was the minimum for ECMWF followed by UKMO, JMA, IMD-HWRF (all less than 150 km). The 72 hr track forecast error was the minimum for UKMO followed by ECMWF, IMD-WRF, JMA, IMD-HWRF (all less than 250 km). As the average error is also not consistent for individual models for different lead periods, it is better to utilise the MME guidance for track forecast. At the same time, MME runs should be ensured twice daily during entire life period of cyclonic disturbances. As the MME and other deterministic models are run twice daily and operational forecasts are issued every three hourlies. As a result, the statistical interpolation has to be made for individual deterministic models as well as MME for every six hours viz. 00, 06, 12 and 18 UTC observations, so that this guidance can be better utilised by forecasters objectively and accuracy of track forecast can be improved.
- The average intensity forecast errors of IMD-HWRF model were higher than that of SCIP-dynamical statistical model. It indicates that there is scope to improve the performance of IMD-HWRF model by implementing coupled version and better data assimilation. Further, the intensity forecast errors of HWRF is very high for 72 hr or more lead period (>20 knots).
- Based on the campaign conducted so far, the NWP groups should bring out the limitation and capabilities of various models used operationally based on critical assessment of their

performance. Further, the threshold criteria for genesis and intensification based on Grayparameters derived from models may be developed.

- In view of development in recent years in ensemble prediction, attempts should be made to create dynamical cone of uncertainty, location specific probability of precipitation, strong wind and stom surge/coastal inundation.
- Intensity forecast especially rapid intensification and rapid weakening over the sea was still challenging during 2016. R&D groups should make coordinated effort to develop a technique for forecasting rapid intensification and weakening of TC over the Sea.
- In spite of several attempts, aircraft recorraissance which is one of the key objectives of FDP could not be carried out so far. MoES and IMD however should continue their efforts to achieve this objective.

(d) Early warning and preparedness for effective disaster management

- Increase in lead period with demonstrated accuracy level helps in motivating the Disaster Managers to initiate action. The minimum loss of life due to VSCS, Vardah demonstartes the above facts.
- Pre-cyclone exercise: Biennial meetings are held in the month of March and September before commencement of Cyclone Season in which IMD officials and Disaster Manager Authorities, participate to chalk out the plan for the season to examine the preparedness. This exercise helps in improving the cyclone management
- Pre-Storm exercise: The meeting conducted within the IMD under the Chairmanship of DGM as and when a cyclonic storm is expected based on NWP guidance helps in the preparedness and last minute action, if any, regarding update of instruments, availability of spares, update of telecom lines for dissemination of bulletins /warnings and manpower issues.
- Triggering Media and General Public with the following helps in better management of cyclone
    - Daily Press release
    - Holding of press conference
    - SMS
    - Round the clock response to press and electronic media.
    - FAQs (Do's and Dont's)
    - Dedicated website for cyclones
- Similarly triggering of disaster managers by the following approach also helps in better management
    - Introduction of SMS for Cabinet Secretary at National Level to District Collectors at district level
    - Personal briefing over phone.
    - Telefax and e-mail every 3 hourly
    - Participation in Crisis Management Committee every day
- Triggering Vulnerability Group like (i) Fishermen and (ii) Farmer
- Synergised SOP (SSOP):
    - INCOIS, Hyderabad disseminated warnings through SMS and Electronic Display Boards (EDB) to coastal population especially meant for fishermen. The ocean state forecast bulletins issued by INCOIS is modified in accordance with Cyclone

Warning bulletins issued by IMD. This has been achieved through Synergised SOP for dissemination of bulletins between IMD and INCOIS.

- QPF and QPE for river catchments are issued by the designated Flood Meteorological Offices of IMD. Liaison with Flood Meteorological Agencies beforehand for regulation of inflow and outflow of water from Dams is essential. Hence need has been for developing Synergised SOP with the Authorities. The same is in progress.
- There is also need for location specific probabilistic forecast of rainfall and wind for major cities.

CHAPTER-VII

Acknowledgements

India Meteorological Department is thankful to all the member countries of WMO/ESCAP Panel including Bangladesh, Myanmar, Maldives, Pakistan, Sultanate of Oman, Sri Lanka, Thailand and Yemen for their continued support through exchange of meteorological information and crucial meteorological data at the time of landfall. We are also thankful to Indian Space Research Organisation, National Centre for Medium Range Weather Forecasting, Indian Air Force, Indian Navy, Indian Institute of Technology Delhi, Indian Institute of Technology Bhubaneswar, Indian National Centre for Ocean Information Services, Hyderabad and National Institute of Ocean Technology, Chennai for their valuable inputs. We also acknowledge contribution from Satellite Meteorology Division, NWP Division, Information System and Services Division, Radar Division, RMC Kolkata/ Chennai, ACWC Kolkata/ Chennai, CWC Bhubaneswar/ Vishakhapatnam, DWR Chennai/ SHAR/ Machhilipatnam/ Vishakhapatnam/ Karaikal and Paradip. We thank all officials of Cyclone Warning Division, IMD, New delhi for their valuable contribution to bring out this report on Forecast Demonstration Project on landfalling cyclones over the Bay of Bengal-2016". We also thank Mr Mukesh Kumar and Mr Santosh Singh, for typesetting and compilation of the report.

APPENDIX-I

Daily FDP Reports from 15th October-20th December from Next Page

FDP (Cyclone) NOC Report Dated 15 October, 2016

Weather Briefing

Synoptic features:

The upper air cyclonic circulation over Kerala Lakshadweep area now lies over Lakshadweep area neighbourhood between 3.1 km & 4.5 km above mean sea level. An upper air cyclonic circulation lies over southeast Bangladesh & neighbourhood and extends upto 2.1 km above mean sea level. An upper air cyclonic circulation lies over southwest Bay of Bengal (BOB) off Tamilnadu Coast and extends upto 0.9 km above mean sea level.

Dynamical and thermodynamical features:

Surface Temperature (SST):

SST is around 29-30°C over entire Bay of Bengal and Andaman Sea. It is around 31°C over western parts of BOB off Tamilnadu, north Andhra Pradesh, Odisha and West Bengal coasts.

SST is around 28°C over most parts of eastern Arabian Sea (AS) and 32°C off north Maharashtra and adjoining Gujarat coast. It is 26-27°C over western parts of AS except over Pesian Gulf and Gulf of Aden where SST is around 31°C.

Tropical Cyclone Heat Potential (TCHP):

TCHP is below 80-90 kJ/cm^2 over entire BoB except over north BOB, parts of westcentral BOB off north AP and Odisha coast and southwest BOB off Sri Lanka coast where it is less than 50 kJ/cm^2. TCHP is 100 kJ/cm^2 over southeast Andaman Sea between some eqautorial parts and 4.0^0 N.

TCHP is below 50kJ/cm^2 over northwest extending up to some southwest parts of AS and eastern parts of AS off west coast of India. It is 70-80 kJ/cm^2 over eastcentral and adjoining southern parts of AS.

Relative Vorticity:

Relative vorticity at 850 hPa is positive and is 25X10^{-5} s-1 over central BoB and adjoining Andaman sea and equatorial region. It is negative over western parts and eastern parts of BoB.

It is around 40X10^{-5} s-1 over some parts of southwest BOB.

It is positive and around 25X10^{-5} s-1 over northern, eastcentral and southern parts of AS. It is negative over central AS. It is about 40X10^{-5} s-1 over parts of eastcentral and southeast.

Convergence:

Lower level convergence is about 5 x10^{-5} s-1 over south Andaman Sea and some parts of southwest BoB.

Lower level convergence is between 5 to 10 x 10^{-5} s-1over parts of southeast AS off Kerala coast and 5 x 10^{-5}s-1over parts of eastcentral AS off Maharashtra coast.

Divergence:

Upper level divergence is 5-10x10^{-5} s-1 over parts of southeast BoB, Andaman Sea. and parts of equatorial region of BoB.

No zone of positive upper level divergence over entire AS. It is -5x10^{-5} s-1 over some parts of westcentral AS off Gulf of Aden.

Wind Shear: Wind shear is 5-10 knots over central & north BoB and Andaman Sea and is increasing towards south BoB.

Wind shear is 5-10 knots over central parts of AS and is increasing towards northern parts and southern parts of AS. Wind Shear Tendency: There is decreasing tendency (-5 to -10 Knots) over eastcentral and adjoining northeast BoB. It is positive over north Andaman Sea. The shear tendency is decreasing -5-10 knots over northern parts and southwest & adjoining southeast parts of AS. It is increasing 5 to 10 knots over westcentral parts of AS.

Upper tropospheric ridge: The upper tropospheric ridge at 200 hPa runs along 22.0°N over BOB.

Satellite observations based on INSAT imagery:

Bay of Bengal & Andaman Sea:- According to satellite imagery, scattered low and medium clouds with embedded moderate to intense convection lies over south BOB and Andaman Sea. **Arabian Sea:-** According to satellite imagery, scattered low and medium clouds with embedded moderate to intense convection lies over southeast AS.

Large scale features :

M.J.O. Index: MJO index is in Phase 6 with amplitude less than 1 and would move to phase 7 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: Vortex (Sarika) over west Pacific Ocean adjoining Philippines centred near 14.4N/124.4E. Intensity T5.0.

NWP Input for FDP Cyclone based on 0000 UTC:

IMD-GFS: The analysis of IMD-GFST574 model charts based on 0000 UTC of 15th October, 2016 shows a cyclonic circulation in the lower levels extending up to 700 hPa above mean sea level over west-central Bay of Bengal, which is likely to move northeastward in next 72 hours towards Myanmar coast as a cyclonic circulation. Another cyclonic circulation in lower tropospheric levels up to 700 hPa is seen over Lakshadweep and adjoining Arabian Sea off Kerala coast which is weakening after 48 hours.

IMD-WRF: The WRF model analysis and forecasts over the Bay of Bengal also show almost similar patterns like that is seen with GFS model.

NCMRWF-NCUM: It suggests circulation over southeast Bay on 15th. It moves to central Bay on 16th and less marked on 17th. Another circulation formed over north Andaman Sea on 17th and becomes low pressure area over east central Bay on 18th. It lies over central Bay on 19th meandering over the area till 24 th Oct without intensification. On 25th, it becomes well marked over east central Bay.

NCMRWF-UM-Regional Model : It suggests circulation over southeast Bay on 15th. It moves to central Bay on 16th and less marked on 17th. Another circulation formed over north Andaman Sea on 17th and becomes low pressure area over east central Bay on 18th .

ECMWF. : ECMWF suggests formation of a low pressure area on 19-21st meandering over central Bay.

NCEP-GFS : Model suggests no low pressure area during next five days

JMA: JMA Model indicates no low pressure area formation during next 3 days.

ARP-Meteo France: ARP Model indicates no low preessure area during next 3 days.

IITM-GEFS: Model suggests no low pressure area during next five days based on 0000 UTC of 14th.

Dynamical statistical models of IMD:

Genesis Potential Parameter (GPP): The Genesis Potential Parameter (GPP) analysis and forecasts based on 0000 UTC of 15 October 2016 shows a moderate GPP zone over Lakshadweep region moving southward associated with the circulation. Another significant GPP zone is likely to appear off Myanmar coast in 72 hours, however, with moderate intensification.

Summary and Conclusion: Most of the models suggest the formation of cyclonic circulation/ low pressure area over the central Bay on 18th/ 19th . It is expected to meander over the region during 19-21st without any significant intensification.

Probability of cyclogenesis over Bay of Bengal and Andaman Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis over Arabian Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Nil	Nil	Nil	Nil

Advisory: No IOP for next five days.

FDP (Cyclone) NOC Report Dated 16 October, 2016

Synoptic features:

The upper air cyclonic circulation over Lakshadweep area & neighbourhood between 3.1 km & 4.5 km above mean sea level persists. The upper air cyclonic circulation over southeast Bangladesh & neighbourhood now lies over Tripura and neighbourhood and extends upto 2.1 km above mean sea level. The upper air cyclonic circulation over southwest Bay of Bengal (BOB) off Tamilnadu Coast extending upto 0.9 km above mean sea level persists.

Dynamical and thermodynamical features:

Surface Temperature (SST):

SST is around 29-30°C over entire Bay of Bengal and Andaman Sea. It is around 31°C over western parts of BOB off Tamilnadu, north Andhra Pradesh, Odisha and West Bengal coasts.

SST is around 28°C over most parts of eastern Arabian Sea (AS) and 32°C off north Maharashtra and adjoining Gujarat coast. It is 26-27°C over western parts of AS except over Persian Gulf and Gulf of Aden where SST is around 31°C.

Tropical Cyclone Heat Potential (TCHP):

TCHP is below 80-90 kJ/cm^2 over entire BoB except over north BOB, parts of westcentral BOB off north AP and Odisha coast and southwest BOB off Sri Lanka coast where it is less than 50 kJ/cm^2. TCHP is 100 kJ/cm^2 over southeast Andaman Sea between some equatorial parts and 4^0 N.

TCHP is below 50kJ/cm^2 over northwest extending up to some southwest parts of AS and eastern parts of AS off west coast of India. It is 70-80 kJ/cm^{2}over eastcentral and adjoining southern parts of AS.

Relative Vorticity:

Relative vorticity at 850 hPa is positive and is 2.5X10^{-5}s-1 over central BoB & adjoining Andaman Sea and equatorial region. It is negative over western parts and northeastern parts of BoB. It is around 4.0X10^{-5}s-1 over some parts of south Andaman Sea.

It is positive and around 2.5X10^{-5}s-1 over northern, eastcentral and southern parts of AS. It is negative over central and northwest AS. It is about 4.0X10^{-5}s-1 over parts of southeast AS.

Convergence:

Lower level convergence is about 5 x 10^{-5}s^{-1} over south Andaman Sea and 5 to 10 x 10^{-5}s^{-1} over some parts of southwest BoB, south Andaman Sea & adjoining equatorial region.

Lower level convergence is between 5 to 10 x 10^{-5}s^{-1} over parts of southeast AS & equatorial region adjoining southeast AS.

Divergence:

Upper level divergence is 5 to10x10^{-5} s-1 over parts of eastcentral BoB off Myanmar coast and equatorial region upto 5^0N.

No zone of positive upper level divergence over entire AS.

Wind Shear:

Wind shear is 5-10 knots over central & north BoB and is increasing towards south BoB.

Wind shear is 5-10 knots over central parts of AS and is increasing towards northern parts and southern parts of AS.

Wind Shear Tendency:

There is decreasing tendency (-5 knots) over westcentral BoB. It is +5 knots over parts of north Andaman Sea and westcentral BoB.

The shear tendency is decreasing -5-10 knots over northern parts and southwest & adjoining southeast parts of AS. It is increasing 5 to 10 knots over eastcentral parts of AS off Karnataka coast.

Upper tropospheric ridge:

The upper tropospheric ridge at 200 hPa runs along 20.0°N over BOB and 22.0°N over AS.

Satellite observations based on INSAT imagery:

Bay of Bengal & Andaman Sea:-

According to satellite imagery, scattered low and medium clouds with embedded moderate to intense convection lies over southeast BOB, Andaman Sea, Arakan coast, Gulf of Martaban and Tenasserim coast.

Arabian Sea:-

According to satellite imagery, scattered low and medium clouds with embedded moderate to intense convection lies over southeast AS.

Large scale features:

M.J.O. Index:

MJO index is in Phase 6 with amplitude less than 1 and would move to phase 7 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean:

Typhoon (Sarika) over west Pacific Ocean adjoining Philippines centred near 16.6N/117.2E. Intensity T4.5. It is expected to move west-northwestwards and cross Vietnam coast near Hanoi around 0600 UTC of 19th Oct. Another typhoon (Haima) located near lat. 11.0^0N and long. 138^0E likely to intensify and move northwestwards across Philippines towards Hong Kong coast by 21 Oct 2016.

NWP Input for FDP Cyclone based on 0000 UTC:

IMD-GFS: The analysis of IMD-GFST574 model charts based on 0000 UTC of 16th October, 2016 show a cyclonic circulation in the lower levels extending up to 700 hPa above mean sea level over south-west Bay of Bengal, which is likely to move northeastward in next 72 hours towards Myanmar coast as a cyclonic circulation. Another cyclonic circulation in lower tropospheric levels up to 700 hPa is seen over Lakshadweep and adjoining Arabian Sea off south Kerala coast which is weakening in 48 hours.

IMD-WRF: The WRF model analysis and forecasts based on 00 UTC of 16th October 2016 over the Bay of Bengal also shows almost similar circulation pattern with two significant cyclonic circulations like that is seen with GFS model. But the cyclonic circulation over Bay of Bengal shows intensification after 48 hours and moves northwestward in contrast to GFS model. In addition a feeble cyclonic circulation is also been found over Tripura and adjoining areas which persists for 72 hours.

NCMRWF-NCUM: It suggests circulation over eastcentral Bay during 16-18th . It lies as low on 19th over same area and becomes depression on 24th, a cyclonic storm on 25th and a severe cyclonic storm on 26th over the same area.

NCMRWF-UM-Regional Model : It suggests circulation over southeast Bay on 16th. It lies as a low over central Bay on 18th and becomes depression over same area on 19th. Another circulation formed over north Andaman Sea on 17th and becomes low pressure area over east central Bay on 18th and a depression on 19th.

ECMWF: ECMWF suggests formation of a low pressure area during 18-21st meandering over central Bay and becomes less marked on 22nd.

NCEP-GFS: Model suggests low pressure area over EC Bay on 19th. It lies as extended low over same area on 20th and 21st and becomes less marked on 22nd. Another extended low forms over EC Bay on 24th and persists over the same region till 26th.

JMA: JMA Model indicates low pressure area formation over central and adjoining southwest Bay.

ARP-Meteo France: ARP Model indicates low pressure area on 17th over EC Bay off Arakan coast, depression over eastcentral Bay on 18th and deep depression/cyclonic storm over west central Bay on 19th.

IITM-GEFS: Model suggests low pressure area over north Andaman Sea on 17th, extended low on 18th over same region and less marked on 19th. Another extended low appears on EC Bay and adjoining north Andaman Sea on 20th. As a low over north Andaman Sea on 21st and becomes less marked thereafter.

NCMRWF-NEPS Model: It suggests circulation over central Bay during 16-18th. It lies as a low over central Bay on 19th and becomes depression over same area on 20th, deep depression on 22nd over northwest Bay off Paradip coast, and lies as a low over interior Odisha on 23rd and becomes less marked thereafter

Dynamical statistical models:

IMD Genesis Potential Parameter (GPP):

The Genesis Potential Parameter (GPP) analysis and forecasts based on 0000 UTC of 16 October 2016 shows a very weak GPP zone over Lakshadweep region moving southward associated with the circulation and shows intensification in 72 hours. Another significant GPP zone is likely to appear off Myanmar coast in 72 hours, however, which is showing intensification.

Summary and Conclusion:

Most of the models suggest the formation of low pressure area over the central Bay on 18th. It is expected to meander over the region during 19-22nd with large variance in possible intensification. While ARP-

MeteoFrance model, Unified Model and its ensemble system intensify it into a cyclonic storm, others show no significant intensification.

Probability of cyclogenesis over Bay of Bengal and Andaman Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis over Arabian Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Nil	Nil	Nil	Nil

Advisory:

- The possibility of formation of low on 18th October and its possible intensification into a cyclonic storm as predicted by a few models need to be watched and monitored
- No IOP for next five days.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	15/12	**16/00**	**16/03**
India	81	59	84
Coastal stations			
WB	7	3	7
Odisha	7	5	7
AP	12	12	12
Tamil Nadu	11	9	11
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	12	16	15
Myanmar	12	0	12
Thailand	3	3	3
SriLanka	10	9	10

- **RS/RW** (12Z) of 15 / 10 /2016 18/38
- **No. of Ascents reaching 250 hPa levels: 17/38 , MISDA:- 20**

- **RS/RW** (00Z) of 16 / 10 /2016 34/38
- **No. of Ascents reaching 250 hPa levels: 34/38 , MISDA: 4**
-

No. of PILOT Ascents

15/12Z	**16/00Z**
16/37	11/34

Buoy Data

15/12Z	**16/00Z**	**16/03Z**
9	9	9

STATUS OF CHENNAI REGION OBSERVATION

No. of Synop data

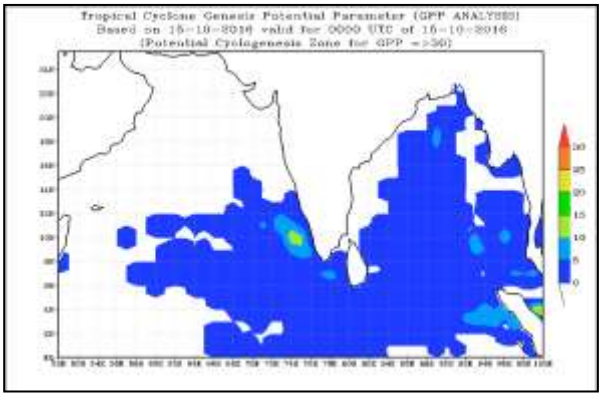
Date→	**15.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**19**

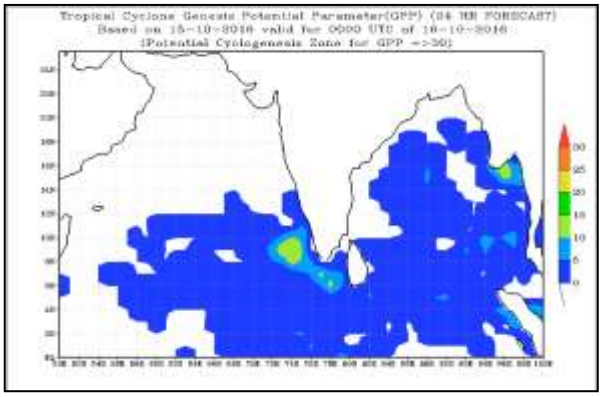
No. of RS/RW Ascents

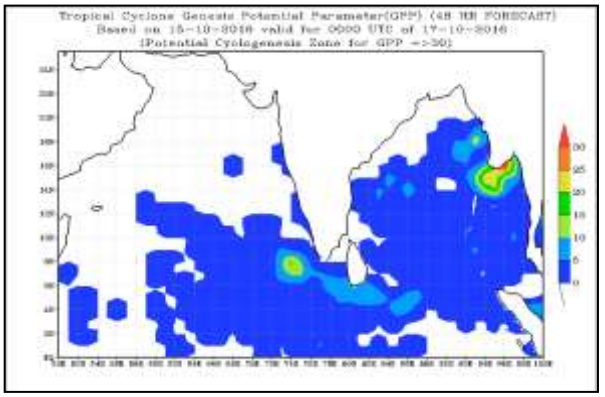
00Z /15.10.2016 : 6
No. of Ascents reaching 250 hPa level = 6
MISDA : 2
12Z /15.10.2016 : 3
No. of Ascents reaching 250 hPa level = 2
MISDA : 5
No. of PILOT Ascents:

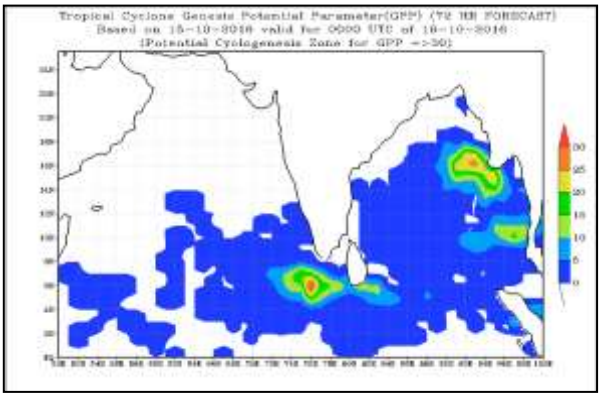
15.10.2016	
06Z	18Z
5	5

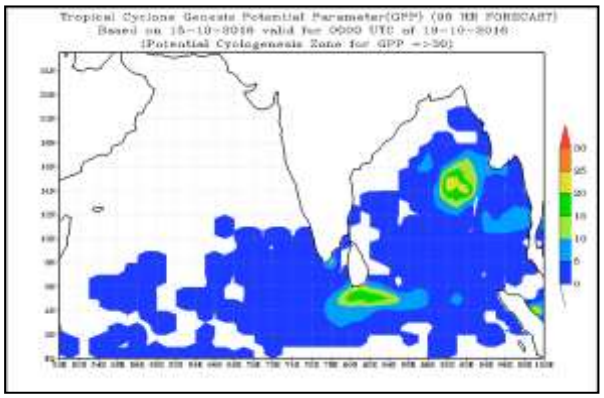
Annexure-II

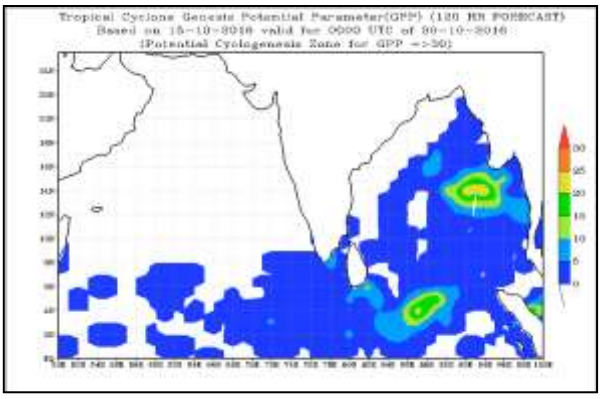

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 15-10-2016 valid for 0000 UTC of 16-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

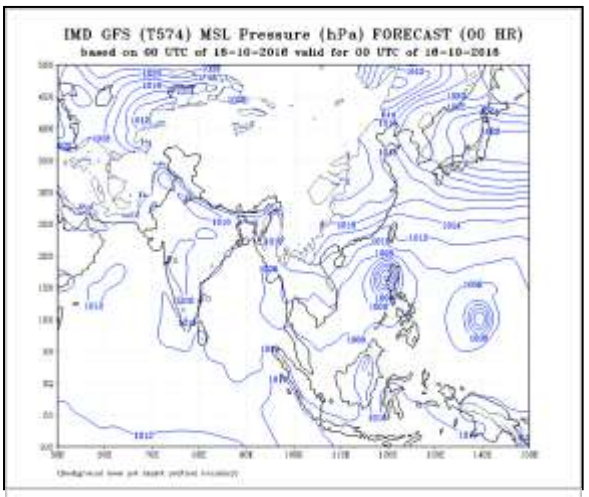

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

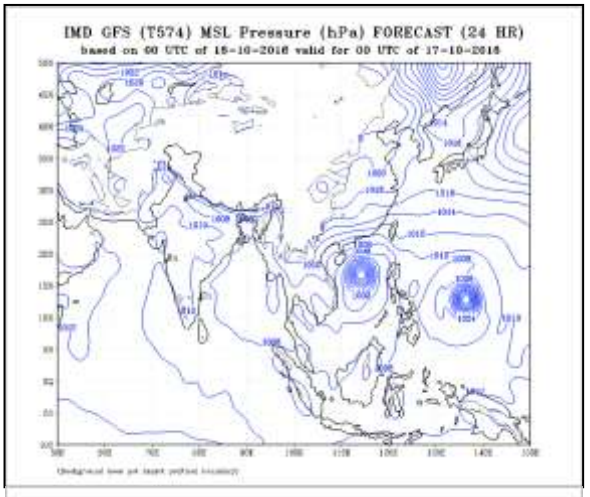

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

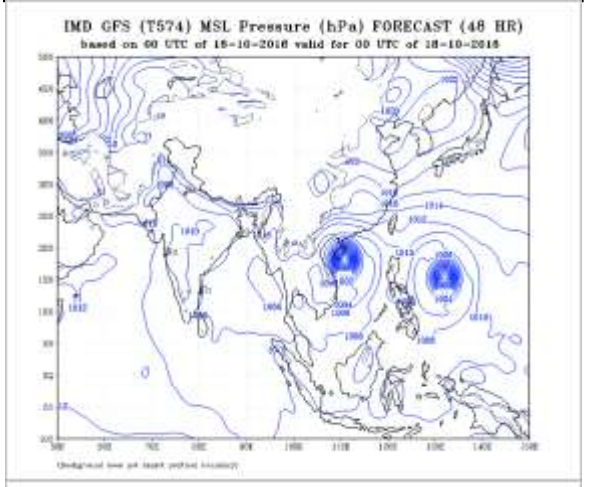

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
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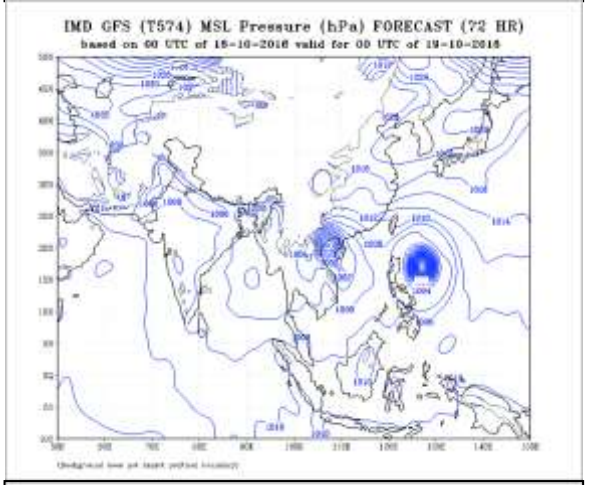

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

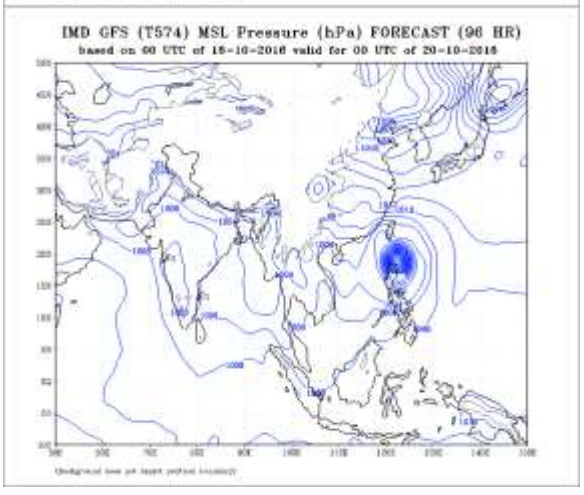

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 15-10-2016 valid for 0000 UTC of 20-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

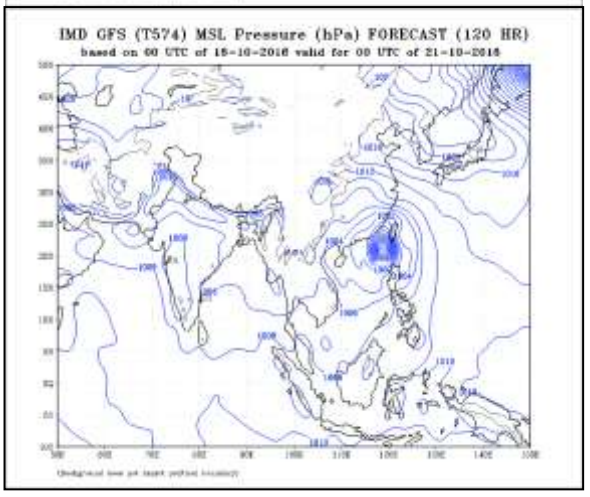

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 16-10-2018

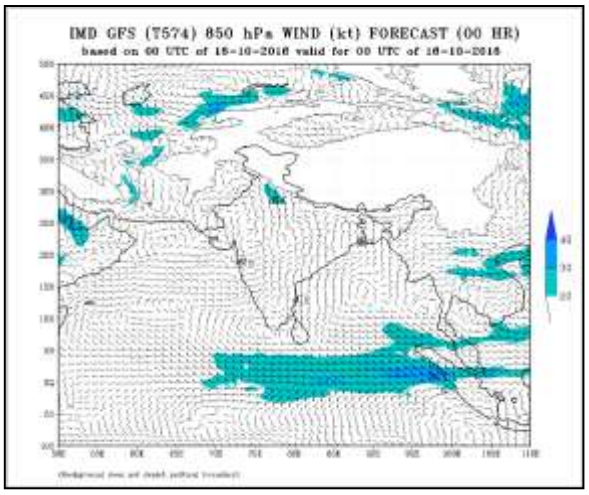

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 17-10-2018

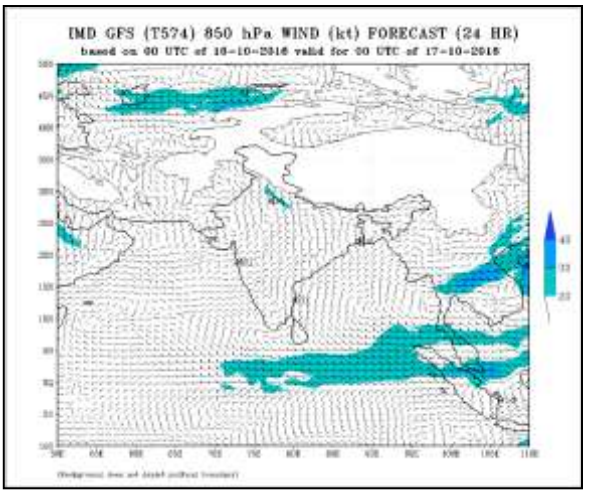

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
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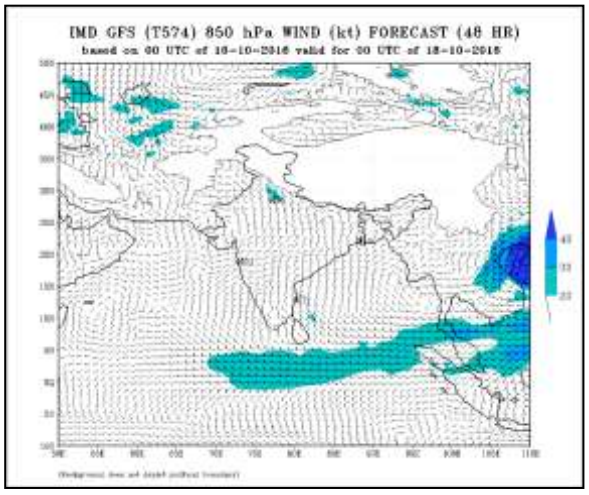

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
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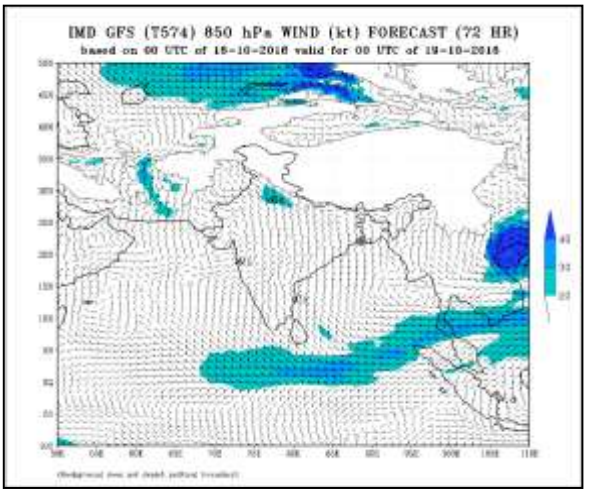

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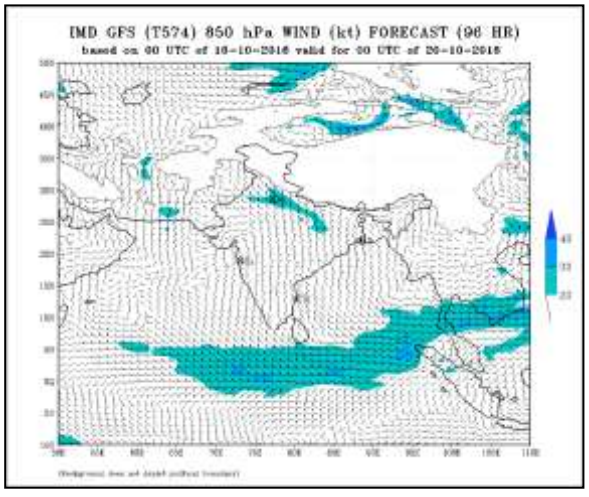

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
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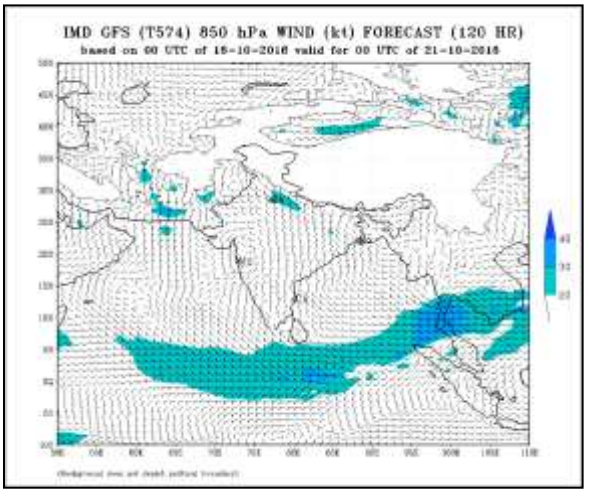

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 15-10-2018

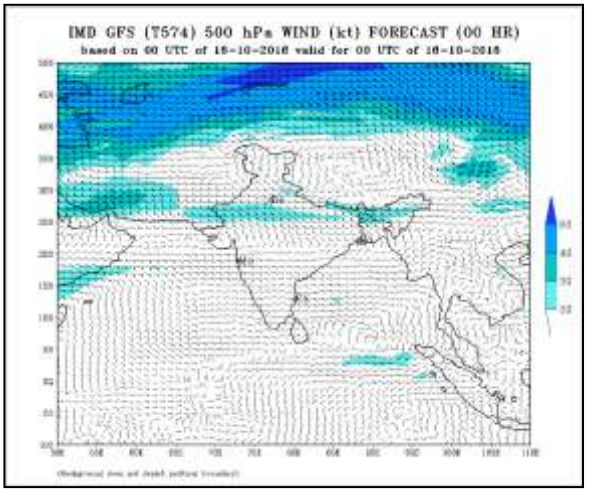

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 17-10-2018

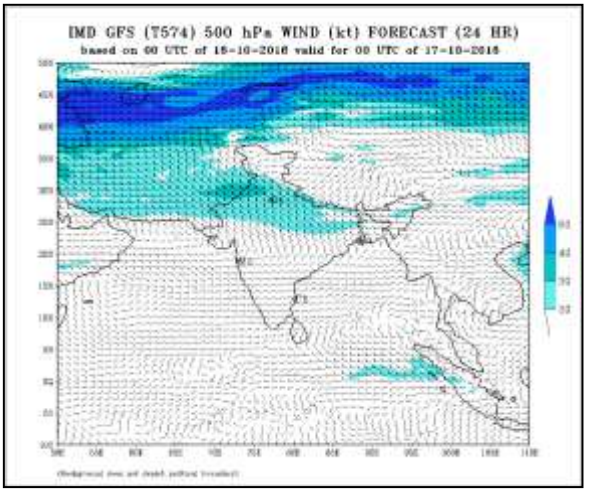

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 18-10-2018

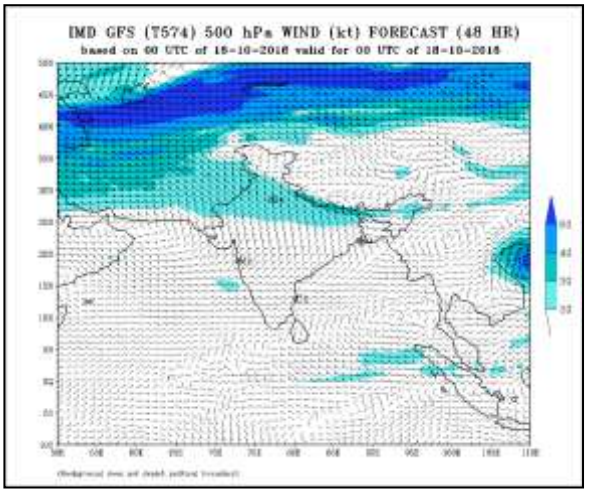

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 19-10-2018

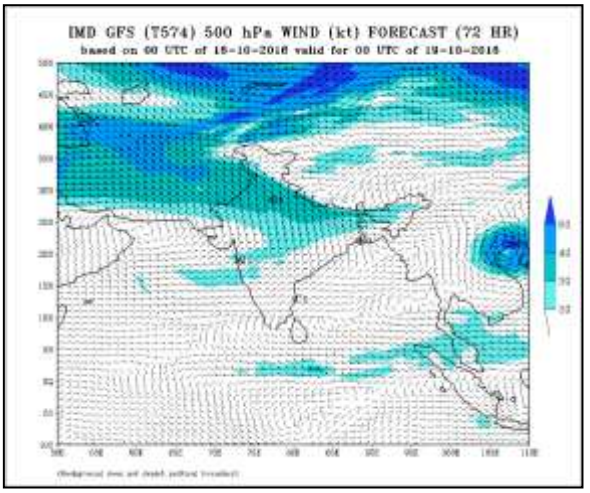

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 20-10-2018

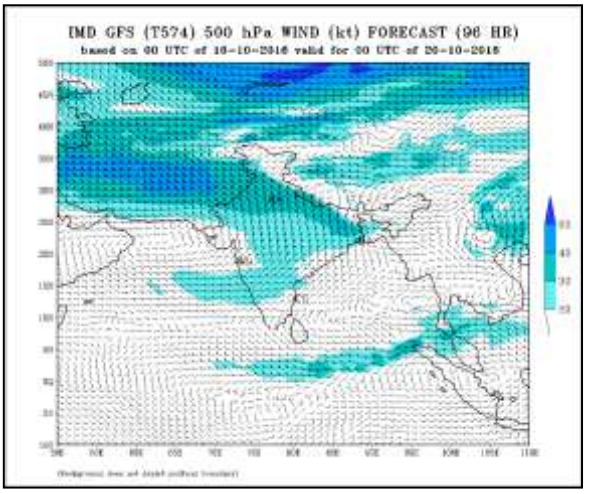

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 21-10-2018

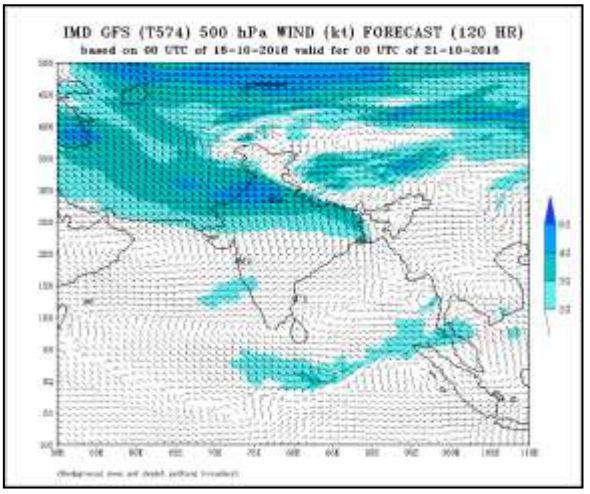

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
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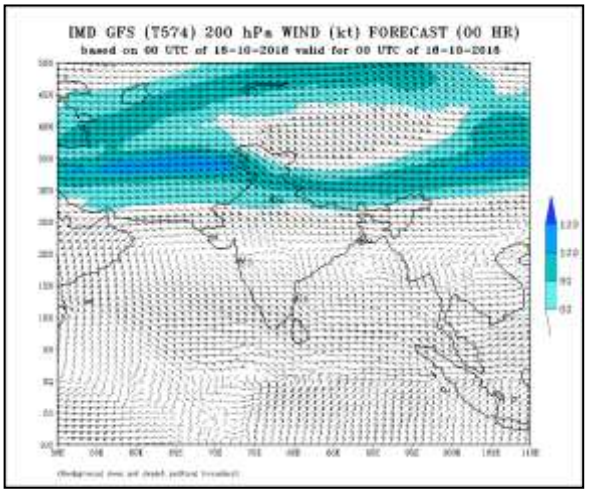

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 17-10-2018

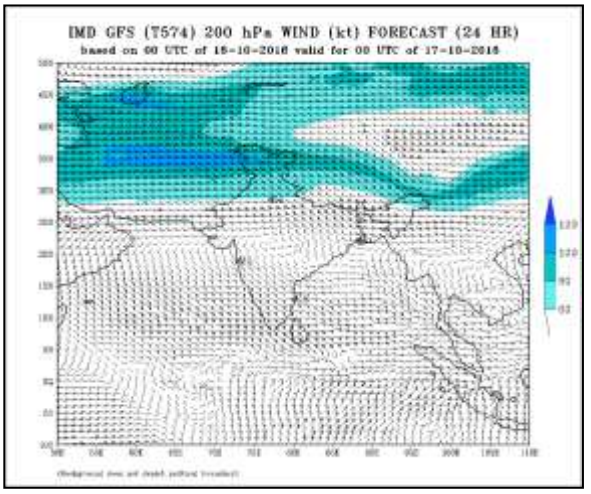

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 18-10-2018

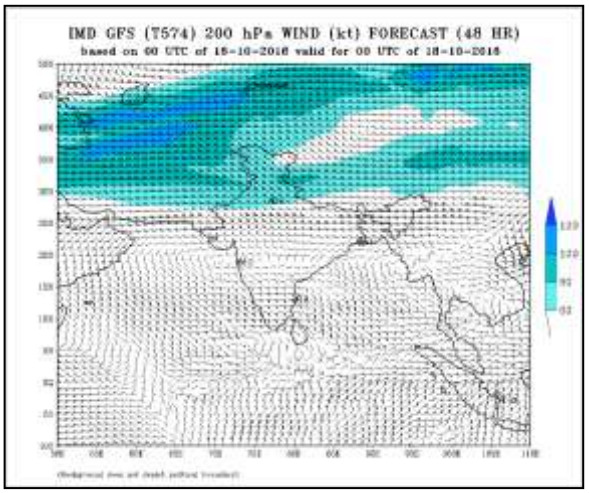

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
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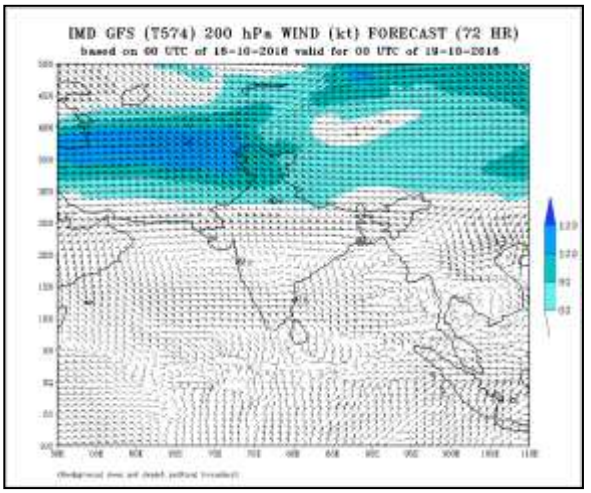

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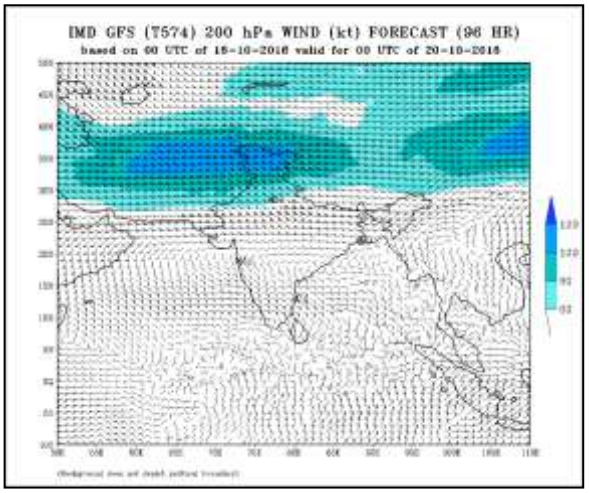

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
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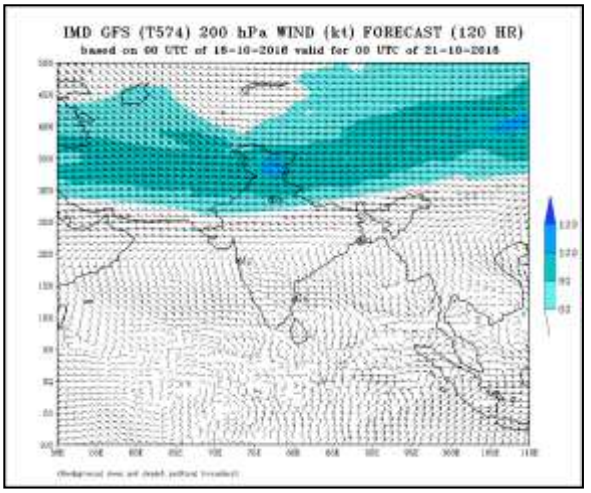

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 16-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 17-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 18-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 19-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 20-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 15-10-2018 valid for 00 UTC of 21-10-2018

FDP (Cyclone) NOC Report Dated 17 October, 2016

Synoptic features:

The upper air cyclonic circulation over southwest Bay of Bengal off Tamilnadu coast persists and now seen between 1.5 & 3.1 km above mean sea level. An upper air cyclonic circulation lies over Arakan Coast & neighbourhood and extends upto 3.1 km above mean sea level.

Dynamical and thermodynamical features:

Surface Temperature (SST):

SST is around 29-30°C over entire Bay of Bengal and Andaman Sea. It is around 31°C over western parts of BOB off Tamilnadu, north Andhra Pradesh, Odisha and West Bengal coasts.

SST is around 28°C over most parts of eastern Arabian Sea (AS) and 32°C off north Maharashtra and adjoining Gujarat coast. It is 26-27°C over western parts of AS except over Pesian Gulf and Gulf of Aden where SST is around 31°C.

Tropical Cyclone Heat Potential (TCHP):

TCHP is below 80-90 kJ/cm^2 over entire BoB except over north BOB, parts of westcentral BOB off north AP and Odisha coast and southwest BOB off Sri Lanka coast where it is less than 50 kJ/cm^2. TCHP is 100 kJ/cm^2 over southeast Andaman Sea between some eqautorial parts and 4^0 N.

TCHP is below 50kJ/cm^2 over northwest extending up to some southwest parts of AS and eastern parts of AS off west coast of India. It is 70-80 kJ/cm^2over eastcentral and adjoining southern parts of AS.

Relative Vorticity:

Relative vorticity at 850 hPa is positive and is 2.0X10^{-5}s-1 over central BoB & adjoining Andaman Sea and equatorial region. It is negative over western parts and northeastern parts of BoB. It is around 4.0X10^{-5}s-1 over some parts of north Andaman Sea.

It is positive and around 2.5X10^{-5}s-1 over parts of west central and southwest AS. It is mostly negative over rest AS except for a small pocket in the eastern part of east central AS.

Convergence:

Lower level convergence is about 5 x $10^{-5}s^{-1}$ over north Andaman Sea and 5 to 10 x $10^{-5}s^{-1}$ over some parts of southwest BoB, south Andaman Sea & adjoining equatorial region. It is 5 x $10^{-5}s^{-1}$ over a small region in west central Bay.

Lower level convergence is around -5 x $10^{-5}s^{-1}$ over eastern parts of southeast AS & between 5 to 10 x $10^{-5}s^{-1}$ over equatorial region adjoining southeast AS.

Divergence:

Upper level divergence is 5x10^{-5} s-1 over south of BoB and adjoining equatorial region and also over north Andaman Sea.

Zone of positive upper level divergence is seen only over equatorial region of AS.

Wind Shear:

Wind shear is 5-10 knots over central & north BoB and is increasing towards south BoB.

Wind shear is 0-5 knots over central parts of AS and is increasing towards northern parts and southern parts of AS.

Wind Shear Tendency:

There is increasing tendency (5 knots) over BoB to the north of 10 ^{0}N. However, a small pocket of decreasing tendency (-5 to -10 knots) is seen over north Andaman sea.

There is increasing tendency over most parts of AS except for western parts of west central AS and adjoining equatorial regions.

Satellite observations based on INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low or medium clouds with embedded moderate to intense convection is seen over east central & south Bay, Arakan coast, Andaman sea, Gulf of Martaban, and Tenasserim coast.

Arabian Sea:

According to satellite imagery, scattered low or medium clouds with embedded moderate to intense convection is seen over south east Arabian Sea.

Large scale features:

M.J.O. Index:

MJO index is in Phase 6 with amplitude less than 1 and would move to phase 7 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean:

Typhoon (Sarika) over west Pacific Ocean adjoining Philippines centred near 17.5^0N/113.0^0E at 0600 UTC is expected to move west-northwestwards and cross Hainan Island by 18th and weaken into a severe tropical storm before making landfall over north Vietnam coast on 19th Oct. Another typhoon (Haima) located near lat. $13.3.0^0$N and long. 135.5^0E likely to intensify and move northwestwards across Philippines and make landfall to the north of Hong Kong coast by 21 Oct 2016 with a reduced intensity.

NWP Input for FDP Cyclone based on 0000 UTC:

IMD-GFS

The analysis of IMD-GFST574 model charts based on 0000 UTC of 17th October, 2016 show the likely formation of a low pressure area north Andaman Sea and adjoining east central BoB on 18th. The system is seen to be meandering over the same region without any significant intensification till 21st and becomes less marked thereafter.

IMD-WRF

The WRF model analysis and forecasts based on 00 UTC of 17th October 2016 show a quasi-stationary cyclonic circulation over east-central Bay of Bengal during next 72 hours.

NCMRWF-NCUM: It suggests circulation over Andaman sea and adjoining eastcentral Bay during 17-18th. It lies as low on 19th over same area and moves to northwest Bay off Odisha coast till 22nd and then move back to east central Bay and becomes a depression on 24th. The system is likely persist till 27th October.

NCMRWF-UM-Regional Model : It suggests circulation over Andaman sea and adjoining east central Bay during 18-19th. It lies as a low over west central Bay on 20th.

ECMWF : ECMWF suggests formation of a low pressure area on 18th with likelihood of intensification on 22nd over central Bay. It further weakens to a low on 23rd and becomes less marked west central Bay on 24th. Formation of another low is also suggested on 25 over northwest Bay without any appreciable movement or intensification.

NCEP-GFS : Model suggests low pressure area over EC Bay and adjoining north Andaman sea on 19th and persist over the same region till 21st and becomes less marked on 22nd.

JMA: JMA Model indicates low pressure area formation over central Bay on 19th.

ARP-Meteo France Model indicates low pressure area during 17-18th over EC Bay and adjoining Andaman Sea, which concentrates into a depression over eastcentral Bay on 20th.

IITM-GEFS: Model suggests low pressure area over east central and north Andaman Sea during 18-21st , which becomes less marked on 22nd.

NCMRWF-NEPS Model: It suggests low over southwest Bay on 19th which becomes more marked over southwest Bay and adjoining Central Bay. This weakens and becomes less marked over north Bay on 25th. Likelihood of another low is also there from 21st over north Andaman Sea. Even though, both the system show signs of slight intensification, the movement of them is erratic.

Dynamical statistical models:

IMD Genesis Potential Parameter (GPP):

The Genesis Potential Parameter (GPP) analysis on 0000 UTC of 17 October 2016 shows a very weak GPP over entire Arabian Sea. A region of significant values of GPP over Indian Ocean around 6^0N and long 78^0E is likely to develop in the next 24 hour which shows an eastward movement in 48 hour forecast and become weak thereafter. A significant GPP zone is seen over Gulf of Martaban in the analysis field, which is likely to move northward and become weaker in 48 hours. However, this region further shows development along with its eastward movement till 120 hours. But it is becoming weaker thereafter.

Summary and Conclusion:

Most of the models suggest the formation of low pressure area over the central/ eastcentral Bay on 18/19th. It is expected to meander over the region till 21st. Majority of the models suggest no appreciable intensification of the system, except Unified Model suggesting Depression on 24th, ECMWF on 22nd and ARP-MeteoFrance on 20th. No model suggests intensification upto cyclonic storm intensity. Also all models suggest weakening of the system over the Sea without landfall.

Probability of cyclogenesis over Bay of Bengal and Andaman Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis over Arabian Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Nil	Nil	Nil	Nil

Advisory:

- The possibility of formation of low on 19th October over central/ eastcentral and its possible intensification into a depression on 22nd as predicted by a few models need to be watched and monitored.
- No IOP for next five days.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	16/12	**17/00**	**17/03**
India	79	42	67
Coastal stations			
WB	9	0	8
Odisha	6	5	6
AP	10	2	3
Tamil Nadu	10	8	10
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	14	16	11
Myanmar	11	0	12
Thailand	3	1	2
SriLanka	9	8	8

- **RS/RW** (12Z) of 16 / 10 /2016: 18/38
- **No. of Ascents reaching 250 hPa levels: 17, MISDA: 20**

- **RS/RW** (00Z) of 17 / 10 /2016: 34/38
- **No. of Ascents reaching 250 hPa levels: 34, MISDA: 4**

No. of PILOT Ascents

16/12Z	**17/00Z**
16 /37	11/34

Buoy Data

16/12Z	**17/00Z**	**17/03Z**
9	12	13

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**16.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**16**	**20**	**20**

No. of RS/RW Ascents

00Z /16.10.2016 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /16.10.2016 : 3

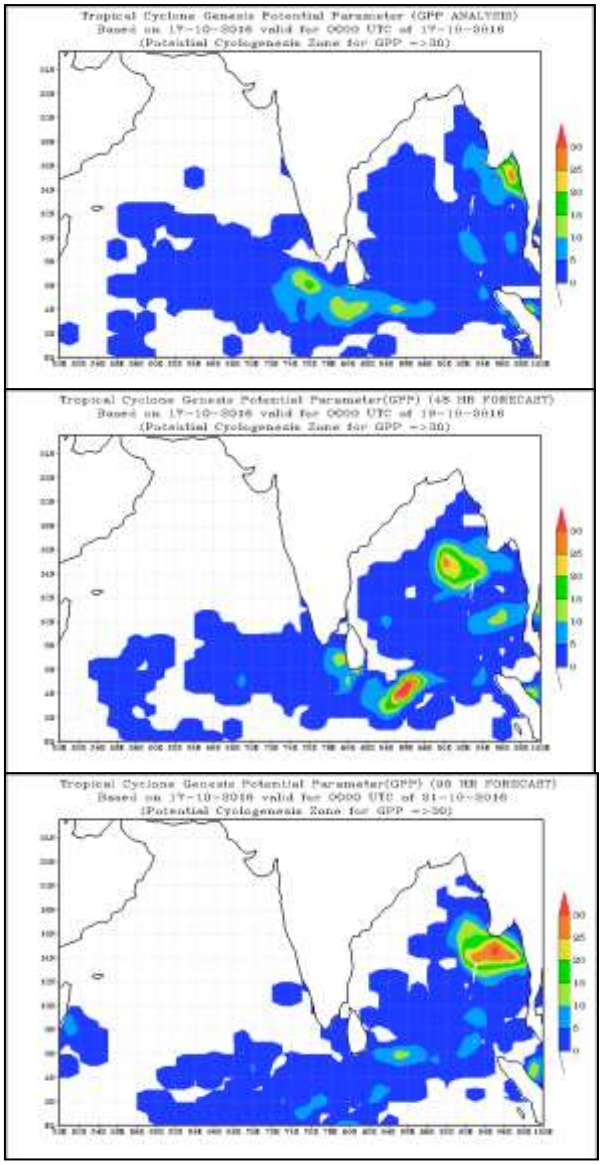
No. of Ascents reaching 250 hPa level = 3

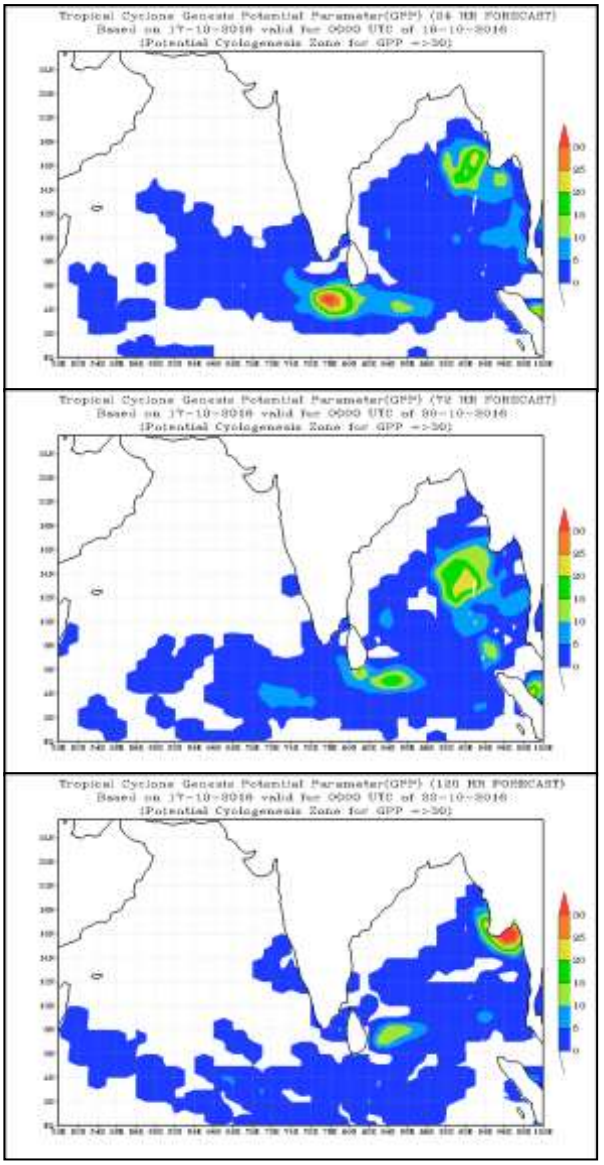
MISDA : 5

No. of PILOT Ascents:

16.10.2016	
06Z	18Z
3	5

Annexure-II


Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 17-10-2016 valid for 0000 UTC of 17-10-2016
(Potential Cyclogenesis Zone for GPP =>30)


Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 17-10-2016 valid for 0000 UTC of 18-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

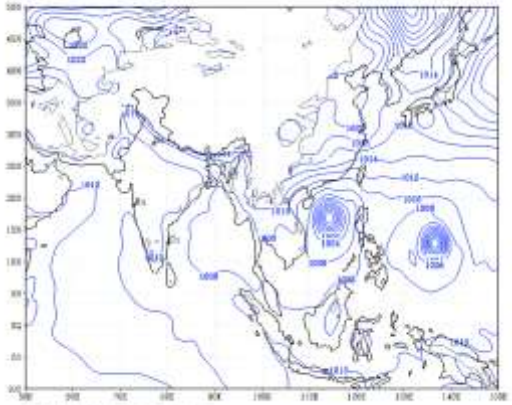
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 17-10-2016 valid for 0000 UTC of 19-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 17-10-2016 valid for 0000 UTC of 20-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

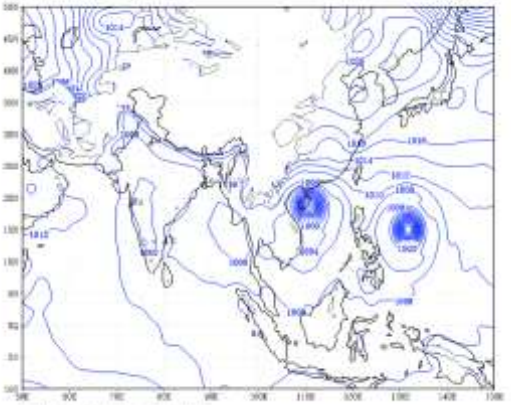
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 17-10-2016 valid for 0000 UTC of 21-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 17-10-2016 valid for 0000 UTC of 22-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

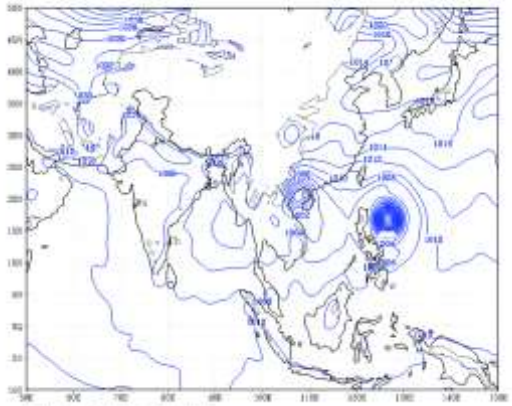
IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 17-10-2016



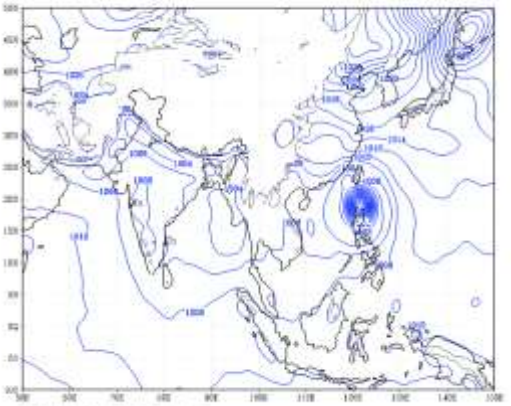
IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
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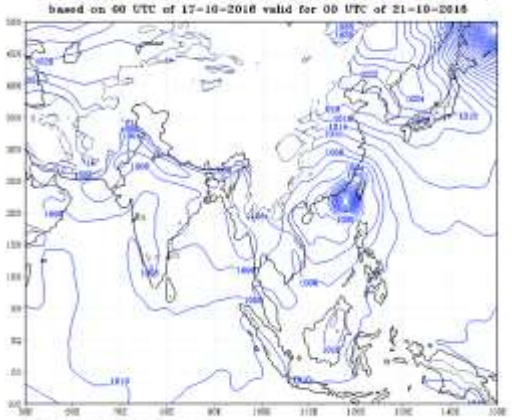
IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 19-10-2016



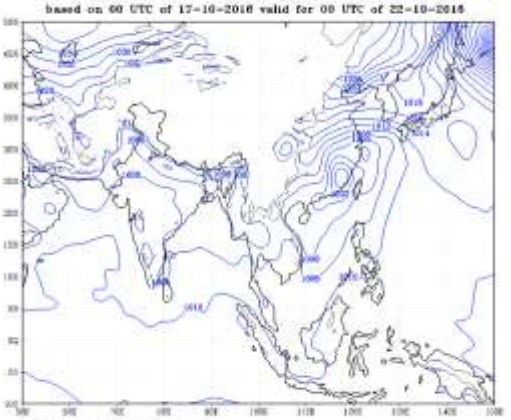
IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 20-10-2016

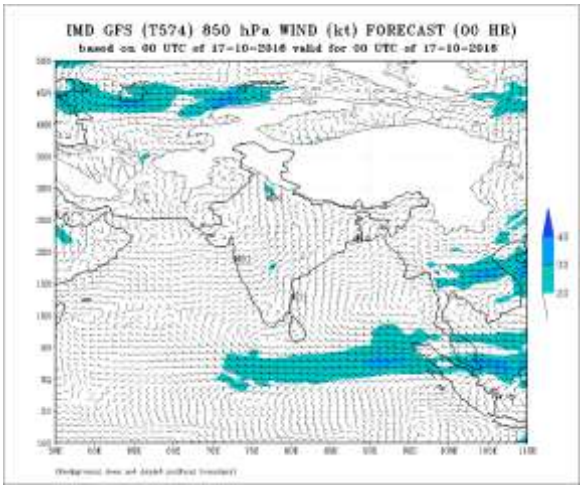


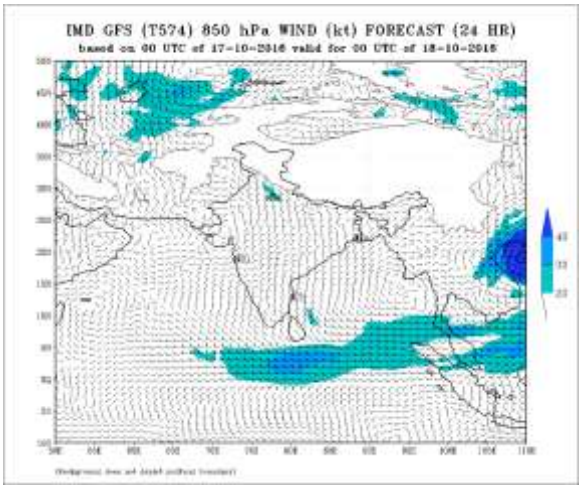
IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
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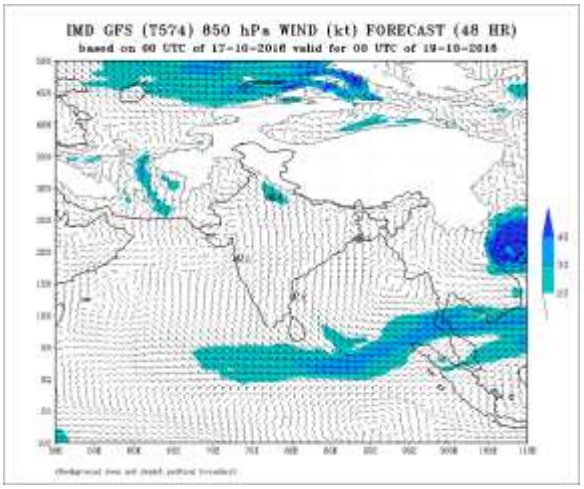


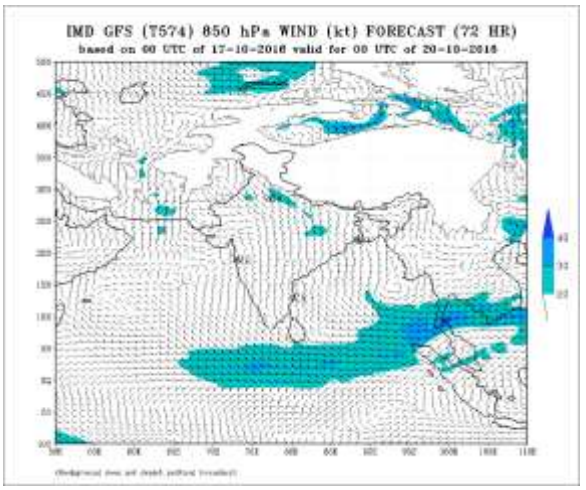
IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 22-10-2016

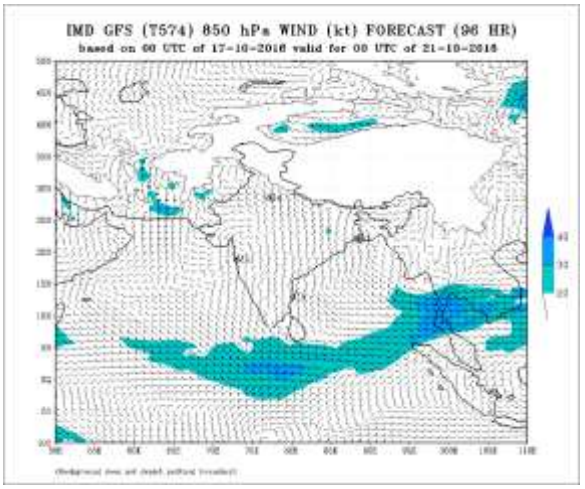


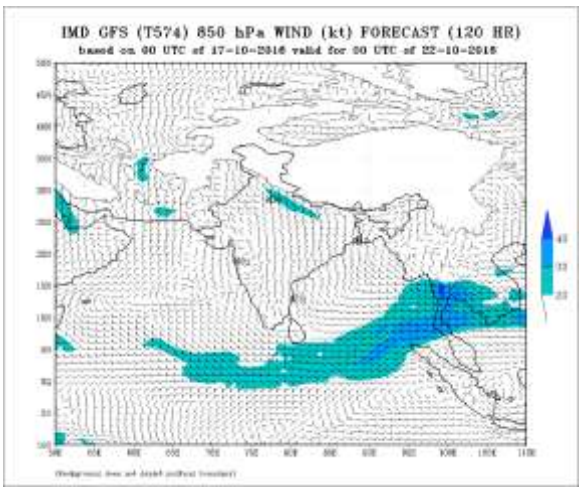

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 17-10-2016

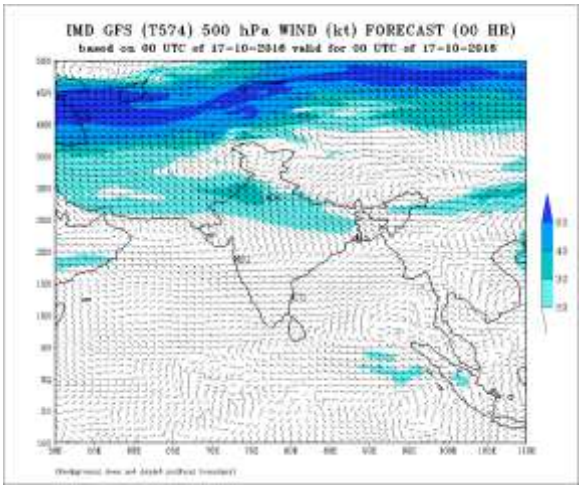

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 18-10-2016

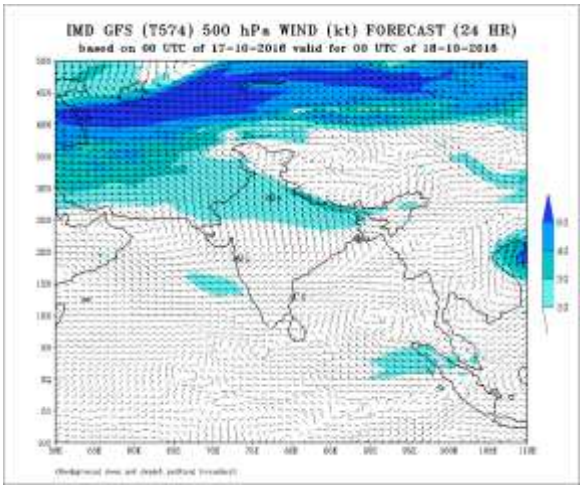

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
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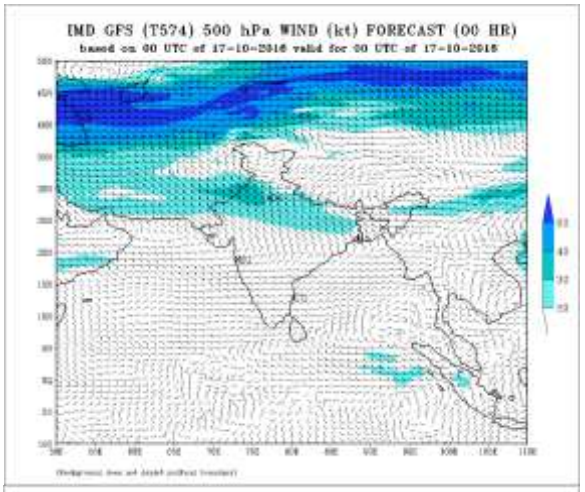

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
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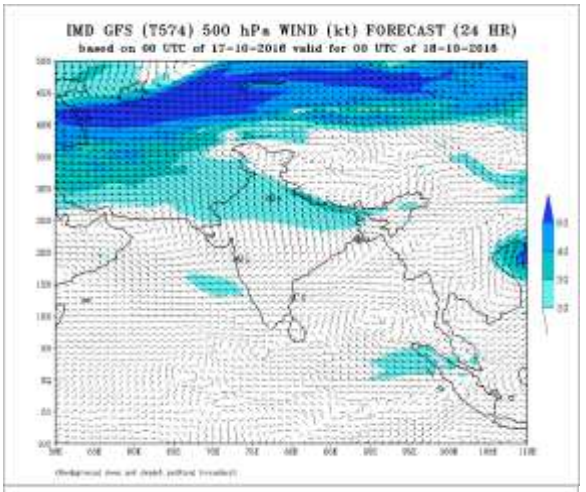

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
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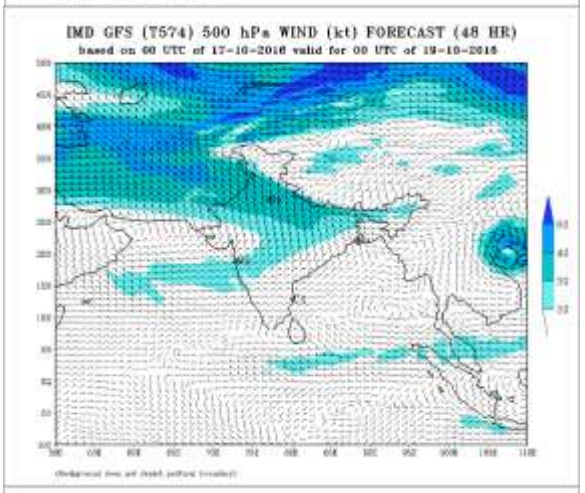

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 22-10-2016

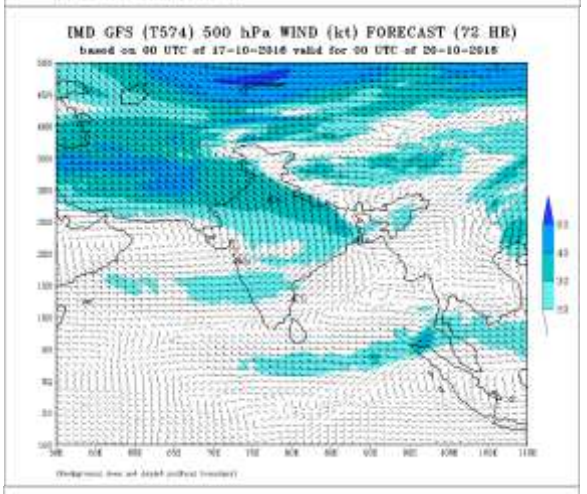

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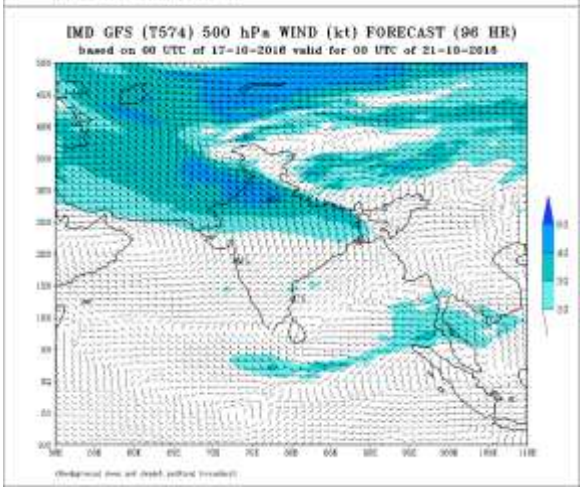

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
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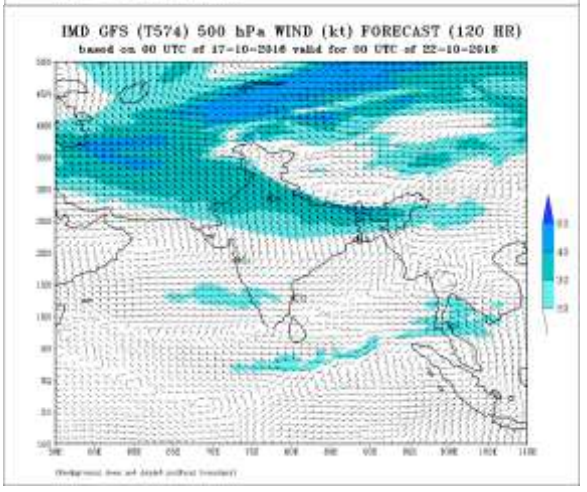

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based on 00 UTC of 17-10-2016 valid for 00 UTC of 17-10-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 18-10-2016

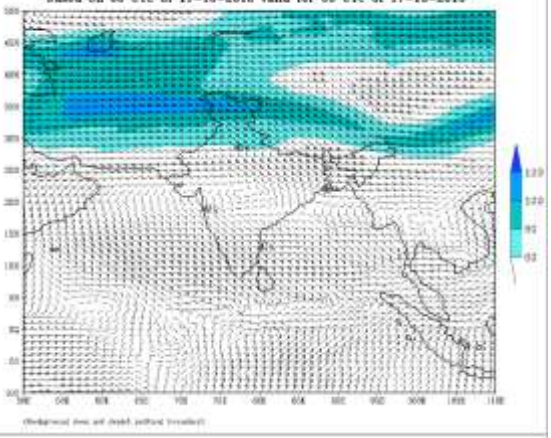

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 19-10-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 20-10-2016

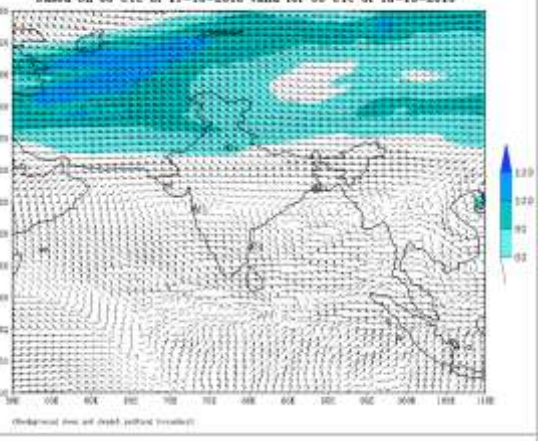

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 21-10-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 22-10-2016

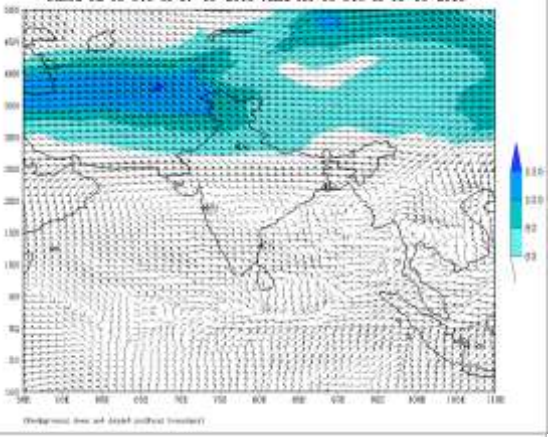
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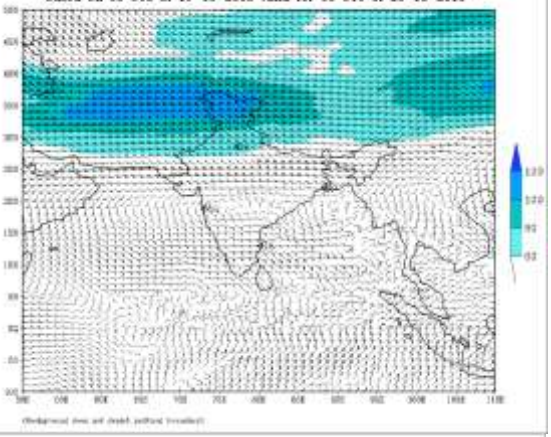
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 18-10-2016



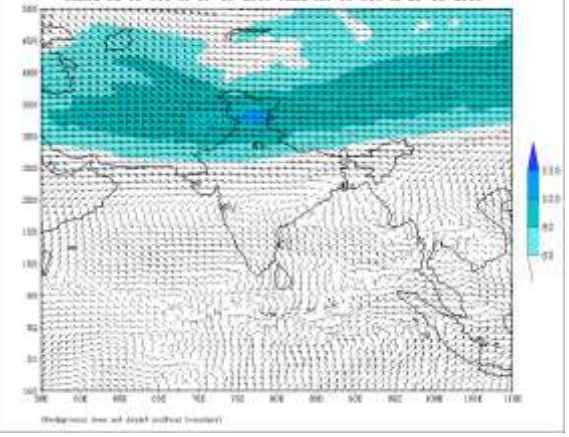
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
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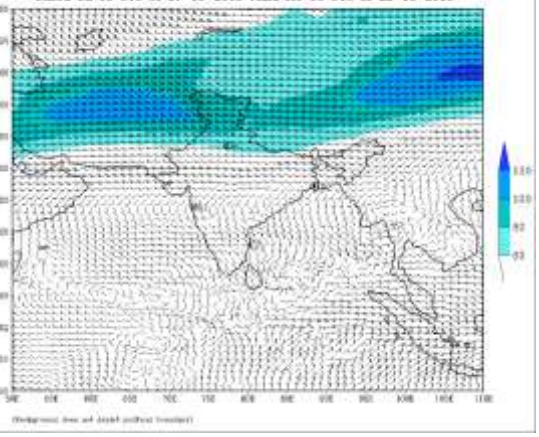
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 20-10-2016



IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 21-10-2016



IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 17-10-2016 valid for 00 UTC of 22-10-2016



FDP (Cyclone) NOC Report Dated 18 October, 2016

Synoptic features:

The upper air cyclonic circulation over Arakan Coast & neighbourhood, now lies over eastcentral Bay of Bengal & neighbourhood and extends upto 3.1 km above mean sea level. Under its influence, a low pressure area is likely to develop over same region during next 24 hours. A trough extends from the above system to southwest Bay of Bengal in the lower levels. The upper air cyclonic circulation over southwest Bay of Bengal off Tamilnadu coast has merged with the above trough. An upper air cyclonic circulation lies over Gangetic West Bengal & neighbourhood between 2.1 & 3.6 km above mean sea level. The upper air cyclonic circulation over Tripura & neighbourhood has become less marked.

Dynamical and thermodynamical features

Surface Temperature (SST):

SST is around 29-30°C over entire Bay of Bengal and Andaman Sea. It is around 31°C over western parts of BoB off Andhra Pradesh, Central Bay and over northern parts of north Andaman Sea.

SST is around 26-28°C to the west of 55°E over Arabian Sea (AS). It is 32°C off Gujarat coast. It is 28-30°C over remaining parts of AS.

Tropical Cyclone Heat Potential (TCHP):

TCHP is 110-120 kJ/cm^2 in a small region over central BoB. Over north BOB it is less than 50 kJ/cm^2. Remaining BoB. It varies between 80-110 kJ/cm^2.

TCHP is below 50kJ/cm^2 over north AS, west central western parts of southwest AS and also off the entire west coast of India. It is 60-90 kJ/cm^{2}over remaining parts of AS.

Relative Vorticity:

Relative vorticity at 850 hPa is positive and is 2.0X10^{-5}s-1 over most parts of central and south BoB & adjoining equatorial region. It is negative over western parts of north Bay. It is around 4.0X10^{-5}s-1 over some parts of east Central Bay.

It is positive and around 2.5X10^{-5}s-1 over western parts of west central and southwest AS. It is mostly negative over rest AS except for an area in the eastern part of east central AS and adjoining equatorial region.

Convergence:

Lower level convergence is about 5 to 10 x 10^{-5}s^{-1} over some parts of southwest BoB, south Andaman Sea & adjoining equatorial region. It is 5 x 10^{-5}s^{-1} over a small region in WC Bay.

Lower level convergence is around 5 x 10^{-5}s^{-1} in some isolated pockets over equatorial region adjoining southeast AS. Remaining AS is mostly neutral.

Divergence:

Upper level divergence is 5-10 x10^{-5} s-1 over North Andaman sea and adjoining south east BoB. It is positive over southern parts of south west BoB adjoining equatorial region and the value reaches upto 20 x10^{-5} s-1.

Zone of positive upper level divergence is seen over a small area in equatorial region of AS.

Wind Shear:

Wind shear is 5-15 knots over central & north BoB and is increasing towards south BoB.

Wind shear is 5-15 knots over central parts of AS and is increasing towards northern parts and southern parts of AS.

Wind Shear Tendency:

There is decreasing tendency (-5 to -10 knots) over north Andaman sea and adjoining east central and also over south west Bay. However, a small pocket of decreasing tendency (-5 to -10 knots) is seen over.

There is increasing tendency over south AS except for a small region of decreasing tendency (-5 knots) over east central AS.

Satellite observations based on INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low or medium clouds with embedded moderate to intense convection is seen over east central and adjoining north Andaman sea in association with Low Level Circulation over the area (.)

Arabian Sea:- No significant clouds are seen over the region.

Large scale features

Upper tropospheric Ridge: The upper tropospheric ridge at 200 hPa runs along 18 ^{0}N and along 22 ^{0}N over Arabian Sea.

M.J.O. Index: MJO index is in Phase 6 with amplitude less than 1 and would move to phase 7 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean:

Typhoon (Sarika) over west Pacific Ocean adjoining Philippines centred near 19.2^0N/109.9^0E at 0600 UTC is expected to move northwestwards and cross Hainan Island by 18th and weaken into a severe tropical storm before making landfall over north Vietnam coast on 19th Oct. Another typhoon (Haima) located near lat. 15.4^0N and long. 130.6^0E likely to intensify and move west- northwestwards across Philippines and make landfall to the north of Hong Kong coast by 21 Oct 2016 with a reduced intensity.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS: The analysis/forecast charts based on 0000 UTC of 18th October, 2016 show a cyclonic circulation in the lower troposphere extending up to 700 hPa above mean sea level over east-central Bay of Bengal off Myanmar coast, which is likely to remain quasi-stationary over the same area till 48 hours and move towards Arakan coast as a feeble cyclonic circulation in 96 hours. The cyclonic circulation is like to dissipate in 120 hours. No other significant development of cyclonic feature over Indian Seas till 168 hours.

NCEP-GFS: The analysis/forecast charts of the model based on 0000 UTC of 18th October, 2016 show similar features like IMD-GFS model except the persistence of the cyclonic circulation over Arakan coast till 144 hours.

ECMWF: It shows an extended low over EC Bay on 19th, low over same area till 22nd. It becomes well marked on 23rd over EC Bay and adjoining north Andaman Sea and becomes depression near Myanmar coast (Irrawaddy Delta) on 24th and Deep Depression over same area on 25th and lies over central and adjoining north Bay as a Depression on 26th.

IMD WRF: The WRF model analysis and forecasts based on 00 UTC of 18th October 2016 show a quasi-stationary cyclonic circulation extending up to 500 hPa over east-central Bay of Bengal during next 48 hours with a significant intensification to become a depression at the surface in 72 hours and northeastward movement towards Myanmar coast.

NCMRWF-NCUM: It shows a clear development of a low during 18-20th over eastcentral and adjoining westcentral Bay. It becomes depression on 21st over WC Bay, deep depression on 22nd over EC Bay and cyclonic storm over north Andaman Sea on 23rd. On 24th it further intensifies into Severe cyclonic storm (SCS) close to Myanmar coast near Yerawadi delta and it lies over northern part of EC Bay on 25th and over north Bay on 26th, over WC Bay on 27th and near north Andhra Pradesh coast on 28th as SCS.

NCMRWF-UM-Regional Model : It suggests low over east central bay and adjoining Andaman sea on 18, over WC Bay on 19th, well marked on 20th over central and adjoining south Bay, depression over south Bay on 21st .

JMA: JMA Model indicates low pressure area over east central Bay on 18th onwards which shifts gradually to south east bay without any intensification.

ARP-Meteo France Model indicates low pressure area during 18-19th over EC Bay and adjoining north Andaman Sea, which shows some intensification on 20th moving over to north Andaman sea.

IITM-GEFS: Model suggests an extended low on 18 and then a low pressure area over east central and north Andaman Sea during 20-23rd, which becomes less marked on 24th .

NCMRWF-NEPS Model: It suggests low over central Bay on 19th and over southwest Bay on 20th and becomes more marked over the same area on 21st. IT becomes depression over WC Bay on 22nd, cyclonic storm over central and adjoining north Bay on 23rd. It crosses Bangladesh and adjoining West Bengal coast as Cyclonic storm on 24th and becomes less marked on 25th.

Another low is seen over north Andaman Sea on 27th and rapidly intensifies into cyclonic storm on 28th over central Bay.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

GPP: The Genesis Potential Parameter (GPP) analysis and forecasts based on 0000 UTC of 18th October 2016 shows a very weak GPP zone over east-central Bay of Bengal off Myanmar coast which is likely to move southward over east-central Bay of Bengal in 72 hours. The zone move eastward towards Arakan coast till 120 hours with intensification and dissipate thereafter in 144 hours over Arakan coast.

Summary and Conclusion:

Most of the models suggest the formation of low pressure area over the eastcentral Bay on 18th/19th. Majority of the models continue to suggest no appreciable intensification of the system, except Unified Model (global and regional and EPS) suggesting Depression on 21st, ECMWF on 24th near Irrawaddy delta. Unified model and its EPS suggest intensification upto cyclonic storm intensity on 23rd and 24th over north Andaman Sea and central and adjoining north Bay respectively. Hence, there is large divergence in the model guidance with respect to further intensification of the low and its movement.

Probability of cyclogenesis over Bay of Bengal and Andaman Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Nil	Nil	Nil	Low

Probability of cyclogenesis over Arabian Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Nil	Nil	Nil	Nil

Advisory:

- The possibility of formation of low on 19th October over east central and its possible intensification into a depression on 21/22nd near Myanmar coast (Near Irrawaddy delta) as predicted by a few models and GPP need to be watched and monitored.
- No IOP for next five days.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	17/12	**18/00**	**18/03**
India	70	69	83
Coastal stations			
WB	8	3	7
Odisha	6	5	6
AP	9	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	8	14	16
Myanmar	12	12	12
Thailand	3	3	3
SriLanka	10	9	8

- **RS/RW** (12Z) of 17 / 10 /2016: 18/39
- **No. of Ascents reaching 250 hPa levels: 17, MISDA: 21**

- **RS/RW** (00Z) of 18 / 10 /2016: 33/38
- **No. of Ascents reaching 250 hPa levels: 33, MISDA: 5**

No. of PILOT Ascents

17/12Z	**18/00Z**
23 /37	20/34

Buoy Data

17/12Z	**18/00Z**	**18/03Z**
13	13	14

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**17.10.2017**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /17.10.2017 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /17.10.2017 : 4

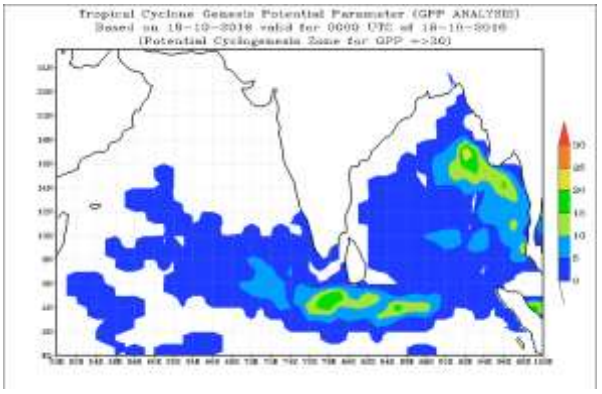
No. of Ascents reaching 250 hPa level = 3

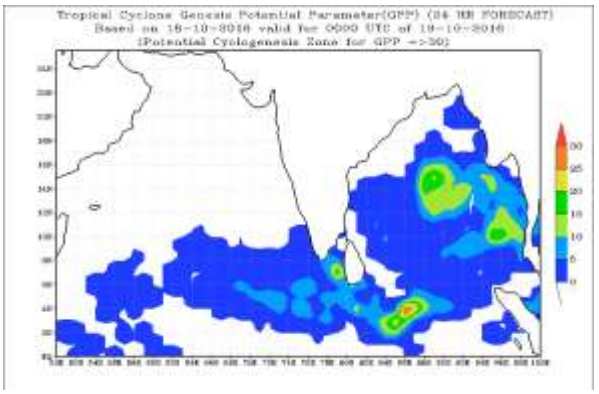
MISDA : 4

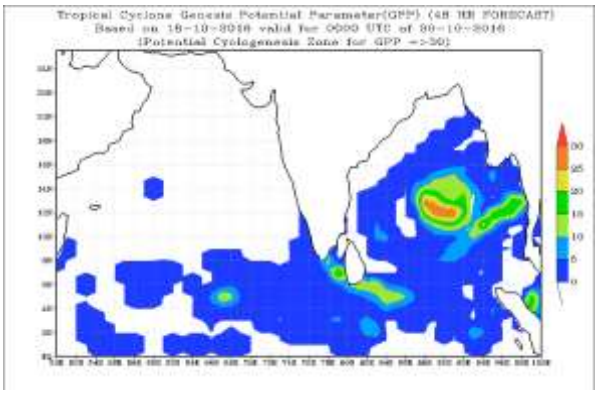
No. of PILOT Ascents:

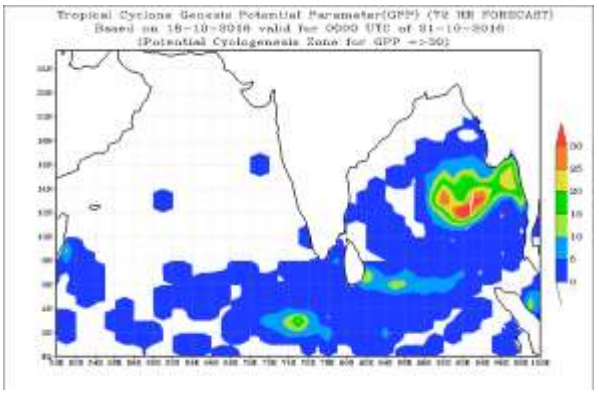
17.10.2017	
06Z	18Z
2	0

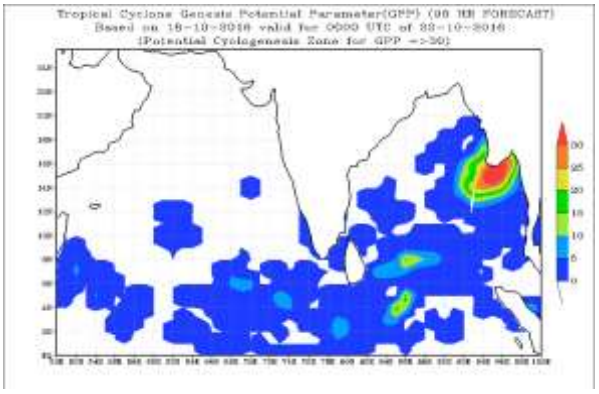
Annexure-II

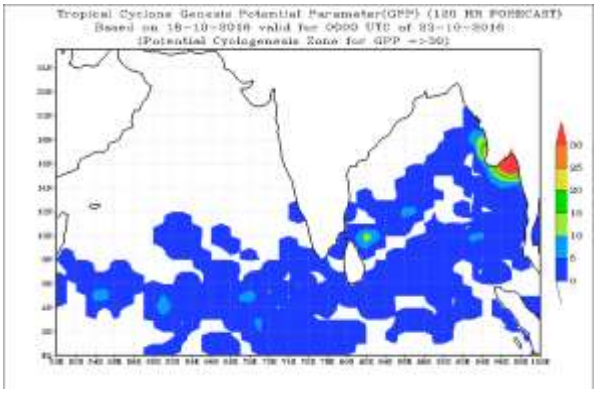

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 18-10-2016 valid for 0000 UTC of 18-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

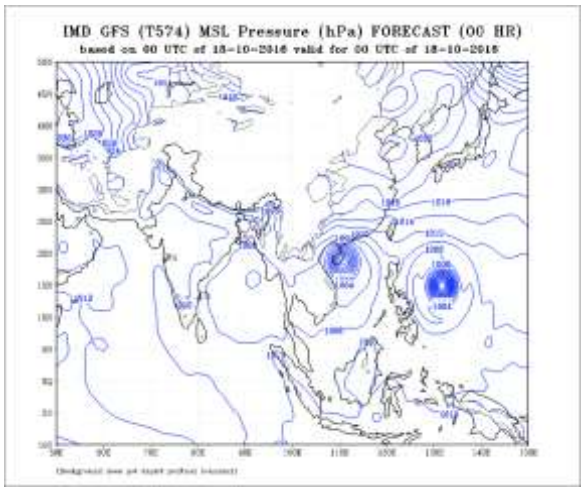

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 18-10-2016 valid for 0000 UTC of 19-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

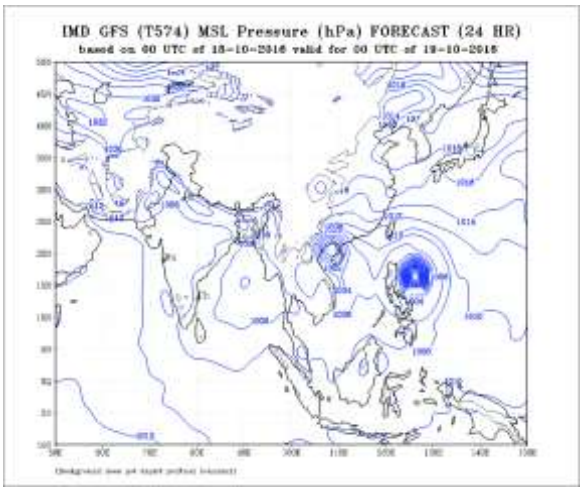

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 18-10-2016 valid for 0000 UTC of 20-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

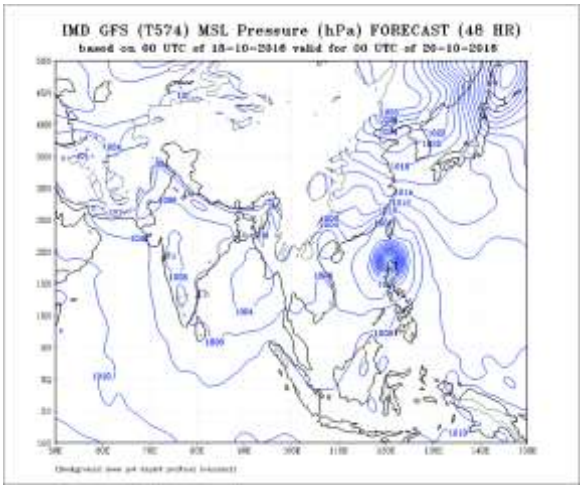

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 18-10-2016 valid for 0000 UTC of 21-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

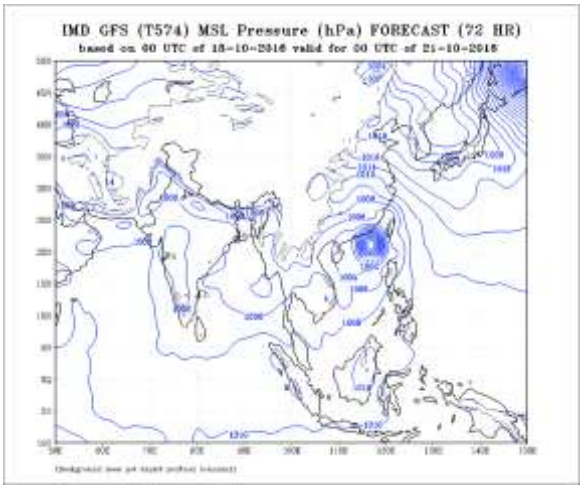

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 18-10-2016 valid for 0000 UTC of 22-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

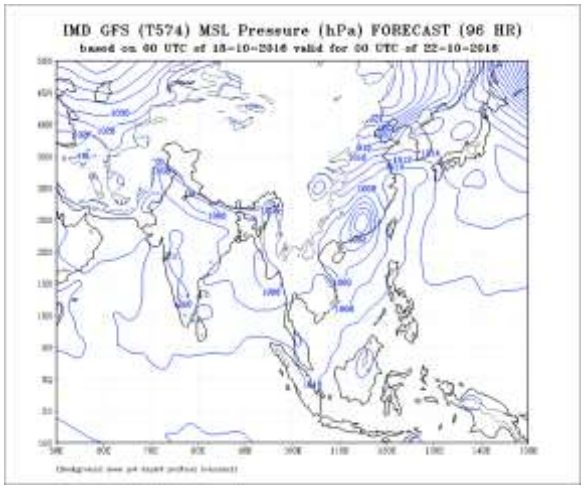

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 18-10-2016 valid for 0000 UTC of 23-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

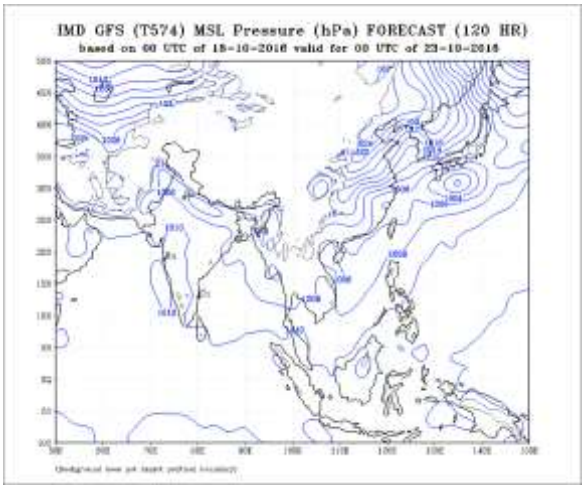

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 18-10-2016

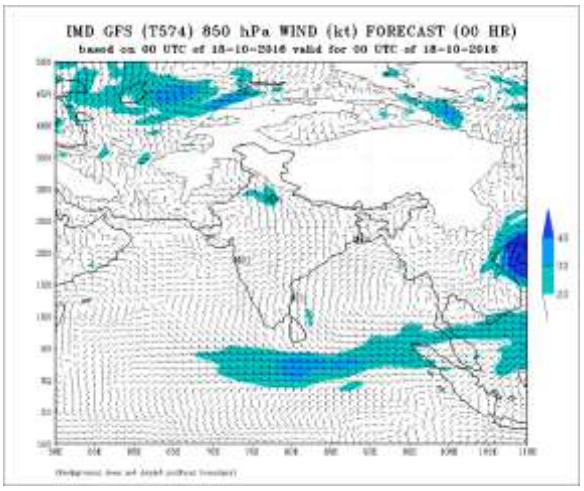

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 19-10-2016

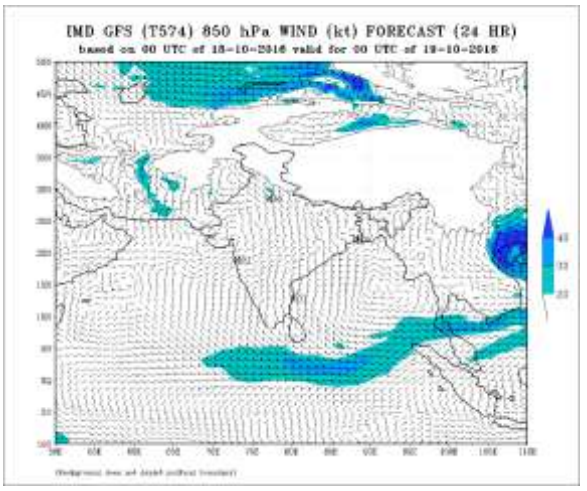

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
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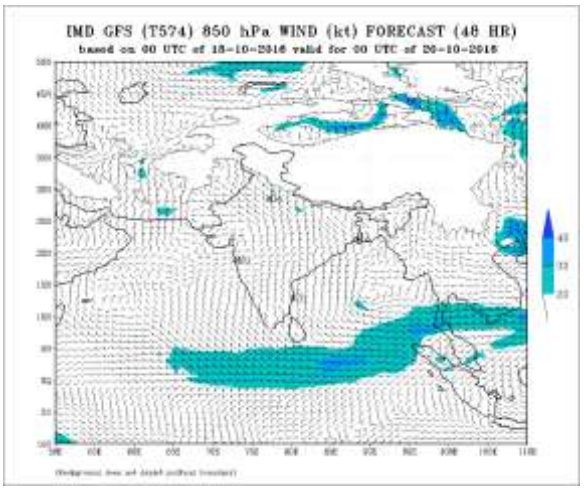

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 21-10-2016

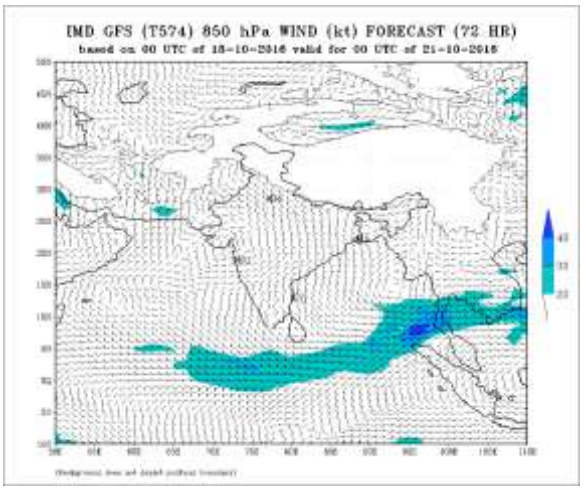

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 22-10-2016

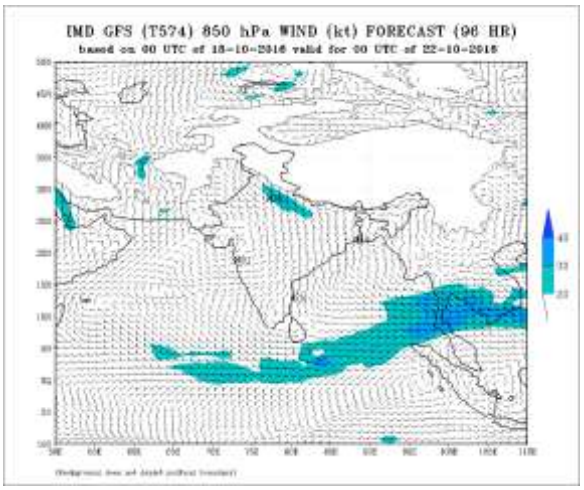

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 23-10-2016

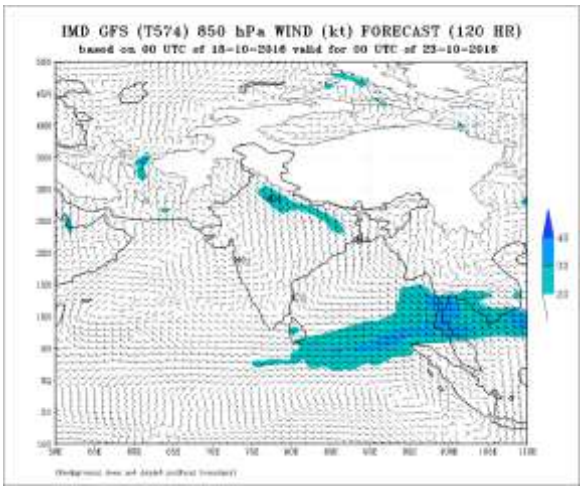

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 18-10-2016

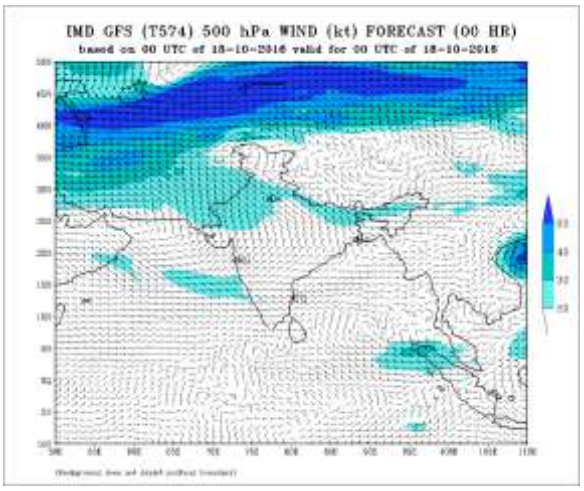

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 19-10-2016

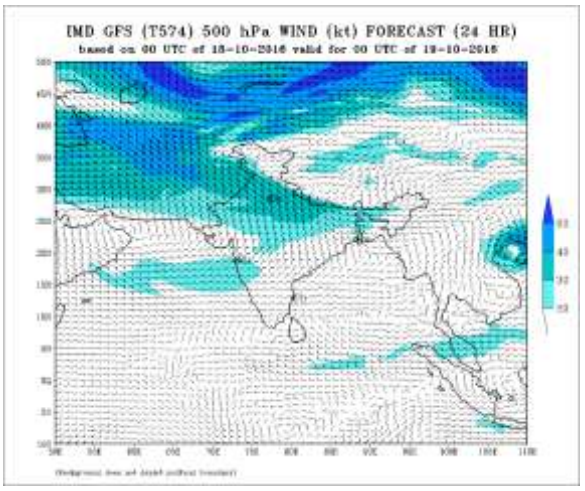

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 20-10-2016

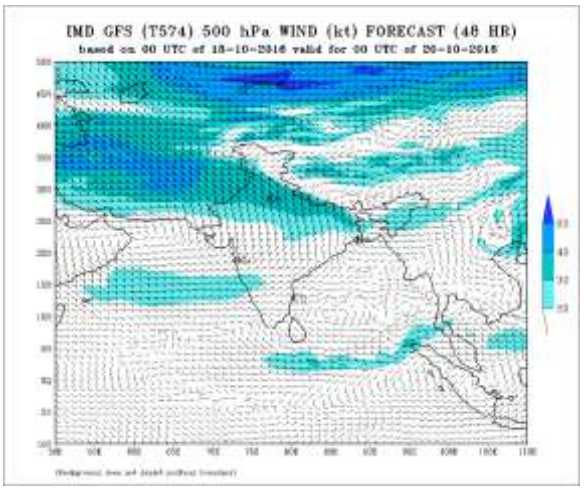

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 21-10-2016

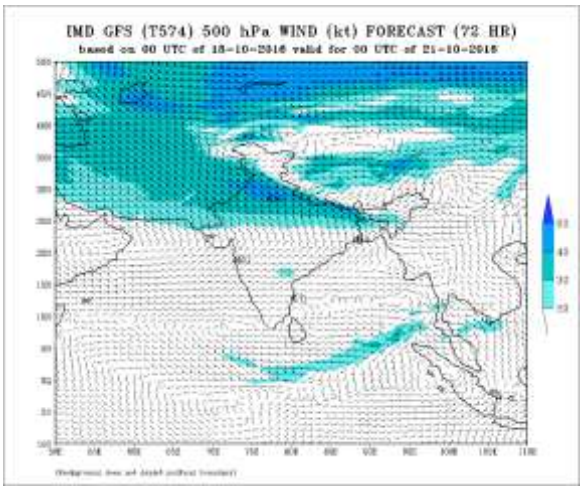

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 22-10-2016

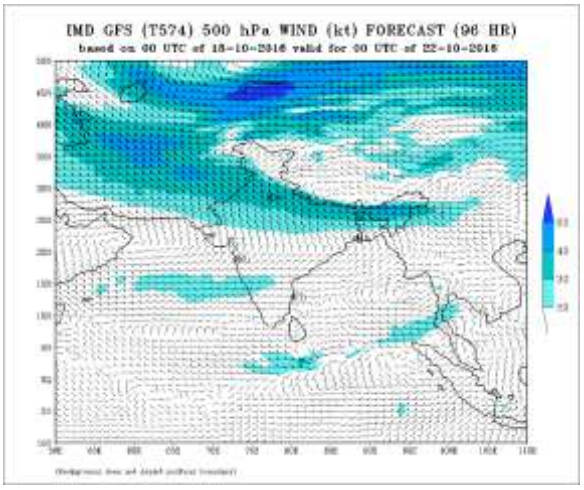

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 23-10-2016

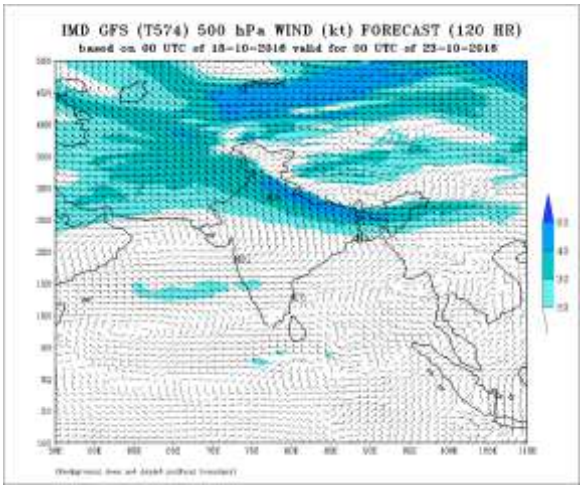

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 18-10-2016

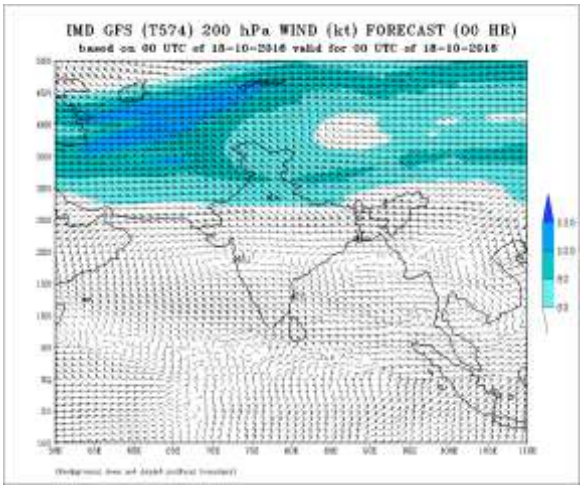

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
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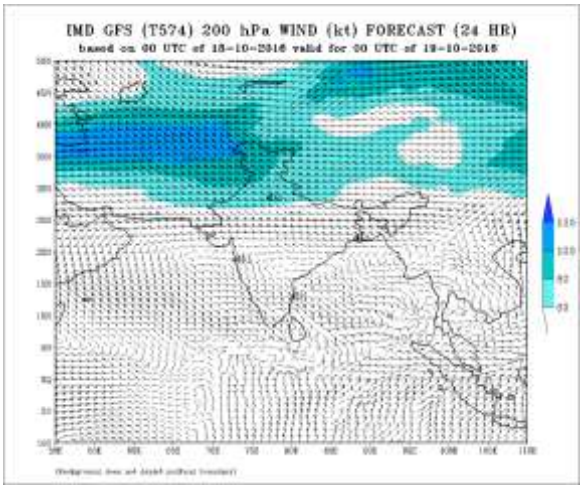

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
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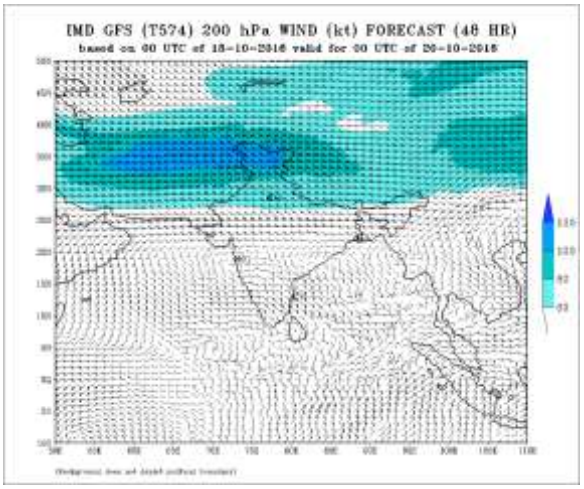

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
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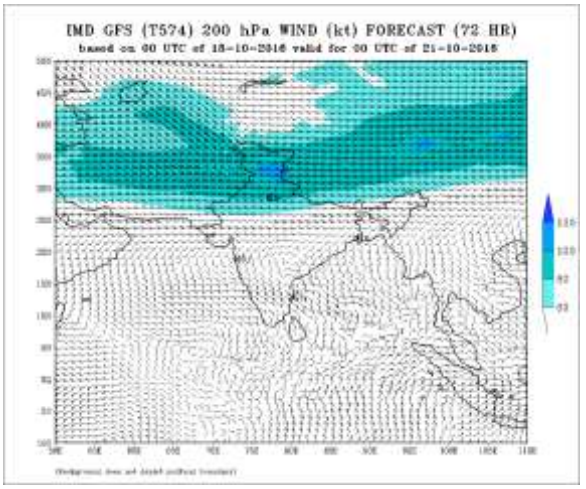

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
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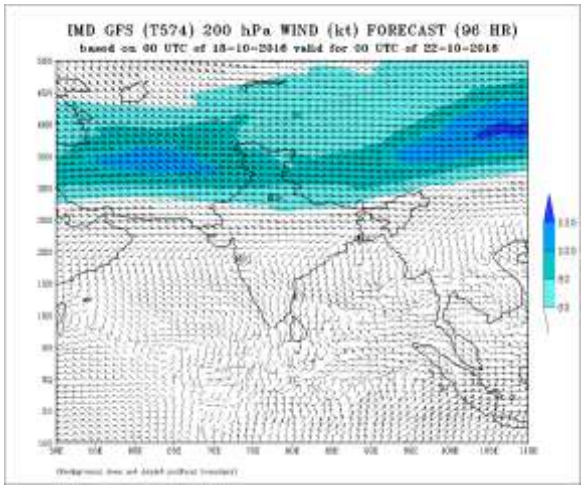

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 18-10-2016 valid for 00 UTC of 23-10-2016

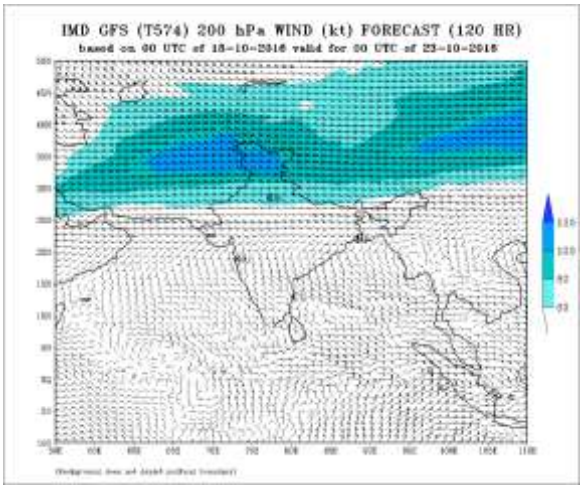

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 18-10-2018 valid for 00 UTC of 18-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 18-10-2018 valid for 00 UTC of 19-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 18-10-2018 valid for 00 UTC of 20-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 18-10-2018 valid for 00 UTC of 21-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 18-10-2018 valid for 00 UTC of 22-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 18-10-2018 valid for 00 UTC of 23-10-2018

FDP (Cyclone) NOC Report Dated 19th October, 2016

Synoptic features:

Under the influence of the upper air cyclonic circulation over east central Bay of Bengal & neighbourhood, a low pressure area has formed over east central Bay of Bengal & neighbourhood at 00 UTC of today. The associated upper air cyclonic circulation extends upto 4.5 km above mean sea level. The system is likely to become a well marked low pressure area over the same region during next 48 hours. The trough extending from the above system to southwest Bay of Bengal in the lower levels persists. An east-west shear zone at 3.1 km above mean sea level runs roughly along latitude 11.0°N. The upper air cyclonic circulation over Gangetic West Bengal & neighbourhood has become less marked.

Dynamical and thermodynamical features:

Surface Temperature (SST):

SST is around 29-30°C over most parts of Bay of Bengal and northeastern Andaman Sea. It is around 31°C over western parts of Bay of Bengal off Andhra Pradesh, Central Bay and over northern parts of north Andaman Sea.

SST is around 26-29°C over most parts of Arabian Sea (AS). SST is around 32°C off Gujarat coast.

Tropical Cyclone Heat Potential (TCHP):

TCHP is 110-120 kJ/cm^2 over west and eastcentral Bay of Bengal. TCHP is 80-110 kJ/cm^2 over remaining parts of Bay of Bengal except north Bay of Bengal is less than 50 kJ/cm^2.

TCHP is below 50kJ/cm^2 over north and adjoining western parts of southwest AS and also off the west coast of India. It is 60-90 kJ/cm^{2}over remaining parts of AS.

Relative Vorticity:

Relative vorticity at 850 hPa is positive and is 0-50X10^{-5}s-1 over eastcentral and southeast Bay of Bengal & adjoining equatorial region. It is negative over north and adjoining western parts of Bay of Bengal.

It is positive and around 20-50X10^{-5}s-1 over northeast and off east of Oman coast and some part of the central Arabian sea. 0-20 X10^{-5}s-1over southeast Arabian sea adjoining Kerala-Karnataka coast. It is negative over rest AS.

Convergence:

Lower level convergence is about 5 to 10 x 10^{-5}s^{-1} over westcentral and adjoining south of 10°N Bay of Bengal and south Andaman Sea.

Lower level convergence is around 5 x 10^{-5}s^{-1} in over northwest Arabian sea.

Divergence:

Upper level divergence is 10-20 x10^{-5} s-1 over westcentral and adjoining southeast Bay of Bengal and the south Andaman Sea.

Upper-level divergence is 5-10 x10^{-5} s-1 over the eastcentral adjoining westcentral Arabian sea.

Wind Shear:

Wind shear is 5 knots over east of the system and 10-15 knots over central & north adjoining the southeast Bay of Bengal.

Wind shear is 10-15 knots over central parts of AS.

Wind Shear Tendency:

There is decreasing tendency (-5 to -10 knots) over north Andaman sea and adjoining east central and also over the southeast Bay of Bengal.

There is decreasing tendency over east central and southeast AS except increasing tendency over northwest part of the Arabian sea.

Satellite observations based on INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low or medium clouds with embedded moderate to intense convection is seen over east central and adjoining north Andaman sea in association with Low-Level Circulation over the area (.)

Arabian Sea:- No significant clouds are seen over the region.

Large scale features:

Upper tropospheric Ridge: The upper tropospheric ridge at 200 hPa runs along 19^0 N over Bay of Bengal and along 20^0 N over the Arabian Sea.

M.J.O. Index: MJO index is in Phase 6 with an amplitude of less than 1 and would move to phase 7 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean:

Typhoon (Sarika) crossed China coast about 200 km northeast of Hanoi anound 4 UTC of 19th Oct. and in weakening phase. Another typhoon (Haima) located near lat. 16.7^0N and long. 120.7^0E likely to move west-northwestwards and make landfall to the east of Hong Kong coast around 0900 UTC of 21 Oct 2016 with a reduced intensity (40 knots). Thereafter, it would recurve northeastwards.

NWP Input for FDP Cyclone based on 0000 UTC:

IMD-GFST574: The analysis/forecast charts based on 00 UTC of 19thOctober, 2016 show a low pressure area over east central Bay of Bengal with associated cyclonic circulation in the lower troposphere extending up to 500 hPa above mean sea level. The low pressure system is likely to remain quasi-stationary over the same area till 21st October 2016 and becomes a well-marked low. The system shows eastward movement towards Arakan coast and intensification into a depression on 22nd October 2016 and becomes a low over Arakan coast 23rd and becomes less marked thereafter.

NCEP-GFS: The analysis/forecast charts of the model based on 00 UTC of 19thOctober, 2016 show a low pressure area over east-central Bay of Bengal off Myanmar coast with associated cyclonic circulation extending up to 500 hPa above mean sea level which persists till 25thOctober over the same area and moves to northwest bay and dissipates thereafter.

ECMWF: The model charts based on 00 UTC of 19th October 2016 shows a low pressure area along with associated cyclonic circulation extending up to 500 hPa above mean sea level over east-central Bay of Bengal. The low is seen on 21st over EC and adjoining central south bay. It moved northeastwards and lay over EC bay on 22nd. It concentrated into a depression over EC

Bay on 23rd near Arakan coast and weakened into a well marked low near Arakkan coast on 24th. Moving north northwestwards, it lies over northeast Bat and adjoining Bangladesh coast on 27th and became less marked on 28th October. Anoth low forms over EC Bay near Arakan coast on 28th and is seen as a well marked low over northwest and adjoining west central Bay on 29th.

IMD WRF: The WRF model analysis and forecasts based on 00 UTC of 19th October 2016 show a quasi-stationary low pressure system with associated cyclonic circulation extending up to 500 hPa over east-central Bay of Bengal. The system is likely to intensify on 21st to become a depression and a cyclonic storm on 22ndOctober 2016 with northeastward movement towards Arakan Coast.

NCMRWF-NCUM: It shows a low over on19th over eastcentral Bay which is seen over westcentral bay on 20th. It becomes depression on 21st over Central Bay, cyclonic storm on 22nd over central Bay and a severe cyclonic storm over northeast Bay during 23rd to 25th. It weakens into cyclonic storm on 26th over NW and adjoining WC Bay and further to depression on 27th over near north Andhra Pradesh-south Orissa. It became a low over interior Andhra on 28th.

NCMRWF-UM-Regional Model : It suggests low over east central bay and adjoining Andaman sea on 19, which becomes well marked/ depression on 20th over southeast Bay, a cyclonic storm over the same area on 21st and a SCS on 22nd over EC Bay.

JMA: JMA Model indicates low pressure area over east central and adjoining SE Bay on 19th which shifts to south east Bay and adjoining EC Bay on 20th and became WML over the same region. It moved northeastwards and remained a well marked low on 22nd over EC Bay.

ARP-Meteo France Model indicates low pressure area on 19th over EC Bay and adjoining SE Bay and is seen as a low on 20th over SE and adjoining EC Bay and as a well marked low pressure area over the same region and It moved northeastwards lay as a WML on 21st over EC Bay.

IITM-GEFS: Model suggests a low on 20th over EC Bay which persists over the same area on 21st . Becomes a well marked low over east central and north Andaman Sea 22nd, which weakens into a low on 23 over the same area. This low moves to Myanmar coast on 24th and becomes less marked on 25th .

NCMRWF-NEPS Model: It suggests low over east central Bay on 19th and which becomes well marked over southwest Bay on 20th and a depression over the same area on 21st. It becomes Deep Depression over SW Bay on 22nd, then moves over to WC and adjoining SW bay on 23rd. It intensifies into a CS on 24th over WC Bay. It continues as CS on 25th and moves to WC Bay, off Andhra coast. It further becomes a depression on

26th over NW Bay off Orissa coast and becomes low off Andhra Pradesh coast on 27th and becomes less marked on 28th.

Another low is seen over north Andaman Sea and adjoining Myanmar and Thailand on 27th and rapidly intensifies into SCS on 28th over east central Bay and adjoining North Andaman Sea and lies over EC Bay on 29th.

Dynamical statistical models:

IMD Genesis Potential Parameter (GPP):

The Genesis Potential Parameter (GPP) analysis and forecasts based on00 UTC of 19thOctober 2016 shows a significant GPP zone over east-central Bay of Bengal. It suggests formation of cyclonic storm on 22nd over EC Bay which will move northeast wardsclose to Arakan coast on 23rd October 2016. It will then moved north-northwestwards and maintain intensity of cyclonic storm till 25th over northeast Bay and weaken on 26th.

Summary and Conclusion:

All models could detect the formation of low pressure area over east central Bay on 19th (0000UTC). ECMWF, IMD-WRF and Unified models (deterministic global and regional, and EPS) indicate intensification into Depression on 23rd, 21st and 21st respectively. Unified model and its EPS as well as IMD WRF suggest further intensification upto cyclonic storm intensity on 22nd. There is consensus about the movement as all the models suggest initial movement of the system towards Arakan coast during next 3 days and thereafter northwestwards/ north-northwestwards towards north Bay. However, they continue to show large divergence with respect to further intensification of the low.

Probability of cyclogenesis over Bay of Bengal and Andaman Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Low	Fair	Fair	Fair

Probability of cyclogenesis over Arabian Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Nil	Nil	Nil	Nil

Advisory:

- There is fair possibility of intensification of low over east central Bay into a depression on 21/22nd as predicted by a few models and GPP. It needs to be watched and monitored.
- No IOP for next five days.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	18/12	**19/00**	**19/03**
India	39	30	46
Coastal stations			
WB	7	3	9
Odisha	6	5	6
AP	9	11	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	8	14	16
Myanmar	12	12	12
Thailand	3	3	3
SriLanka	10	9	8

- **RS/RW** (12Z) of 18 / 10 /2016: 18/39
- **No. of Ascents reaching 250 hPa levels: 18, MISDA: 00**

- **RS/RW** (00Z) of 19 / 10 /2016: 34/39
- **No. of Ascents reaching 250 hPa levels: 33, MISDA: 5**

No. of PILOT Ascents

18/12Z	**19/00Z**
06 /69	05/63

Buoy Data

18/12Z	**19/00Z**	**19/03Z**
15	15	15

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**18.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /18.10.2016 : 6

No. of Ascents reaching 250 hPa level = 6

MISDA : 2

12Z /18.10.2016 : 3

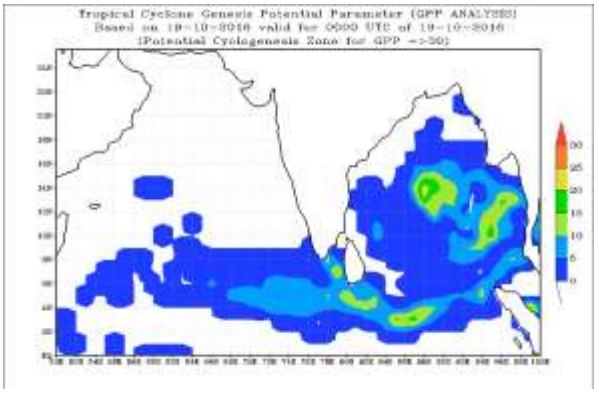
No. of Ascents reaching 250 hPa level = 3

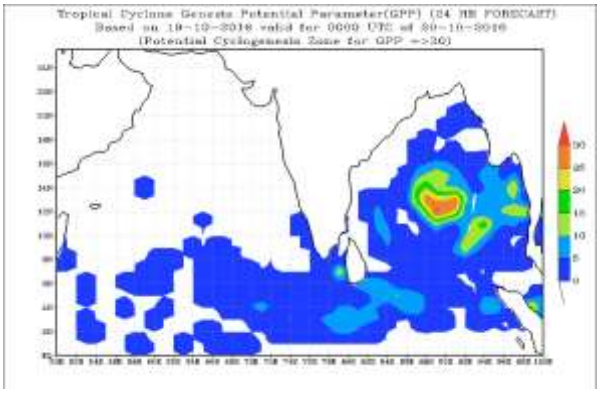
MISDA : 5

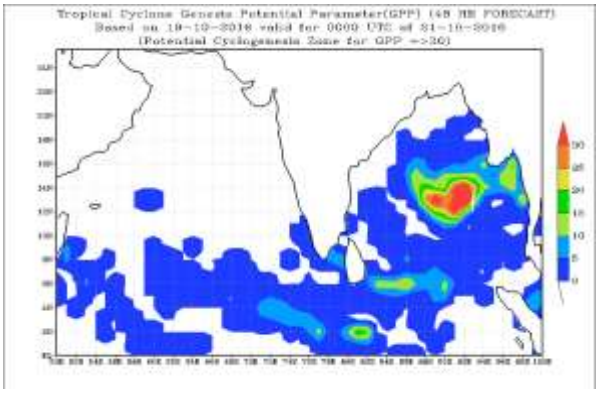
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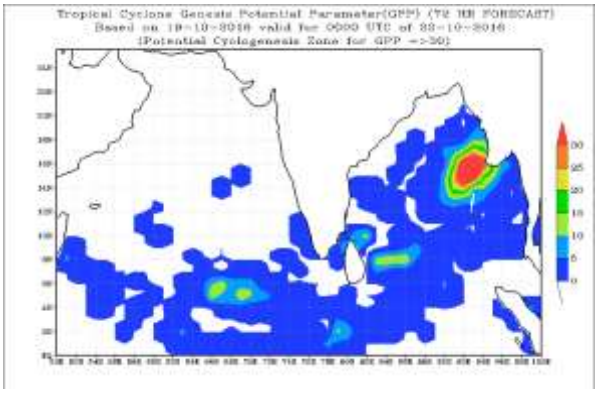
18.10.2016	
06Z	18Z
4	5

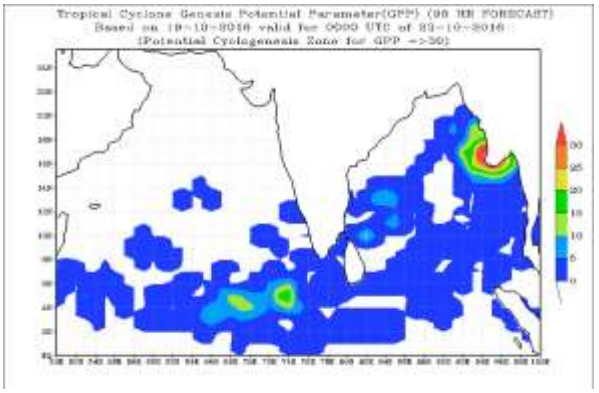
Annexure-II

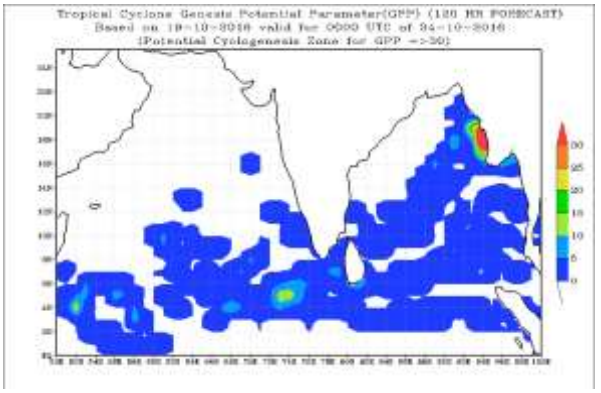

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 18-10-2016 valid for 0000 UTC of 18-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

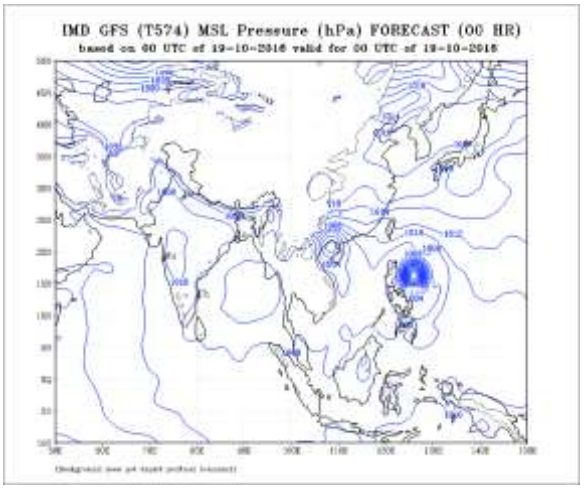

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

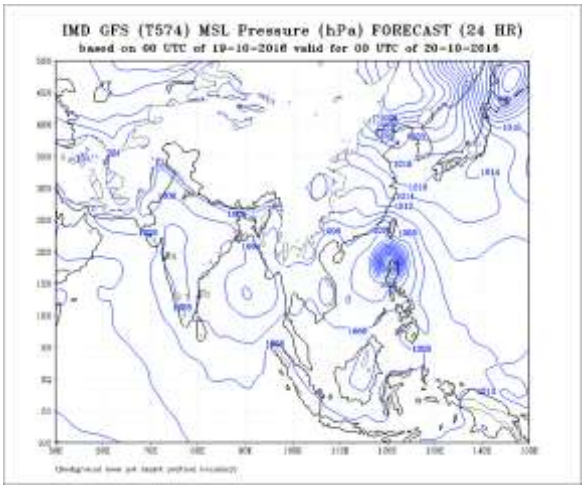

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
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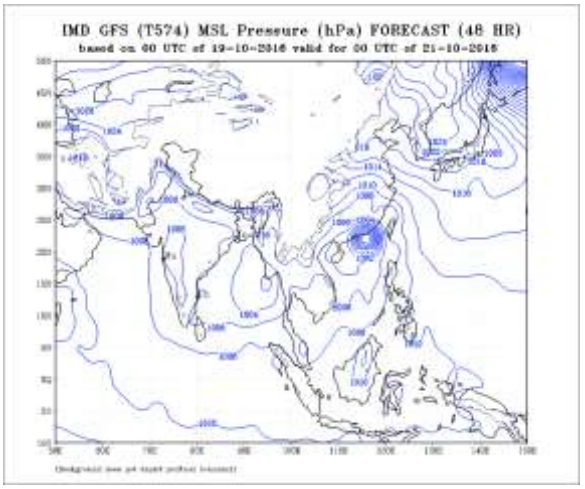

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

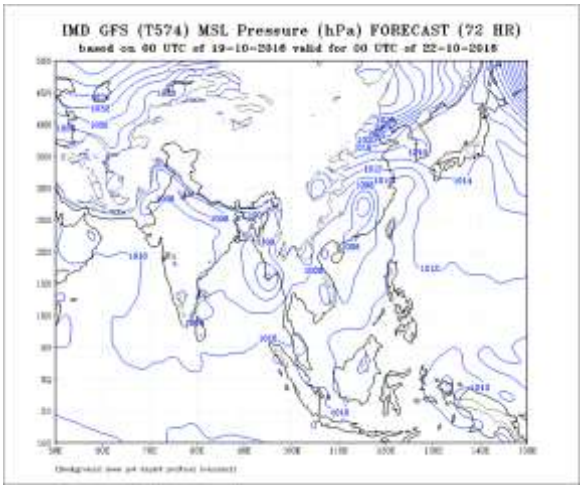

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
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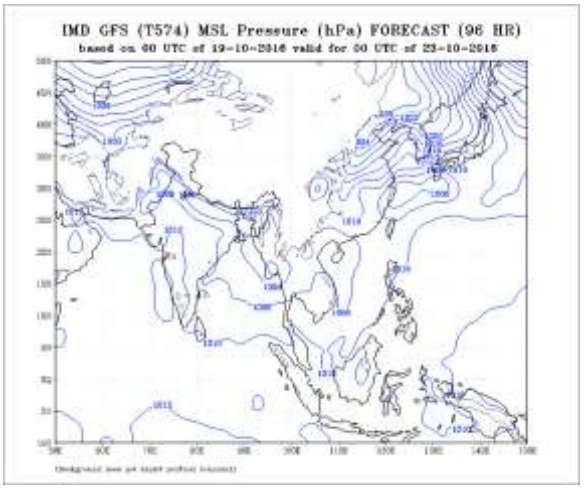

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

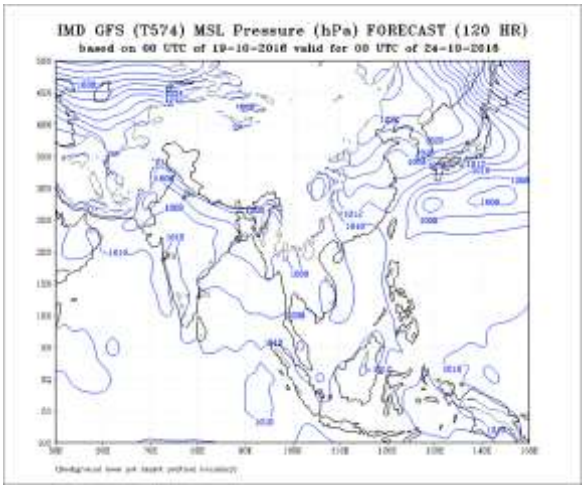

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 19-10-2016 valid for 00 UTC of 19-10-2016

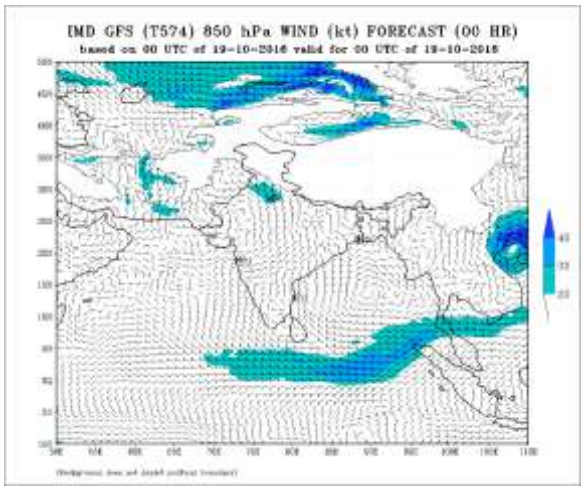

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 19-10-2016 valid for 00 UTC of 20-10-2016

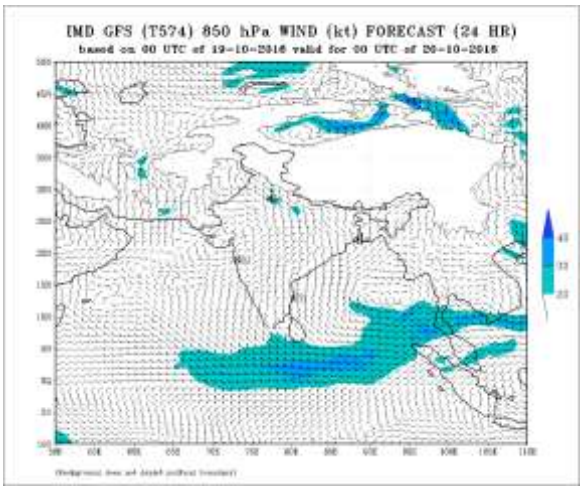

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
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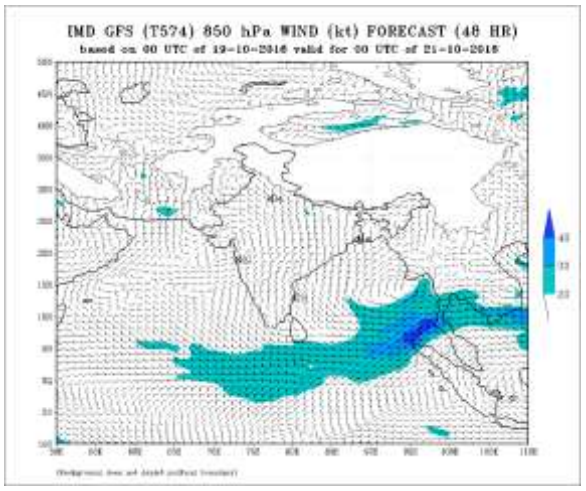

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
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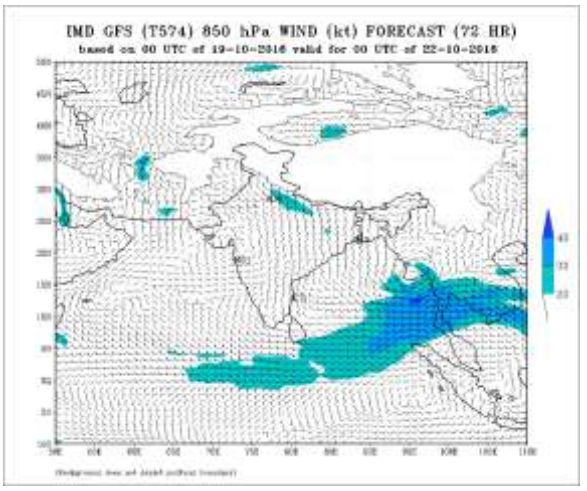

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 19-10-2016 valid for 00 UTC of 23-10-2016

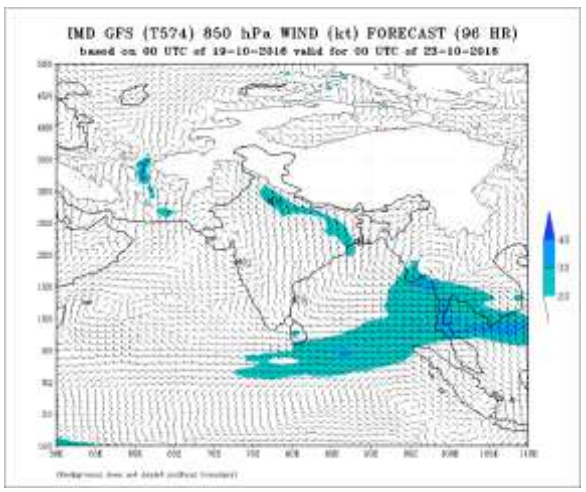

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
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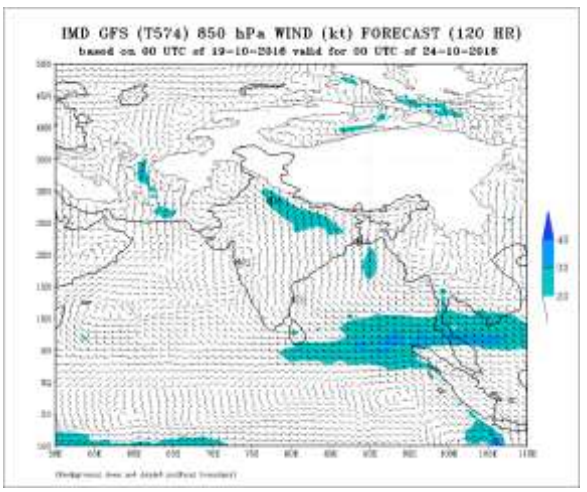

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 19-10-2018 valid for 00 UTC of 19-10-2018

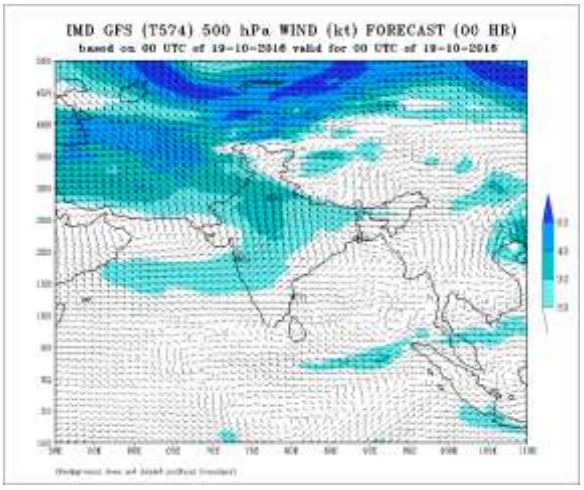

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
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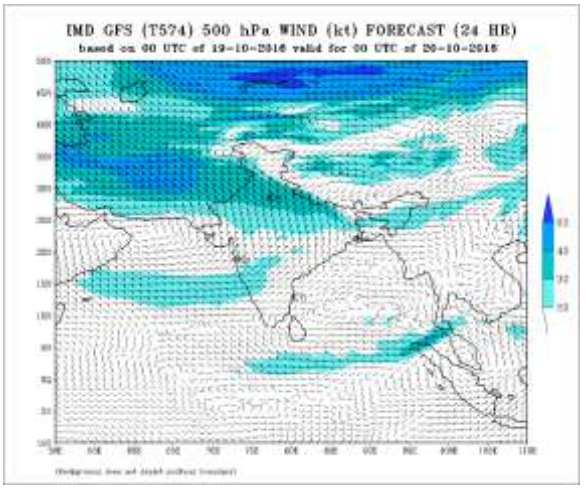

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 19-10-2018 valid for 00 UTC of 21-10-2018

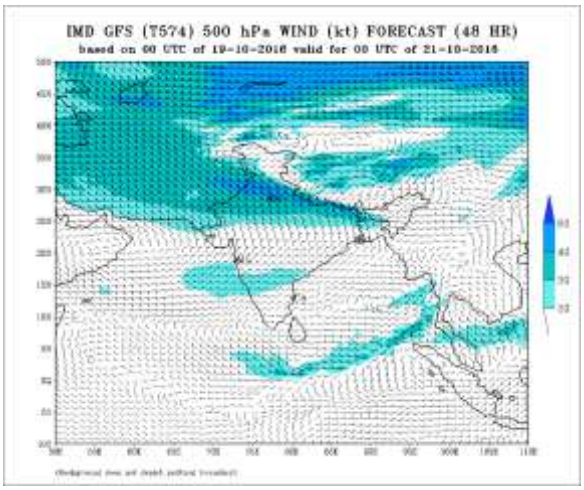

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
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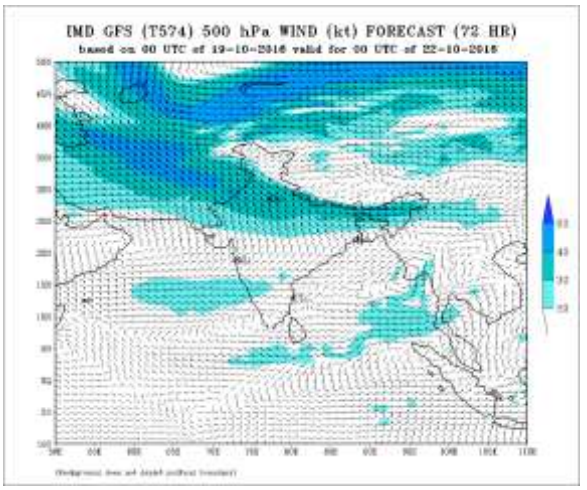

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 19-10-2018 valid for 00 UTC of 23-10-2018

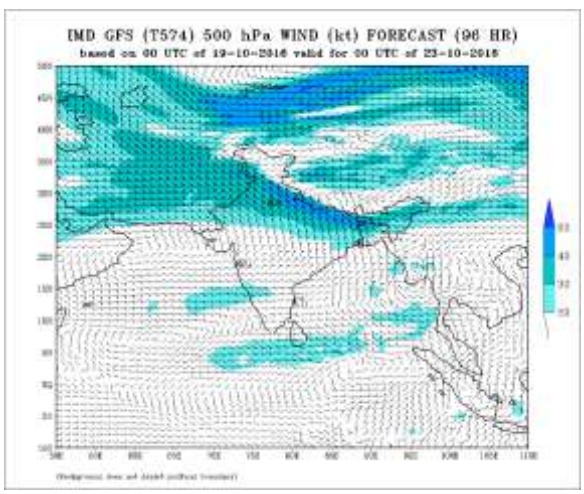

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 19-10-2018 valid for 00 UTC of 24-10-2018

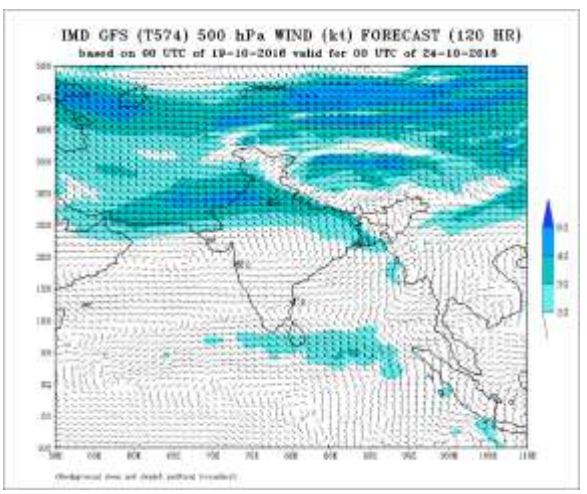

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
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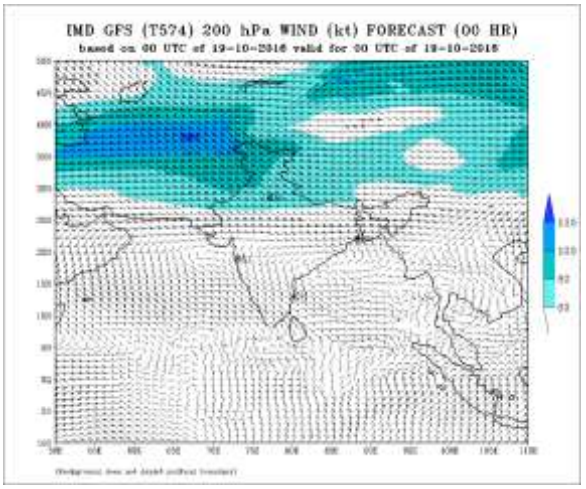

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
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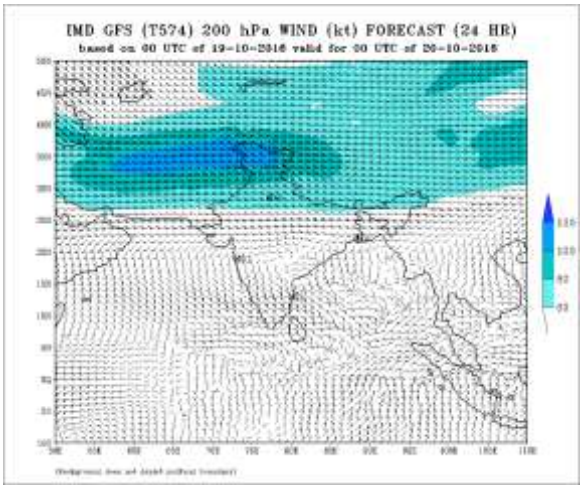

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
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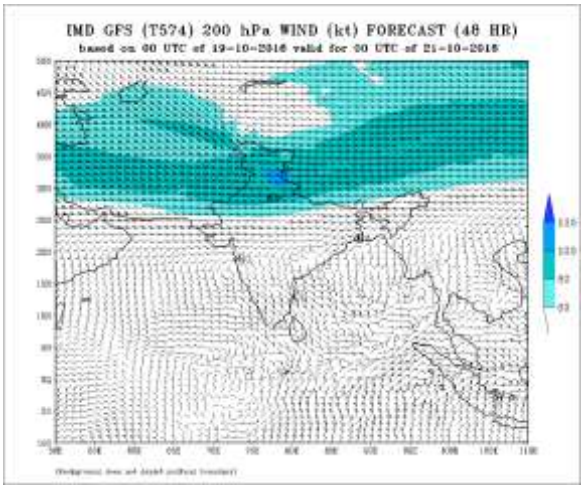

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
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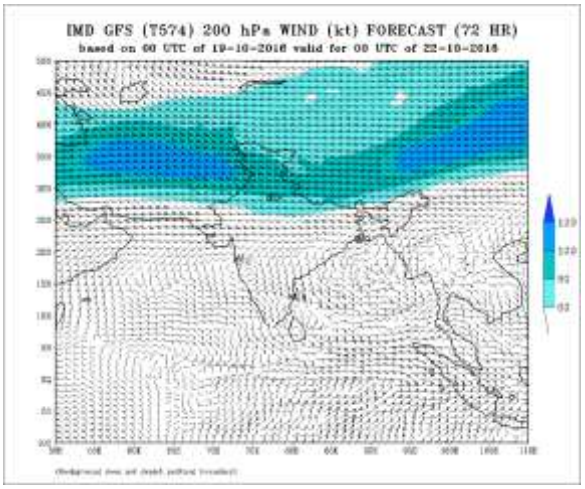

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
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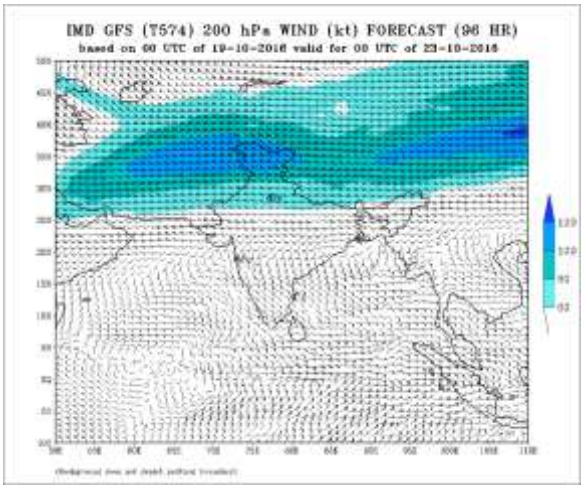

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
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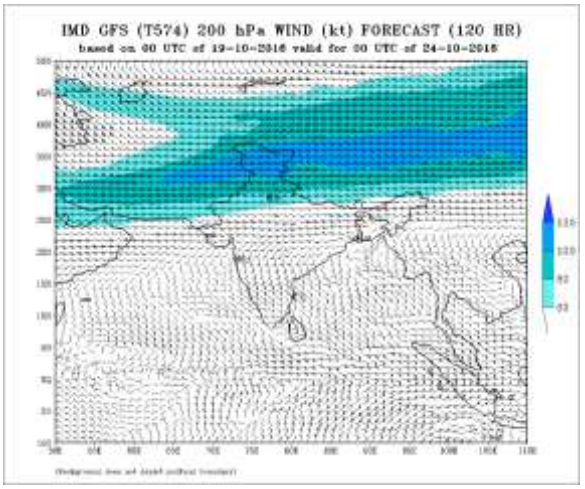

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 19-10-2018 valid for 00 UTC of 19-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 19-10-2018 valid for 00 UTC of 20-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 19-10-2018 valid for 00 UTC of 21-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 19-10-2018 valid for 00 UTC of 22-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 19-10-2018 valid for 00 UTC of 23-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 19-10-2018 valid for 00 UTC of 24-10-2018

FDP (Cyclone) NOC Report Dated 20th October, 2016

Synoptic features:

The low pressure area over eastcentral Bay of Bengal & neighbourhood has become well marked and now lies over eastcentral & adjoining southeast Bay of Bengal. The associated upper air cyclonic circulation extends upto mid-tropospheric level. The system is likely to intensify into a depression during next 48 hours. The trough from the above system to southwest Bay of Bengal in the lower levels persists. The Western Disturbance as an upper air cyclonic circulation over north Pakistan and adjoining Jammu & Kashmir, now lies over eastern parts of Jammu & Kashmir & neighbourhood between 3.1 & 3.6 km above mean sea level. The east west shear zone, now seen at 4.5 km above mean sea level roughly along latitude 11.0°N.

Dynamical and thermodynamical features

Surface Temperature (SST):

SST is around 29-30°C over most parts of Bay of Bengal and northeastern Andaman Sea. It is around 31°C over western parts of Bay of Bengal off Andhra Pradesh, Central Bay and over northern parts of north Andaman Sea.

SST is around 26-29°C over most parts of Arabian Sea (AS). SST is around 32°C off Gujarat coast.

Tropical Cyclone Heat Potential (TCHP):

TCHP is 110-120 kJ/cm^2 over west and eastcentral Bay of Bengal. TCHP is 80-110 kJ/cm^2 over remaining parts of Bay of Bengal except north BAY OF BENGAL is less than 50 kJ/cm^2.

TCHP is below 50kJ/cm^2 over north and adjoining western parts of southwest AS and also off the west coast of India. It is 60-90 kJ/cm^{2}over remaining parts of AS.

Relative Vorticity:

Relative vorticity at 850 hPa is positive and is 0-50X10^{-5}s-1 over eastcentral and southeast Bay of Bengal & adjoining equatorial region. It is negative over north and adjoining western parts of Bay of Bengal.

It is positive and around 20-50X10^{-5}s-1 over northeast and off east of Oman coast and some part of the central Arabian sea. 0-20 X10^{-5}s-1over southeast Arabian sea adjoining Kerala-Karnataka coast. It is negative over rest AS.

Convergence:

Lower level convergence is about 5 to 10 x 10^{-5}s^{-1} over westcentral and adjoining south of 10°N Bay of Bengal and south Andaman Sea.

Lower level convergence is around 5 x 10^{-5}s^{-1} in over northwest Arabian sea.

Divergence:

Upper level divergence is 10-20 x10^{-5} s-1 over westcentral and adjoining southeast Bay of Bengal and the south Andaman Sea.

Upper-level divergence is 5-10 x10^{-5} s-1 over the eastcentral adjoining westcentral Arabian sea.

Wind Shear:

Wind shear is 5 knots over east of the system and 10-15 knots over central & north adjoining the southeast Bay of Bengal.

Wind shear is 10-15 knots over central parts of AS.

Wind Shear Tendency:

There is decreasing tendency (-5 to -10 knots) over north Andaman sea and adjoining east central and also over the southeast Bay of Bengal.

There is decreasing tendency over east central and southeast AS except increasing tendency over northwest part of the Arabian sea.

Satellite observations based on INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, The intensity of the system is T1.0 and the vortex lay centred at 0300 UTC neat lat. 13.50N and long. 89.00E. Broken low or medium clouds with embedded intense to very intense convection lie around the system centre .

Arabian Sea: No significant clouds are seen over the region.

Large scale features:

Upper tropospheric Ridge: The upper tropospheric ridge at 200 hPa runs along 19^0 N and along 20^0 N over the Arabian Sea.

M.J.O. Index:

MJO index is in Phase 7 with very less amplitude. It would move to phase 8 during next 3 days. While the phase of MJO is unfavourable for genesis and intensification, the very less amplitude over this unfavourable phase will be favourable for cyclogenesis over Bay of Bengal.

Storms and Depression over South China Sea/ South Indian Ocean:

Typhoon (Sarika) crossed China coast about 200 km northeast of Hanoi anound 4 UTC of 19th Oct. and in weakening phase. Another typhoon (Haima) located near lat. 19.8 0N and long. 117.60E likely to move northwestwards and make landfall to the east of Hong Kong coast around 0600 UTC of 21 Oct 2016 with a reduced intensity (50 knots). Thereafter, it would recurve northeastwards.

NWP Input for FDP Cyclone based on 0000 UTC:

IMD-GFS: The analysis and forecast charts based on 00 UTC of 20th October, 2016 show a low pressure area over east central Bay of Bengal with associated cyclonic circulation in the lower troposphere extending up to 500 hPa above mean sea level. The low pressure system is likely to intensify into a Depression on 21st and remain quasi-stationary over the same area till 22nd October 2016. The system shows eastward movement towards Arakan coast and intensification into a Deep Depression on 23rd October 2016 over the Arakan coast and remains as Deep Depression till 25th October 2016 over the same area. On 26 th the DD was seen over north Bay. The system was seen as a WML off Orissa coast on 27th and become less marked thereafter.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 20 October, 2016 show a low pressure area over east-central Bay of Bengal with associated cyclonic circulation extending up to 500 hPa above mean sea level. It remains a low on 21st . The low pressure system is likely to intensify into Depression on 22 October 2016 with eastward movement towards Arakan coast and remains as Depression till 26 October 2016. It moves northwestwards and weakens into a WML over north Bay on 26th and lay off Orissa coast on 27th. On 28th it became a low off Andhra Coast and became less marked on 29th .

ECMWF: The model charts based on 00 UTC of 20 October 2016 shows a low pressure area along with associated cyclonic circulation extending up to 500 hPa above mean sea level over east-central Bay of Bengal. The system is likely to intensify into a Depression on 21 October 2016 with eastward movement, into a Deep Depression on 22 October and remains as Deep Depression till 24 October 2016 over the Arakan coast. The system is likely to further intensify into a Cyclonic Storm on 25 October and into a Severe Cyclonic Storm on 26 October with northwestward movement till 26 October 2016 and moves westward thereafter lying over WC Bay off Andhra Pradesh coast on 27th and weakens into a Low on 28th over North Andhra Pradesh.

IMD WRF: The WRF model analysis and forecasts based on 00 UTC of 20 October 2016 show a low pressure system with associated cyclonic circulation extending up to 500 hPa over east-central Bay of Bengal. The system is likely to intensify into a Depression on 21 October 2016 over EC and adjoining SE bay, into a Cyclonic Storm on 22 October 2016 moving eastward and into a Severe Cyclonic Storm on 23 October 2016 with eastward movement towards Arakan Coast.

NCMRWF-NCUM: It shows a low over on 20th over eastcentral Bay which is seen over eastcentral and adjoining NW bay on 21st. On 22nd the WML is seen over east and became depression over EC Bay near Arakkan coast on 23rd intensified into cyclonic storm on 24 th over EC Bay off Arakkan coast. It weakened into a depression on 25th off Arakkan coast and move over to north bay as a depression on 26 th . It became a low on 27th near West Bengal Coast and became less marked on 28th .

NCMRWF-UM-Regional Model : It suggests low over southeast and adjoining west central bay on 20th and became a depression over southeast Bay on 21st , and a cyclonic storm over EC Bay on 22nd. It further intensified into SCS on 23rd over EC Bay and adjoining North Andaman coast.

JMA: JMA Model indicates low pressure area over southeast Bay on 20th which persisted over the same area on 21 st also. The low was seen over EC Bay on 22nd which became a well marked low over the same area on 23rd .

ARP-Meteo France Model indicates low pressure area over SE Bay on 20th and as a WML over the same region on 21st and as depression during 22 nd to 23 rd.

IITM-GEFS: Model suggests a low on 20th over EC Bay and adjoining SE bay and over EC bay on 21st as a low. It becomes a well marked low over east central on 22nd, which moves eastwards and lay near Arakkan

coast on 23rd. The WML weakens into a low over EC and adjoining NE bay on 24th and moves to north bay on 25th and became less marked on 26th.

NCMRWF-NEPS Model: It suggests low over central and adjoining east central Bay on 20th and a WML over SE Bay on 21st and a depression over central and SE Bay area on 22 nd. It becomes a cyclonic storm over EC Bay on 23 rd and moved eastwards near Arakkan coast, on 24th over EC Bay. It becomes a low and moves northwards, crosses Bangladesh and adjoining Myanmar coast and lies over Bangladesh and adjoining NMMT on 25 th and become less marked on 28th .

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

GPP: The Genesis Potential Parameter (GPP) analysis and forecasts based on 00 UTC of 20 October 2016 shows a significant GPP zone over east-central Bay of Bengal which is likely intensify and move eastward towards Arakan coast till 24 October 2016. The zone is likely to shift northwestward along Myanmar coast till 26 October and dissipates thereafter over northwest Bay of Bengal. Analysis and forecast of area average GPP suggests (shown in figure below) that the system has potential to intensify into a Cyclonic Storm.

Summary and Conclusion:

All the models except GEFS and JMA indicate intensification of the well marked low pressure area over east central and adjoining southeast Bay of Bengal into a Depression on 21st / 22nd October over EC Bay. Further it is expected to move northeastwards from tomorrow and reach Arakan coast by around 24th Oct. It may persist over the area with/without landfall over Arakan coast till 25th. Thereafter, it would recurve norwestwards skirting Myanmar and adjoining Bangladesh. However, though there is consensus among the models about the movement towards Arakan coast, there is large divergence about the movement thereafter as it varies from westwards to north-northwest/northwards reaching north Andhra Pradesh coast to Bangladesh coast. Compared to yesterday, more models (about 50%) are also suggesting further intensification of the system into a cyclonic storm over EC Bay around 23rd/24th October.

Probability of cyclogenesis over Bay of Bengal and Andaman Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Fair	Moderate	High	High	High

Probability of cyclogenesis over Arabian Sea during next 120 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
Nil	Nil	Nil	Nil	Nil

Advisory:

- There is fair possibility of intensification of well marked low over east central Bay into a depression on 21st and becoming moderate to high probability on 22nd. There is also fair to moderate probability for further intensification into cyclonic storm.
- It would reach Arakan coast as a Deep Depression/ cycloic storm on 24th October. Thereafter it would recurve northwestwards skirting Myanmar coast during 25-27th .
- No IOP for next five days over Indian coast. However, intense observation may be taken by Myanmar during 23-25 Oct. 2016.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	95/12	**20/00**	**20/03**
India	43	30	44
Coastal stations			
WB	8	3	9
Odisha	6	5	6
AP	12	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	7	1	6
Bangladesh	13	14	13
Myanmar	0	10	9
Thailand	0	2	2
SriLanka	10	9	9

- **RS/RW** (12Z) of 19 / 10 /2016: 16/39
- **No. of Ascents reaching 250 hPa levels: 16, MISDA: 23**

- **RS/RW** (00Z) of 20 / 10 /2016: 34/39
- **No. of Ascents reaching 250 hPa levels: 34, MISDA: 5**

No. of PILOT Ascents

19/12Z	**20/00Z**
05 /37	02/34

Buoy Data

19/12Z	**20/00Z**	**20/03Z**
16	18	14

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**19.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**21**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /18.10.2016 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /18.10.2016 : 3

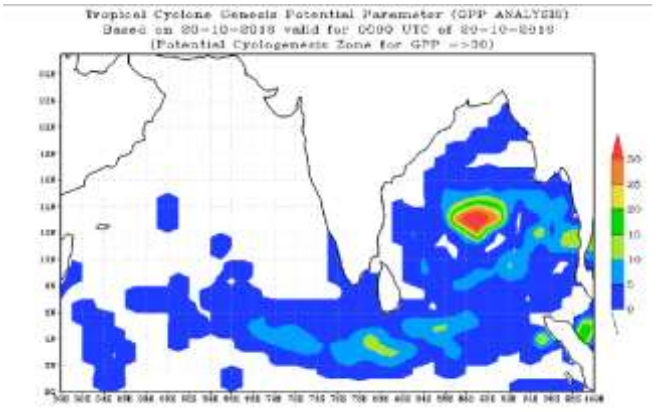
No. of Ascents reaching 250 hPa level = 3

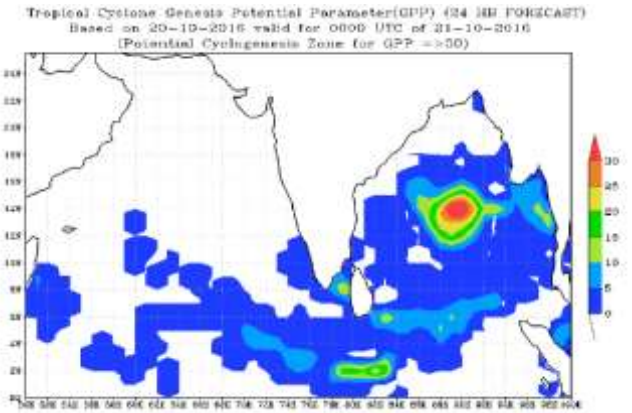
MISDA : 5

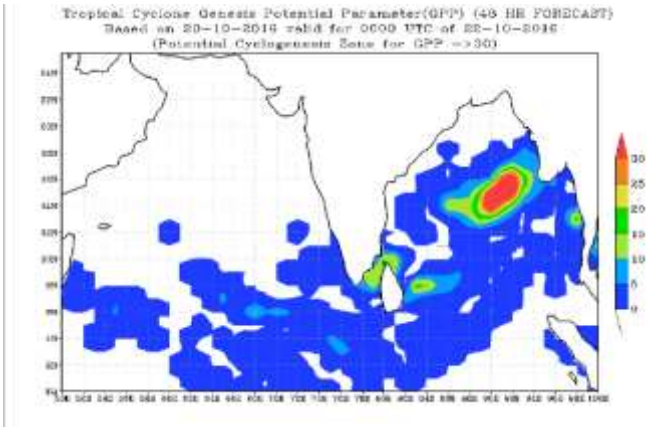
No. of PILOT Ascents:

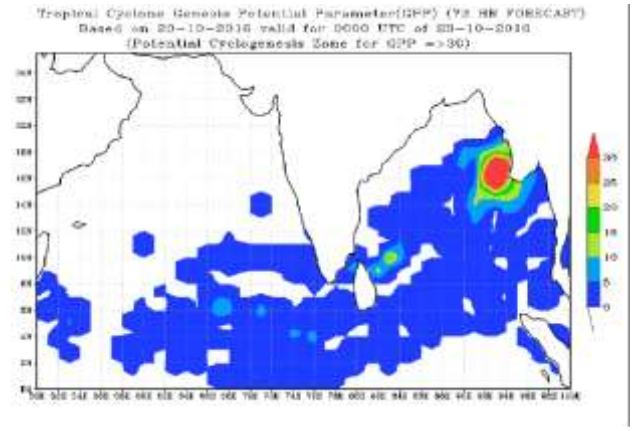
19.10.2016	
06Z	18Z
5	5

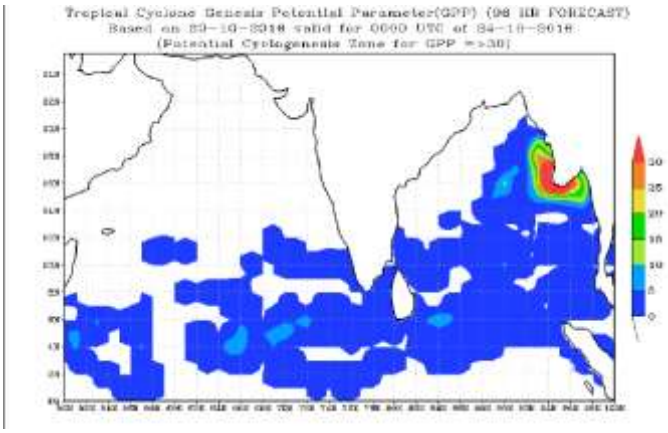
Annexure-II

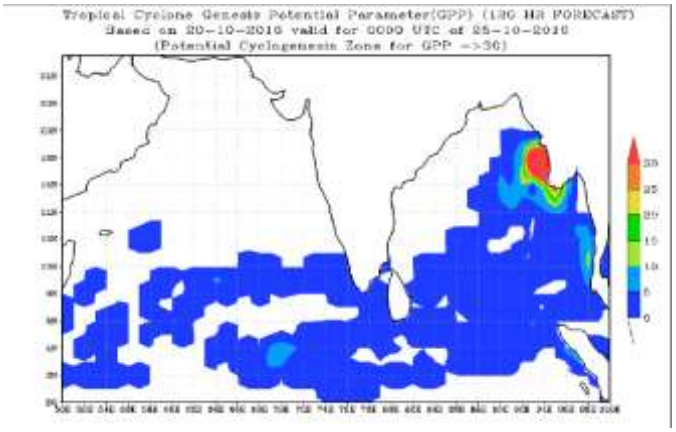

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 20-10-2016 valid for 0000 UTC of 20-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

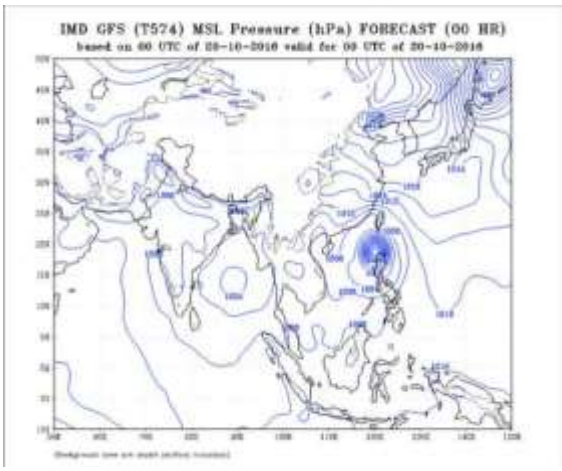

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 20-10-2016 valid for 0000 UTC of 21-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

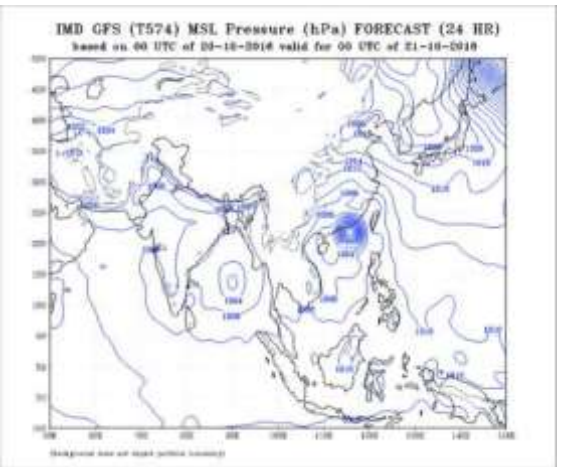

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 20-10-2016 valid for 0000 UTC of 22-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

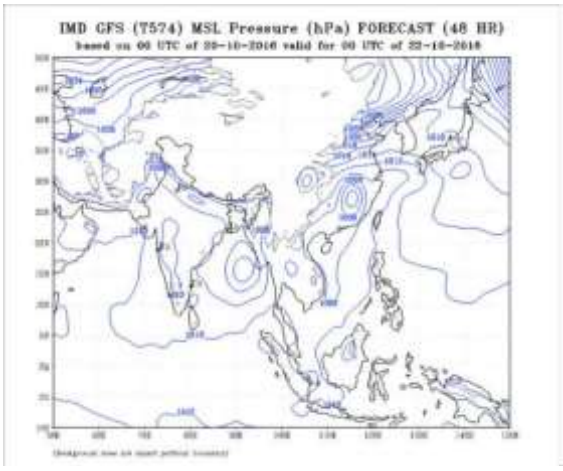

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 20-10-2016 valid for 0000 UTC of 23-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

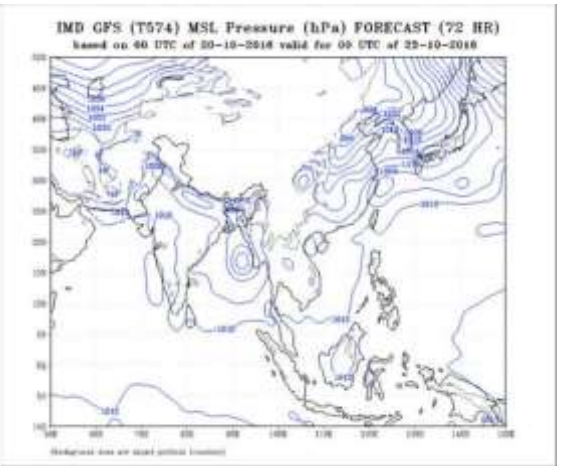

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 20-10-2016 valid for 0000 UTC of 24-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

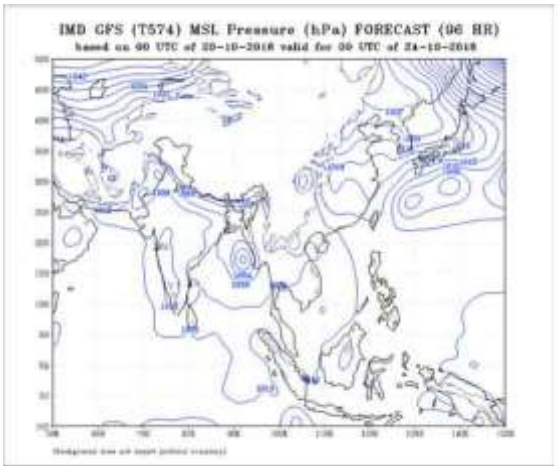

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 20-10-2016 valid for 0000 UTC of 25-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

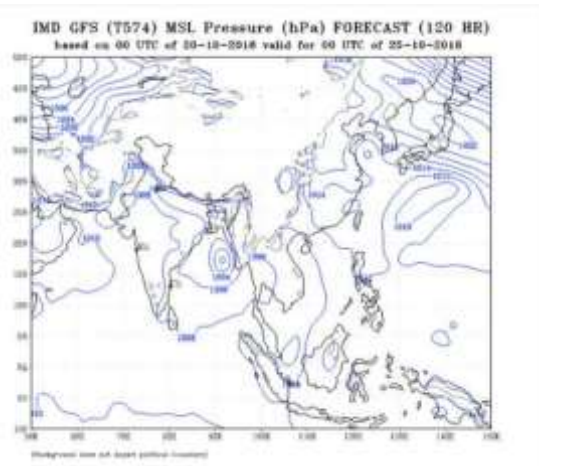

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 20-10-2018 valid for 00 UTC of 20-10-2018

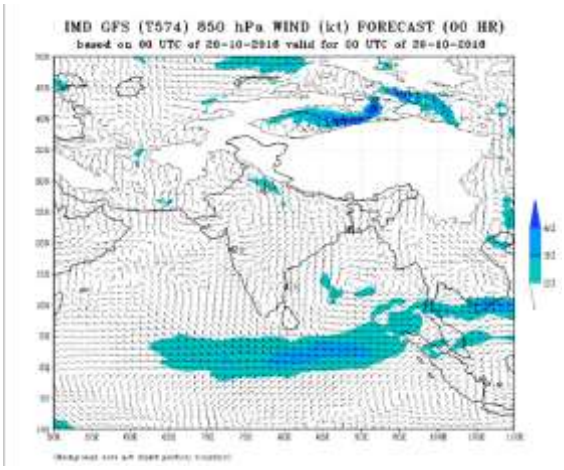

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 20-10-2018 valid for 00 UTC of 21-10-2018

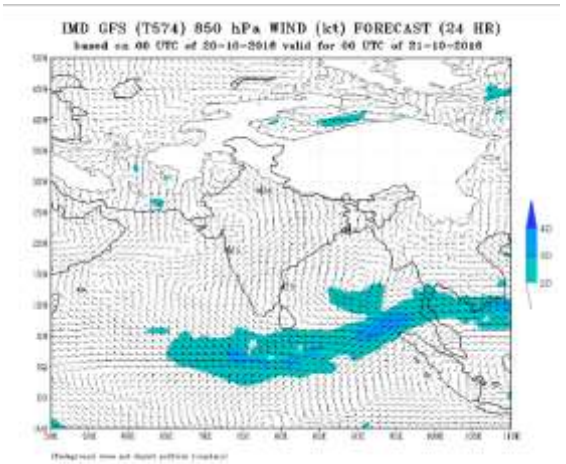

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 20-10-2018 valid for 00 UTC of 22-10-2018

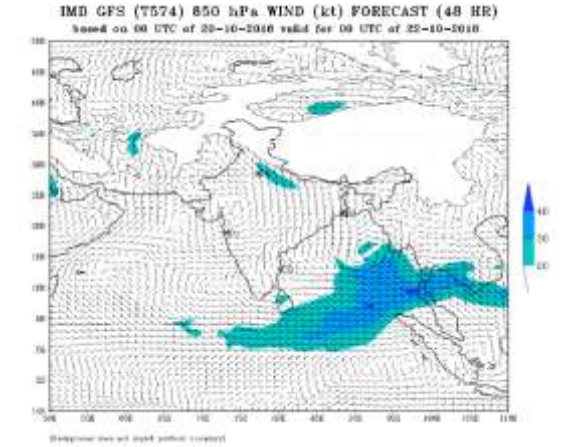

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
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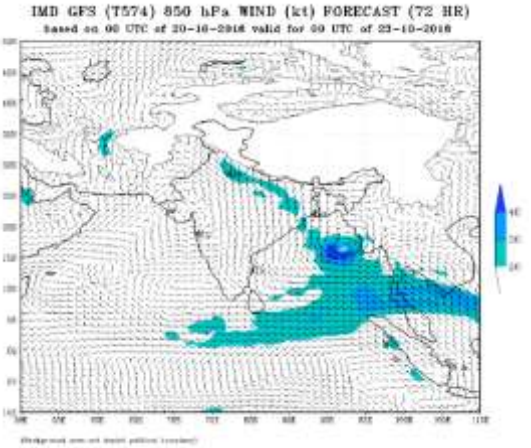

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
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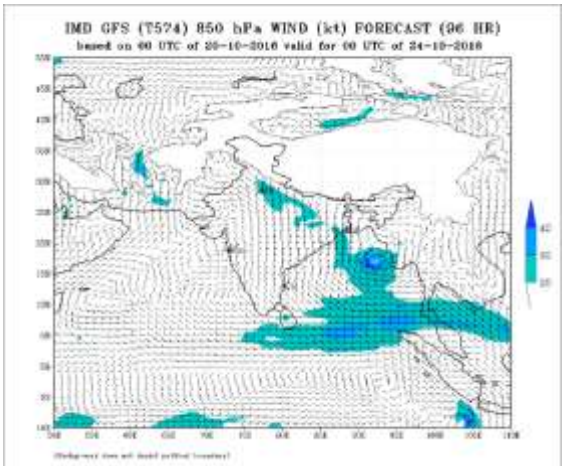

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
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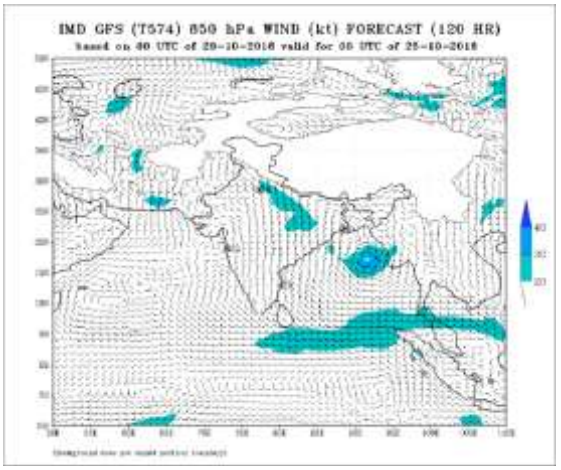

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 20-10-2016

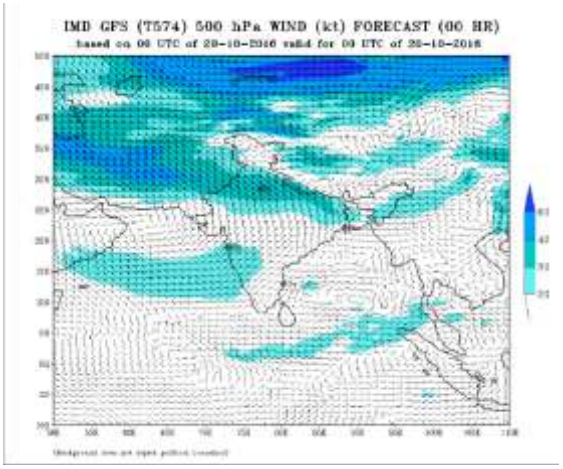

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 21-10-2016

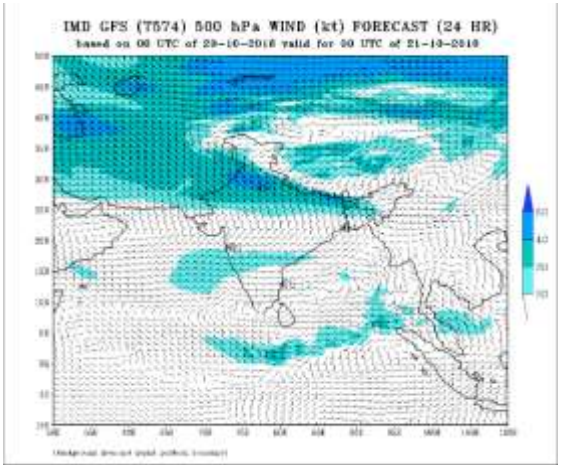

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
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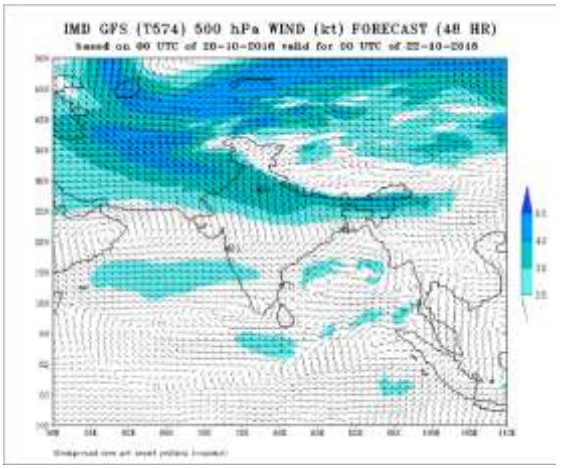

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
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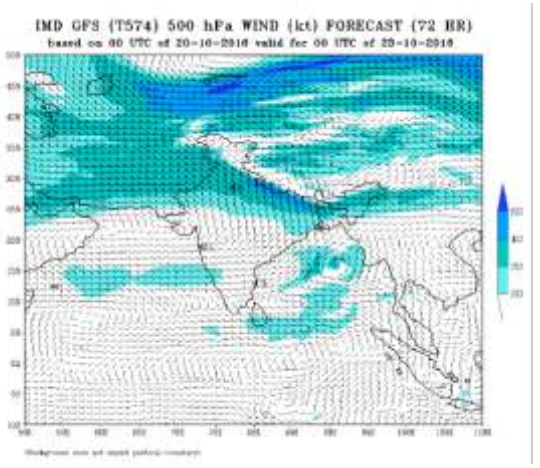

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 24-10-2016

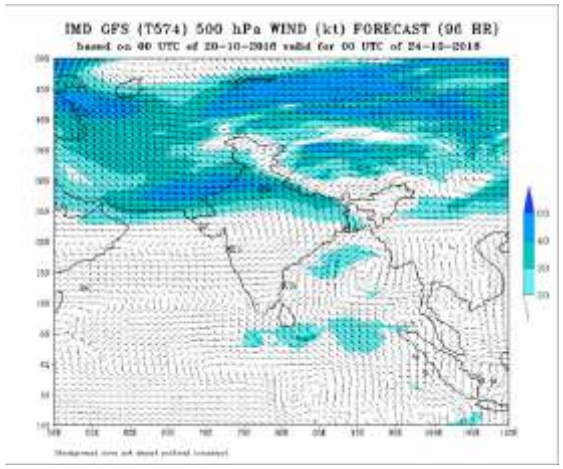

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
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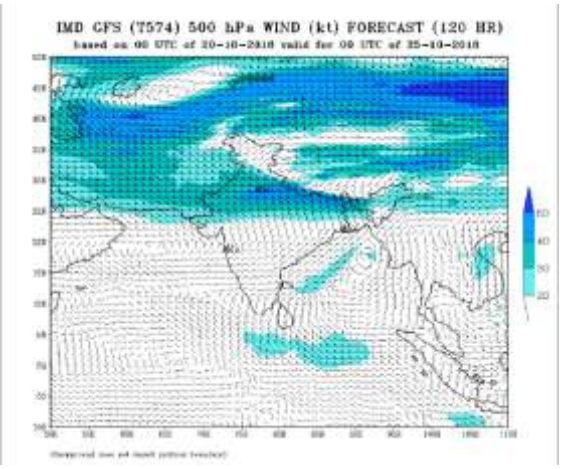

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 20-10-2016

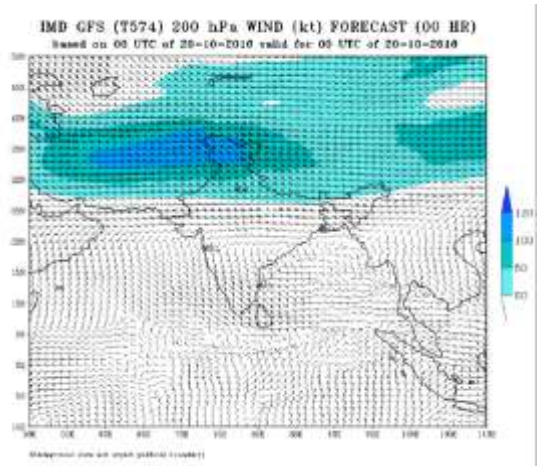

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
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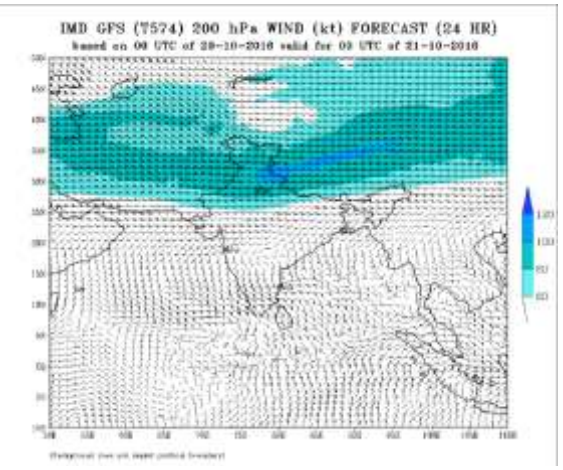

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 22-10-2016

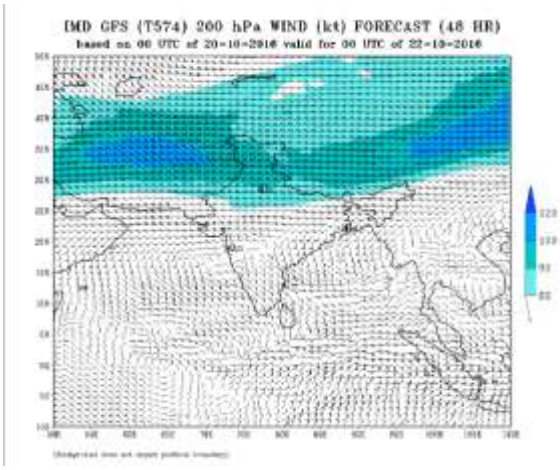

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
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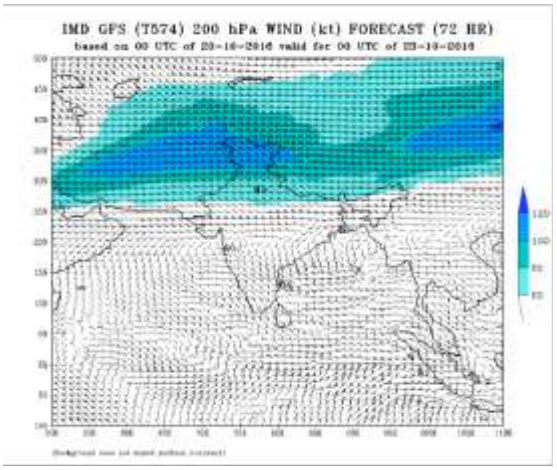

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 24-10-2016

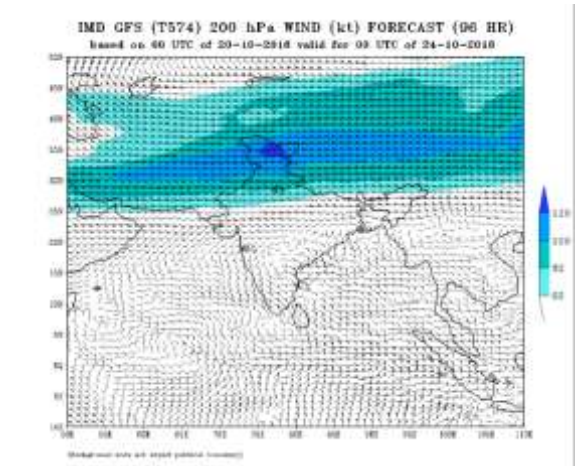

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 25-10-2016

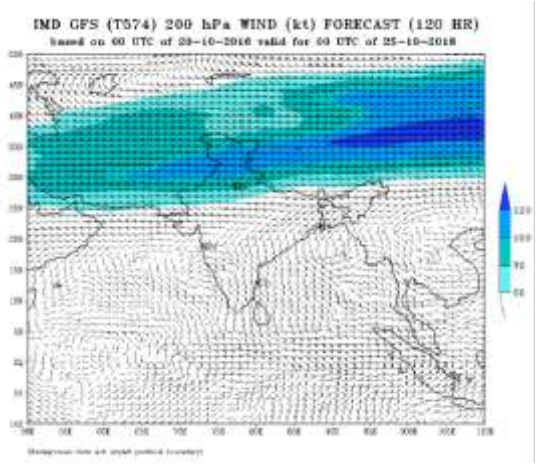

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 20-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 21-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 22-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 23-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 24-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 20-10-2016 valid for 00 UTC of 25-10-2016

FDP (Cyclone) NOC Report Dated 21st October, 2016

Synoptic features:

The depression over central & adjoining southeast Bay of Bengal remained practically stationary and lay centred at 0830 hours IST of today the 21st October 2016, near Lat. 13.5°N and Long.88.5°E, about 500 km west-northwest of Port Blair and 900 km west southwest of Yangon (Myanmar). The system is very likely to move initially east northeastwards towards Myanmar coast. It is very likely to intensify further into a deep depression during next 24 hours and into a cyclonic storm in subsequent 24 hours. The east-west shear zone at 4.5 km above mean sea level roughly along latitude 11.0°N has become less marked.

Dynamical and thermodynamical features:

Surface Temperature (SST):

SST is around 29-30°C over most parts of Bay of Bengal and northeastern Andaman Sea. It is around 31°C over western parts of Bay of Bengal off Andhra Pradesh, Central Bay and over northern parts of north Andaman Sea.

SST is around 26-29°C over most parts of Arabian Sea (AS). SST is around 32°C off Gujarat coast.

Tropical Cyclone Heat Potential (TCHP):

TCHP is 110-120 kJ/cm^2 over east of the system of Bay of Bengal. TCHP is 80-110 kJ/cm^2 over remaining parts of Bay of Bengal except north Bay of Bengal is less than 50 kJ/cm^2.

TCHP is below 50kJ/cm^2 over north and adjoining western parts of southwest AS and also off the west coast of India. It is 60-90 kJ/cm^{2}over remaining parts of AS.

Relative Vorticity:

Relative vorticity at 850 hPa is positive and is 5-8X10^{-5}s^{-1} over the system center of Bay of Bengal. It is negative over north and adjoining western parts of Bay of Bengal.

It is positive and around 2-5X10^{-5}s^{-1} over northeast and off east of Oman coast and some parts of the central Arabian sea. It is 1-2 X10^{-5}s^{-1}over southeast Arabian sea adjoining Kerala-Karnataka coast. It is negative over rest AS.

Convergence:

Lower level convergence is about 10 to 15 x 10^{-5}s^{-1} over around the system of Bay of Bengal and Lower level convergence is about 5-10 x 10^{-5}s^{-1} over south Andaman Sea and over southern parts of India.

Lower level convergence is around 5 x 10^{-5}s^{-1} in some pockets of south Arabian sea.

Divergence:

Upper level divergence is 10-20 x10^{-5} s-1 over over around the system of Bay of Bengal.

Upper-level divergence is 5-10 x10^{-5} s-1 over the southeast Arabian Sea adjoining Indian Ocean.

Wind Shear:

Wind shear is 5-10 knots to the north of 13^{o}N and it increases to the south.

Wind shear is 5-10 knots over east central and adjoining west central parts of AS.

Wind Shear Tendency:

There is increasing tendency (5 -10 knots) over southeast and southwest parts of bay of bengal and adjoining south Andaman sea

There is decreasing tendency over east and westcentral AS except increasing tendency over southeastern part of the Arabian sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

Vortex over central bay & n/hood has organised and centred within half a deg of 13.5^0 N/88.5^0 E with intensity T1.5. Associated broken low/medium clouds with embedded intense to very intense convection over bay bet lat 10.5^0 N to 16.5^0 N long 81.5^0 E to 88.5^0 E

Arabian sea:

Scattered low/ medium clouds with embedded isolated weak convection off Kerala coast.

Large scale features

Upper tropospheric Ridge: The upper tropospheric ridge at 200 hPa runs along 19^0 N over Bay of Bengal.

M.J.O. Index: MJO index is in Phase 7 with very less amplitude. It would move to phase 8 during next 3 days. While the phase of MJO is unfavourable for genesis and intensification, the very less amplitude over this unfavourable phase will be favourable for cyclogenesis over Bay of Bengal.

Storms and Depression over South China Sea/ South Indian Ocean:

The typhoon (Haima) located to the east of Hongkong, has moved north-northwestward and made landfall just 46nm to the east-northeast of Hongkong before 0600 UTC of 21 Oct 2016 with a reduced intensity. Thereafter, it is has recurved northeastwards and is weakening rapidly.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The analysis and forecast charts based on 00 UTC of 21 October, 2016 show a Depression over east central Bay of Bengal with associated cyclonic circulation extending up to 500 hPa above mean sea level. The low pressure system is likely to intensify in to Deep Depression on 22 October and cyclonic storm on 23 October 2016 with northeastward movement till 24 October 2016. Thereafter the system shows north-northwestward movement towards Bangladesh coast and cross Bangladesh cost on 28 October 2016.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 21 October, 2016 show a low pressure area over east-central Bay of Bengal with associated cyclonic circulation extending up to 500 hPa above mean sea level. The low pressure system shows northeastward movement and is likely to intensify into a deep Depression on 23 and makes a landfall over Arakan coast 24 October 2016. Thereafter, it moves northwestward and emerges over north-east Bay of Bengal as a deep depression. The system with westward movement intensifies to become a cyclonic storm on 26, remain cyclone on 27. Moving further west the system weakens a bit and makes landfall over Orissa and Andhra Pradesh coast on 28 October 2016.

ECMWF: The model charts based on 00 UTC of 21 October 2016 shows a low pressure system along with associated cyclonic circulation extending up to 500 hPa above mean sea level over east-central Bay of Bengal. The system is likely to intensify into a deep Depression on 22 October 2016 with northeastward movement, into a cyclonic storm on 23 October. Thereafter, it recurves and crosses the Arakan coast with a north-northwestward movement on 24 October 2016 with intensification. The system is likely to intensify further into a severe Cyclonic Storm on 25 over northeast Bay of Bengal and moves westward towards Indian coast on 26 October 2016 as a severe cyclonic storm. The system reaches Orissa and north Andhra Pradesh coast on 28 October 2016 with a little intensification before landfall.

WRF: The WRF model analysis and forecasts based on 00 UTC of 21 October 2016 show a depression with associated cyclonic circulation extending up to 500 hPa over east-central Bay of Bengal. The system is likely to intensify into a cyclonic storm on 22 over EC and into a Severe Cyclonic Storm on 23 October 2016 over northeast Bay of Bengal off Arakan Coast with a northeastward movement.

NCMRWF-NCUM: It shows a well marked low over WC bay and adjoining SE bay on 21st . On 22nd the WML became depression over EC Bay and a cyclonic storm on 23rd over EC Bay near Arakkan coast. It became a SCS on 24th over the same area and was seen as SCS on 25th over EC Bay and adjoining north bay. It weakened into a cyclonic storm over NW bay and adjoining central Bay on 26th and weakened into a deep depression on 27th over WC bay off Andhra coast and became less marked on 28th.

NCMRWF-UM-Regional Model: It suggests a well marked low over central and adjoining southeast bay on 21st. Moving northeastwards, it became a cyclonic storm on 22nd over central bay . It further moved in NNE direction and became a SCS on 23rd over EC Bay. It continued to move in the same direction as SCS and is seen over EC Bay near Arakkan Coast on 24th.

JMA: JMA Model indicates low pressure area over east central and adjoining southeast Bay on 21st which is seen over EC Bay on 22nd and as a well marked low over the same area on 23rd . On 24th the WML is seen moving NE and is over EC Bay.

ARP-Meteo France Model indicates a well marked low pressure area over SE Bay on 21st which moves to EC bay and adjoining SE bay on 22nd and it is seen as depression on 23rd over EC Bay.

IITM-GEFS: NA.

NCMRWF-NEPS Model: It suggests a WML over SE and adjoining central Bay on 21st and a cyclonic storm over central Bay area on 22nd. Moving northwards it becomes a severe cyclonic storm over north Bay on 23rd . It further moved NW and seen as SCS over NW Bay on 24th . It weakened into CS over WC bay off Andhra coast on 26th and moved westwards crossing Andhra coast and is seen as a WML over interior Andhra on 27th . Further moving westwards, the low is seen over coastal Maharashtra and adjoining EC Arabian Sea on 28th.

The low is seen off the coast of Maharashtra over EC Arabian Sea on 29th. On 30th it seen as a WML over EC ArSea and as a low on 31st over central ArSea.

Dynamical statistical models:

IMD Genesis Potential Parameter (GPP):

GPP: The Genesis Potential Parameter (GPP) analysis and forecasts based on 00 UTC of 21 October 2016 shows a significant GPP zone over east-central Bay of Bengal which is likely intensify and move northeastward towards Arakan coast till 24 October 2016. With a northwestward movement crossing Arakan coast the GPP zone recurves and emerges again over Bay of Bengal on 25 October 2016. The significant GPP zone move westward till 28 October 2016 to reach Orissa and North Andhra coast. Analysis and forecast of area average GPP suggests that the system has potential to intensify into Cyclonic Storm.

MME TRACK: Consensus MME track forecast based on 0000 UTC of 21 October 2016 shows initial northeastward movement of the "DEPRESSION" over the east central Bay of Bengal towards Arakan coast till 0000 UTC of 24 October 2016 and recurvature thereafter towards west-northwestward direction.

SCIP INTENSITY: Intensity prediction by the SCIP model shows that the "DEPRESSION" over the east central Bay of Bengal is likely to intensify into a Cyclonic Storm at 0000 UTC of 23 October 2016.

RAPID INTENSIFICATION: Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 5.2% (Inference: RI probability VERY LOW).

Summary and Conclusion:

Most of the models indicate intensification of the depression over east central and adjoining southeast Bay of Bengal into a cyclonic storm on 23rd. Further the system is expected to move northeastwards and reach Arakan coast and recurve in west/ northwest direction from 24th Oct.

Advisory:

- No IOP for next five days over Indian coast. However, intense observation may be taken by Myanmar during 23-25 Oct. 2016.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time(UTC)		
	20/12/	**21/00**	**21/03**
India	38	35	44
Coastal stations			
WB	6	2	9
Odisha	6	6	6
AP	9	11	12
TamilNadu	10	9	10
Puducherry	1	1	1
A& N	6	6	6
Bangladesh	15	13	14
Myanmar	0	8	12
Thailand	0	0	2
SriLanka	1	8	5

No. of RS/RW Ascents

12Z /20.10.2016 : 16/39

No. of Ascents reaching 250 hPa level = 15

MISDA : 23

00Z /21.10.2016 :25

No. of Ascents reaching 250 hPa level =25

MISDA : 14

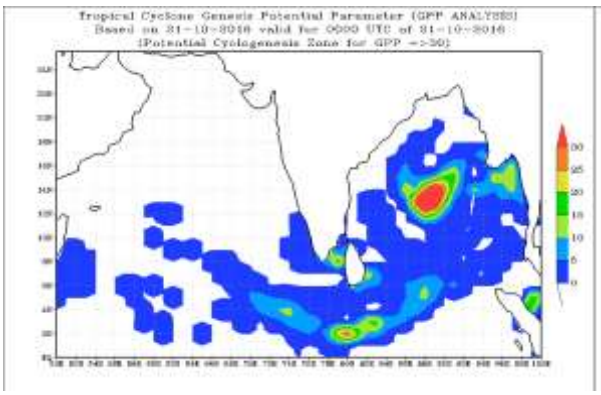
No. of PILOT Ascents:

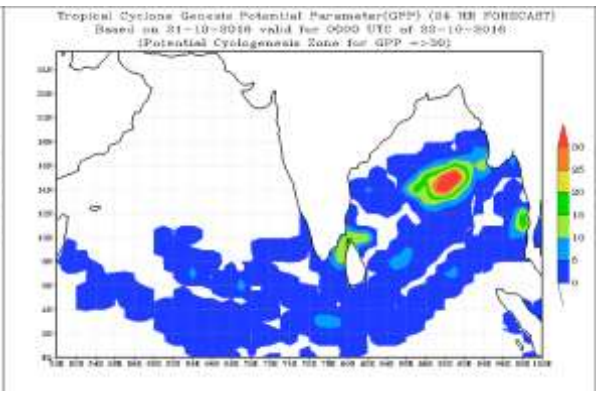
20.10.2016	
20/12Z	21/00Z
20/37	16/34

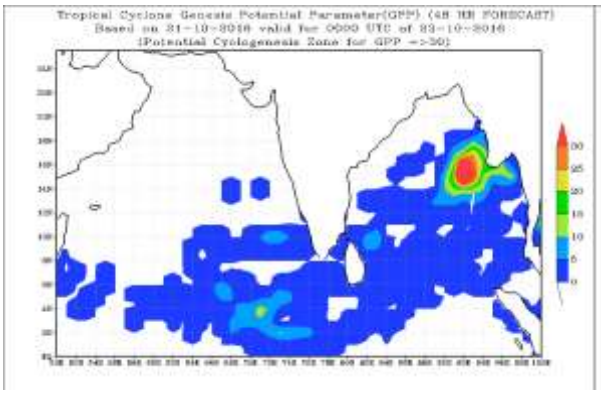
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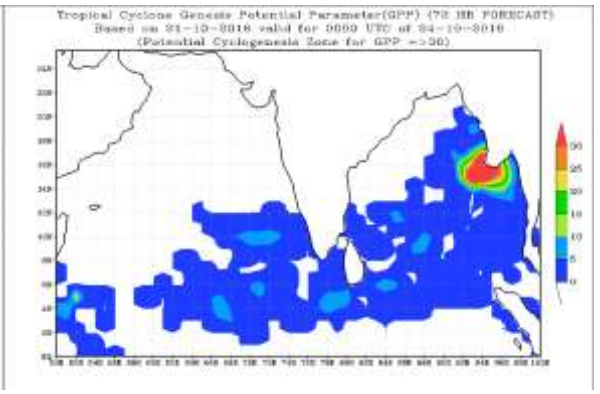
20/12Z	**21/00Z**	**21/03Z**
13	**16**	**13**

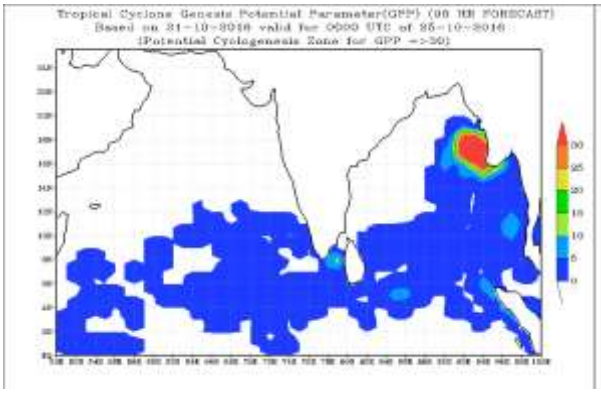
Annexure-II

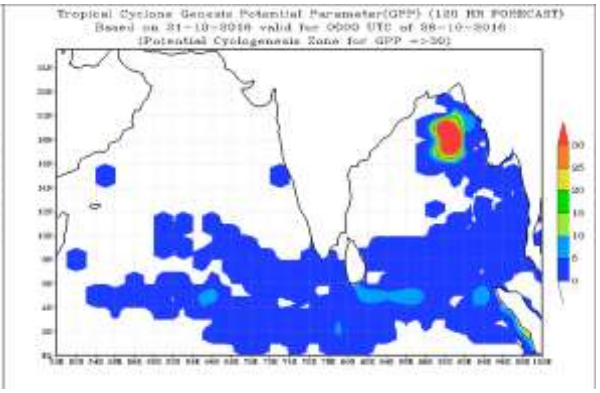

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 31-10-2016 valid for 0000 UTC of 31-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

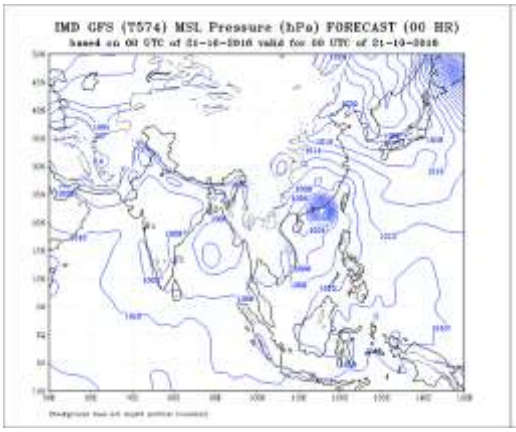

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 31-10-2016 valid for 0000 UTC of 01-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

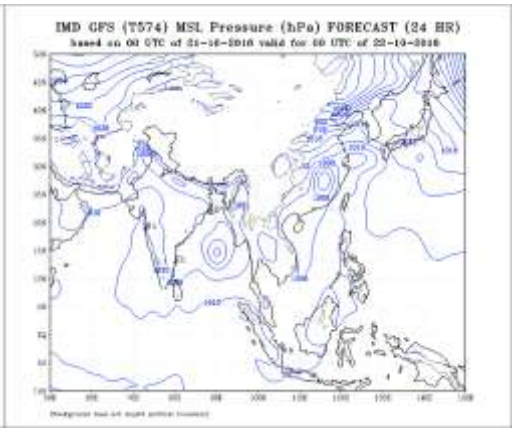

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 31-10-2016 valid for 0000 UTC of 02-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

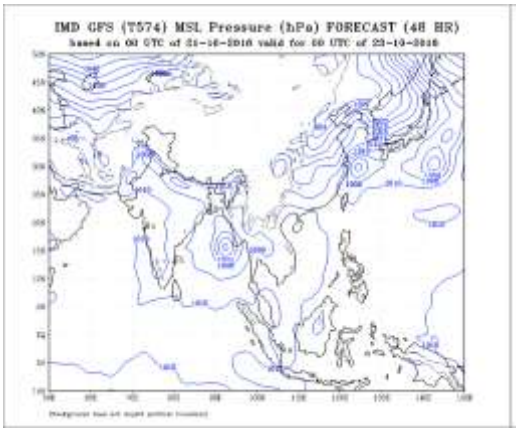

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 31-10-2016 valid for 0000 UTC of 03-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

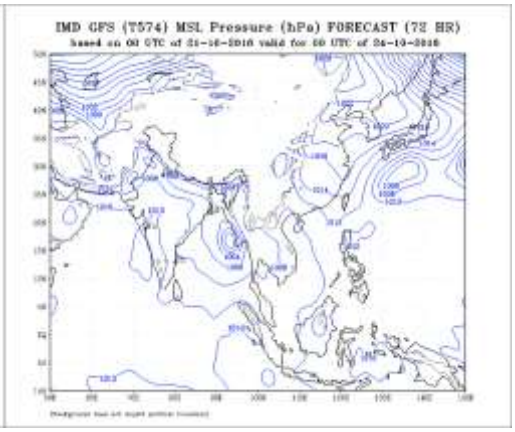

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 31-10-2016 valid for 0000 UTC of 04-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

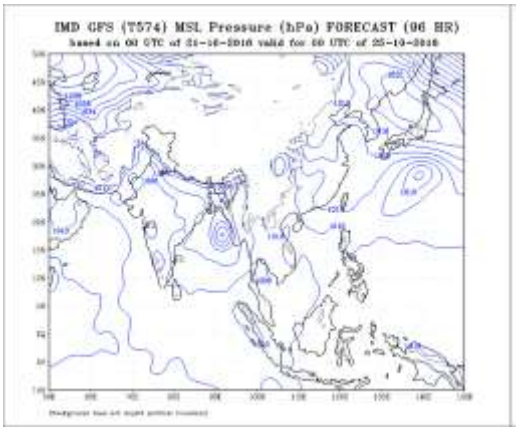

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 31-10-2016 valid for 0000 UTC of 05-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

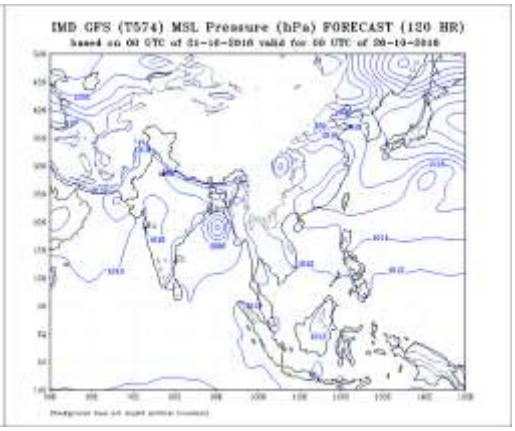

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)

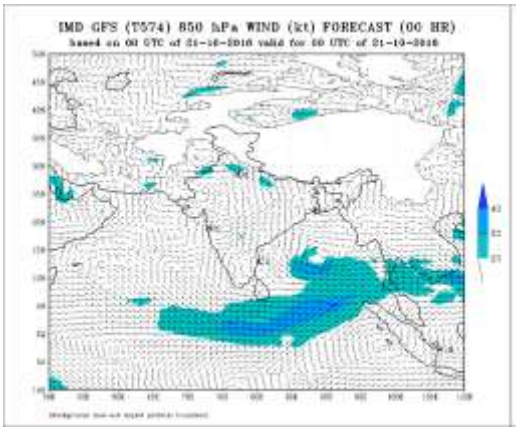

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

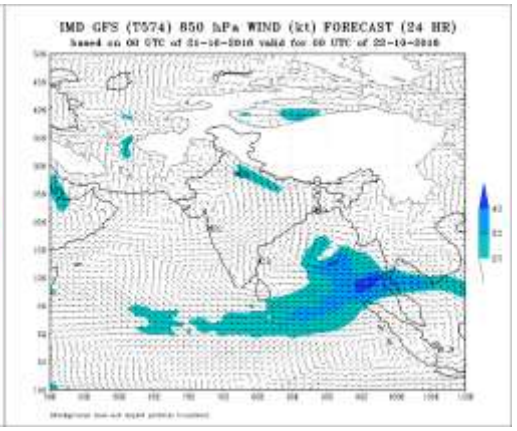

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

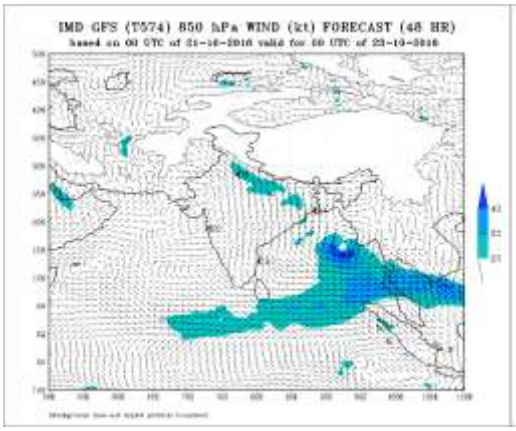

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

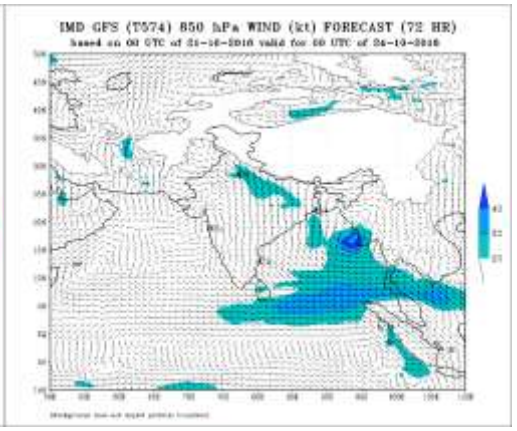

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

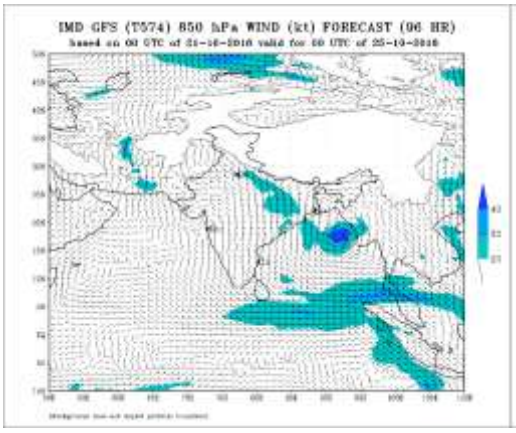

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

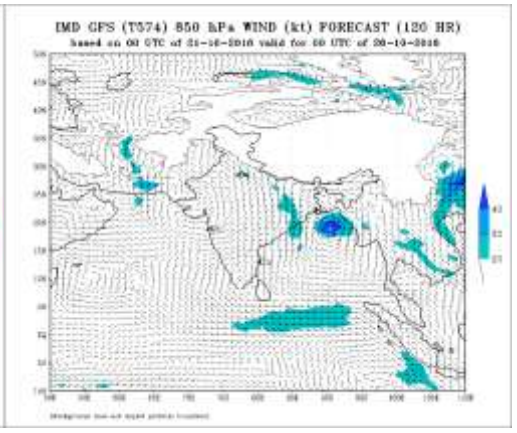

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

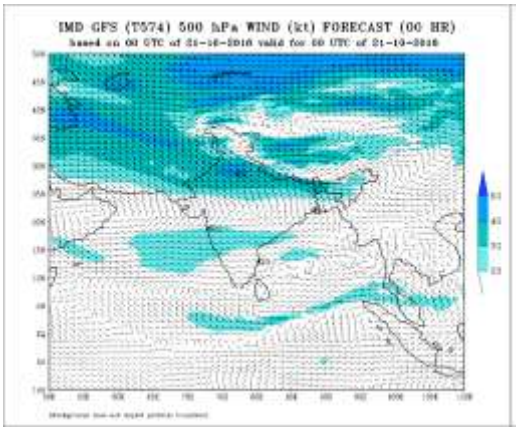

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

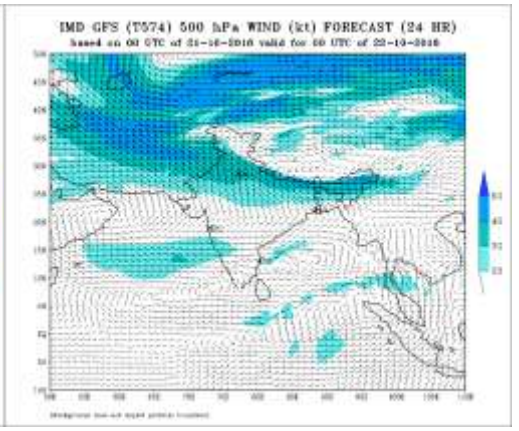

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

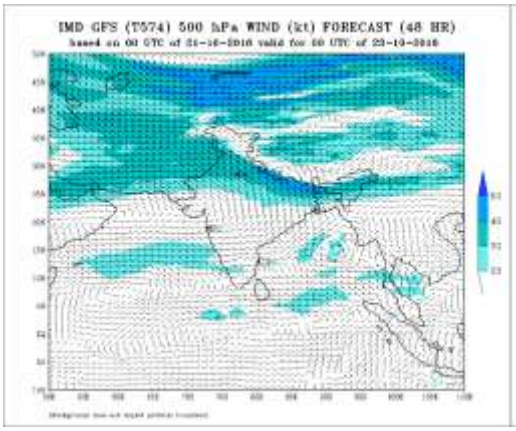

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

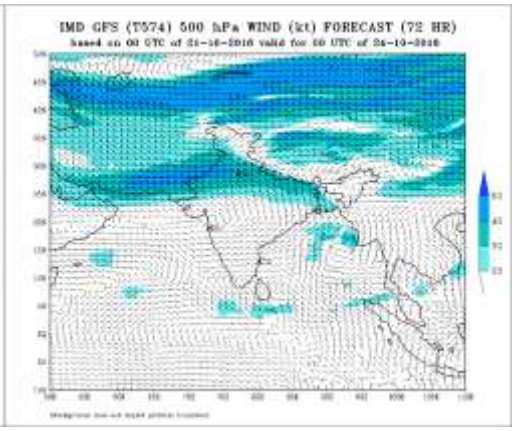

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

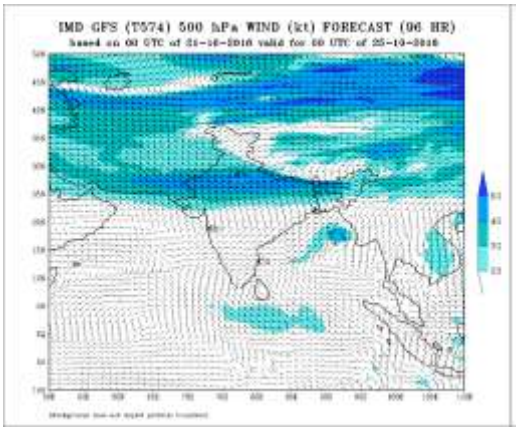

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

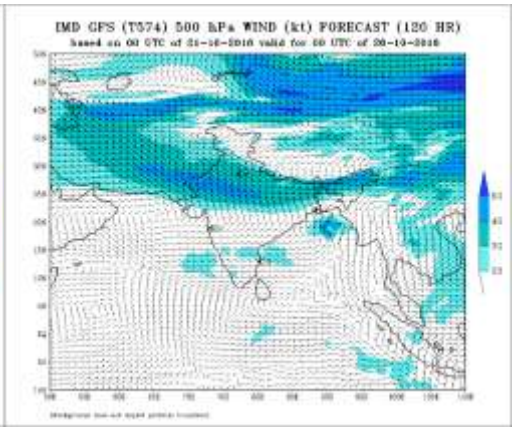

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)

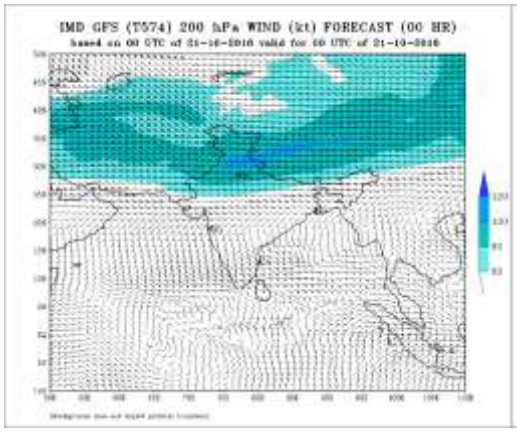

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

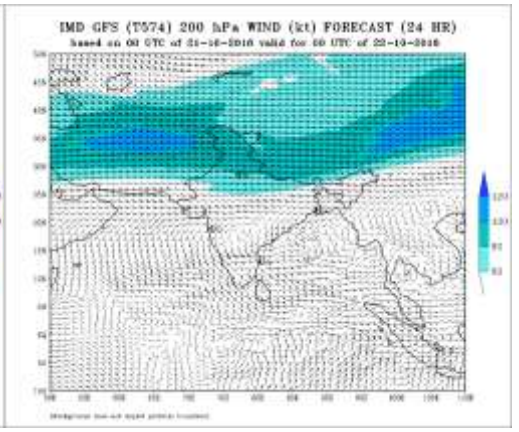

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

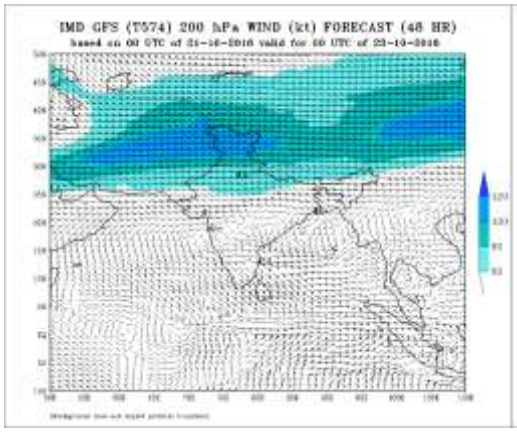

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

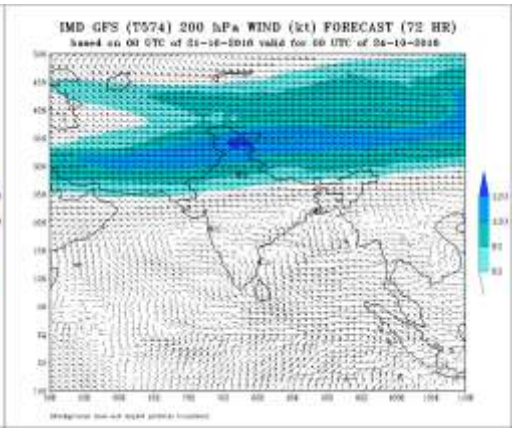

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

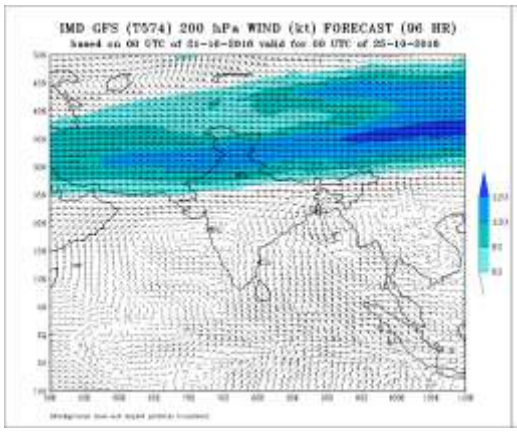

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

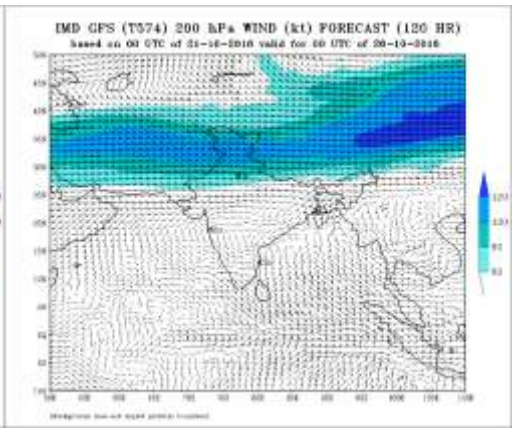

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)

FDP (Cyclone) NOC Report Dated 22nd October, 2016

Synoptic features:

The depression over eastcentral & adjoining southeast Bay of Bengal moved east northeastwards with speed of 8 kmph during past 6 hours and lay centred at 0830 hours IST of today i.e., 22nd October 2016, over eastcentral Bay of Bengal, near Latitude 14.5°N and Longitude 91.3°E, about 350 km northwest of Port Blair and 570 km southwest of Yangon (Myanmar). The system is most likely to intensify into a deep depression during next 24 hours and subsequently into a cyclonic storm. It will move -northeastwards and reach north Myanmar coast on 23rd October evening. Thereafter, it will recurve initially north-northwestwards skirting Myanmar coast and then northwestward towards northwest and adjoining westcentral Bay of Bengal.

An upper air cyclonic circulation lies over southeast Arabian Sea- Lakshadweep area between 3.6 & 5.8 km above mean sea level.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29-30˚C around the system centre. It increases towards northeast. It is around 28-29°C over remaining parts of Bay of Bengal and northeastern Andaman Sea.

SST is around 26-29°C over most parts of Arabian Sea (AS) except for small areas off the coast of Karnataka and Maharashtra.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 60-80 kJ/$cm^{2.}$ It increases towards northeast sector of the system. TCHP is below 50kJ/cm^2 over north and adjoining western parts of southwest AS and also off the west coast of India. It is 60-70 kJ/cm^2over remaining parts of AS.

Relative Vorticity:

The low level relative vorticity is about $150x10^{-6}$ $second^{-1}$ and vorticity centre lies to the east-northeast of the system centre.

It is positive and around $2\text{-}5X10^{-5}s\text{-}^{1}$ over northeast and off east of Oman coast and some parts of the central Arabian sea. It is 1-2 $X10^{-5}s\text{-}^{1}$over southeast Arabian sea adjoining Kerala-Karnataka coast. It is negative over rest AS.

Convergence:

Lower level convergence is about $10x\ 10^{-5}s^{-1}$ over around the system centre over Bay of Bengal. It is about 5-10 x $10^{-5}s^{-1}$ over south Andaman Sea and over southern parts of India.

Lower level convergence is around 10-15 x $10^{-5}s^{-1}$ over equatorial Arabian Sea.

Divergence:

Upper level divergence is 20 $x10^{-5}$ s-1 over around the system of Bay of Bengal.

Upper-level divergence is 5-10 $x10^{-5}$ s-1 over the southeast Arabian Sea adjoining Indian Ocean.

Wind Shear:

Wind shear is 10-20 knots around system centre and decrease towards north Myanmar coast

Wind shear is 5-10 knots over east central and adjoining west central parts of AS.

Wind Shear Tendency:

There is increasing tendency (5 -10 knots) over southeast and southwest parts of Bay of Bengal and adjoining south Andaman sea

There is decreasing tendency over east and westcentral AS except increasing tendency over southeastern part of the Arabian sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

Broken low/medium clouds with embedded intense to very intense convection over Bay between lat 12.0°N to 17.0°N long 83.5°E to 92.0°E in association with the vortex over EC bay & neighbourhood centred near 14.5°N/91.3°E with intensity T1.5 at 0900 UTC. Scattered low/medium clouds with embedded moderate to intense convection over Bay islands. Scattered low/medium clouds with embedded isolated weak to moderate convection over north coastal Andhra Pradesh and Tamil Nadu.

Arabian Sea:

Scattered low/ medium clouds with embedded isolated weak convection off Kerala coast.

Large scale features

Upper tropospheric Ridge: The upper tropospheric ridge at 200 hPa runs along 19^0 N over Bay of Bengal.

M.J.O. Index: MJO index is in Phase 1 with very less amplitude. It would move to phase 8 during next 3 days. While the phase of MJO is unfavourable for genesis and intensification, the very less amplitude over this unfavourable phase will be favourable for cyclogenesis over Bay of Bengal.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The analysis and forecast charts based on 00 UTC of 22 October, 2016 show the Depression over east central Bay of Bengal with associated cyclonic circulation extending up to 500 hPa above mean sea level. The system is likely to intensify into Deep Depression on 23 October and cyclonic storm on 24/25 October, 2016 with northeastward movement towards the Myanmar coast. Thereafter the system shows north-northwestward movement towards Bangladesh coast till 26th and weaken on 27th October, 2016.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 22 October, 2016 show the Depression over east-central Bay of Bengal with associated cyclonic circulation extending up to 500 hPa above mean sea level. The system likely to move in northeastward direction and intensify into a deep Depression and Cyclone by 24 October 2016. Thereafter, the system shows north-northwestward movement towards northeast Bay of Bengal during subsequent 2 days.

ECMWF (SWFDP Products): The model charts based on 00 UTC of 22 October 2016 shows the Depression over the East-central Bay of Bengal along with associated cyclonic circulation extending up to 500 hPa above mean sea level. The system is likely to intensify into a deep Depression on 23 October 2016 and Cyclone on 23rd evening/24th morning with northeastward movement. Thereafter, it recurves and moves in north-Northwesterly direction for subsequent 2 days towards Bangladesh. The system likely to intensify further on 27th into severe cyclonic storm for a brief period and cross western parts of Bangladesh and adjoining West Bengal Coast on 27th late night/28th early morning.

WRF: The WRF model analysis and forecasts based on 00 UTC of 22 October 2016 show a depression with associated cyclonic circulation extending up to 500 hPa over east-central Bay of Bengal. The system is likely to intensify into Deep Depression on 23 over EC and into a Cyclonic Storm on 24 October while moving in northeastward direction and subsequently shows north-northwestward movement and intensify into severe cyclonic storm on 25 October, 2016 over northeast Bay of Bengal off Arakan Coast.

JMA: JMA Model indicates a well marked low pressure area on 22nd over east central and adjoining southeast Bay. Moving northeastwards, it becomes a depression on 24th over EC Bay near Myanmar coast. It recurves and moves in a west northwestery direction on 25th and becomes a deep depression over EC Bay.

ARP-Meteo France Model indicates a depression over EC Bay on 22nd which moves in an eastward direction and becomes a deep depression on 23rd over EC Bay. Further moving east northeastwards it intensifies into a cyclone 24th and SCS on 25th over the same area.

NCMRWF-NCUM: It shows a low over EC bay on 22nd and a WML on 23rd over EC Bay and adjoining SE Bay. Moving northeastwards, it becomes a depression on 24th and a cyclone on 25. On 26th the CS is seen over EC and adjoining WC Bay. Moving westwards, it weakens into a depression over WC Bay on 27th and further to a low over coastal Andhra Pradesh on 28th. It becomes less marked on 29th.

NCMRWF-UM-Regional Model: It suggests a low over east central Bay on 22nd. Moving northeastwards, it becomes a WML on 23rd, a depression on 24th and a cyclonic storm on 25th over east central Bay.

NCMRWF-NEPS Model: It suggests a cyclonic storm over EC Bay on 22nd. Moving northeastwards it becomes a severe cyclonic storm over EC Bay on 23rd. It further moves in a WNW direction and seen over EC and adjoining WC Bay on 24th. Moving westwards, it is seen over WC Bay on 25th. Further moving southwestwards, it is seen over WC Bay off Andhra coast on 26th and weakens into a depression on 27th. It lies over interior peninsular India on 28th and becomes less marked thereafter.

IITM-GEFS: Based on the 00 UTC analysis on 22nd, a WML is seen over EC Bay near Irrawaddy Delta on 23rd. It moves very close to the coast on 24th and further recurves and moves in WNW direction on 25th. It continues to move in WNW direction on 26th and further in a NW direction on 27th and is seen over NW and adjoining central Bay on 27th. It crosses Bangladesh and adjoining West Bengal Coast on 28th and became less marked thereafter.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

The Genesis Potential Parameter (GPP) analysis and forecasts based on 00 UTC of 22nd October 2016 shows a significant GPP zone over east-central Bay of Bengal which is likely intensify and move northeastward towards Myanmar coast (Irrawaddi delta) till 24th October 2016. With a northwestward movement crossing Arakan coast the GPP zone recurves and emerges again over Bay of Bengal on 26th October 2016. The significant GPP zone move westward till 27th October 2016 then northward on 28th and becomes less marked on 29th . Analysis and forecasts of GPP based on 0000 UTC of 22 October 2016 suggests that the Depression over the Bay of Bengal is likely to intensify into a Cyclonic Storm.

MME TRACK: MME track forecast based on 0000 UTC of 22 October 2016 shows initial northeastward movement of the "DEPRESSION" over the east central Bay of Bengal towards Arakan coast till 0000 UTC of 24 October 2016 and recurvature thereafter towards west-northwestward direction reaching NW and adjoining WC Bay on 27/0000 UTC.

SCIP INTENSITY: Intensity prediction by the SCIP model shows that the "DEPRESSION" over the east central Bay of Bengal is likely to intensify into a Cyclonic Storm at 0000 UTC of 24 October 2016.

RAPID INTENSIFICATION: Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 5.2% (Inference: RI probability VERY LOW)

Summary and Conclusion:

Past 24 hours observations indicated that the system moved east-northeastwards under the influence of lower and middle level westerlies. The steering speed was about 10 knots in the direction of east-northeast (070^0). The system maintained its intensity as depression without intensification mainly due to high wind shear (about 20 knots) prevailing over the region. As the system moves northeastwards, it will gradually experience relatively lower wind shear and alongwith increase in SST. Hence the environment will be favourable for intensification from tomorrow, the 23rd Oct. 2016. Majority of numerical models also indicate steady intensification of the system and movement towards Myanmar coast during next 24 hours. Thereafter, most models suggest the recurvature of the system. However, there is large divergence in the direction and point of recurvature and regarding landfall over Myanmar. While GFS based models and ECMWF suggest recurvature towards northeast Bay of Bengal after the landfall over Myanmar coast near Irrawaddy delta, the Unified models, its EPS, JMA, Meteo-France models suggest movement towards WC Bay without landfall over Myanmar.

Considering all the above, it would move northeastwards and reach near Myanmar coast by 23rd evening and start recurving northwestwards, skirting Myanmar coast on 24th and will reach NW and adjoining WC Bay on the morning of 27th. After the recurvature, the system will again experience decrease in Ocean heat content, decrease in middle to upper level moisture due to prevailing continental westerlies and also gradual increase in wind shear, if the system moves towards north Bay of Bengal. These factors may restrict the intensification of the system over the north Bay of Bengal. On the other hand it may lead to gradual weakening of the system. It is also reflected by the guidance given by ECMWF and GFS based models. However, under these circumstances, there is very low probability of rapid intensification or rapid weakening of the system. The same is also predicted by the Rapid Intensification Index of IMD.

Advisory:

- In view of the large divergence regarding landfall over Myanmar near Irrawaddy delta and re-curvature direction thereafter, it need to be further monitored closely.
- However, whether it crosses Myanmar coast or not, it will be very close to Irrawaddy delta and hence north Myanmar coast may experience adverse weather due to this system from 23rd evening onwards.
- No IOP for next five days over Indian coast. However, intense observation may be taken by Myanmar during 23-25 Oct. 2016.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time(UTC)		
	21/12	22/00	22/03
India	45	39	44
Coastal stations			
WB	9	9	8
Odisha	7	6	7
AP	12	12	12
TamilNadu	10	10	10
Puducherry	1	1	1
A& N	6	1	6
Bangladesh	9	9	10
Myanmar	1	-	0
Thailand	1	1	1
SriLanka	10	9	10

No. of RS/RW Ascents

12Z /21.10.2016 : 35/39

No. of Ascents reaching 250 hPa level = -

MISDA : 5

00Z /22.10.2016 :36

No. of Ascents reaching 250 hPa level =-

MISDA : 7

No. of PILOT Ascents:

22.10.2016	
21/12Z	22/00Z
6/37	3/34

Buoy Data

21/12Z	22/00Z	22/03Z
11	11	11

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**21.10.2116**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**22**
Chennai Region (Coasts of AP & TN)	**19**	**22**	**20**	**20**	**21**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /21.10.2116 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /21.10.2116 : 4

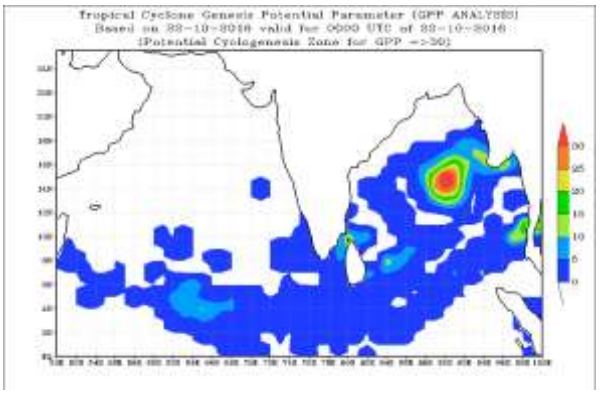
No. of Ascents reaching 250 hPa level = 4

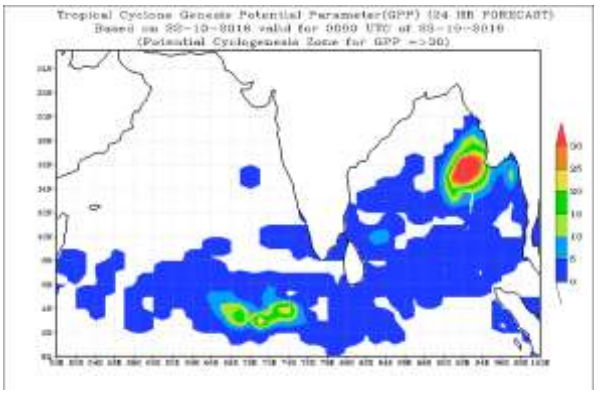
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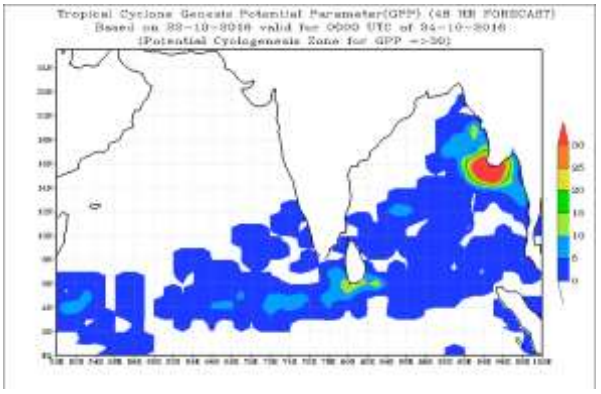
No. of PILOT Ascents:

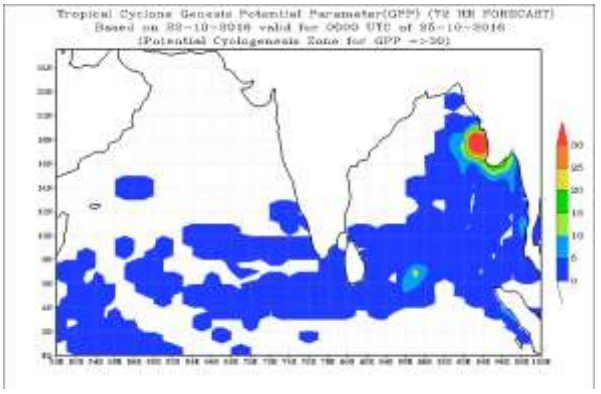
21.10.2116	
06Z	18Z
3	2

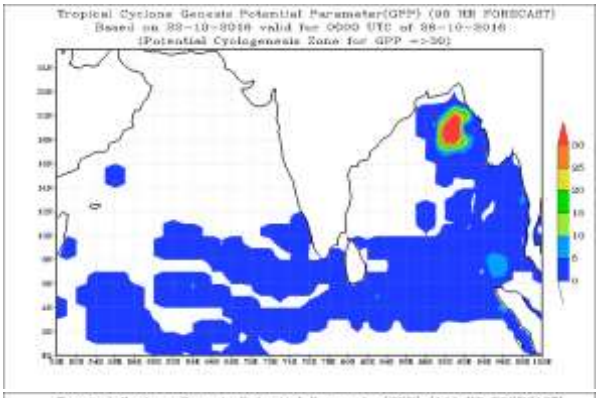
Annexure-II

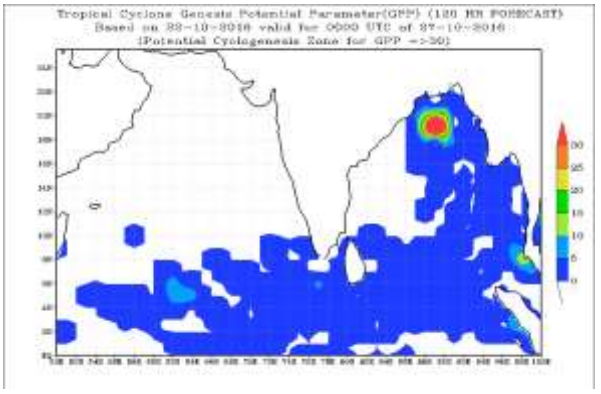

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 22-10-2016 valid for 0000 UTC of 22-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

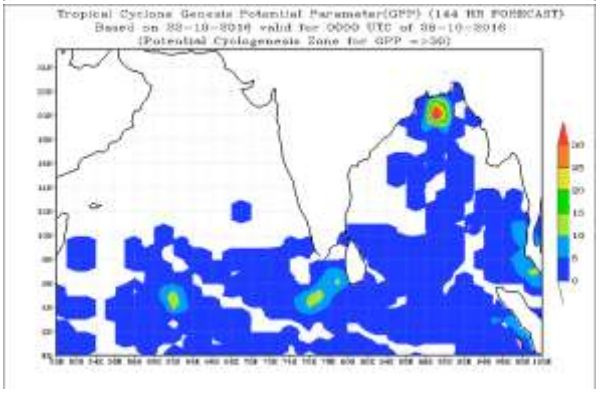

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 22-10-2016 valid for 0000 UTC of 23-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

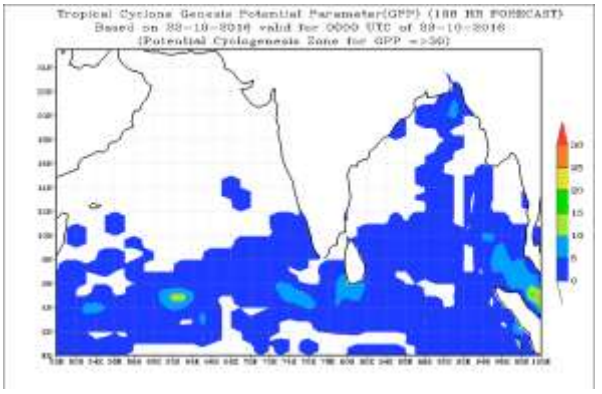

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 22-10-2016 valid for 0000 UTC of 24-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

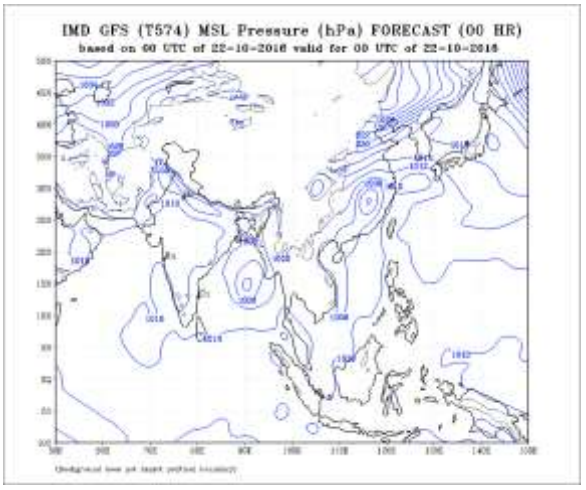

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 22-10-2016 valid for 0000 UTC of 25-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

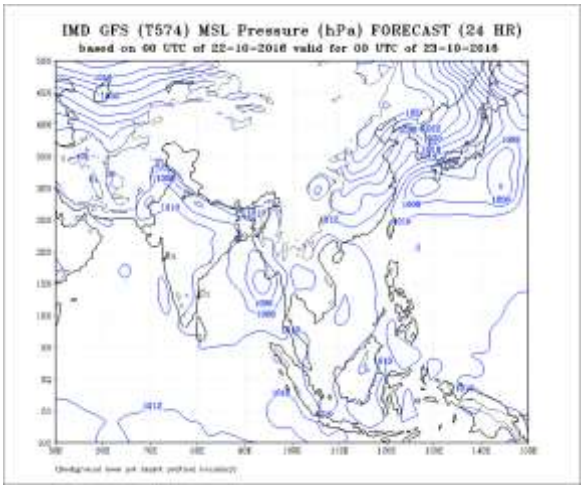

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 22-10-2016 valid for 0000 UTC of 26-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

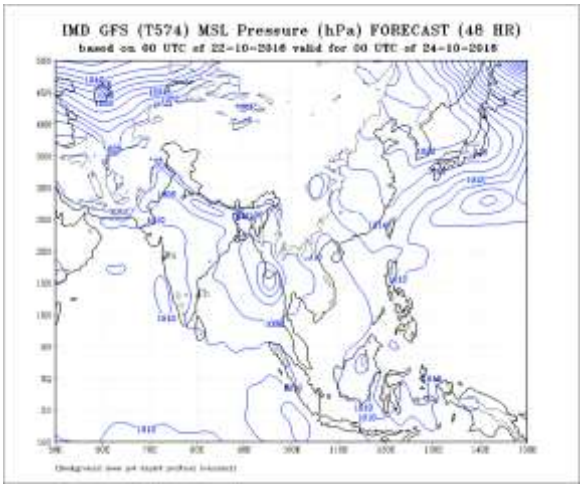

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 22-10-2016 valid for 0000 UTC of 27-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

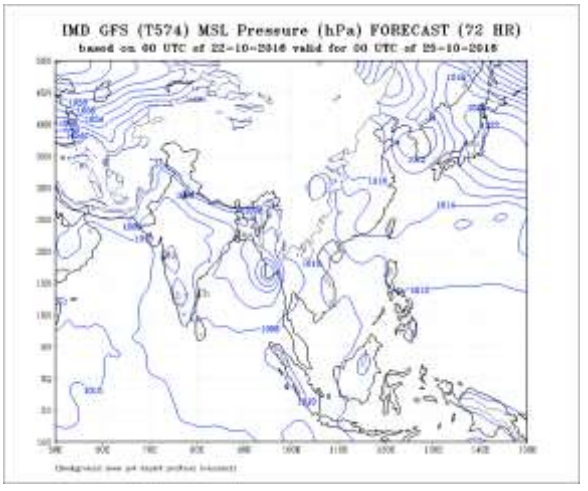

Tropical Cyclone Genesis Potential Parameter(GPP) (144 HR FORECAST)
Based on 22-10-2016 valid for 0000 UTC of 28-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

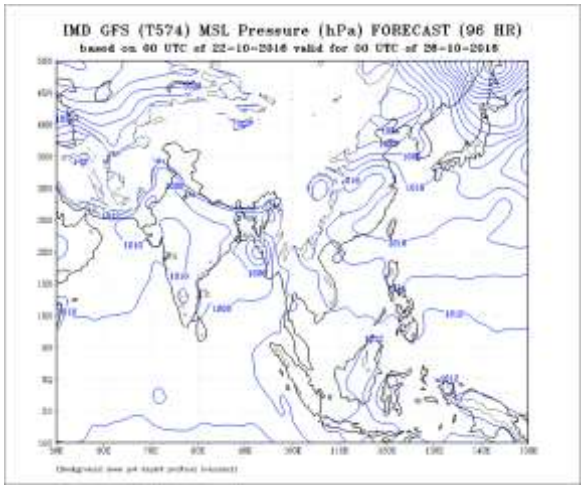

Tropical Cyclone Genesis Potential Parameter(GPP) (168 HR FORECAST)
Based on 22-10-2016 valid for 0000 UTC of 29-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

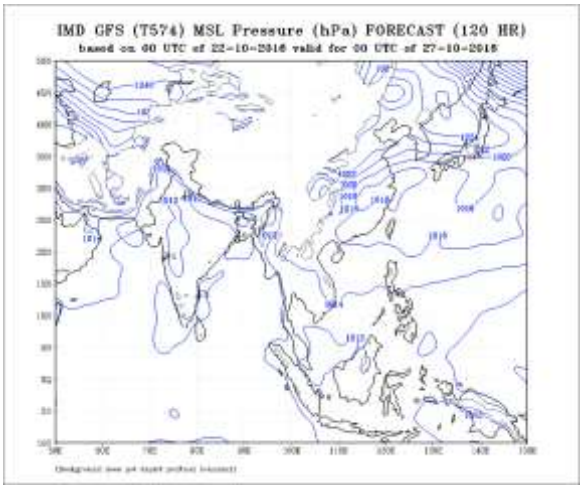

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 22-10-2018 valid for 00 UTC of 22-10-2018

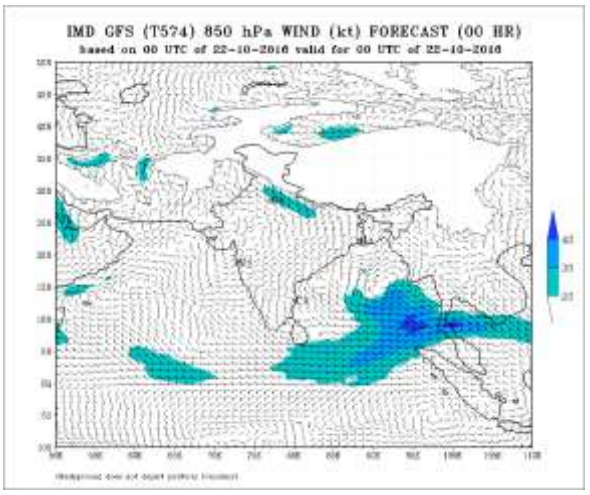

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
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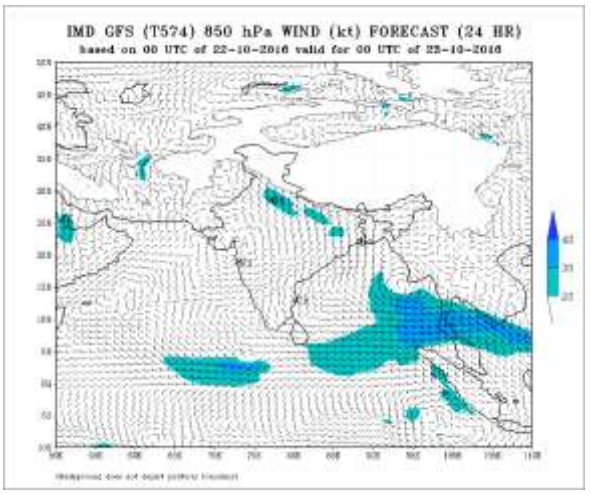

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
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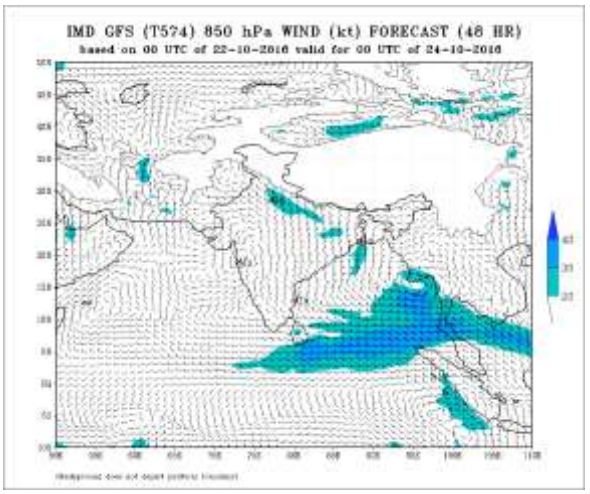

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
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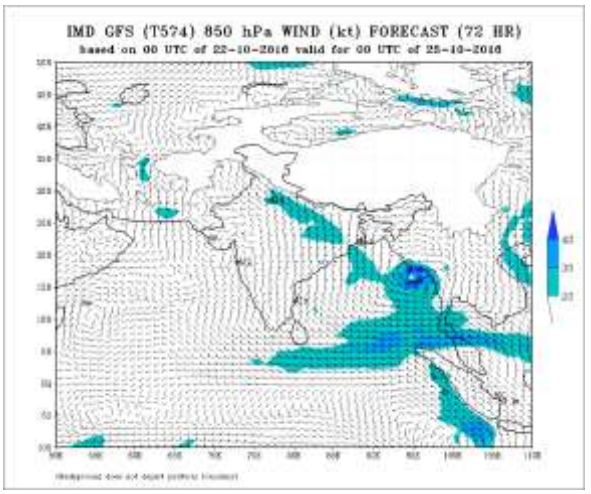

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 22-10-2018 valid for 00 UTC of 26-10-2018

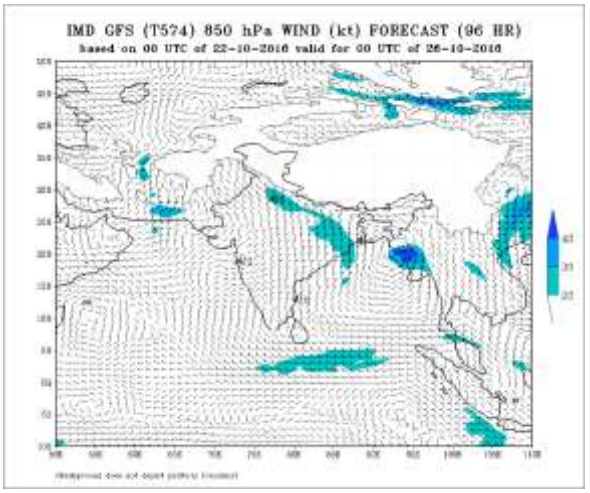

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 22-10-2018 valid for 00 UTC of 27-10-2018

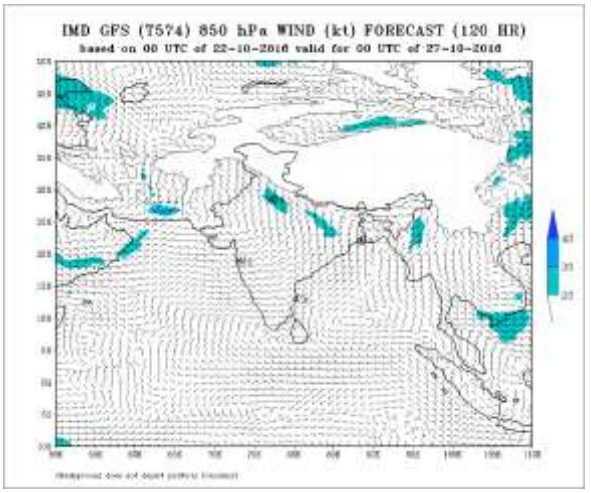

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 22-10-2016

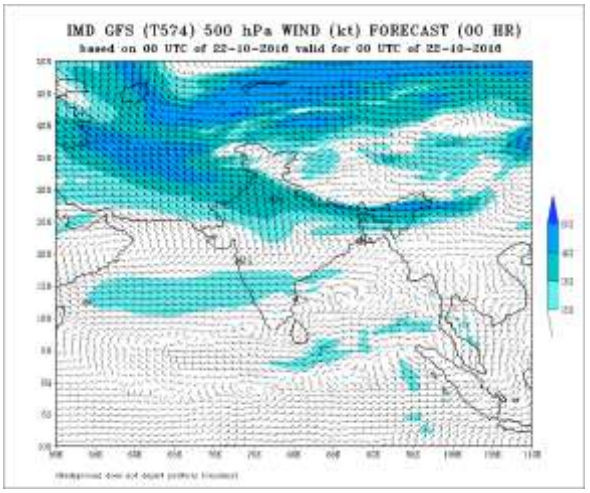

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
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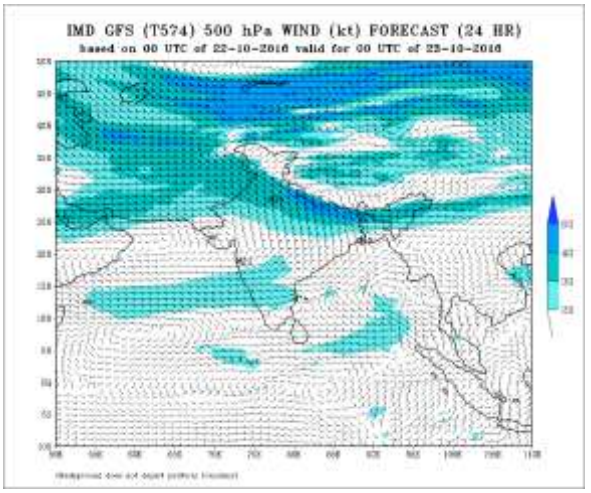

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
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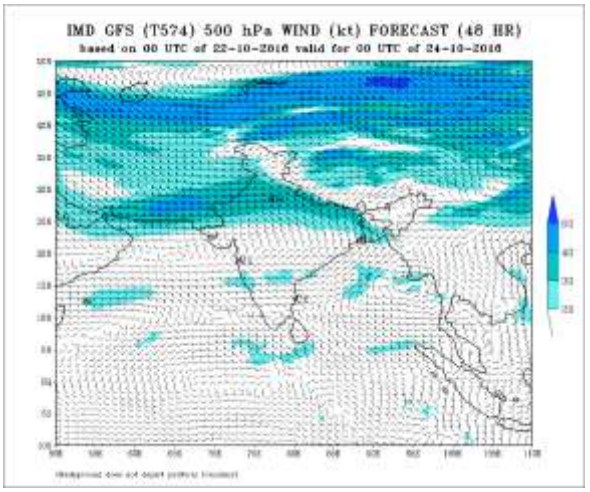

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 25-10-2016

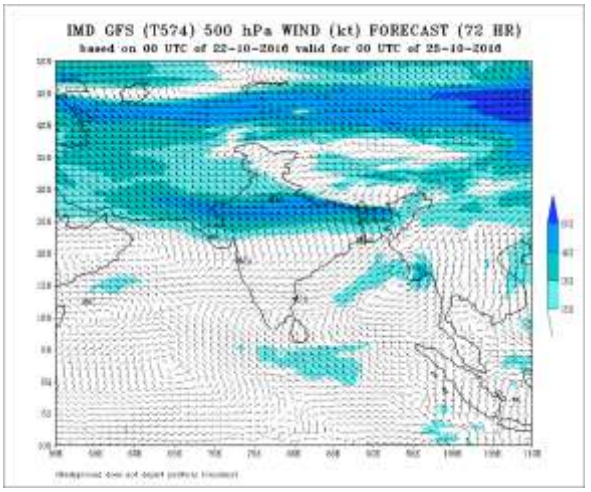

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 26-10-2016

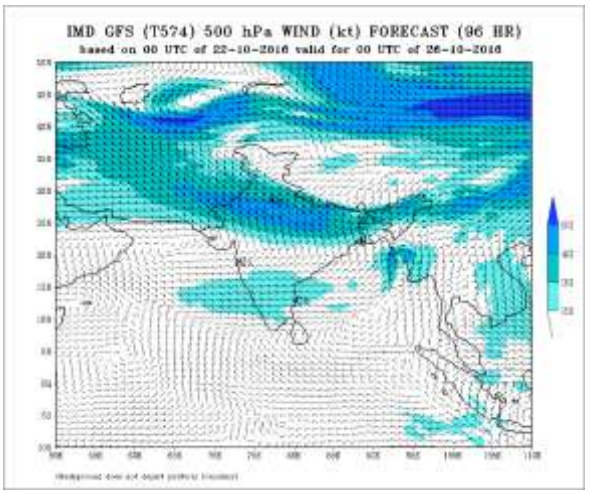

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 27-10-2016

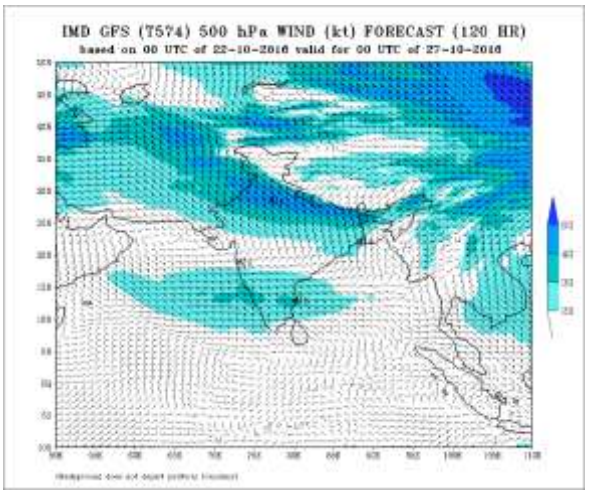

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 22-10-2016

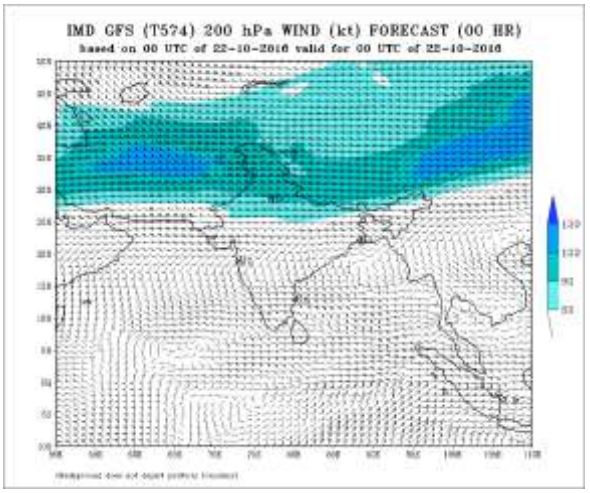

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 23-10-2016

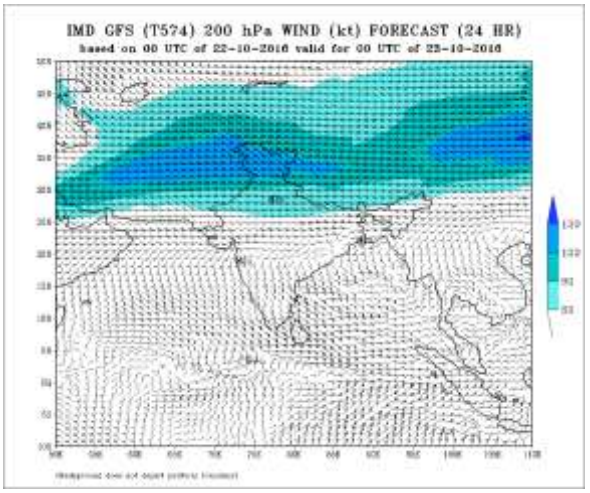

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 24-10-2016

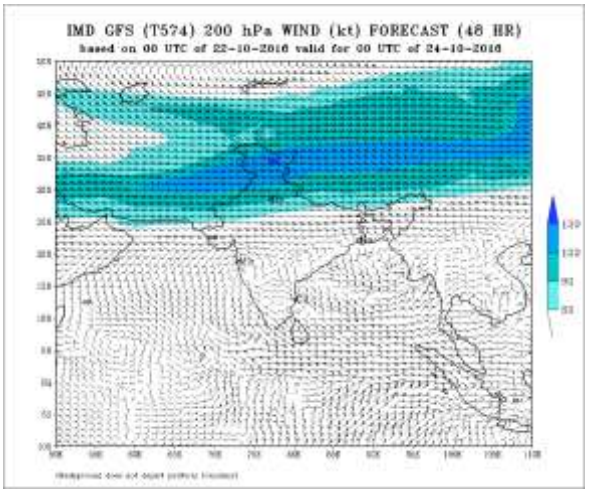

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 25-10-2016

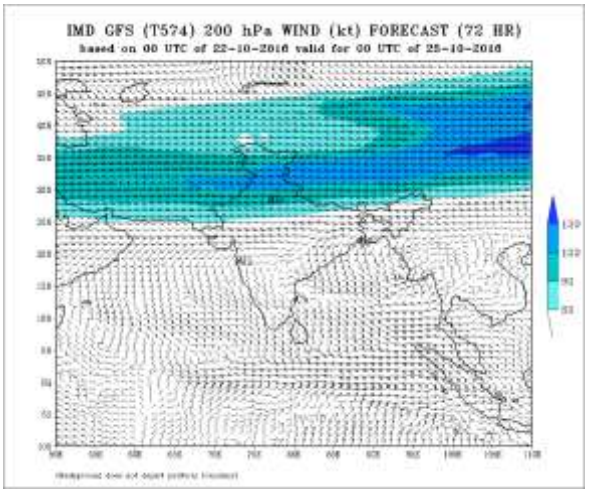

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 26-10-2016

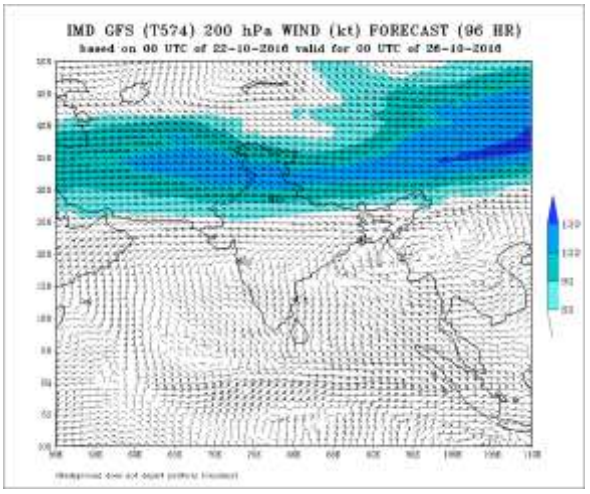

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 27-10-2016

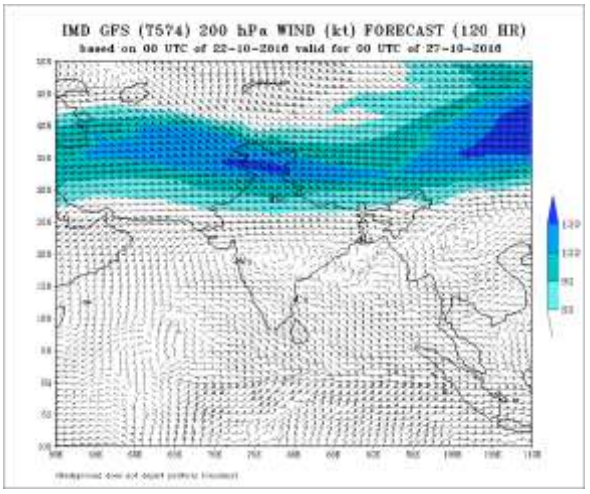

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 22-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 23-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 24-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 25-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 26-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 22-10-2016 valid for 00 UTC of 27-10-2016

FDP (Cyclone) NOC Report Dated 23rd - October, 2016

Synoptic features:

The depression over eastcentral Bay of Bengal moved east-northeastwards during past 12 hrs, intensified into a deep depression and lay centred at 0300 UTC of today, the 23 rd October, 2016 over eastcentral Bay of Bengal, near latitude 15.5º N and longitude 93.0º E, about 420 km north of Port Blair (43333) and 360 km west-southwest of Yangon (48097). The system is most likely to intensify into a cyclonic storm during next 24 hours. It will move northeastwards and reach close to north Myanmar coast by today evening. Thereafter, it will recurve initially north-northwestwards skirting Myanmar coast and then northwestwards towards northwest Bay of Bengal.

The upper air cyclonic circulation over southeast Arabian Sea Lakshadweep area now lies over southeast Arabian Sea between 3.6 & 5.8 km above mean sea level.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29-30˚C It is around 28-29°C over remaining parts of Bay of Bengal and northeastern Andaman Sea.

SST is around 26-28°C over most parts of Arabian Sea (AS) except for small areas off the coast of Karnataka and Maharashtra.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 100 kJ/CM^2. It increases towards northeast sector of the system. TCHP is below 50kJ/cm^2 over most parts of AS except for EC and adjoining SE AS, where it is 50-70 kJ/cm^2.

Relative Vorticity:

The low level relative vorticity is about 150x10^{-6} second^{-1} and vorticity centre lies to the east-northeast of the system centre.

It is positive and around 20-50X10^{-6}s^{-1} over northeast and off east of Oman coast and some parts of the central Arabian sea. It is negative over rest AS.

Convergence:

Lower level convergence is about 20x 10^{-5}s^{-1} over around the system centre over Bay of Bengal. It is about 5-10 x 10^{-5}s^{-1} over south Andaman Sea and over southern parts of India.

There is no area of significant lower level convergence over Arabian Sea.

Divergence:

Upper level divergence is 30 x10^{-5} s-1 over around the system of Bay of Bengal.

Wind Shear:

Wind shear is 10-15 knots around system centre and it decrease towards northeast direction becoming 5-10 knots near Arakan & adjoining Tenasserim coast.

Wind shear is 5-10 knots over east central and adjoining west central parts of AS. It increases towards north and towards south.

Wind Shear Tendency:

There is increasing tendency (5 -10 knots) over southeast and southwest parts of Bay of Bengal and adjoining south Andaman sea

The shear tendency is zero roughly along 15^{o}N latitude over the Arabian sea. It increases to the north and south.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

Broken low/medium clouds with embedded intense to very intense convection over Bay between lat 12.0^{o}N to 18.0^{o}N long 86.0^{o}E to 95.0^{o}E in association with the vortex over EC bay & neighbourhood centred near 15.5^{o}N/92.7^{o}E with intensity T2.0 at 0900 UTC. Scattered low/medium clouds with embedded moderate to intense convection over Bay islands.

Arabian Sea:

No significant clouds over the region.

Large scale features

Upper tropospheric Ridge: An upper air anticyclonic circulation lies over Myanmar near Irrawaddy delta.

M.J.O. Index: MJO index is in Phase 1 with very less amplitude. It would continue to remain in phase 1 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The analysis and forecast charts based on 00 UTC of 23rd October, 2016 show the Depression over east central Bay of Bengal. The system is likely to intensify into Deep Depression on 24th October and northeastward movement towards the Myanmar coast. It becomes a cyclonic storm on 25th October, 2016 and the system shows west-northwestward movement towards Orissa coast till 27th October, 2016. Thereafter it shows north northwestward movement and cross Orissa and adjoining West Bengal coast on 28 and becomes less marked on 29th.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 23 October, 2016 show the Depression over east-central Bay of Bengal with associated cyclonic circulation extending up to 500 hPa above mean sea level. The system likely to move in northwestward direction and intensify into a deep Depression/Cyclone by 24th October 2016. Thereafter, the system shows north-northwestward movement towards north Bay of Bengal during subsequent 2 days and crossed West Bengal and adjoining Bangladesh coast on 27th and became les marked on 28th.

ECMWF (SWFDP Products): The model charts based on 00 UTC of 23 October 2016 shows the Deep Depression over the East-central Bay of Bengal along with associated cyclonic circulation extending up to 500 hPa above mean sea level. The system is likely to move in northeast direction towards Myanmar coast till 24th and further move in North/Northwestward direction till 28 October, 2016 towards the west-Bengal/ Bangladesh coast. There is a possibility of the system to intensify into a cyclonic storm while moving towards west-Bengal/ Bangladesh coast.

WRF: The WRF model analysis and forecasts based on 00 UTC of 23rd October 2016 show a deep depression over east-central Bay of Bengal. The system is likely to intensify into Deep Depression on 24th over EC. Moving in an eastward direction it touched Irrawaddy delta and re-emerges into EC Bay and into a Cyclonic Storm on 25th October. Thereafter while moving in northwestward direction intensifies into severe cyclonic storm on 26th October, 2016 over northwest and adjoin WC Bay of Bengal.

JMA: JMA Model indicates a well marked low pressure area on 23rd over EC Bay. Moving northeastwards, it becomes a depression on 24th over EC Bay near Myanmar coast. It recurves and moves in a west northwesterly direction on 25th and becomes a deep depression on 25th and a SCS on 26th over EC Bay and adjoining WC Bay.

ARP-Meteo France Model indicates a WML over EC Bay on 23rd which moves in northeastward direction and becomes a deep depression on 24th over EC Bay. Further it recurves and moves in a northwestward direction and intensifies into a cyclone 25th and continued to move in NW direction on 26th and is seen over central BoB.

NCMRWF-NCUM: It shows a low over EC bay near Irrawaddy delta on 23rd and it became a deep depression on 24th over EC bay and moved in NW direction. Moving west northwestwards, it becomes a cyclone on 25th. On 26th the CS is seen over EC and adjoining WC Bay. Moving westwards, it weakens into a depression over WC Bay on 27th and crosses south Andhra coast on 28th and weakens into a low pressure area on 28th. Moving westwards, it becomes less marked on 30th.

NCMRWF-UM-Regional Model: It suggests a low over east central Bay on 23rd over EC Bay. Moving northeastwards, it becomes a CS on 24th . It recurves thereafter and moves in a west southwesterly direction and becomes a severe cyclonic storm on 25th over east central Bay remained practically stationary on 26th.

NCMRWF-NEPS Model: It suggests a cyclonic storm over EC Bay on 23rd. Moving northwards it becomes a severe cyclonic storm over NE and adjoining EC Bay on 24th . It continues to move in a north direction and seen over central part of the north Bay on 25th. Further moving west-northwestwards, it is seen over NW Bay on 26th. Continue to move in the same direction it crosses the North Orissa and adjoining West Bengal coast on 27th and weakens into WML over land on 28th. Further moving in a slight northeast direction it is seen as a low pressure area over Bangladesh on 29th and becomes less marked on 30th .

IITM-GEFS: Based on the 00 UTC analysis on 23rd, a depression is seen over EC Bay near Irrawaddy Delta on 24th. It moves in a westward direction and became a deep depression over EC Bay on 25th. It continues to move in west direction on 26th and further in a NE direction on 27th and is seen over North Orissa coast on 28th. It became less marked thereafter.

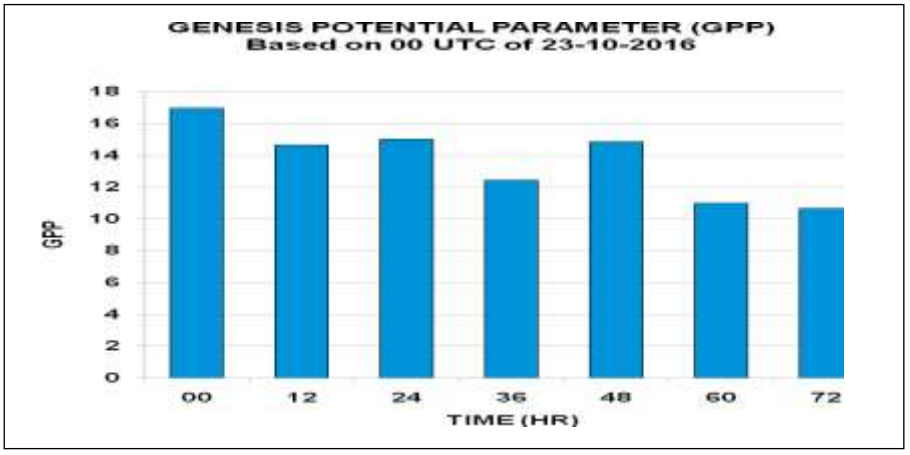
IITM-GFS(T1534) based on 22/0000 UTC initial condition : WML on 23rd over EC Bay off Irrawaddy delta, Depression on 24th to the south of Irrawaddy delta and over Irrawaddy delta on 25th, CS on 26th over EC Bay

off north Myanmar coast, SCS over EC and adjoining NE Bay off Bangladesh coast on 27th and close to Bangladesh coast to west of Chittagong on 28th and becomes less marked on 29th.

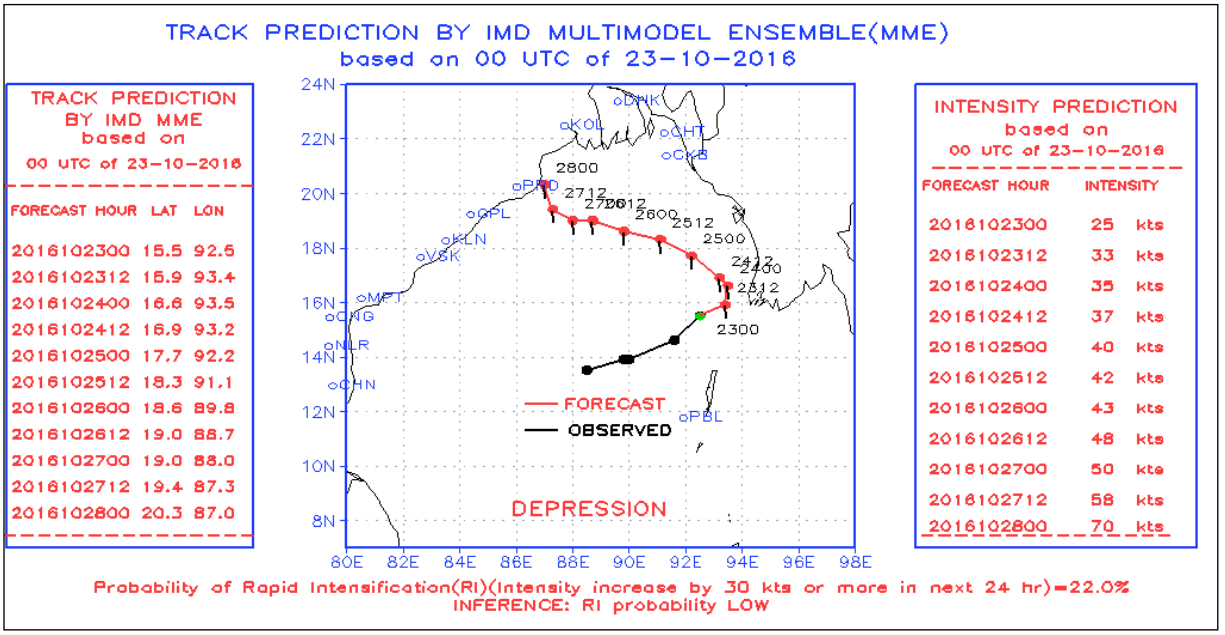
Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

The Genesis Potential Parameter (GPP) analysis and forecasts based on 00 UTC of 23rd October 2016 shows a significant GPP zone over east-central Bay of Bengal which is likely to intensify and move northeastward towards Myanmar coast (Irrawaddi delta) till 24th October 2016. With a northwestward movement the GPP zone recurves and re-emerges over EC Bay of Bengal on 25th October 2016. The significant GPP zone move northward to NE BoB on 26th October 2016 then further northward to head bay on 27th and becomes less marked on 28th . Analysis and forecasts of GPP based on 0000 UTC of 23 October 2016 suggests that the Depression over the Bay of Bengal has potential to intensify into a Cyclonic Storm.



MME TRACK: MME track forecast based on 0000 UTC of 23 October 2016 shows initial northeastward movement of the "DEPRESSION" over the east central Bay of Bengal towards Arakan coast till 0000 UTC of 24 October 2016 and recurvature thereafter towards northwestward direction.



SCIP INTENSITY: Intensity prediction by the SCIP model shows that the "DEPRESSION" over the east central Bay of Bengal is **likely to intensify into a Cyclonic Storm at 0000 UTC of 24 October 2016.**

RAPID INTENSIFICATION: Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 22% (**Inference: RI probability LOW**).

Summary and Conclusion:

Past 24 hours observations indicated that the system moved east-northeastwards under the influence of lower and middle level westerlies. The steering speed was about 5 knots in the direction of east-northeast (070^0). The system intensified into a deep depression mainly due to decrease in wind shear prevailing over the region in addition to increase in low level convergence and vorticity as well as upper level

divergence. Also the system moved over the area with higher Ocean thermal energy. Similar condition will prevail during next 48 hrs. Hence, the system will continue to intensify further becoming cyclonic storm during next 24 hrs. The presence of anti-cyclonic circulation over Myanmar close to Irrawaddy delta will lead to recurvature of the system initially to north-northwest and then northwest. Also as the system intensifies into the cyclonic storm, the steering level will extend to upper tropospheric level which will cause the system to move northwestwards towards India coast. Also Majority of numerical models also indicate steady intensification of the system and movement towards Myanmar coast during next 12 hours. Thereafter, most models suggest the recurvature of the system. However, there is large divergence in the direction and point of recurvature and regarding landfall over Myanmar. While GFS based models, ECMWF and UM-EPS suggest recurvature towards north Bay of Bengal, the Unified models, JMA, Meteo-France models suggest movement towards WC Bay.

Considering all the above, the deep depression would move northeastwards for next 12 hrs and start recurving north-northwestwards and will reach NW Bay on the morning of 27th. After the recurvature, the system will again experience decrease in Ocean heat content, decrease in middle to upper level moisture due to prevailing continental westerlies, if the system moves towards north Bay of Bengal. These factors may restrict the intensification of the system over the north Bay of Bengal. However, the low to moderate wind shear may favour the intensification. It is also reflected by the guidance given by ECMWF, UM-EPS and GFS based models. However, under these circumstances, there is very low probability of rapid intensification or rapid weakening of the system. The same is also predicted by the Rapid Intensification Index of IMD.

Advisory:

- Intense observation may be taken by Myanmar coast during 23-25th, over Bangladesh, Odisha, north Andhra Pradesh and West Bengal coasts during 25-27th Oct. 2016.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	22/12	**23/00**	**23/03**
India	45	38	47
Coastal stations			
WB	8	3	9
Odisha	6	6	6
AP	12	12	12
Tamil Nadu	12	10	12
Puducherry	1	1	1
A & N	6	6	7
Bangladesh	9	9	10
Myanmar	4	2	5
Thailand	1	1	1
SriLanka	10	8	10

- **RS/RW** (12Z) of 22 / 10 /2016 35 /39
- **No. of Ascents reaching 250 hPa levels: 35 , MISDA:- 4**

- **RS/RW** (00Z) of 23 / 10 /2016 36 /39
- **No. of Ascents reaching 250 hPa levels: 36 , MISDA: 3**
-

No. of PILOT Ascents

22/12Z	**23/00Z**
6/37	3/34

Buoy Data

22/12Z	**23/00Z**	**23/03Z**
11	11	11

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**22.10.2216**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**19**

No. of RS/RW Ascents

00Z /22.10.2216 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /22.10.2216 : 2

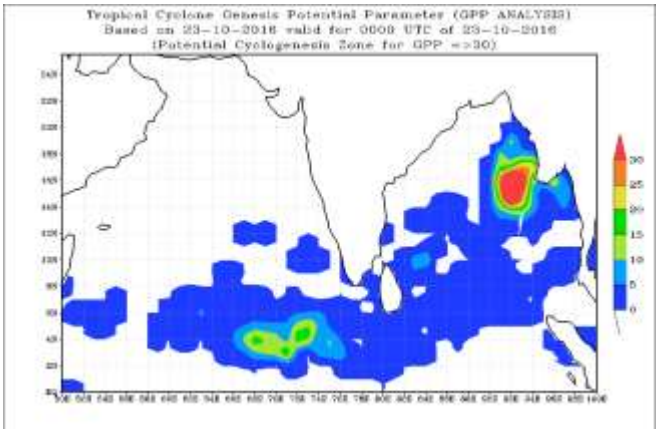
No. of Ascents reaching 250 hPa level = 2

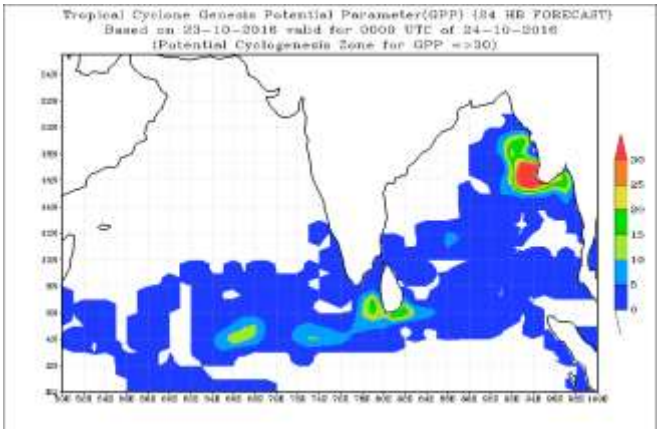
MISDA : 6

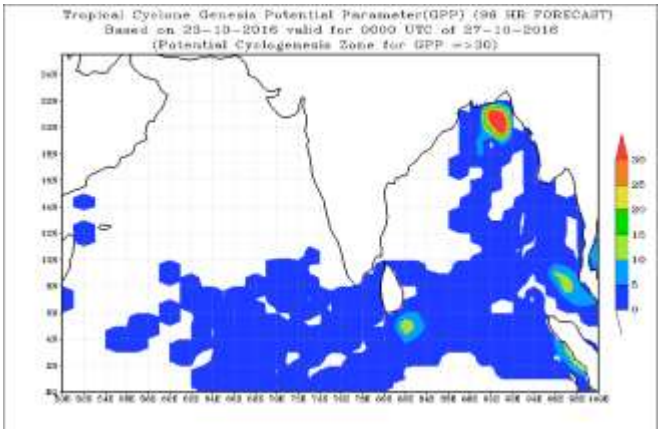
No. of PILOT Ascents:

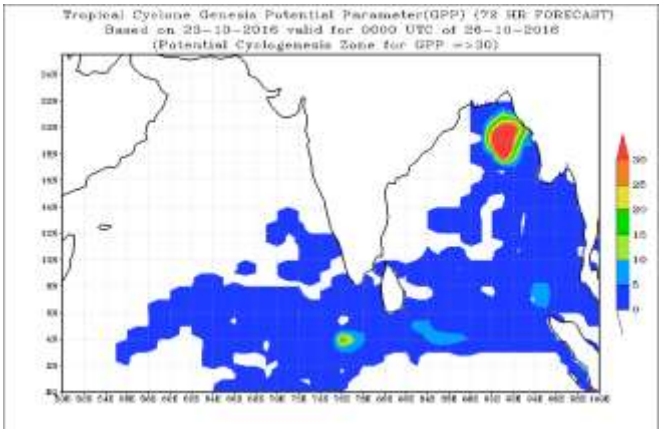
22.10.2216	
06Z	18Z
4	3

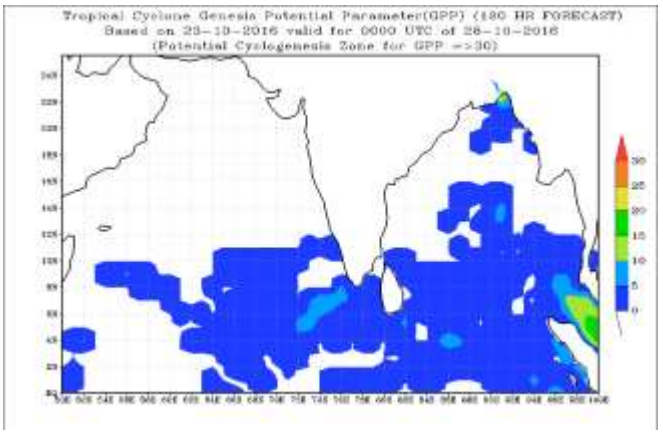
Annexure-II

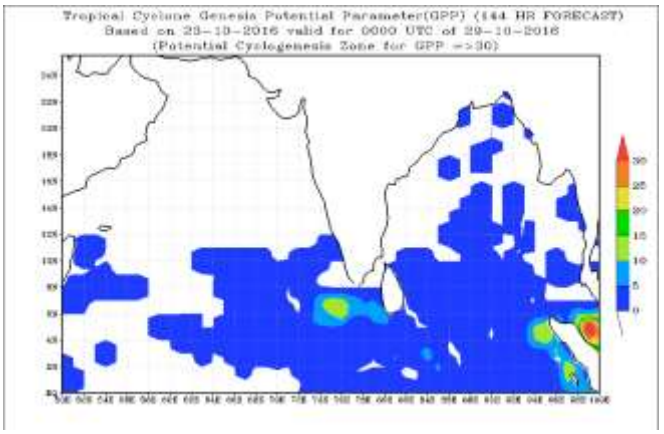

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 23-10-2016 valid for 0000 UTC of 23-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

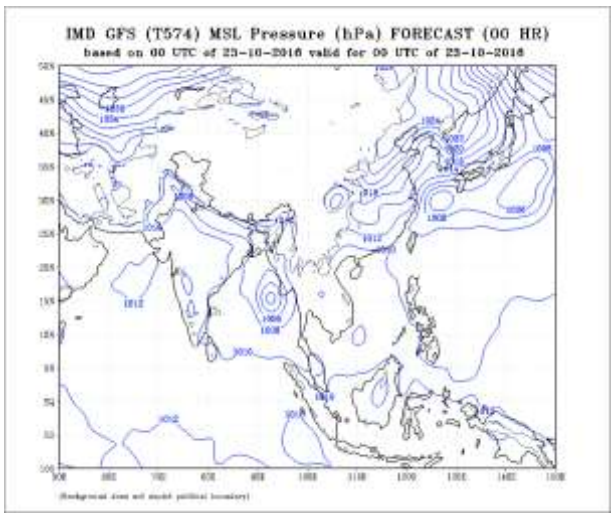

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 23-10-2016 valid for 0000 UTC of 24-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

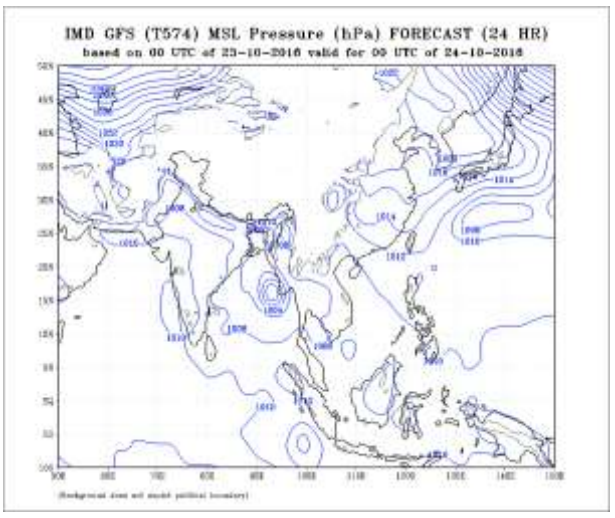

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 23-10-2016 valid for 0000 UTC of 27-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

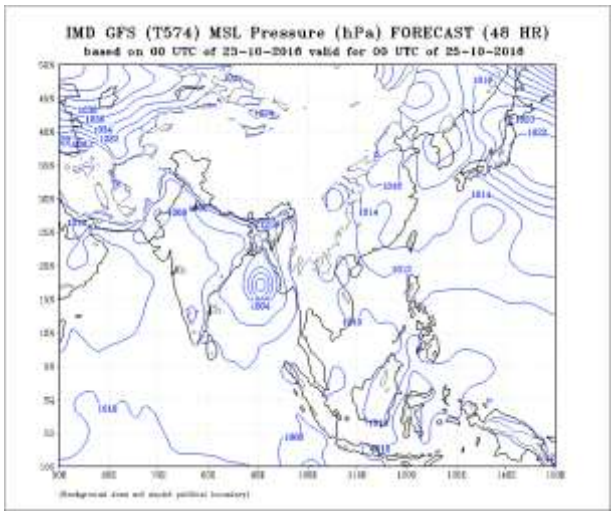

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 23-10-2016 valid for 0000 UTC of 26-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

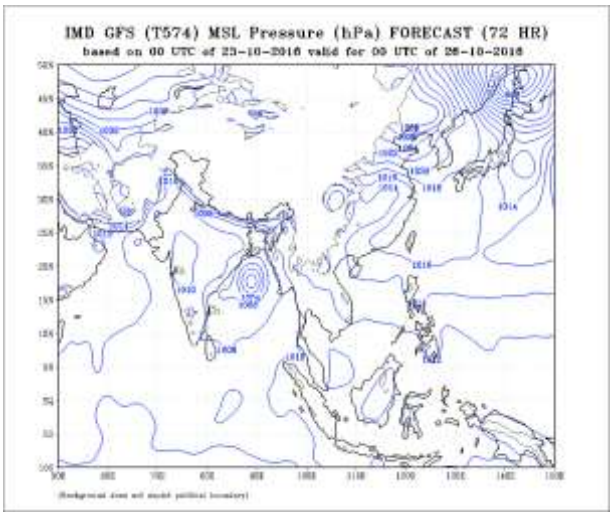

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 23-10-2016 valid for 0000 UTC of 28-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

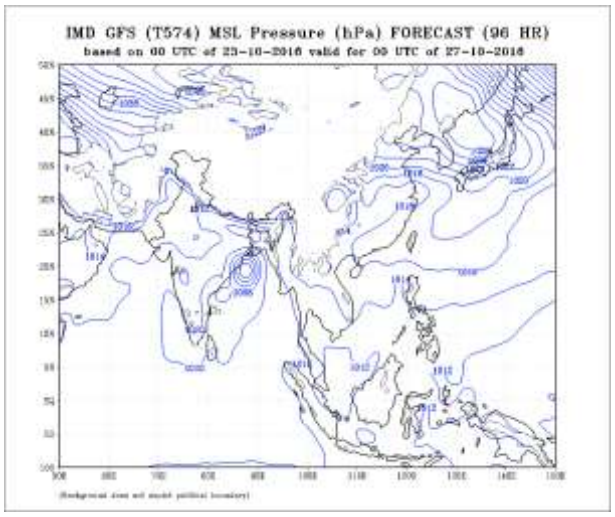

Tropical Cyclone Genesis Potential Parameter(GPP) (144 HR FORECAST)
Based on 23-10-2016 valid for 0000 UTC of 29-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

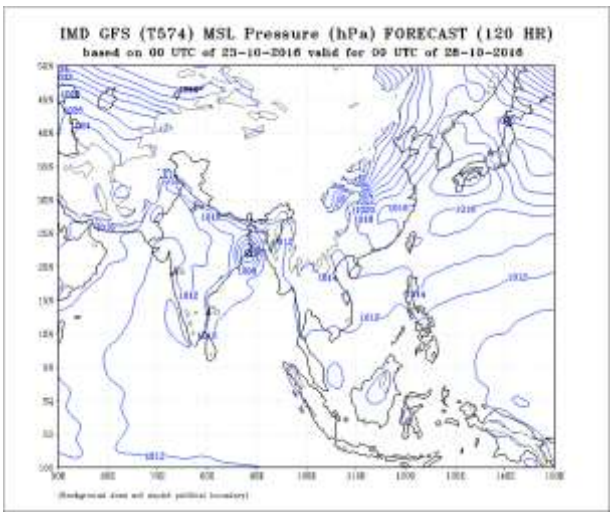

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 23-10-2016

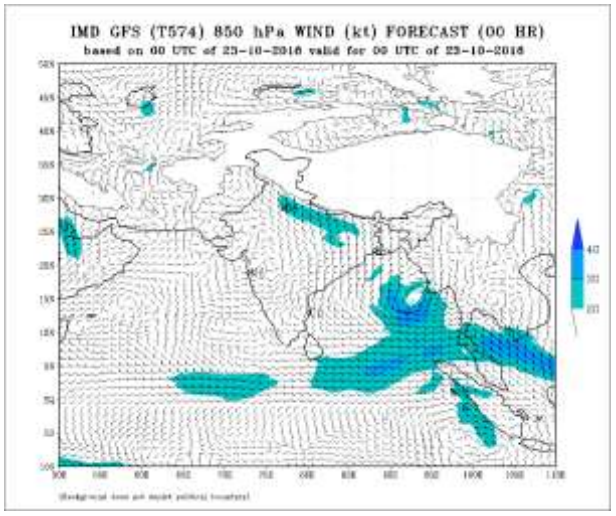

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 24-10-2016

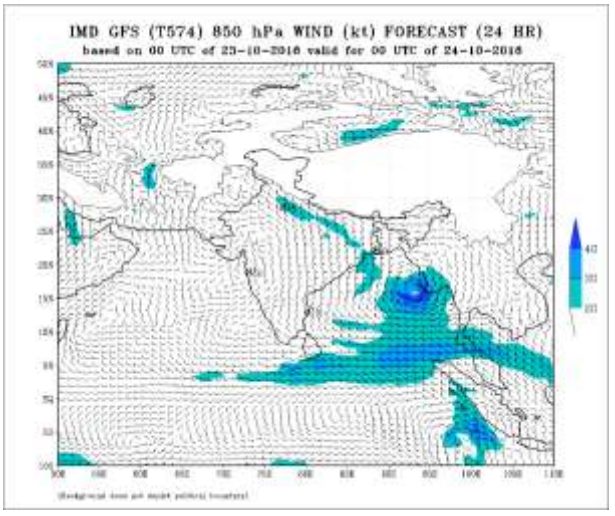

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 25-10-2016

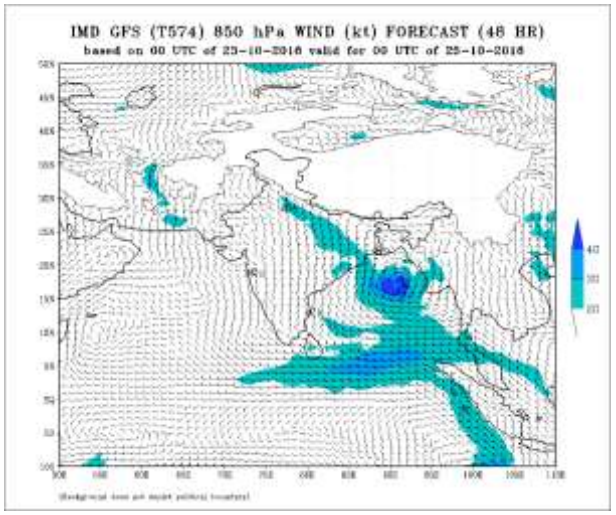

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 26-10-2016

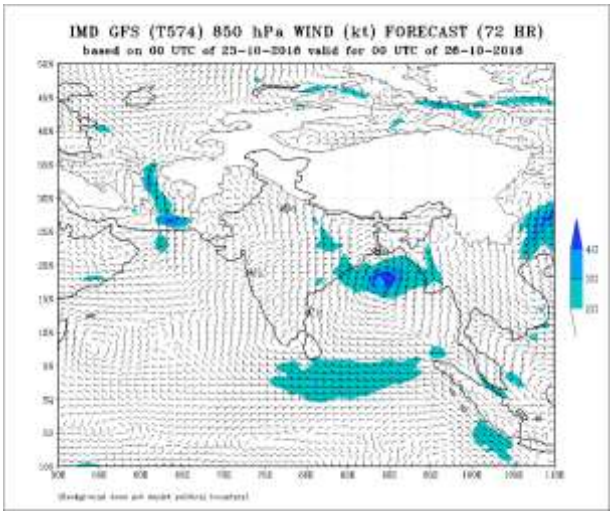

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 27-10-2016

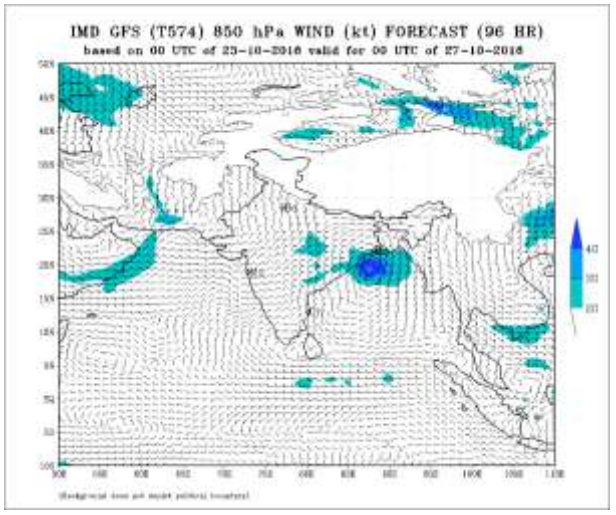

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 28-10-2016

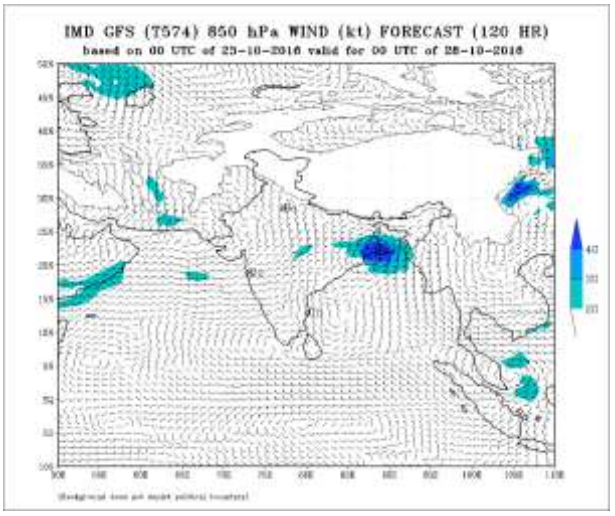

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 23-10-2016

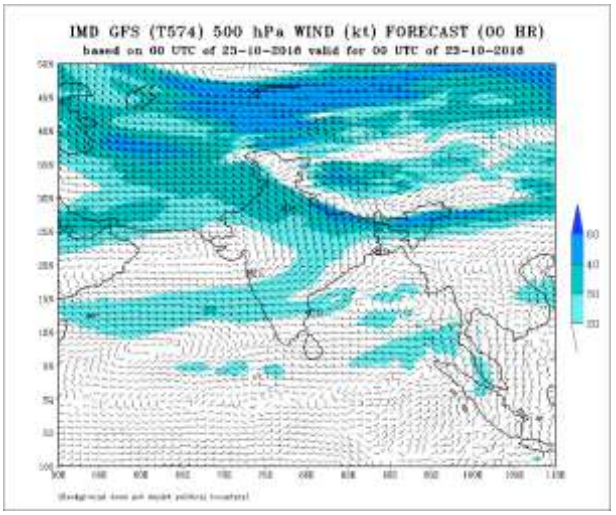

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 24-10-2016

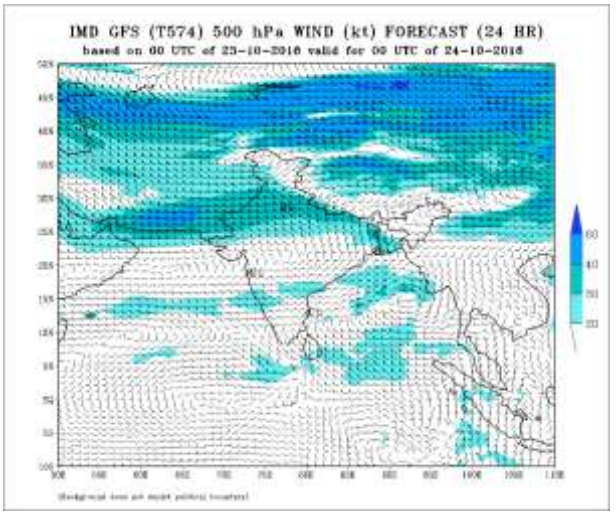

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 25-10-2016

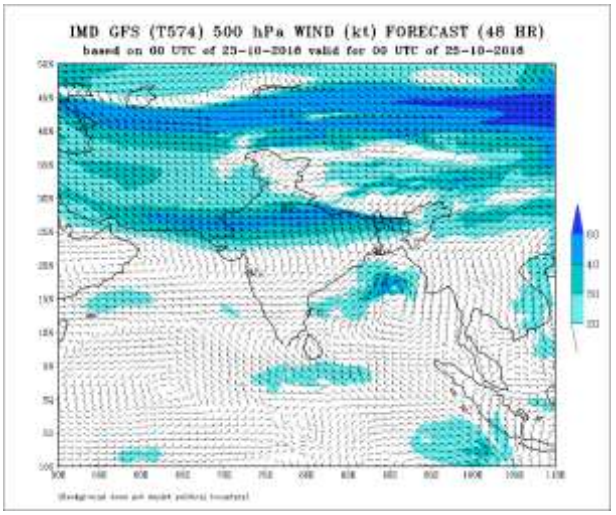

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 26-10-2016

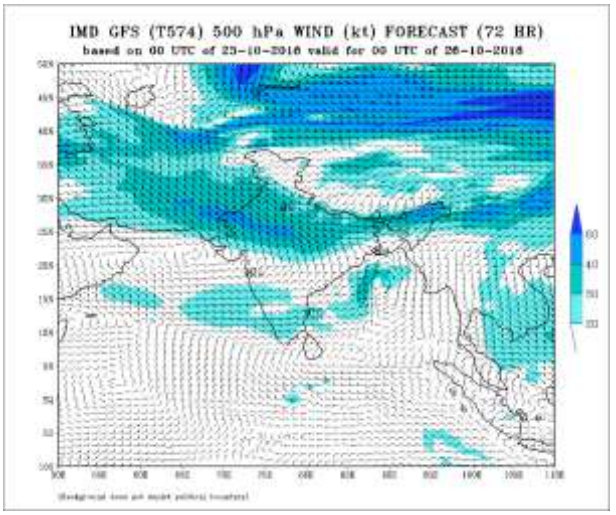

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 27-10-2016

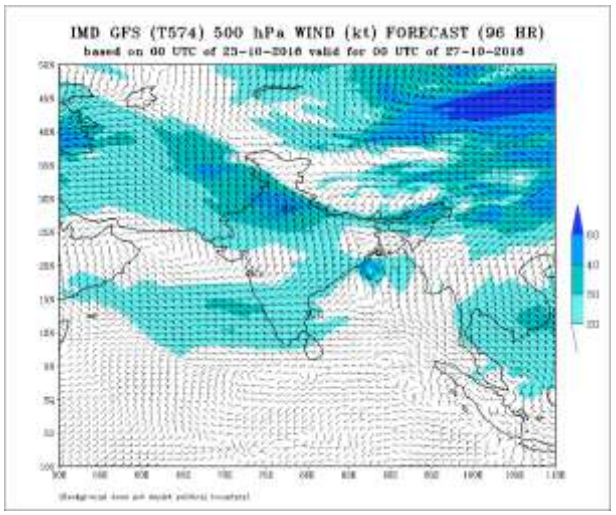

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 28-10-2016

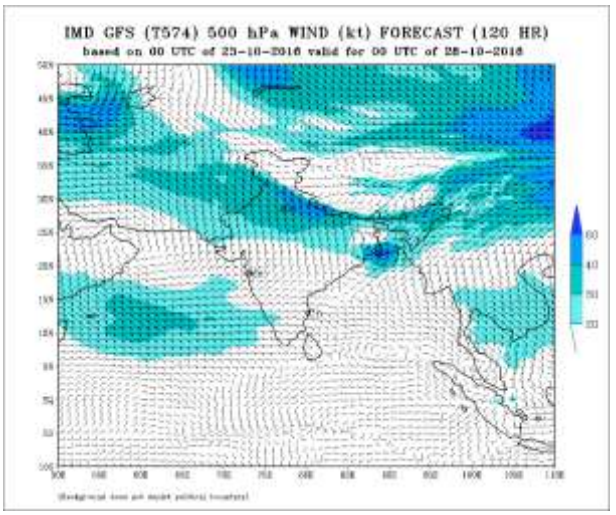

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 23-10-2016

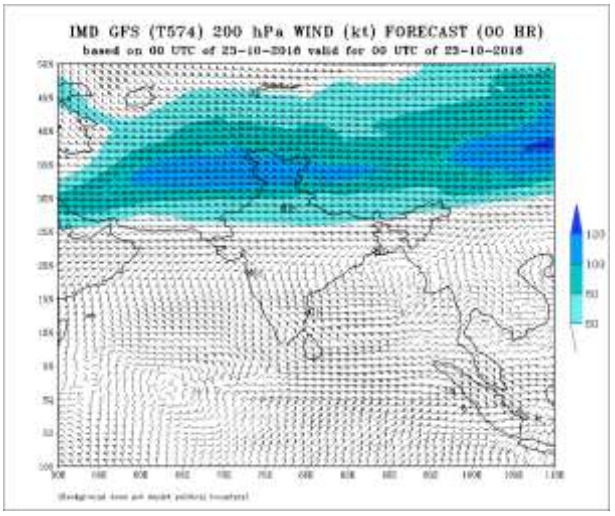

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 24-10-2016

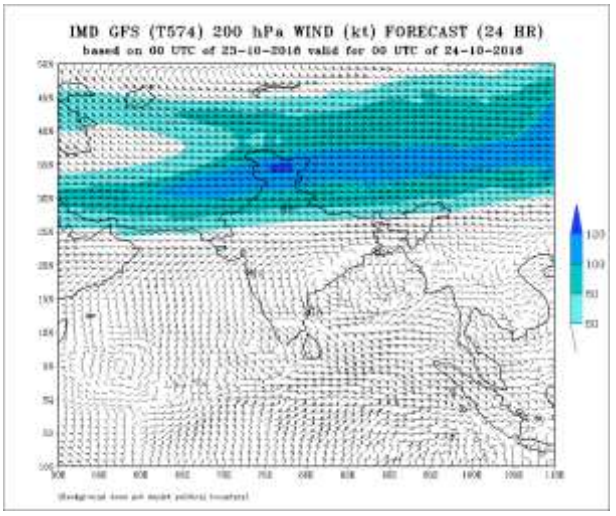

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 25-10-2016

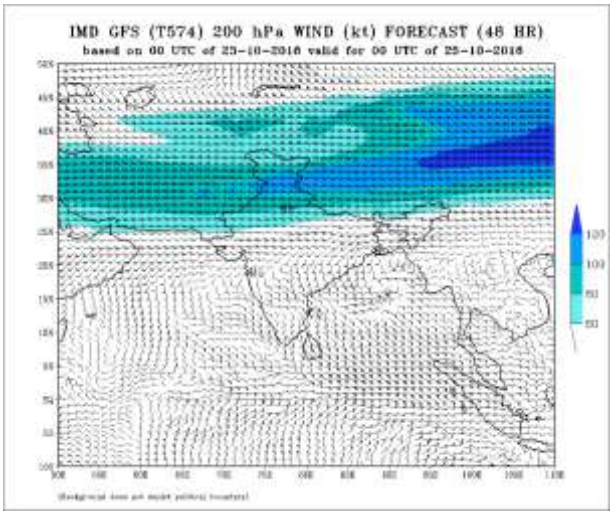

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 26-10-2016

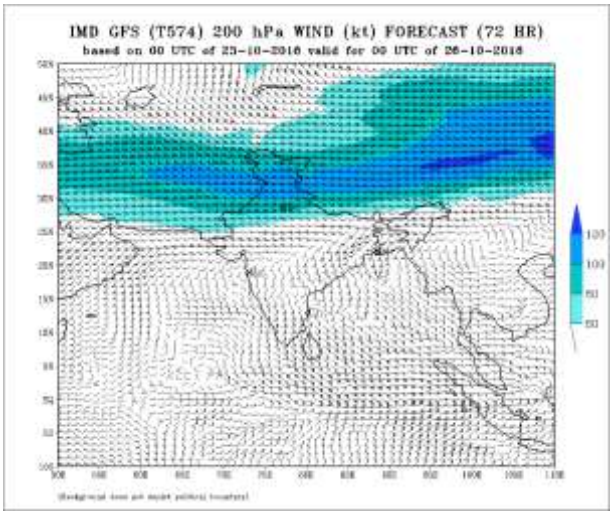

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 27-10-2016

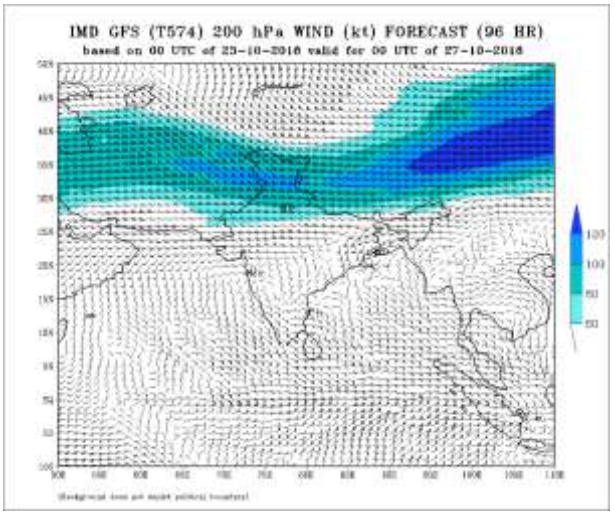

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 28-10-2016

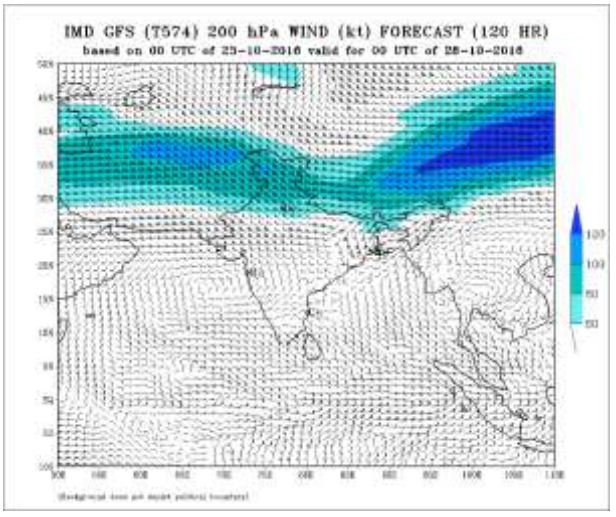

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 23-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 24-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 25-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 26-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 27-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 23-10-2016 valid for 00 UTC of 28-10-2016

FDP (Cyclone) NOC Report Dated 24th October, 2016

Synoptic features:

The deep depression over eastcentral Bay of Bengal remained practically stationary during past 06 hrs and lay centred at 1130 hrs IST of today, the 23 rd October, 2016 over eastcentral Bay of Bengal, near Latitude 15.5º N and Longitude 93.0º E, about 420 km north of Port Blair and 360 km west-southwest of Yangon. The system is most likely to intensify into a cyclonic storm during next 24 hours. It will move northeastwards and reach close to north Myanmar coast by today evening. Thereafter, it will recurve initially north-northwestwards skirting Myanmar coast and then northwestwards towards northwest Bay of Bengal.

The upper air cyclonic circulation over southeast Arabian Sea persists and now seen between 1.5 &4.5 km above mean sea level. An east-west shear zone between 4.5 & 5.8 km above mean sea level runs roughly along Latitude 11.0°N.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29-30˚C around the system area.

SST is around 26-28°C over most parts of Arabian Sea (AS) except for small areas off the coast of Karnataka and Maharashtra.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 100 kJ/CM^2. It increases towards northeast sector of the system and decreases towards northwest and north except a small pocket of northwest Bay of Bengal off Orissa coast. TCHP is below $50kJ/cm^2$ over most parts of AS except for EC and adjoining SE AS, where it is 50-70 kJ/cm^2.

Relative Vorticity:

The low level relative vorticity is about $150x10^{-6}$ $second^{-1}$ and vorticity is oriented from eastsoutheast to west-northwest.

It is positive and around $20\text{-}50X10^{-6}s^{-1}$ over northeast and off east of Oman coast and some parts of north Arabian sea. It is negative over rest AS.

Convergence:

Lower level convergence is about $15x\ 10^{-5}s^{-1}$ over around the system centre over Bay of Bengal. It is about $5\text{-}10\ x\ 10^{-5}s^{-1}$ over south Andaman Sea and over southern parts of India.

There is no area of significant lower level convergence over Arabian Sea.

Divergence:

Upper level divergence is $20\ x10^{-5}$ s-1 over around the system of Bay of Bengal.

Wind Shear:

Wind shear is 10-15 knots around system centre.

Wind Shear Tendency:

There is increasing tendency (5 -10 knots) over major parts of Bay of Bengal and adjoining south Andaman sea

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

Broken low/medium clouds with embedded intense to very intense convection over Bay between lat 14.0^oN to 17.0^oN long 89.0^oE to 94.0^oE in association with the vortex over EC bay & neighbourhood centred near $16.6^oN/92.7^oE$ with intensity T1.5/CI 1.5 at 0900 UTC. Scattered low/medium clouds with embedded moderate to intense convection over Bay islands.

Arabian Sea:

No significant clouds over the region.

Large scale features

Upper tropospheric Ridge: An upper air anticyclonic circulation over north bay.

M.J.O. Index: MJO index is in Phase 1 with very less amplitude. It would continue to remain in phase 1 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The analysis and forecast charts based on 00 UTC of 24th October, 2016 show the Deep Depression over east central Bay of Bengal close to Myanmar coast. Subsequently the system is likely to re-

curve and move in North/northwestward direction and intensify into a cyclone on 25 October, 2016. The system will remain as cyclone on 26th and likely to further move in North/Northwestward direction and cross West-Bengal and adjoining Bangladesh coast on 27/28 October, 2016.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 24th October, 2016 show the Deep Depression over east-central Bay of Bengal close to Myanmar coast with associated cyclonic circulation extending up to 500 hPa above mean sea level. The system is likely to move in Northwestward direction towards Odisha coast till 28th/29th October, 2016 with further intensification is not very clear.

ECMWF: The model charts based on 00 UTC of 24th October 2016 shows the Deep Depression over the East-central Bay of Bengal close to Myanmar coast along with associated cyclonic circulation extending up to 500 hPa above mean sea level. The system is likely to move in northwestward direction during subsequent 4 days and will intensify into cyclone during the period and is likely to cross south Odisha and adjoining Andhra Pradesh on 29th October, 2016.

WRF: The WRF model analysis and forecasts based on 00 UTC of 24th October 2016 show the Deep Depression with associated cyclonic circulation extending up to 500 hPa over east-central Bay of Bengal close to Myanmar coast. The system is likely to intensify into a cyclone by 25th October with very slow movement northwestward. Further the system likely to move in North/Northwestward direction towards Odisha coast till 27th October, 2016.

JMA: Model analysis indicates a DD on 24th over EC Bay. The system moved west-northwestward without appreciable intensification till 26th. It became a low on over WC Bay and is seen moving towards Andhra coast.

ARP-Meteo France Model indicates the over EC Bay on 24th analysis field moves in a west-northeastward direction and becomes a deep depression on 25th over EC Bay. Further it continues to moves in the northwest direction till 27th.

NCMRWF-NCUM: The forecasts based on 24th 00UTC analysis show a clear intensification of the system over SW Bay of Bengal. This system is seen to be moving north-northwestwards from 25th to 26th October. The system is seen to cross Andhra coast by 27th and it becomes less marked on 28th .

NCMRWF-UM-Regional Model: The forecasts based on 24th Oct 2016 indicate intensification and westward movement of the BoB system from Day 1 to Day 3 forecasts. The system is seen to be off the coasts of south Odisha and north Andhra Pradesh border in the Day 3 forecast (27 Oct).

NCMRWF-NEPS Model: The MSLP analysis and forecasts obtained from NEPS based on the initial conditions of 24th October 2016 forecasts show a northwestwards movement of the system from 25th to 26th October. Continuing in the same direction the system is seen off the coast Andhra Pradesh and by 29th the system is seen to be weakened.

IITM-GEFS: Based on the 00 UTC analysis on 24th, a depression is seen over EC Bay near Irrawaddy Delta on 24th. It moves in a northwestward direction and became a deep depression over WC Bay and adjoining NW on 25th. Further it moves in a northeastward direction along the coast and crossed Orissa and adjoining West Bengal coast on 27th. It became less marked thereafter.

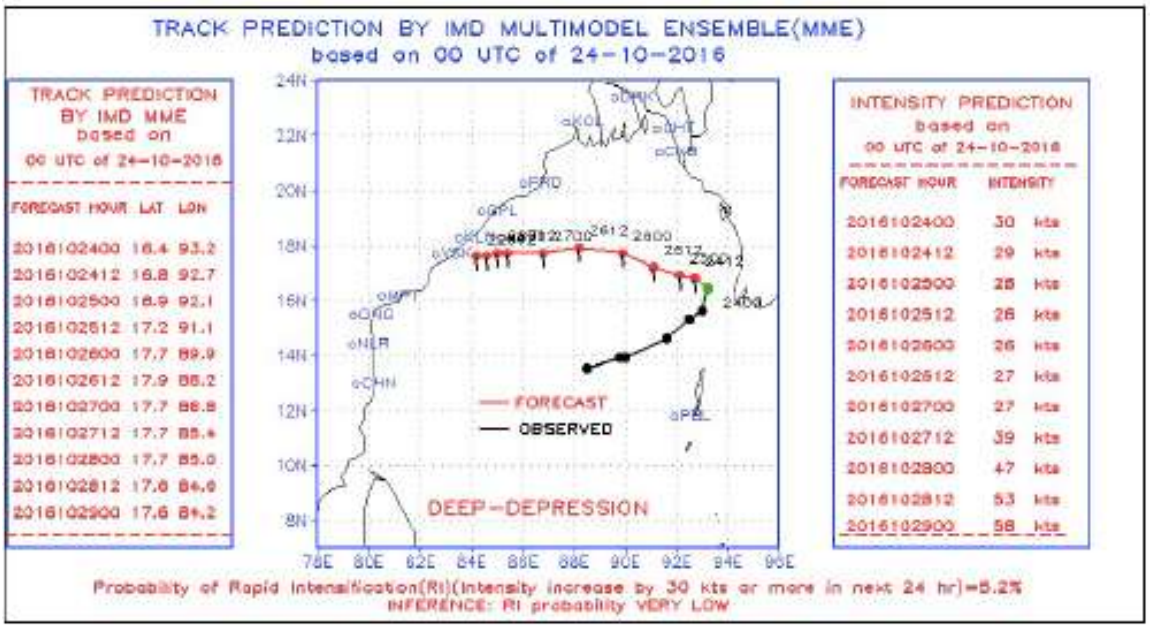
IITM-GFS(T1534): Based on 23/0000 UTC initial condition: DD on 24th over EC Bay off Irrawaddy delta, intensified into a CS on 25th, moving west-northwestwards the CS was seen over central bay on 26th . Maintaining the west-northwestward movement, the system is seen off Orissa and adjoining West Bengal Coast on 27th. On 28th it was seen inland as a DD and became less marked on 29th.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

The Genesis Potential Parameter (GPP) analysis and forecasts based on 00 UTC of 24th October 2016 shows a significant GPP zone over east-central Bay of Bengal Myanmar coast (Irrawaddi delta). With a northwestward movement the GPP zone recurves over EC Bay of Bengal on 25th October 2016. The significant GPP zone move west-northward to WC BoB on 26th October 2016 then over NW bay on 27th and off Orissa coast on 28th and 29th. On 30th the zone is seen off north Orissa and adjoining WB coast. On 31st it moved over to land. Analysis and forecasts of GPP based on 0000 UTC of 24 October 2016 suggests that the Deep-Depression over the Bay of Bengal has potential to intensify into a Cyclonic Storm.

MME TRACK: MME track forecast based on 0000 UTC of 24 October 2016 shows that the "DEEP-DEPRESSION" is to recurve and the system is likely to move, initially, in a west-northwest ward direction and thereafter, in almost westward direction moving closer to Visakhapatnam.



SCIP INTENSITY: Intensity prediction by the SCIP model, based on 0000 UTC of 24 October 2016, shows that the "DEEP-DEPRESSION" over Bay of Bengal is likely to weaken initially and intensify further into a Cyclonic Storm at 1200 UTC of 27 October 2016.

RAPID INTENSIFICATION: Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 5.2% (Inference: RI probability VERY LOW).

Summary and Conclusion:

Past 24 hours observations indicate that the system moved nearly northwards with a speed of about 5 knots. The system shows signs of weakening in the morning today mainly due to increase in wind shear prevailing over the region. However the scatterometer and other observations in the region indicate the wind speed of about 30 knots. Due to prevailing favourable environmental conditions around system centre, there is possibility of intensification, though there is a temporary sign of weakening in convection. There is large divergence in the model guidance with regards to track of the system, which varies from westwards to north-northwestwards. Majority of numerical models also indicate steady intensification of the system.

Advisory:

- Intense observation may be taken by Myanmar coast during 24-25th, over Bangladesh, Odisha, north Andhra Pradesh and West Bengal coasts during 25-28th Oct. 2016.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	23/12	**24/00**	**24/03**
India	40	31	45
Coastal stations			
WB	1	0	3
Odisha	6	1	3
AP	7	3	2
Tamil Nadu	15	6	14
Puducherry	0	0	0
A & N	0	0	0
Bangladesh	0	14	13
Myanmar	0	0	0
Thailand	0	1	0
SriLanka	8	7	8

- **RS/RW** (12Z) of 23 / 10 /2016 36 /39
- **No. of Ascents reaching 250 hPa levels: 16 , MISDA:- 2**

- **RS/RW** (00Z) of 24 / 10 /2016 36/39
- **No. of Ascents reaching 250 hPa levels: 34 , MISDA: 6**
-

No. of PILOT Ascents

23/12Z	**24/00Z**
04 /37	5/69

Buoy Data

23/12Z	**24/00Z**	**24/03Z**
13	12	13

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**23.10.2316**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /23.10.2316 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /23.10.2316 : 4

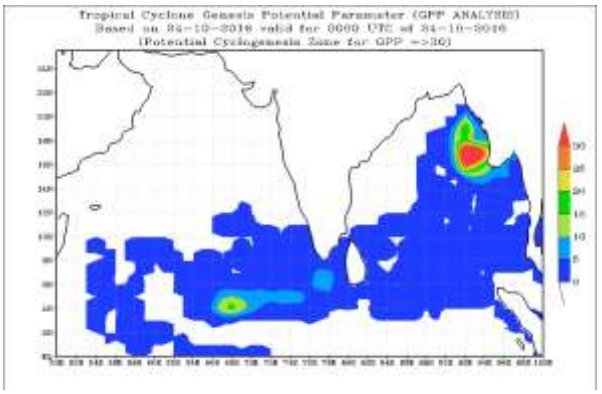
No. of Ascents reaching 250 hPa level = 4

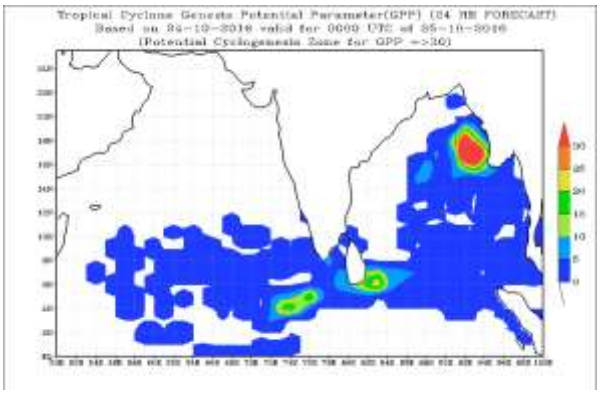
MISDA : 4

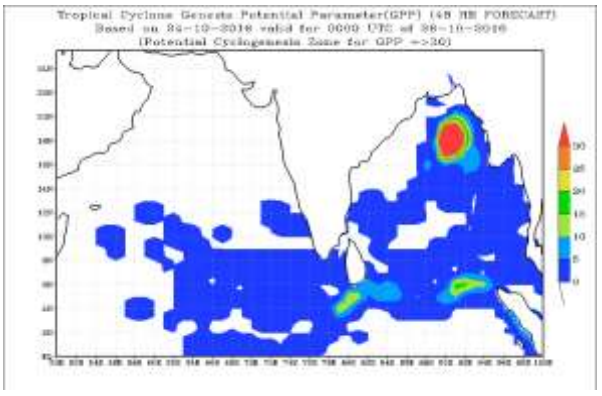
No. of PILOT Ascents:

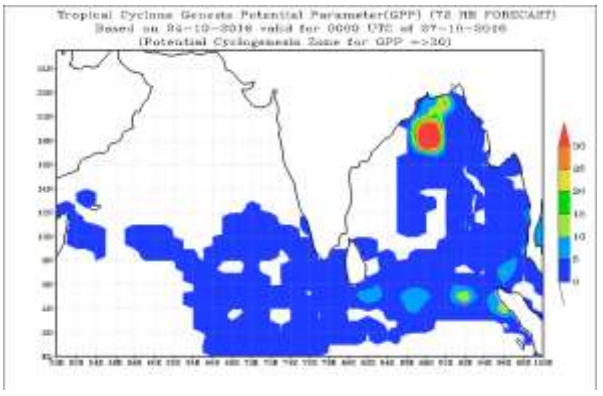
23.10.2316	
06Z	18Z
4	4

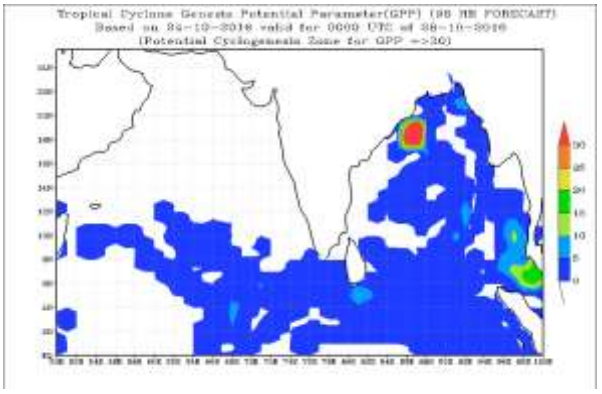
Annexure-II

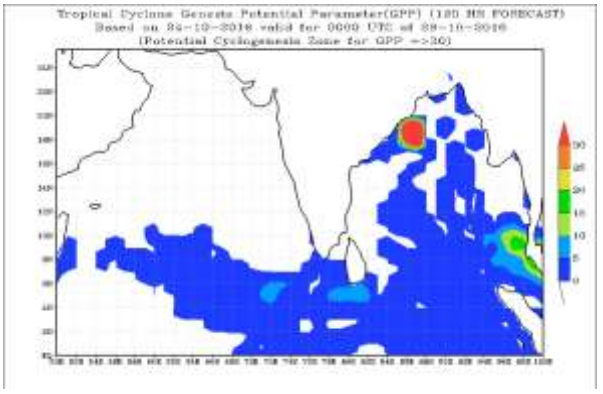

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 24-10-2018 valid for 0000 UTC of 24-10-2018
(Potential Cyclogenesis Zone for GPP =>30)

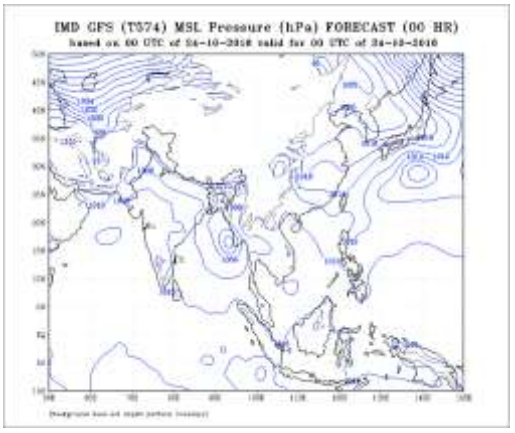

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 24-10-2018 valid for 0000 UTC of 25-10-2018
(Potential Cyclogenesis Zone for GPP =>30)

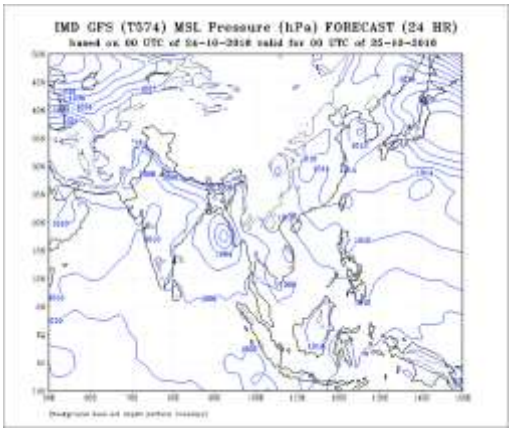

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 24-10-2018 valid for 0000 UTC of 26-10-2018
(Potential Cyclogenesis Zone for GPP =>30)

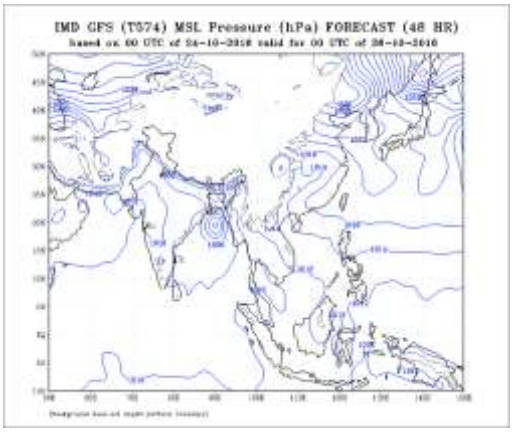

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 24-10-2018 valid for 0000 UTC of 27-10-2018
(Potential Cyclogenesis Zone for GPP =>30)

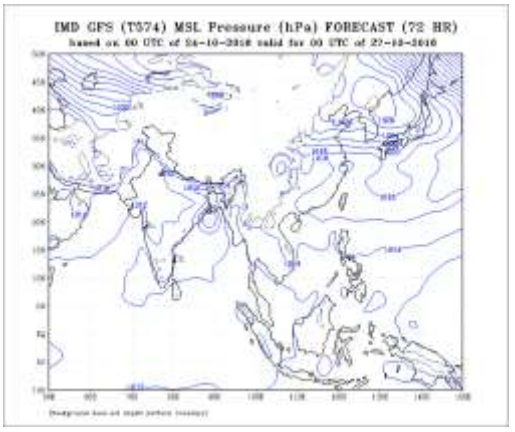

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 24-10-2018 valid for 0000 UTC of 28-10-2018
(Potential Cyclogenesis Zone for GPP =>30)

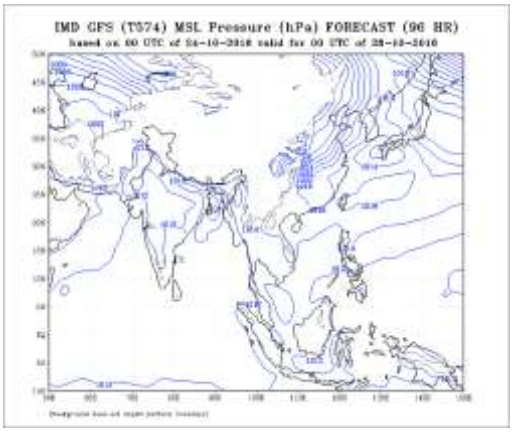

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 24-10-2018 valid for 0000 UTC of 29-10-2018
(Potential Cyclogenesis Zone for GPP =>30)

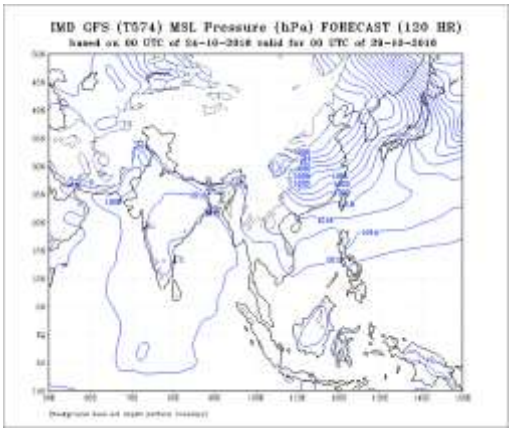

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)

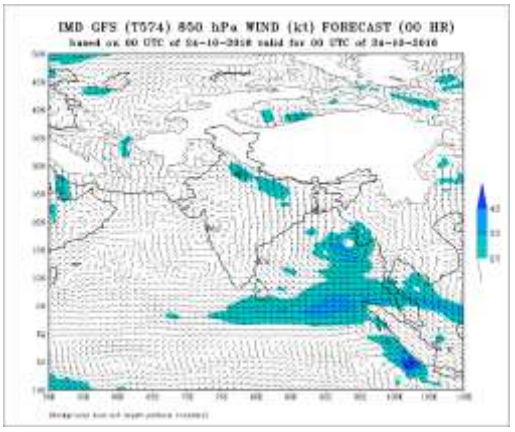

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

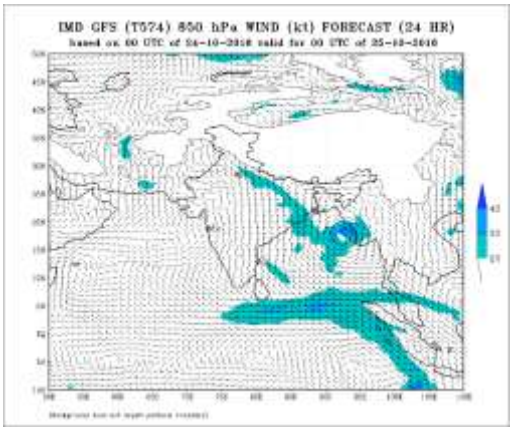

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

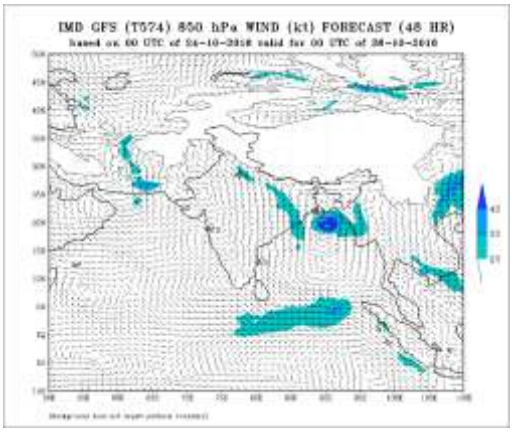

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

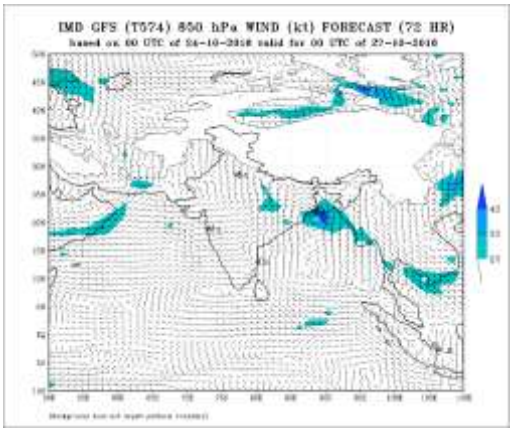

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

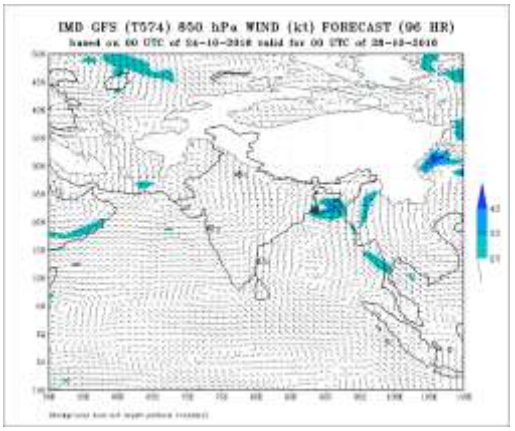

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

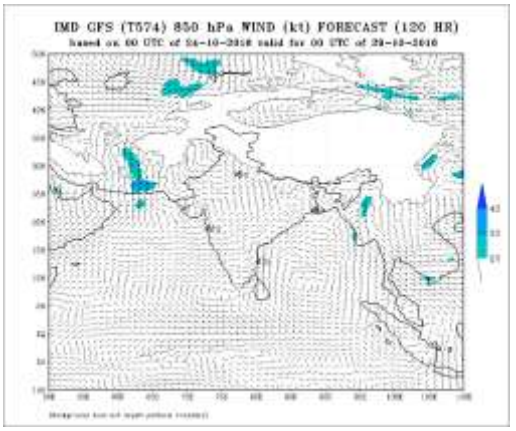

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

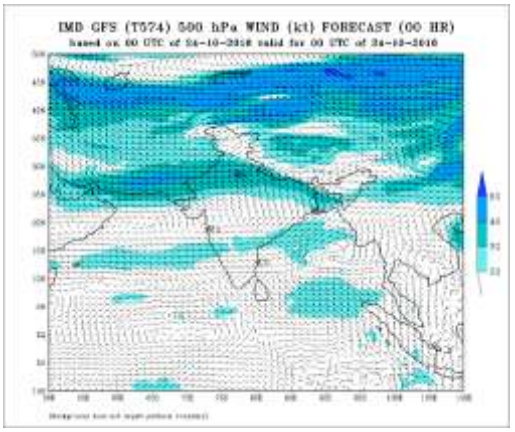

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

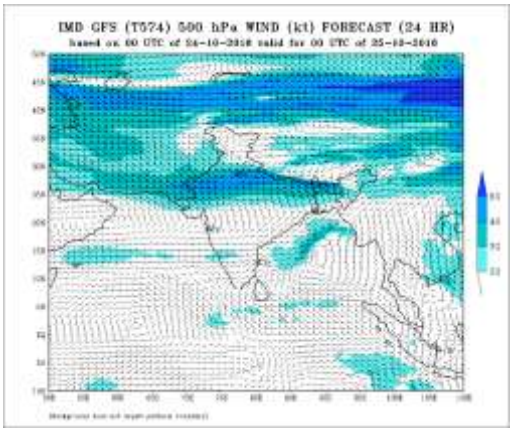

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

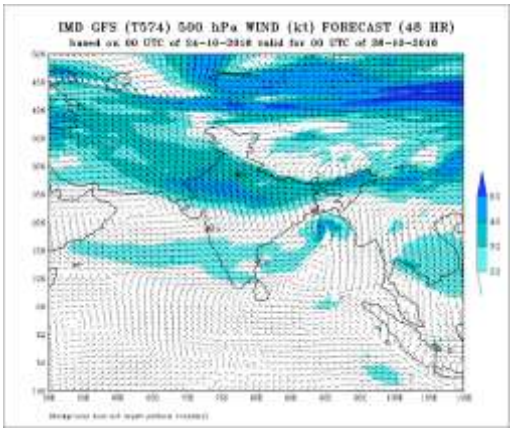

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

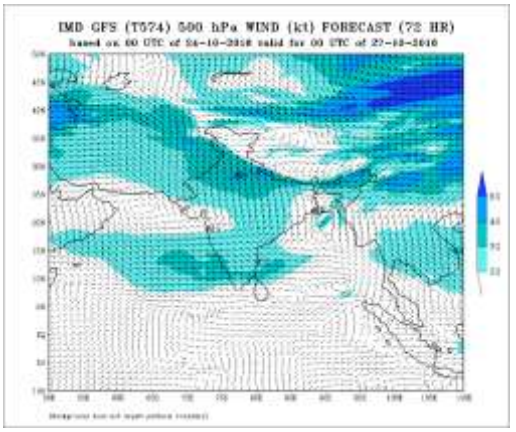

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

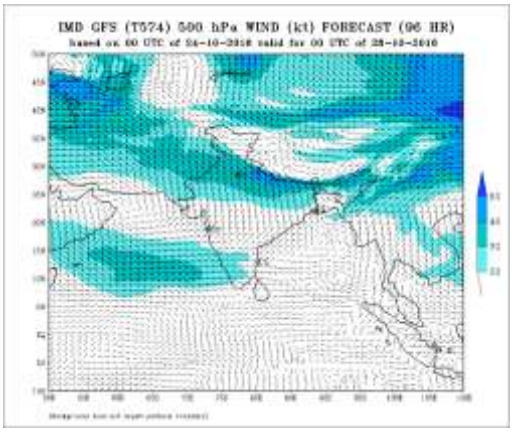

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

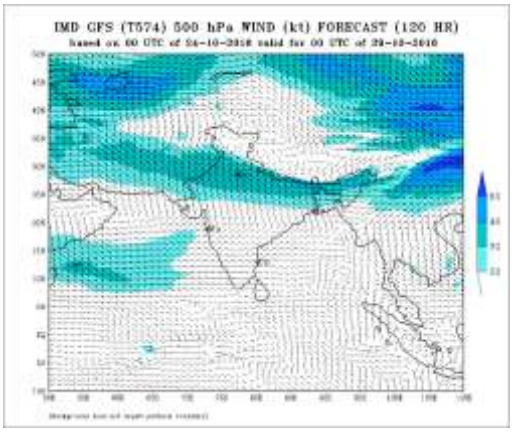

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)

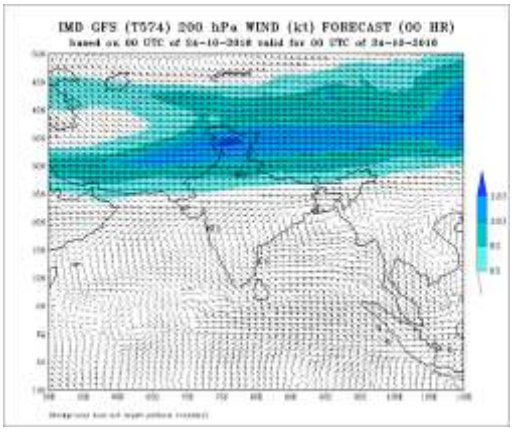

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

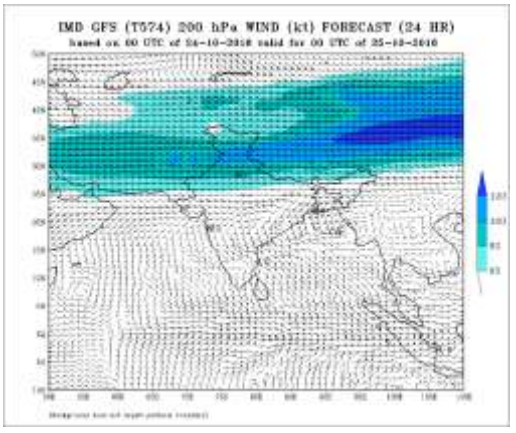

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

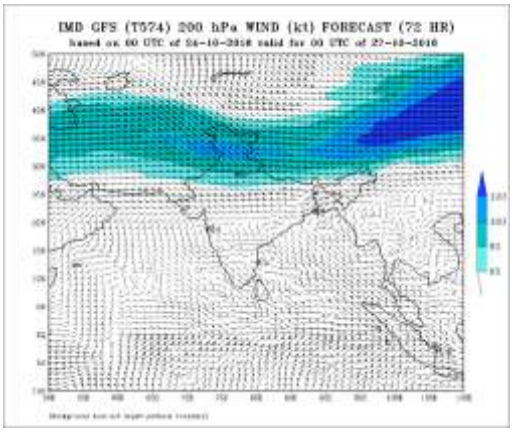

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

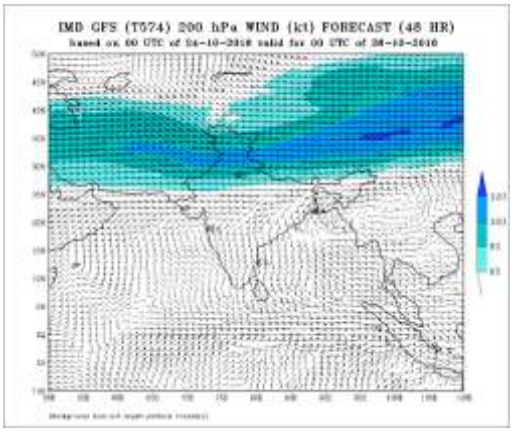

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

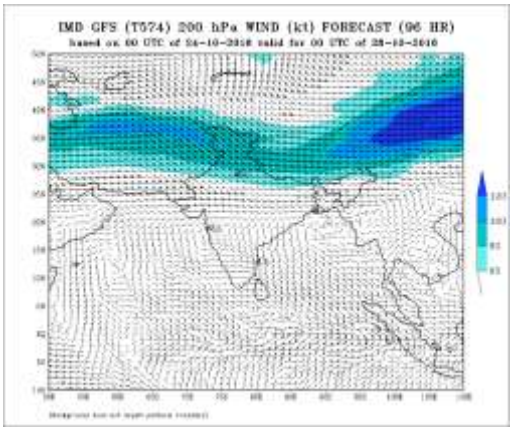

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

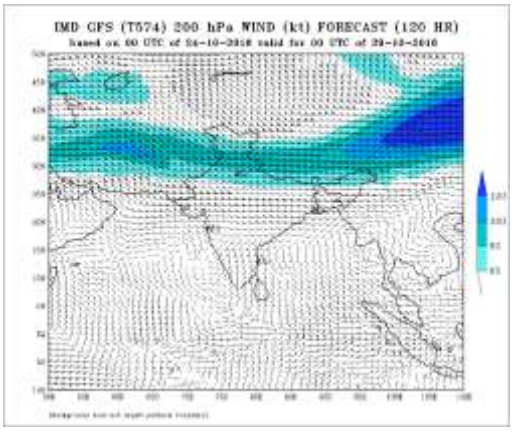

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)

FDP (Cyclone) NOC Report Dated 25th October, 2016

Synoptic features:

The deep depression over eastcentral Bay of Bengal moved further west-northwestwards in past 03 hours, intensified into a cyclonic storm "**KYANT**" and lay centred at 0830 hrs IST of 25th October, 2016 over eastcentral Bay of Bengal, near Latitude 17.0º N and Longitude 91.2º E, about 620 km north-northwest of Port Blair, 710 km south-southeast of Gopalpur and 850 km east of Vishakhapatnam The system will move initially west-northwestwards and then west to west-southwestwards towards westcentral Bay of Bengal during next 72 hours.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 31˚C around the system area.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 100 kJ/CM^2 and to its northeast. The same value is seen over a small pocket off north Andhra coast and south Orissa coast.

Relative Vorticity:

The low level relative vorticity is about $250x10^{-6}$ $second^{-1}$ and vorticity centre is towards the SW of the system centre.

Convergence:

Lower level convergence is positive and is about $5x\ 10^{-5}s^{-1}$ over and around the system centre over Bay of Bengal. There is no area of significant lower level convergence over Arabian Sea.

Divergence:

Upper level divergence is 20 $x10^{-5}$ s-1 around the system centre.

Wind Shear:

Wind shear is 10-15 knots around system centre. It increases towards north and south of the system.

Wind Shear Tendency:

There is decreasing tendency (-5 to -10 knots) over around the system area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

Vortex (Kyant) is seen over EC bay & neighbourhood centred at 16.8N/90.5E with intensity T2.5 and CDO pattern. Associated broken low/med clouds with embedded intense to very intense convection over bay between latitude 14.0^0N to 20.0^0N and longitude 86.5E to 93.0E. Scattered low/medium clouds with embedded isolated weak to moderate convection is seen over rest of the bay and Andaman sea.

Arabian Sea:

Scattered low/medium clouds is seen with embedded isolated weak convection over SE Arabian sea.

Large scale features

Upper tropospheric Ridge: The ridge is seen at 21^0N over BoB and at 19^0N over Arabian Sea.

M.J.O. Index: MJO index is in Phase 1 with very less amplitude. It would continue to remain in phase 1 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC:

IMD-GFST574: The analysis charts based on 00 UTC of 25th October, 2016 show the Deep Depression over east central Bay of Bengal. The model indicates intensification into a cyclone by 06 UTC of 25th. The system likely to move very slowly in west-north-west direction towards west-central Bay of Bengal and likely to intensify further till 26th morning. Subsequently, the system is likely to move in west-south-west direction towards south Odisha and north Andhra coast and finally cross Andhra coast on 30th . However, the intensity of the system will remain fluctuating after 26th October before crossing the coast.

NCEP-GFS: The analysis charts of the model based on 00 UTC of 25th October, 2016 show the Deep Depression over east-central Bay of Bengal. The forecast indicates that the system is likely to intensify

into cyclone and move in west-north-west direction till 26th and subsequently likely to move in west-south-west direction and likely to cross Andhra coast by 28th/29th October, 2016. The intensity of the system will remain fluctuating before crossing the coast.

ECMWF: The model charts based on 00 UTC of 25th October 2016 shows the Deep Depression over the East-central Bay of Bengal along with associated cyclonic circulation extending up to 500 hPa above mean sea level in the analysis field. The forecast indicated intensification into a cyclone by 25th itself and is likely to move in west-north-west direction during subsequent 2 days (26 to 27 Oct) and further in west-south-west direction during next 2 days (28 and 29 Oct) and likely to cross Andhra Pradesh on 30th October, 2016.

WRF: The WRF model analysis and forecasts based on 00 UTC of 25th October 2016 show the Deep Depression with associated cyclonic circulation extending up to 500 hPa over east-central Bay of Bengal in the analysis charts. The system is likely to intensify into a cyclone by 25th afternoon/evening and move in west-north-west direction towards south Odisha and adjoining north Andhra coast till 27th/28th October, 2016.

JMA: Model analysis indicates a DD on 25th over EC Bay. The system moved west-northwestward without appreciable intensification till 27th. It became a low on 28th over WC Bay and is seen moving in west-southwestwards direction towards Andhra coast.

ARP-Meteo France Model indicates the system over EC Bay on 25th analysis field moves in a west-southwestward direction and becomes a deep depression on 26th over EC Bay. Further it continues to moves in the same direction and seen close to south Andhra coast on 28th.

NCMRWF-NCUM: The 850 hPa wind plots from NCUM's Analysis, and forecasts based on 25th Oct 2016 initial conditions show the DD near Myanmar coast in the analysis slowly intensifies and moves west wards and then towards AP coast on 28th .

NCMRWF-UM-Regional Model: The forecasts based on 25th Oct 2016 analysis indicate intensification and westward movement of the BoB system on 26th and 27th. The system is seen moving west-southwestward and crossing south Andhra coast on 28th .

NCMRWF-NEPS Model: The MSLP analysis and forecasts obtained from NEPS based on the initial conditions of 25th October 2016 forecasts show the DD gradually intensifies and moves west-southwestwards and further intensifies and moves towards Odisha and AP coast till 27th and crossed south Andhra coast on 28th .

IITM-GEFS: Based on the 00 UTC analysis on 25th, a CS is seen over EC Bay on 26th. Further it moves in a northwestward direction it is seen over central bay on 26th. Further the system
recurved in a westward and then in west-southwestward direction and moved closer to south Andhra coast on 27th.

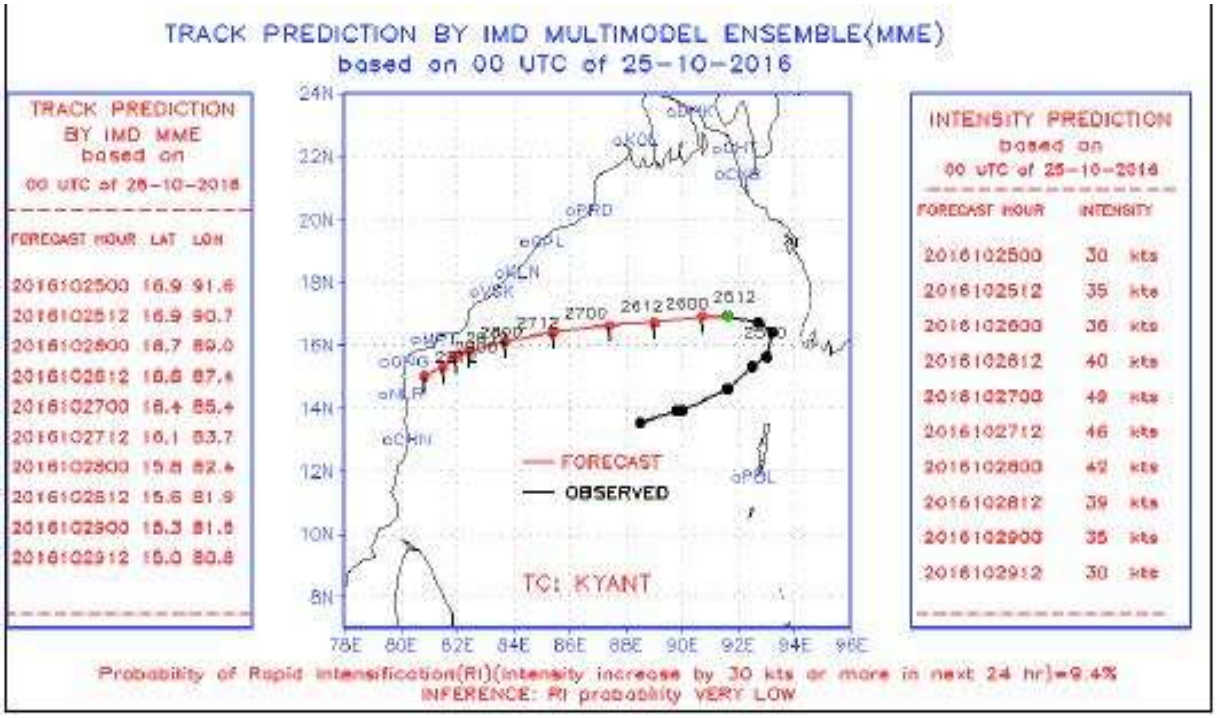
IITM-GFS(T1534): Based on 24/0000 UTC initial condition: CS on 25th over EC Bay off Irrawaddy delta, intensified and seen moving in northwestward direction on 26th. The CS maintained its northwestward movement and lay off Orissa coast on 27th and 28th. The system moved northeastwards along the coast on 29th and crossed Bangladesh Coast on 29th and became less marked on 30th .

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

The Genesis Potential Parameter (GPP) analysis and forecasts based on 00 UTC of 25th October 2016 shows a significant GPP zone over east-central Bay of Bengal. The significant GPP zone move west-northwestward to WC BoB on 26th October 2016 then over NW bay and adjoining WC Bay on 27th and off South Orissa and north Andhra coast. The significant zone became weaker and moved slightly southwestwards on 28th. On 29th the zone became less marked off south Andhra coast. Another significant GPP zone appeared over EC Bay, close to Irrawaddy delta.

MME TRACK: MME track forecast based on 0000 UTC of 25 October 2016 shows that the cyclonic storm "KYANT" is likely to move gradually in a westsouthwestward direction.



SCIP INTENSITY: Intensity prediction by the SCIP model, based on 0000 UTC of 25 October 2016, shows that the cyclonic storm "KYANT" over Bay of Bengal is likely to maintain its intensity till 0000 UTC of 29 October 2016 with slight increase in its intensity around 1200 UTC of 27 October 2016.

RAPID INTENSIFICATION: Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 9.4% (Inference: RI probability VERY LOW)

Summary and Conclusion:

The deep depression over east central Bay of Bengal moved further west-northwestwards in past 24hours and intensified into a cyclonic storm "**KYANT**" over EC Bay. Most of the models show movement of the system in a west-southwest direction and reach west central Bay and reach Machilipatnam in Andhra coast around the morning of 30th October. Majority of the models suggest a temporary intensification of the system over WC Bay and gradual weakening thereafter while it reaches near Machilipatnam.

Advisory:

Intense observation may be taken over coastal Andhra Pradesh during 27-30th October 2016.

Annexure I

Region	Date/Time (UTC)		
	24/12	**25/00**	**25/03**
India	39	30	45
Coastal stations			
WB	3	1	3
Odisha	1	2	6
AP	7	5	6
Tamil Nadu	22	11	22
Puducherry	1	1	1
A & N	0	0	0
Bangladesh	0	14	11
Myanmar	0	0	1
Thailand	0	0	0
SriLanka	5	7	8

- **RS/RW** (12Z) of 24/ 10 /2016: 36/39
- **No. of Ascents reaching 250 hPa levels: 16, MISDA: 19**

- **RS/RW** (00Z) of 25 / 10 /2016: 35/39
- **No. of Ascents reaching 250 hPa levels: 28, MISDA: 6**

No. of PILOT Ascents

24/12Z	**56/00Z**
16 /37	28/34

Buoy Data

15/12Z	**16/00Z**	**16/03Z**
14	13	13

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**24.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /18.10.2016 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /18.10.2016 : 4

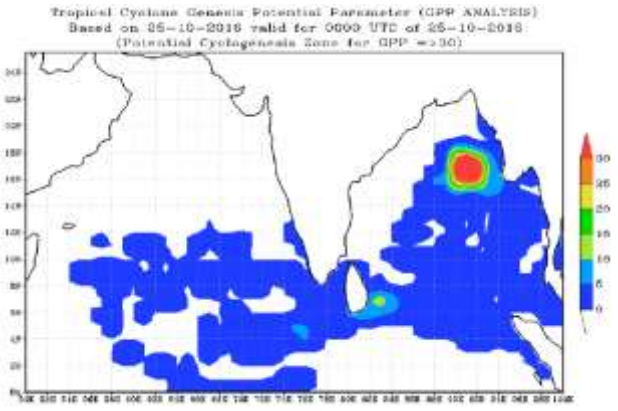
No. of Ascents reaching 250 hPa level = 4

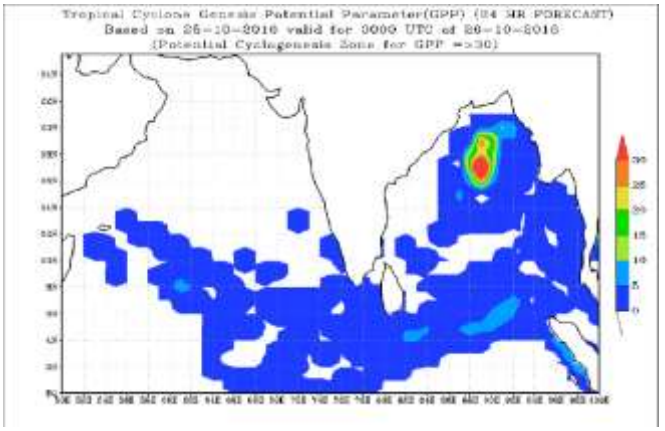
MISDA : 4

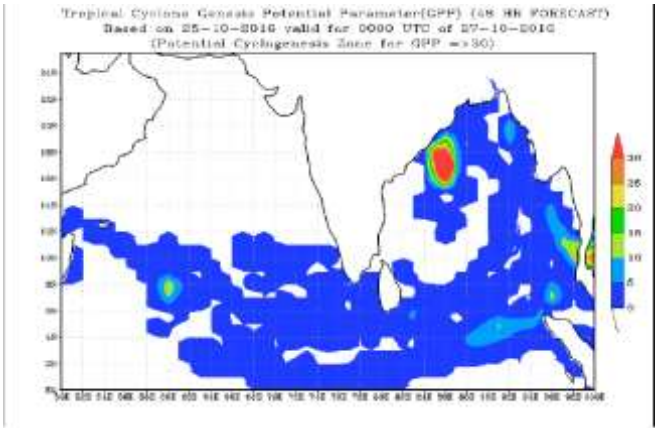
No. of PILOT Ascents:

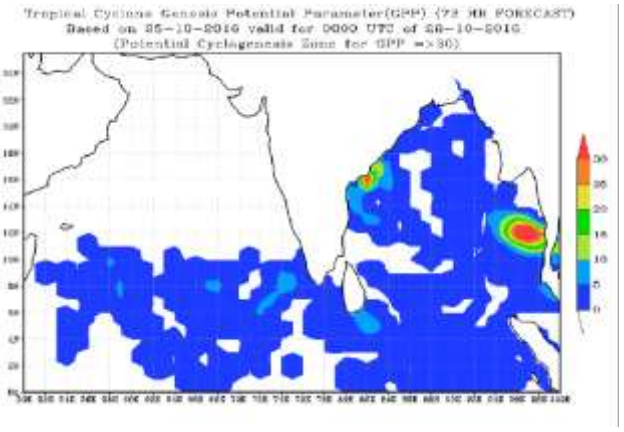
19.10.2016	
06Z	18Z
4	4

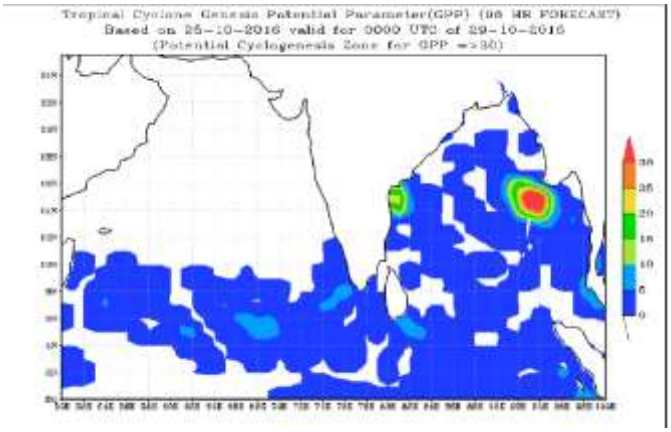
Annexure-II

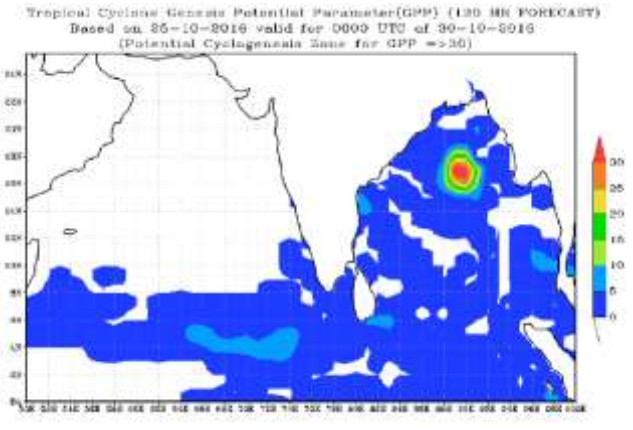

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 25-10-2016 valid for 0000 UTC of 25-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

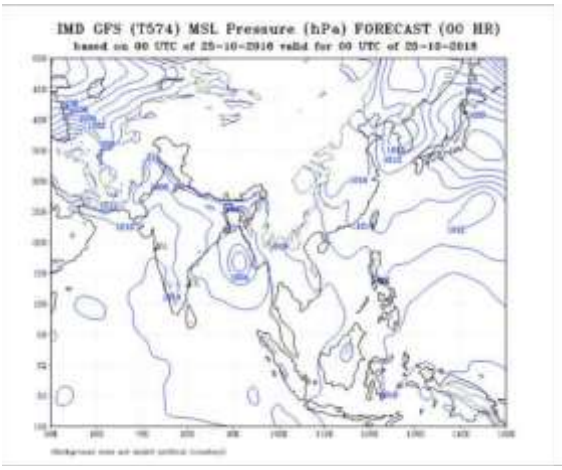

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 25-10-2016 valid for 0000 UTC of 26-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

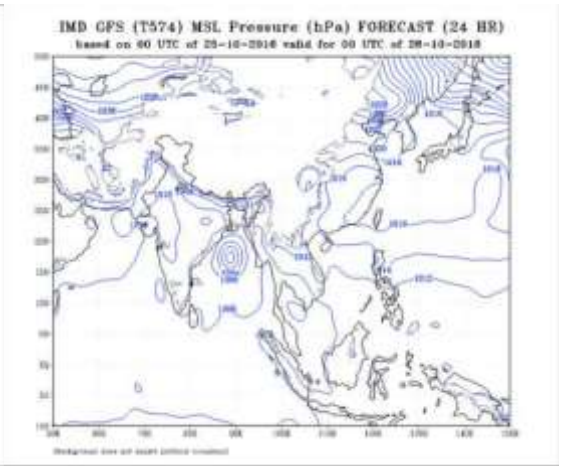

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 25-10-2016 valid for 0000 UTC of 27-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

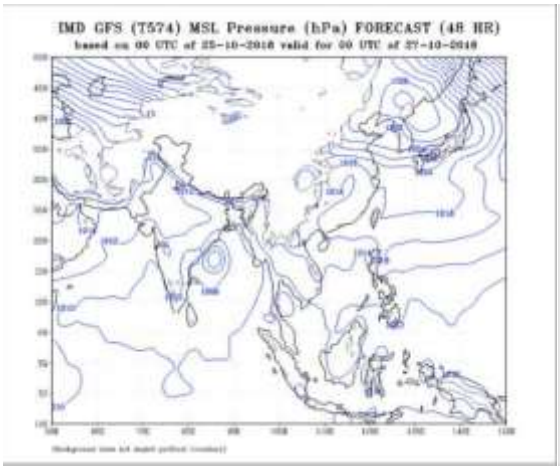

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 25-10-2016 valid for 0000 UTC of 28-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

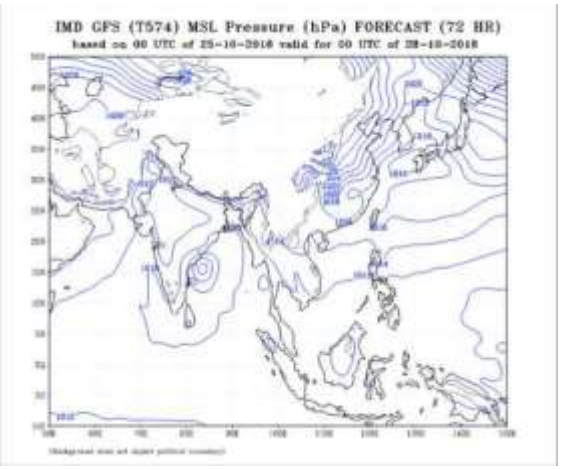

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 25-10-2016 valid for 0000 UTC of 29-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

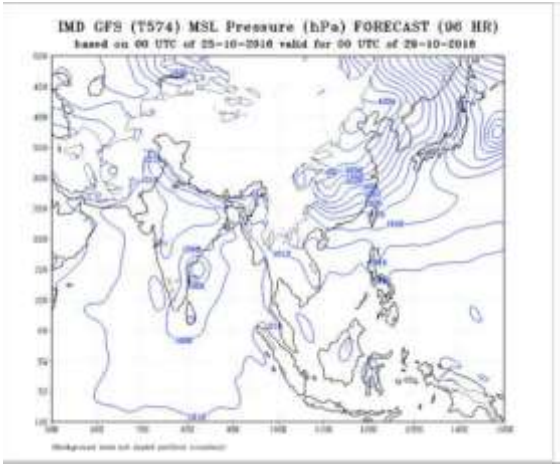

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 25-10-2016 valid for 0000 UTC of 30-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

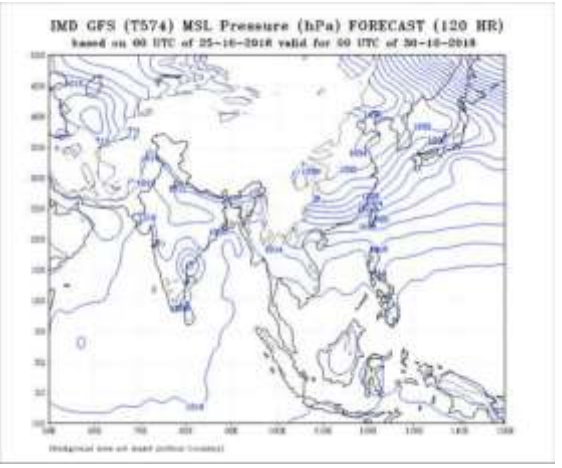

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 25-10-2018

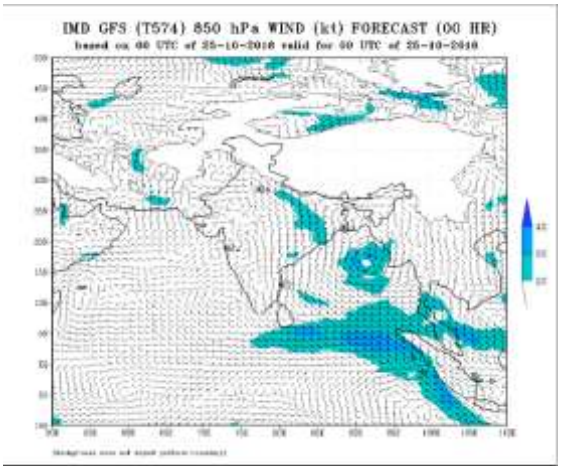

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 26-10-2018

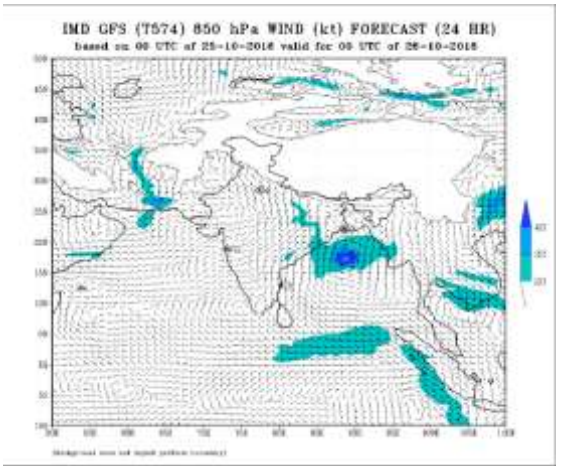

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 27-10-2018

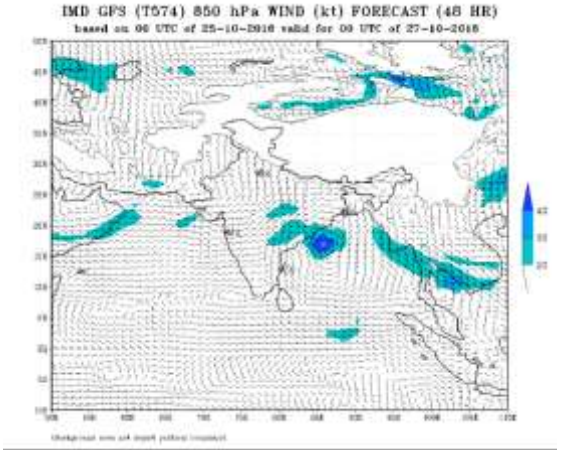

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 28-10-2018

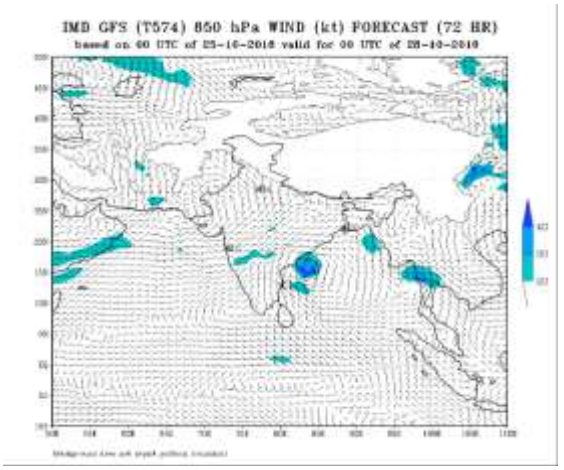

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 29-10-2018

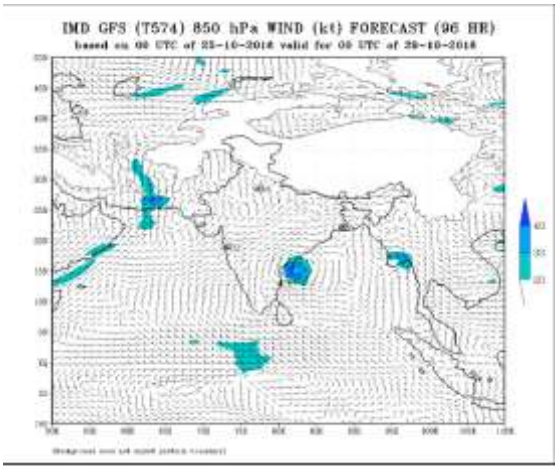

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 30-10-2018

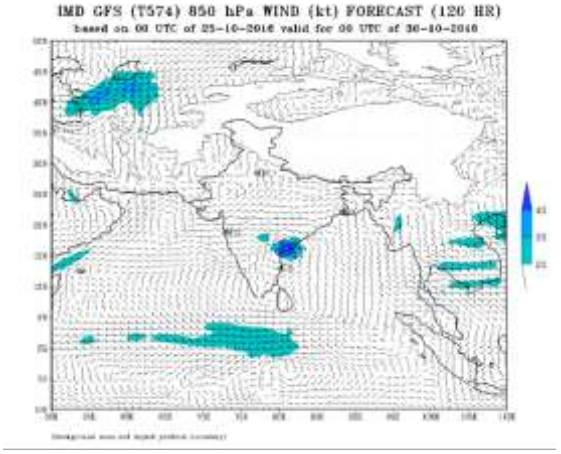

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 25-10-2018


IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 26-10-2018

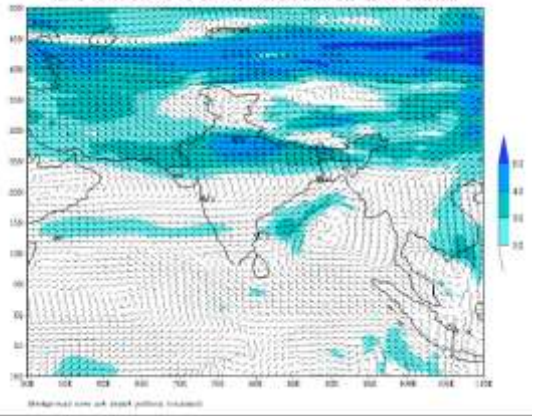

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 27-10-2018


IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 28-10-2018

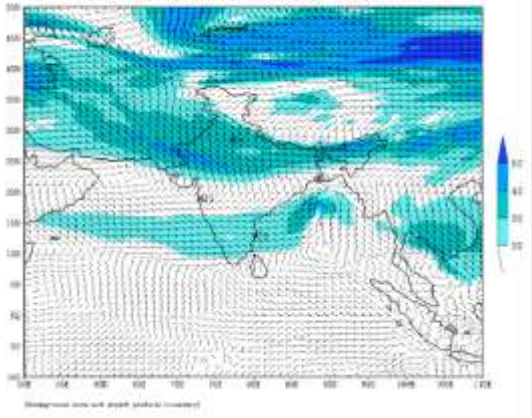

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 29-10-2018


IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 25-10-2018 valid for 00 UTC of 30-10-2018

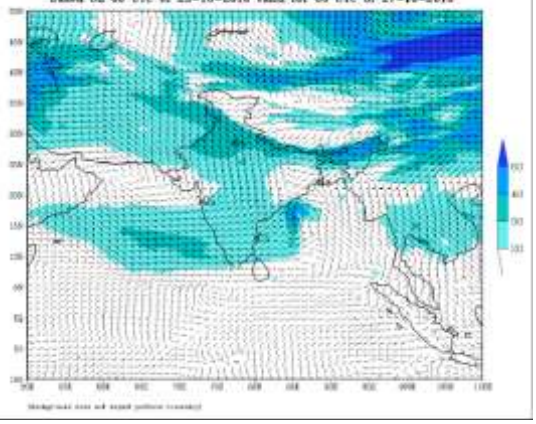
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 25-10-2016



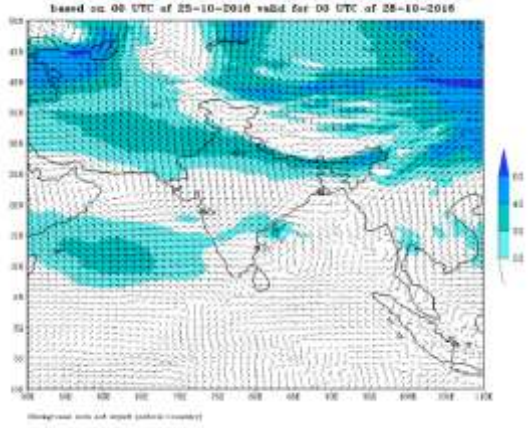
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 26-10-2016



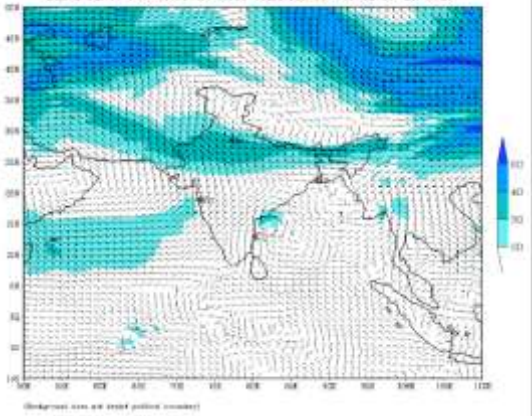
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 27-10-2016



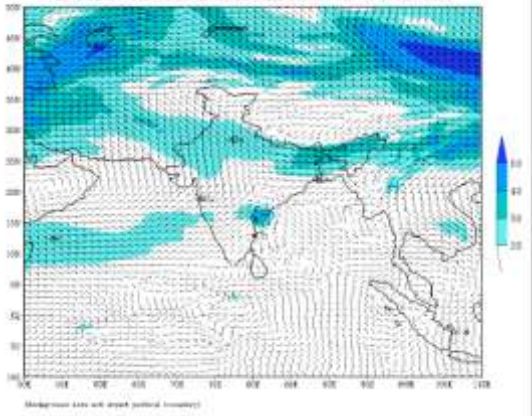
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 28-10-2016

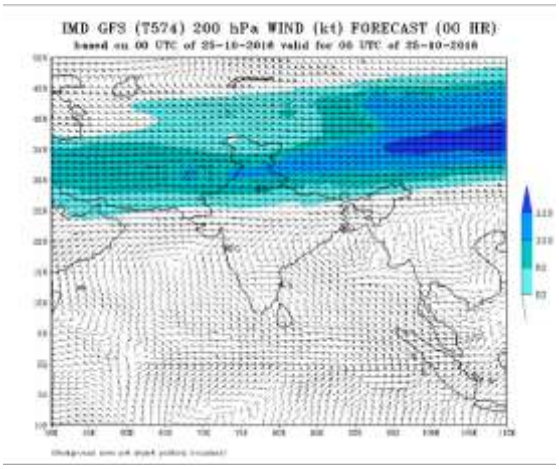


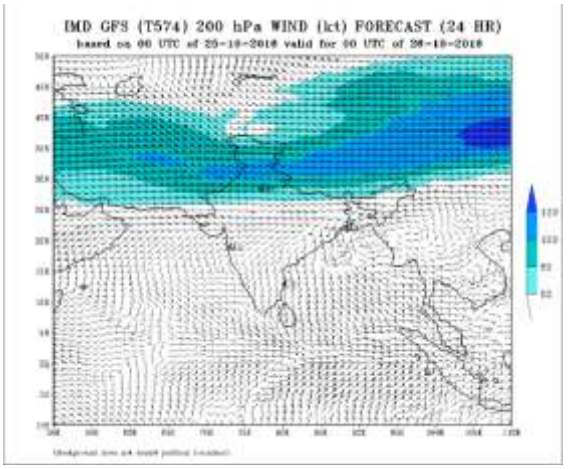
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 29-10-2016

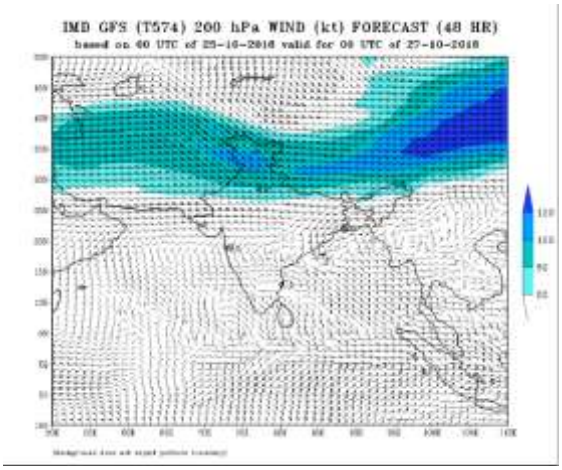


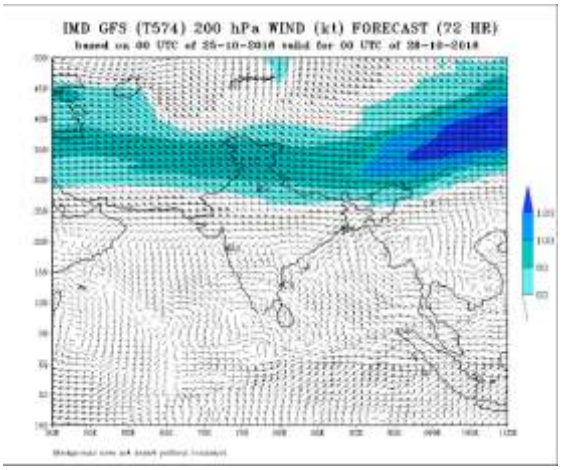
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 30-10-2016

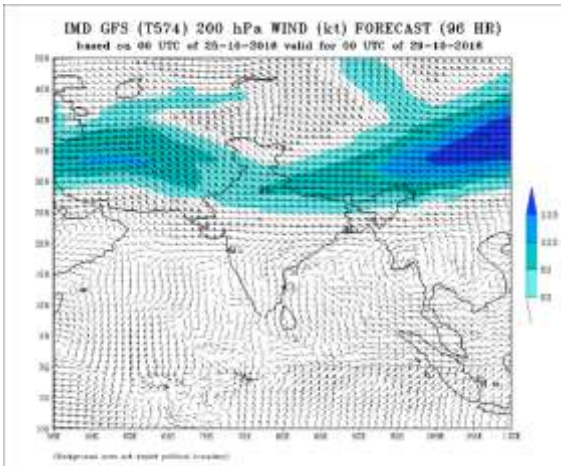


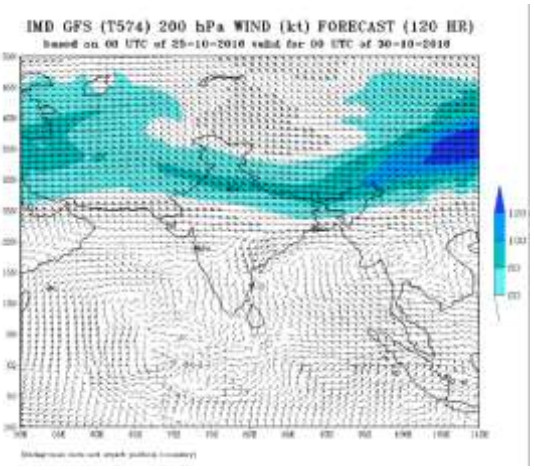

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 25-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 26-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 27-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 28-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 29-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 25-10-2016 valid for 00 UTC of 30-10-2016

FDP (Cyclone) NOC Report Dated 26th October, 2016

Synoptic features:

The cyclonic storm **'KYANT'** over eastcentral Bay of Bengal moved further west-southwestwards in past 06 hours with speed 18 kmph and lay centred at 1130 hrs IST of 26th October, 2016 over central Bay of Bengal, near Latitude 16.5º N and Longitude 88.0º E, 450 km southeast of Gopalpur, 520 km east-southeast of Vishakhapatnam and 730 km east-northeast of Machilipatnam. It is most likely to move west-southwestwards towards westcentral Bay of Bengal during next 72 hours.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 30˚C around the system area.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 80-100 kJ/CM^2 and decreases towards southwest.

Relative Vorticity:

The low level relative vorticity is about $200x10^{-6}$ $second^{-1}$ and vorticity centre is towards the SW of the system centre.

Convergence:

Lower level convergence is positive and is about $20x\ 10^{-5}s^{-1}$ over and around the system centre over Bay of Bengal. There is no area of significant lower level convergence over Arabian Sea.

Divergence:

Upper level divergence is 40 $x10^{-5}$ s-1 around the system centre.

Wind Shear:

Wind shear is low (5-10) knots around system centre. It increases towards southwest of the system.

Wind Shear Tendency:

There is decreasing tendency (-5 to -10 knots) over around the system area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, the convective clouds continue to show CDO pattern. The intensity of the system is T 2.5. Associated broken low/medium clouds with embedded intense to very intense convection lie over Bay of Bengal between latitude 14.00N to 20.00N and longitude 85.00E to 90.00E. The lowest cloud top temperature (CTT) is about -90^0 C.

Arabian Sea:

No significant clouds over Arabian sea.

Large scale features

Upper tropospheric Ridge: An anticyclonic circulation lies over Myanmar an another anticyclone is seen over north Arabian sea.

M.J.O. Index: MJO index is in Phase 1 with very less amplitude. It would continue to remain in phase 1 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The analysis charts based on 00 UTC of 26th October, 2016 show the cyclone over the western part of east central Bay of Bengal. It weakens into a depression near south Andhra coast on 27th. The model indicates likely movement in west-south-west direction towards east off south Andhra coast and it is likely to cross south Andhra and adjoining north Tamil Nadu coast around 29 October with gradual weakening of the system.

NCEP-GFS: The analysis charts of the model based on 00 UTC of 26th October, 2016 show the cyclonic system over west-central Bay of Bengal. The system weakens to a depression on 27th . The forecast indicates that the system is likely to move in west-south-west direction and cross Andhra coast by 28th/29th October, 2016. The intensity of the system is likely to decrease over the west-central Bay of Bengal before crossing the coast.

ECMWF: The model charts based on 00 UTC of 26th October 2016 shows the cyclonic storm over East-central Bay of Bengal. The forecast indicated west-south-west movement of the system during next 2 to 3

days (27 and 29 Oct) and likely to cross south Andhra and north Tamil Nadu coast on 29th/30th October, 2016 with gradual weakening of the system.

WRF: The WRF model analysis and forecasts based on 00 UTC of 26th October 2016 show the cyclonic storm over east-central Bay of Bengal in the analysis charts. The forecast indicated west-south-west movement of the system during next 2 days (27 and 28 Oct) and likely to cross south Andhra and north Tamil Nadu coast on 28th October, 2016 with gradual weakening of the system.

JMA: Model forecast for 27th indicates a CS over WC Bay. The system moving west-southwestwards weakened into a DD on 28th close to south Andhra coast and became a low on 29th and became less marked by the same evening.

ARP-Meteo France Model indicates the CS over EC Bay on 26th analysis field moves in a west-southwestward direction and becomes a deep depression on 28th over WC Bay. Further it continues to moves in the same direction and seen to cross south Andhra and adjoining north Tamilnadu coast on 29th as a low.

NCMRWF-NCUM: The 850 hPa wind plots from NCUM's Analysis, and forecasts based on 26th Oct 2016. The plots show the CS KYANT in the analysis slowly moves west wards and then towards AP coast on 27th and on 28th the system is seen crossing the coast. It became less marked on 30th.

NCMRWF-UM-Regional Model:

The forecasts based on 26th Oct 2016 indicate southwestward movement of CS 'Kyant' from 27th. The CS is seen to be very close to south Andhra coast on 28th and weakened further and crossed south Andhra coast and adjoining north Tamilnadu coast on 29th.

NCMRWF-NEPS Model:

The MSLP analysis and forecasts obtained from NEPS based on the initial conditions of 26th October 2016 show the CS KYANT gradually moves south westwards and weaken into a DD on 27th near near APcoast. Further weakening it is seen as a low off north Tamilnadu coast on 29th and became less marked on 30th.

IITM-GEFS: Based on the 00 UTC analysis on 26th, the CS is seen to be weakening over WC bay into a depression on 27th and on 28th to a low and becomes less marked thereafter over WC Bay.

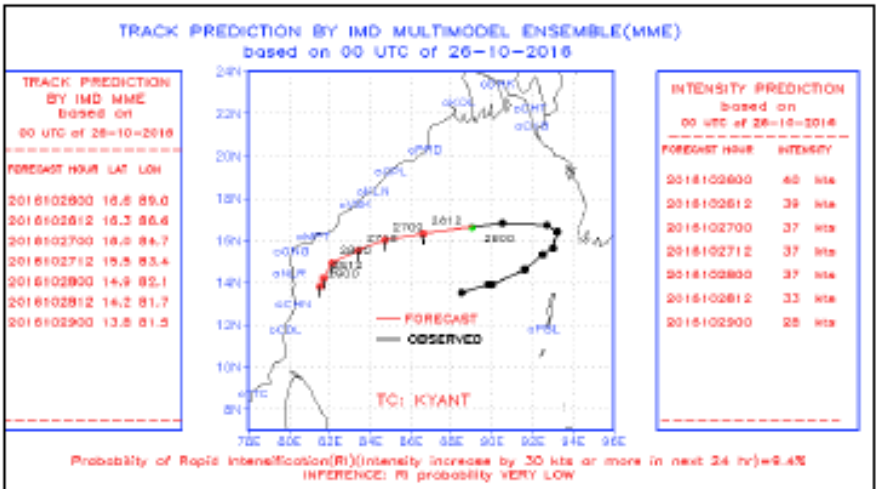
IITM-GFS(T1534): Based on 25/0000 UTC initial condition: CS over EC on 26th forecast, which moved west-southwestwards and weakened and is seen near south Andhra coast on 29th as a very low intensity system. It crossed coast on 29th and became less marked thereafter.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

The Genesis Potential Parameter (GPP) forecasts based on 00 UTC of 26th October 2016 analysis shows a significant GPP zone over central Bay of Bengal. The significant GPP zone move west-southwestward to WC BoB on Bay on 27th and reduced in intensity and size. It further weakened on 28th and 29th and is seen off south Andhra and north Tamil Nadu coast. The zone became less marked off on 30th .

MME TRACK: MME track forecast based on 0000 UTC of 26 October 2016 shows that the cyclonic storm "KYANT" is likely to move in the west-southwestward direction till 0000 UTC of 28 October 2016 and southwestwards thereafter.



SCIP INTENSITY: Intensity prediction by the SCIP model based on 0000 UTC of 26th October 2016 shows that the cyclonic storm "**KYANT**" over Bay of Bengal is likely to maintain its intensity till 0000 UTC of 28 October 2016 and weaken thereafter.

RAPID INTENSIFICATION: Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 9.4% (**Inference: RI probability VERY LOW**).

Summary and Conclusion:

The cyclonic storm '**KYANT**' over EC Bay did not intensify further during the past 24 hours and moved in a west southwestward direction. An anticyclonic circulation lies over Myanmar and another anticyclone is seen over north Arabian Sea. Under the influence of these two anti-cyclonic circulations, the system is expected to move west-southwestwards during next 72 hours. Majority of numerical models and IMD MME also support the above forecast.

Advisory:

- Intense observation may be taken over coastal Andhra Pradesh during 27-30th October 2016 and over north Tamil Nadu coast during 28- 30th October 2016.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	25/12	26/00	26/03
India	41	33	45
Coastal stations			
WB	4	2	4
Odisha	5	1	5
AP	7	3	6
Tamil Nadu	19	11	20
Puducherry	1	1	1
A & N	0	0	0
Bangladesh	0	15	15
Myanmar	2	3	1
Thailand	0	2	3
SriLanka	5	7	8

- **RS/RW** (12Z) of 25 / 10 /2016 18/37
- **No. of Ascents reaching 250 hPa levels: 18 , MISDA:- 19**
- **RS/RW** (00Z) of 26 / 10 /2016 30/35
- **No. of Ascents reaching 250 hPa levels: 28 , MISDA: 5**
-

No. of PILOT Ascents

25/12Z	26/00Z
20/37	33/34

Buoy Data

25/12Z	26/00Z	26/03Z
14	15	14

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**25.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**19**

No. of RS/RW Ascents

00Z /25.10.2016 : 7

No. of Ascents reaching 250 hPa level = 6

MISDA : 1

12Z /25.10.2016 : 4

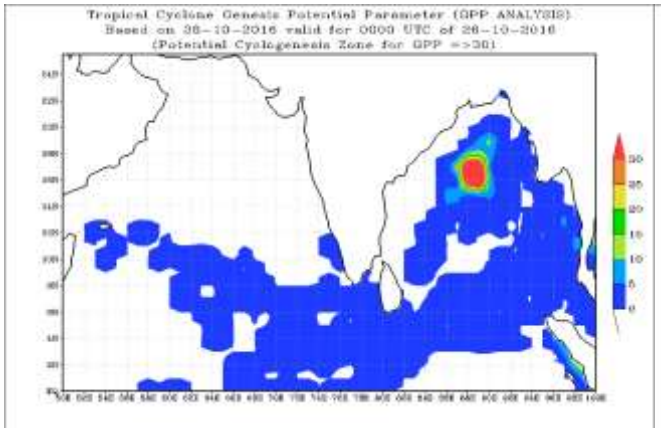
No. of Ascents reaching 250 hPa level = 4

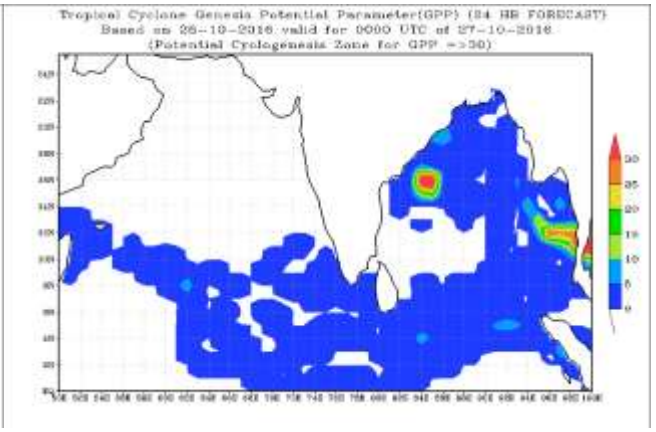
MISDA : 4

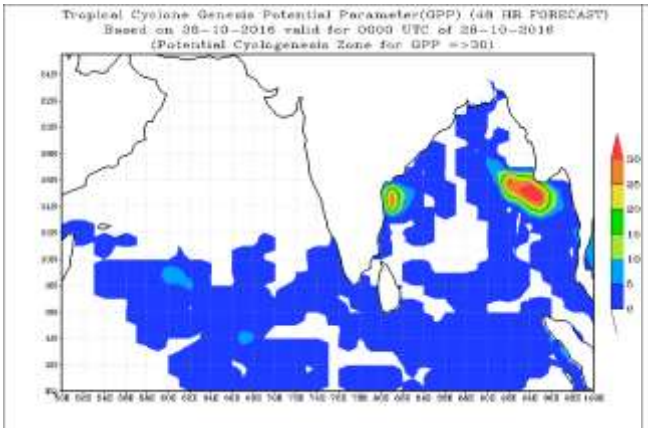
No. of PILOT Ascents:

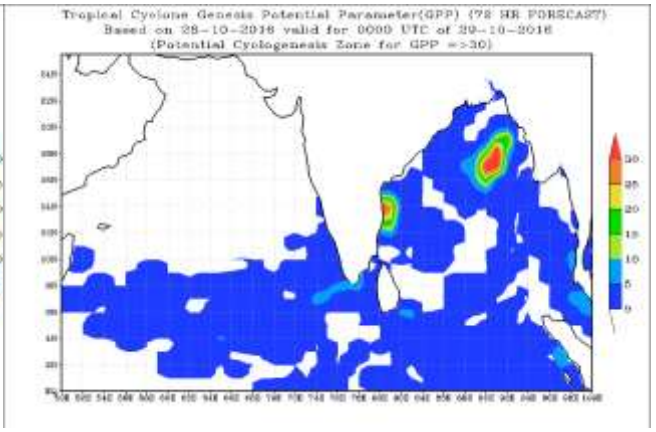
25.10.2016	
06Z	18Z
3	3

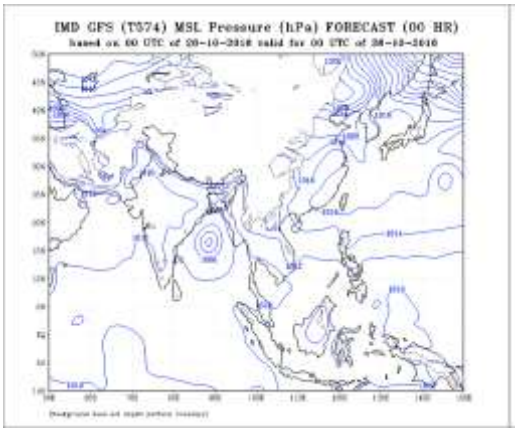
Annexure-II

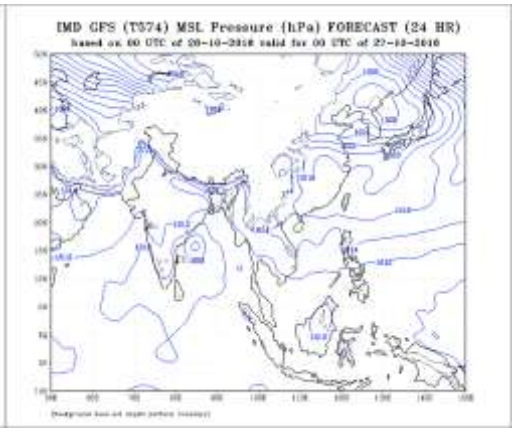

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 26-10-2016 valid for 0000 UTC of 26-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

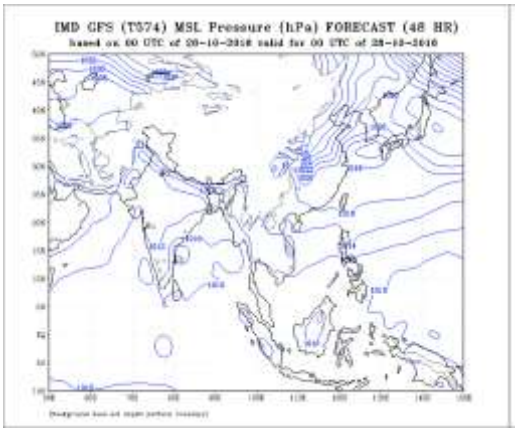

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 26-10-2016 valid for 0000 UTC of 27-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

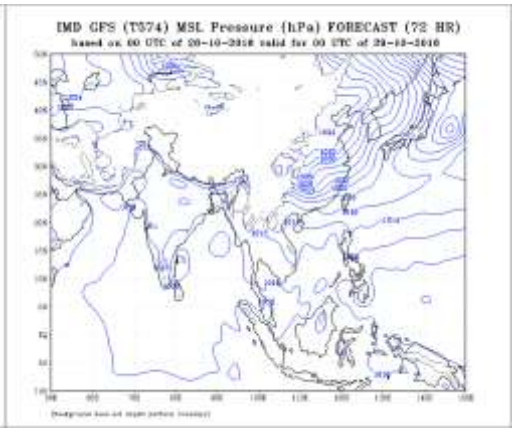

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 26-10-2016 valid for 0000 UTC of 28-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

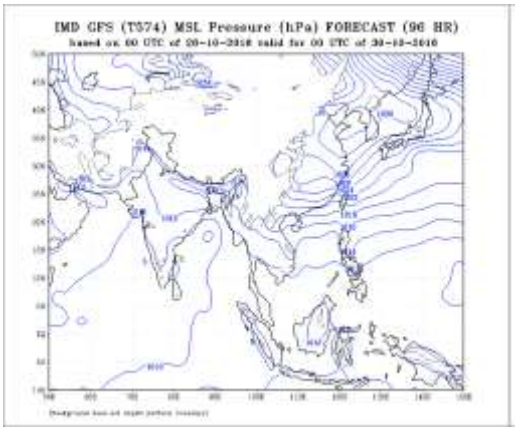

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 26-10-2016 valid for 0000 UTC of 29-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

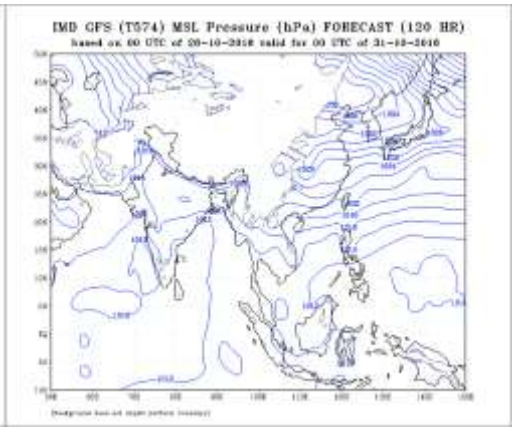

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)

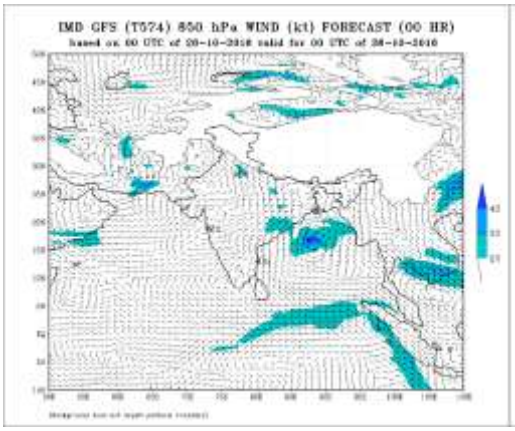

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

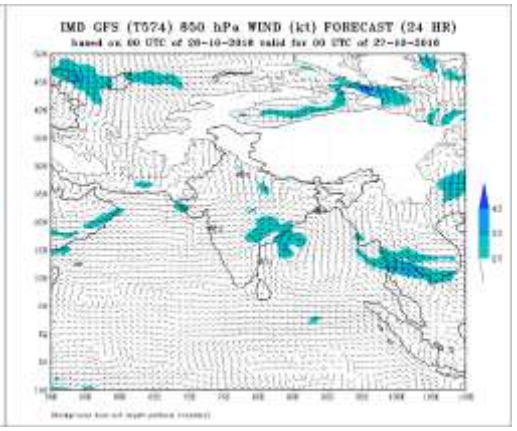

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

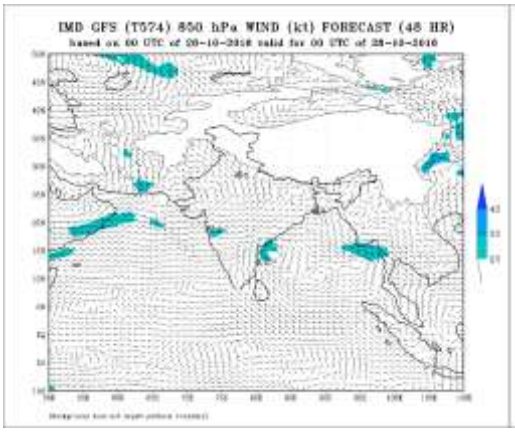

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

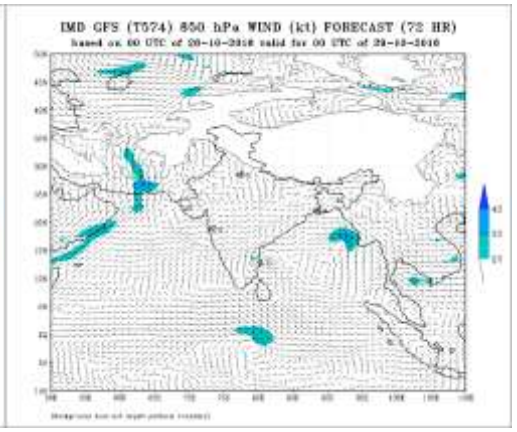

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

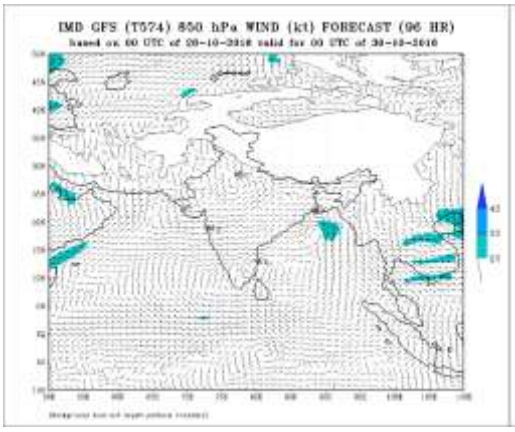

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

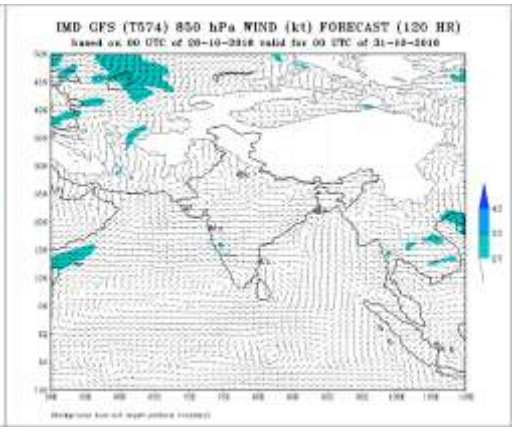

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

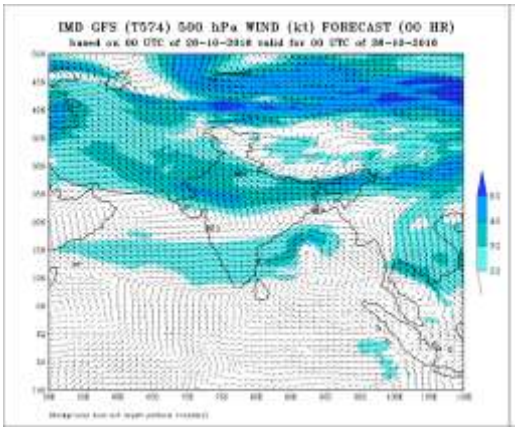

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

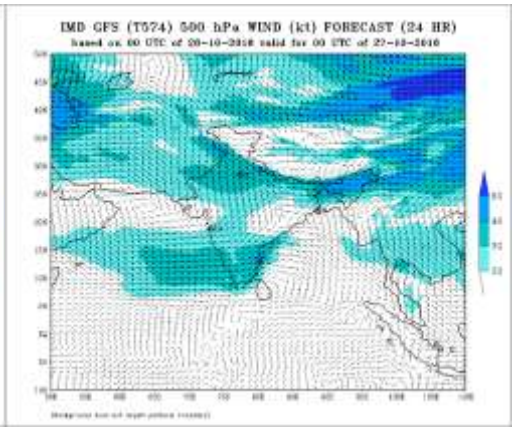

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

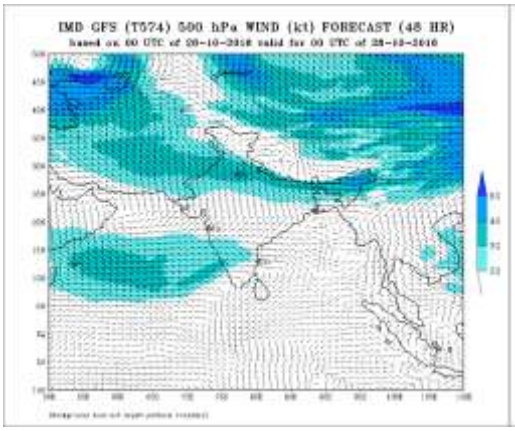

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

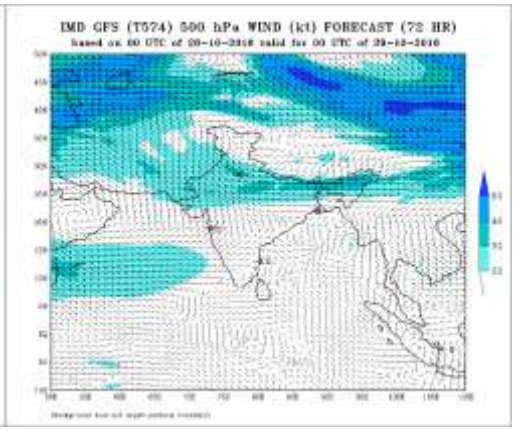

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

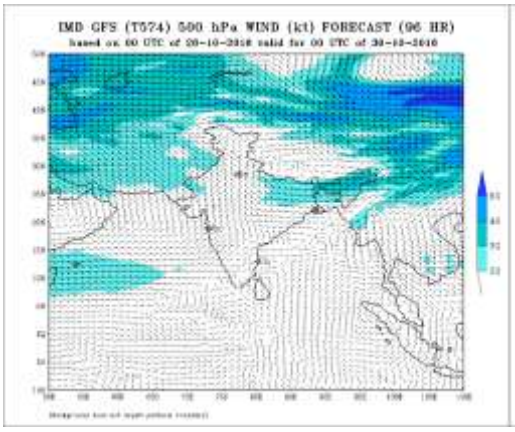

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

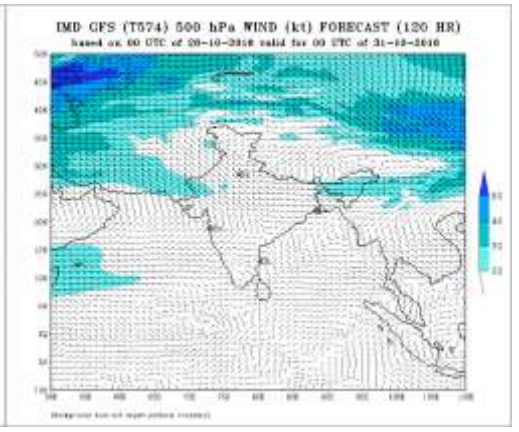

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)

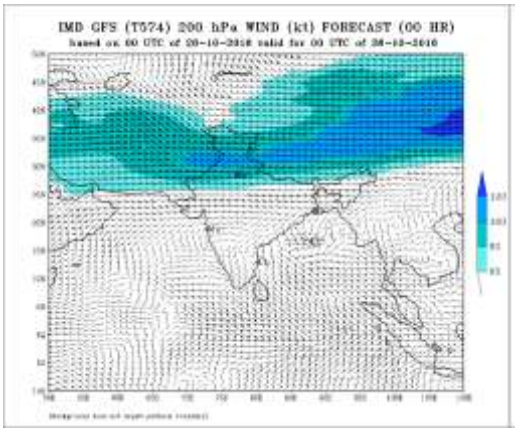

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

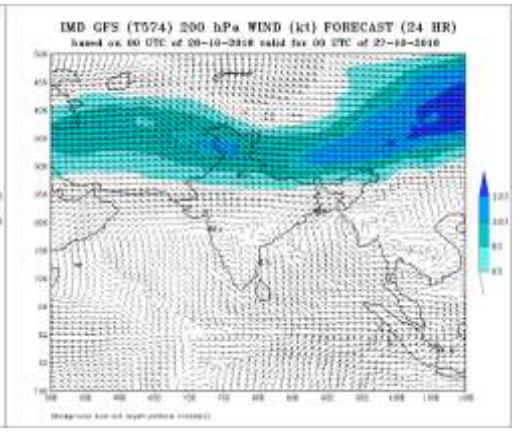

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

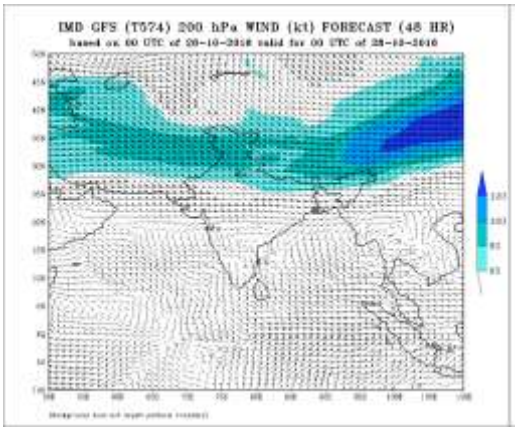

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

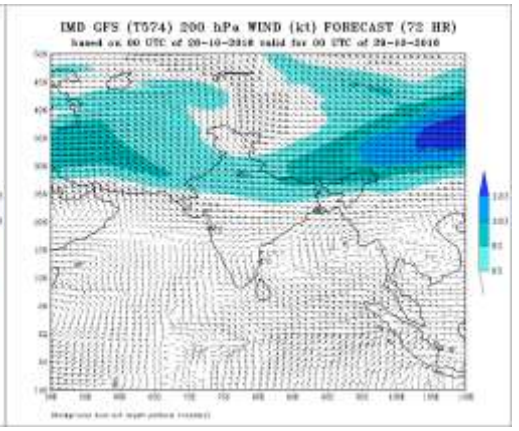

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

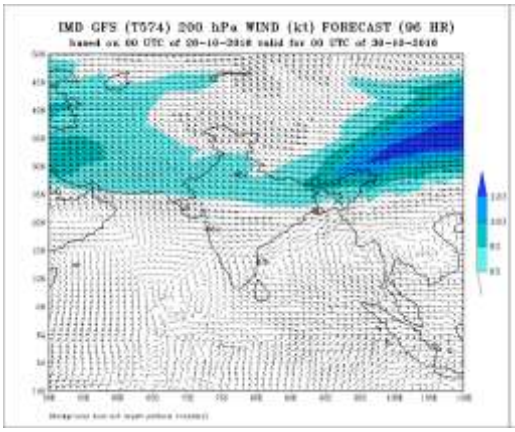

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

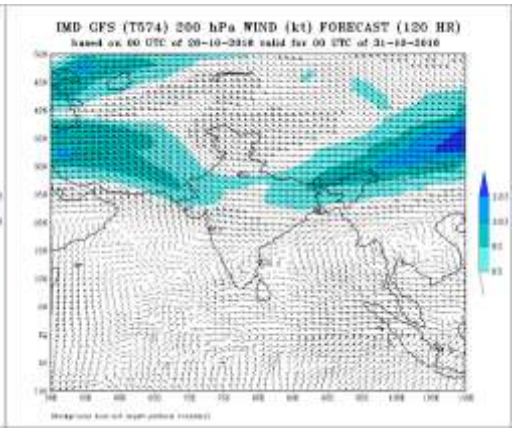

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)

FDP (Cyclone) NOC Report Dated 27th October, 2016

Synoptic features:

The cyclonic storm 'KYANT' over central Bay of Bengal moved west-southwestwards and weakened into a deep depression and lay centered at 2100 UTC of 26th October 2016 over westcentral Bay of Bengal, near lat.15.9°N/long.85.9°E. It continued to move west-southwestwards and lies centred at 0300 hours UTC of today, the 27th October 2016 over the same region, near lat.15.5°N/long.85.0°E, about 550 kms east-northeast of Nellore, 310 kms southeast of Vishakhapatnam and 420 kms east of Machilipatnam. It is most likely to move west-southwestwards and weaken into a depression during next 24 hours. A trough in the lower levels runs from the above system to Bangladesh across northwest Bay of Bengal. A cyclonic circulation extending upto 3.1 kms a. s. l. lies over gulf of Siam and neighbourhood.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29˚C around the system area.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 50-75 kJ/CM^2.

Relative Vorticity:

The low level relative vorticity is about $100x10^{-6}$ $second^{-1}$ and vorticity centre is towards the SW of the system centre.

Convergence:

Lower level convergence is positive and is about $10x\ 10^{-5}s^{-1}$ over and around the system centre over Bay of Bengal. There is no area of significant lower level convergence over Arabian Sea.

Divergence:

Upper level divergence is $10\ x10^{-5}$ s-1 around the system centre.

Wind Shear:

Wind shear is moderate (10-15) knots around system centre.

Wind Shear Tendency:

There is decreasing tendency (-5 to -10 knots) over around the system area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, broken low/medium clouds with embedded intense to very intense convection lie over Bay of Bengal between latitude 13.5°N to 81.2°N and longitude 81.2°E to 84.5°E in association with the vortex near 15.3°N/84.5°E. The intensity of the system is T 2.0. The lowest cloud top temperature (CTT) is about -77^0 C.

Arabian Sea:

No significant clouds over Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 19^0N latitude over BoB. An anticyclone is seen over north Arabian sea.

M.J.O. Index: MJO index is in Phase 1 with very less amplitude. It would move towards phase 8 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The analysis charts based on 00 UTC of 27th October, 2016 show the DD over the west central Bay of Bengal weakens on 28th and becomes less marked by 29th over the same area. Another low is seen to be developing over WC Bay off Tamil Nadu coast on 03 November.

NCEP-GFS: The analysis charts of the model based on 00 UTC of 27th October, 2016 show the cyclonic system over west-central Bay of Bengal weakens rapidly and becomes less marked by 29th.Another low developed off Tamil Nadu coast on 05 November.

ECMWF: The model charts based on 00 UTC of 27th October 2016 shows the cyclonic storm over East-central Bay of Bengal weakened and became less marked rapidly. The model also indicates formation of a fresh low pressure system over the south-east Bay of Bengal around 1st November, which is likely to further

intensify while moving in northwestward direction. It is seen as a well marked on 03rd and a depression on 04th November.

WRF: The WRF model analysis and forecasts based on 00 UTC of 27th October 2016 show the Deep Depression over west-central Bay of Bengal in the analysis charts. The forecast indicated west-south-west movement of the system on 28th October and likely to cross south Andhra and north Tamil Nadu coast on 28th October, 2016 and gradual weakening thereafter.

JMA: Model forecast for based on 27th 00UTC analysis indicates system over WC Bay weakens rapidly.

Meteo-France ARP Model indicates the system over EC Bay on 27th analysis field moves in a west-southwestward direction and becomes less marked by 28th.

NCMRWF-NCUM:

The forecast based on 27th Oct 2016 initial conditions shows that CS KYANT over WC Bay weakened on 28th. Another low appears over WC bay near to Tamil Nadu coast is seen on 04th November and remain more or less at the same area with same intensity for subsequent two days.

NCMRWF-UM-Regional Model:

The forecasts based on 27th Oct 2016 initial conditions show the circulation over WC Bay in the analysis field to become less marked on 28th.

NCMRWF-NEPS Model:

The MSLP analysis and forecasts (Day-1) obtained from NEPS based on the initial conditions of 27th October 2016 are given in Figure 3. These forecasts show the CS KYANT is weakening near APcoast

IITM-GEFS: Based on the 00 UTC analysis on 27th, only a very feeble low is seen in the analysis field. One low pressure area is seen over SW bay and adjoining WC bay on 03 November which becomes WML on 04th November.

IITM-GFS(T1534): Based on 26/0000 UTC initial condition: the low seen on the 27th forecast field is seen to become less marked on 28th off south Andhra coast.

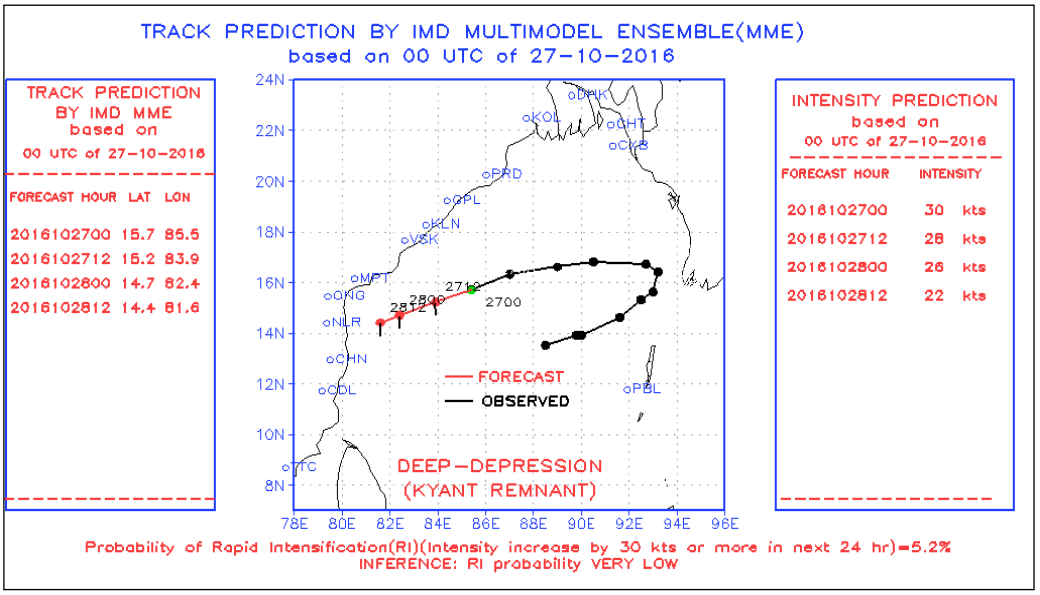
<u>Dynamical statistical models;</u>

IMD Genesis Potential Parameter (GPP):

The Genesis Potential Parameter (GPP) forecasts based on 00 UTC of 27th October 2016 analysis shows a small area of significant GPP values over central Bay of Bengal. The significant GPP zone move west-southwestward and further reduces in size and strength by 28th and becomes insignificant on 29th.

MME TRACK:

MME track forecast based on 0000 UTC of 27 October 2016 shows west-southwestward movement of the DEEP DEPRESSION (Remnant of the cyclonic storm KYANT)



SCIP INTENSITY:

Intensity prediction by the SCIP model shows gradual weakening of the DEEP DEPRESSION (Remnant of the cyclonic storm KYANT) and dissipation over Sea.

RAPID INTENSIFICATION:Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 5.2% (**Inference: RI probability VERY LOW**).

Summary and Conclusion:

The deep depression over WC Bay of Bengal is likely to move west-southwestwards and weaken gradually.

The possibility of emergence of the circulation from Gulf of Thailand into Bay of Bengal and its further intensification into a Low Pressure area over southeast/eastcentral Bay of Bengal by 31st Oct/ 01 November needs to be monitored

Advisory:

- Intense observation may be taken over south coastal Andhra Pradesh and north coastal Tamil Nadu during 28-29th October 2016.

Probability of cyclogenesis (formation of depression) over Bay of Bengal

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
Probability	Nil	Nil	Nil	Nil	Low

Probability of cyclogenesis (formation of depression) over Arabian Sea

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
Probability	Nil	Nil	Nil	Nil	Nil

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	26/12	**27/00**	**27/03**
India	40	32	45
Coastal stations			
WB	4	2	2
Odisha	6	1	4
AP	9	5	6
Tamil Nadu	22	11	15
Puducherry	1	1	1
A & N	0	0	0
Bangladesh	0	15	15
Myanmar	0	12	12
Thailand	3	3	3
SriLanka	3	10	10

- **RS/RW** (12Z) of 26 / 10 /2016 38 /43
- **No. of Ascents reaching 250 hPa levels: 16 , MISDA:- 20**

- **RS/RW** (00Z) of 27 / 10 /2016 38/43
- **No. of Ascents reaching 250 hPa levels: 37 , MISDA: 5**
-

No. of PILOT Ascents

26/12Z	**27/00Z**
18 /37	24/34

Buoy Data

26/12Z	**27/00Z**	**27/03Z**
14	14	12

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**26.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /26.10.2016 : 6

No. of Ascents reaching 250 hPa level = 6

MISDA : 2

12Z /26.10.2016 : 4

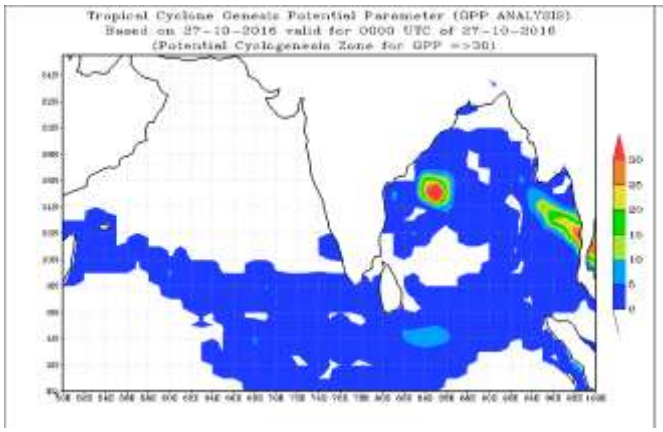
No. of Ascents reaching 250 hPa level = 4

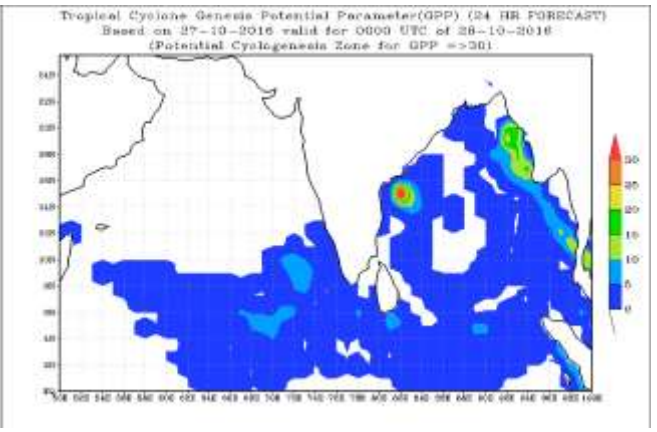
MISDA : 4

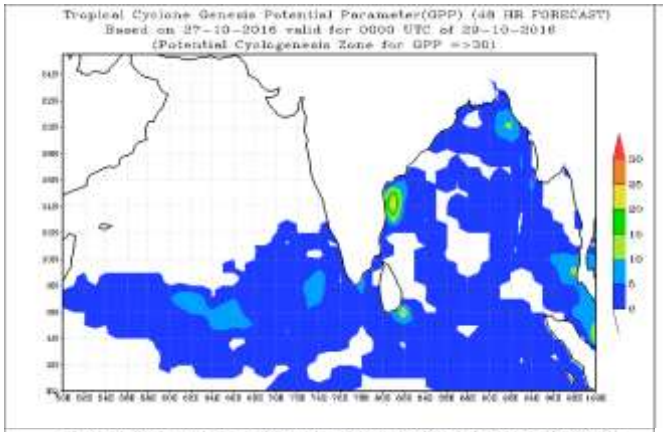
No. of PILOT Ascents:

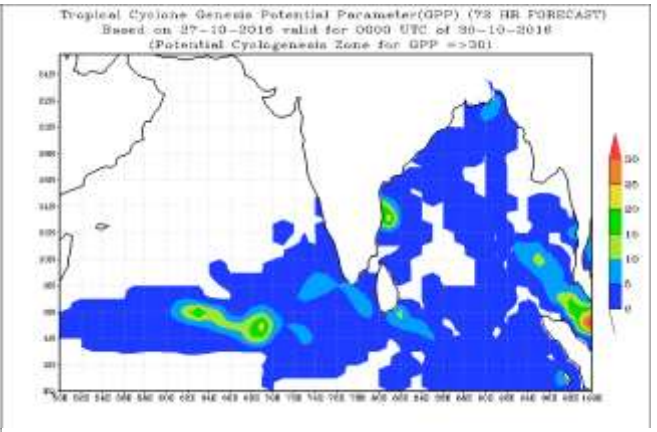
26.10.2016	
06Z	18Z
5	3

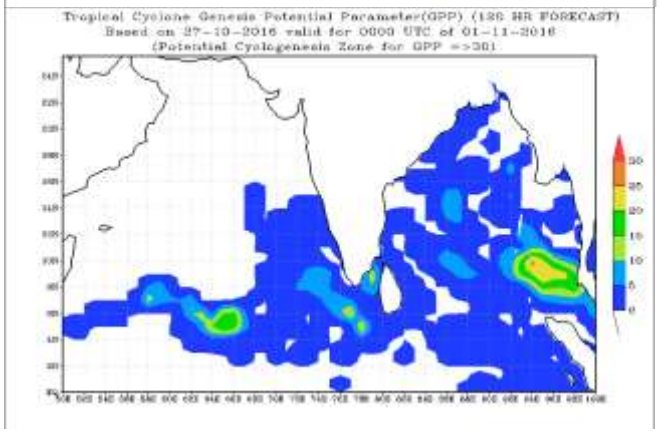
Annexure-II

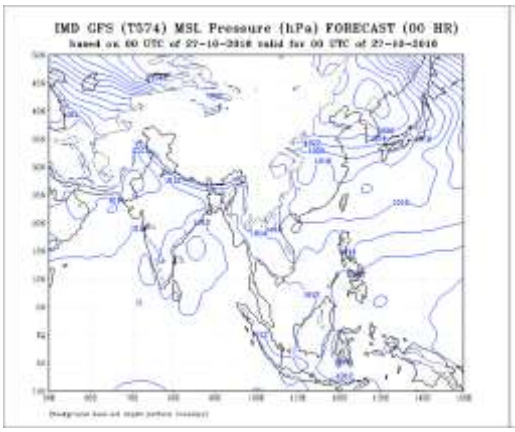

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 27-10-2016 valid for 0000 UTC of 27-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

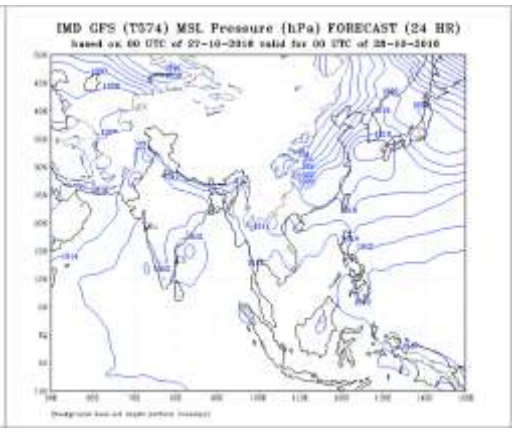

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 27-10-2016 valid for 0000 UTC of 28-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

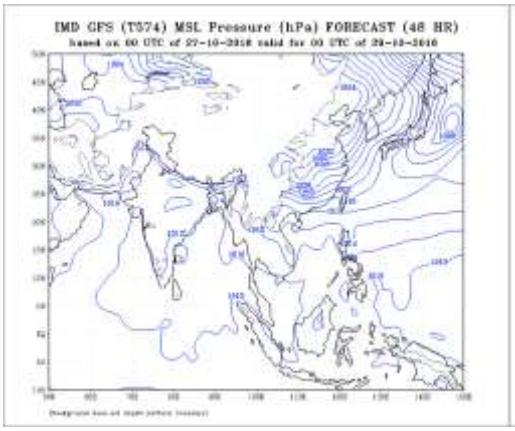

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 27-10-2016 valid for 0000 UTC of 29-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

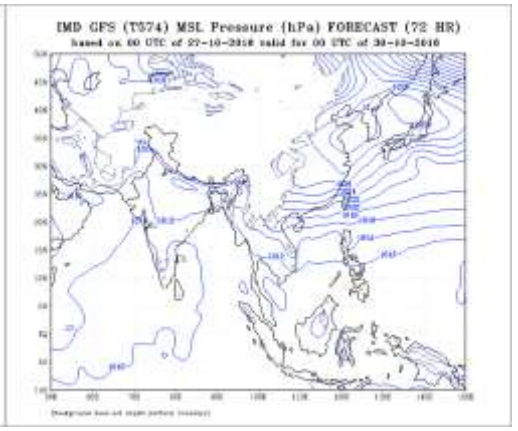

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 27-10-2016 valid for 0000 UTC of 30-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

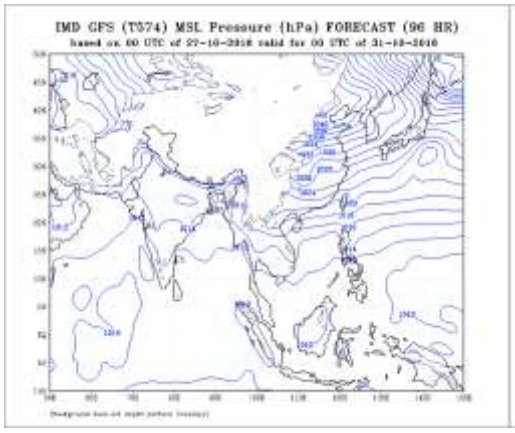

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 27-10-2016 valid for 0000 UTC of 01-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

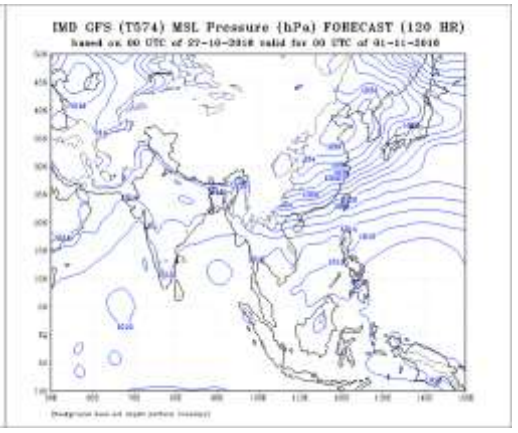

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)

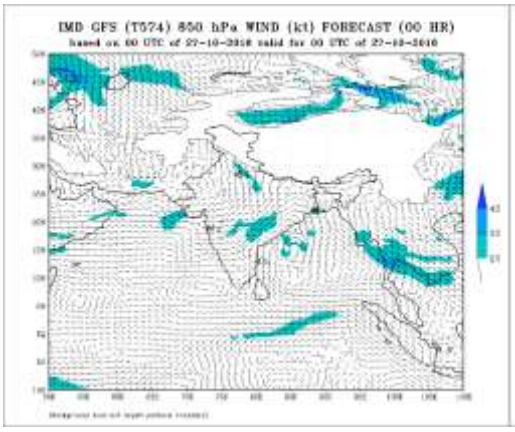

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

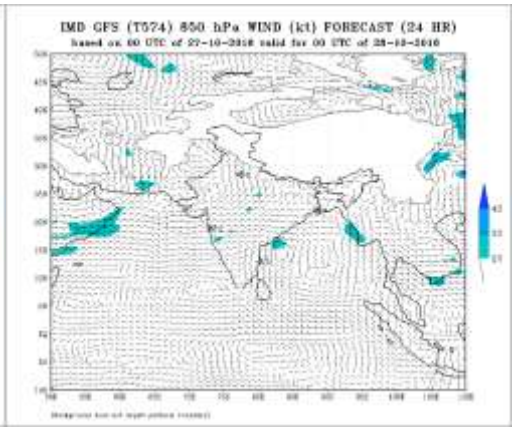

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

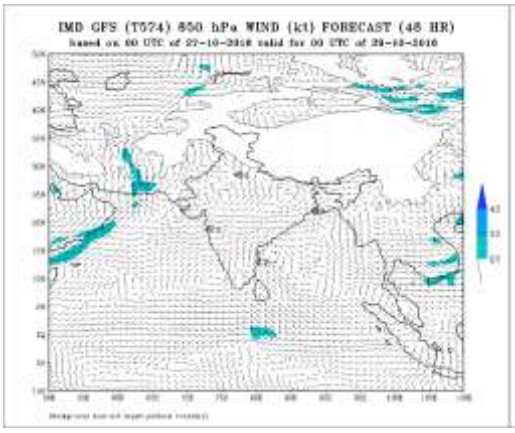

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

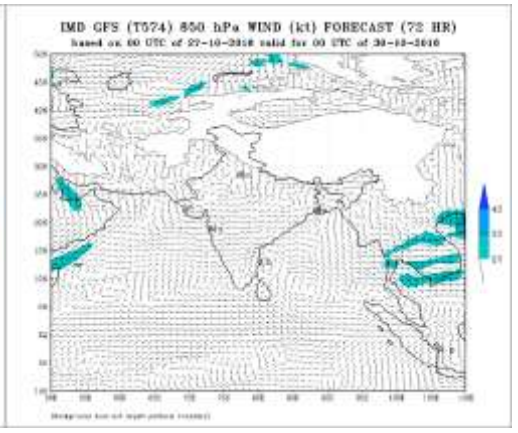

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

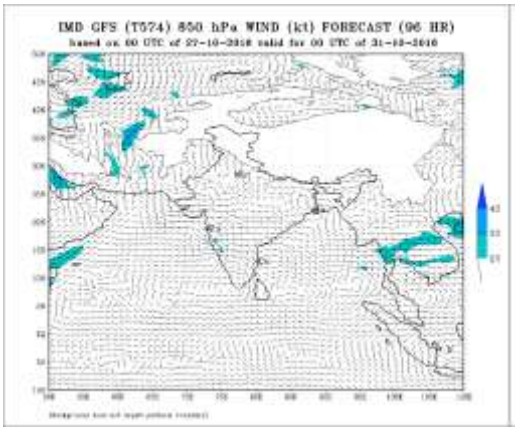

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

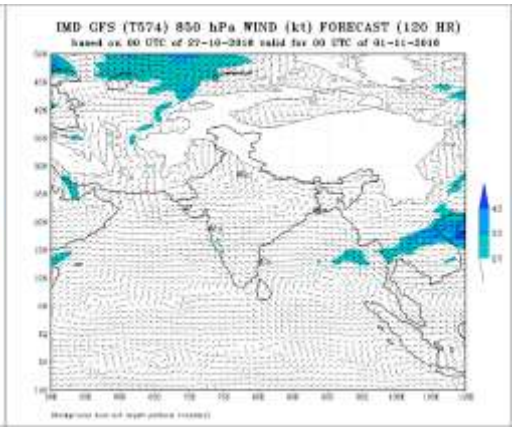

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

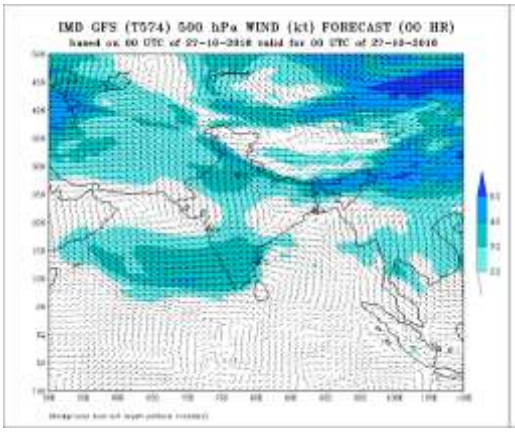

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

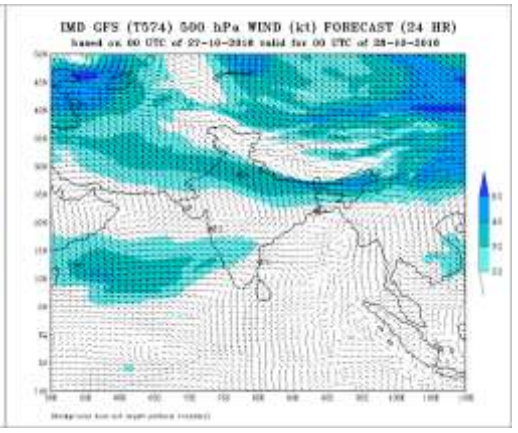

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

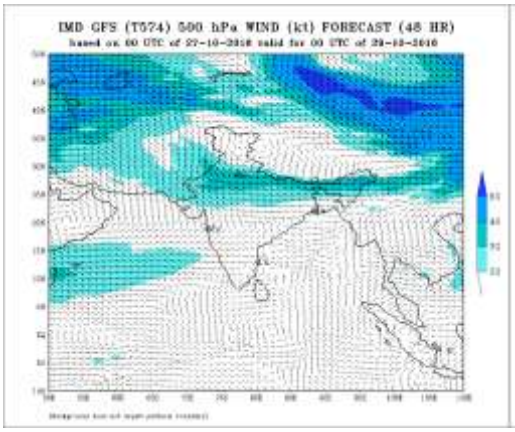

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

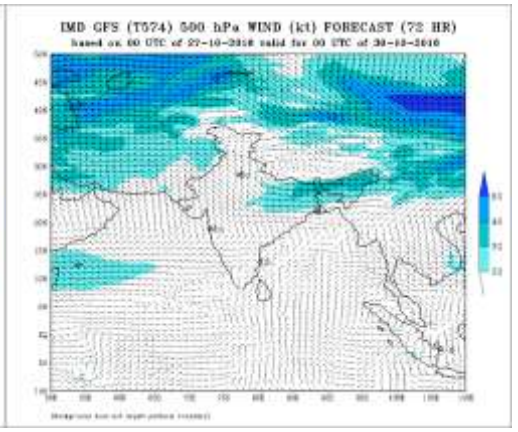

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

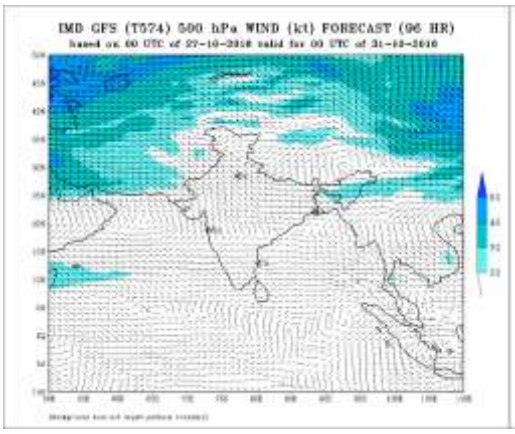

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

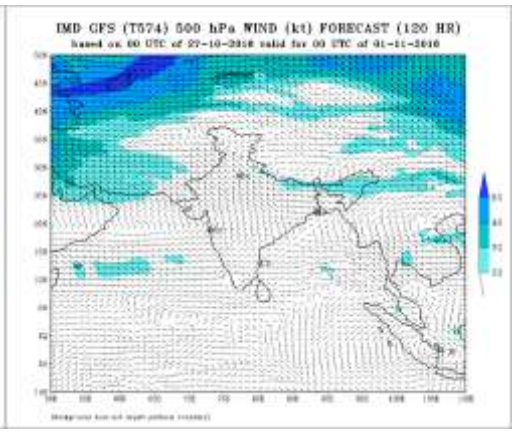

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)

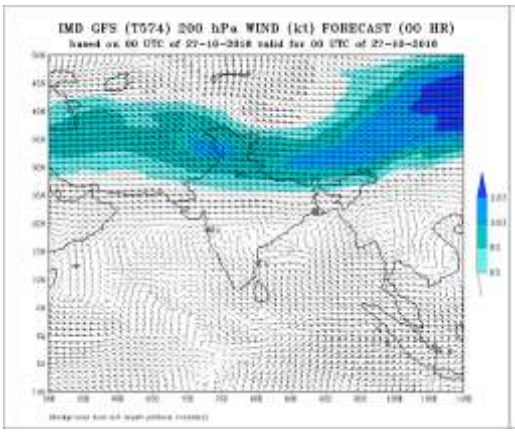

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

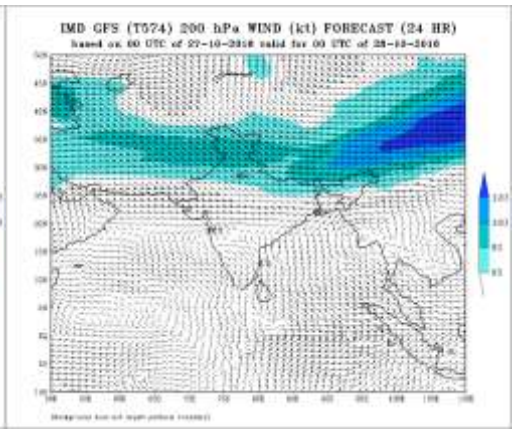

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

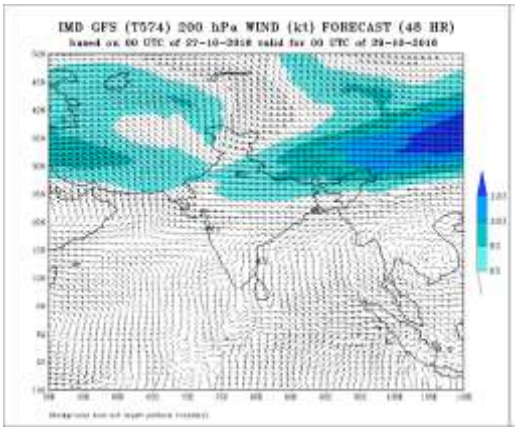

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

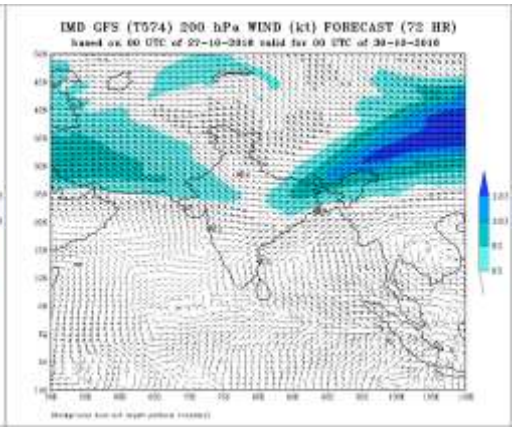

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

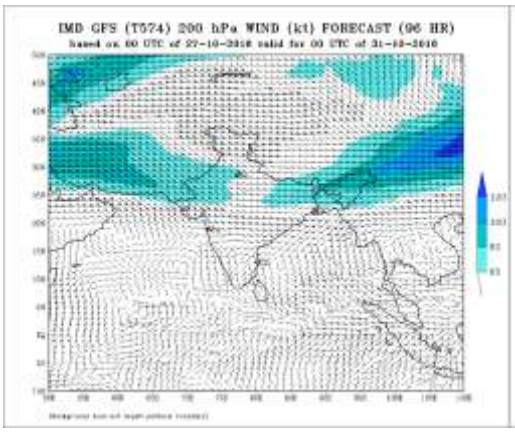

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

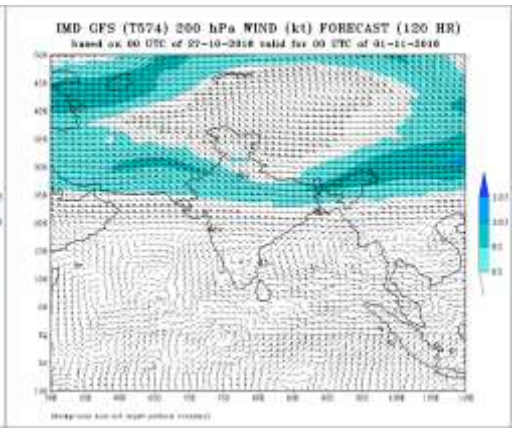

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 27-10-2018 valid for 00 UTC of 27-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 27-10-2018 valid for 00 UTC of 28-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 27-10-2018 valid for 00 UTC of 29-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 27-10-2018 valid for 00 UTC of 30-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 27-10-2018 valid for 00 UTC of 31-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 27-10-2018 valid for 00 UTC of 01-11-2018

FDP (Cyclone) NOC Report Dated 28th October, 2016

Synoptic features:

The Deep Depression over westcentral Bay of Bengal moved westwards, weakened into a Depression and lay centred at 1200 UTC of yesterday, the 27th October, 2016 over the same region, near Lat.15.5º N/Long.83.5ºE, about 240 kms south-southeast of Vishakhapatnam and 260 kms east-southeast of Machilipatnam and 390 kms east-northeast of Nellore. It moved west-southwestwards and further weakened and lay as a well marked low pressure area at 0000 UTC of today over westcentral Bay of Bengal off Andhra Pradesh coast. It further weakened into a low pressure area and lies over the same region by today morning. Associated cyclonic circulation extends upto 3.6 kms a. s. l. tilting southwestwards with height. The trough in the lower levels from this system to Bangla Desh has become less marked. A cyclonic circulation extending upto 4.5 kms a. s. l. lies over eastcentral Bay of Bengal and neighbourhood. A shear zone in lower levels extends from the low pressure area to coastal Karnataka across Rayalaseema and south Interior Karnataka. The cyclonic circulation over Gulf of Siam and neighbourhood has become less marked.

Dynamical and thermodynamical features :

Surface Temperature (SST):

The sea surface temperature is 29˚C around over most parts of Bay of Bengal and is around 28˚C over Arabian Sea.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 50-75 kJ/CM^2 over most parts of BoB and Arabian Sea.

Relative Vorticity:

The low level relative vorticity is about $70x10^{-6}$ $second^{-1}$ over SW Bay near Tamilnadu coast and is about $30-40x10^{-6}$ $second^{-1}$ over WC Bay and adjoining Myanmar coast

Convergence:

Lower level convergence is positive and is about 5-10x $10^{-5}s^{-1}$ over WC Bay and adjoining Myanmar coast. There is no area of significant lower level convergence over Arabian Sea.

Divergence:

Upper level divergence is around 5-10 $x10^{-5}$ s-1 over WC Bay and adjoining Myanmar coast.

Wind Shear:

Wind shear is low to moderate over central and adjoining south Bay of Bengal. It is low to moderate over central and south Arabian Sea.

Wind Shear Tendency:

There is decreasing tendency southeast Arabian Sea and southwest Bay and adjoining equatorial ocean.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection between latitude 14.0°N to 16.3°N and longitude 80.7°E to 82.7°E in association with the vortex near 15.0°N/81.7°E over westcentral Bay of Bengal and neighbourhood. The intensity of the system is T 1.0. Broken low/medium clouds with embedded moderate to intense convection over Arakan coast and adjoining EC Bay in association with low level circulation over the area.

Arabian Sea:

No significant clouds over Arabian sea.

Large scale features

Upper tropospheric Ridge: An anticyclone is seen over Myanmar. Ridge at 200 hPa lies at 20^0N latitude over north Arabian sea.

M.J.O. Index: MJO index is in Phase 8 with very less amplitude. It would remain in phase 8 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The analysis charts based on 00 UTC of 28th October, 2016 show the low pressure area over west central Bay of Bengal off Andhra Pradesh coast, which is likely to be weaken by 29th October, 2016.

The model forecast also indicates possible formation of a low pressure system on 1st November, 2016 over southeast-Bay of Bengal, which is likely to intensify and move in northwest direction towards south Andhra coast during subsequent 3 to 4 days

NCEP-GFS: The analysis charts of the model based on 00 UTC of 28th October, 2016 show a low on 05th November which moves little westwards on 06th over west-central Bay of Bengal.

ECMWF: The model charts based on 00 UTC of 28th October 2016 shows the presence of a low pressure system over south-west and adjoining west central Bay of Bengal around 02nd November, which persists on 03rd over the same area.

WRF: The WRF model analysis and forecasts based on 00 UTC of 28th October 2016 show the low pressure system over west-central Bay of Bengal and adjoining off Andhra coast. The system is likely to be weaken.

JMA: Model forecast for based on 28th 00UTC analysis indicates the low over WC Bay off Tamil Nadu coast persists over the area on 29th and becomes less marked on 30th .

Meteo-France ARP Model indicates the low over SW Bay on 28th analysis field becomes less marked on 29th.

NCMRWF-NCUM:

The forecast based on 28th Oct 2016 initial conditions shows low over WC bay on 04th , 05th , and 06th November and remain more or less at the same area with same intensity during the period. Another low is seen over during 04-06th November over SE Arabian sea without any intensification.

NCMRWF-UM-Regional Model:

The forecasts based on 28th Oct 2016 initial conditions show no significant circulation pattern over BoB as well as Arabian Sea.

NCMRWF-NEPS Model:

The MSLP analysis and forecasts (obtained from NEPS based on the initial conditions of 28th October 2016 shows a low pressure area on 05th over WC Bay which becomes more marked on 06th November.

IITM-GEFS: Based on the 00 UTC analysis on 28th, a low pressure area is seen over SW bay and adjoining WC bay on 02 which persists through 03 and 04th November which becomes WML on 05th November without appreciable movement.

IITM-GFS(T1534): Based on 27/0000 UTC initial condition: The low seen on the 28th forecast field is seen to become less marked on 29th off south Andhra coast. Another low formed on 02nd November over WC Bay off Tamil Nadu coast, which persisted over the same area through 04th November.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

The Genesis Potential Parameter (GPP) forecasts based on 00 UTC of 28th October 2016 analysis shows an area of significant GPP values over Andaman Sea and adjoining SE Bay of Bengal on 03rd November which shows a west-northwestward movement in the subsequent three days.

Summary and Conclusion:

A low pressure area is likely to emerge into Andaman Sea and adjoining SE Bay on 01 November. It may concentrate into a depression on 02nd November and move in west-northwest direction towards Andhra Pradesh Coast with gradual intensification.

Advisory:

- No IOP for next 5 days.

Probability of cyclogenesis (formation of depression) over Bay of Bengal

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
Probability	Nil	Nil	Nil	Low	Fair

Probability of cyclogenesis (formation of depression) over Arabian Sea

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
Probability	Nil	Nil	Nil	Nil	Nil

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	27/12	**28/00**	**28/03**
India	50	29	43
Coastal stations			
WB	9	4	8
Odisha	14	4	5
AP	8	11	11
Tamil Nadu	12	8	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	13	14	14
Myanmar	0	0	12
Thailand	0	2	0
SriLanka	9	9	10

- **RS/RW** (12Z) of 27/ 10 /2016 38/43
- **No. of Ascents reaching 250 hPa levels: 37 , MISDA:-19**

- **RS/RW** (00Z) of 28 / 10 /2016 36/43
- **No. of Ascents reaching 250 hPa levels: 34 , MISDA: 5**
-

No. of PILOT Ascents

27/12Z	**28/00Z**
07/69	04/69

Buoy Data

27/12Z	**28/00Z**	**28/03Z**
18	17	17

AWS :

Region	Date/Time (UTC)		
	27/12	**28/00**	**28/03**
WB	03	01	04
Odisha	06	01	06
AP	09	03	08
Tamil Nadu	23	15	21
Puducherry	01	01	01
A&N	0	0	0

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**27.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /27.10.2016 : 6

No. of Ascents reaching 250 hPa level = 6

MISDA : 2

12Z /27.10.2016 : 5

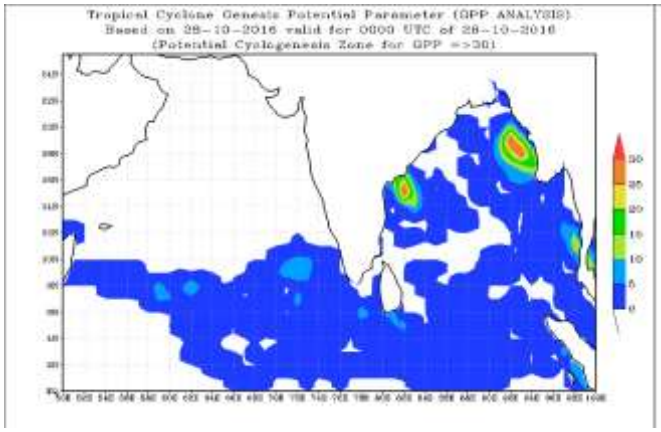
No. of Ascents reaching 250 hPa level = 4

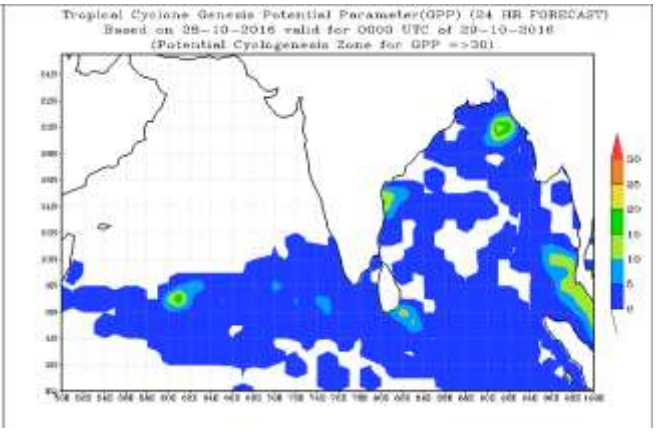
MISDA : 4

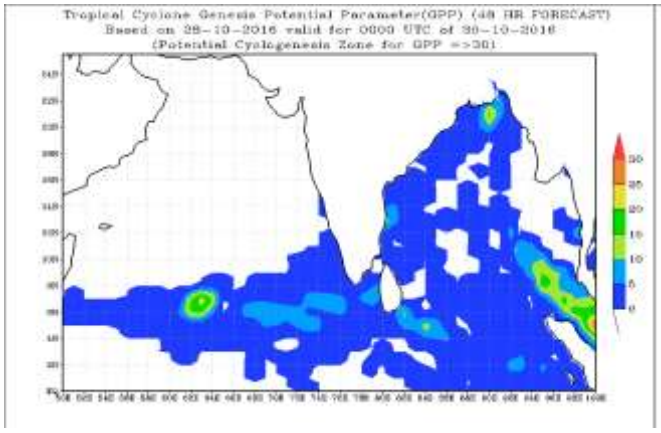
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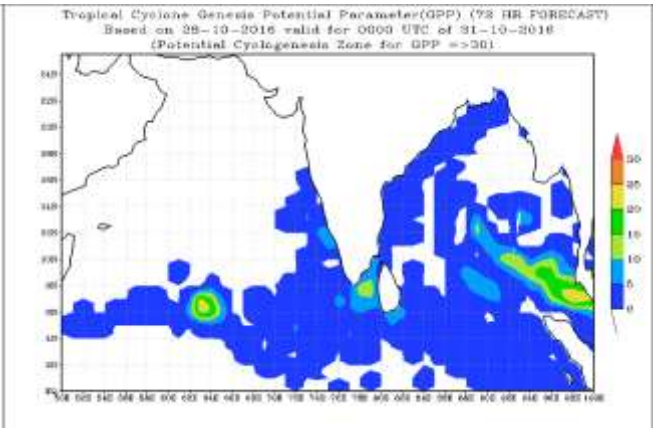
27.10.2016	
06Z	18Z
2	1

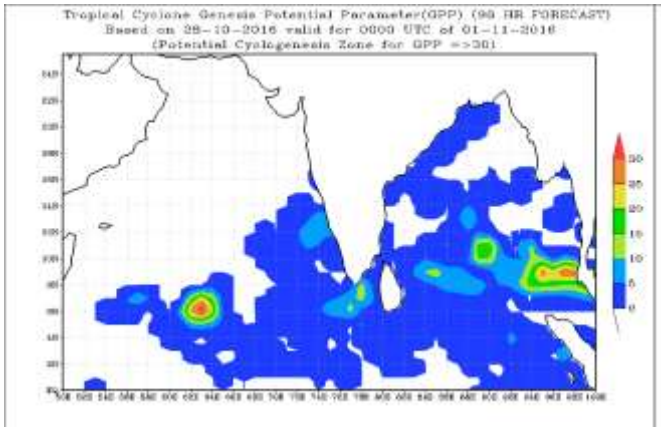
Annexure-II

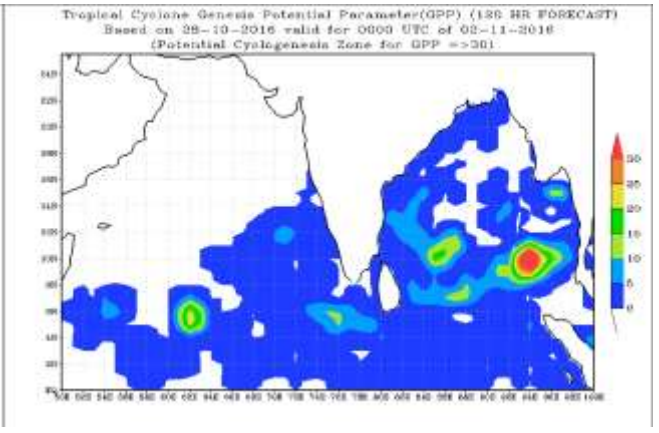

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 28-10-2016 valid for 0000 UTC of 28-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

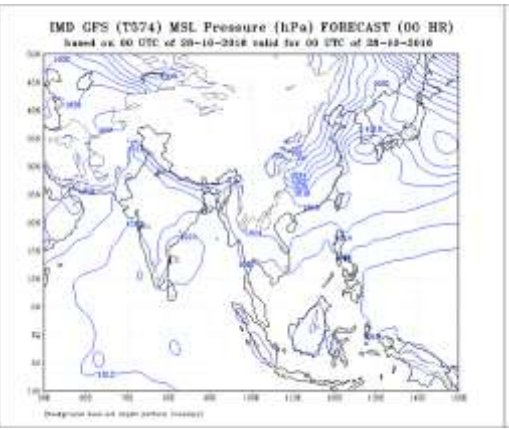

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 28-10-2016 valid for 0000 UTC of 29-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

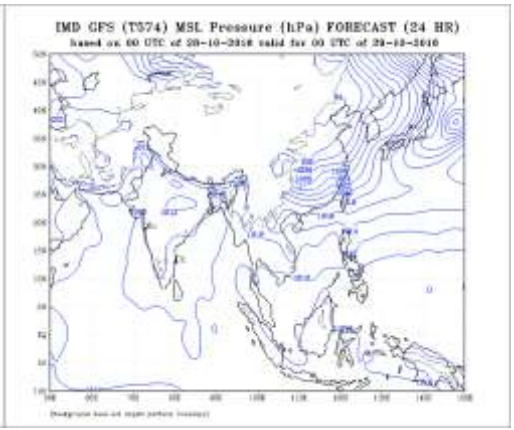

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

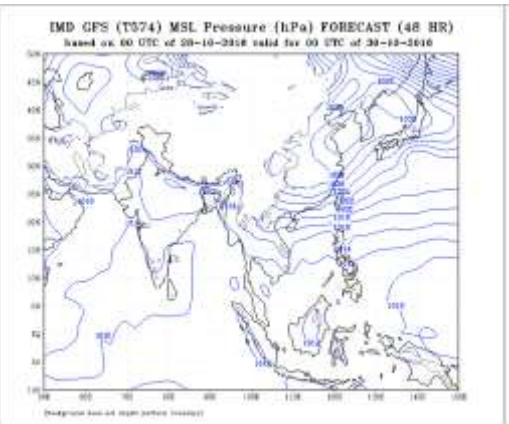

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 28-10-2016 valid for 0000 UTC of 31-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

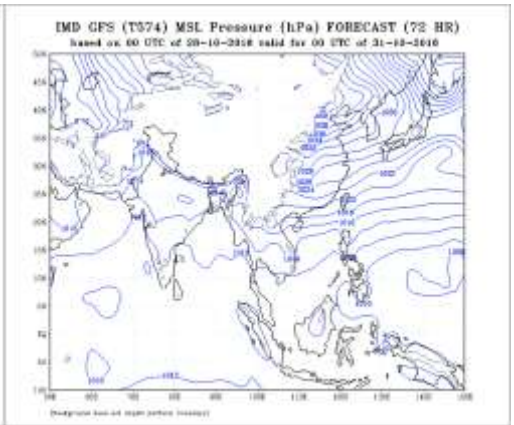

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 28-10-2016 valid for 0000 UTC of 01-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

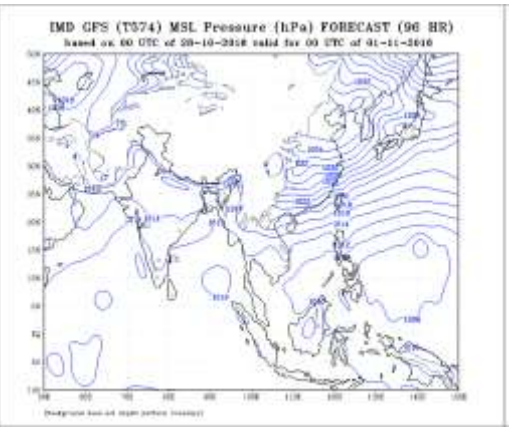

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 28-10-2016 valid for 0000 UTC of 02-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

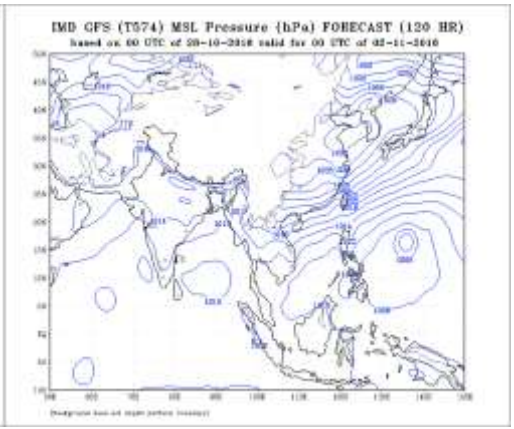

EMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)

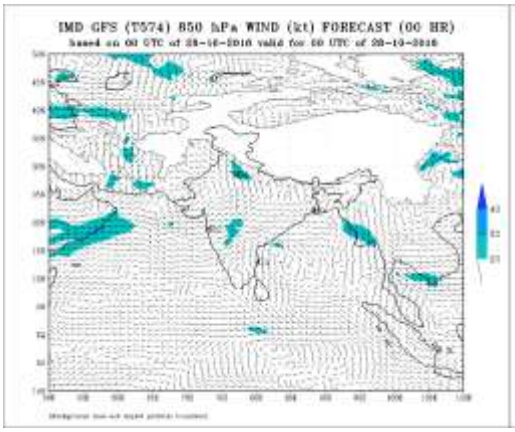

EMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

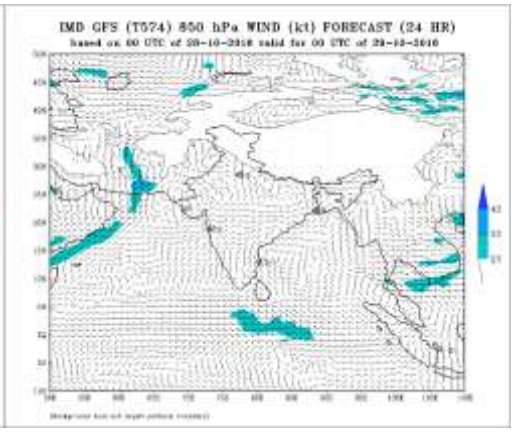

EMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

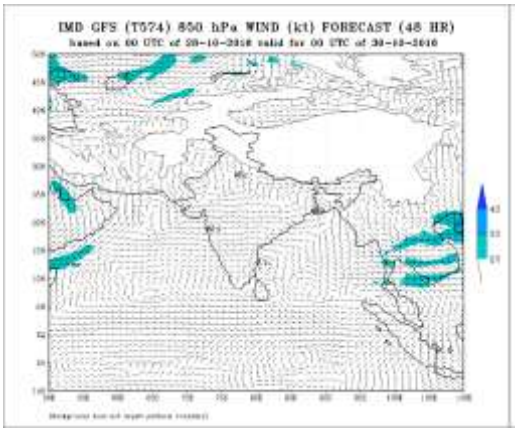

EMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

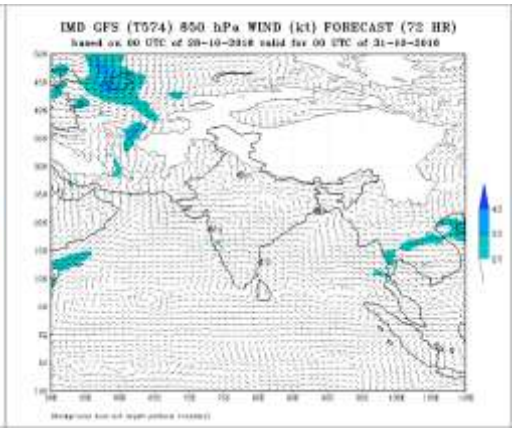

EMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

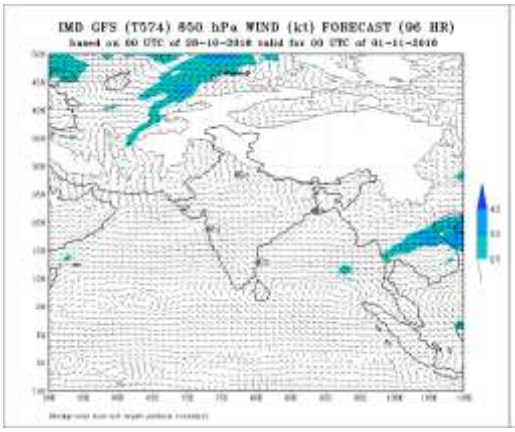

EMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

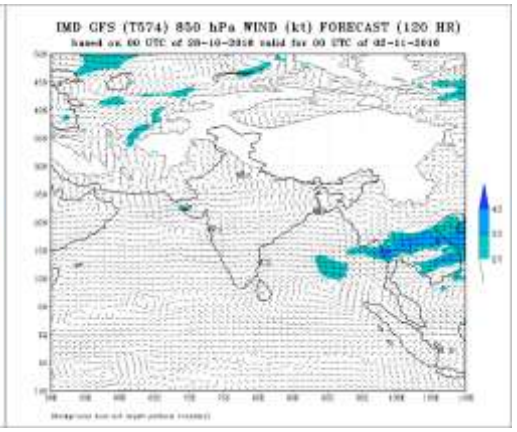

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

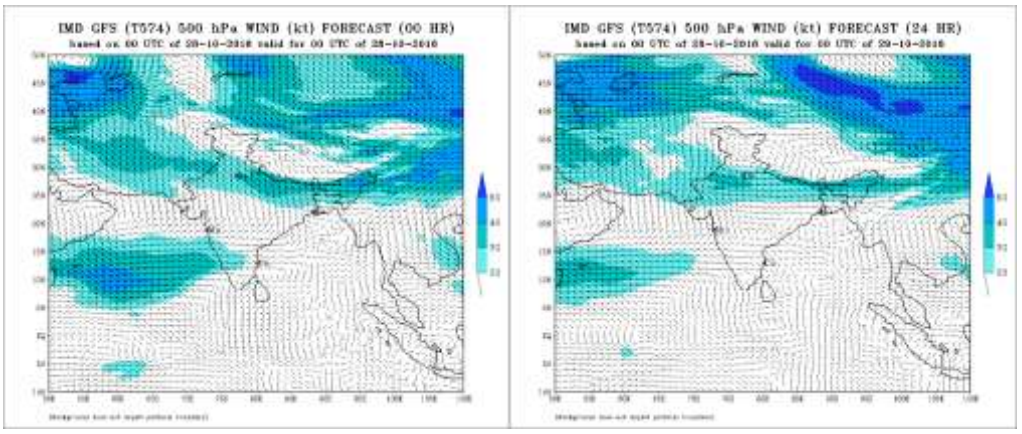

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

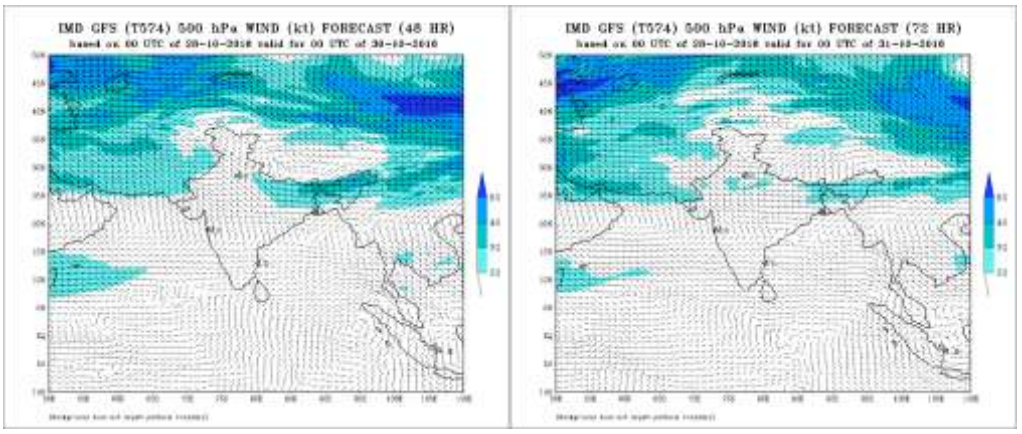

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

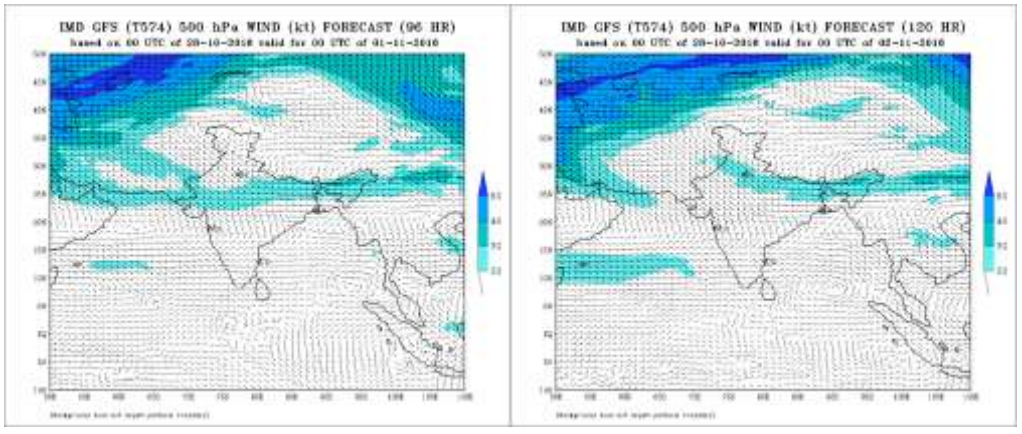

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

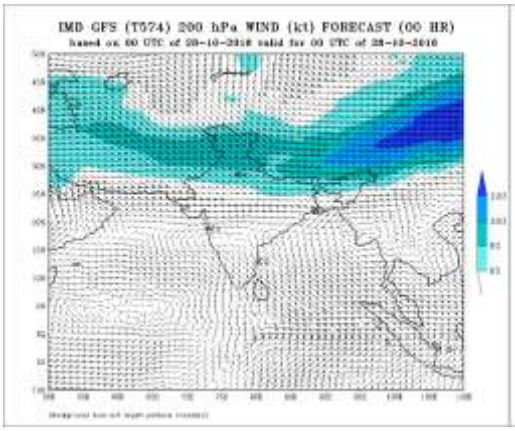

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

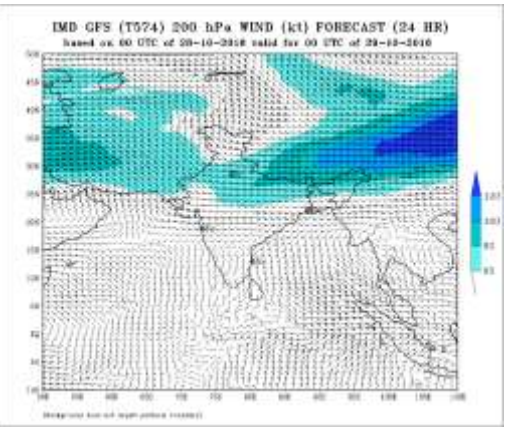

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

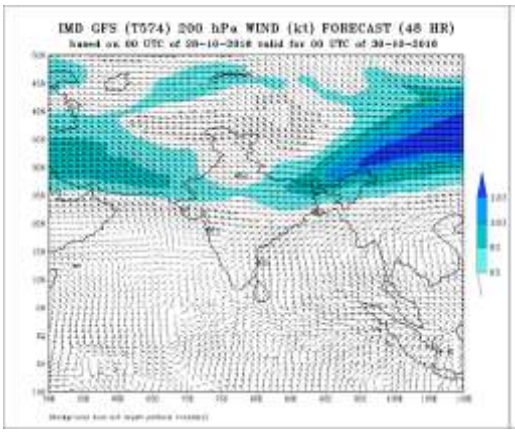

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

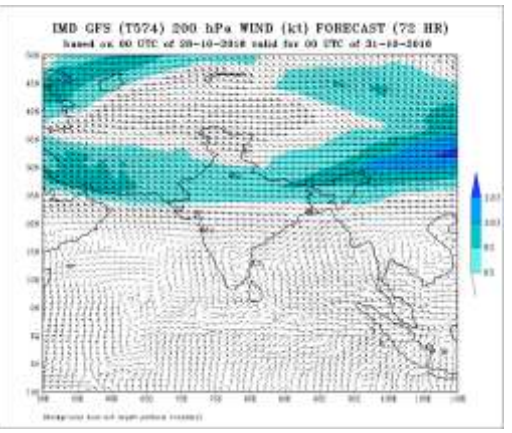

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

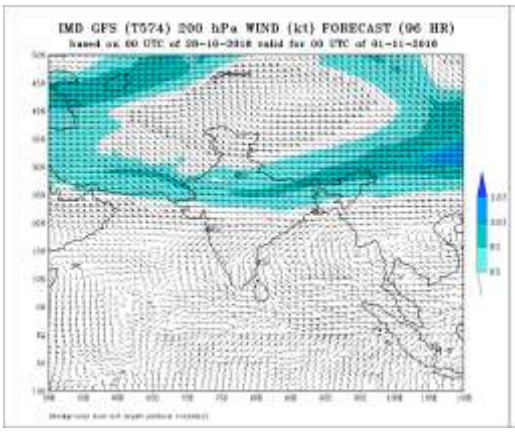

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

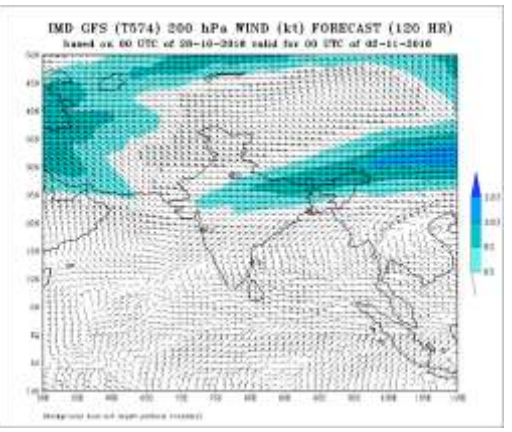

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 29-10-2018 valid for 00 UTC of 29-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 29-10-2018 valid for 00 UTC of 30-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 29-10-2018 valid for 00 UTC of 30-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 29-10-2018 valid for 00 UTC of 31-10-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 29-10-2018 valid for 00 UTC of 01-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 29-10-2018 valid for 00 UTC of 02-11-2018

FDP (Cyclone) NOC Report Dated 29th October, 2016

Synoptic features:

The low pressure area over westcentral Bay of Bengal off Andhra Pradesh coast persists. Associated cyclonic circulation extends upto 3.6 kms a. s. l. The shear zone in lower levels from the above system to coastal Karnataka across coastal Andhra Pradesh, Rayalaseema and south Interior Karnataka also persists. A fresh low pressure area is likely form over southeast Bay of Bengal and neighbourhood around 1st Nov. The cyclonic circulation extending upto 4.5 kms a. s. l. over eastcentral Bay of Bengal and neighbourhood now lies over eastcentral Bay of Bengal and adjoining northeast Bay of Bengal.

Dynamical and thermodynamical features :

Surface Temperature (SST):

The sea surface temperature is 28-30˚C around over most parts of Bay of Bengal. Over Arabian Sea, SST is less than 28˚C to the north of 10°N except for a small pocket of high values off south Gujarat coast. It is between 28-30˚C in the remaining area, except off Somalia coast where the values are less than 28˚C.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 50-75 kJ/CM^2 over most parts of BoB. Over Arabian Sea, TCHP is less than 50 kJ/CM^2 to the north of 15°N and is about 50-75 kJ/CM^2 over remaining parts.

Relative Vorticity:

The low level relative vorticity is about $50x10^{-6}$ $second^{-1}$ over SW Bay near Tamilnadu coast and is about 20-$30x10^{-6}$ $second^{-1}$ over NE Bay and adjoining Myanmar coast

Convergence:

Lower level convergence is positive and is about 5-10x $10^{-5}s^{-1}$ over NE Bay and adjoining Myanmar coast. There is no area of significant lower level convergence over Arabian Sea.

Divergence:

Upper level divergence is around 10-20 $x10^{-5}$ s-1 over WC Bay and adjoining Tamil Nadu coast. It is about 5 $x10^{-5}$ s-1 over NE Bay and adjoining Myanmar coast. Divergence is negative over the west coast of peninsular India.

Wind Shear:

Wind shear is low to moderate over central and adjoining south Bay of Bengal and over central parts of Andaman Sea. It is low to moderate over central and south Arabian Sea. It increases to the north and south.

Wind Shear Tendency:

There is decreasing tendency over central Arabian Sea. There is increasing tendency to the north and south. Decreasing tendency is seen over Central Bay. There is increasing tendency to the north and south.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, broken low/medium clouds with embedded moderate to intense convection between latitude 13.0°N to 16.5°N and to the west of longitude 83.0°E in association with the vortex near 14.5°N/81.0°E over westcentral Bay of Bengal off south coastal Andhra Pradesh. The intensity of the system is T 1.0. Scattered low/medium clouds with embedded moderate to intense convection over NE Bay and neighbourhood in association with low level circulation over the area.

Arabian Sea:

Scattered low/medium clouds with embedded isolated weak to moderate convection over south Arabian Sea south of lat 10.0°N

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies **at 14**^{0}N latitude over BoB. An anticyclone is seen over Myanmar. Ridge at 200 hPa lies around 22^{0}N latitude over north Arabian sea.

M.J.O. Index: MJO index is in Phase 7 with very less amplitude. It would move to phase 8 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 29 October 2016 shows formation of a low pressure system over southeast Bay of Bengal on 31 October which moves northwestward direction. The model also shows intensification of the system into a Depression on 01 November, Deep Depression on 2 November, cyclonic storm on 3 November and severe cyclonic storm on 4 November over west central Bay of Bengal off Andhra Pradesh coast. Model forecasts also show approaching of a fresh cyclonic storm from South China Sea but with northward movement not entering over the Andaman Sea.

NCEP-GFS: The forecast charts of the model based on 00 UTC of 29 October 2016 show a low on 02 November which moves westward direction towards west-central Bay of Bengal. The model also shows intensification of the system into a Depression on 3 November, Deep Depression on 4 November and cross the Andhra Pradesh coast on 6 November 2016.

ECMWF: The model charts based on 00 UTC of 29 October 2016 shows formation of a low pressure system over southeast Bay of Bengal on 01 November which moves northwestward direction. The model also shows intensification of the system into a Deep Depression on 2 November and cyclonic storm on 3 November and cross the north Andhra Pradesh coast on 4 November 2016. Model forecasts also show emergence of a cyclonic storm over the north and adjoining south Andaman Sea on 4 November 2016 with northwestward movement and further intensification into severe cyclonic storm on 5 November 2016 over the east central Bay of Bengal.

WRF: The WRF model analysis and forecasts based on 00 UTC of 29 October 2016 show no significant feature during next 72 hours.

JMA: Model forecast for based on 28th 00UTC analysis indicates the low over WC Bay off Tamil Nadu coast persists over the area on 29th and becomes less marked on 30th .

Meteo-France ARP Model indicates the low over SW Bay on 28th analysis field becomes less marked on 29th.

NCMRWF-NCUM:

The forecast based on 29th Oct 2016 initial conditions shows low over EC bay and adjoining SE Bay on 01st November. Moving in a NW direction it becomes more marked on 03rd and reaches south Orissa and adjoin north Andhra coast on 05th . It weakens thereafter.

NCMRWF-UM-Regional Model:

The forecasts based on 29th Oct 2016 initial conditions show a low pressure system over south Andaman sea on 31st October, which moving westwards intensifies to a CS on 01st November over SE bay.

NCMRWF-NEPS Model:

Based on the 00 UTC analysis on 29th, a low pressure area is seen over central parts of Andaman Sea on 31st October which moves northwestwards and intensifies to a CS over northern parts of SE Bay on 01st November. Continuing to move in northwest direction the CS crosses Orissa and adjoining West Bengal coast on 04th and becomes less marked on 05th.

IITM-GEFS:

The forecast based on 29th initial conditions shows the development of a low over Andaman sea on 31st which moving westwards becomes more marked on 03rd over SW Bay near Tamil Nadu coast. It becomes a WML on 04th and a depression on 05th over the same area. It weakened on 06th.

IITM -GFS T1534: The forecast based on 29th initial conditions shows the presence of a low from 3rd to 5th November without any appreciable movement or intensification.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

GPP forecasts based on 00 UTC of 29 October 2016 shows formation of a cyclogenesis zone over the south and adjoining north Andaman Sea on 31 October 2016 and northwest movement with gradual organization. Forecast also shows that the zone reaches to Andhra Pradesh coast on 5 November 2016.

Summary and Conclusion:

Majority of the models indicate the presence of a low pressure area on 31st October over Andaman Sea. Most of them show intensification of the low into depression on 01st November. Regarding movement of the system, most of the models indicate northwestward movement towards Andhra Pradesh Coast, except for NCUM and NEPS, which show more of north component in the direction of movement. IMD WRF, UM-Regional Model, JMA, and Meteo-France ARP do not give any indication on the presence of the low pressure area over Andaman Sea and neighbourhood.

A low pressure area is likely to emerge into Andaman Sea and adjoining SE Bay on 01 November. It may concentrate into a depression on 02nd November and move in west-northwest direction towards Andhra Pradesh Coast with gradual intensification.

Advisory:

- Upper air observations may be taken four times a day on 01st and 02nd November over Andaman and Nicobar Islands.

Probability of cyclogenesis (formation of depression) over Bay of Bengal

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
Probability	Nil	Nil	Low	Fair	Moderate

Probability of cyclogenesis (formation of depression) over Arabian Sea

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
Probability	Nil	Nil	Nil	Nil	Nil

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	28/12	**29/00**	**29/03**
India	50	29	43
Coastal stations			
WB	9	4	8
Odisha	14	4	5
AP	8	11	11
Tamil Nadu	12	8	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	13	14	14
Myanmar	0	0	12
Thailand	0	2	0
SriLanka	9	9	10

- **RS/RW** (12Z) of 28/ 10 /2016 37/43
- **No. of Ascents reaching 250 hPa levels: 35 , MISDA:-7**

- **RS/RW** (00Z) of 29 / 10 /2016 36/43
- **No. of Ascents reaching 250 hPa levels: 35 , MISDA: 7**
-

No. of PILOT Ascents

28/12Z	**29/00Z**
07/69	05/69

Buoy Data

28/12Z	**29/00Z**	**29/03Z**
17	11	17

AWS :

Region	Date/Time (UTC)		
	28/12	**29/00**	**29/03**
WB	04	01	05
Odisha	07	01	07
AP	11	07	11
Tamil Nadu	26	11	25
Puducherry	01	01	01
A&N	0	0	0

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**28.10.2816**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**19**

No. of RS/RW Ascents

00Z /28.10.2816 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /28.10.2816 : 4

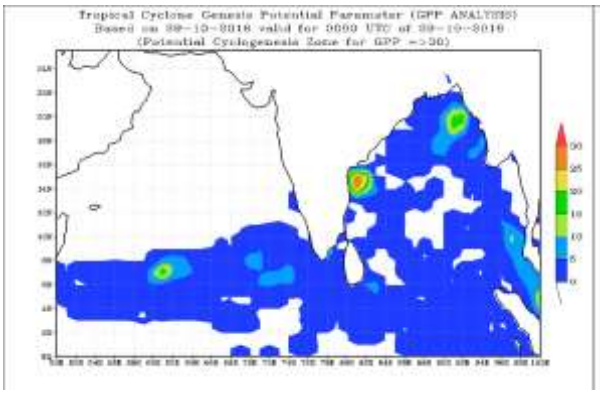
No. of Ascents reaching 250 hPa level = 4

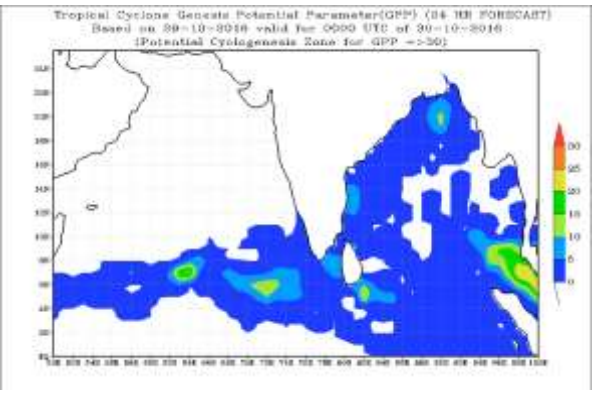
MISDA : 4

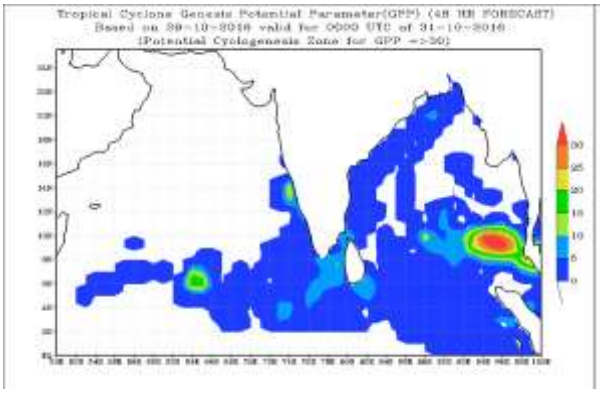
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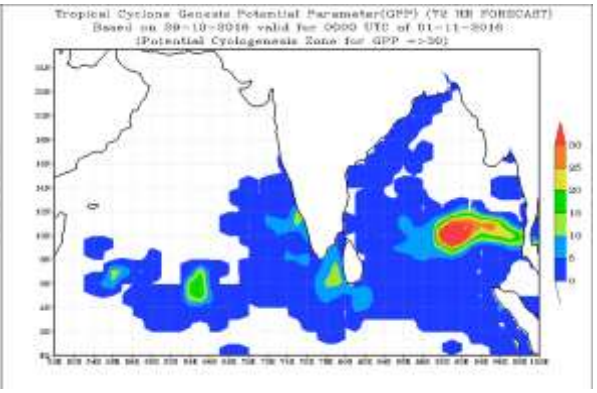
28.10.2816	
06Z	18Z
2	5

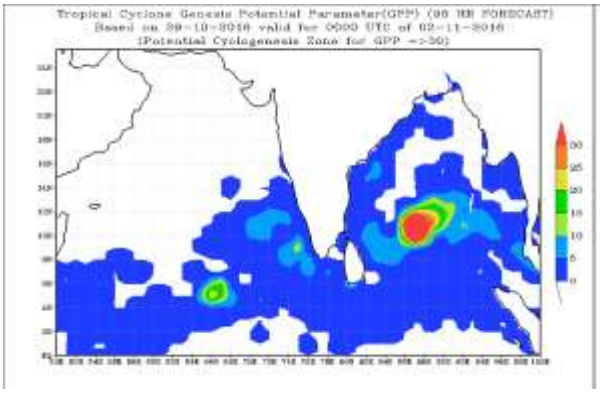
Annexure-II

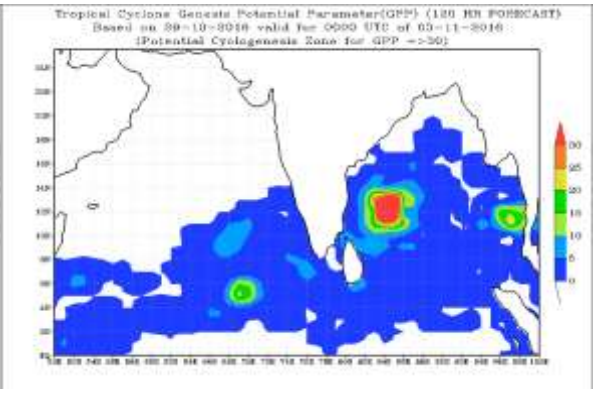

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 30-10-2016 valid for 0000 UTC of 30-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

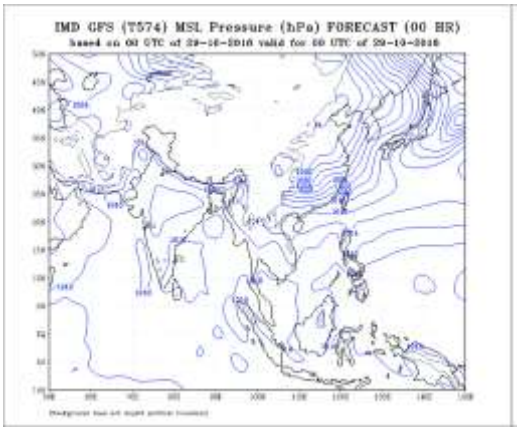

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

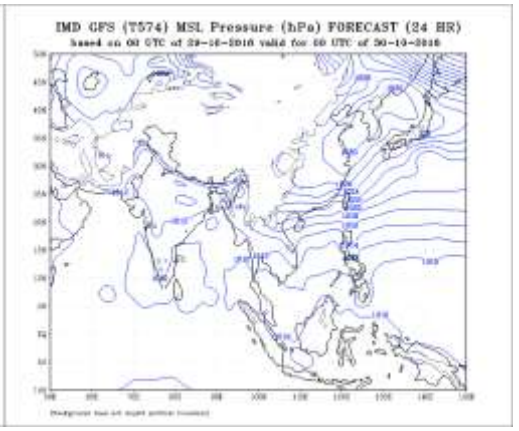

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

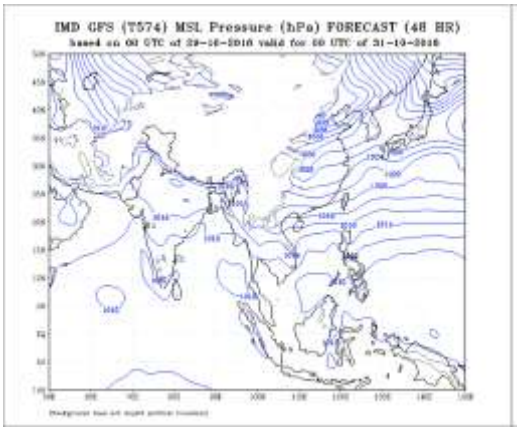

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 30-10-2016 valid for 0000 UTC of 01-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

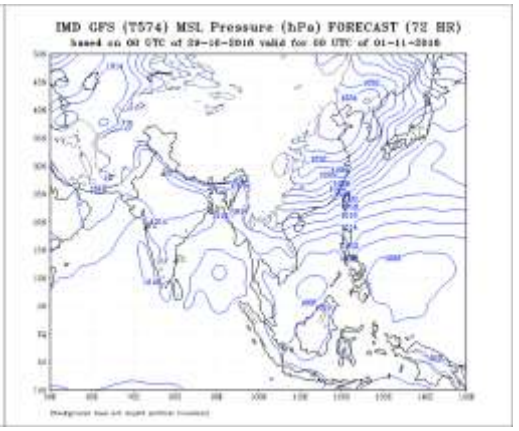

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Based on 30-10-2016 valid for 0000 UTC of 02-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

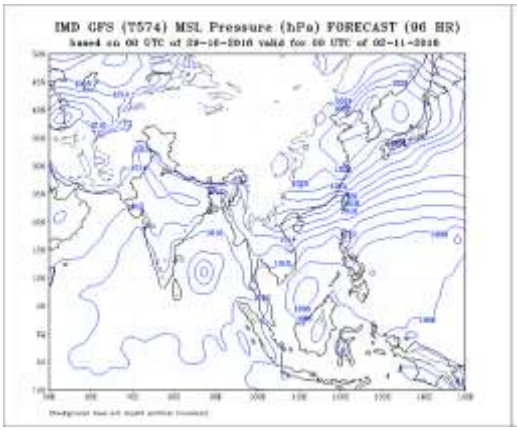

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 30-10-2016 valid for 0000 UTC of 03-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

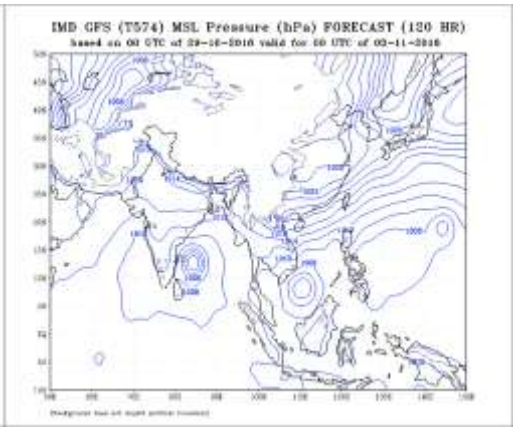

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)

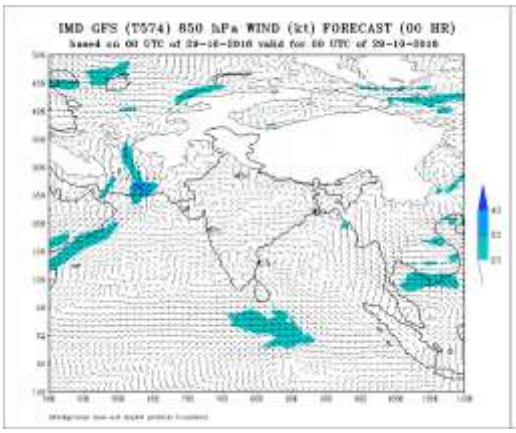

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

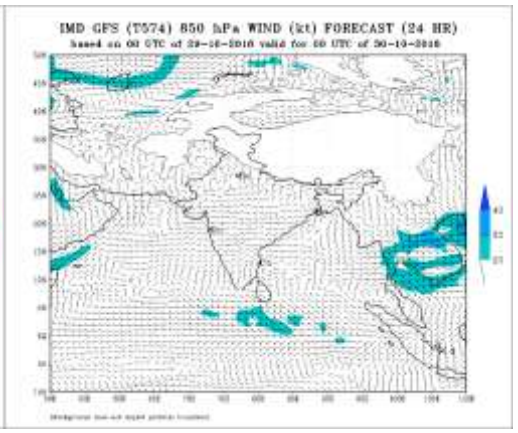

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

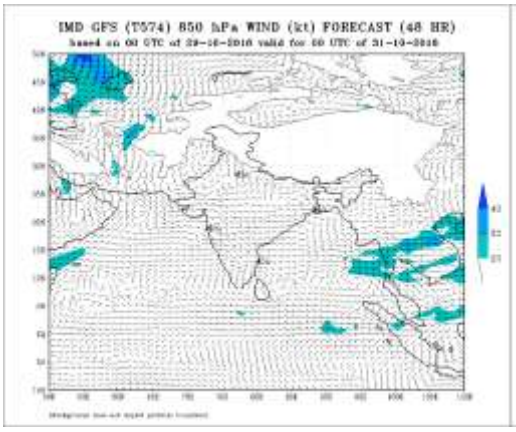

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

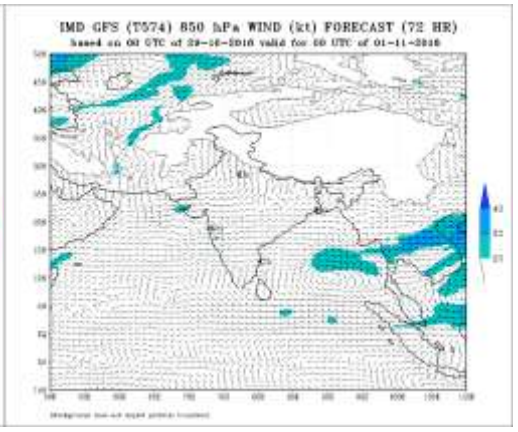

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

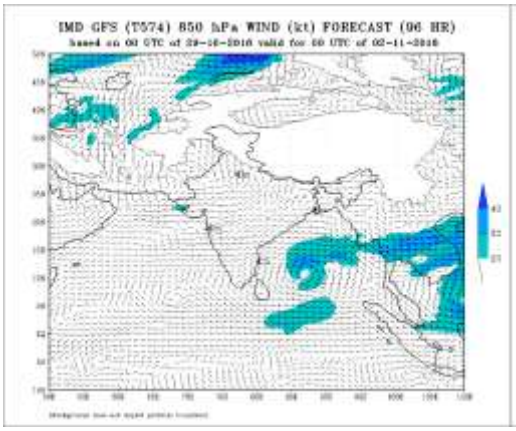

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

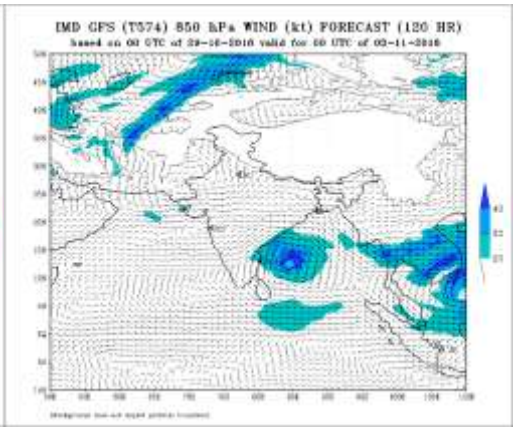

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

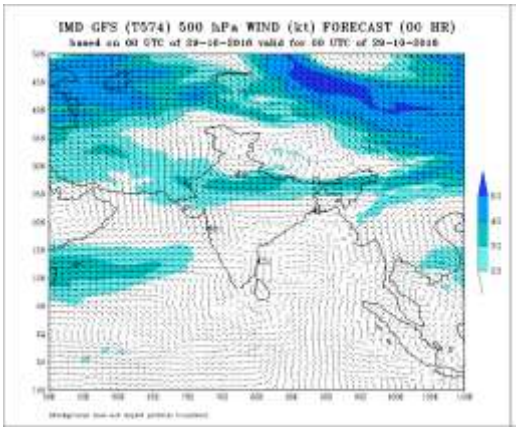

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

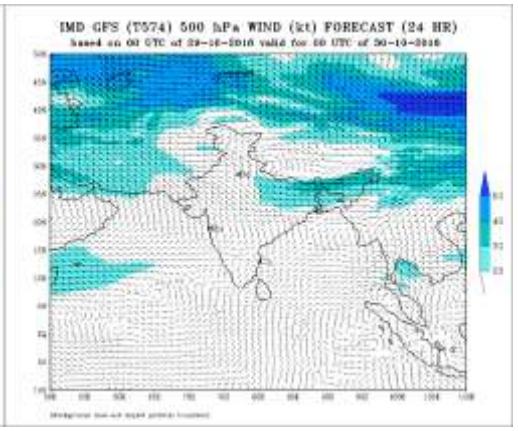

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

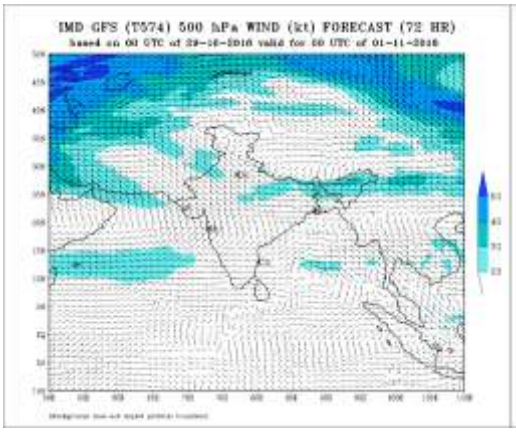

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

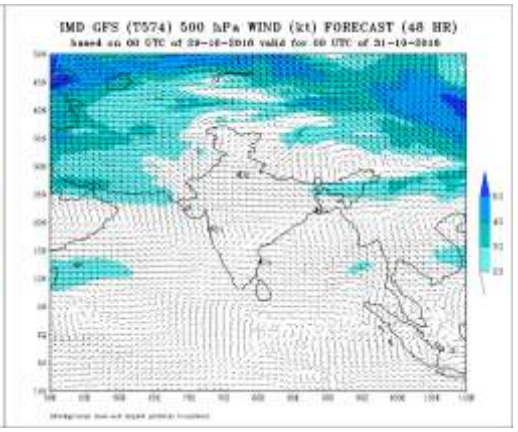

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

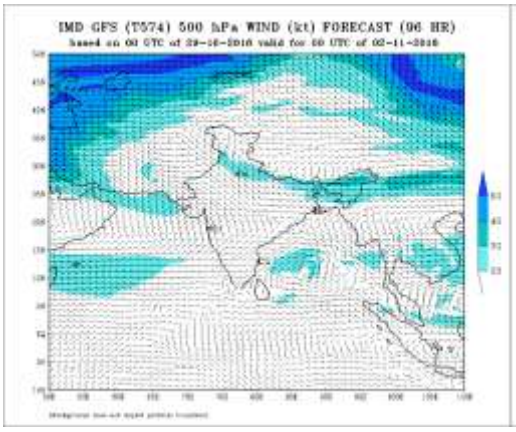

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

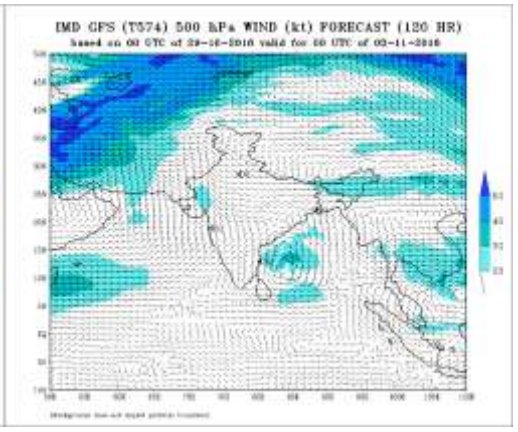

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)

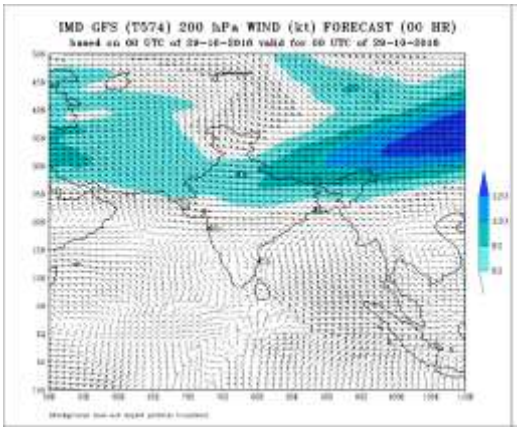

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

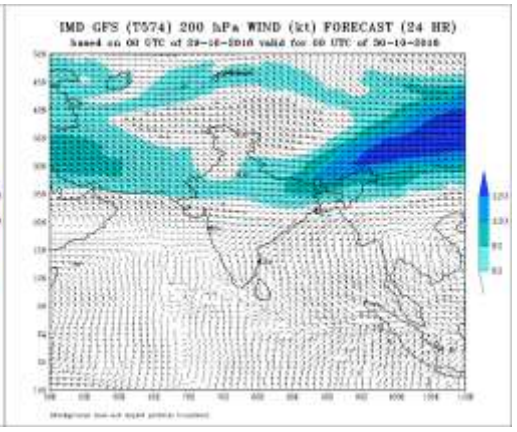

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

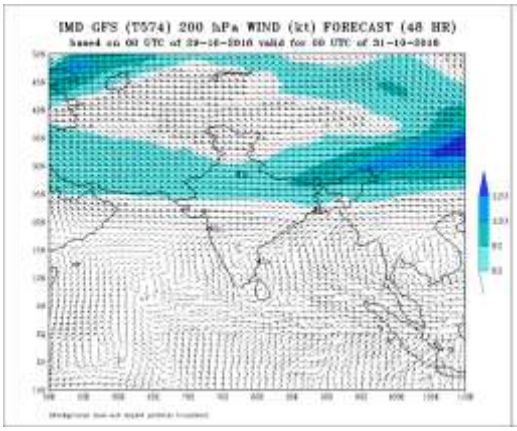

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

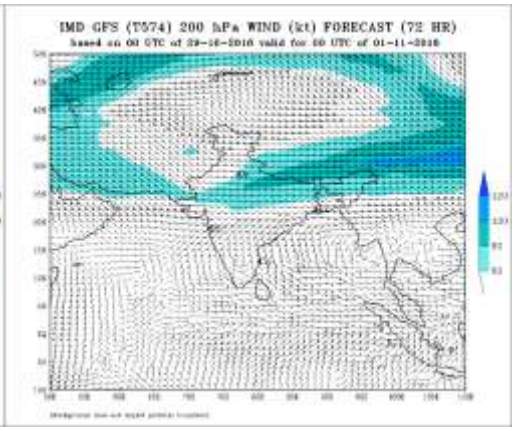

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

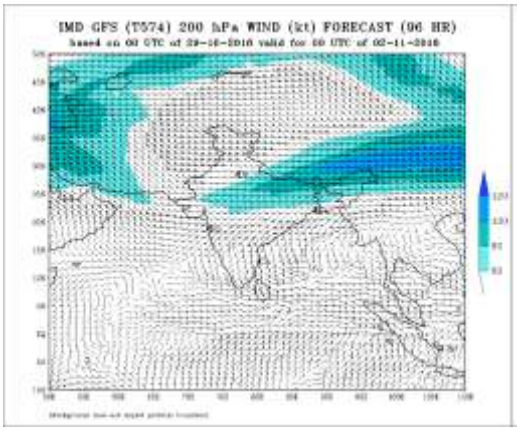

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

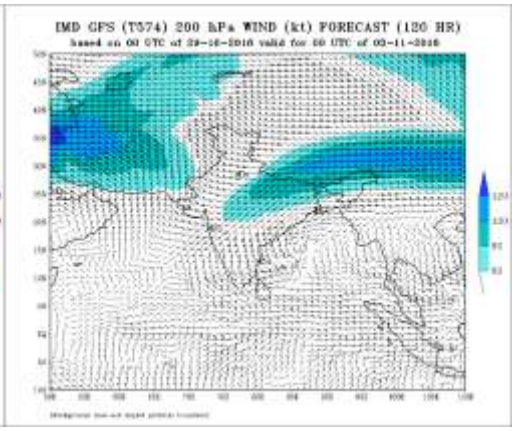

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 29-10-2016 valid for 00 UTC of 29-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 29-10-2016 valid for 00 UTC of 30-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 29-10-2016 valid for 00 UTC of 31-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 29-10-2016 valid for 00 UTC of 01-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 29-10-2016 valid for 00 UTC of 02-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 29-10-2016 valid for 00 UTC of 03-11-2016

FDP (Cyclone) NOC Report Dated 30th October, 2016

Synoptic features:

The low pressure area over southwest Bay of Bengal off north Tamil Nadu coast, now lies as a trough of low at mean sea level over southwest Bay of Bengal off Tamil Nadu coast. The associated upper air cyclonic circulation over southwest Bay of Bengal off north Tamil Nadu coast extends upto mid-tropospheric level. The east-west shear zone from the above system to north Kerala has become less marked. The upper air cyclonic circulation over eastcentral & adjoining northeast Bay of Bengal, now lies over north Bay of Bengal and extends upto 2.1 km above mean sea level.

An upper air cyclonic circulation lies over Malay Peninsula & neighbourhood and extends upto mid-tropospheric level. It is likely to move westwards and under its influence a fresh low pressure area is very likely to form over southeast Bay of Bengal & neighbourhood around 1st November.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 30-32˚C around over most parts of Bay of Bengal. Over Arabian Sea, SST is 27-29˚C to the north of 10°N except for a small pocket of high values off south Gujarat coast. It is between 28-30˚C in the remaining area, except off Somalia coast where the values are less than 28˚C.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 100 kJ/CM^2 over south Andaman Sea, adjoining SE Bay and equatorial ocean. Rest of the area it is less than 100 kJ/CM^2. Over Arabian Sea, TCHP is less than 50 kJ/CM^2 to the north of 15°N and is about 50-75 kJ/CM^2 over remaining parts.

Relative Vorticity:

The low level relative vorticity is about 30-40x10^{-6} second^{-1} over Gulf of Thailand and adjoining Malay Peninsula and Andaman Sea. It is about 15x10^{-6} second^{-1} over SW Bay near Tamilnadu coast and is about 20x10^{-6} second^{-1} over NE Bay and adjoining Myanmar coast

Convergence:

Lower level convergence is positive and is about 5-10x 10^{-5}s^{-1} over Gulf of Thailand. It is about 5x 10^{-5}s^{-1} over central parts of Andaman Sea. There is no area of significant lower level convergence over Arabian Sea.

Divergence:

Upper level divergence is around 5-10 x10^{-5} s-1 over WC Bay and adjoining Tamil Nadu coast. It is about 20 x10^{-5} s-1 over Gulf of Thailand and adjoining Malay Peninsula and Andaman Sea. The region of positive divergence thence extends southwestwards to equatorial region.

Wind Shear:

Wind shear is low to moderate over central Bay and adjoining south Bay of Bengal and also over central parts of Andaman Sea. It is low to moderate over central and south Arabian Sea. It increases to the north and south.

Wind Shear Tendency:

There is decreasing tendency over South Arabian Sea. There is increasing tendency to the north and south. Increasing tendency is seen over Central and north Bay.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded isolated moderate to intense convection over WC Bay off south coastal Andhra Pradesh and Tamil Nadu are seen in association with feeble low level circulation over the area. Scattered low/medium clouds with embedded moderate to intense convection over North Bay and neighbourhood are also seen in association with another feeble low level circulation over the area. Scattered low/medium clouds with embedded moderate to intense convection over Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded isolated weak to moderate to intense convection over southeast Arabian Sea south of lat 10.0°N

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 17^{0}N latitude over BoB. An anticyclone is seen over Myanmar. Ridge at 200 hPa lies around 19^{0}N latitude over north Arabian sea.

M.J.O. Index: MJO index is in Phase 7 with very less amplitude. It would move to phase 8 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 30 October 2016 shows formation of a low pressure system over southeast Bay of Bengal on 31 October which moves northwestward direction. The model also shows intensification of the system into a Deep Depression from a Depression during 1 to2 November and into a cyclonic storm on 3 November. The system become a severe cyclonic storm during 4 to 5 November over west central Bay of Bengal off Andhra Pradesh coast and made a landfall on 6 November over North Andhra Pradesh Coast and weakened thereafter over same area along east coast for next 2 days.

NCEP-GFS: The forecast charts of the model based on 00 UTC of 30 October 2016 show a low on 02 November which moves northwestward direction in west-central Bay of Bengal. The model also shows intensification and northwestward movement and landfall over North Andhra Pradesh coast during 3 to 6 November 2016 similar to IMD-GFS model.

ECMWF: The model charts based on 00 UTC of 30 October 2016 shows formation of a low pressure system over southeast Bay of Bengal on 01 November which moves northwestward direction. The model also shows intensification of the system into a Deep Depression on 2 November and cyclonic storm on 3 November and cross the north Andhra Pradesh coast on 4 November 2016. The system then weakened gradually thereafter for next 2 days as it moves along the east coast of India towards head bay region.

WRF: The WRF model analysis and forecasts based on 00 UTC of 30 October 2016 show no significant feature during next 2 days but the formation of low pressure system over south-central Bay of Bengal on 2 November 2016.

JMA: Model forecast for based on 30th 00UTC analysis indicates formation of a low over SE and adjoining Andaman Sea Bay on 02nd.

Meteo-France ARP Model based on 30th 00UTC analysis indicates the likelihood of formation of a low over SE and adjoining Andaman Sea Bay on 01st November which showed a westward movement without intensification.

NCMRWF-NCUM:

The forecast based on 30th Oct 2016 initial conditions show a low over SE bay and adjoining SE Bay on 02nd November. It became a depression on 03rd near Tamil Nadu coast. It is seen as a DD over the same area during 04-06th. It intensified into a CS on 07th and into a SCS on 09th with a slight northeastward movement.

NCMRWF-UM-Regional Model:

The forecasts based on 30th Oct 2016 initial conditions show the likelihood of a low pressure system over south Andaman sea on 31st October, which moving westwards intensifies to a CS on 01st November over SE bay and a SCS on 02nd November over WC Bay.

NCMRWF-NEPS Model:

Based on the 00 UTC analysis on 30th, a low pressure area is seen over central parts of Andaman Sea on 02nd November which moves northwestwards and rapidly intensifies into a CS and over WC Bay on 03rd . Continuing to move in northwest direction the CS is seen off the coast of north Andhra coast on 05th and over WC bay on 06th , over EC Bay and adjoining north Bay on 06th . It crossed Bangladesh and adjoining Myanmar coast on 07th.

IITM-GEFS:

The forecast based on 30th initial conditions shows the development of a low over Andaman Sea and adjoining SE Bay on 31st which moving west northwestwards becomes a depression by 03rd and a CS on 04th over WC Bay near Andhra coast. It becomes a WML on 05th and further and becomes less marked on 05th over the same area.

IITM -GFS T1534: Not available.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

GPP: GPP forecasts based on 00 UTC of 30 October 2016 initial conditions shows formation of a cyclogenesis zone over the south and adjoining north Andaman Sea on 31 October 2016 and northwest movement with intensification and organization. Forecast also shows that the zone reaches to Andhra

Pradesh coast on 5 November 2016 and gradually moves north-northeastward along the coast on 7 November 2016.

Summary and Conclusion:

Majority of the models continue to indicate the presence of a low pressure area on 01st November over Andaman Sea. Most of them show intensification of the low into depression on 02nd November. Regarding movement of the system also there is continuity in the forecast by the models and most of them indicate northwestward movement and reach Andhra Pradesh Coast by 04/05th November. As an exception NEPS, meandering of the system over bay and finally crossed Bangladesh and adjoining Myanmar coast on 07th.

A low pressure area is likely to emerge into Andaman Sea and adjoining SE Bay on 01st November. It may concentrate into a depression on 02nd November and move in west-northwest direction towards Andhra Pradesh Coast with gradual intensification which needs to be monitored.

Advisory:

- Upper air observations may be taken four times a day on 01st and 02nd November over Andaman and Nicobar Islands.
- Intense observations may be taken over Andhra Pradesh coast during 04-05th November 2016.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Low	Fair	Moderate	Moderate

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	29/12	**30/00**	**30/03**
India	43	30	40
Coastal stations			
WB	6	02	06
Odisha	06	05	05
AP	12	12	12
Tamil Nadu	12	10	10
Puducherry	01	01	01
A & N	6	00	6
Bangladesh	14	15	11
Myanmar	0	0	00
Thailand	03	01	02
SriLanka	069	9	10

- **RS/RW** (12Z) of 29/ 10 /2016 35/43
- **No. of Ascents reaching 250 hPa levels: 16 , MISDA:-18**
- **RS/RW** (00Z) of 30 / 10 /2016 34/43
- **No. of Ascents reaching 250 hPa levels: 25 , MISDA: 08**
-

No. of PILOT Ascents

29/12Z	**30/00Z**
03/69	02/69

Buoy Data

29/12Z	**30/00Z**	**30/03Z**
13	16	14

AWS :

Region	Date/Time (UTC)		
	29/12	**30/00**	**30/03**
WB	03	01	04
Odisha	05	01	06
AP	07	03	07
Tamil Nadu	21	09	20
Puducherry	01	01	01
A&N	0	0	0

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**29.10.2816**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /29.10.2816 : 7

No. of Ascents reaching 250hPa level =7

MISDA :1

12Z /29.10.2816 : 5

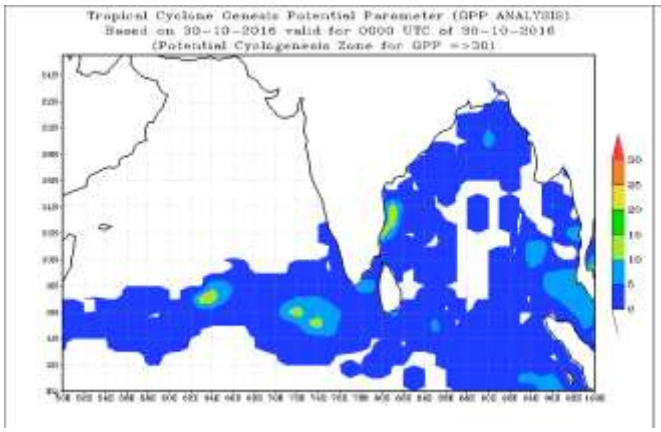
No. of Ascents reaching 250 hPa level =5

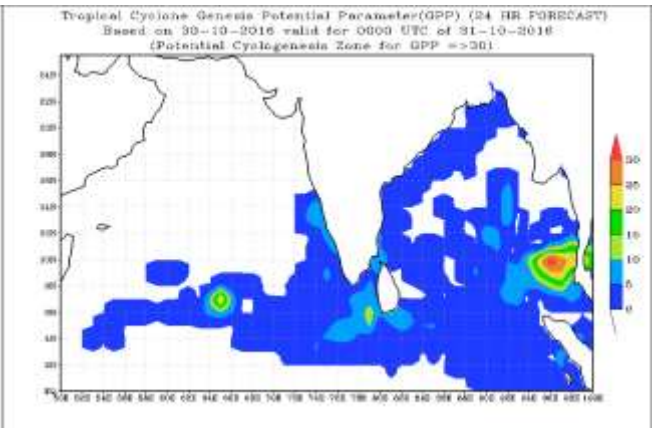
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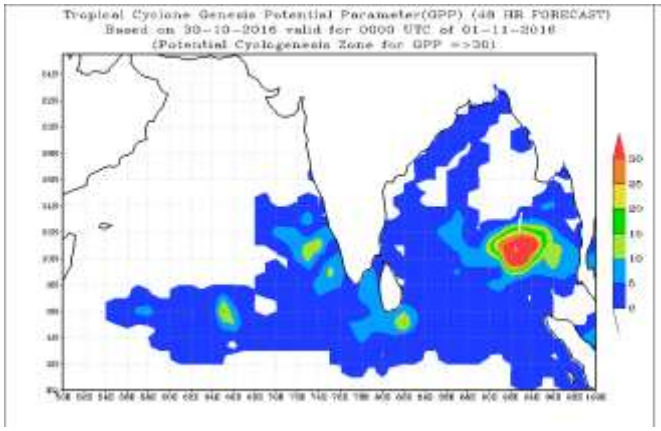
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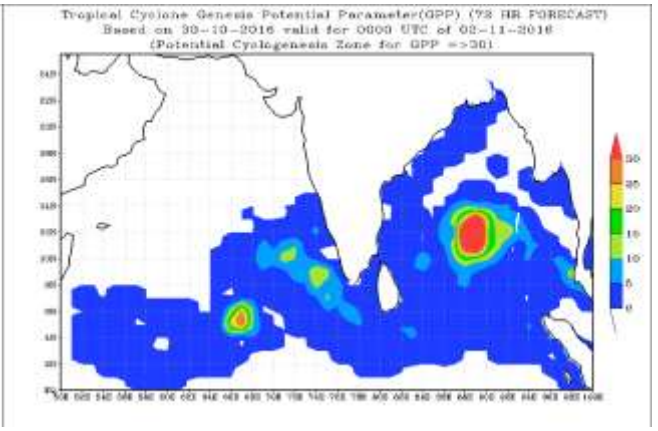
29.10.2816	
06Z	18Z
2	3

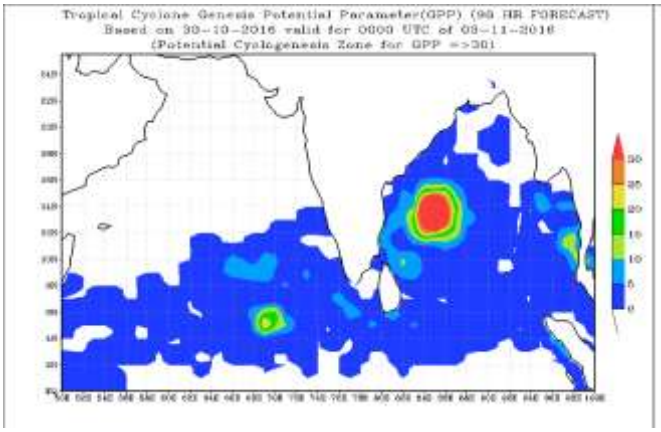
Annexure-II

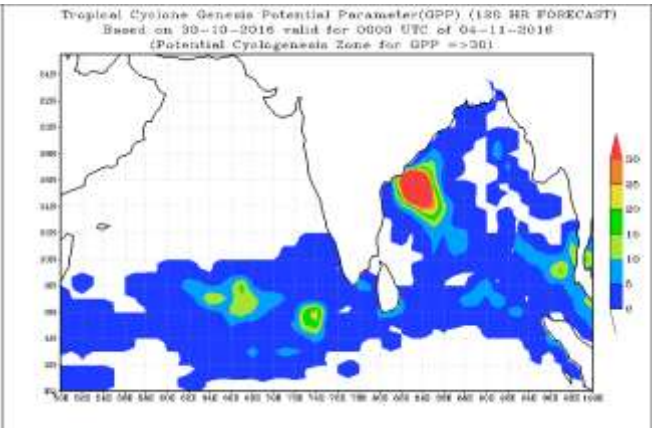

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 30-10-2016 valid for 0000 UTC of 30-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

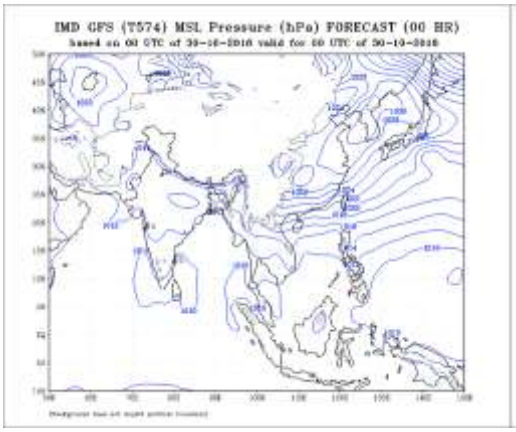

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

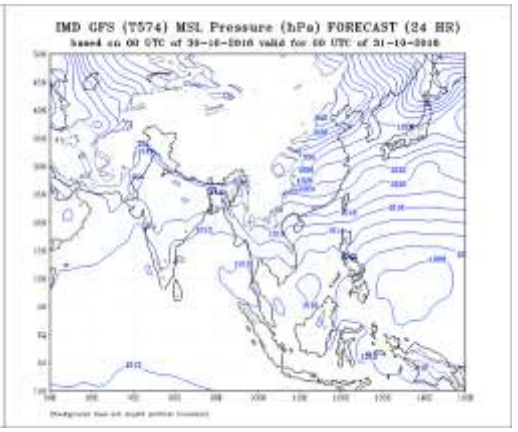

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

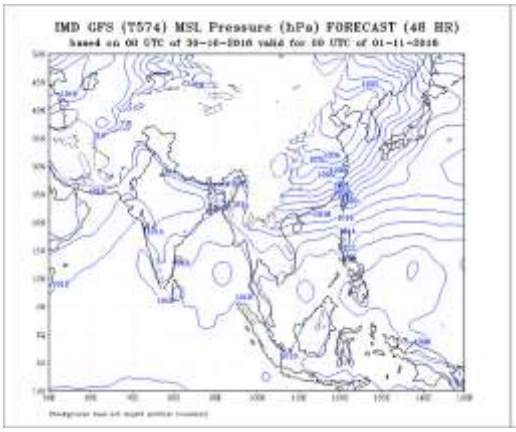

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 30-10-2016 valid for 0000 UTC of 02-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

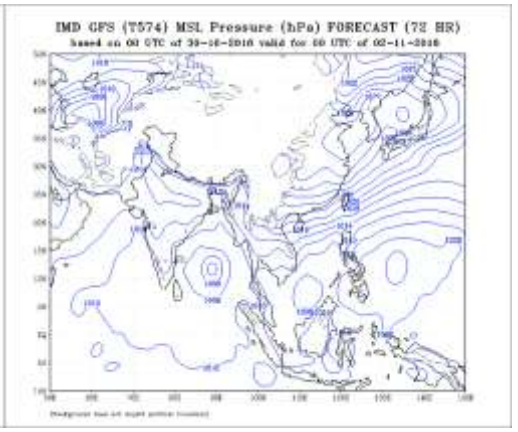

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 30-10-2016 valid for 0000 UTC of 03-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

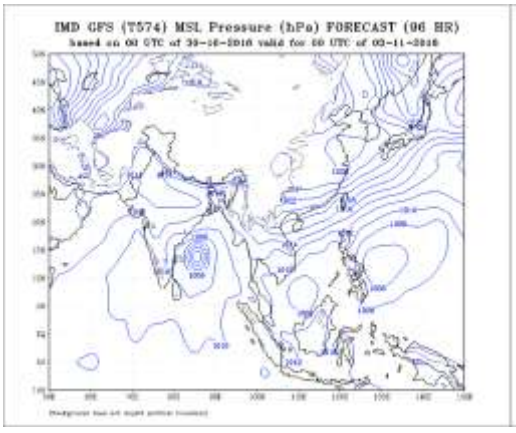

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 30-10-2016 valid for 0000 UTC of 04-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

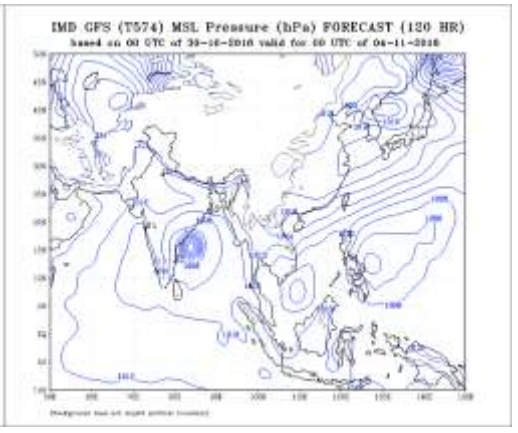

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)

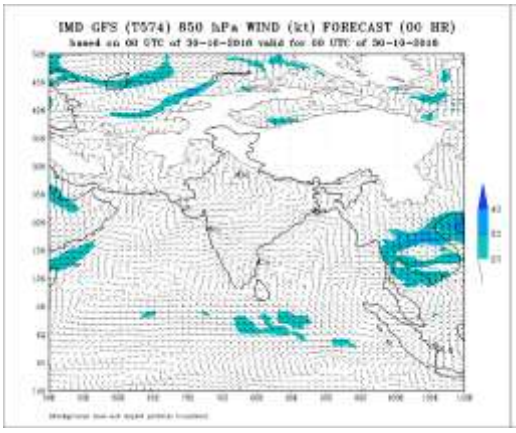

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

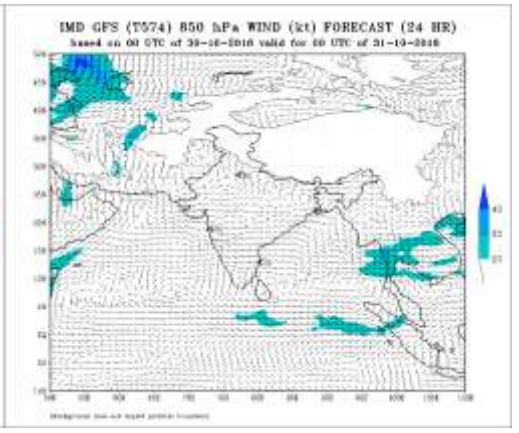

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

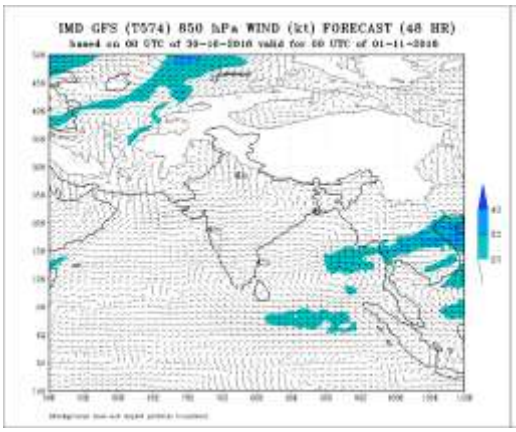

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

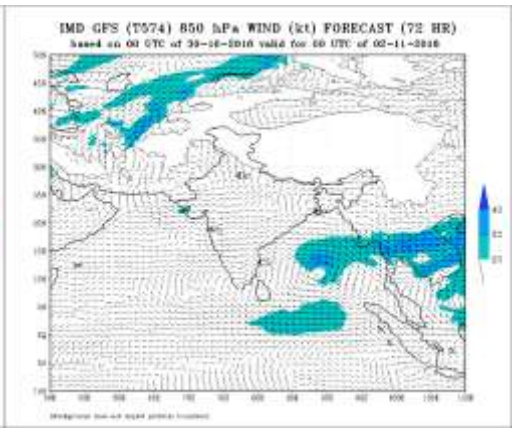

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

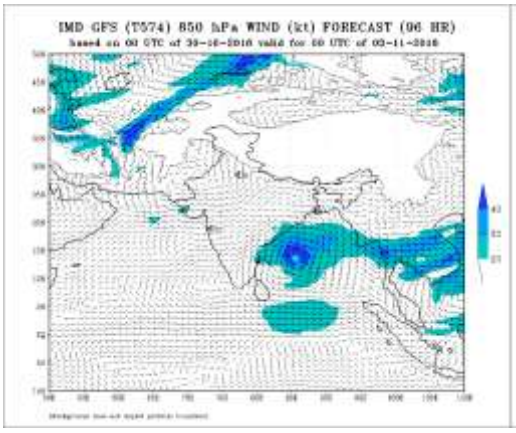

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

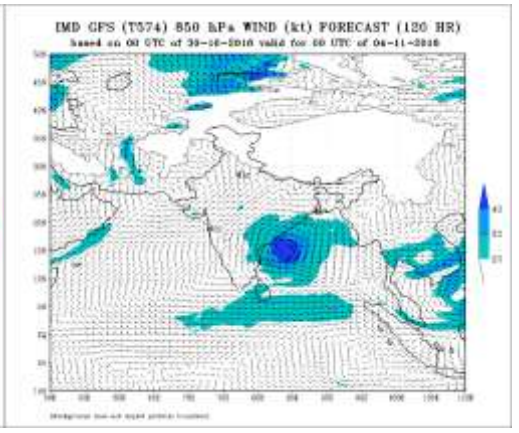

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

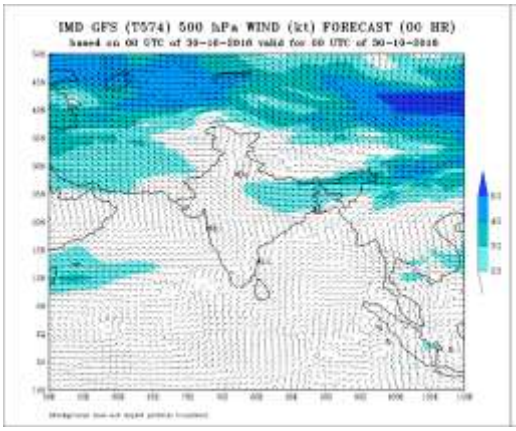

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

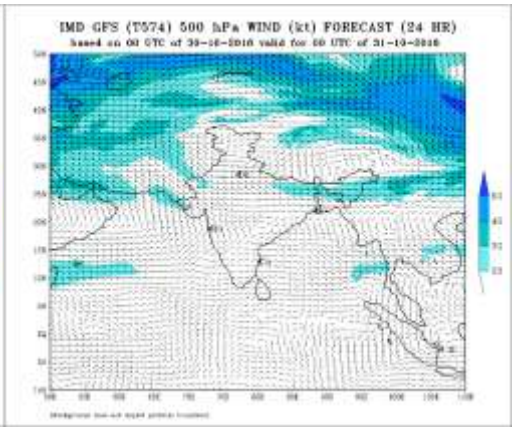

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

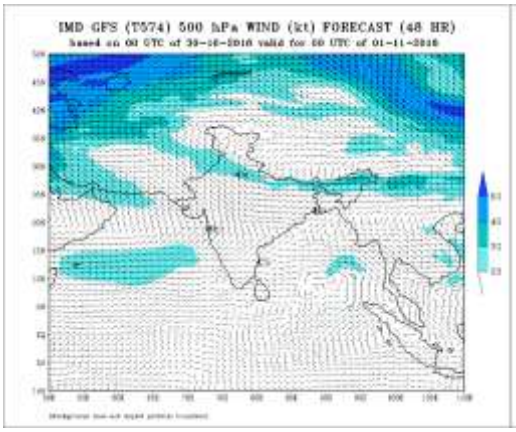

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

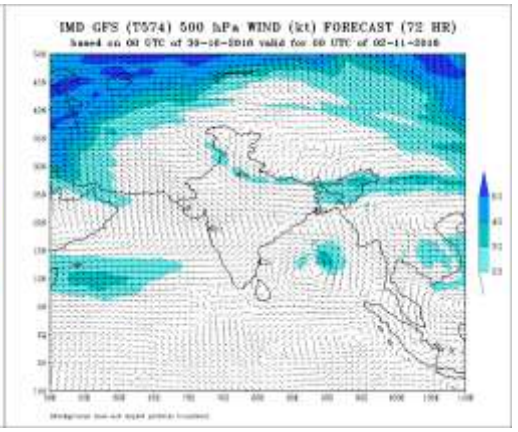

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

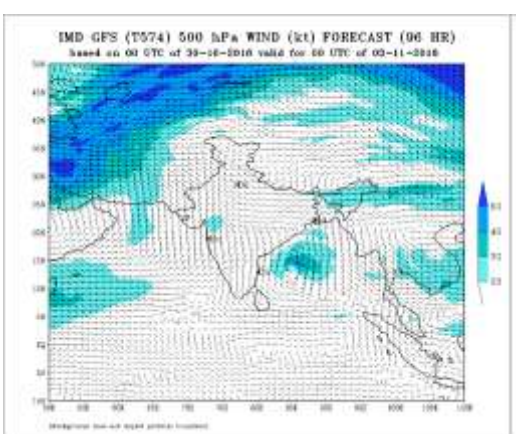

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

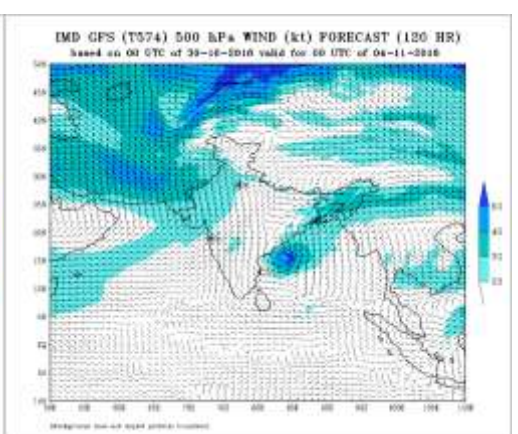

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)

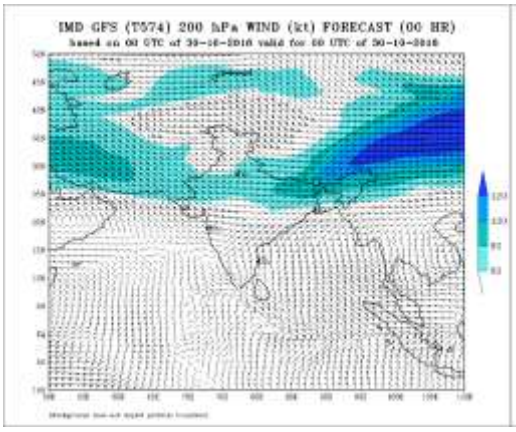

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

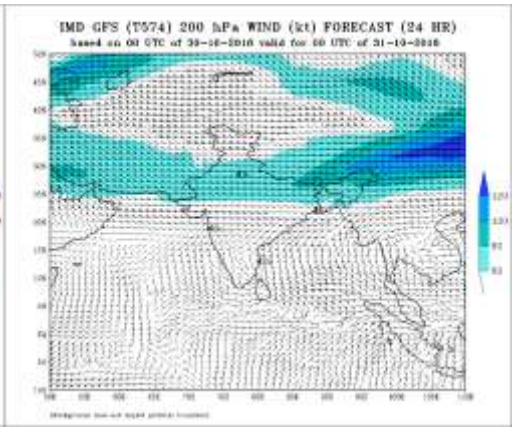

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

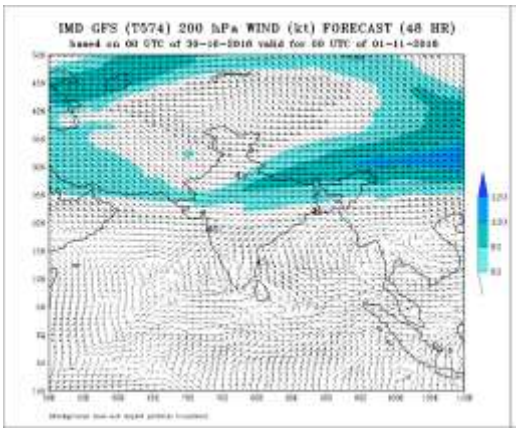

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

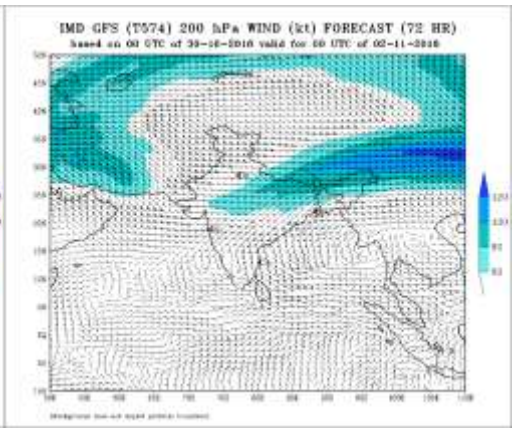

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

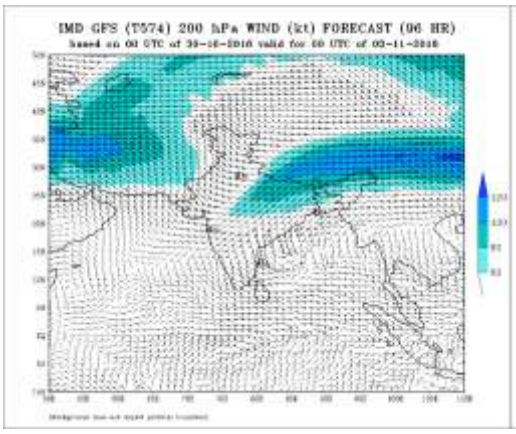

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

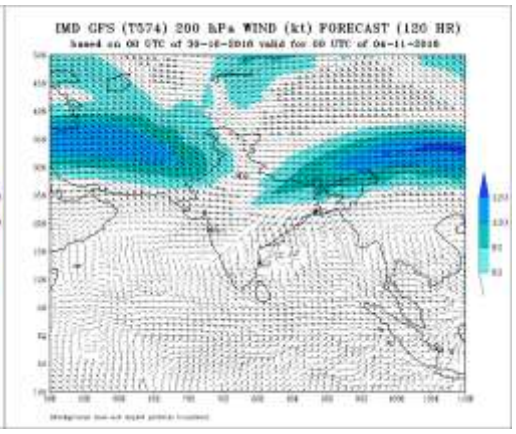

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 30-10-2016 valid for 00 UTC of 30-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 30-10-2016 valid for 00 UTC of 31-10-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 30-10-2016 valid for 00 UTC of 01-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 30-10-2016 valid for 00 UTC of 02-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 30-10-2016 valid for 00 UTC of 03-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 30-10-2016 valid for 00 UTC of 04-11-2016

FDP (Cyclone) NOC Report Dated 31st October, 2016

Synoptic features:

The trough of low at mean sea level over southwest Bay of Bengal off Tamil Nadu coast has become less marked. The embedded cyclonic circulation in the above trough over westcentral Bay of Bengal off Andhra Pradesh coast now lies as a cyclonic circulation extending upto 1.5 kms a. s. l. over interior Tamil Nadu and adjoining Kerala and south Karnataka. The cyclonic circulation extending upto mid tropospheric levels over Malay peninsula and neighbourhood now lies over south Andaman Sea and neighbourhood. It is likely to move westwards and under its influence, a low pressure area is very likely to form over south Bay of Bengal and neighbourhood during next 24 hours.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 29-31˚C around over most parts of Bay of Bengal. In a small pocket off Tamil Nadu coast, SST is 31-32˚C. Over Arabian Sea, SST is 27-29˚C to the north of 10°N except for a small pocket of high values off south Gujarat coast. It is between 28-30˚C in the remaining area, except off Somalia coast where the values are less than 28˚C.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 100 kJ/CM^2 over southern parts of south Andaman Sea. Rest of BoB, it is less than 100 kJ/CM^2. Over entire Arabian Sea, TCHP is less than 80 kJ/CM^2.

Relative Vorticity:

The low level relative vorticity is about 30-40x10^{-6} second^{-1} over Gulf of Thailand and adjoining Malay Peninsula and Andaman Sea. It is about 15x10^{-6} second^{-1} over NE Bay and adjoining Myanmar coast.

Convergence:

There is positive low level convergence Gulf of Thailand, Malay Peninsula and adjoining Andaman Sea with value 10x 10^{-5}s^{-1}

Divergence:

Upper level convergence is positive and is about 10-20x 10^{-5}s^{-1} over Gulf of Thailand, Malay Peninsula and adjoining Andaman Sea. It is about 5-10x 10^{-5}s^{-1} over southern most peninsular India and neighbouring sea area. There is no area of significant upper level divergence over Arabian Sea.

Wind Shear:

Wind shear is low to moderate over central Bay and adjoining south Bay of Bengal and also over central parts of Andaman Sea. It is low to moderate over central and south Arabian Sea. It increases to the north and south.

Wind Shear Tendency:

There is increasing tendency over most parts of Arabian Sea. Decreasing tendency is seen over Central Bay and over central Andaman Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, broken low/medium clouds with embedded intense to very intense convection over North Malay Peninsula and over area between latitude 6.0^{0}N to 13.0^0 N and longitude 94.0^{0}E to 102.0^{0}E are seen in association with low level circulation over the area. Scattered low/medium clouds with embedded moderate to intense convection over Andaman Sea and adjoining Tennaserim coast.

Arabian Sea:

Broken low/medium clouds with embedded isolated moderate to intense convection over southeast Arabian Sea off Kerala coast.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 17^{0}N latitude over BoB. An anticyclone is seen over Myanmar. Ridge at 200 hPa lies around 18^{0}N latitude over north Arabian Sea.

M.J.O. Index: MJO index is in Phase 7 with very less amplitude. It would move to phase 2 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 31 October2016 shows formation of an extended low pressure system over southeast Bay of Bengal on 1 November which moves northwestward direction. The model also shows intensification of the system into a Deep Depression on 3 November and into a cyclonic storm on 4 November. The system would intensify into a severe cyclonic storm during 3 to 4 November over the west central Bay of Bengal off Andhra Pradesh coast and cross North Andhra Pradesh Coast on 5 November and gradual weakening thereafter over same area and becomes low on 8 November over the west central Bay of Bengal off Andhra Pradesh coast.

NCEP-GFS: The forecast charts of the model based on 00 UTC of 31 October 2016 show formation of a low on 02 November over the southeast Bay of Bengal and adjoining Andaman Sea which moves northwestward direction and intensified into a Depression on 4 November 2016 over the west-central and adjoining southwest Bay of Bengal. The model also shows recurvature towards northeastward direction from 5 November and intensification into a cyclonic storm on 7 November over the head Bay of Bengal and cross Bangladesh coast between 7th and 8th November 2016 and weaken thereafter.

ECMWF: The model charts based on 00 UTC of 31 October 2016 shows formation of a low pressure system over the southeast and adjoining east-central Bay of Bengal on 02 November which moves northwestward direction. The model also shows intensification of the system into a Deep Depression on 3 November and cyclonic storm on 4 November 2016 over the west-central Bay of Bengal off north Andhra Pradesh coast. Thereafter the system would recurve towards northeast direction along and off north Andhra Pradesh, Odisha and West Bengal coast as cyclonic storm and cross West Bengal and Bangladesh boarder between 5th and 6th November 2016 and weaken thereafter.

WRF: The WRF model forecasts based on 00 UTC of 31 October 2016 show formation of a Depression over the southwest Bay of Bengal on 3 November 2016.

JMA: Model forecast for based on 31st 00UTC analysis indicates formation of an extended low over SE and adjoining Andaman Sea Bay on 03rd.

Meteo-France ARP Model based on 31st 00UTC analysis indicates the likelihood of formation of a low over SE and adjoining Andaman Sea Bay on 01st November which shows a westward/ west-northwestward movement without intensification till 03rd November.

NCMRWF-NCUM:

The forecast based on 31st Oct 2016 initial conditions show a low over SE bay and adjoining SW Bay on 02nd November. It becomes a depression on 03rd near Tamil Nadu coast. It is seen as a CS over the same area during 04th. Further it moves in a northeastward direction and intensifies into SCS over WC bay on 05th. Further moving north-northeastwards, it crossed Bangladesh coast and adjoining Myanmar coast on 07th and became less marked on 08th.

NCMRWF-UM-Regional Model:

The forecasts for 01st November based on 31st Oct 2016 initial conditions show the likelihood of a low pressure system over south Andaman sea, which moving westwards intensifies to a CS on 02nd November over SW bay. It shows a northward movement on 03rd November.

NCMRWF-NEPS Model:

Based on the 00 UTC analysis on 31st October, a low pressure area is seen over central parts of Andaman Sea on 01st November which moves westwards and intensifies into a depression over EC Bay and adjoining SE Bay on 02nd . Further moving in NW direction it intensifies into a CS Central Bay on 03rd . Continuing to move in northwest direction the CS is seen off the coast of north Andhra coast on 04th and 05th. Further it re-curves in a northeast direction and lies over north Bay on 06th , over NE Bay off Myanmar coast on 07th . It crosses Bangladesh and adjoining Myanmar coast on 07/08th.

IITM-GEFS:

The forecast based on 31st initial conditions shows an extended low over Andaman Sea and adjoining SE Bay on 01st November which moving west northwestwards becomes a depression by 03rd over northern parts of SW Bay and is seen over WC Bay off Andhra coast on 04th. Further moving northeastwards, it is seen off south Orissa and north Andhra on 05th. On 06th it is seen crossing Bangladesh coast and adjoining West Bengal coast.

IITM -GFS T1534: The 24 hour forecast valid on 31st October based on 30th initial conditions show the formation of a low over Andaman Sea. Moving westward, it is seen over SE Bay on 01st November and becomes well marked on 02nd. It moves in a northwesterly direction on 03rd and becomes a DD/CS and an

SCS off south Andhra coast on 04th. Further it is seen moving in a northeastward direction along the coast during 05th -07th

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

GPP forecasts based on 00 UTC of 31 October 2016 shows formation of a cyclogenesis zone over the south and adjoining north Andaman Sea on 1st November 2016 with further organization and northwestward movement till 4th November 2016 and recurvature thereafter in northeastward direction. Forecast also shows that the zone reaches to head Bay of Bengal off Bangladesh coast on 7th November 2016.

IITM Cyclogenesis Probability based on Genesis Potential Index (GPI) from CGEPS

It does not show any cyclogenesis during next two weeks based on initial condition of 28th Oct. initial conditions.

Summary and Conclusion:

Majority of the models continue to indicate the presence of a low pressure area on 01st November over Andaman Sea and adjoining southeast Bay. Most of them show intensification of the low into depression on 02nd November. Regarding movement of the system also there is continuity in the forecast by the models and most of them indicate northwestward movement and reach Andhra Pradesh Coast by 04/05th November. As an exception NEPS moves the system towards Tamil Nadu coast and thereafter recurves towards northeast direction.

Considering all the above model guidance and diagnostic features, a low pressure area is likely to form over Andaman Sea and adjoining SE Bay on 01st November. It may concentrate into a depression on 02nd November and move in northwest direction reaching close to westcentral Bay close to Andhra Pradesh Coast with gradual intensification by 4th/ 5th November. Thereafter, it may recurve northeastwards and reach West Bengal and Bangladesh coasts skirting north Andhra Pradesh and Odisha coast by 6th/7th November.

Advisory:

- Upper air observations may be taken four times a day on 01st and 02nd November over Andaman and Nicobar Islands.
- Intense observations may be taken over Andhra Pradesh coast during 04-05th November 2016.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Low	Moderate	High	High

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	30/12	31/00	31/03
India	34	31	39
Coastal stations			
WB	3	0	4
Odisha	4	1	2
AP	6	4	5
Tamil Nadu	15	09	13
Puducherry	1	1	1
A & N	0	0	0
Bangladesh	0	15	12
Myanmar	0	0	12
Thailand	3	3	3
SriLanka	5	7	8

- **RS/RW** (12Z) of 30 / 10 /2016 16/36
- **No. of Ascents reaching 250 hPa levels: 16 , MISDA:- 20**
- **RS/RW** (00Z) of 31 / 10 /2016 28/34
- **No. of Ascents reaching 250 hPa levels: 27 , MISDA: 6**
-

No. of PILOT Ascents

30/12Z	31/00Z
17/37	34/34

Buoy Data

30/12Z	31/00Z	31/03Z
14	14	14

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**30.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**19**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /30.10.2016 : 6

No. of Ascents reaching 250 hPa level = 6

MISDA : 2

12Z /30.10.2016 : 4

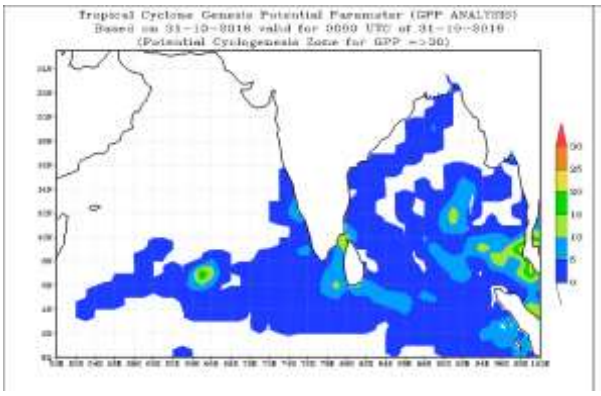
No. of Ascents reaching 250 hPa level = 4

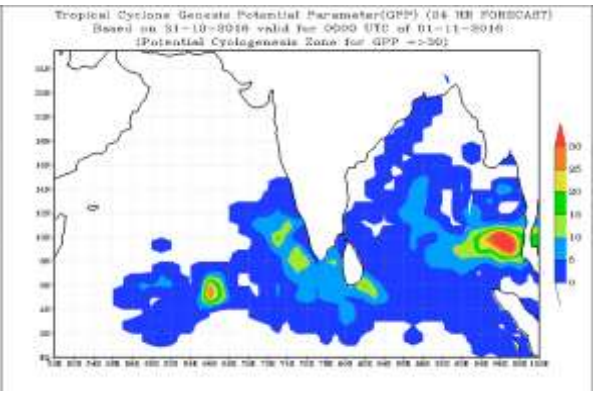
MISDA : 4

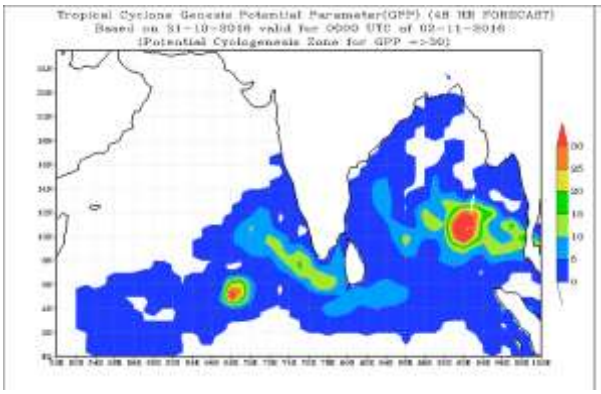
No. of PILOT Ascents:

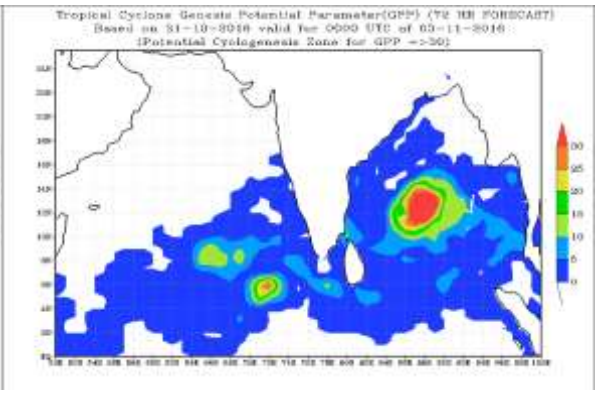
30.10.2016	
06Z	18Z
2	2

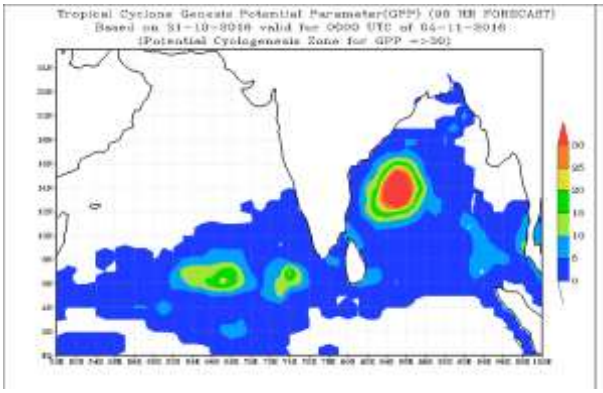
Annexure-II

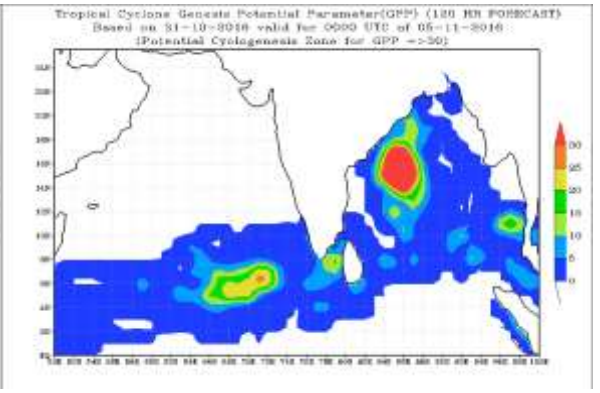

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 31-10-2016 valid for 0000 UTC of 31-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

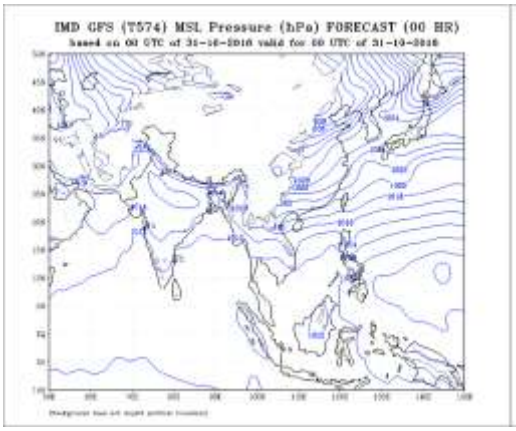

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 31-10-2016 valid for 0000 UTC of 01-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

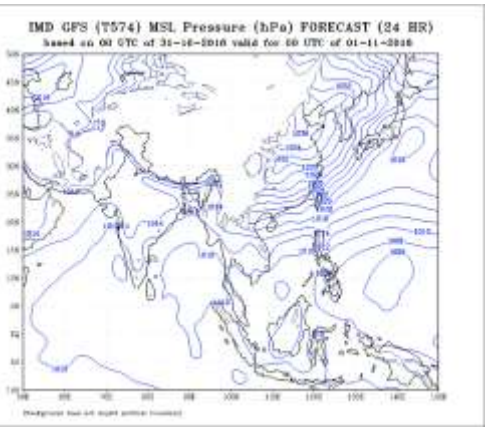

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 31-10-2016 valid for 0000 UTC of 02-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

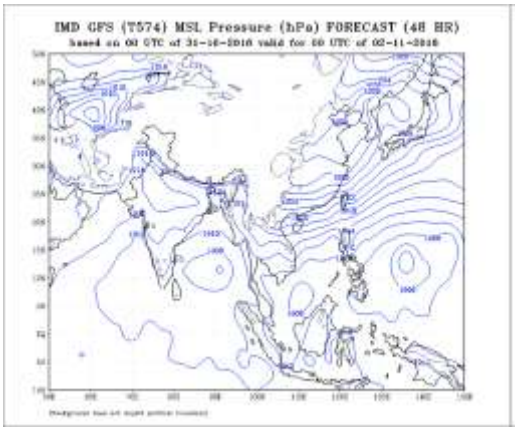

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 31-10-2016 valid for 0000 UTC of 03-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

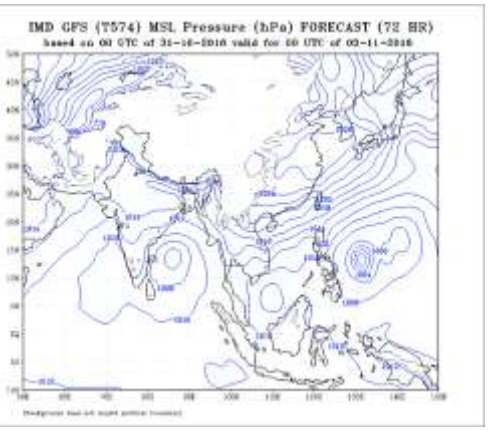

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 31-10-2016 valid for 0000 UTC of 04-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

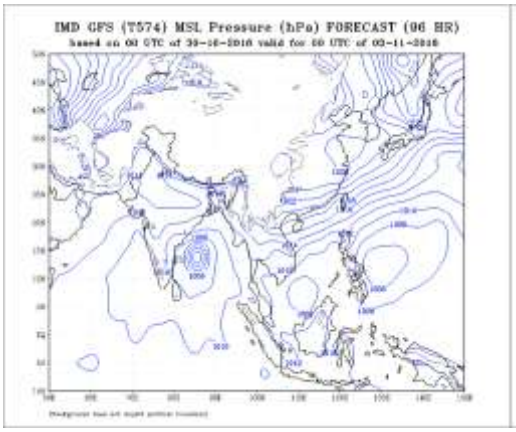

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 31-10-2016 valid for 0000 UTC of 05-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

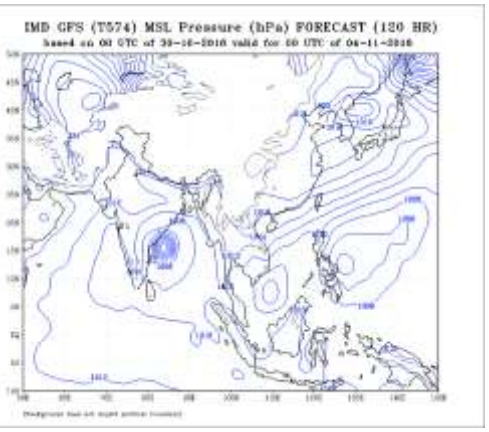

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 31-10-2016 valid for 00 UTC of 31-10-2016

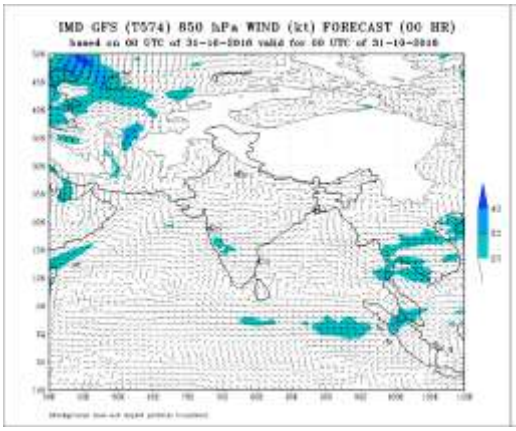

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 31-10-2016 valid for 00 UTC of 01-11-2016

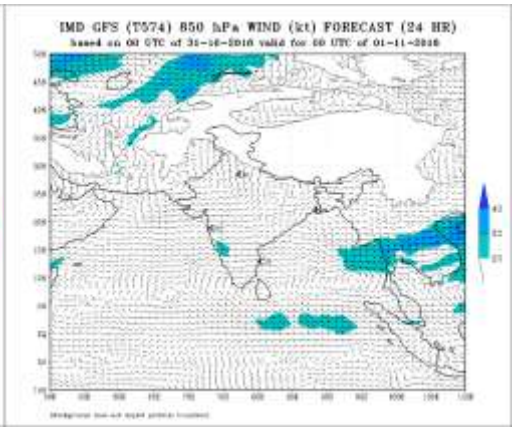

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 31-10-2016 valid for 00 UTC of 02-11-2016

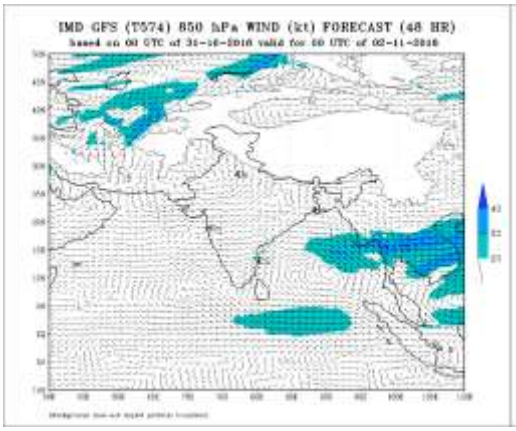

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 31-10-2016 valid for 00 UTC of 03-11-2016

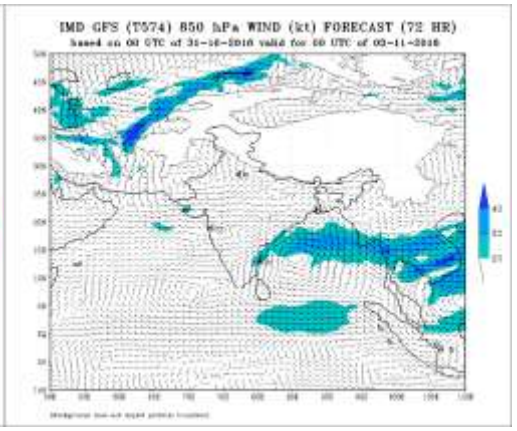

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 31-10-2016 valid for 00 UTC of 03-11-2016

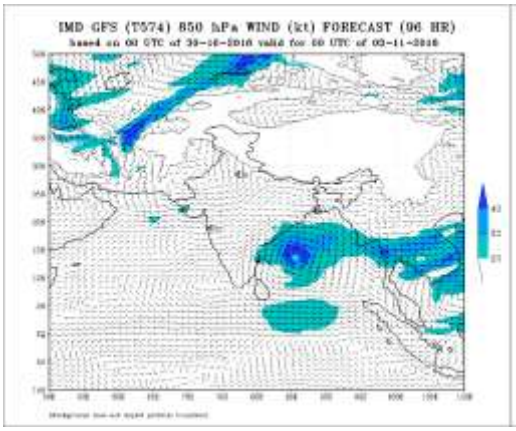

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 31-10-2016 valid for 00 UTC of 04-11-2016

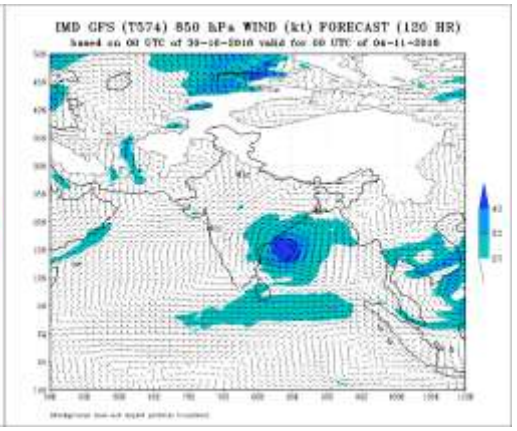

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

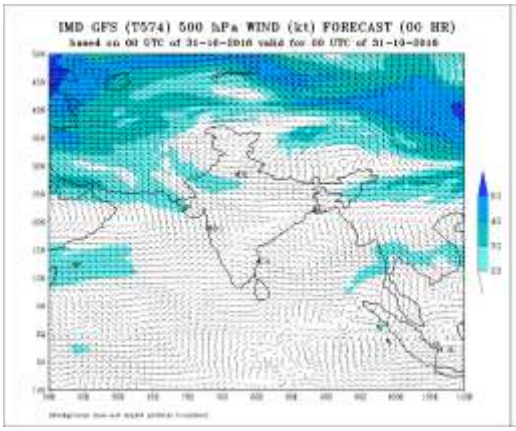

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

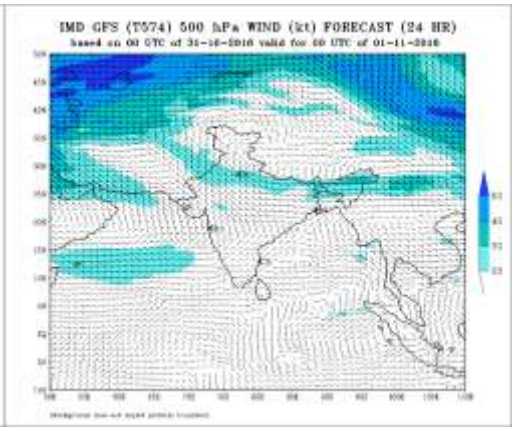

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

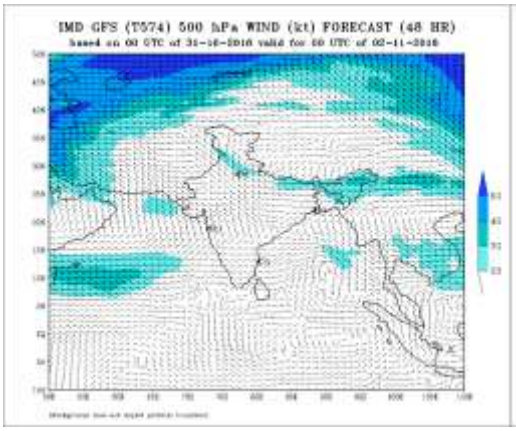

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

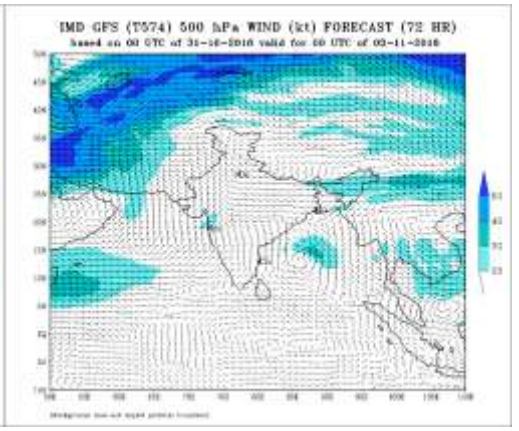

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

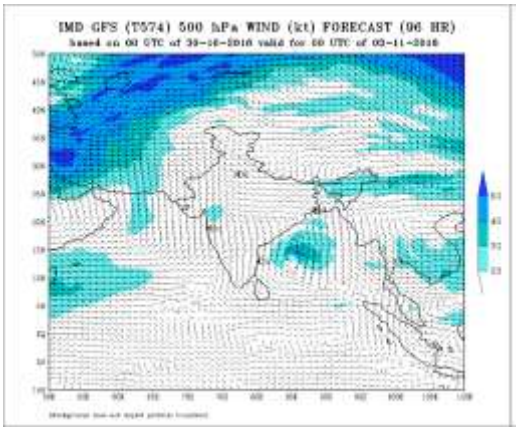

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

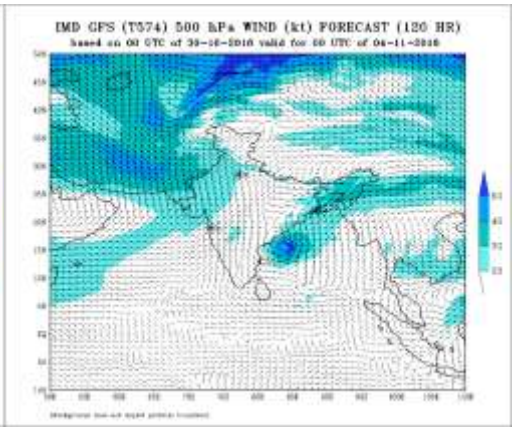

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)

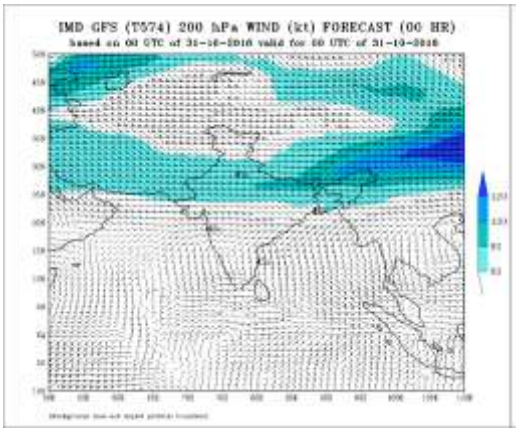

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

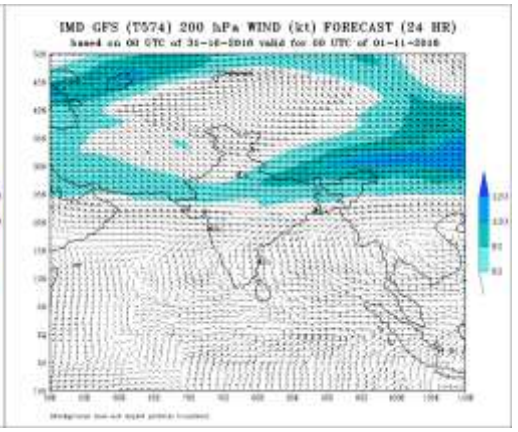

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

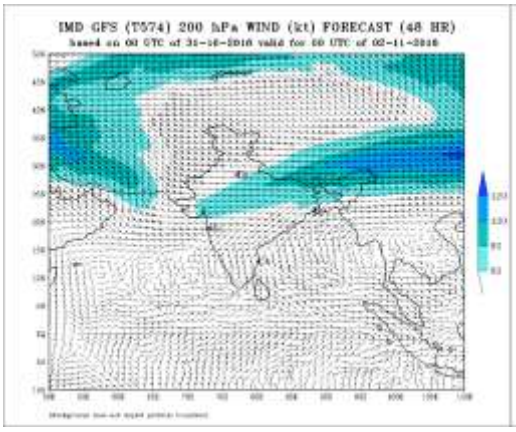

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

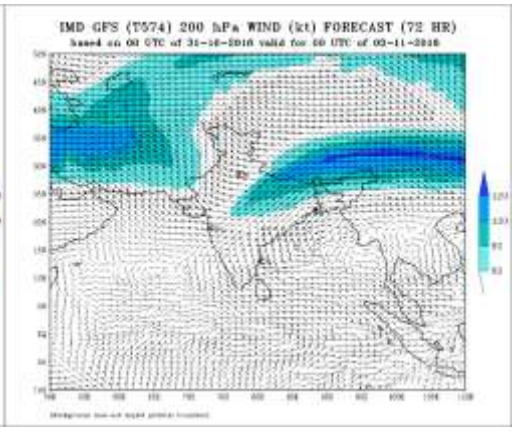

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

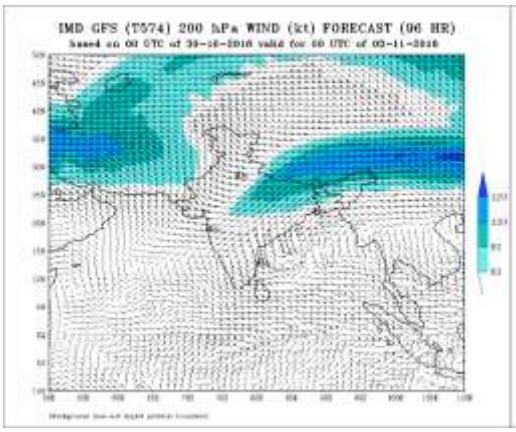

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

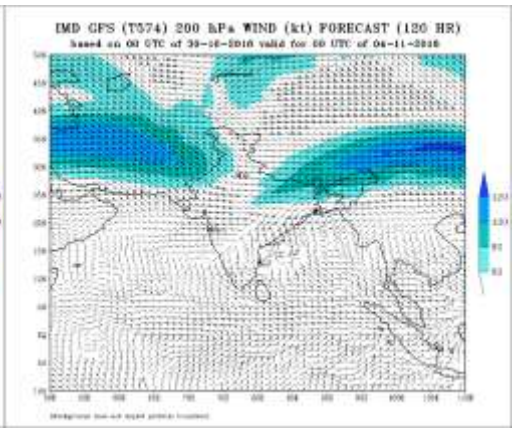

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)

FDP (Cyclone) NOC Report Dated 01 November, 2016

Synoptic features:

Under the influence of the cyclonic circulation over south Andaman Sea and neighbourhood a low pressure area has formed over the same region. Associated cyclonic circulation extends upto 7.6 km a. s. l. System is very likely to concentrate into a Depression during next 24 hours. Subsequently it is very likely to intensify further while moving northwestwards. The cyclonic circulation over interior Tamil Nadu and adjoining Kerala and south Karnataka now lies over southeast Arabian Sea off Kerala coast and extends upto 0.9 km a. s. l.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29-31˚C around over most parts of Bay of Bengal except for small pockets in North Andaman Sea, where SST is 31-32˚C. Over Arabian Sea, SST is 27-29˚C to the north of 10°N except for a small pocket of high values off south Gujarat coast. It is between 28-30˚C in the remaining area, except off Somalia coast where the values are less than 28˚C.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 100 kJ/CM^2 over southern parts of south Andaman Sea. Rest of BoB, it is less than 100 kJ/CM^2. Over entire Arabian Sea, TCHP is less than 80 kJ/CM^2.

Relative Vorticity:

The low level relative vorticity is about $60x10^{-6}$ $second^{-1}$ over south Andaman Sea.

Convergence:

Low level convergence is 10-20x $10^{-5}s^{-1}$ around the system area. There is positive convergence off west coast of India.

Divergence:

Upper level convergence is positive and is about 20-30x $10^{-5}s^{-1}$ over SE Bay and adjoining Andaman Sea. It is about 5-10x $10^{-5}s^{-1}$ over southern most peninsular India and neighbouring sea area. There is no area of significant upper level divergence over Arabian Sea.

Wind Shear:

Wind shear is low to moderate over central parts of Andaman Sea. It is low to moderate over central and south Arabian Sea. It increases to the north and south.

Wind Shear Tendency:

There is increasing tendency over Andaman Sea and adjoining SE Bay.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, low level circulation over Andaman Sea and neighbourhood has intensified and now centered within a half degree of lat 11.5N/93.5N (.) Intensity T1.0, (CTBT -81^{0}C). Associated broken low/medium clouds with embedded intense to very intense convection over Andaman Sea and adjoining EC Bay. Scattered low/medium clouds with embedded moderate to intense convection are seen over South Bay, south of 15^{0}N and rest of Andaman Sea and Tennaserim coast.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection over Comorin area and adjoining southeast Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 15^{0}N latitude over BoB. An anticyclone is seen over Myanmar. Ridge at 200 hPa lies around 18^{0}N latitude over north Arabian Sea.

M.J.O. Index: MJO index is in Phase 8 with very less amplitude. It would move to phase 3 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 1 November 2016 shows an extended low pressure system over southeast Bay of Bengal which moves northwestward direction. The model also shows intensification of the system into a Depression on 2 November, and into a cyclonic storm on 3 November. The system would intensify into a severe cyclonic storm on 4 November over the west central Bay of Bengal and recurve northeastward direction along off north Andhra Pradesh, Odisha and West

Bengal coast from 4 November with further intensification and cross Bangladesh coast during 6th forenoon and weaken thereafter.

NCEP-GFS: The forecast charts of the model based on 00 UTC of 1 November 2016 show formation of a low pressure area on 02 November over the southeast Bay of Bengal and adjoining Andaman Sea which moves northwestward direction and intensifies into a Deep Depression on 3 November 2016 over the west-central and adjoining southwest Bay of Bengal. The model also shows recurvature towards northeastward direction along off north Andhra Pradesh, Odisha and West Bengal coast from 4 November and intensification into a cyclonic storm on 4 November and cross Bangladesh coast on 7 November 2016 and weaken thereafter.

ECMWF: The model charts based on 00 UTC of 1 November 2016 shows a low pressure system over the south and adjoining north Andaman Sea which moves northwestward direction till 4 November and recurvature thereafter towards northeast direction along and off north Andhra Pradesh, Odisha and West Bengal coast. The model also shows intensification of the system into a Deep Depression on 3 November and cyclonic storm on 4 November 2016 over the west-central Bay of Bengal off north Andhra Pradesh coast and weakening after 5 November over the head Bay of Bengal.

WRF: The WRF model analysis and forecasts based on 00 UTC of 1 November 2016 show a low pressure area over the southeast Bay of Bengal which moves northwest direction during next 72 hours. The forecast also shows the intensification of the system into a Depression on 3 November and cyclonic storm on 4 November over the southwest Bay of Bengal off north Tamil Nadu coast.

JMA: Model forecast for based on 01st November 00UTC analysis do not give any indication of the low over Andaman Sea and adjoining SE Bay.

Meteo-France ARP Model based on 1st November 00UTC analysis indicates a low over SE and adjoining Andaman Sea Bay which shows a westward/ west-northwestward movement without intensification till 03rd November.

NCMRWF-NCUM:

The forecast based on 1st November 2016 initial conditions show a low over SE bay and adjoining SW Bay on 02nd November. It becomes a depression on 03rd near Tamil Nadu coast. It moves in northward direction and seen as a CS over WC Bay on 04th. Further it moves in a northeastward direction it is seen over NE and adjoining EC Bay on 6th and crossed Bangladesh coast the same day.

NCMRWF-UM-Regional Model:

The forecasts based on 01st November initial conditions show the likelihood of a low pressure system over south Andaman sea, which moving westwards intensifies to a CS on 02nd November over SW Bay. It shows a northward movement on 03rd November.

NCMRWF-NEPS Model:

Based on the 00 UTC analysis on 1st November, a low pressure area is seen over central parts of Andaman Sea on 01st November which moves northwards and intensifies into a CS on 03rd over Central Bay. Further moving in a northwest direction the CS is seen over NW Bay and adjoining WC Bay on 04th. Further it re-curves in a northeast direction and lies over north Bay on 05th, and crosses Bangladesh and adjoining Myanmar coast the same day. Another low forms on 04th off Tamil Nadu and adjoining Sri Lanka coast. This low also shows a north-northeastward movement till 08th to reach off Irrawaddy Delta.

IITM-GEFS:

The forecast based on 01st November initial conditions shows an extended low over SE Bay on 02nd which moving west northwestwards becomes a depression by 03rd over northern parts of SW Bay and is seen as a CS over WC Bay off Andhra coast on 04th. Further moving northeastwards along the east coast of India, it is seen off south Orissa and north Andhra on 05th. On 06th it is seen crossing Bangladesh coast and adjoining West Bengal coast.

IITM -GFS T1534: The 24 hour forecast valid on 1st November based on 31stinitial conditions show the formation of a low over SE Bay and adjoining Andaman Sea on 02nd. Moving westward, it is seen over SE Bay on 03rd November and is well marked. It moves in a northwesterly direction and becomes a DD off south Andhra coast on 04th. Further it is seen moving in a northeastward direction along the coast and is seen as a CS over north Bay on 06th and crosses Bangladesh coast and adjoining West Bengal and Mayanmar coasts the same day.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

GPP analysis and forecasts based on 00 UTC of 1 November 2016 shows a cyclogenesis zone over the south and adjoining north Andaman Sea and moves northwestward direction with further organization till 4 November 2016 and recurves thereafter towards northeastward direction. Forecast also shows that the zone reaches to northwest Bay of Bengal on 6 November 2016 and crosses Bangladesh coast thereafter.

Summary and Conclusion:

Majority of the models indicated the low pressure area on 01st November over Andaman Sea and adjoining southeast Bay. A few models like IMD-GFS and UM-Regional Model indicate intensification of the low into depression on 2nd and remaining models show the same on 03rd November. Most models show further intensification into a cyclonic storm on 04th November, except IMD-GFS and UM regional models which show on 3rd Nov.

Regarding movement of the system also there is continuity in the forecast by the models. While NCUM global and regional models, Meteo-France ARP and IMD-WRF show initial west-northwestward movement and hence reaching the system over southwest Bay of Bengal off Tamil Nadu and adjoining south AP coast by 4th Nov, remaining models suggest northwestward movement and reach West Central Bay off Andhra Pradesh Coast by 04th November. The models are unanimous about the recurvature of the system from 4th towards northeast skirting east coast of India and crossing Bangladesh coast by 6th Nov 2016.

Considering all the above model guidance and diagnostic features, the low pressure area over south Andaman Sea and neighbourhood is very likely to concentrate into a depression on 02nd/3rd November in into a cyclonic storm on 3rd/4 th November. It is very likely to move initially west-northwestward and then northwestward till 4th Nov reaching west central Bay off Andhra Pradesh Coast. Thereafter, it may recurve northeastwards skirting east coast of India and cross Bangladesh coast on 6th November.

Advisory:

- Upper air observations may be taken four times a day on 01st and 02nd November over Andaman and Nicobar Islands.
- Intense observations may be taken during 03-05th November over Andhra Pradesh, 4-6 November over Odisha and West Bengal coasts and 5-6 November over Bangladesh coast

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Moderate	High	High	High	High

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Annexure I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	31/12	**01/00**	**01/03**
India	34	31	39
Coastal stations			
WB	3	0	4
Odisha	4	1	2
AP	6	4	5
Tamil Nadu	15	09	13
Puducherry	1	1	1
A & N	0	0	0
Bangladesh	0	15	12
Myanmar	9	0	12
Thailand	3	3	3
SriLanka	5	7	8

- **RS/RW** (12Z) of 31/ 10 /2016: 16/36
- **No. of Ascents reaching 250 hPa levels: 16, MISDA: 20**

- **RS/RW** (00Z) of 01 / 10 /2016: 28/34
- **No. of Ascents reaching 250 hPa levels: 27, MISDA: 6**

No. of PILOT Ascents

31/12Z	**01/00Z**
17 /37	34/34

Buoy Data

31/12Z	**01/00Z**	**01/03Z**
14	14	14

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**31.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**19**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /18.10.2016 : 6

No. of Ascents reaching 250 hPa level = 6

MISDA : 2

12Z /18.10.2016 : 4

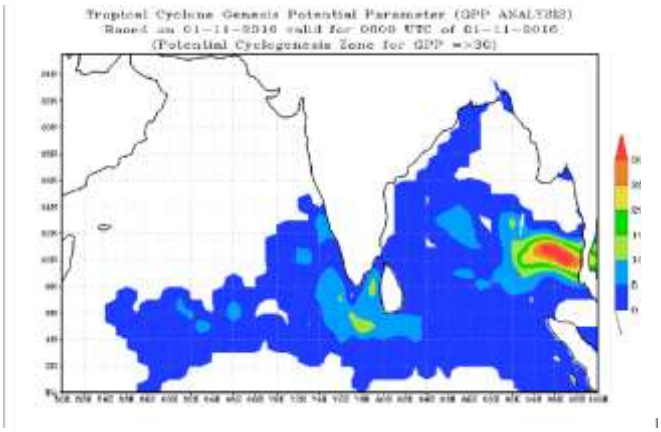
No. of Ascents reaching 250 hPa level = 4

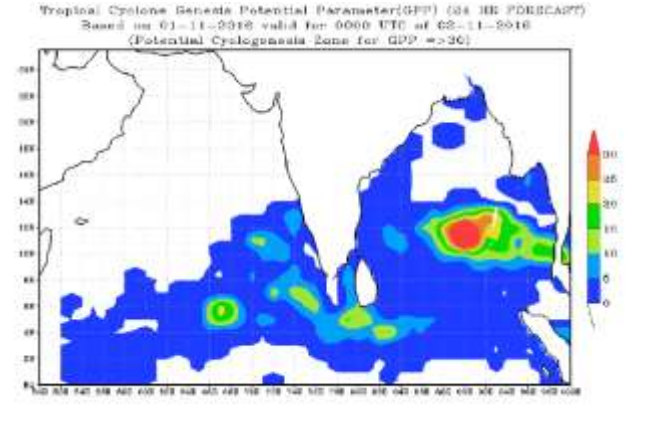
MISDA : 4

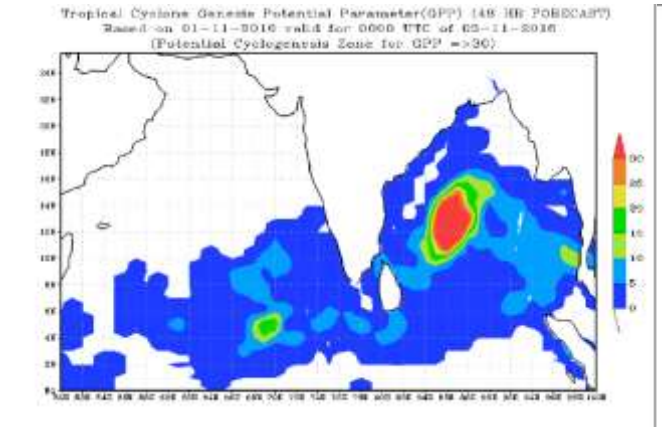
No. of PILOT Ascents:

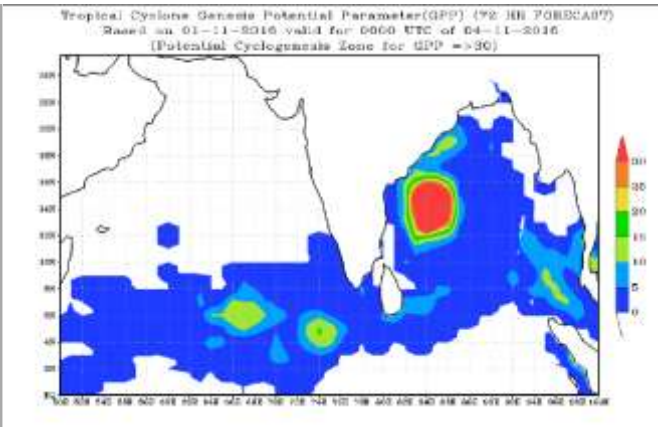
31.10.2016	
06Z	18Z
2	2

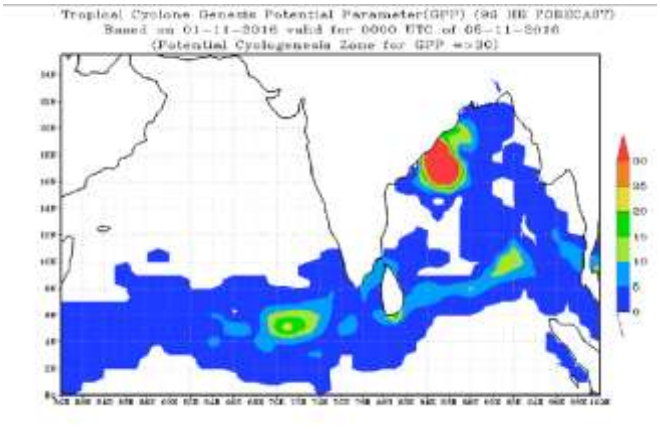
Annexure-II

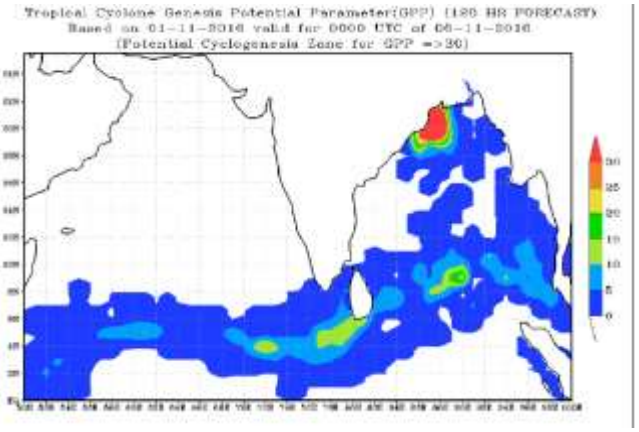

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 01-11-2016 valid for 0000 UTC of 01-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

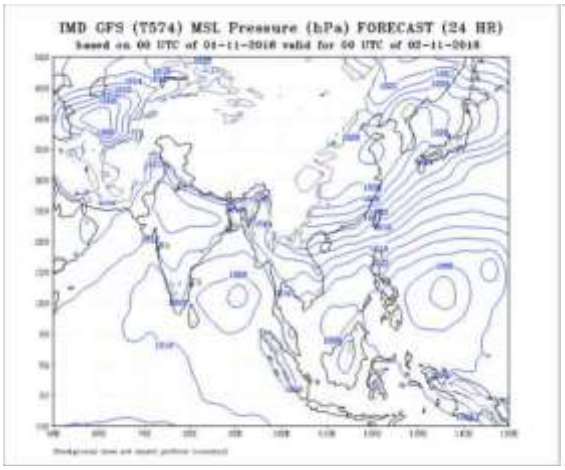

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 01-11-2016 valid for 0000 UTC of 02-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

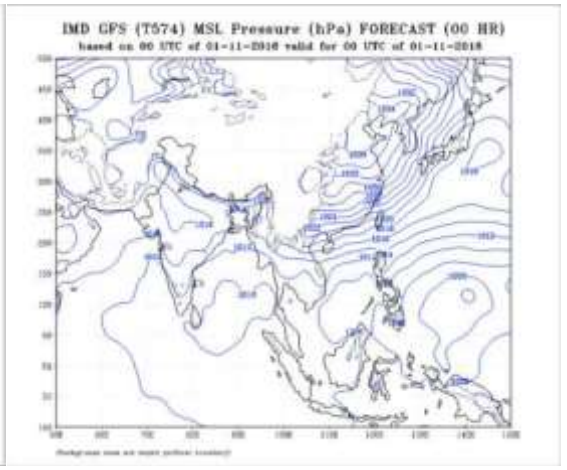

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 01-11-2016 valid for 0000 UTC of 03-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

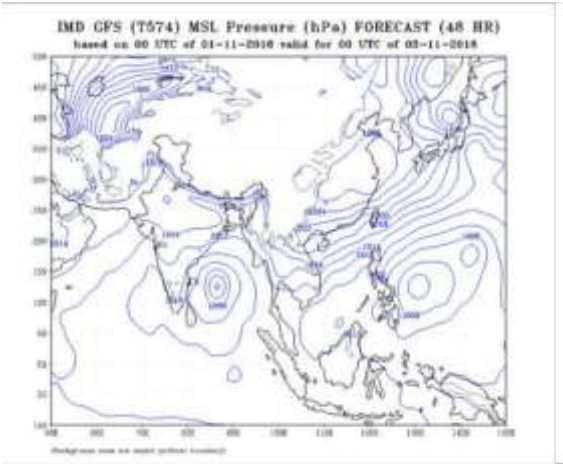

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 01-11-2016 valid for 0000 UTC of 04-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

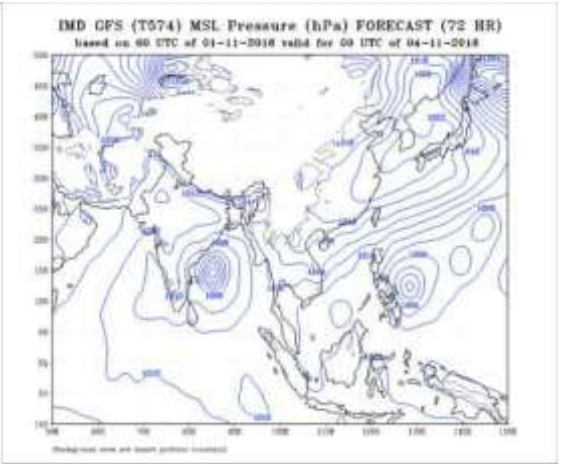

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 01-11-2016 valid for 0000 UTC of 05-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

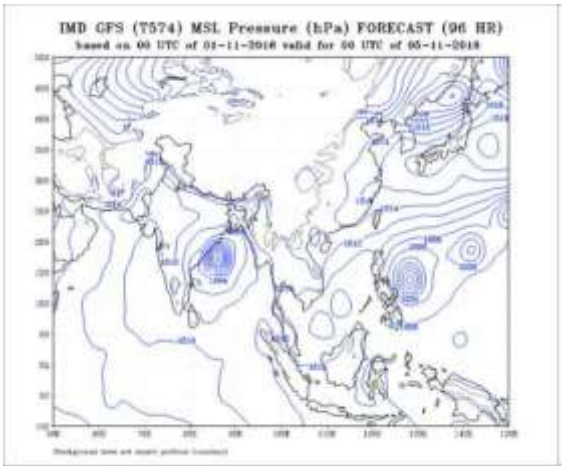

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 01-11-2016 valid for 0000 UTC of 06-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

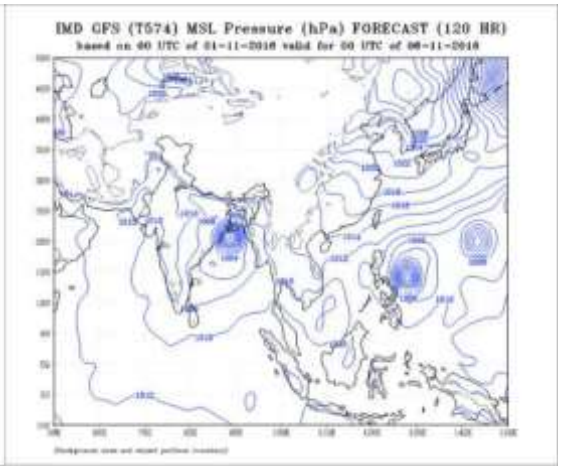

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 02-11-2018


IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 01-11-2018

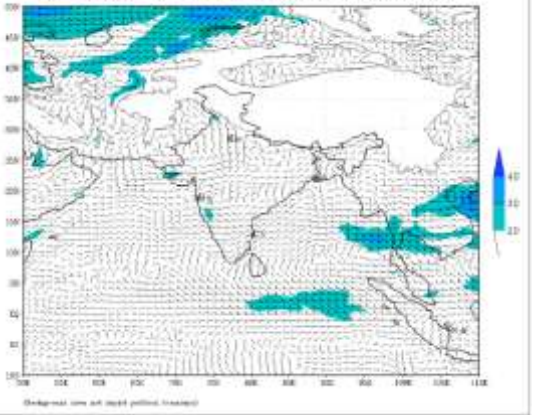

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 03-11-2018


IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 04-11-2018

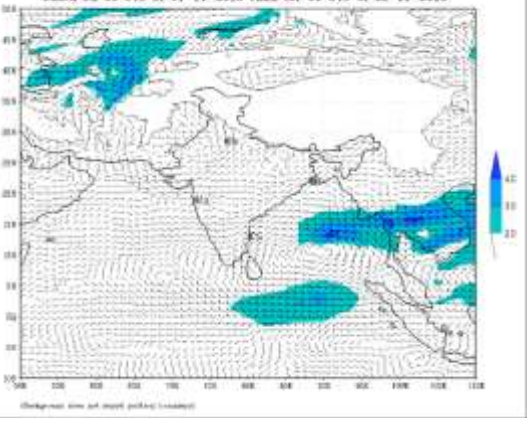

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 05-11-2018


IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 06-11-2018

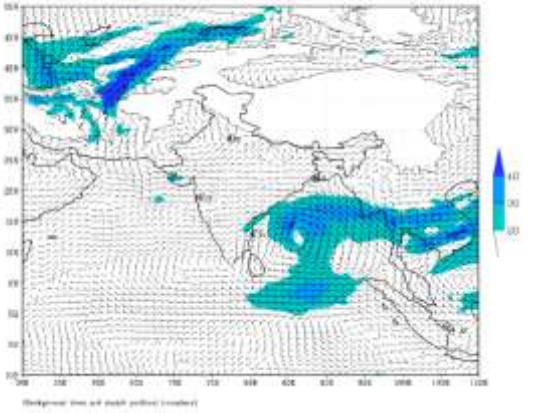
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 01-11-2016



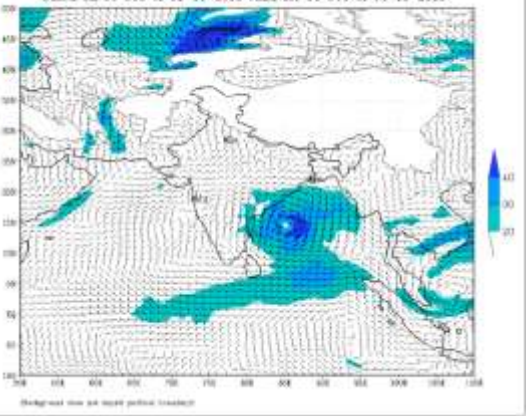
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
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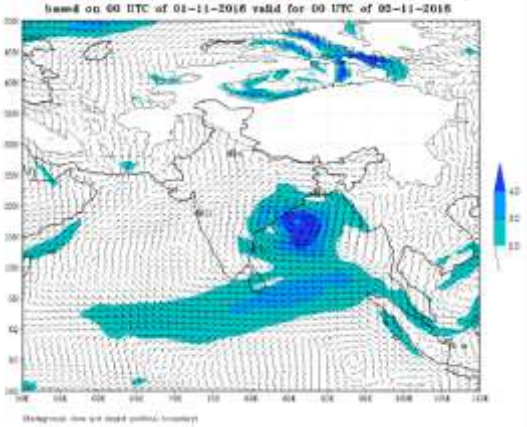
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 03-11-2016



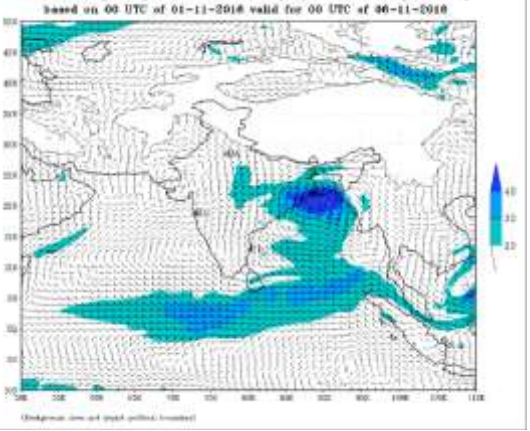
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 04-11-2016



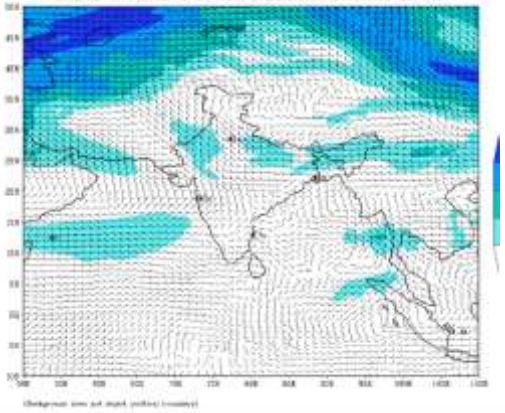
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 05-11-2016



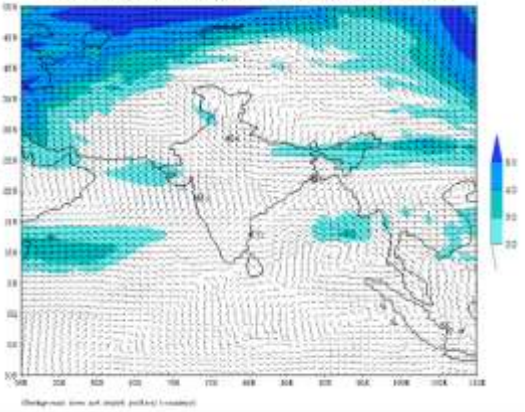
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 06-11-2016



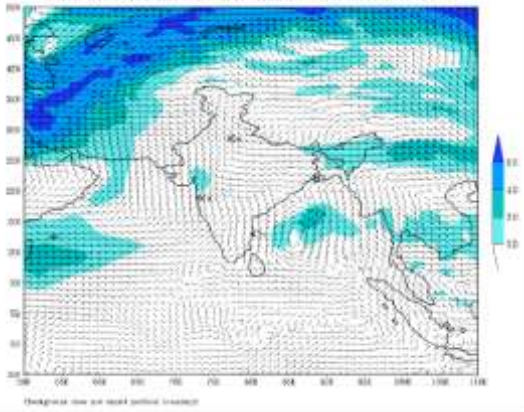
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 01-11-2016



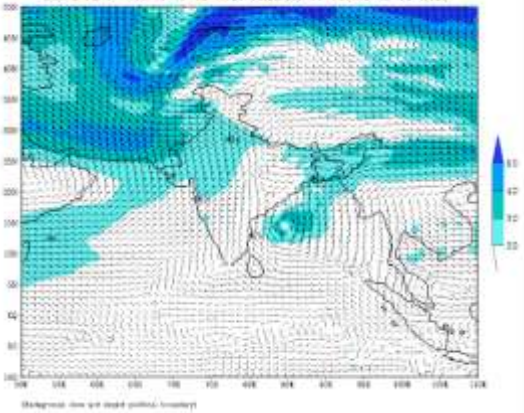
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 02-11-2016



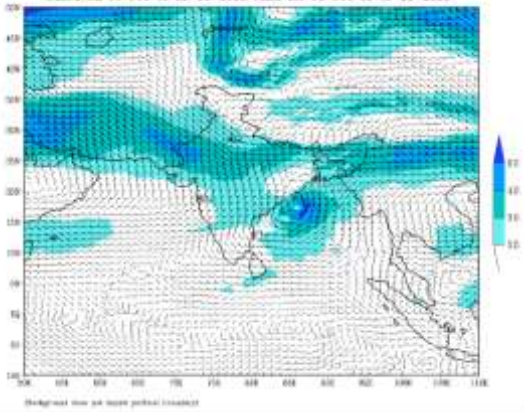
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 03-11-2016



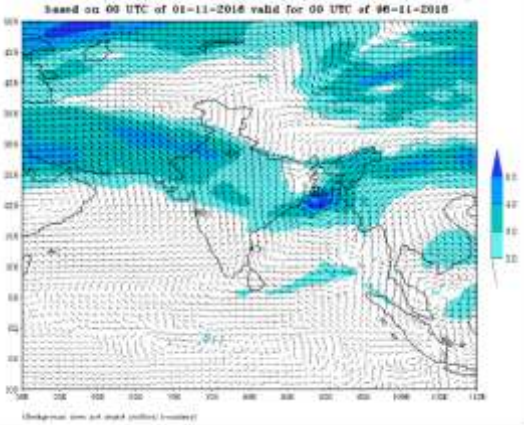
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 04-11-2016

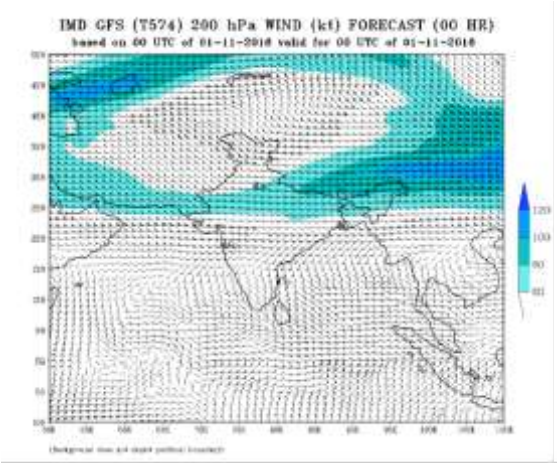


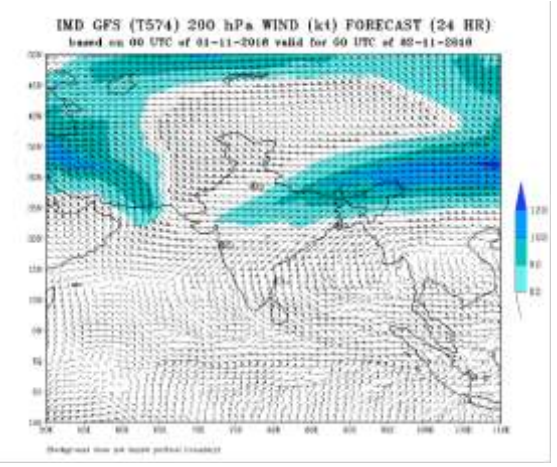
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 05-11-2016

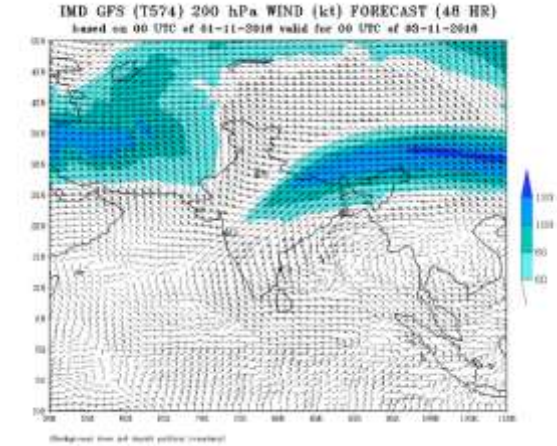


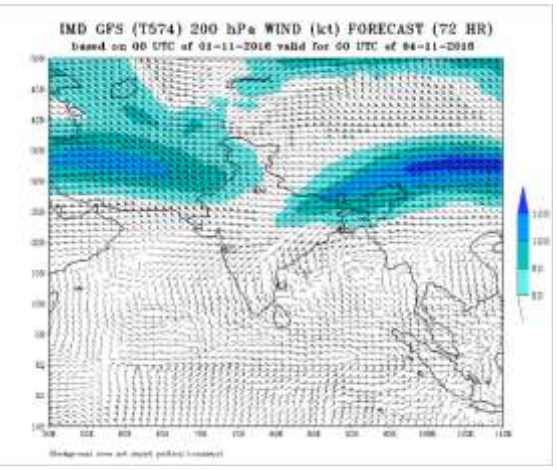
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 01-11-2016 valid for 00 UTC of 06-11-2016

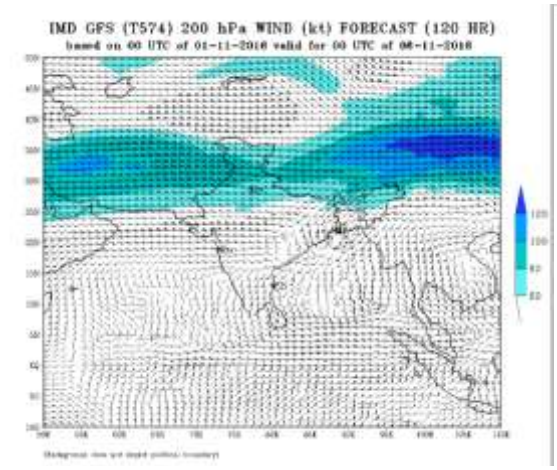


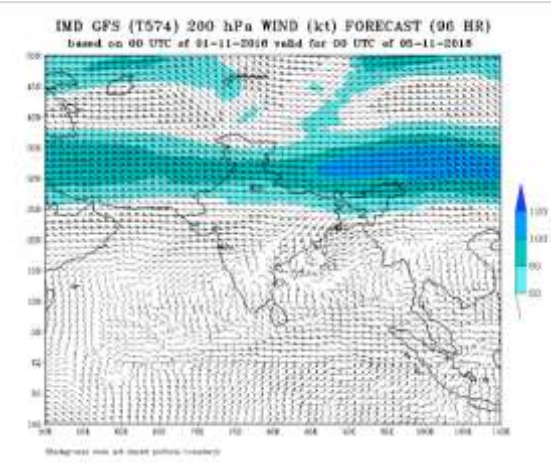

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 01-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 02-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 03-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 04-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 06-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 01-11-2018 valid for 00 UTC of 05-11-2018

FDP (Cyclone) NOC Report Dated 02 November, 2016

Synoptic features:

The low pressure area over the south Andaman Sea & neighbourhood became a well marked low pressure area over central Andaman Sea and adjoining areas of southeast Bay of Bengal, yesterday evening and now lies over southeast Bay of Bengal and neighbourhood. Associated cyclonic circulation extends upto mid-tropospheric levels. System is very likely to concentrate into a Depression during next 24 hours. Subsequently it is very likely to intensify further while moving northwestwards.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29-30˚C around over most parts of Bay of Bengal except for small pockets of higher values in west central and southwest Bay. Over central parts of Andaman Sea, SST is between 26-28˚C. Over Arabian Sea, SST is 28-29˚C to the north of 10°N except for a small pocket of low values off north Maharashtra coast. It is between 28-30˚C in the remaining area, except off Somalia coast where the values are less than 28˚C.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 100 kJ/CM^2 over the system area and also over southern parts of south Andaman Sea. Rest of BoB, it is less than 100 kJ/CM^2. Over entire Arabian Sea, TCHP is less than 80 kJ/CM^2.

Relative Vorticity:

The low level relative vorticity is about $70x10^{-6}$ $second^{-1}$ over SE Bay around the system area.

Convergence:

Low level convergence is 100x $10^{-5}s^{-1}$ over the system area. There are no significant zones of positive convergence in Arabian Sea Area.

Divergence:

Upper level convergence is positive and is about 20-30x $10^{-5}s^{-1}$ over the system area. It is about 10-20x $10^{-5}s^{-1}$ over southern most peninsular India and neighbouring sea area. There is no area of significant upper level divergence over Arabian Sea.

Wind Shear:

Wind shear is low (5-10 kt) over system area in Bay of Bengal. It is low to moderate over central and adjoining south Arabian Sea. It increases to the north and south.

Wind Shear Tendency:

There is increasing tendency over parts of Andaman Sea. There is increasing tendency over south Bay to the south of 10^0N

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, the vortex now lies centered within a half degree of lat 12.5N/90.0N (.) Intensity T1.0, (CTBT -81^0C). Associated broken low/medium clouds with embedded intense to very intense convection Bay of Bengal between latitude 10.0^0N to 20.0^0N and longitude 83.0^0E to 93.0^0E. Scattered low/medium clouds with embedded moderate to intense convection are seen over rest of South Bay, Andaman Sea and Tennaserim coast.

Arabian Sea:

Scattered low/medium clouds with embedded week to moderate convection over Comorin area and adjoining southeast Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 15^0N latitude over BoB. Ridge at 200 hPa lies around 18^0N latitude over north Arabian Sea.

M.J.O. Index: MJO index is in Phase 6 with very less amplitude. It would move to phase 5 through phases 3 and 4 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 2 November 2016 shows low pressure system over southeast Bay of Bengal which moves northwestward direction. The model also shows intensification of the

system into a Depression on 4 November, into a cyclonic storm on 6 November over the head Bay of Bengal. The track of the system shows recurvature towards northeastward direction off north Andhra Pradesh, Odisha and West Bengal coast from 4 November and cross Bangladesh coast during 6th night and weaken thereafter.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 2 November 2016 show a low pressure area over the southeast Bay of Bengal which moves northwestward direction and intensifies into a Depression on 3 November 2016, into a Deep Depression on 4 November 2016 and cyclonic storm on 5 November over the west-central Bay of Bengal. The model also shows recurvature towards northeastward direction from 4 November with further intensification into a severe cyclonic storm on 6 November over the head Bay of Bengal and cross Bangladesh coast during 6 November night and weaken thereafter.

ECMWF: The model charts based on 00 UTC of 2 November 2016 shows a low pressure system over the southeast Bay of Bengal which moves northwestward direction till 4 November and recurvature thereafter towards northeast direction. The model also shows intensification of the system into a Depression on 3 November and cyclonic storm on 4 November 2016 over the westcentral Bay of Bengal and gradual weakening thereafter. The system becomes less marked over the head Bay of Bengal on 9 November 2016.

WRF: The WRF model analysis and forecasts based on 00 UTC of 2 November 2016 show a low pressure area over the southeast Bay of Bengal which moves west-northwest direction during next 24 hours. The forecast also shows the intensification of the system into a Deep Depression on 3 November over the southwest Bay of Bengal and into a cyclonic storm on 4 November over the same area. The system would recurve thereafter towards northeastward direction with further intensification into a severe cyclonic storm over the west central Bay of Bengal.

JMA: Model forecast for based on 02nd November 00UTC analysis shows a low over SE Bay which is seen over central parts of south Bay on 03rd and over SW and adjoining west central and southeast Bay on 4th November. It is seen as a well marked low pressure area on 5th over southwest Bay.

Meteo-France ARP Model based on 2nd November 00UTC analysis indicates a low over SE Bay becomes a well marked low pressure area on 03rd and a depression 04th over southwest Bay. Further it shows a northeastward movement and becomes a DD on 05th November.

NCMRWF-NCUM:

The forecast based on 02nd November 2016 initial conditions show a low over northern parts of SE bay. It becomes a depression on 03rd over central Bay and adjoining SE Bay. It moves in northwestward direction and seen as a CS over WC Bay, close to Andhra coast on 04th. Moving in east-northeastward direction it intensifies into a SCS over central Bay on 05th and on 6th lies over northern parts of Central Bay and adjoining north Bay and crossed Bangladesh coast the same day.

NCMRWF-UM-Regional Model:

The analysis on 02nd November show a low pressure system over SE Bay and adjoining north Andaman Sea, which moving westwards intensifies to a CS on 03rd November over northern parts of SW Bay. It shows a northwestward movement on 04th November and lies over northern parts of SW Bay and adjoining WC Bay.

NCMRWF-NEPS Model:

Based on the 00 UTC analysis on 02nd November, a low pressure area is seen over north Andaman Sea on which moves northwards and intensifies into a CS on 03rd over East Central Bay. Further moving in a northwest direction the CS is seen over WC Bay on 04th. Further it re-curves in a east-northeast direction and lies over central Bay and adjoining north Bay on 05th, wakened over EC Bay and adjoining NE Bay on 6th and became less marked by 09th.

IITM-GEFS:

The forecast for 03rd November based on 02nd November initial conditions shows low over northern parts of SE Bay and adjoining WC Bay, which moving northwestwards becomes a depression by 04th over WC Bay and is seen moving in a northeastward direction along the east coast on 05th to reach NW Bay off south Orissa coast. On 06th it is seen crossing Bangladesh coast and adjoining West Bengal coast.

IITM -GFS T1534: The 24 hour forecast valid on 02nd November based on initial conditions of 1st show the formation of a low over SE Bay. Moving westward, it is seen over northern parts of SW Bay on 03rd November and is well marked. It moves in a west-northwesterly direction and becomes a CS off south Andhra- north Tamil Nadu coast on 04th. Further it is seen moving in a northeastward direction along the coast and is seen as a CS over WC Bay off north Andhra coast on 05th and became SCS on 06th over northwest Bay crosses West Bengal and adjoining Bangladesh coast the same day.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

GPP analysis and forecasts based on 00 UTC of 2 November 2016 shows a cyclogenesis zone over the southeast Bay of Bengal and moves northwestward direction with further organization till 4 November 2016 and recurves thereafter towards northeastward direction. Forecast also shows that the zone reaches to head Bay of Bengal on 6 November 2016 with little disorganization and crosses Bangladesh coast thereafter.

Summary and Conclusion:

Majority of the models indicated the low pressure area on 02nd November over southeast Bay. Most of the models indicate intensification of the low into depression on 03rd. Most models show further intensification into a cyclonic storm on 04th November, except NCEP-GFS which shows the intensification into CS on 05th and UM regional model which show intensification into CS on 3rd Nov.

Regarding movement of the system also there is continuity in the forecast by the models. While NCUM regional model and Meteo-France ARP show initial west-northwestward movement and hence reaching the system over southwest Bay of Bengal off Tamil Nadu and adjoining south AP coast by 4th Nov, remaining models suggest northwestward movement and reach West Central Bay off Andhra Pradesh Coast by 04th November. The models are unanimous about the recurvature of the system from 4th towards northeast skirting east coast of India and crossing Bangladesh coast by 6th Nov 2016 except ECMWF and NCMRWF-NEPS mldels. While ECMWF continues to show weakening of the system over northeast Bay before landfall, NCMRWF-NEPS also shows similar weakening based on today's initial condition.

Considering all the above model guidance and diagnostic features, the well marked low pressure area over south east Bay and neighbourhood is very likely to concentrate into a depression on 3rd November and further intensify into a cyclonic storm on 4th November . It is very likely to move initially west-northwestward and then northwestward till 4th Nov reaching west central Bay off Andhra Pradesh Coast. Thereafter, it may recurve northeastwards skirting east coast of India and cross Bangladesh coast on 6th November. However, there is also fair probability for slight weakening of the system before landfall due to colder sea, low Ocean heat content, increased vertical wind shear.

Advisory:

- Intense observations may be taken during 03-05th November over Andhra Pradesh, 4-6 November over Odisha and West Bengal coasts and 5-6 November over Bangladesh coast

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	High	High	High	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	01/12	02/00	02/03
India	45	34	40
Coastal stations			
WB	9	6	7
Odisha	7	6	7
AP	12	12	12
Tamil Nadu	10	8	7
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	3	2
Myanmar	0	0	12
Thailand	3	3	3
SriLanka	5	9	10

AWS:

Region	Date/Time (UTC)		
	01/12	02/00	02/03
WB	4	2	4
Odisha	4	2	6
AP	8	12	8
Tamil Nadu	23	12	22
Puducherry	0	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 01 / 11 /2016 34/43
- **No. of Ascents reaching 250 hPa levels: 34 , MISDA:- 21**
- **RS/RW** (00Z) of 02 / 11 /2016 33/43
- **No. of Ascents reaching 250 hPa levels: 33 , MISDA: 6**
-

No. of PILOT Ascents

01/12Z	02/00Z
06/69	05/69

Buoy Data

01/12Z	02/00Z	02/03Z
13	12	12

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**01.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /01.11.2016 : 6

No. of Ascents reaching 250 hPa level = 6

MISDA : 2

12Z /31.10.2016 : 3

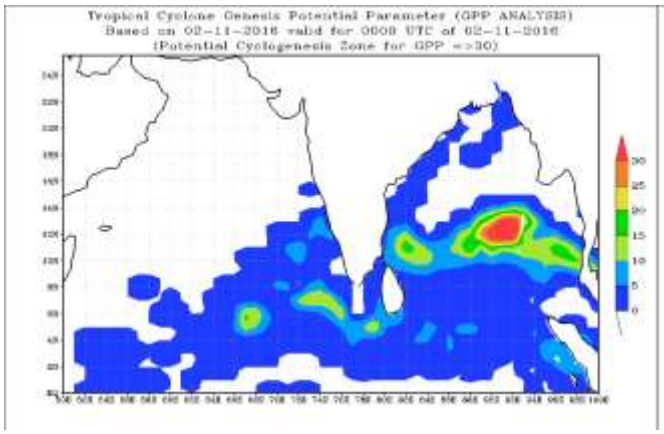
No. of Ascents reaching 250 hPa level = 3

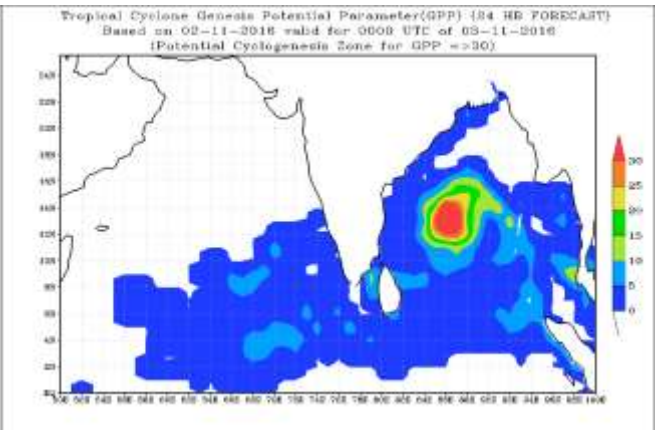
MISDA : 5

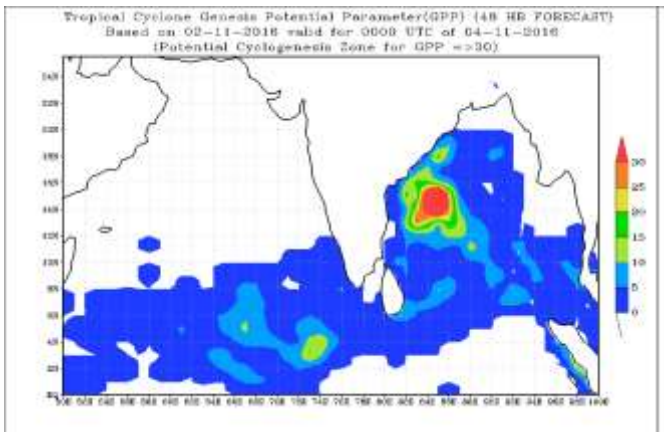
No. of PILOT Ascents:

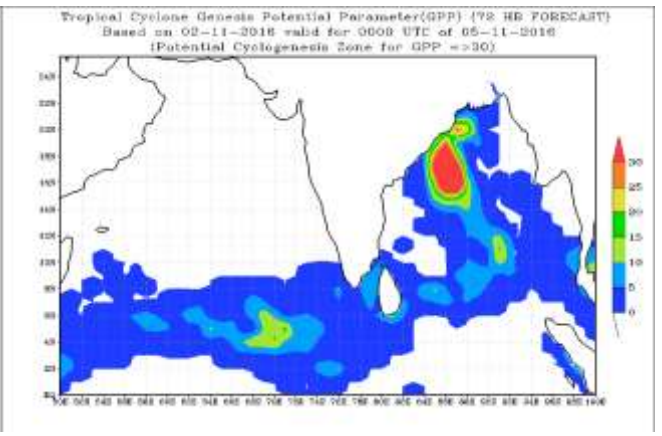
01.11.2016	
06Z	18Z
3	2

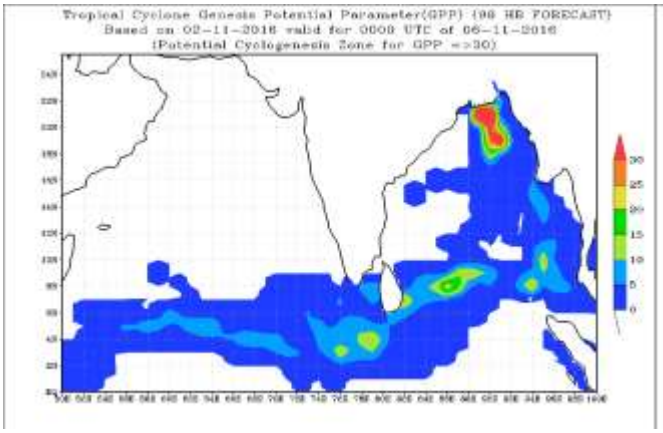
Annexure-II

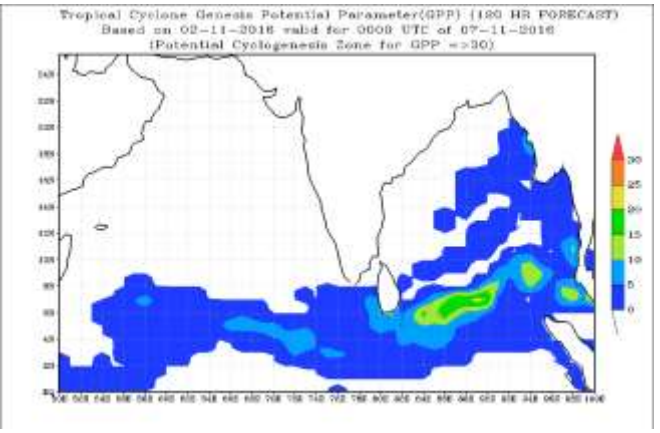

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 02-11-2016 valid for 0000 UTC of 02-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

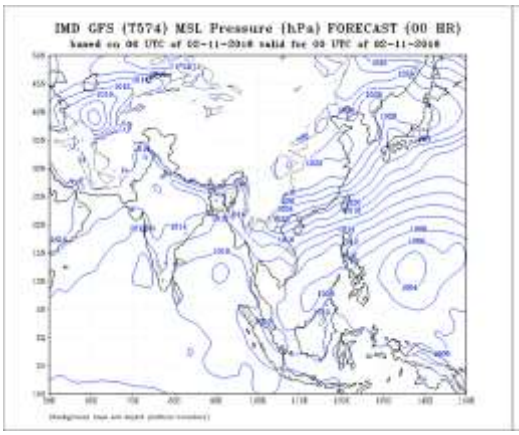

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 02-11-2016 valid for 0000 UTC of 03-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

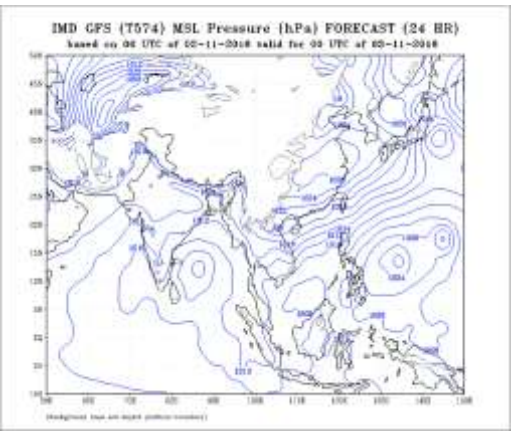

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 02-11-2016 valid for 0000 UTC of 04-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

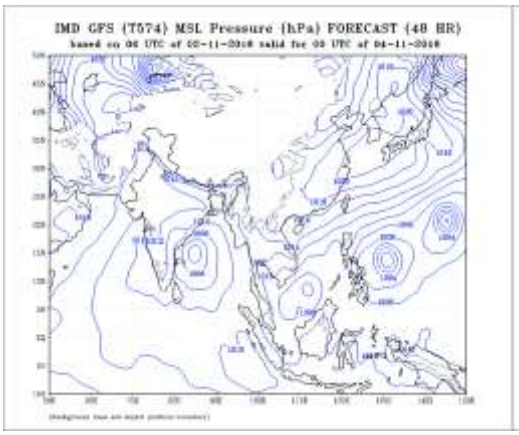

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 02-11-2016 valid for 0000 UTC of 05-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

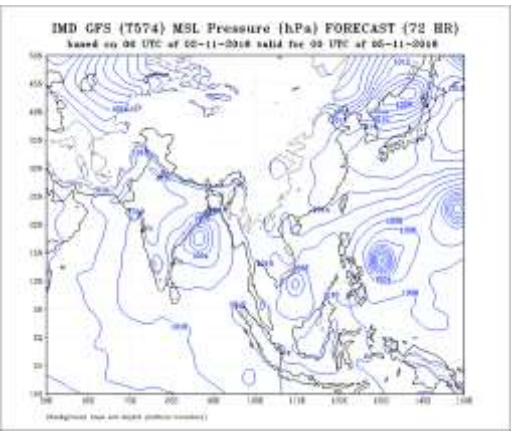

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 02-11-2016 valid for 0000 UTC of 06-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

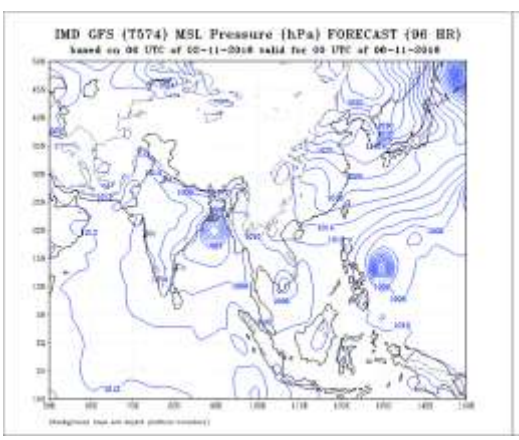

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 02-11-2016 valid for 0000 UTC of 07-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

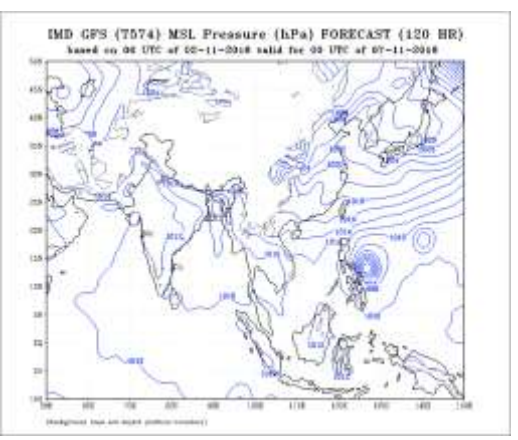

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)

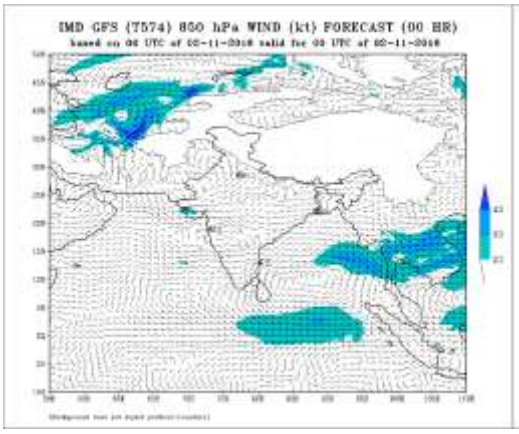

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

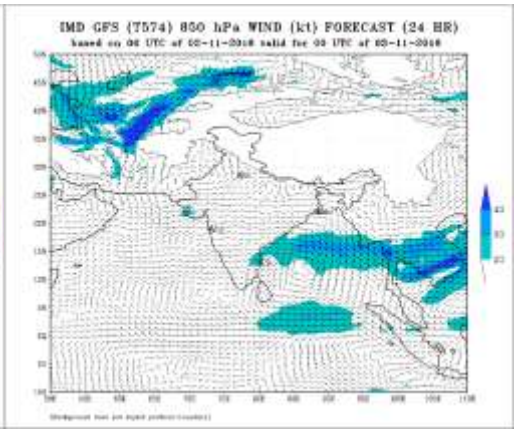

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

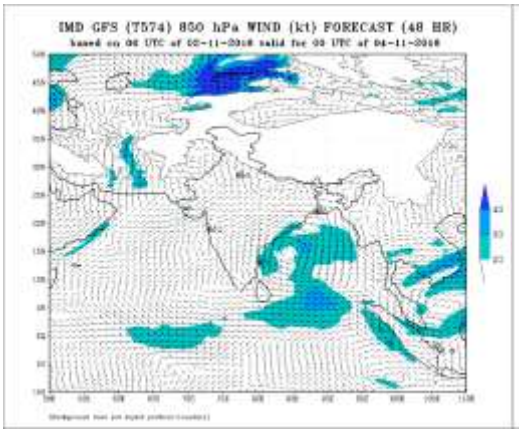

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

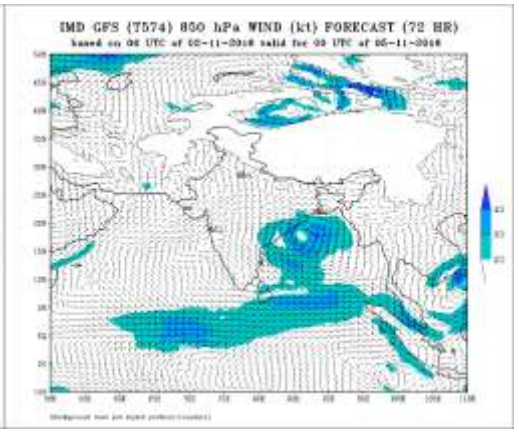

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

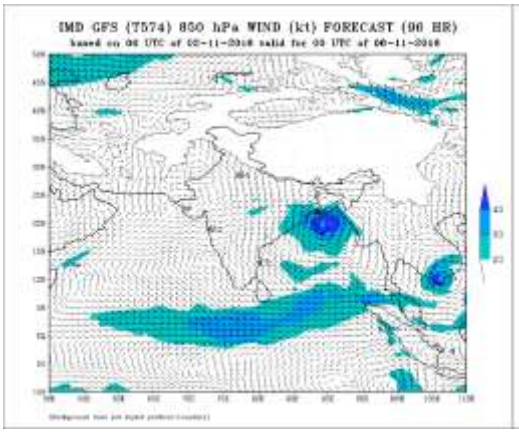

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

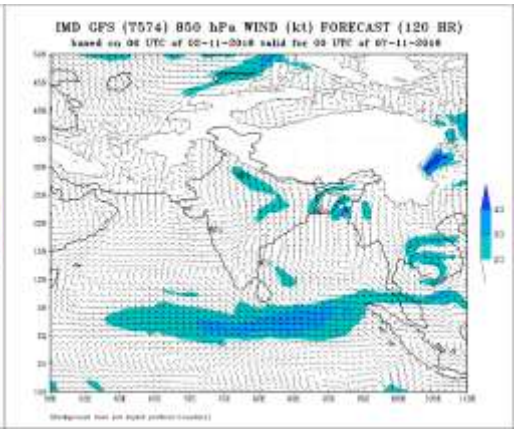

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

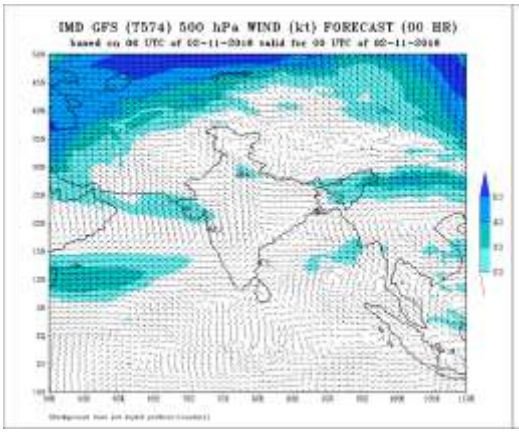

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

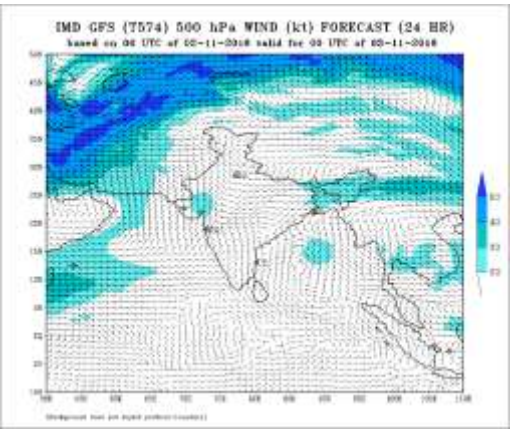

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

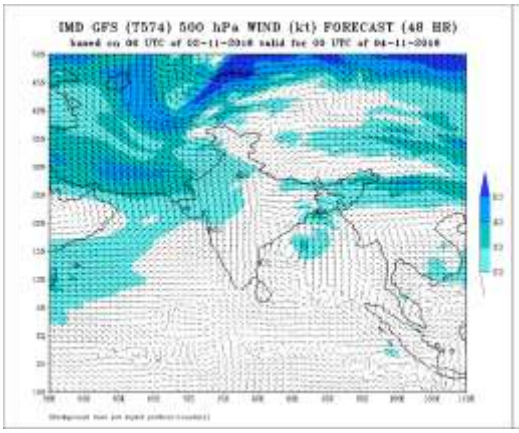

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

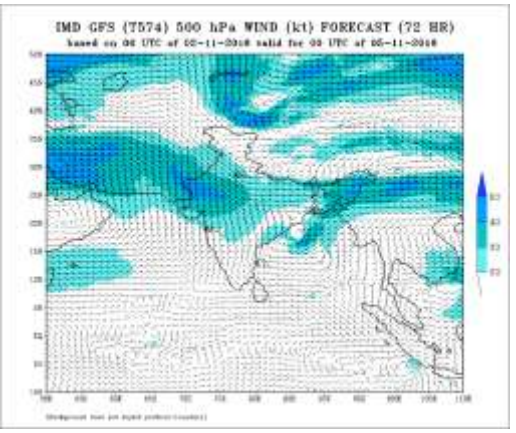

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

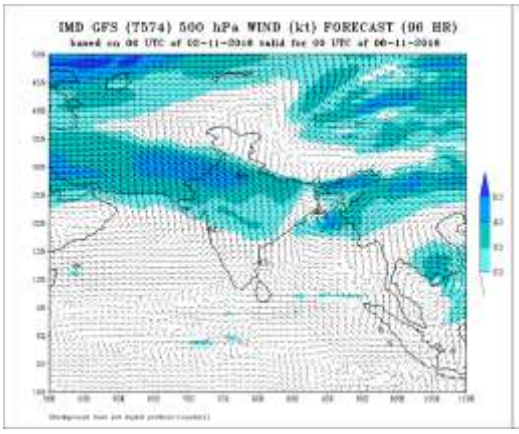

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

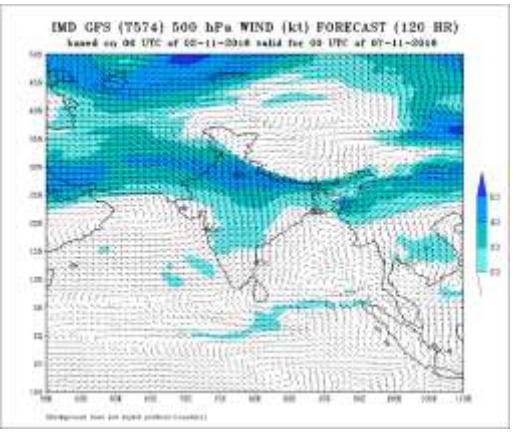

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)

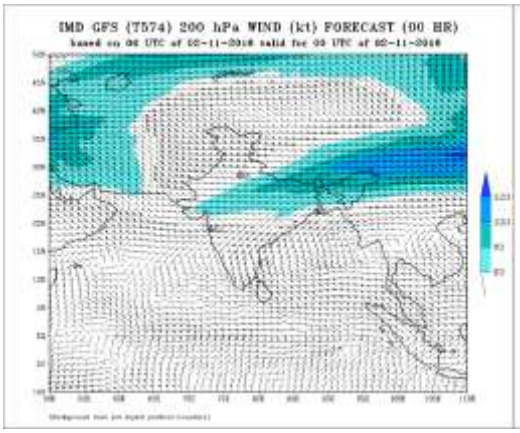

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

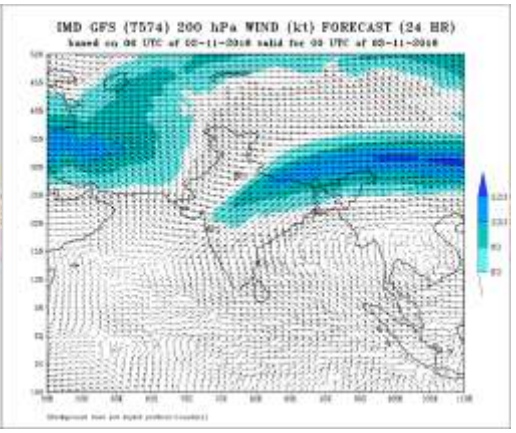

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

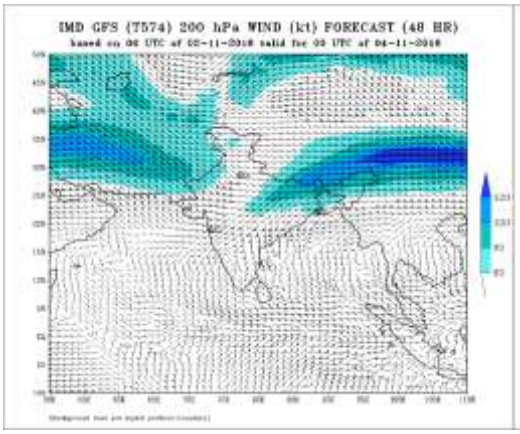

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

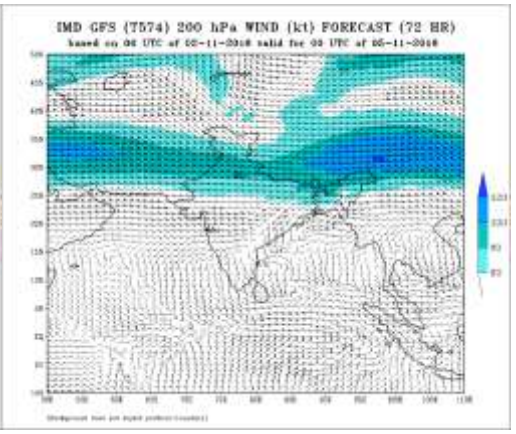

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

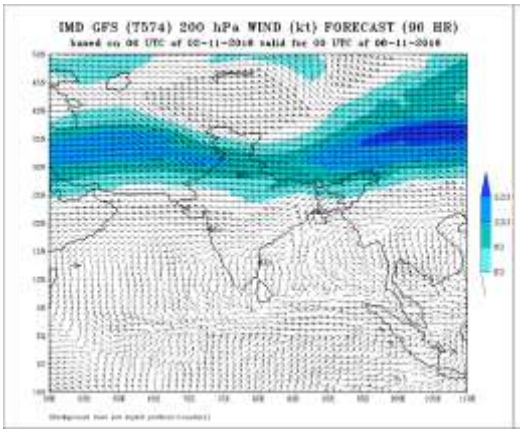

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

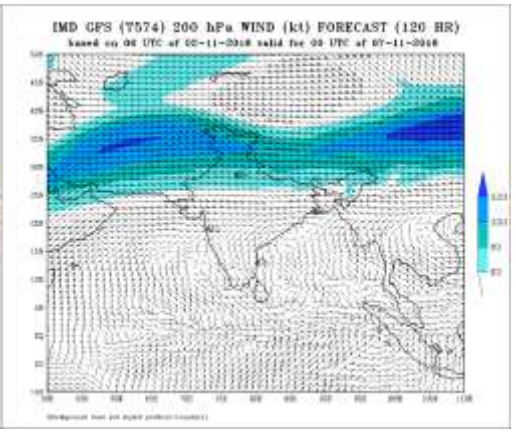

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 06 UTC of 02-11-2018 valid for 00 UTC of 02-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 06 UTC of 02-11-2018 valid for 00 UTC of 03-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 06 UTC of 02-11-2018 valid for 00 UTC of 04-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 06 UTC of 02-11-2018 valid for 00 UTC of 05-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 06 UTC of 02-11-2018 valid for 00 UTC of 06-11-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 06 UTC of 02-11-2018 valid for 00 UTC of 07-11-2018

FDP (Cyclone) NOC Report Dated 03 November, 2016

Synoptic features:

The well marked low pressure area over southeast Bay of Bengal and neighbourhood has concentrated into a Depression and lay centred at 1500 UTC (2030 hrs IST) of yesterday, the 2nd November 2016 over the same region near Lat.12.8°N/Long.88.2°E. It moved northwestwards and lies centred at 0830 hrs IST of today the 3rd November, 2016 over central and adjoining southeast Bay of Bengal near Lat. 13.5°N / Long. 86.5°E, about 570 kms southeast of Vishakhapatnam, 750 kms south of Paradip and 1020 kms south-southwest of Khepupara (Bangladesh). The system is very likely to move initially north-westwards during next 24 hours and then recurve northeastwards towards Bangladesh coast during subsequent 48 hours. It is very likely to intensify into a Deep Depression during next 24 hours and subsequently move northeastwards.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29-30˚C over most parts of Bay of Bengal except for small pockets of higher values in west central, southwest Bay and Andaman Sea. Over Arabian Sea, SST is 26-28˚C over most parts of southwest, west central and northeast Arabian Sea. It is between 28-30˚C in the remaining area.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 100 kJ/CM^2 over southern parts of south Andaman Sea. Rest of BoB, it is less than 100 kJ/CM^2. Over entire Arabian Sea, TCHP is less than 80 kJ/CM^2.

Relative Vorticity:

The low level relative vorticity is about $140x10^{-6}$ $second^{-1}$ over the system area.

Convergence:

Low level convergence is 10x $10^{-5}s^{-1}$ over the system area. There are no significant zones of positive convergence in Arabian Sea Area.

Divergence:

Upper level convergence is positive and is about 30x $10^{-5}s^{-1}$ over the system area. The area of high divergence is oriented in a southwest to northeast direction. It is about 10x $10^{-5}s^{-1}$ over southern most peninsular India and neighbouring sea area. There is no area of significant upper level divergence over Arabian Sea.

Wind Shear:

Wind shear is moderate (10-15kt) over system area in Bay of Bengal. It is low to moderate over central and adjoining south Arabian Sea. It increases to the north and south.

Wind Shear Tendency:

There is neutral tendency over system area. There is increasing tendency over southwest Bay to the south of the system.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, the vortex now lies centered within a half degree of lat 14.0^0N /85.6^0E (.) Intensity T1.5, (CTBT -86^0C). Associated broken low/medium clouds with embedded intense to very intense convection over Bay of Bengal between latitude 12.0^0N to 20.0^0N and longitude 82.0^0E to 90.0^0E.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection over Comorin area and adjoining southeast Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 17^0N latitude over BoB. Ridge at 200 hPa lies around 19^0N latitude over north Arabian Sea.

M.J.O. Index: MJO index is in Phase 4 with very less amplitude. It would move to phase 5 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 3 November 2016 shows the Depression over southwest Bay of Bengal moves northwestward direction till 4 November 2016. The model also shows intensification of the system into a Deep Depression on 4 November and into a cyclonic storm on 5 November over the west central Bay of Bengal. The track of the system shows recurvature towards northeastward direction along off north Andhra Pradesh, Odisha and West Bengal coast from 4 November and gradual weakening after 5 November 2016.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 3 November 2016 show Depression over the Bay of Bengal moves northwestward direction and intensifies into a Deep Depression on 4 November 2016 and cyclonic storm on 5 November over the west-central Bay of Bengal. The model also shows recurvature towards northeastward direction from 4 November and gradual weakening after 5 November 2016.

ECMWF: The model charts based on 00 UTC of 3 November 2016 shows Depression over the Bay of Bengal moves northwestward direction till 4 November and recurvature thereafter towards east-northeastward direction. The model also shows intensification of the system into a Deep Depression on 4 November over the westcentral Bay of Bengal and gradual weakening thereafter. The system becomes less marked over the northeast Bay of Bengal on 10 November 2016.

WRF: The WRF model analysis and forecasts based on 00 UTC of 3 November 2016 show a Depression over the southwest and adjoining southeast Bay of Bengal moves west-northwest direction during next 24 hours and recurve thereafter towards northeastward direction. The forecast also shows the intensification of the system into a cyclonic storm on 4 November, into a severe cyclonic storm on 5 November and into a very severe cyclonic storm on 6 November over the westcentral Bay of Bengal.

JMA: Model forecast for based on 03rd November 00UTC analysis shows a low over northern parts of central Bay which is seen over southern parts of west central Bay on 04th as a depression. It is seen near south Andhra coast over SW Bay on 5th November. Further it recurves and moves in a northeastward direction and intensifies into a DD on 06th over central bay.

Meteo-France ARP Model based on 03rd November 00UTC analysis indicates a well marked low over northern part of SE Bay which becomes a depression 04th over northern parts of southwest Bay and adjoining WC Bay. Continuing to move in a northwestward direction it becomes a CS on 05th November and remains as a CS over WC Bay on 6th as well.

NCMRWF-NCUM:

The analysis for 03rd November shows a low over southwest Bay which moving in a westerly direction concentrate into a depression on 04th. On 05th it moves in a northeasterly direction and becomes a deep depression over central Bay and a CS on 06th over north Bay and adjoining EC Bay. It crosses Bangladesh and adjoining Myanmar coast the same night.

NCMRWF-UM-Regional Model:

The analysis on 03rd November show a low pressure system over northern parts of SE Bay, which moving northwestwards concentrates into a depression over west central Bay on 04th November. Thereafter it moves in a east-northeastward direction and intensifies to a CS on 05th over central Bay and on 06th over EC Bay.

NCMRWF-NEPS Model:

The analysis for 03rd November 2016 shows a low over west central bay. The forecast for 04th show that the low becomes a depression over central Bay. It remains practically stationery over the region without further intensification on 05th and then moves in a northeastward direction and seen as a CS over EC Bay on 05th. Moving in northeastward direction it lies over northern parts of EC Bay and adjoining NE Bay on 6th and 7th and crosses Myanmar coast on 7th evening and becomes less marked the next day.

IITM-GEFS: N.A

IITM -GFS T1534: The 24 hour forecast valid on 03rd November based on initial conditions of 02nd show a low over SE Bay. Moving northwestward, it is seen over northern parts of SW Bay on November 04th as a depression. Further it moves in an east-northeasterly direction on 05th and becomes a CS over north Bay on 06th and crosses West Bengal and adjoining Bangladesh coast the same night.

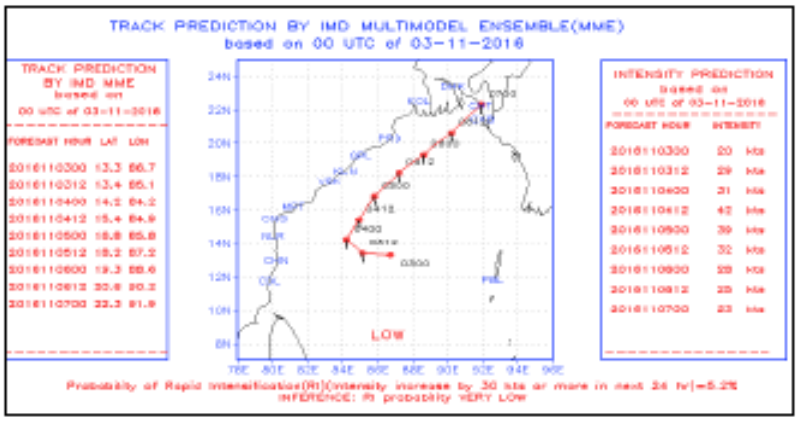
Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

GPP analysis and forecasts based on 00 UTC of 3 November 2016 shows a cyclogenesis zone over the southeast and adjoining westcentral Bay of Bengal and moves northwestward direction during next 24 hours and recurves thereafter towards northeastward direction. Forecast also shows that the zone reaches to head

Bay of Bengal on 6 November 2016 with little disorganization and crosses Bangladesh coast thereafter. Analysis and forecasts of GPP based on 0000 UTC of 3 November 2016 suggests that the Depression over the Bay of Bengal has potential to intensify into a Cyclonic Storm.

MME TRACK: MME track forecast based on 0000 UTC of 3 November 2016 shows northwestward movement of the "DEPRESSION" over the west central Bay of Bengal till 0000 UTC of 4 November 2016 and recurvature thereafter towards northeastward direction.



SCIP INTENSITY: Intensity prediction by the SCIP model shows that the "DEPRESSION" over the Bay of Bengal is likely to intensify into a Cyclonic Storm by 1200 UTC of 4 November 2016 and weakening after 0000 UTC of 5 November 2016.

RAPID INTENSIFICATION: Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 5.2% (Inference: RI probability VERY LOW).

Summary and Conclusion:

The upper tropospheric ridge runs along 17.0 ^{0}N and hence the winds are southeasterly over the region of the depression. The vertical wind shear is moderate around the system centre. It increases towards north becoming more than 20 knots to the north of 15^{0}N. The upper level divergence is about 30x10^{-5} S $^{-1}$. The lower level convergence is about 15x10-5 S $^{-1}$ around the system centre. The relative vorticity is around 150x10^{-6} S $^{-1}$. The relative vorticity, lower level convergence and upper level divergence are oriented from south-southwest to north-northeast, indicating possible recurvature of the system towards northeast after some time. The mean wind in the lower and middle tropospheric levels over the depression region is about 120/08 knots, thus indicating initial west-northwestward movement with a speed of about 15 kmph. A trough in mid-tropospheric westerlies runs along 80.0^0 E and to the north of 17.0^{0}N. It will help in steering the system towards northeast from 4th November onwards.

MJO index lies in phase 4 and will remain in same phase during next 2 days. This condition is favourable for intensification of system. Sea surface temperature is 29-30^0 C. The ocean thermal energy is about 60- 80 KJ/cm^2 around the system centre over central Bay of Bengal. It is relatively higher over west central bay of Bengal (60-80 kJ/cm^2) off north Andhra Pradesh and adjoining Odisha coast. It is less than 50 kJ/cm^2 over north Bay of Bengal.

Many models indicate intensification of the depression on 03rd into a CS on 5th except ECMWF and JMA which show the intensification upto deep depression only. While IMD WRF shows the date intensification into CS as 4th, the Meteo-France ARP model and IITM GFS (1534) show intensification into CS on 6th Nov.

Regarding movement of the system also there is continuity in the forecast by the models, however, there is disagreement amongst the model about the day of recurvature. Some models continue to show the recurvature on 4th, NEPS and IITM GFS (1534) indicate the recurvature on 5th, where as Meteo-France ARP model and NCUM regional model do not show recurvature at all.

Considering the above model guidance and diagnostic features, depression on 3rd November over south east Bay and neighbourhood is likely to intensify into a cyclonic storm on 5th November. It is very likely to move initially west-northwestward and then northwestward till 4th Nov reaching west central Bay off Andhra Pradesh Coast. Thereafter, it may recurve northeastwards skirting east coast of India. However, there is also

fair probability for weakening of the system after recurvature due to colder sea, low Ocean heat content, and increased vertical wind shear.

Advisory:

- Intense observations may be taken during 04-06th November over Andhra Pradesh, over Odisha and West Bengal coasts and 05-06 November over Bangladesh coast

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	02/12	03/00	03/03
India	40	32	46
Coastal stations			
WB	7	3	8
Odisha	7	6	7
AP	9	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	0	0
Myanmar	0	0	3
Thailand	2	2	3
SriLanka	4	4	5

AWS:

Region	Date/Time (UTC)		
	02/12	03/00	03/03
WB	4	1	4
Odisha	5	1	6
AP	7	3	7
Tamil Nadu	22	12	22
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 02 / 11 /2016 : 35/43
- **No. of Ascents reaching 250 hPa levels: 35 , MISDA:- 19**

- **RS/RW** (00Z) of 03 / 11 /2016 : 33/43

- **No. of Ascents reaching 250 hPa levels: 31 , MISDA: 6**
-

No. of PILOT Ascents

02/12Z	03/00Z
15	27

Buoy Data

02/12Z	03/00Z	03/03Z
12	12	13

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**02.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**19**	**20**	**20**

No. of RS/RW Ascents

00Z /02.11.2016 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /02.11.2016 : 4

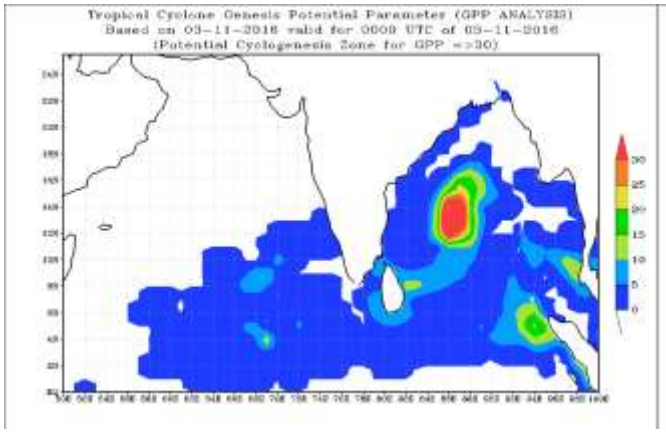
No. of Ascents reaching 250 hPa level = 4

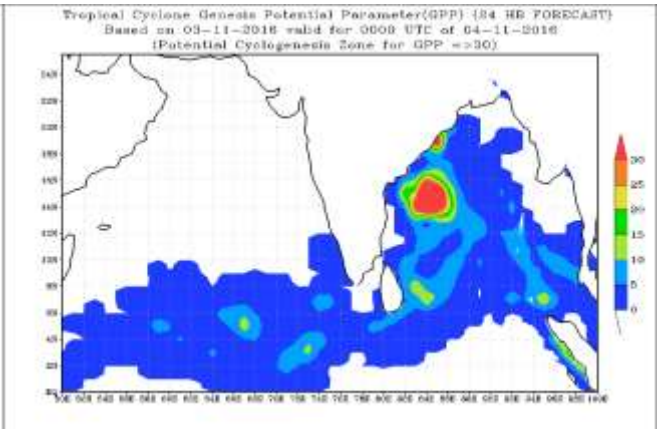
MISDA : 4

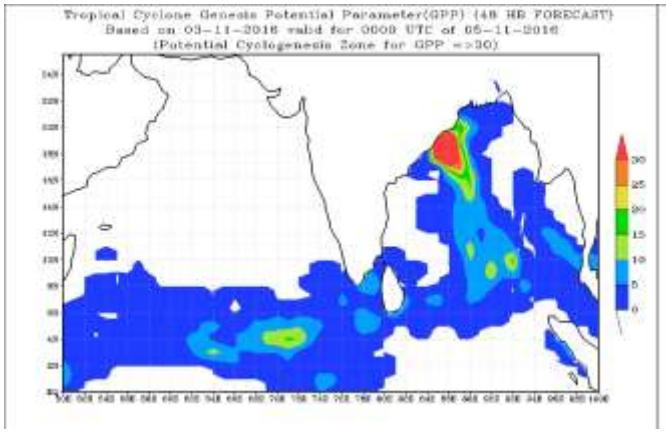
No. of PILOT Ascents:

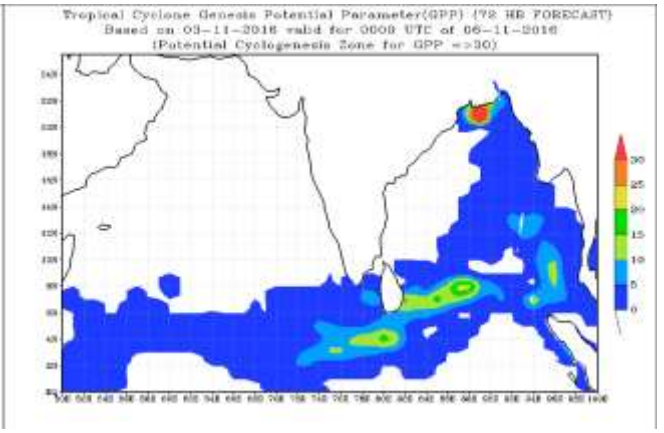
01.11.2016	
06Z	18Z
2	4

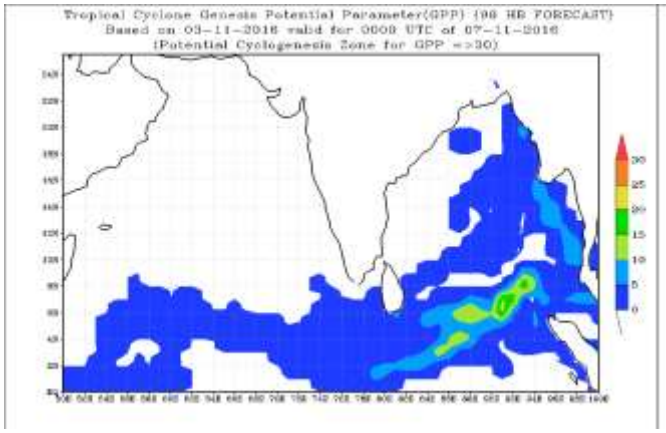
Annexure-II

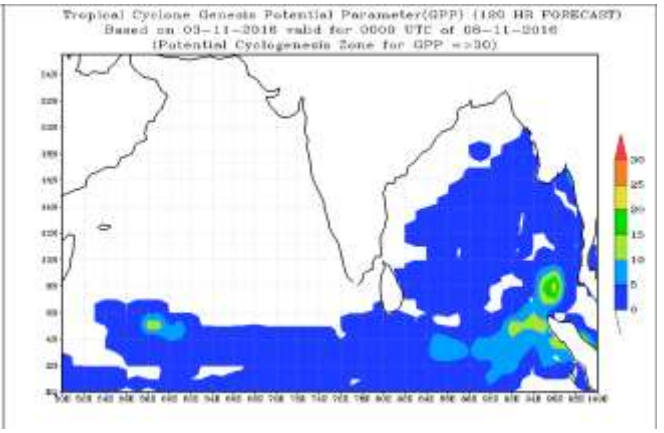

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 03-11-2016 valid for 0000 UTC of 03-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

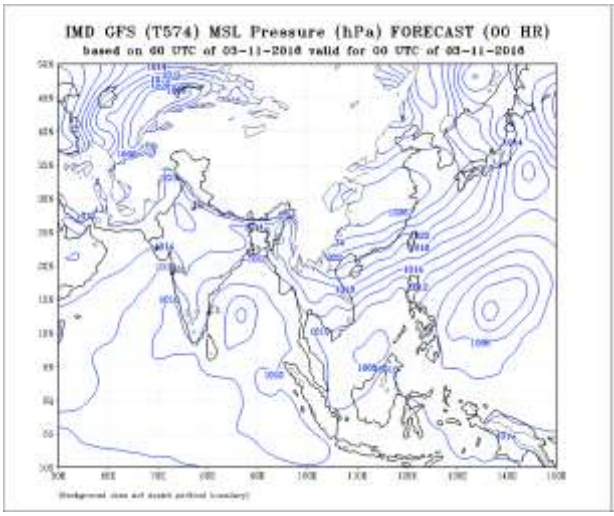

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 03-11-2016 valid for 0000 UTC of 04-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

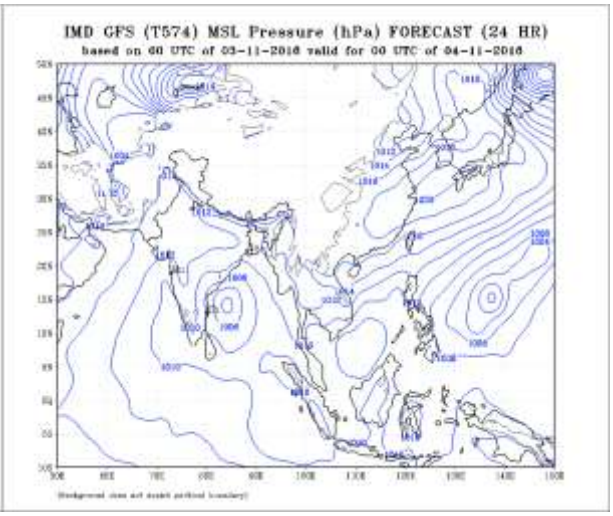

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 03-11-2016 valid for 0000 UTC of 05-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

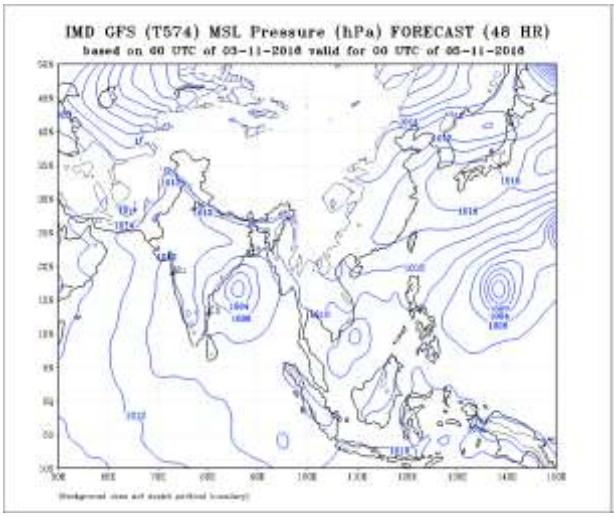

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 03-11-2016 valid for 0000 UTC of 06-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

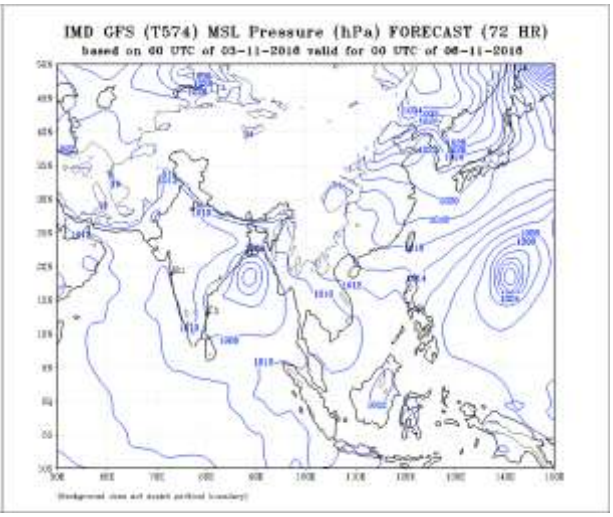

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 03-11-2016 valid for 0000 UTC of 07-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

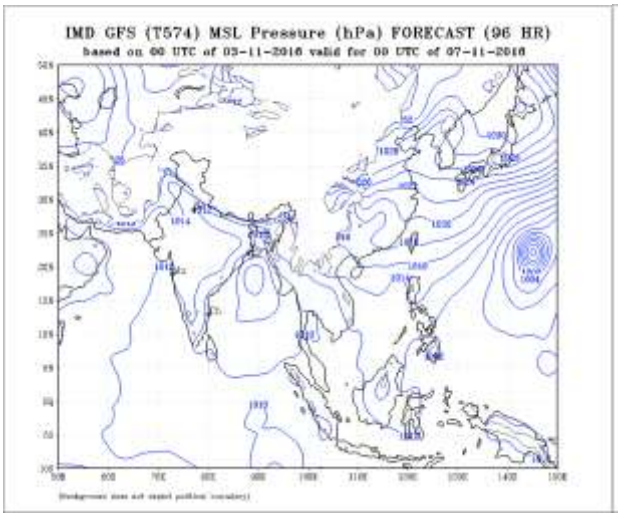

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 03-11-2016 valid for 0000 UTC of 08-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

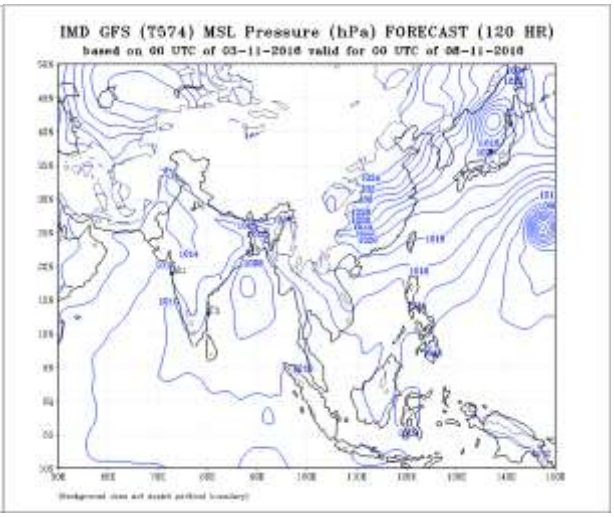

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 03-11-2016

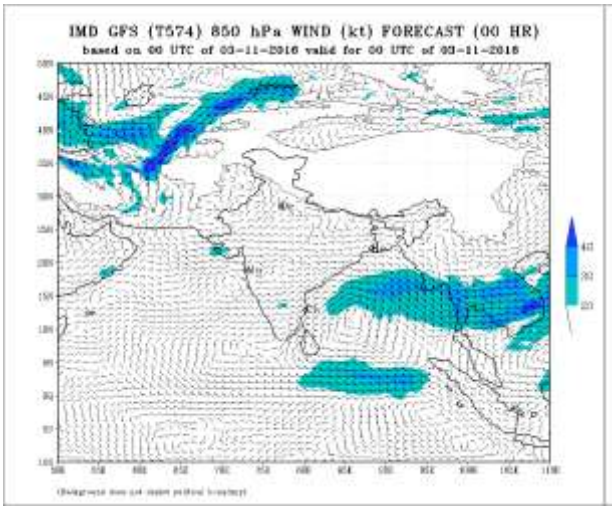

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 04-11-2016

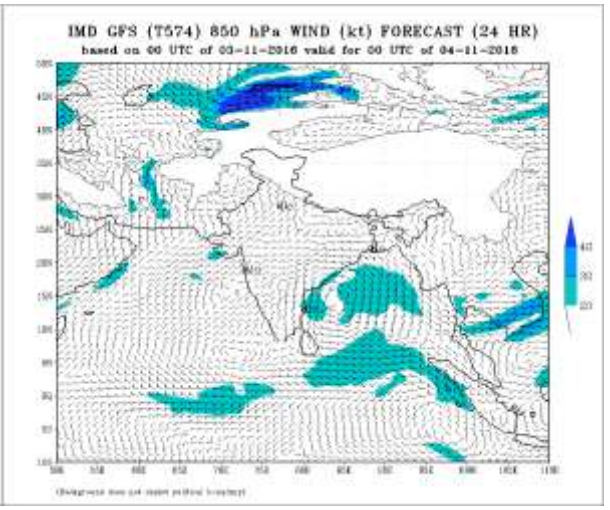

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 05-11-2016

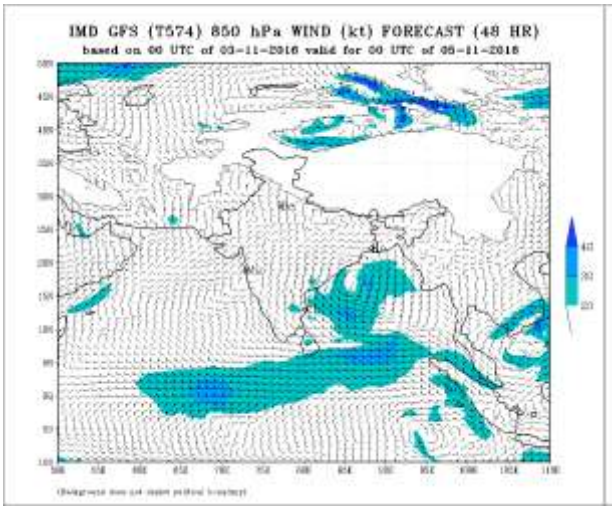

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 06-11-2016

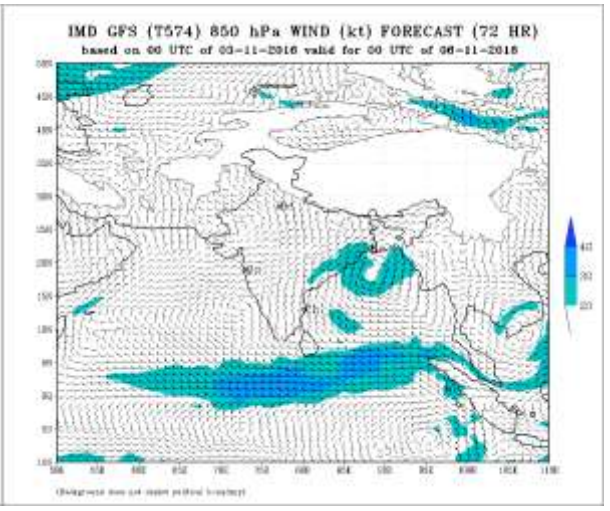

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 07-11-2016

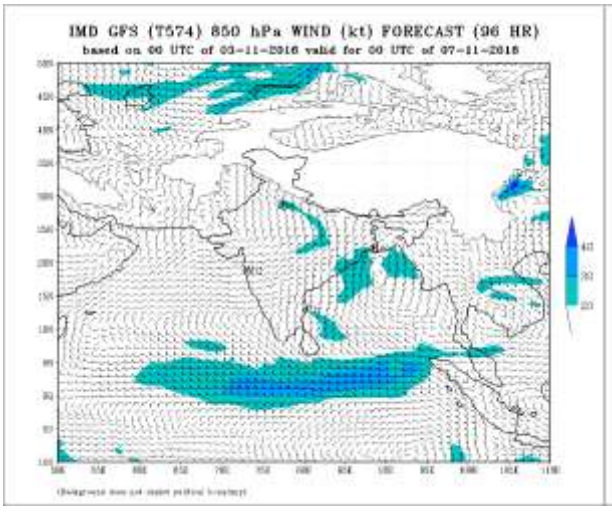

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 08-11-2016

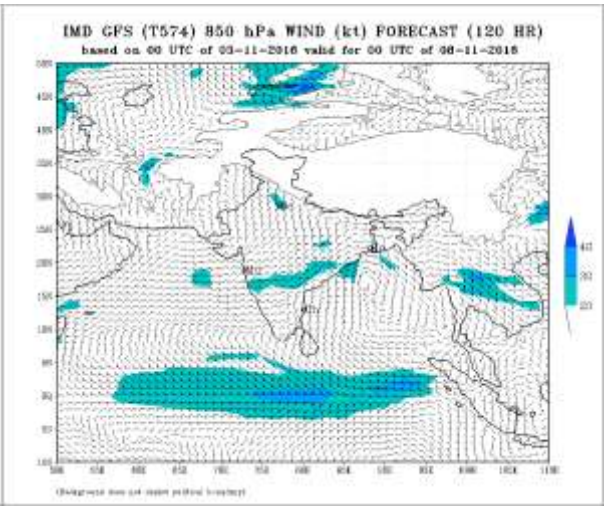

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 03-11-2016

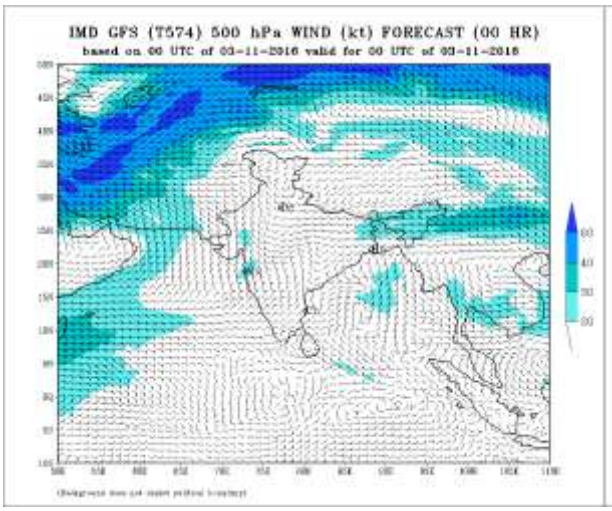

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 04-11-2016

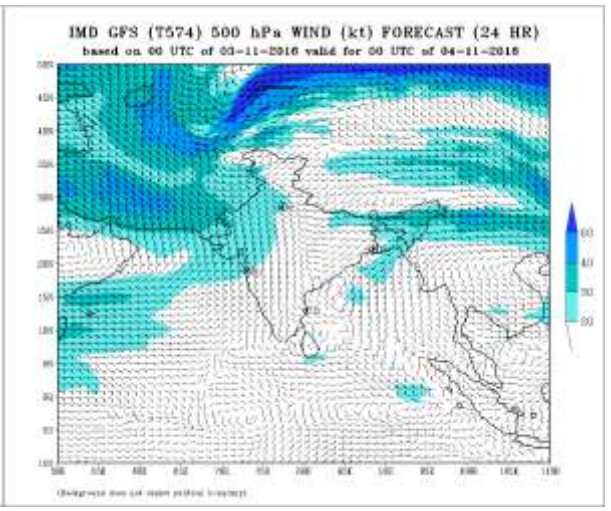

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 05-11-2016

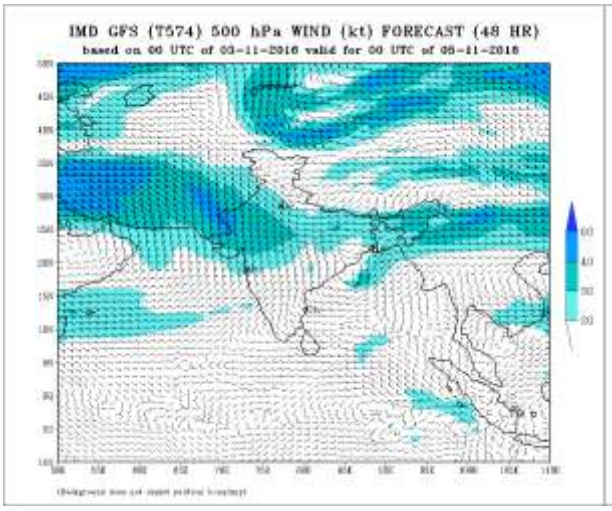

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 06-11-2016

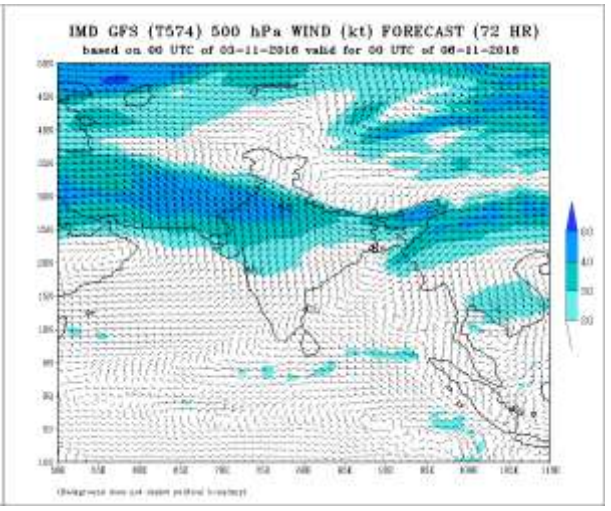

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 07-11-2016

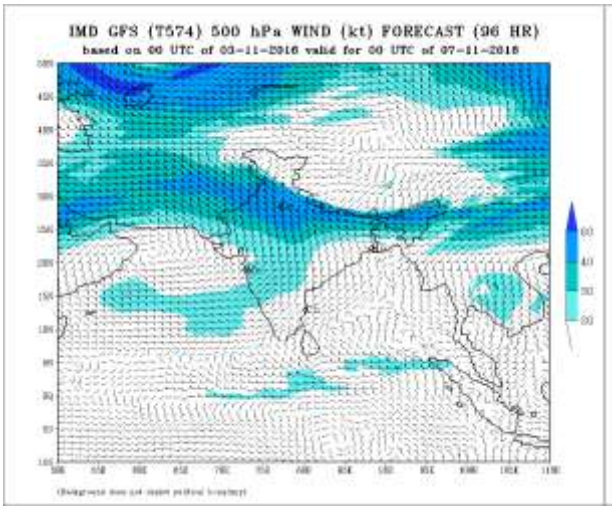

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 08-11-2016

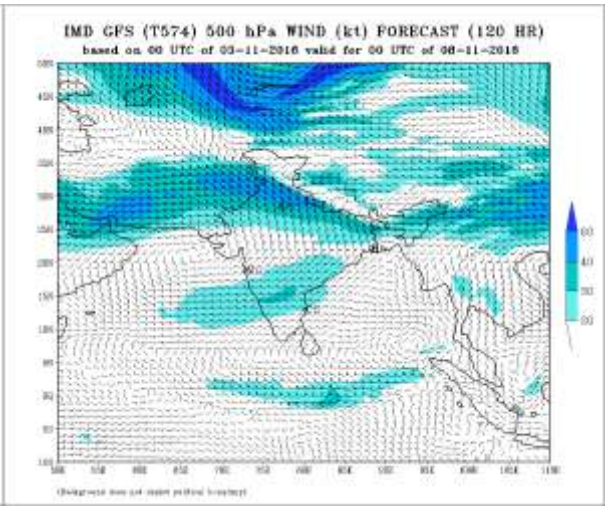

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 03-11-2016

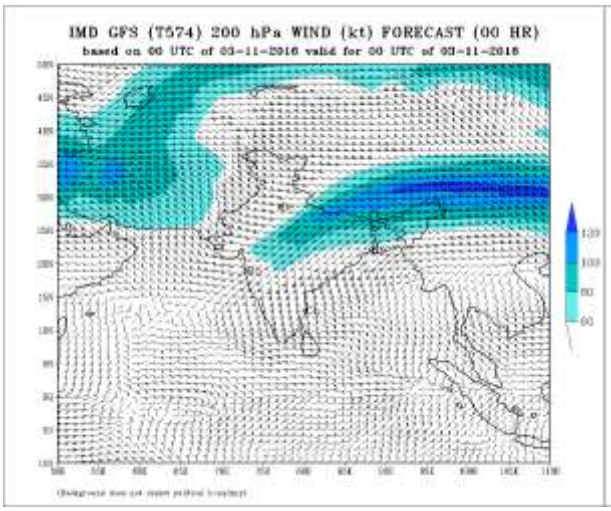

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 04-11-2016

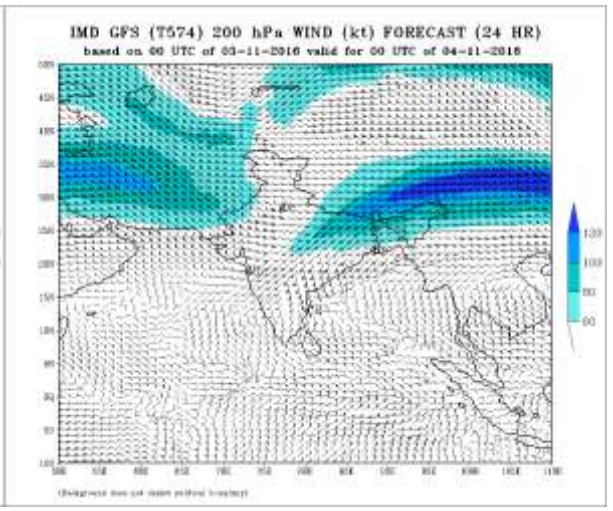

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 05-11-2016

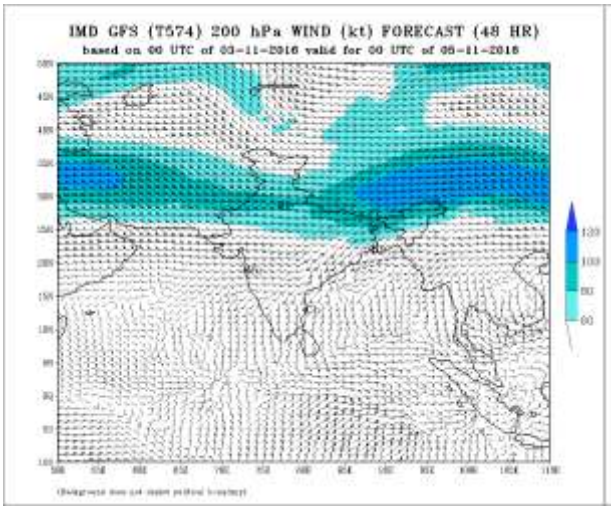

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 06-11-2016

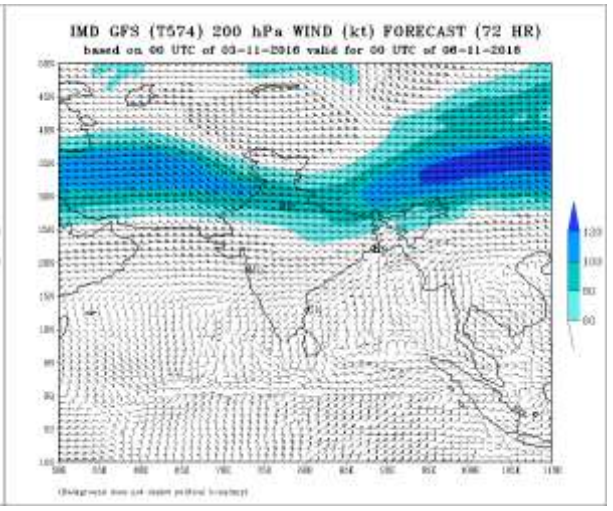

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 07-11-2016

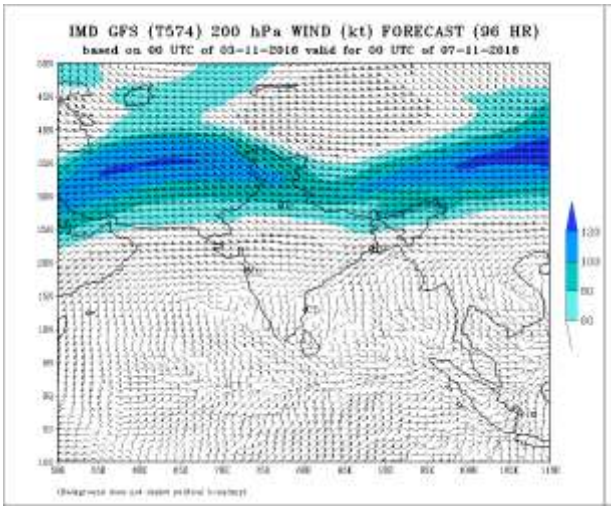

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 08-11-2016

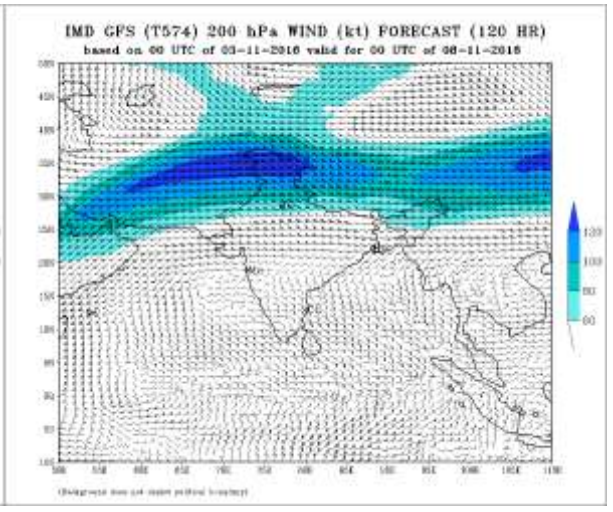

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 03-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 04-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 05-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 06-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 07-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 03-11-2016 valid for 00 UTC of 08-11-2016

FDP (Cyclone) NOC Report Dated 04th November, 2016

Synoptic features:

The Depression over central and adjoining south east Bay of Bengal moved northwestwards and lay centred at 1730 hours IST of yesterday, the 3rd November 2016 over westcentral Bay of Bengal near Lat.14.2°N/Long.85.5°E, about 450 kms south-southeast of Vishakhapatnam, 680 kms south-southwest of Paradip and 990 kms south-southwest of Khepupara(Bangladesh). It further moved north-northwestwards and lay centered at 0530 hours IST of today, the 4th Nov. 2016 over same region near Lat.15.5°N/Long.85.0°E, about 300 kms southsoutheast of Vishakhapatnam, 550 kms southsouthwest of Paradip and 900 kms southwest of Khepupara(Bangladesh). It moved north-northwestwards and now lies centered at 0830 hours IST of today, the 4th November 2016 over westcentral Bay of Bengal near Lat.16.0°/Long.84.7°E, about 240 kms southeast of Vishakhapatnam, 520 kms south-southwest of Paradip and 880 kms south-southwest of Khepupara(Bangladesh). The system is very likely to move north-northwestwards during next 6 hours and then recurve gradually northeastwards towards Bangladesh coast during subsequent 48 hours. It is very likely to intensify into a Deep Depression during next 24 hours. A cyclonic circulation extending up to mid tropospheric levels lies over Malaya Peninsula and neighbourhood. The trough in westerlies with its axis at 5.8 kms a. s. l persists roughly along Long.82.0°E to the north of Lat.17.0°N.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 29-30˚C over most parts of Bay of Bengal except for small pockets of higher values in west central, and north Bay. Over Arabian Sea, SST is 26-28˚C over most parts of southwest and westcentral Arabian Sea. It is between 28-30˚C in the remaining area.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 60- 80 kJ/cm^2 around the system centre over westcentral Bay of Bengal. It is relatively higher over parts of westcentral Bay of Bengal off north Andhra Pradesh & adjoining Odisha coast. It is less than 50 kJ/cm^2 over north Bay of Bengal.

Over entire Arabian Sea, TCHP is less than 80 kJ/CM^2.

Relative Vorticity:

The low level relative vorticity is about $150x10^{-6}$ $second^{-1}$ over the system area.

Convergence:

Low level convergence is 15x $10^{-5}s^{-1}$ over the system area. There are no significant zones of positive convergence in Arabian Sea Area.

Divergence:

Upper level convergence is positive and is about 20x $10^{-5}s^{-1}$ over the system area. The area of high divergence is oriented in a south-southwest to north-northeast direction.

Wind Shear:

Wind shear is moderate (15-25kt) over system area in Bay of Bengal. It is low to moderate over central and adjoining south Arabian Sea. It increases to the north and south.

Wind Shear Tendency:

There is decreasing tendency over system area. There is decreasing tendency over central and southeast Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, the vortex now lies centered within a half degree of lat 16.2^0N /84.5^0E (.) Intensity T1.5, (CTBT -93^0C). Associated broken low/medium clouds with embedded intense to very intense convection over Bay of Bengal between latitude 15.0^0N to 20.0^0N and longitude 82.0^0E to 90.0^0E. Scattered low/medium clouds with embedded moderate to intense convection over rest of the Bay and Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded isolated moderate to intense convection over Comorin area and adjoining southeast Arabian Sea.

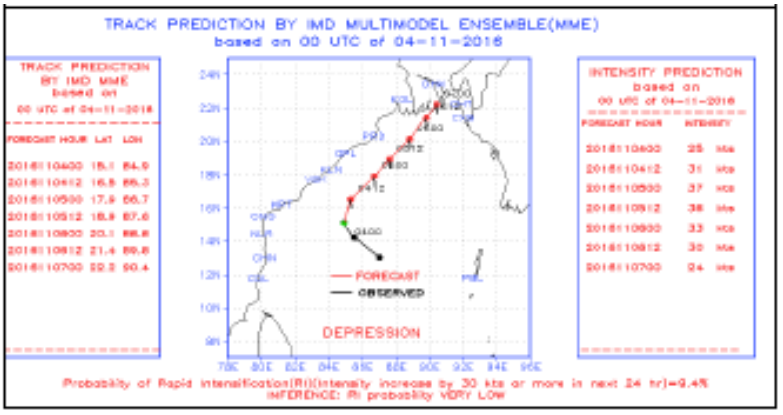
Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 17^0N latitude over BoB. Ridge at 200 hPa lies around 21^0N latitude over north Arabian Sea.
M.J.O. Index: MJO index is in Phase 4. It would move to phase 6 during next 3 days.
Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 4 November 2016 shows intensification of the Depression over the westcentral Bay of Bengal into a cyclonic storm during next 24 hours and moves northeastward direction towards Bangladesh coast and landfall around 00 UTC of 6 November 2016.
NCEP-GFS: Similar like IMD-GFS model the model charts based on 00 UTC of 4 November 2016 of NCEP-GFS also shows intensification of the Depression over the westcentral Bay of Bengal into a cyclonic storm during next 24 hours and moves northeastward direction towards Bangladesh coast and landfall around 00 UTC of 6 November 2016.
ECMWF: The model charts based on 00 UTC of 4 November 2016 shows Depression over the Bay of Bengal moves northeastward direction till 7 November but no landfall. The model also shows intensification of the system into a cyclonic storm during next 24 hours and gradual weakening thereafter.
WRF: The WRF model forecasts based on 00 UTC of 4 November 2016 show a Depression over the Bay of Bengal moves northeastward direction and intensification of the system into a cyclonic storm during next 24 hours and gradual weakening thereafter.
JMA: Model forecast for based on 04th November 00UTC analysis shows a well marked low over west central Bay moves in a northeastward direction and intensifies into a Depression on 5th over central Bay, and over central and adjoining northwest Bay on 06th.
Meteo-France ARP Model based on 04th November 00UTC analysis indicates a depression over WC Bay on 05th which moving northeastwards lies over north Bay on 6th.
NCMRWF-NCUM:
The 850 hPa wind plots from NCUM's Analysis, based on 04th Nov 2016 initial conditions show the DD near Andhra Pradesh coast in the analysis field slowly intensifies and moves NE wards and then towards Bangladesh coast on 7th November. The system weakens before crossing the coast.
NCMRWF-UM-Regional Model:
The analysis on 04th November show the low pressure system over WC Bay, while moving northwestwards concentrates into a depression over north Bay and crosses Bangladesh coast and adjoining West Bengal Coast on 07th.
NCMRWF-NEPS Model: NA
IITM-GEFS: N.A
IITM -GFS T1534: The 24 hour forecast valid on 05th November based on initial conditions of 04th show the depression over WC Bay. Moving northwestward, it is seen crossing Bangladesh and adjoining West Bengal coast on 06th.

Dynamical statistical models
IMD Genesis Potential Parameter (GPP):
GPP analysis and forecasts based on 00 UTC of 4 November 2016 shows a cyclogenesis zone over the westcentral Bay of Bengal which moves northwestward direction and no potential genesis zone after 24 hours.
Analysis and forecasts of GPP also suggests that the Depression over the Bay of Bengal has potential to intensify into a Cyclonic Storm. However it also indicates rapid decay after 12 hours.
MME TRACK:
MME track forecast based on 0000 UTC of 4 November 2016 shows north-northeastward movement of the "DEPRESSION" over the west central Bay of Bengal till 1200 UTC of 4 November 2016 and northeastward direction thereafter towards Bangladesh coast and landfall around 12 UTC of 6 November 2016.



SCIP INTENSITY:

Intensity prediction by the SCIP model shows that the “DEPRESSION” over the Bay of Bengal is likely to intensify into a Cyclonic Storm during next 24 hours and gradual weakening thereafter.

RAPID INTENSIFICATION:

Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 9.4% (Inference: RI probability VERY LOW).

Summary and Conclusion:

The upper tropospheric ridge runs along 17.0^{0}N and hence the winds are southeasterly over the region of the depression. The vertical wind shear has increased during past 24 hours and is about 15-25 kts (moderate to high) around the system centre. It increases towards north and west, becoming more than 30 knots to the north of 18^{0}N. The upper level divergence is about 20x10^{-5} s$^{-1.}$ The lower level convergence is about 15x10^{-5} s^{-1} around the system centre. The relative vorticity is around 150x10^{-6} s^{-1}. The lower level convergence and upper level divergence are oriented from south-southwest to north-northeast, indicating possible recurvature of the system towards northeast after some time. Vorticity field is oriented in north-south direction and is extending upto mid-tropospheric level. The trough in mid-tropospheric westerlies continues at same position and runs along 80.0^{0}E and to the north of 17.0^{0}N. It will help in steering the system towards northeast. MJO index lies in phase 4 with amplitude more than 1. It will move to phase 6 during next 48 hours. This condition is favourable for intensification of system. Sea surface temperature is 29-30^0 C. The ocean thermal energy is about 60- 80 kJ/cm^2 around the system centre over westcentral Bay of Bengal. It is relatively higher over parts of westcentral Bay of Bengal off north Andhra Pradesh & adjoining Odisha coast. It is less than 50 kJ/cm^2 over north Bay of Bengal.

Most NWP models show further intensification into a deep depression during next 24 hrs while a few of them are indicating the intensification of the depression into cyclonic storm. The models are unanimous about the recurvature of the system from today towards northeast skirting east coast of India. The system is expected to reach near Bangladesh coast on 6th Nov 2016 evening/night.

Advisory:

- Intense observations may be taken during 05-06th November over Odisha and West Bengal coasts and over Bangladesh coast.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	03/12	04/00	04/03
India	29	31	45
Coastal stations			
WB	7	3	8
Odisha	6	5	6
AP	9	12	12
Tamil Nadu	0	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	3	3
Myanmar	0	1	1
Thailand	2	2	2
SriLanka	5	7	8

AWS:

Region	Date/Time (UTC)		
	03/12	04/00	04/03
WB	3	1	5
Odisha	4	1	6
AP	5	4	7
Tamil Nadu	17	12	20
Puducherry	0	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 03 / 11 /2016 : 37/43
- **No. of Ascents reaching 250 hPa levels: 18 , MISDA:- 19**

- **RS/RW** (00Z) of 04 / 11 /2016 : 36/39

- **No. of Ascents reaching 250 hPa levels: 30 , MISDA: 6**
-

No. of PILOT Ascents

02/12Z	03/00Z
19	25

Buoy Data

03/12Z	04/00Z	04/03Z
11	12	12

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**03.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**21**	**20**	**20**	**22**	**20**	**20**	**20**

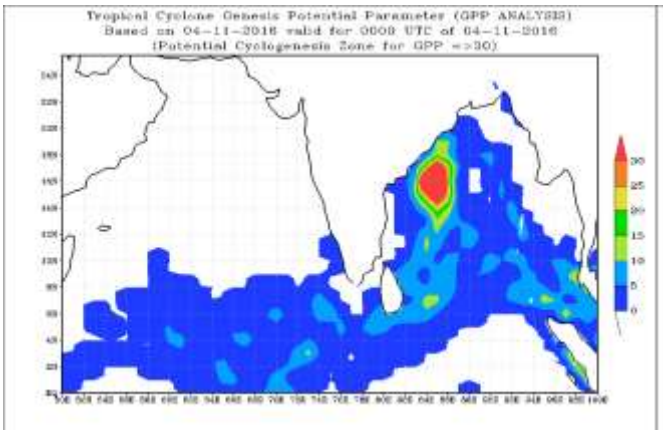
No. of RS/RW Ascents

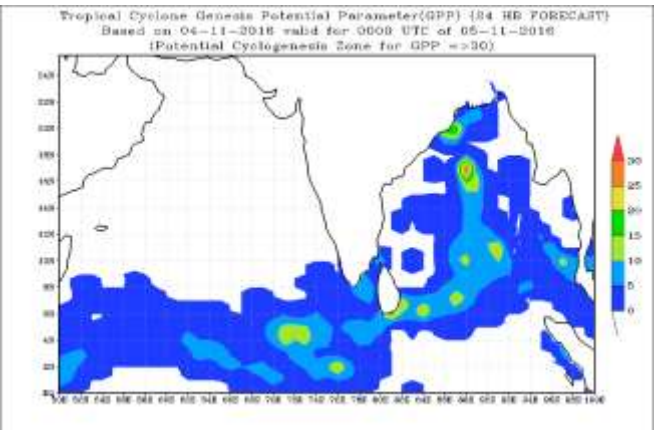
00Z /03.11.2016 : 7
No. of Ascents reaching 250 hPa level = 6
MISDA : 1
12Z /02.11.2016 : 5
No. of Ascents reaching 250 hPa level = 5
MISDA : 3

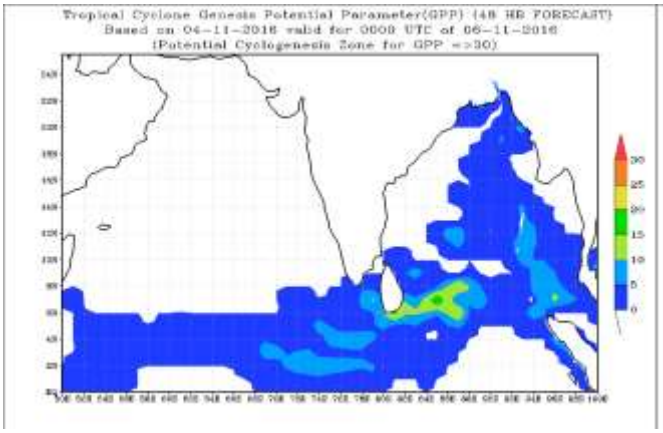
No. of PILOT Ascents:

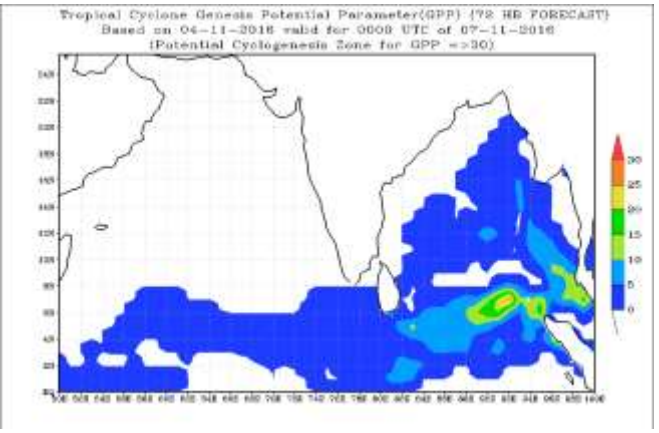
03.11.2016	
06Z	18Z
1	1

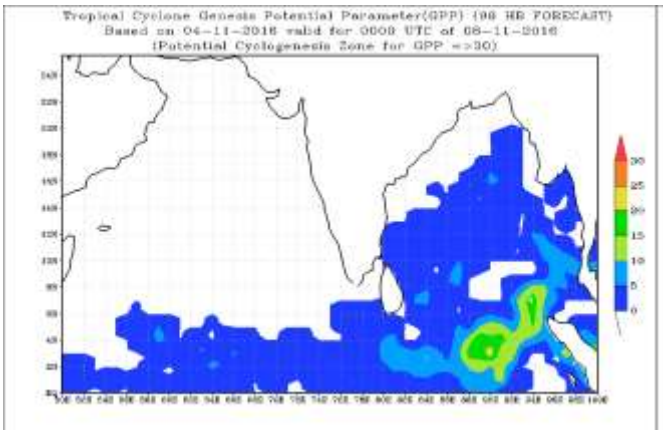
Annexure-II

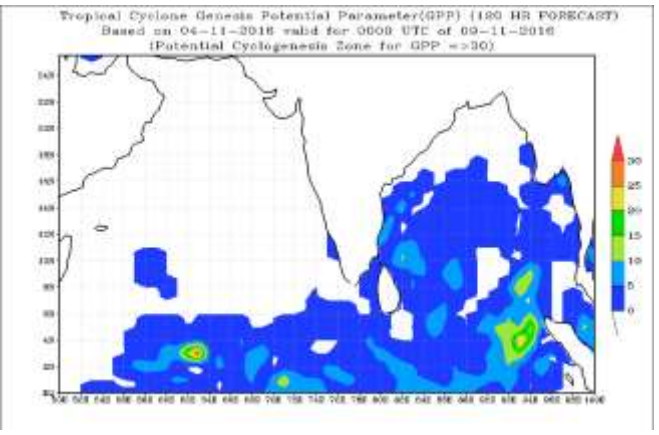

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 04-11-2016 valid for 0000 UTC of 04-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

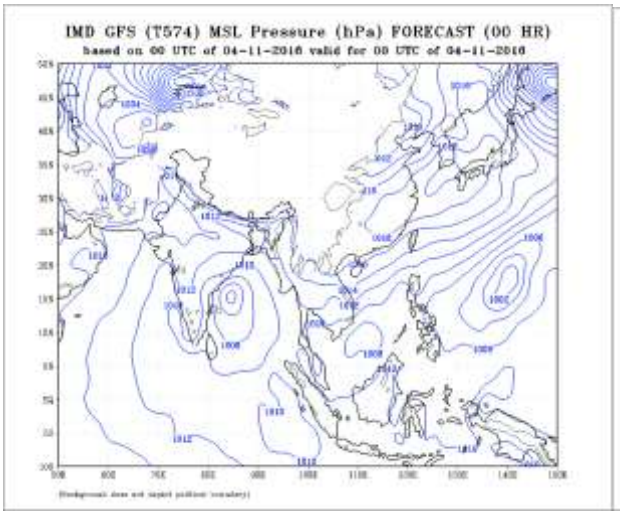

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 04-11-2016 valid for 0000 UTC of 05-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

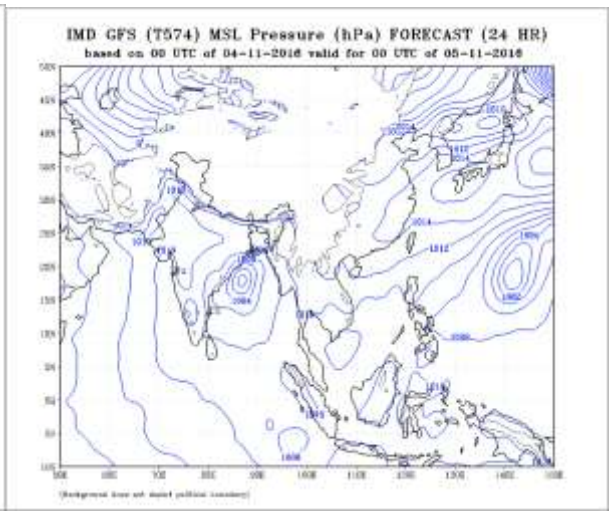

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 04-11-2016 valid for 0000 UTC of 06-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

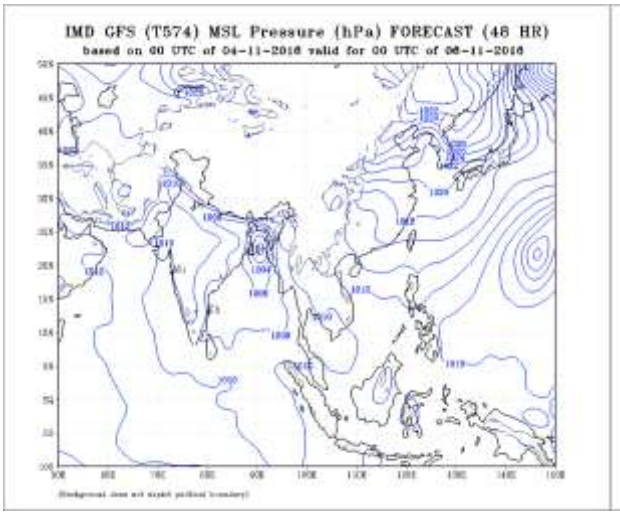

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 04-11-2016 valid for 0000 UTC of 07-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

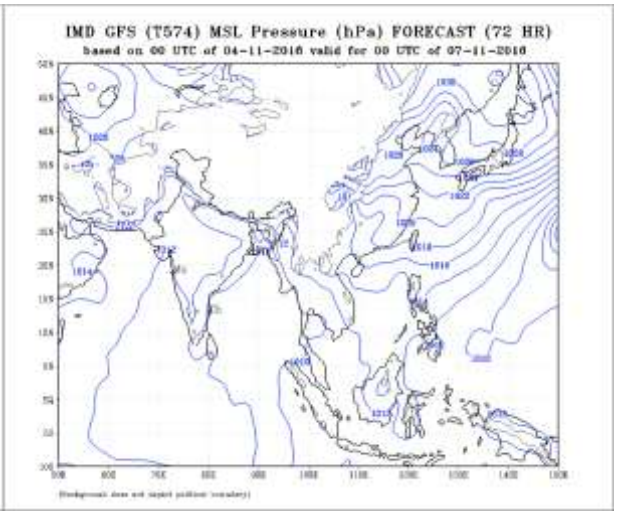

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 04-11-2016 valid for 0000 UTC of 08-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

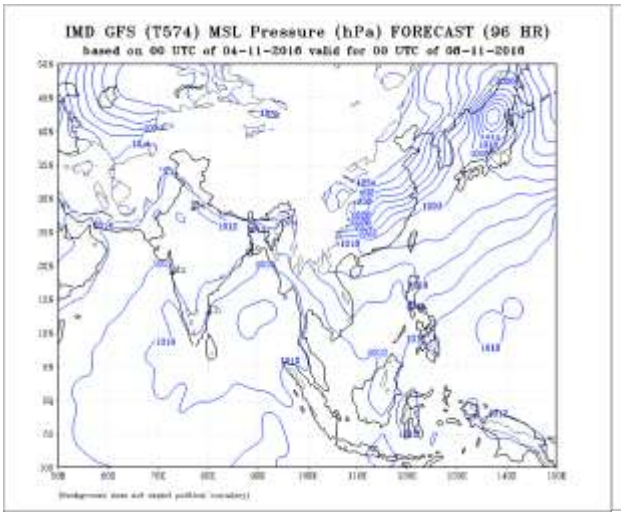

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 04-11-2016 valid for 0000 UTC of 09-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

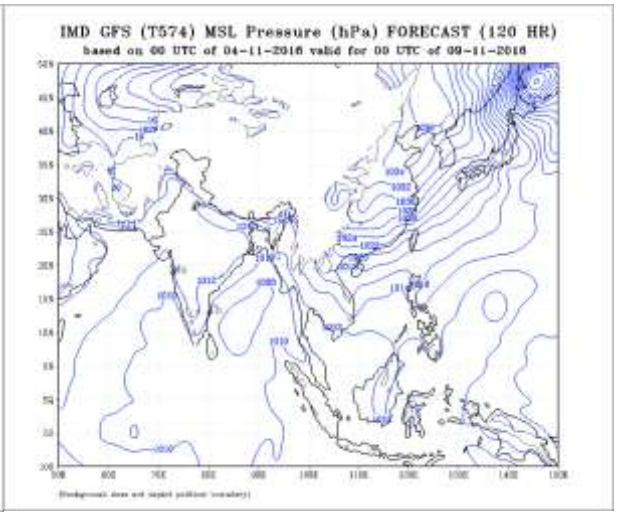

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 04-11-2016

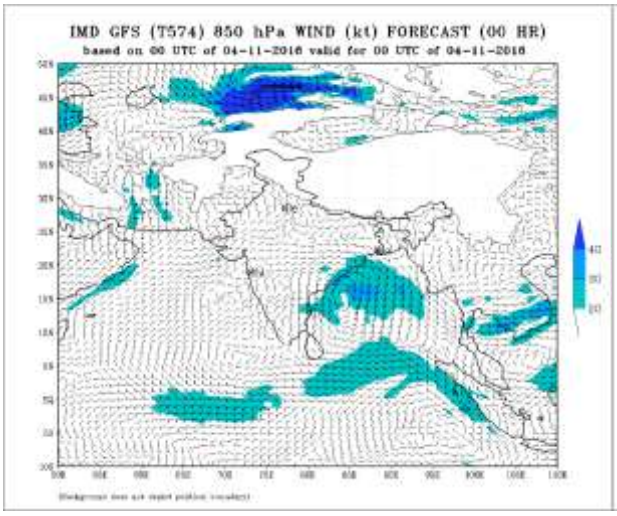

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 05-11-2016

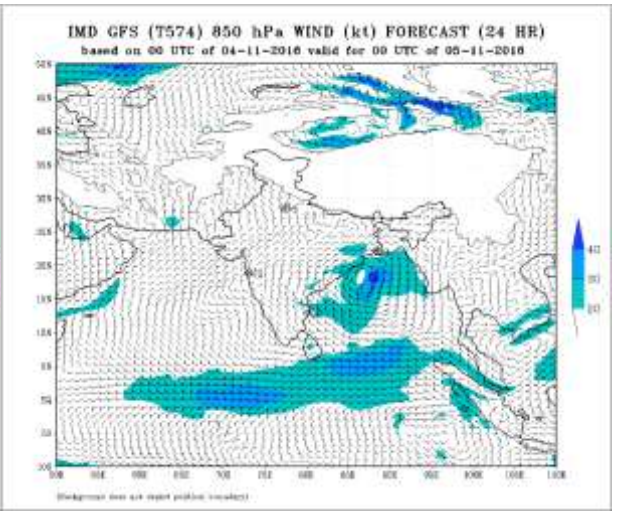

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 06-11-2016

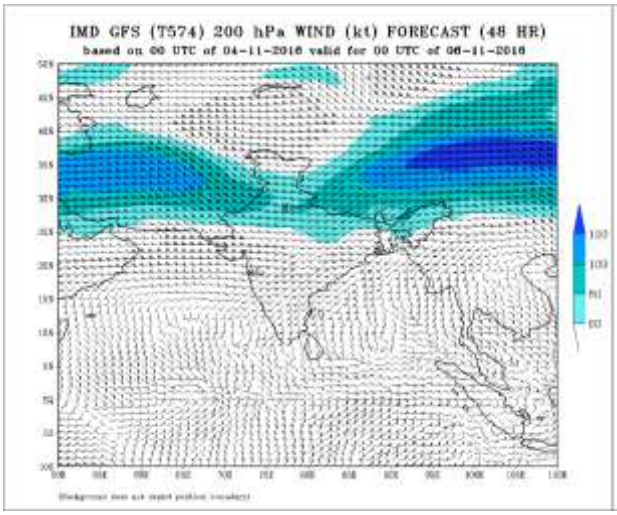

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 07-11-2016

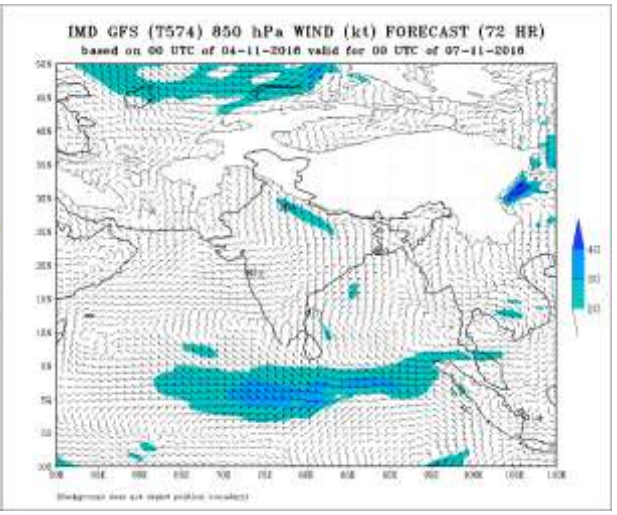

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 08-11-2016

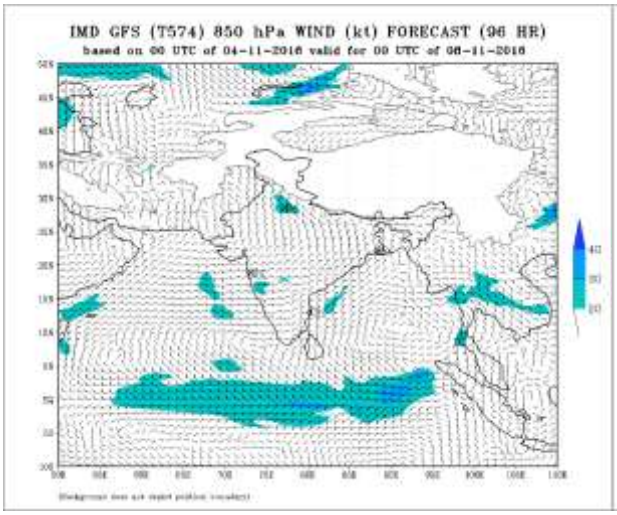

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 09-11-2016

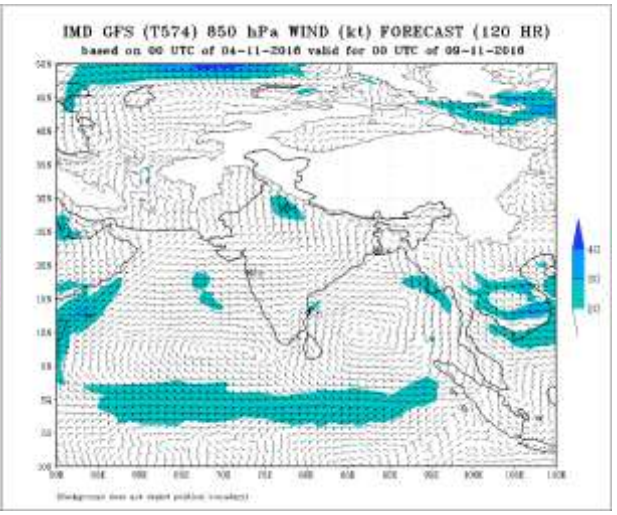

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 04-11-2016

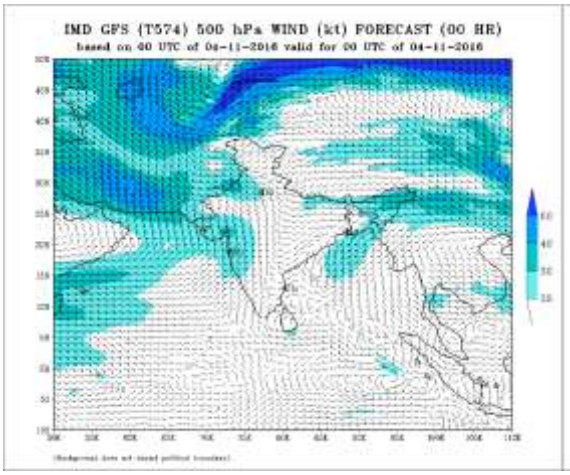

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 05-11-2016

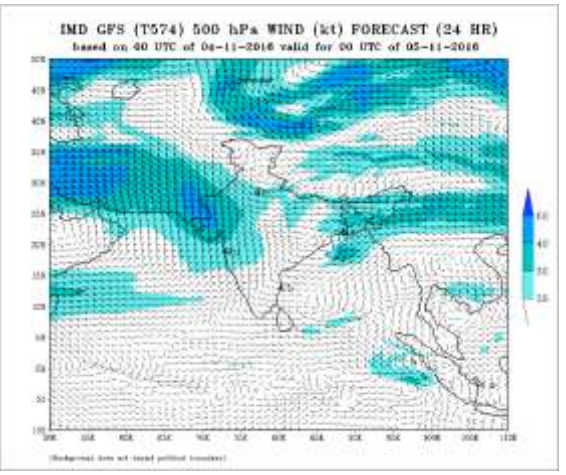

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 06-11-2016

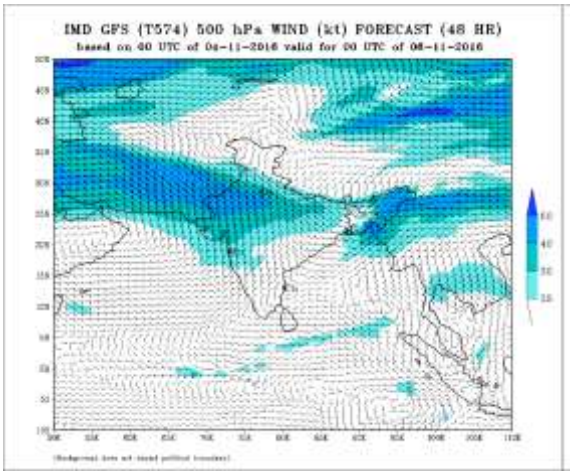

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 07-11-2016

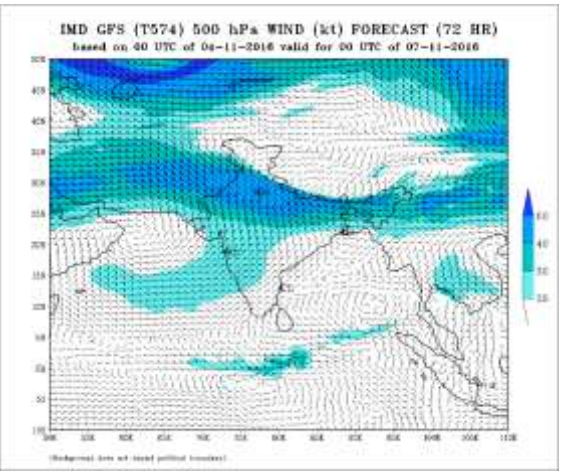

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 08-11-2016

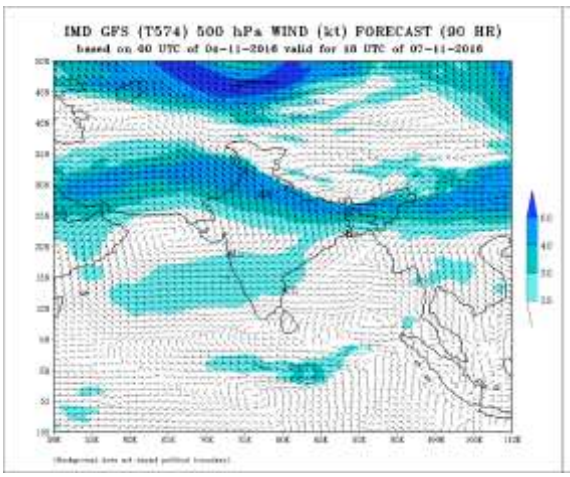

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 09-11-2016

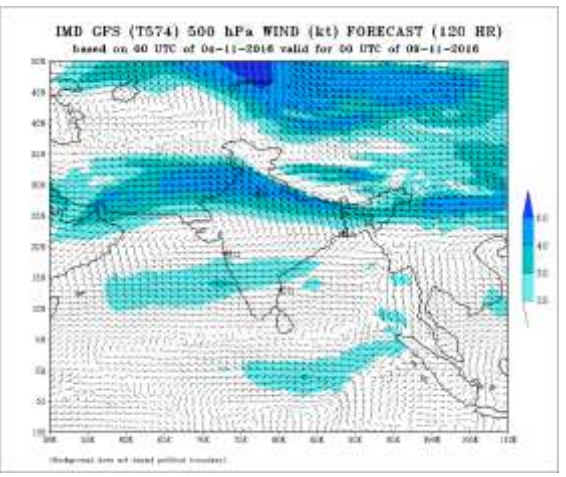

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 04-11-2016

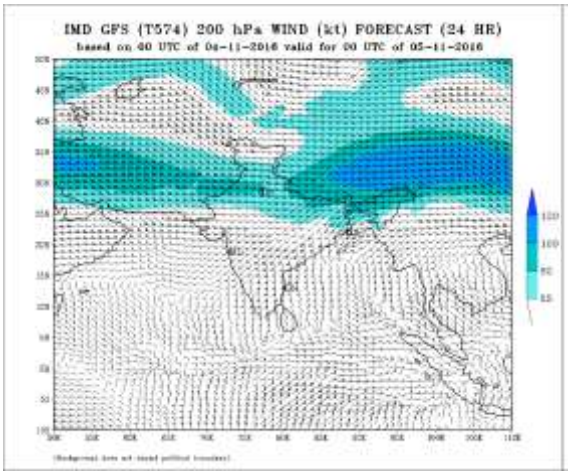

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 05-11-2016

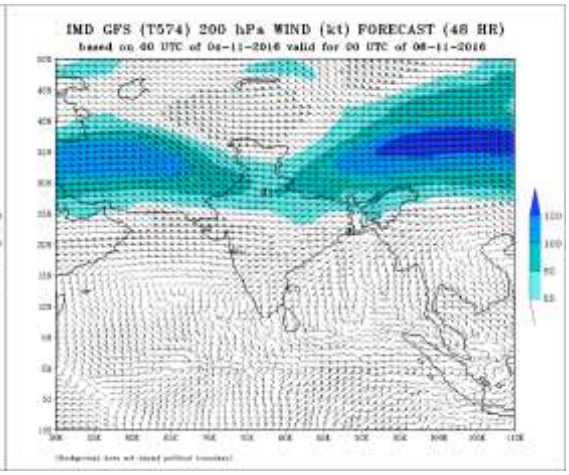

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 06-11-2016

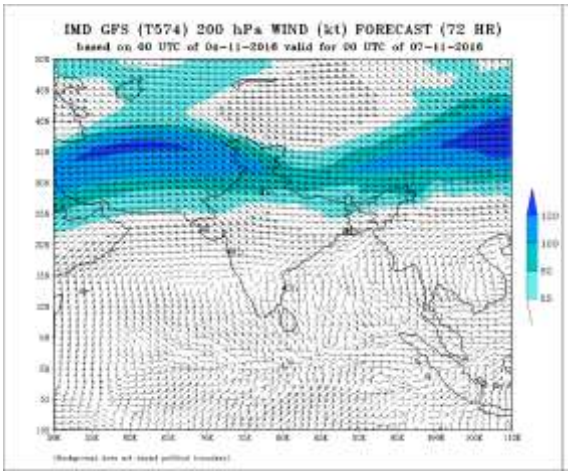

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 07-11-2016

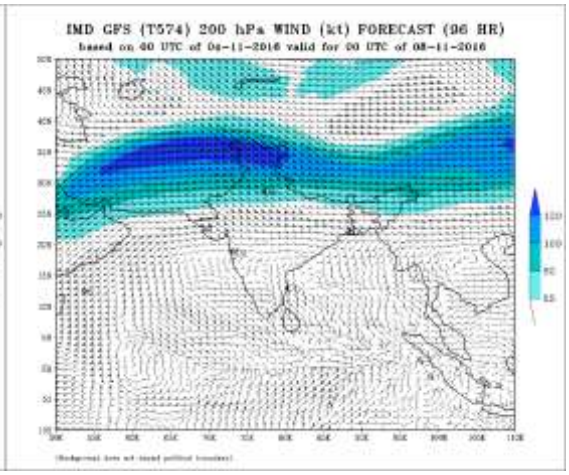

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (90 HR)
based on 00 UTC of 04-11-2016 valid for 18 UTC of 07-11-2016

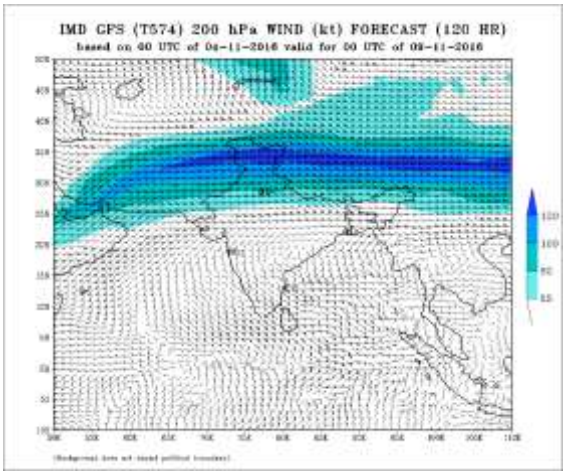

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 09-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 05-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 06-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 07-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 08-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 04-11-2016 valid for 00 UTC of 09-11-2016

FDP (Cyclone) NOC Report Dated 05th November, 2016

Synoptic features:

The Depression over westcentral Bay of Bengal moved northwards and lay centred at 1730 hrs IST of yesterday, the 04th Nov. 2016 over westcentral Bay of Bengal near Lat. 16.3º N / Long. 84.7 ºE, about 210 kms southeast of Vishakhapatnam, 490 kms south-southwest of Paradip and 850 kms south-southwest of Khepupara (Bangladesh).It moved east-northeastwards and lies centred at 0830 hrs IST of today, the 05th November, 2016 over westcentral and adjoining northwest Bay of Bengal near Lat 18.5º N / Long 87.0 ºE, about 490 km south-southwest of Kolkata, 200 kms southeast of Paradip and 510 kms south-southwest of Khepupara (Bangladesh). It is very likely to move northeastwards and cross Bangladesh coast between Long 90.0º E & 92.0º E by evening of 6th November 2016. The upper air cyclonic circulation extending up to mid tropospheric levels over Malaya Peninsula and neighbourhood persists. The trough in westerlies with its axis at 5.8 kms a. s. l now runs roughly along Long. 86°E to the north of Lat. 20°N. The system is likely to move east-northeastwards.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 29-30˚C over most parts of Bay of Bengal except for small pockets of higher values in west central, and north Bay. Over Arabian Sea, SST is 26-28˚C over most parts of southwest and westcentral Arabian Sea. It is between 28-30˚C in the remaining area.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 60- 80 kJ/cm^2 around the system centre over westcentral Bay of Bengal. It is less than 50 kJ/cm^2 over north Bay of Bengal.

Over entire Arabian Sea, TCHP is less than 80 kJ/CM^2. It is less than 50 kJ/cm^2 over north Arabian Sea, WC Arabian Sea, and western parts of SW Arabian Sea.

Relative Vorticity:

The low level relative vorticity is about $150x10^{-6}$ $second^{-1}$ over the system area. There are no significant values of relative vorticity over Arabian Sea.

Convergence:

Low level convergence is about $30x\ 10^{-5}s^{-1}$ over the system area. There are no significant zones of positive convergence in Arabian Sea Area.

Divergence:

Upper level convergence is positive and is about $30x\ 10^{-5}s^{-1}$ over the system area. There is another area of positive divergence seen over south Bay.

Wind Shear:

Wind shear is high(25-30kt) over system area in Bay of Bengal. It further increases to the north. It is low to moderate over central Arabian Sea. It increases to the north and south.

Wind Shear Tendency:

There is decreasing tendency over system area. But the tendency is positive over west central Bay and south Bay. There is increasing tendency over most parts of Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, the vortex now lies centered near lat 17.6^0N /88.0^0E (.) Intensity T1.5, (CTBT -93^0C). Associated broken low/medium clouds with embedded intense to very intense convection over south Bangladesh and over Bay of Bengal to the north of latitude 19.5^0N between longitude 86.0^0E to 92.0^0E. Broken low/medium clouds with embedded moderate to intense convection over Bay between of latitudes 5.0^0N and 19.5^0N and longitude 83.5^0E to 92.5^0E and over South Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded isolated weak to moderate convection over extreme southeast Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 17^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 4. It would move to phase 6 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 5th November 2016 shows a Depression over the westcentral Bay of Bengal and moves northeastward direction towards Bangladesh coast during the next 24 hours and makes landfall after 00 UTC of 6th November 2016.

NCEP-GFS: Similar to IMD-GFS model, the model based on 00 UTC of 5 November 2016 of NCEP-GFS also shows a Depression over the west-central Bay of Bengal and moves northeastward direction towards Bangladesh coast and but shows landfall around 00 UTC of 7 November 2016.

ECMWF: The model charts based on 00 UTC of 5 November 2016 shows a Depression over the Bay of Bengal moves northeastward direction towards Bangladesh coast and landfall around 7 November . This model also shows gradual weakening of the system during next 24 hours. The model shows the formation of a fresh low pressure system over Andaman Sea and adjoining southeast Bay by 08.09th November.

WRF: The WRF model forecast based on 00 UTC of 5 November 2016 show a Depression over the Bay of Bengal and moves northward direction towards North BOB and also shows a slight intensification of the system into a Deep Depression during next 24 hours and gradual weakening thereafter.

JMA: Model forecast for based on 05th November 00UTC analysis shows the depression over northern parts of east central Bay which moves in a northeastward direction and crosses Bangladesh coast in the morning of 07thNovember.

Meteo-France ARP Model based on 05th November 00UTC analysis indicates the depression over WC Bay on 05th moves northeastwards and crosses Bangladesh coast in the morning of 07thNovember.

NCMRWF-NCUM: N.A

NCMRWF-UM-Regional Model: N.A

NCMRWF-NEPS Model: NA

IITM-GEFS: N.A

IITM -GFS T1534:N.A

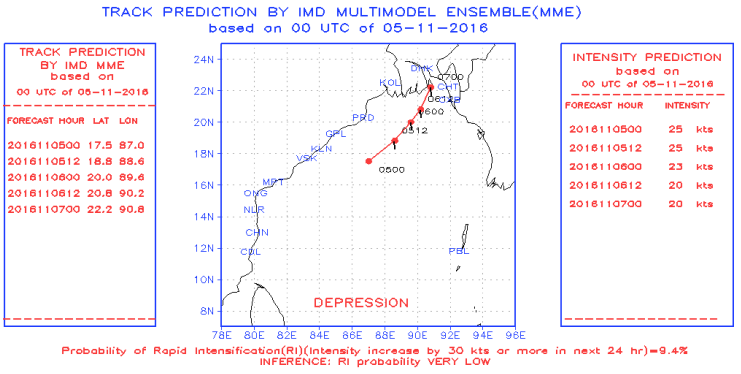
Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 0000 UTC of 5 November 2016 suggests that the Depression over the Bay of Bengal has no potential to intensify into a Cyclonic Storm

MME TRACK:

MME track forecast based on 0000 UTC of 5 November 2016 shows northeast ward movement of the “DEPRESSION” over the Bay of Bengal and landfall around 00 UTC of 7 November 2016 over Bangladesh coast.



SCIP INTENSITY:
Intensity prediction by the SCIP model shows little weakening in its current intensity till landfall of the "DEPRESSION" over the Bay of Bengal.

Summary and Conclusion:
The upper tropospheric ridge runs along 17.0^0 N. The system lies to the north of the ridge. The vertical wind shear is high (about 25-30 kts) around the system centre. It increases towards north. The upper level divergence is about $30x10^{-5}$ s^{-1}. The lower level convergence is about $30x10^{-5}$ s^{-1}. The convergence and divergence maxima lie to the northeast of the system centre. The relative vorticity is around $150x10^{-6}$ s^{-1}. The lower level convergence and upper level divergence are oriented from south-southwest to north-northeast, strengthening movement of the system towards northeast. The trough in mid-tropospheric westerlies runs along 86.0^0E and to the north of 20.0^0N. It will help in steering the system towards northeast. Sea surface temperature is 29- 30^0C. The ocean thermal energy is about 60- 80 kJ/cm^2 around the system centre over westcentral Bay of Bengal. It is less than 50 kJ/cm^2 over north Bay of Bengal. Hence with the ongoing northeastward movement, the system will gradually experience more unfavourable conditions like high vertical wind shear, low ocean heat content and more dry air incursion from northwest. Hence it is very less likely to intensify further, rather it may weaken before crossing coast. Most NWP models are in agreement with above forecast of track and intensity.

Few models are suggesting the formation of a fresh low pressure area over North Andaman Sea and adjoining south east Bay on 08/09th November 2016. The development of this fresh system needs to be monitored.

Advisory:

- Intense observations may be taken during 06th November over West Bengal coast and over Bangladesh coast.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	04/12	05/00	05/03
India	40	30	40
Coastal stations			
WB	8	5	6
Odisha	6	5	6
AP	9	9	9
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	10	10
Myanmar	0	0	12
Thailand	2	3	3
SriLanka	5	9	9

AWS:

Region	Date/Time (UTC)		
	04/12	05/00	05/03
WB	5	1	8
Odisha	6	1	9
AP	5	4	10
Tamil Nadu	23	9	28
Puducherry	0	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 04 / 11 /2016 :35/43
- **No. of Ascents reaching 250 hPa levels: 19 , MISDA:-16**

- **RS/RW** (00Z) of 05 / 11 /2016 : 27/43

- **No. of Ascents reaching 250 hPa levels:20 , MISDA:6**

No. of PILOT Ascents

04/12Z	05/00Z
18	26

Buoy Data

04/12Z	05/00Z	05/03Z
11	10	11

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**04.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /04.11.2016 : 6

No. of Ascents reaching 250 hPa level = 6

MISDA : 2

12Z /04.11.2016 : 5

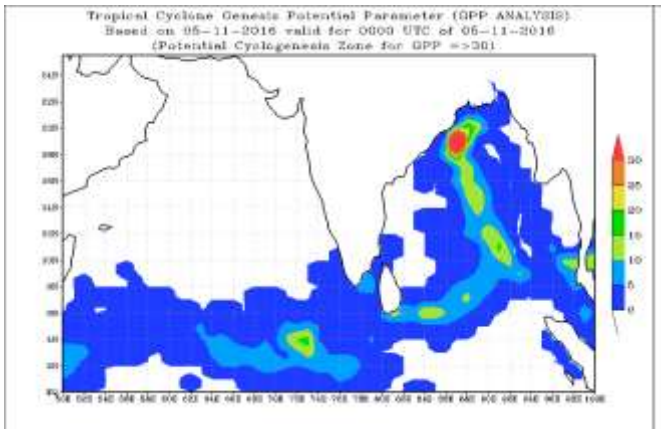
No. of Ascents reaching 250 hPa level = 5

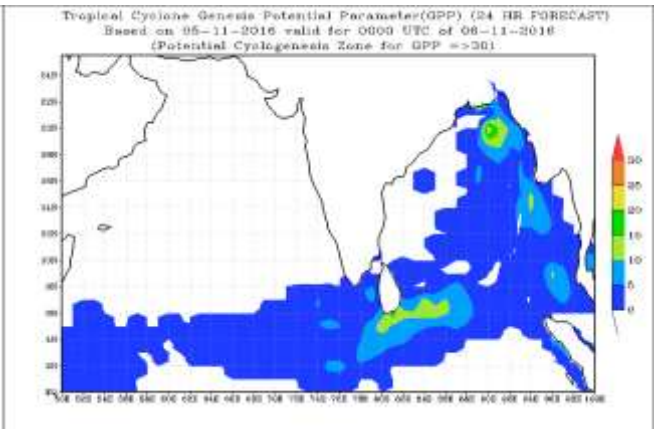
MISDA : 3

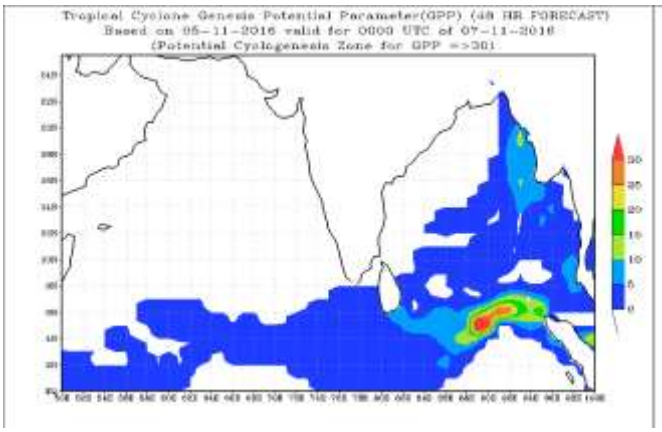
No. of PILOT Ascents:

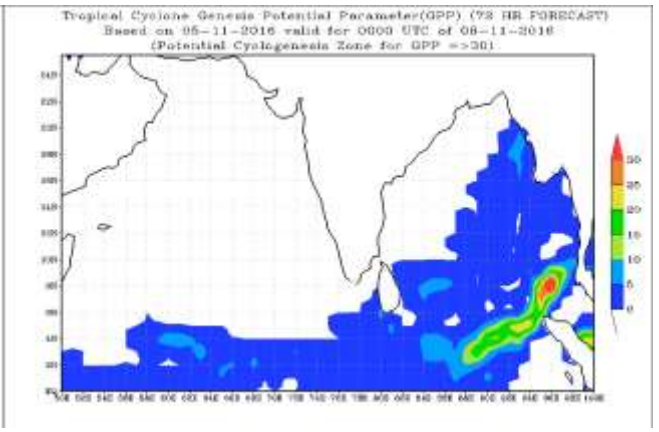
04.11.2016	
06Z	18Z
2	2

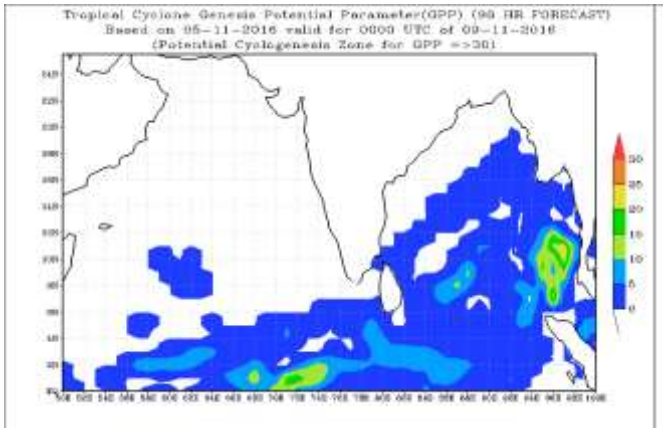
Annexure-II

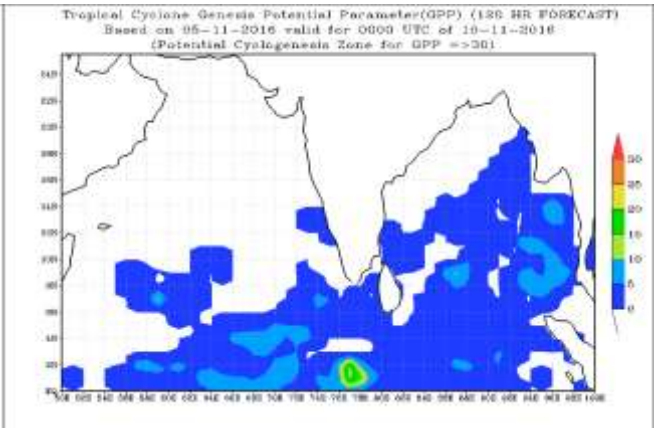

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 05-11-2016 valid for 0000 UTC of 06-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

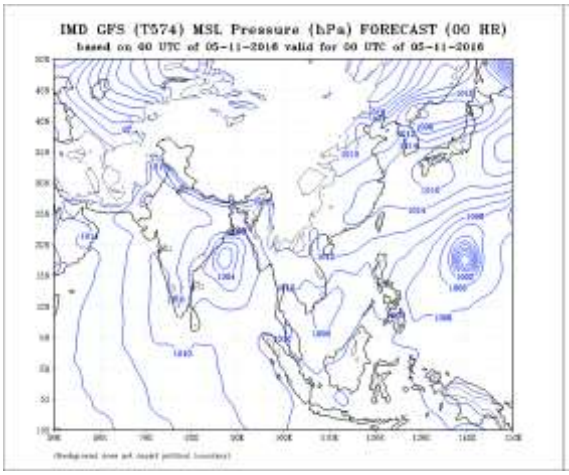

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 05-11-2016 valid for 0000 UTC of 06-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

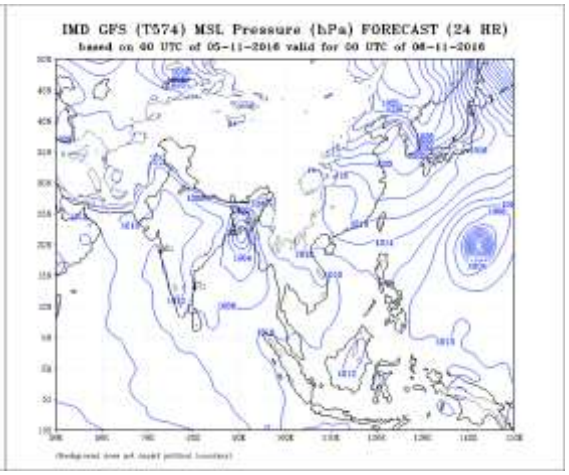

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 05-11-2016 valid for 0000 UTC of 07-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

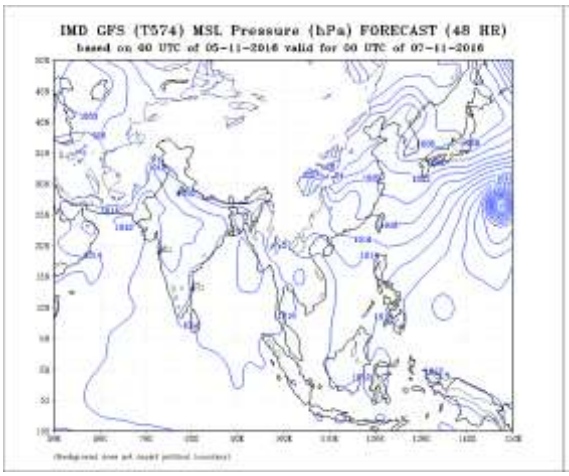

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 05-11-2016 valid for 0000 UTC of 08-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

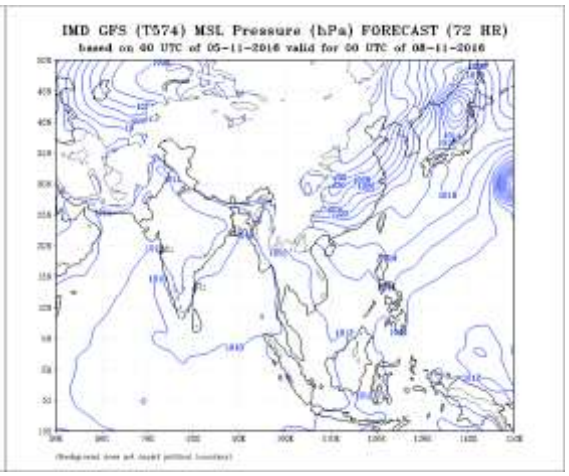

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 05-11-2016 valid for 0000 UTC of 09-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

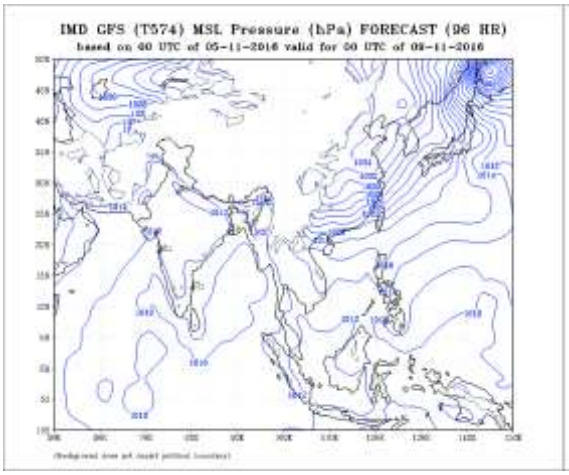

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 05-11-2016 valid for 0000 UTC of 10-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

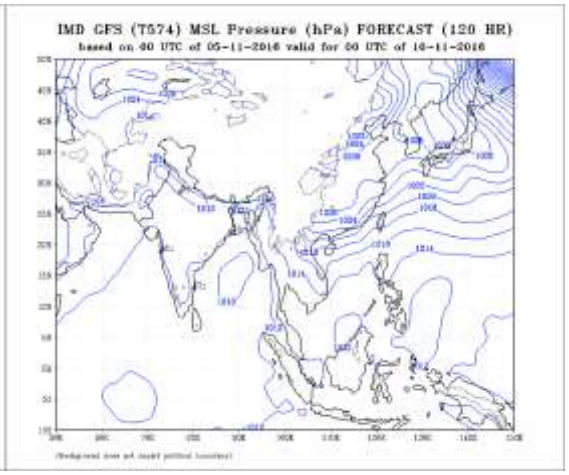

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 05-11-2016

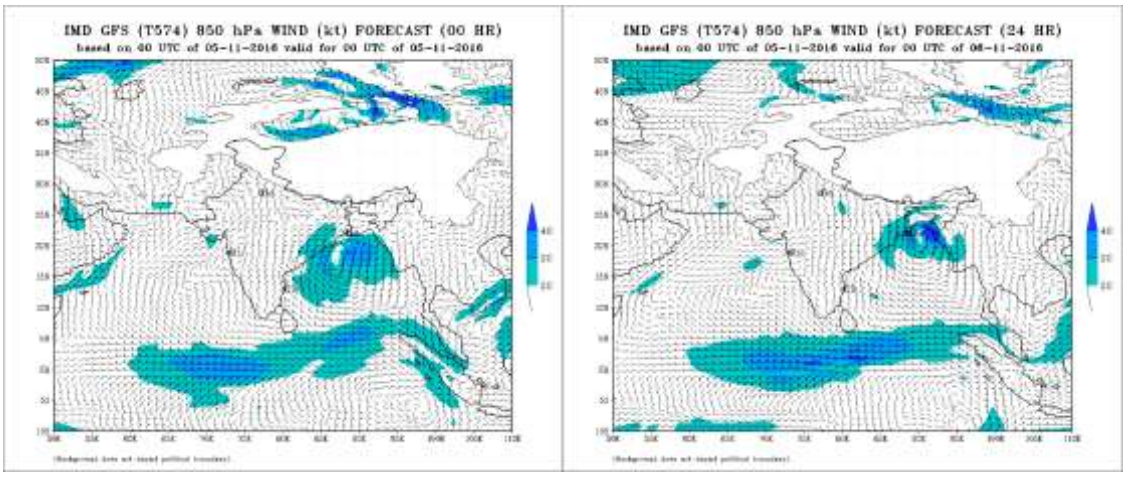

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 06-11-2016

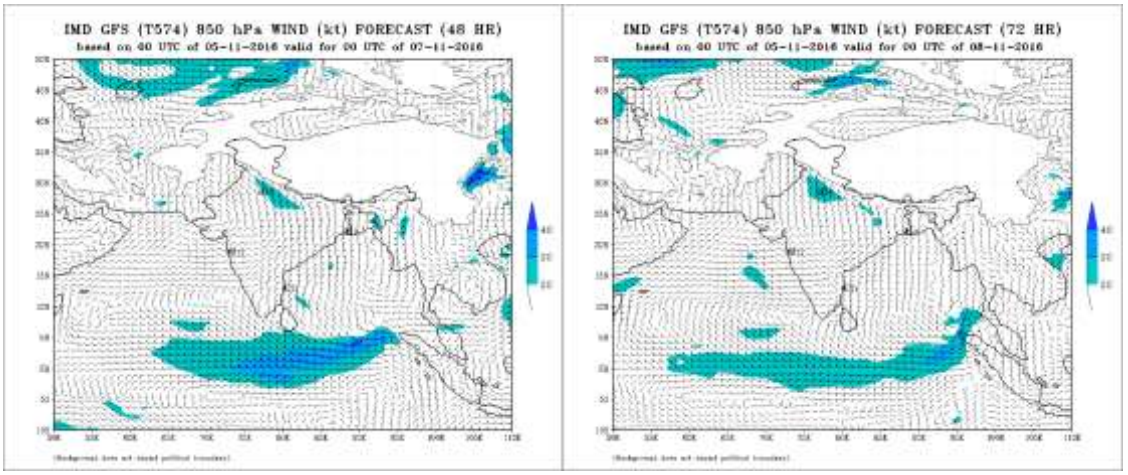

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 07-11-2016

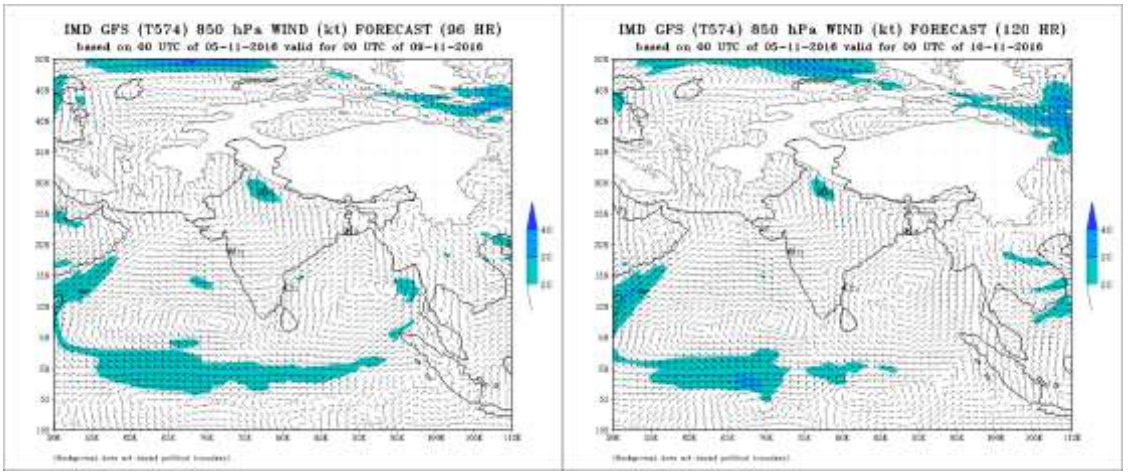

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 08-11-2016

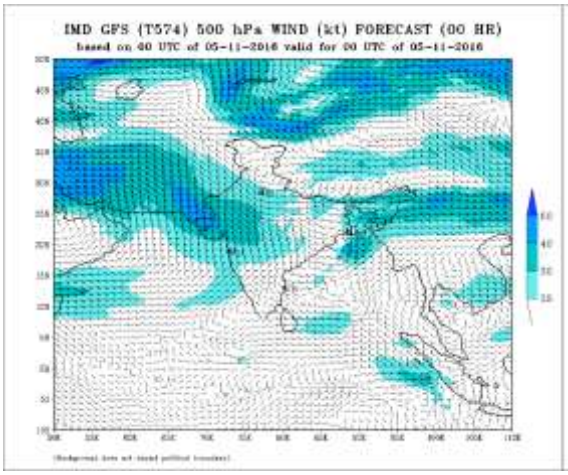

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 09-11-2016

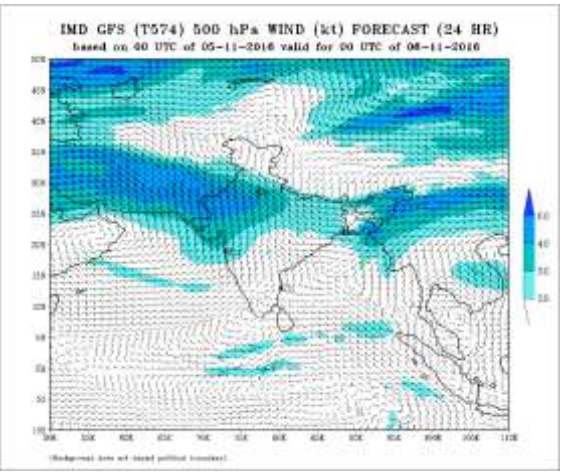

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 10-11-2016

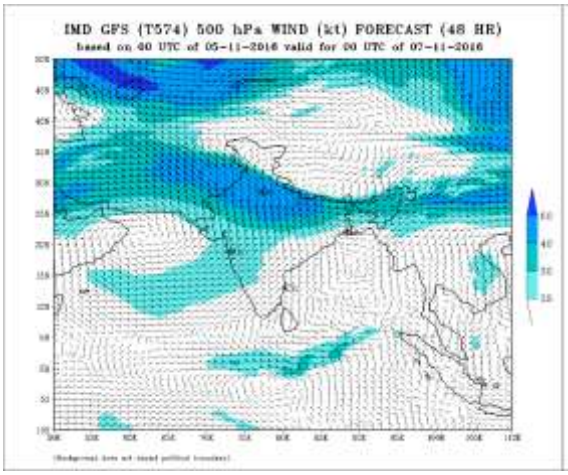

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 05-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 06-11-2016

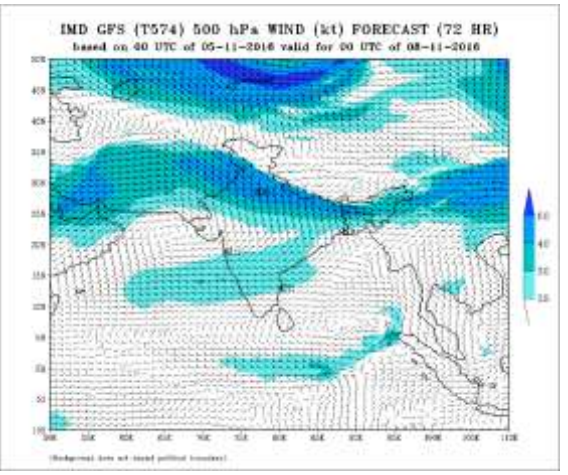

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 07-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 08-11-2016

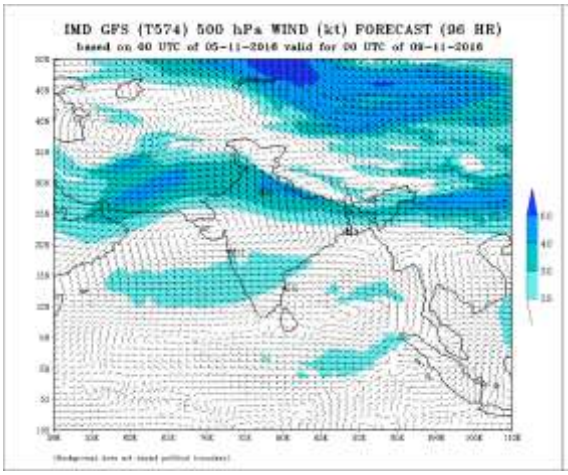

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 09-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 10-11-2016

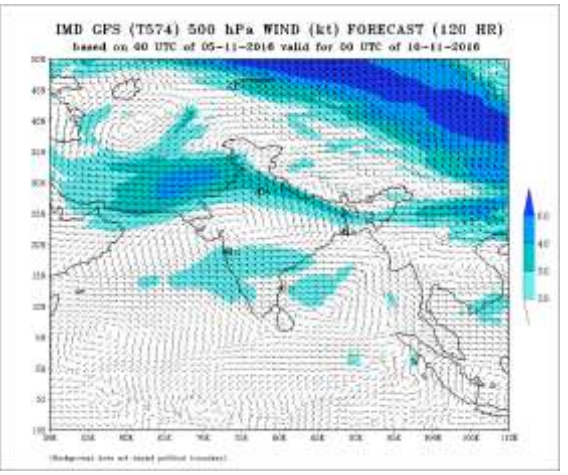

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 05-11-2016

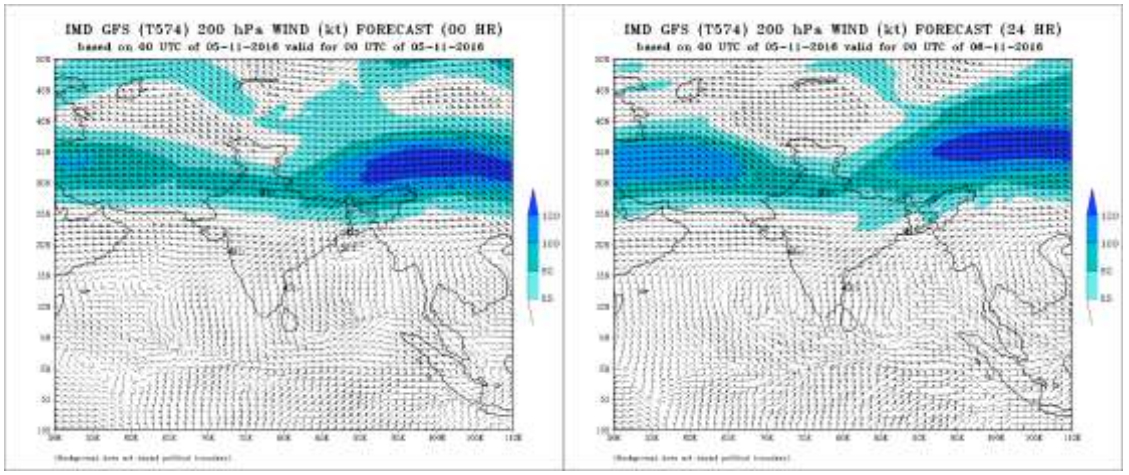

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 06-11-2016

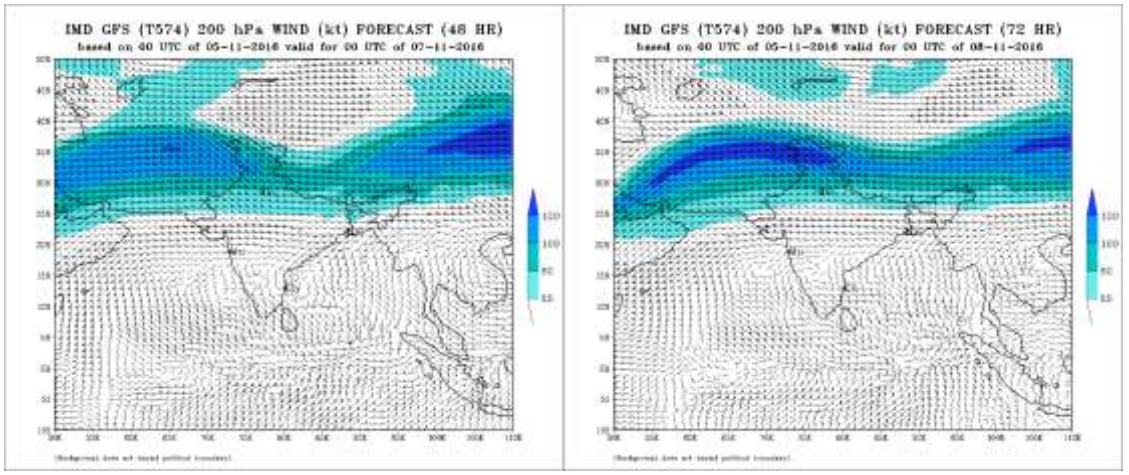

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 07-11-2016

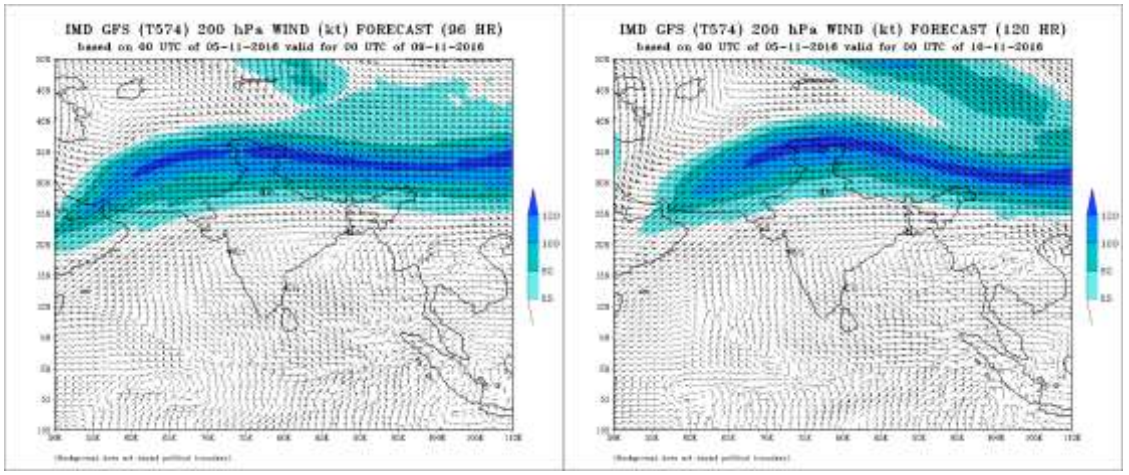

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 08-11-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 09-11-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 10-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 05-11-2016
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 06-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 07-11-2016
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 08-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 09-11-2016
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 05-11-2016 valid for 00 UTC of 10-11-2016

FDP (Cyclone) NOC Report Dated 06th November, 2016

Synoptic features:

The depression over northeast Bay of Bengal moved further east-northeastwards with a speed of about 30kmph during past 06 hours and lay centered at 0830 hours IST of 06th November, 2016 over northeast Bay of Bengal near latitude 21.0°N and longitude 91.5°E, about 360 km east-southeast of Kolkata, 150 km southwest of Chittagong (Bangladesh) and 170 km southeast of Khepupara (Bangladesh). The system would continue to move east-northeastwards, weaken gradually and cross southeast Bangladesh coast near longitude 92.0°E by today, the 06th November 2016 evening. The trough in mid-tropospheric westerlies, now runs roughly along longitude 86.0 E and to the north of latitude 24.0°N. The upper air cyclonic circulation over Malay peninsula & neighbourhood, now lies over Gulf of Siam & neighbourhood and extends upto mid tropospheric levels.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29-30˚C over most parts of Bay of Bengal except for small pockets of higher values in west central, and north Bay.

Over Arabian Sea, SST is between 28-30˚C over most areas except western parts of northwest, west central and southwest Arabian Sea where the value is between 26-28˚C.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal. It is less than 50 kJ/cm^2 over north Bay of Bengal.

Over entire Arabian Sea, TCHP is less than 70 kJ/CM^2.

Relative Vorticity:

The low level relative vorticity is about $100x10^{-6}$ $second^{-1}$ over the system area. There are no significant values of relative vorticity over Arabian Sea.

Convergence:

Low level convergence is about $20X10^{-5}$ s^{-1} to the northeast of the system centre. There are no significant zones of positive convergence in Arabian Sea Area.

Divergence:

The upper level divergence is about $5x10^{-5}s^{-1}$ near the system centre and it is around 10 $x10^{-5}$ s^{-1} to the northeast of the system centre.

There is no significant area of positive divergence over Arabian Sea.

Wind Shear:

Wind shear is high (20-30kt) over system area in Bay of Bengal. It further increases to the north. It is low to moderate over northern parts of south Arabian Sea and adjoining central Arabian Sea. It increases to the north and south.

Wind Shear Tendency:

There is decreasing tendency over system area and to its northeast side. There is increasing tendency over most parts of Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, the vortex now lies centered near lat 21.4^0N /92.2^0E over land. Associated scattered low/medium clouds with embedded intense to very intense convection are seen over northeast Bay, Tripura, adjoining southeast Bangladesh and Mizoram and adjoining Myanmar. Scattered low/medium clouds with embedded moderate to intense convection are seen over south Bay between and over Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded weak to moderate convection are seen over Comorin Area and adjoining southeast Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 18^0N latitude over BoB, to the south of the system.

M.J.O. Index: MJO index is in Phase 5 with amplitude one. It would move to phase 6 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 6 November 2016 shows a Depression over the northeast Bay of Bengal and moves northeastward direction towards south east Bangladesh coast during the next 12 hours and weakening thereafter. It also gives indication of development of a fresh low pressure area near North Andaman Sea and adjoining southeast Bay on 08th. This low moves in a northwestward direction without any appreciable intensification and is seen over WC Bay near Andhra coast on 12th

NCEP-GFS: Similar to IMD-GFS model, the model based on 00 UTC of 6 November 2016 of NCEP-GFS also shows a Depression over the northeast Bay of Bengal and moves northeastward direction towards Bangladesh during the next 12 -24 hours and becomes less marked thereafter.

ECMWF: The model charts based on 00 UTC of 6 November 2016 shows a Depression over the northeast Bay of Bengal and moves northeastward direction towards Bangladesh coast. This model also shows weakening of the system during the next 24 hours. This model further shows the presence of a fresh low pressure system on 8th and on 9th over north Andaman sea and neighbourhood.

WRF: The WRF model forecast based on 00 UTC of 6 November 2016 show a Depression over the northeast Bay of Bengal and moves northward direction towards southeast Bangladesh coast and this model also sows gradual weakening of the system during the next 24 hours.

JMA: Model forecast for based on 06th November 00UTC analysis shows the depression over northeast central Bay moves in a northeastward direction and crosses Bangladesh coast and seen as an extended low in the morning of 07thNovember.

Meteo-France ARP Model based on 06th November 00UTC analysis indicates the depression over NE Bay on 06th moves northeastwards and crosses Bangladesh coast in the morning of 07thNovember.

NCMRWF-NCUM: N.A

NCMRWF-UM-Regional Model: N.A

NCMRWF-NEPS Model: NA

IITM-GEFS: N.A

IITM -GFS T1534: The forecast for 06th November based on the analysis of 5th shows that the depression over north Bay is crossing Bangladesh coast. On 7th it became less marked.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 0000 UTC of 6th November 2016 suggests that the Depression over the Bay of Bengal has no potential to intensify into a Cyclonic Storm

MME TRACK:

MME track forecast based on 0000 UTC of 6 November 2016 shows northeastward movement of the "DEPRESSION" over the Bay of Bengal and landfall before 00 UTC of 7 November 2016 over Bangladesh coast.

SCIP INTENSITY:

Intensity prediction by the SCIP model shows the weakening of its current intensity before landfall of the "DEPRESSION" over the Bay of Bengal.

Summary and Conclusion:

The upper tropospheric ridge runs along 18.0^0 N and the system lies to the north of the ridge. The vertical wind shear is about 20-30 kts (high) around the system centre. It increases towards north. The upper level divergence is about $5x10^{-5}$ s^{-1} near the system centre and it is around $10x10^{-5}$ s^{-1} to the northeast of the system centre. The lower level convergence is about $20x10^{-5}$ s^{-1} to the northeast of the system centre. The relative vorticity is around $100x10^{-6}$ s^{-1}. Sea surface temperature is $29\text{-}30^0$ C. The ocean thermal energy is less than 50 kJ/cm^2 over north Bay of Bengal. Hence with the ongoing northeastward movement, the system will continue to experience more unfavourable conditions like high vertical wind shear, low ocean heat content and more dry air incursion from northwest. Hence, the system is expected to weaken gradually while moving northeastwards. Most NWP models are in agreement with above forecast of track and intensity.

Few models are suggesting the formation of a fresh low pressure area over North Andaman Sea and adjoining south east Bay on 08/09th November 2016. The development of this fresh system needs to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	05/12	06/00	06/03
India	41	43	36
Coastal stations			
WB	9	11	3
Odisha	6	6	6
AP	9	13	11
Tamil Nadu	10	11	10
Puducherry	1	1	1
A & N	6	1	5
Bangladesh	13	13	12
Myanmar	1	1	3
Thailand	3	1	2
SriLanka	10	7	10

AWS:

Region	Date/Time (UTC)		
	05/12	06/00	06/03
WB	5	1	8
Odisha	5	1	6
AP	6	3	2
Tamil Nadu	24	21	23
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 05 / 11 /2016 :37/43
- **No. of Ascents reaching 250 hPa levels: 19, MISDA:-15**

- **RS/RW** (00Z) of 05 / 11 /2016 : 30/43

- **No. of Ascents reaching 250 hPa levels:20, MISDA:5**

- **No. of PILOT Ascents**

05/12Z	06/00Z
4	4

Buoy Data

04/12Z	05/00Z	05/03Z
5	5	5

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**05.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /05.11.2016 : 5

No. of Ascents reaching 250 hPa level = 5

MISDA : 3

12Z /05.11.2016 : 3

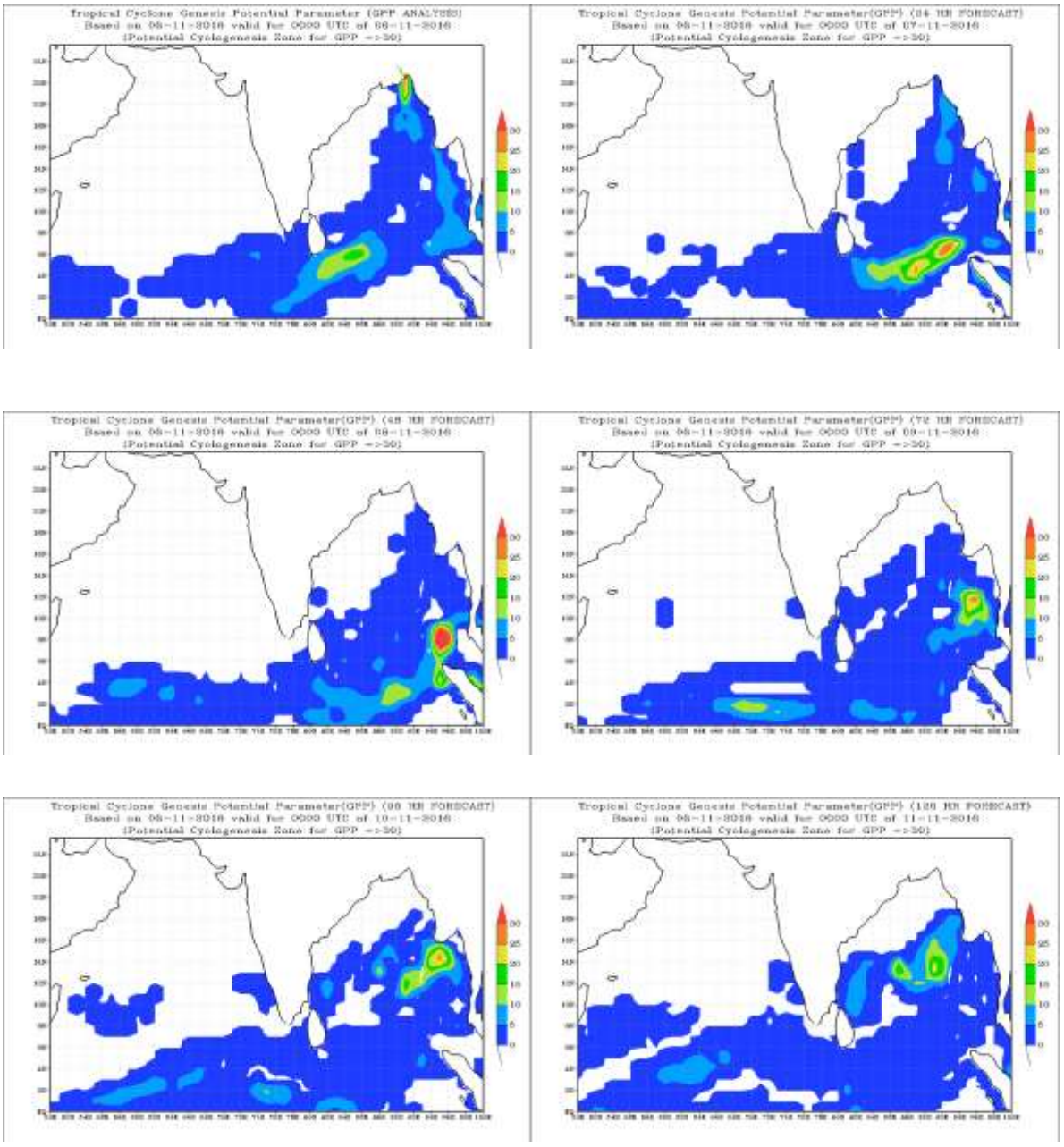
No. of Ascents reaching 250 hPa level = 3

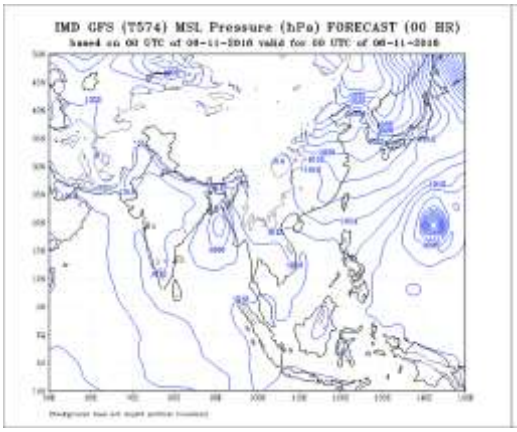
MISDA : 5

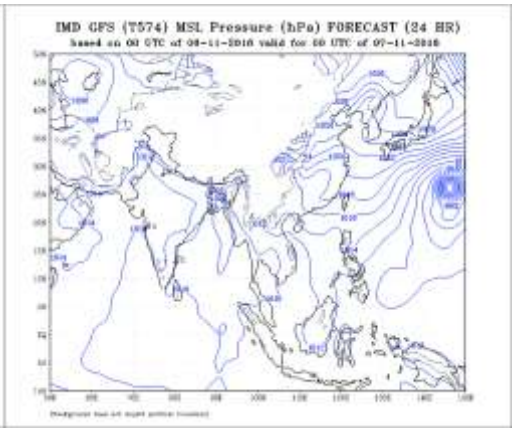
No. of PILOT Ascents:

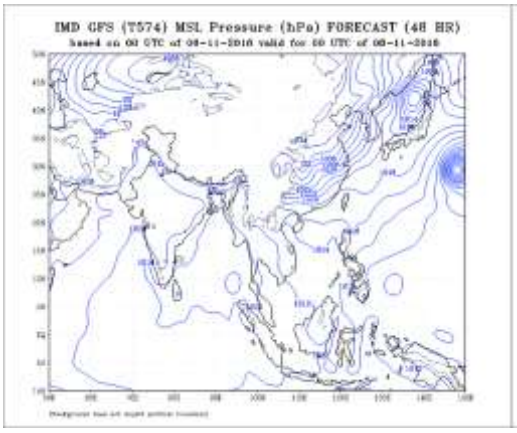
05.11.2016	
06Z	18Z
3	1

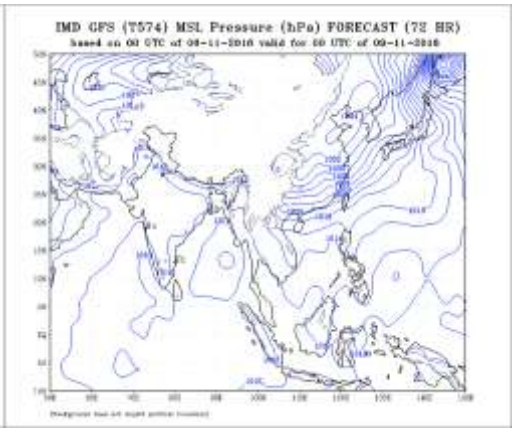
Annexure-II

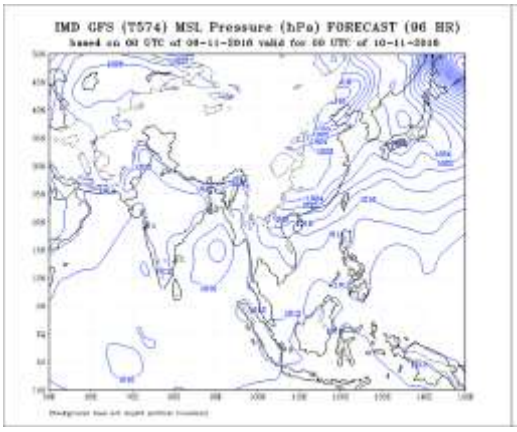

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 06-11-2016 valid for 0000 UTC of 06-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 06-11-2016 valid for 0000 UTC of 07-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 06-11-2016 valid for 0000 UTC of 08-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 06-11-2016 valid for 0000 UTC of 09-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 06-11-2016 valid for 0000 UTC of 10-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 06-11-2016 valid for 0000 UTC of 11-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

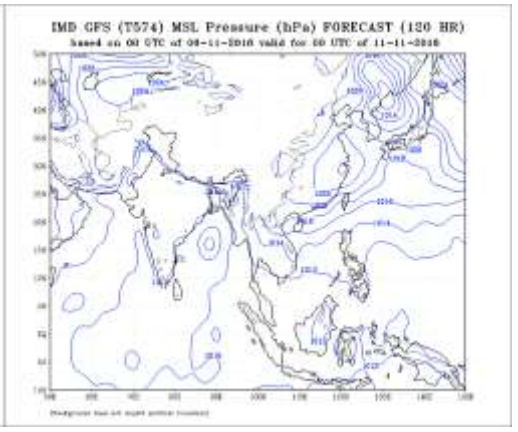

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)

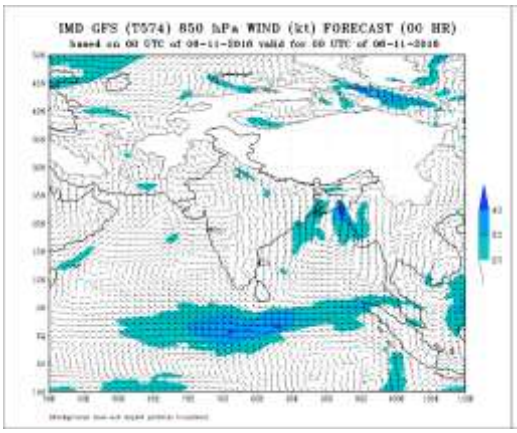

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

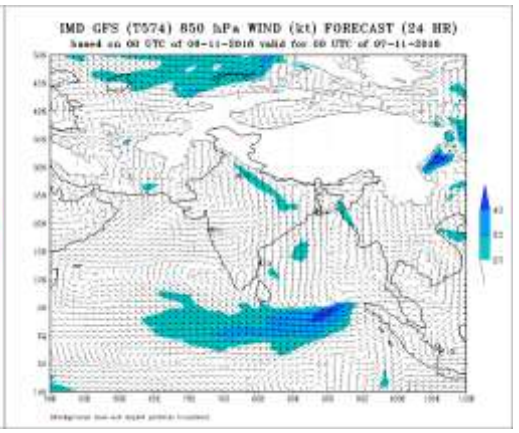

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

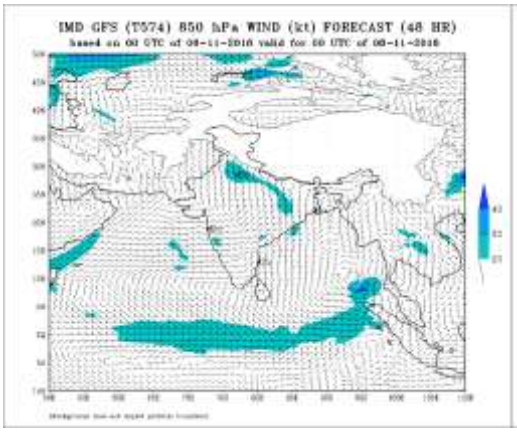

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

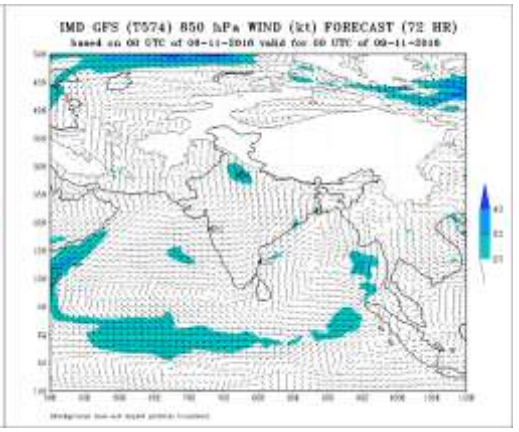

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

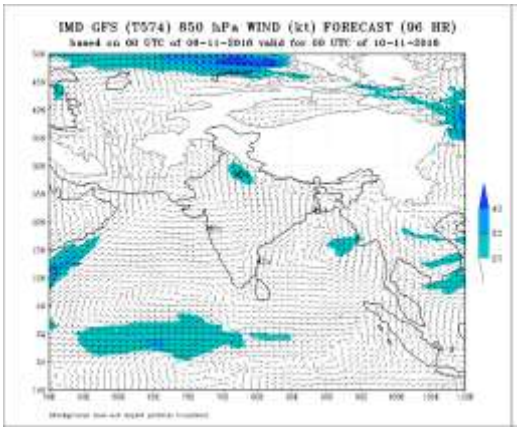

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

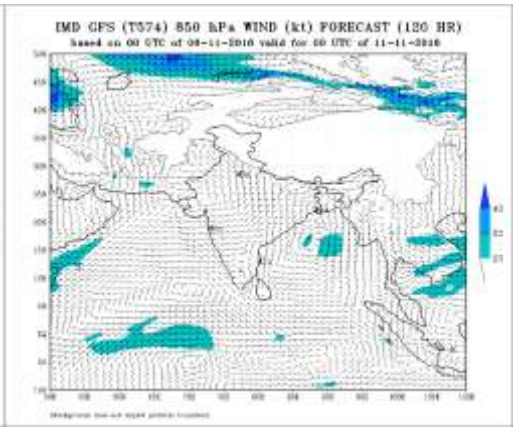

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

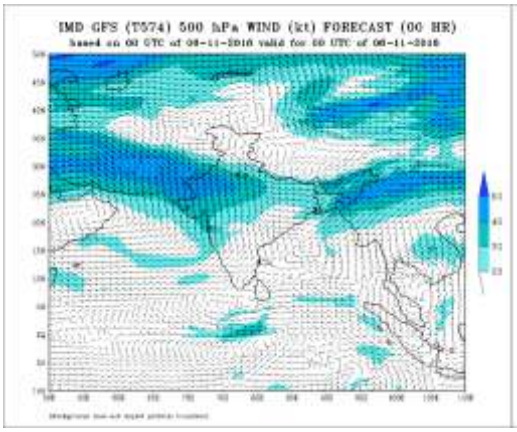

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

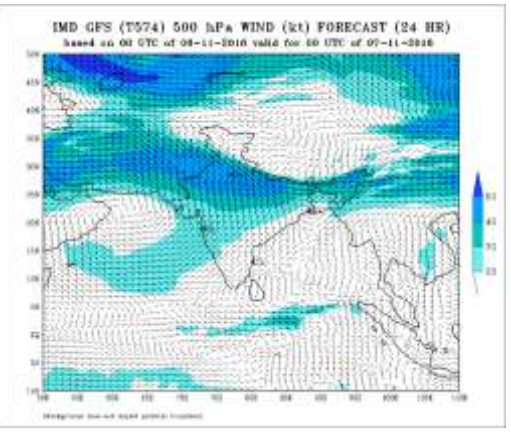

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

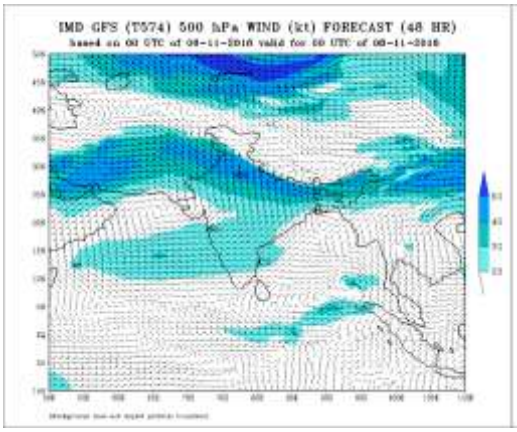

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

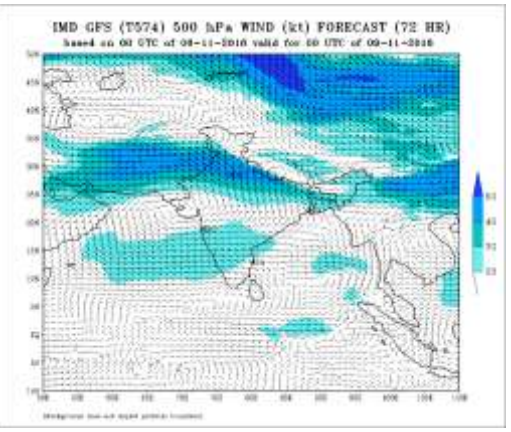

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

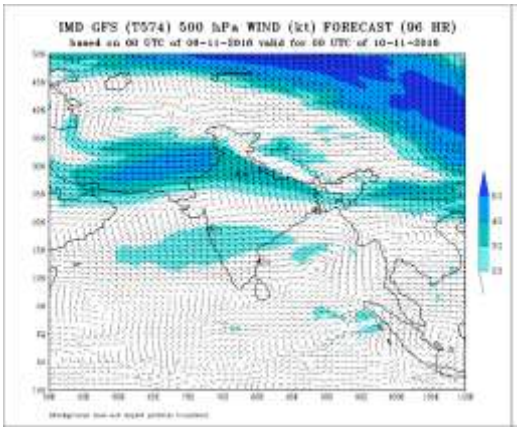

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

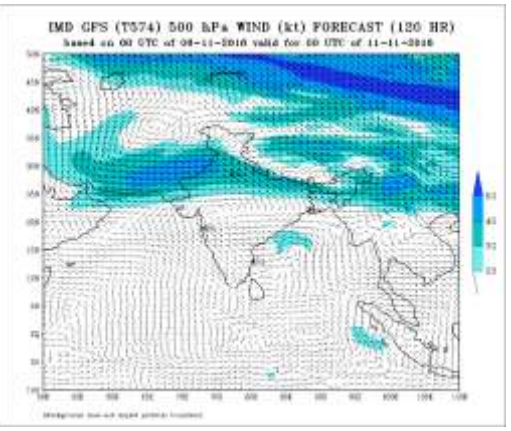

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)

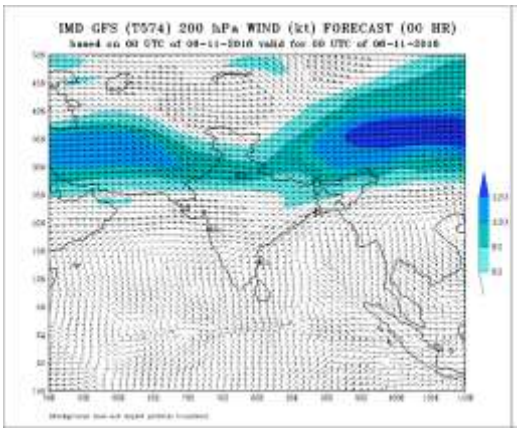

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

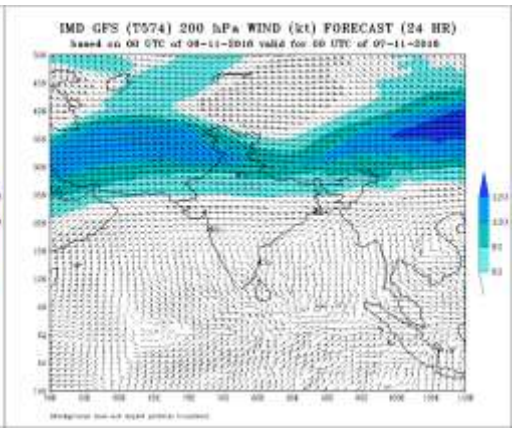

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

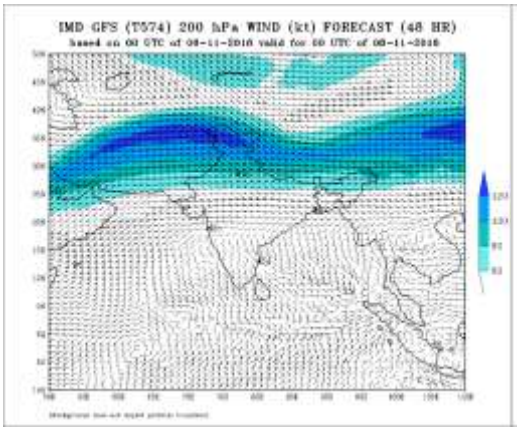

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

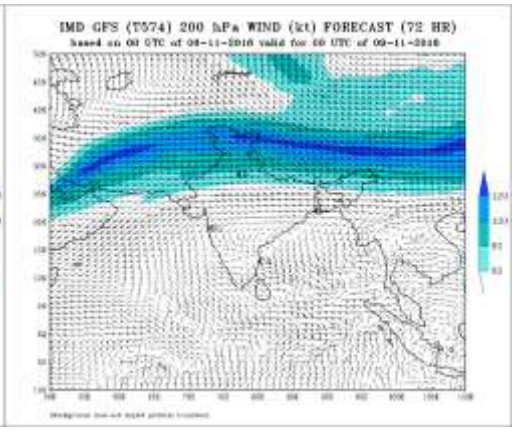

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

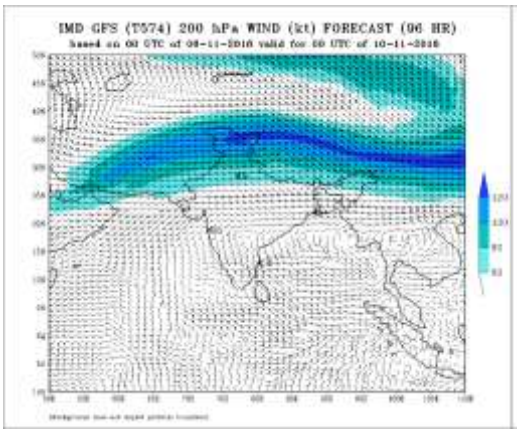

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

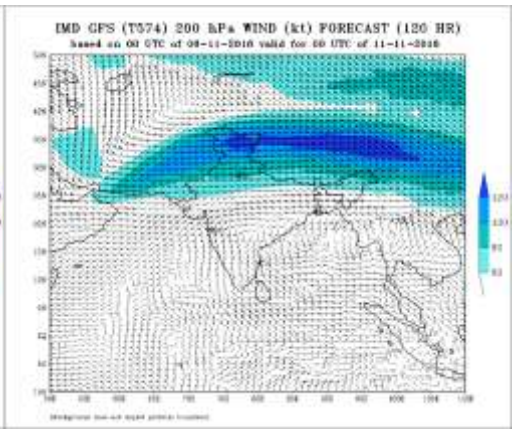

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 08-11-2016 valid for 00 UTC of 08-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 08-11-2016 valid for 00 UTC of 09-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 08-11-2016 valid for 00 UTC of 10-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 08-11-2016 valid for 00 UTC of 11-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 08-11-2016 valid for 00 UTC of 12-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 08-11-2016 valid for 00 UTC of 13-11-2016

FDP (Cyclone) NOC Report Dated 07th November, 2016

Synoptic features:

Yesterday's depression over northeast Bay of Bengal (BOB) moved further northeastwards lay close to Kutubdia (Bangladesh) at 0900 UTC and weakened into a well marked low pressure area over southeast Bangladesh & adjoining northeast BOB at 1730 hrs IST of 06th November, 2016. At 0830 hours IST of today, the 7th November it became less marked. However, the associated upper air cyclonic circulation lies over northeast Bangladesh and adjoining areas of south Assam & Tripura and extends upto 3.1 km above mean sea level.

The trough in mid-tropospheric westerlies, now runs roughly along longitude 87.0 E and to the north of latitude 20.0°N. Yesterday's upper air cyclonic circulation over Gulf of Siam & neighbourhood extending upto mid tropospheric levels persists.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29-30˚C over most parts of BOB except for small pockets of higher values over north Bay.

Over Arabian Sea (AS), SST is between 28-30˚C over most areas except parts of northwest, westcentral and southwest Arabian Sea (AS) where the value is between 26-28˚C.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 60- 80 KJ/cm^2 over most parts of Bay of Bengal and is slightly higher over off & along parts of Andhra Pradesh, Odisha and southeast Bangladesh coasts. It is less than 50 kJ/cm^2 over north Bay of Bengal.

TCHP is less than 50 KJ/cm^2 over north, westcentral and parts of southwest AS. It is 60-80 KJ/cm^2 over eascentral, southeast and adjoining parts of suouthwest AS.

Relative Vorticity:

The low level relative vorticity at 850 hPa level is about 50 $x10^{-6}$ $second^{-1}$ over south Andaman Sea and less than $20x10^{-6}$ $second^{-1}$ over most parts of BOB. It is negative over parts of westcentral and eastcentral BOB off Myanmar coast.

The low level relative vorticity is about 25-30 $x10^{-6}$ $second^{-1}$ over parts of southeast AS.

Convergence:

Low level convergence is about $15X10^{-5}$ s^{-1} over the south Andaman Sea and adjoining equatorial region. It is around $5X10^{-5}$ s^{-1} off & along Myanmar coast and some part of southeast BB.

There is no significant zone of positive convergence in AS Area.

Divergence:

The upper level divergence is elongated, east-west oriented and about $20x10^{-5}s^{-1}$ the south Andaman Sea and adjoining equatorial region..

There is no significant area of positive divergence over AS.

Wind Shear:

Wind shear is high (20-25kt) over south and north BOB. It is decreasing towards northeast BOB over south Bangladesh & Myanmar region.

Wind shear is high more than 25 kt over entire AS except over southeast and adjoining eastcentral AS (15-20 kt).

Wind Shear Tendency:

There is decreasing tendency over south Andaman Sea and adjoining equatorial region. There is increasing tendency over most parts of AS except over parts of southeast AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection lie over south Bay and adjoining Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded isolated weak convection are seen over AS off Lakshadweep coast.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 20^0N latitude over BoB.

M.J.O. Index: MJO index is in Phase 5 with amplitude more than one. It would move to phase 6 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 7 November 2016 shows an upper air cyclonic circulation over northeast Bangladesh and adjoining areas of south Assam & Tripura and persist for during the next 48 hours and weakening thereafter. It shows a fresh extended low over EC Bay on 9th and 10th, over central and adjoining southwest Bay on 11th, over southwest Bay on 12th, near SW Bay near Chennai coast on 13th and less marked on 14th.

NCEP-GFS: Similar to IMD-GFS model, the model based on 00 UTC of 7 November 2016 of NCEP-GFS also shows an upper air cyclonic circulation over northeast Bangladesh and adjoining areas of south Assam & Tripura during the next 24 -48 hours and became less marked thereafter.

ECMWF: The model charts based on 00 UTC of 7 November 2016 shows a low level cyclonic circulation at 850 hPa over northeast Bangladesh and adjoining areas of south Assam and persist for during the next 72 hours. A fresh low/extended low is expected over EC Bay and adjoining north Andaman Sea on 8th from the current cyclonic circulation over Gulf of Siam. It becomes less marked on 9th.

WRF: The WRF model forecast based on 00 UTC of 7 November 2016 show a low level cyclonic circulation at 850 hPa over northeast Bangladesh and adjoining areas of south Assam and persist for during the next 48 hours. There is no significant system over north Indian Ocean during next 3 days.

ARP-MeteoFrance : It shows low over southeast and adjoining Andaman Sea on 8th and southeast and adjoining EC Bay on 9th. It is less marked on 10th November.

JMA : No significant system during next 3 days.

NCMRWF-NCUM: It shows circulation over southeast Bay on 8th, low over SE and adjoining EC Bay on 9th, over EC Bay on 10th and 11th and less marked on 12th November.

NCMRWF-UM-Regional Model: N.A

NCMRWF-NEPS Model: It shows WML over south Andaman Sea and adjoining southeast Bay on 9th, north Andaman Sea and adjoin EC and SE Bay on 10th, Depression over EC Bay on 11th, Depression over WC and adjoining NW Bay on 12th and less marked on 13th November.

IITM-GEFS: It shows extended low over EC Bay during 8-10th, over SE and adjoining SW Bay and central Bay on 11th and less marked on 12th.

IITM -GFS T1534: It shows extended low over EC Bay on 9th, low over EC Bay on 10th and 11th, low over central Bay on 12th and less marked on 13th.

Dynamical statistical models

MME track & SCIP intensity:

At present, No low pressure system persist over north Indian Ocean.

IMD Genesis Potential Parameter (GPP):

GPP: At present, No low pressure system persist over north Indian Ocean.

Summary and Conclusion:

Majority of the models are suggesting the formation of a fresh low pressure area over North Andaman Sea and adjoining south east and east central Bay on 08/09th November 2016. Without further intensification, while moving northwestwards. The development of this fresh system needs to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP: No IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	06/12	07/00	07/03
India	42	33	44
Coastal stations			
WB	9	3	8
Odisha	6	5	6
AP	9	11	11
Tamil Nadu	11	12	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	13	15	12
Myanmar	11	7	8
Thailand	3	3	22
SriLanka	10	8	9

- **AWS:**

Region	Date/Time (UTC)		
	06/12	07/00	07/03
WB	5	2	5
Odisha	5	1	6
AP	7	6	6
Tamil Nadu	10	10	22
Puducherry	1	1	1
A & N	0	0	0

-
- **RS/RW** (12Z) of 06/ 11 /2016: 37/43
- **No. of Ascents reaching 250 hPa levels: 15, MISDA: 21**

- **RS/RW** (00Z) of 07 / 11 /2016: 34/43
- **No. of Ascents reaching 250 hPa levels: 27, MISDA: 6**

No. of PILOT Ascents

06/12Z	07/00Z
5	3

Buoy Data

06/12Z	07/00Z	07/03Z
5	5	5

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**31.10.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**19**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /18.10.2016 : 6

No. of Ascents reaching 250 hPa level = 6

MISDA : 2

12Z /18.10.2016 : 4

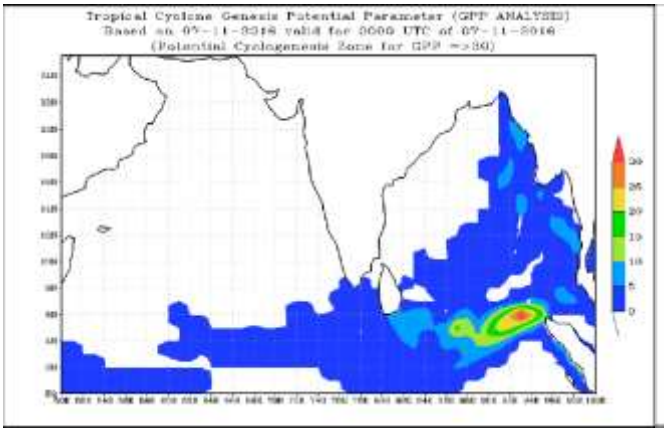
No. of Ascents reaching 250 hPa level = 4

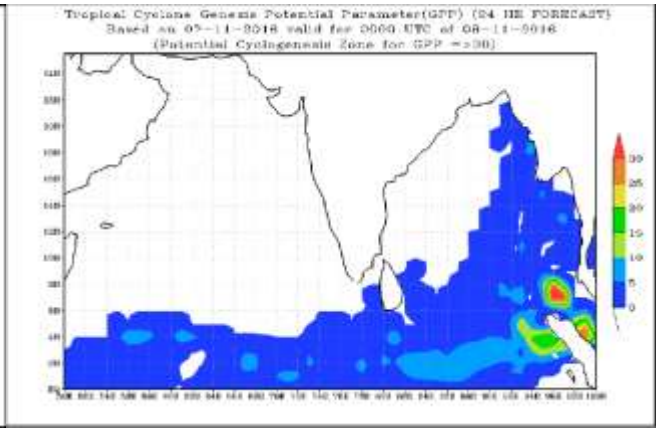
MISDA : 4

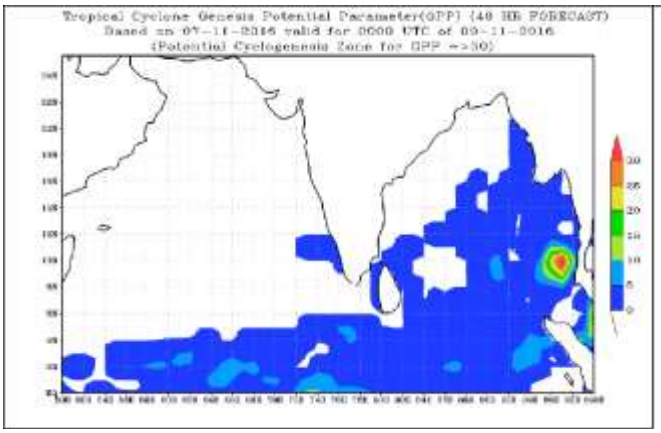
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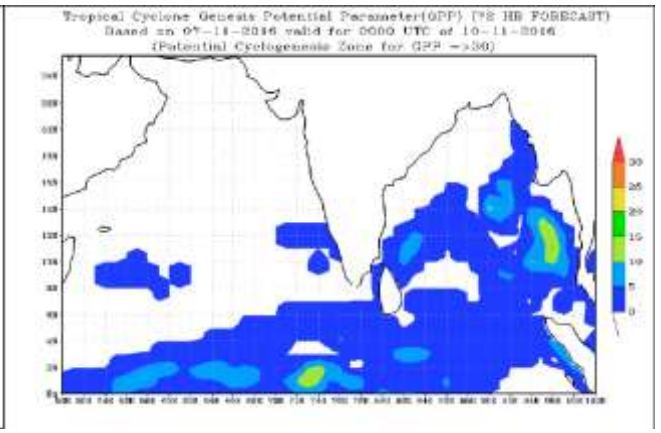
31.10.2016	
06Z	18Z
2	2

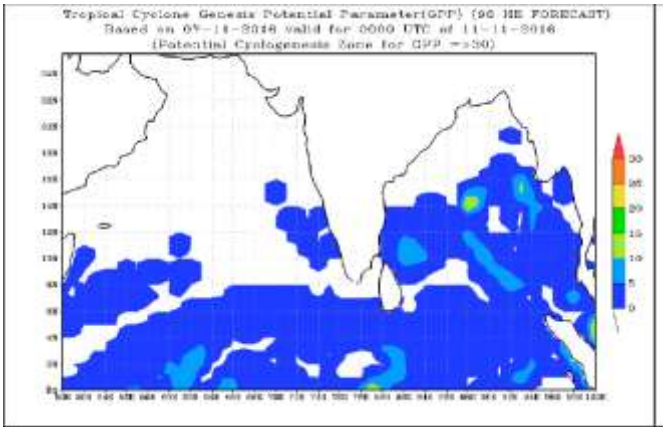
Annexure- II

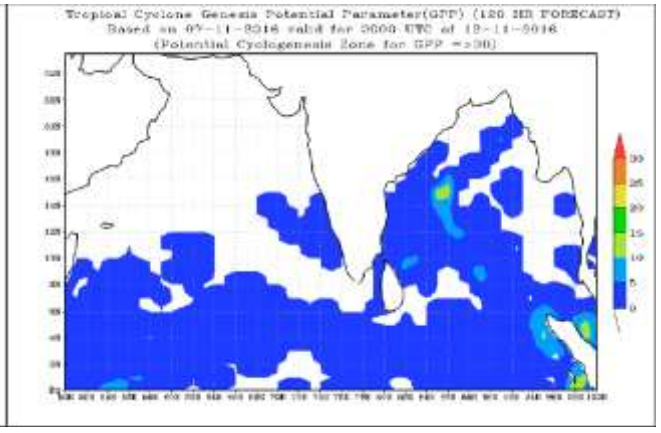

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 07-11-2016 valid for 0000 UTC of 07-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

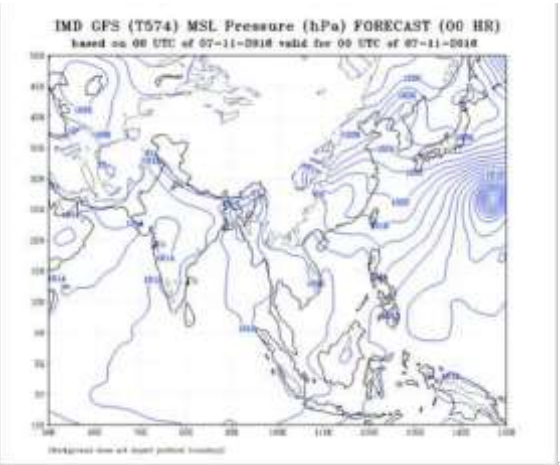

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 07-11-2016 valid for 0000 UTC of 08-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

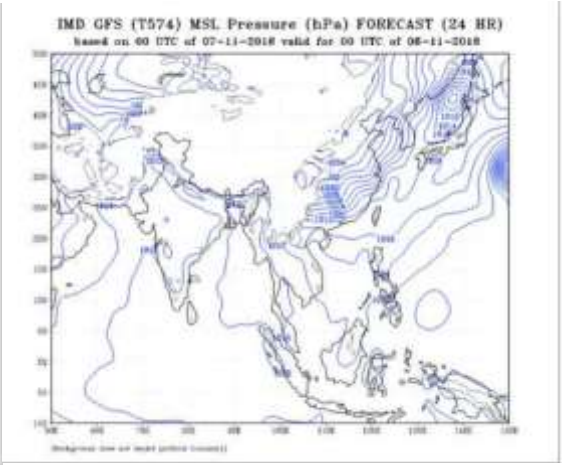

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 07-11-2016 valid for 0000 UTC of 09-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

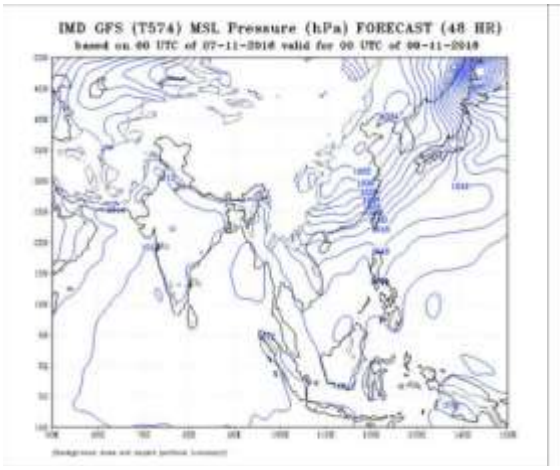

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 07-11-2016 valid for 0000 UTC of 10-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

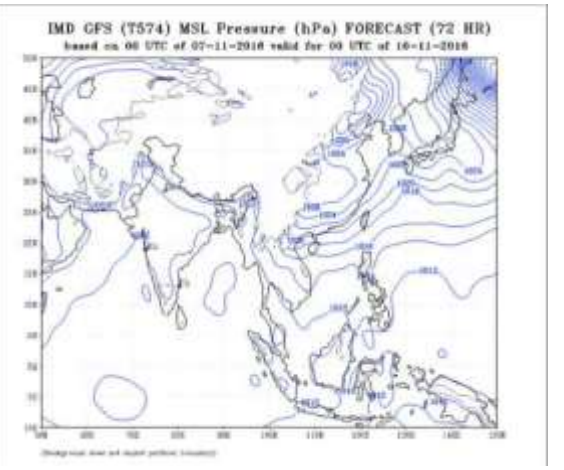

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 07-11-2016 valid for 0000 UTC of 11-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

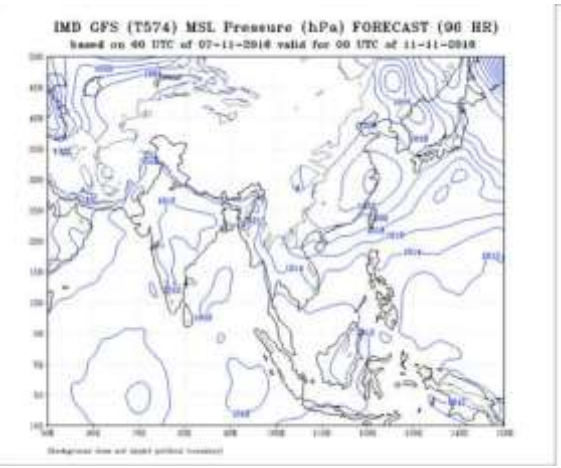

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 07-11-2016 valid for 0000 UTC of 12-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

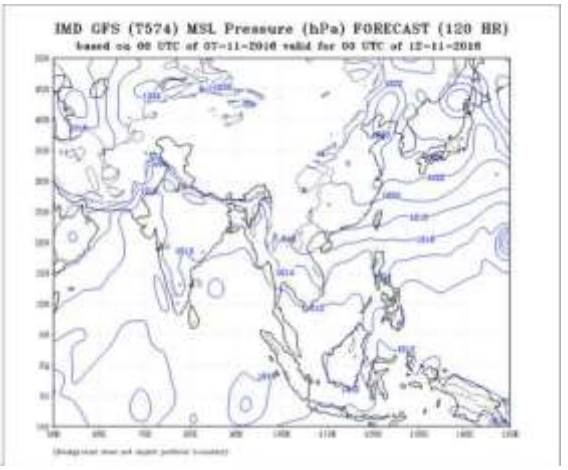

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 07-11-2018 valid for 00 UTC of 07-11-2018


IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 07-11-2018 valid for 00 UTC of 08-11-2018


IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 07-11-2018 valid for 00 UTC of 09-11-2018

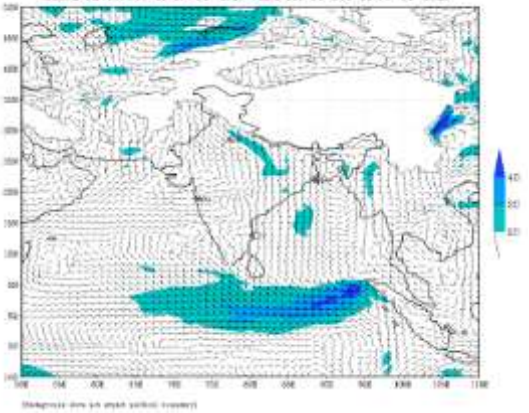

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 07-11-2018 valid for 00 UTC of 10-11-2018


IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 07-11-2018 valid for 00 UTC of 11-11-2018


IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 07-11-2018 valid for 00 UTC of 12-11-2018

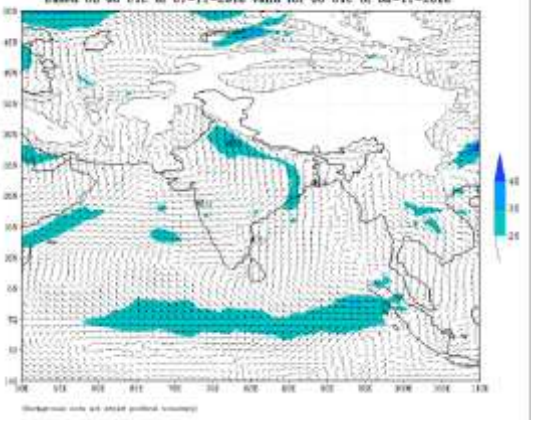
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

based on 00 UTC of 07-11-2016 valid for 00 UTC of 07-11-2016



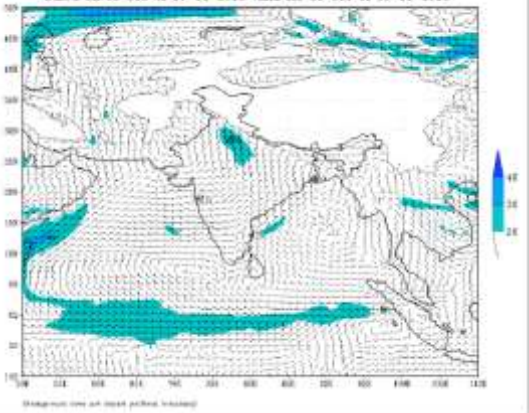
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

based on 00 UTC of 07-11-2016 valid for 00 UTC of 08-11-2016



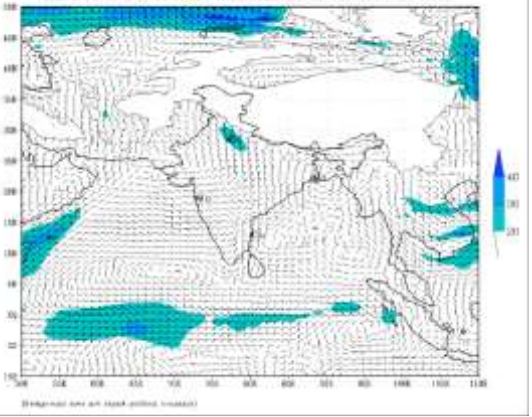
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

based on 00 UTC of 07-11-2016 valid for 00 UTC of 09-11-2016



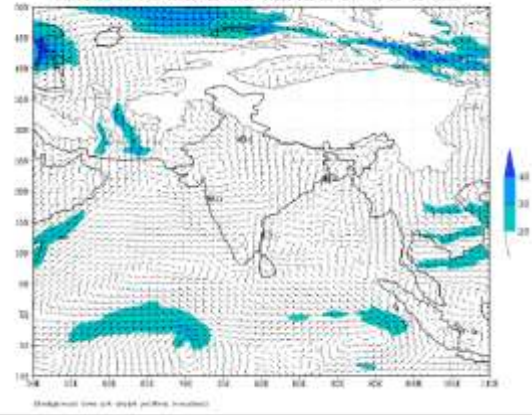
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

based on 00 UTC of 07-11-2016 valid for 00 UTC of 10-11-2016



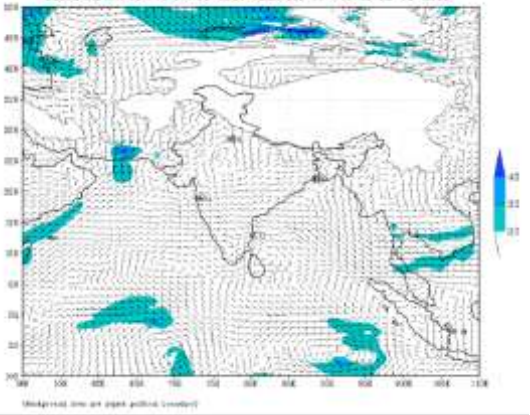
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

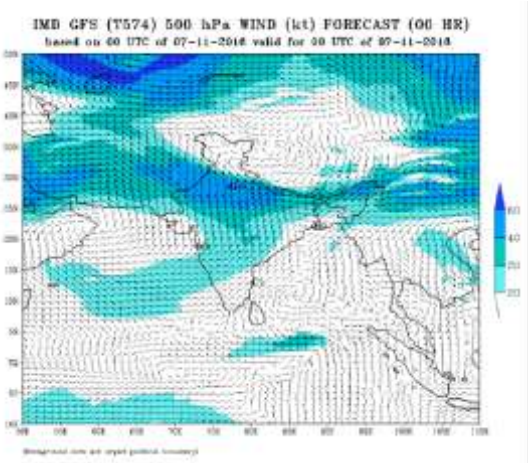
based on 00 UTC of 07-11-2016 valid for 00 UTC of 11-11-2016

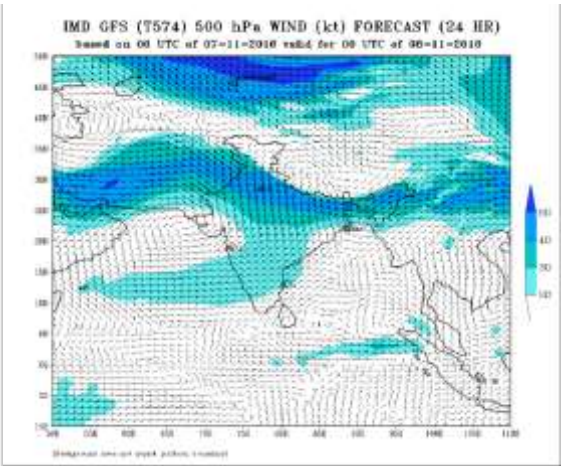


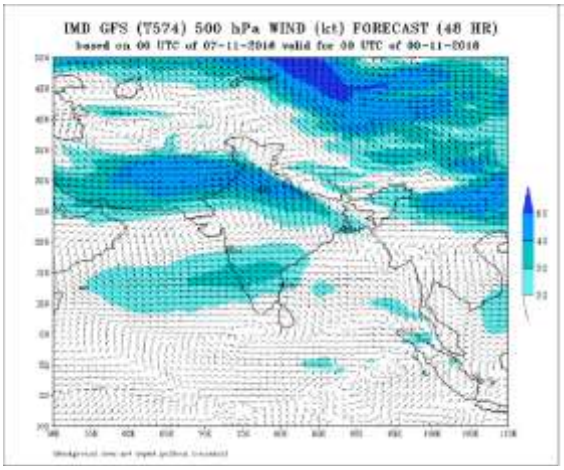
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

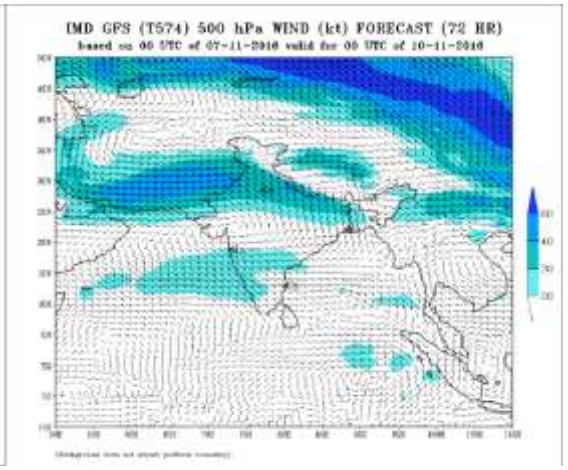
based on 00 UTC of 07-11-2016 valid for 00 UTC of 12-11-2016

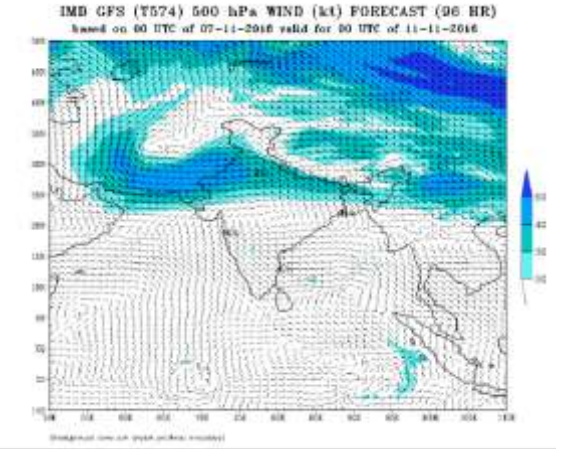


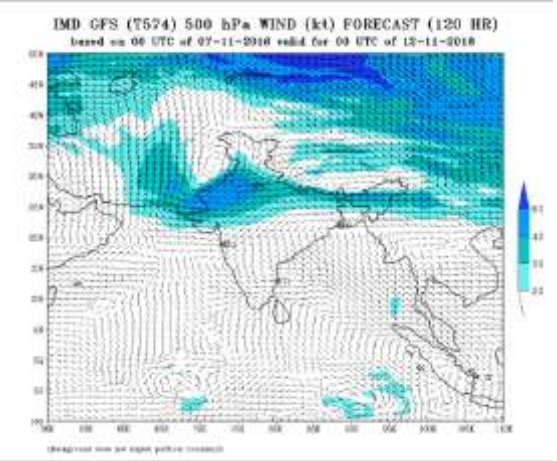

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 07-11-2016

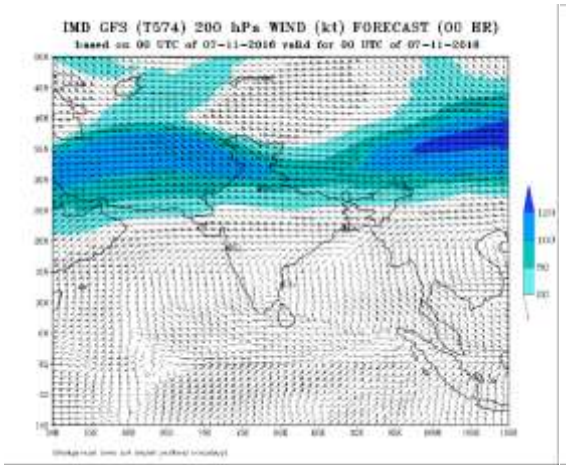

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 08-11-2016

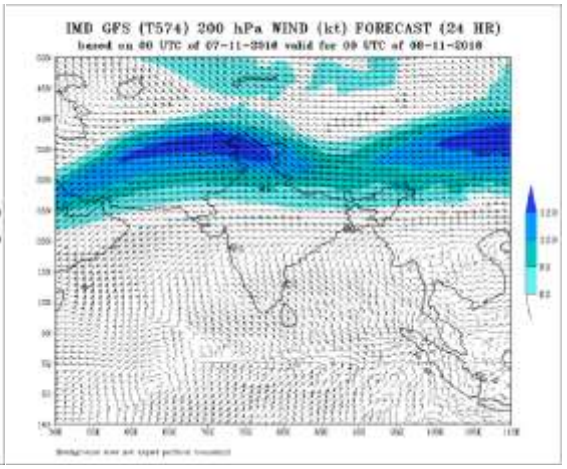

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 09-11-2016

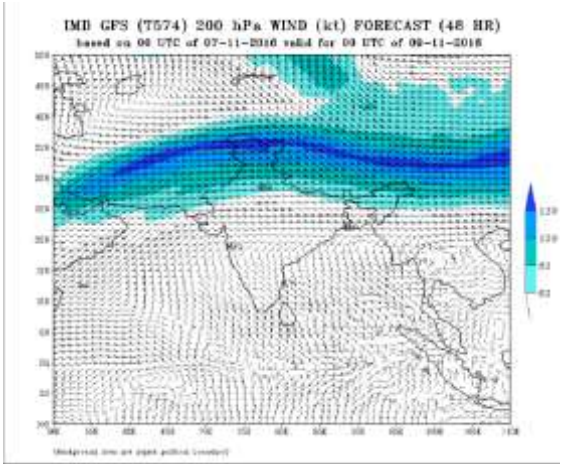

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 10-11-2016

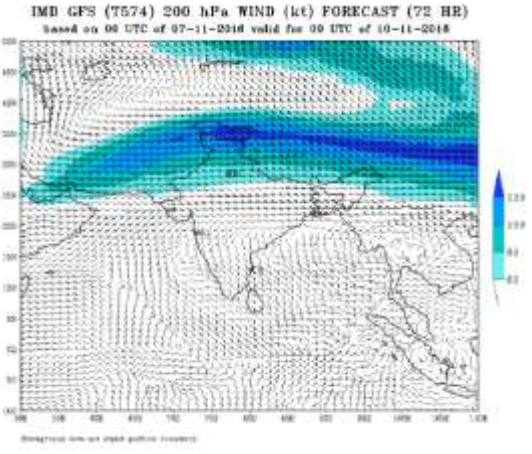

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 11-11-2016

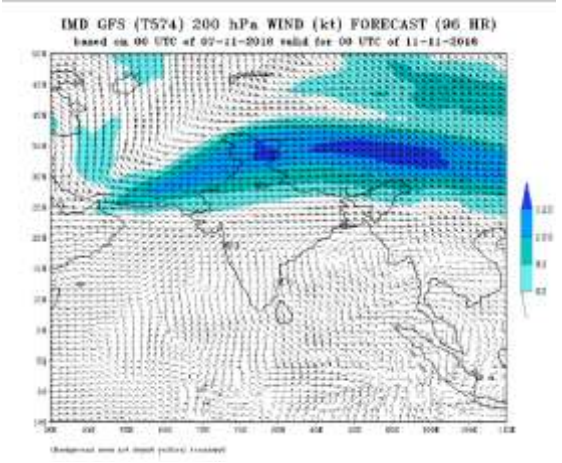

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 12-11-2016

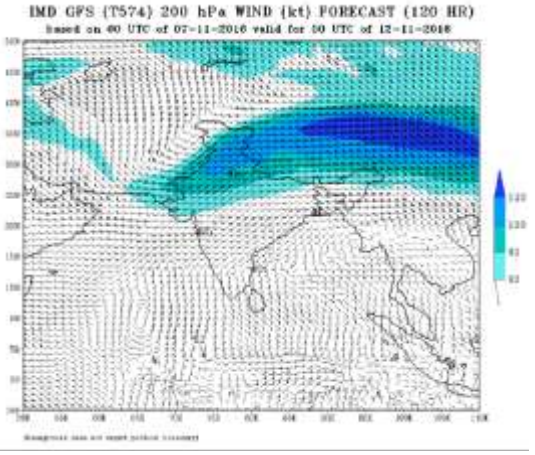

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 07-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 08-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 09-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 10-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 11-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 07-11-2016 valid for 00 UTC of 12-11-2016

FDP (Cyclone) NOC Report Dated 08th November, 2016

Synoptic features:

The cyclonic circulation over Gulf of Siam and neighbourhood persists and now extends upto 1.5 kms a. s. l. A cyclonic circulation extending upto 3.1 kms a. s. l. lies over southeast Bay of Bengal and neighbourhood. The cyclonic circulation over Comorin area & neighbourhood has become less marked.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 29-30˚C over most parts of Bay of Bengal except for pockets of lower values in north Bay.

Over Arabian Sea, SST is between 27-30˚C over most areas of north and central Arabian Sea. SST is 28-30˚C over south Arabian Sea except for the western parts of and southwest Arabian Sea where the value is between 27-29 ˚C.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal. It is less than 50 kJ/cm^2 over north Bay of Bengal.

Over entire Arabian Sea, TCHP is less than 70 kJ/CM^2.

Relative Vorticity:

The low level relative vorticity is less than 30x10^{-6} second^{-1} over Bay of Bengal as well as over Arabian Sea.

Convergence:

There are no significant zones of positive convergence in Bay of Bengal as well as in Arabian Sea Area.

Divergence:

The upper level divergence is about 5x10^{-5}s $^{-1}$ over north Andaman Sea over Gulf of Martaban.

There is no significant area of positive divergence over Arabian Sea.

Wind Shear:

Wind shear is low to moderate over central Bay of Bengal. It further increases to the north and to the south. It is low to moderate over northern parts of south Arabian Sea and adjoining east central Arabian Sea. It increases to the north and south.

Wind Shear Tendency:

There is decreasing tendency over west central Bay and to its northwest and to southeast directions. There is increasing tendency over most parts of Arabian Sea except for southern parts of east central Arabian sea and Lakshadweep area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over Andaman Sea. Scattered low/medium clouds with embedded weak convection are seen over southeast Bay.

Arabian Sea:

No significant clouds over the region.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 18^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 5 with amplitude more than one. It would move to phase 7 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 8 November 2016 shows an upper air cyclonic circulation at 850 hPa level over northeast Bangladesh and adjoining areas of south Assam & Tripura and persist for during the next 72 hours and weakening thereafter. A low pressure area lies over southeast Bay on 9th, becomes less marked on 10th, reappears over southeast and adjoining eastcentral Bay on 11th and becomes less marked on 12th.

NCEP-GFS: Similar to IMD-GFS model, the model based on 00 UTC of 8 November 2016 of NCEP-GFS also shows an upper air cyclonic circulation in the low level over northeast Bangladesh and adjoining areas of south Assam & Tripura during the next 48 -72 hours and became less marked thereafter. No significant system over NIO expected during next 5 days.

ECMWF: 00 UTC of 8 November 2016 shows a low level cyclonic circulation at 850 hPa over northeast Bangladesh and adjoining areas of south Assam and persist for during the next 72 hours. No significant system over NIO expected during next 5 days.

WRF: The WRF model forecast based on 00 UTC of 8 November 2016 show an extended low level cyclonic circulation at 850 and 700 hPa levels over northeast Bangladesh and adjoining areas of south Assam and persist for during the next 48 hours. No significant system expected during next 3 days.

JMA: Model forecast for based on 08th November 00UTC analysis shows as an extended low in the analysis field which becomes less marked on 9th.

Meteo-France ARP Model based on 08th November 00UTC analysis indicates an extended low in the analysis field which becomes less marked on 9th.

NCMRWF-NCUM: No cyclonic circulation in the analysis or in the forecasts till 18th.

NCMRWF-UM-Regional Model: N.A

NCMRWF-NEPS Model: The analysis based on 08 November shows a low over East central Bay and adjoining North Andaman Sea which moves in a northwestward direction and reaches West Central Bay off Andhra coast on 12th without appreciable intensification.

IITM-GEFS: No significant system is expected during next 8 days

IITM -GFS T1534: The forecast fields based on the analysis of 8th do not give indication of formation of low pressure systems over Indian Seas during next 8 days.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 0000 UTC of 8th November 2016 do not suggest any cyclogenesis over Indian seas in the next 5 days.

Summary and Conclusion:

Some of the models are suggesting the formation of a low pressure area over south east Bay on 09th November 2016. However, none of the models show intensification of the system. The models show the system to move in a northwest direction. The development of this fresh system needs to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	07/12	08/00	08/03
India	42	43	44
Coastal stations			
WB	9	8	8
Odisha	6	6	6
AP	9	10	11
Tamil Nadu	11	12	12
Puducherry	1	1	1
A & N	6	6	6
Bangladesh	16	13	13
Myanmar	6	5	9
Thailand	3	3	3
SriLanka	10	9	11

AWS:

Region	Date/Time (UTC)		
	07/12	08/00	08/03
WB	4	-	1
Odisha	4	2	5
AP	7	3	6
Tamil Nadu	25	9	21
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 07 / 11 /2016 :37/43
- **No. of Ascents reaching 250 hPa levels: 16 , MISDA:-20**

- **RS/RW** (00Z) of 08 / 11 /2016 : 36/43

- **No. of Ascents reaching 250 hPa levels:27 , MISDA:7**

No. of PILOT Ascents

07/12Z	08/00Z
7	8

Buoy Data

07/12Z	08/00Z	08/03Z
6	5	5

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**07.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /07.11.2016 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /07.11.2016 : 4

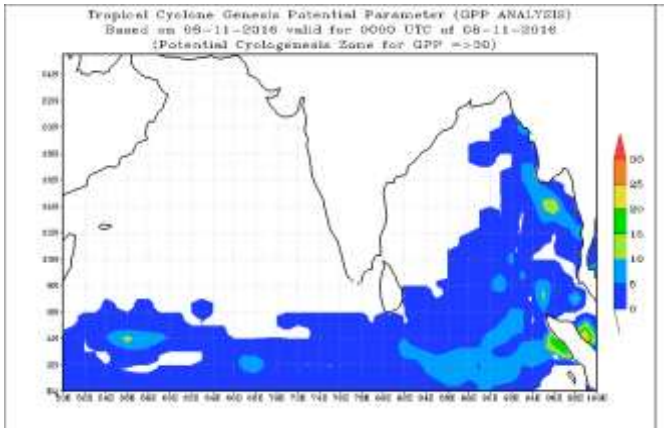
No. of Ascents reaching 250 hPa level = 4

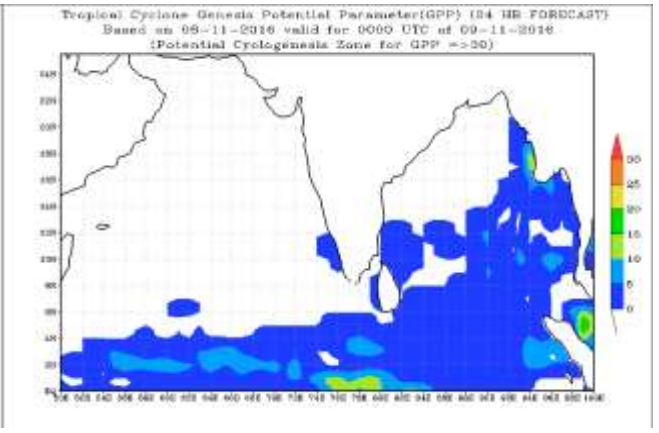
MISDA : 4

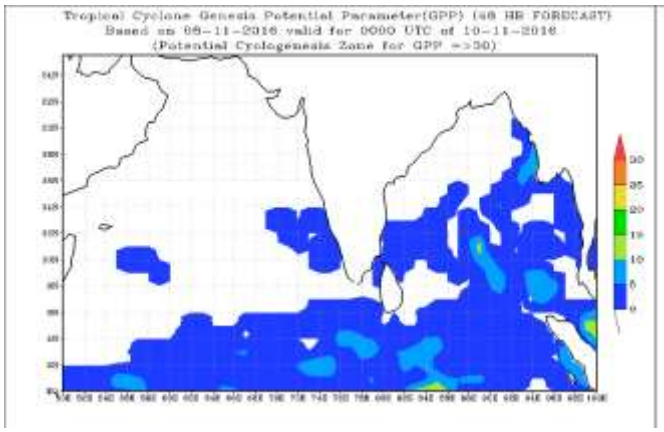
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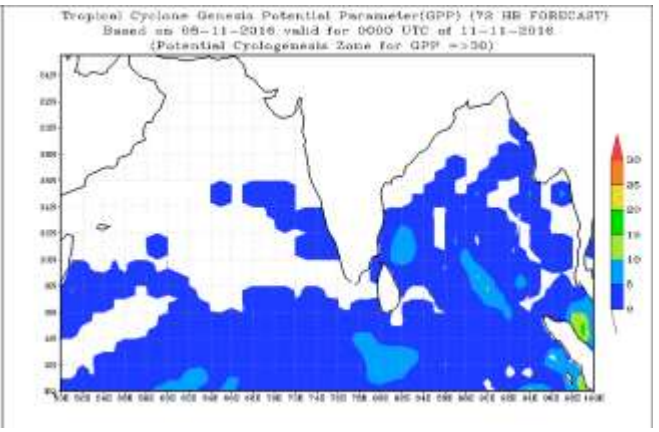
07.11.2016	
06Z	18Z
4	5

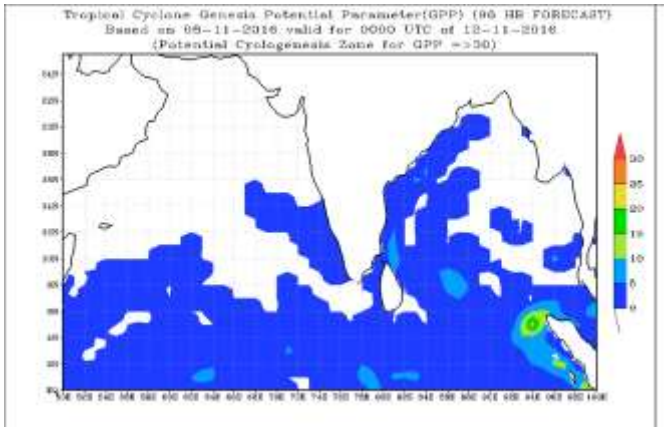
Annexure-II

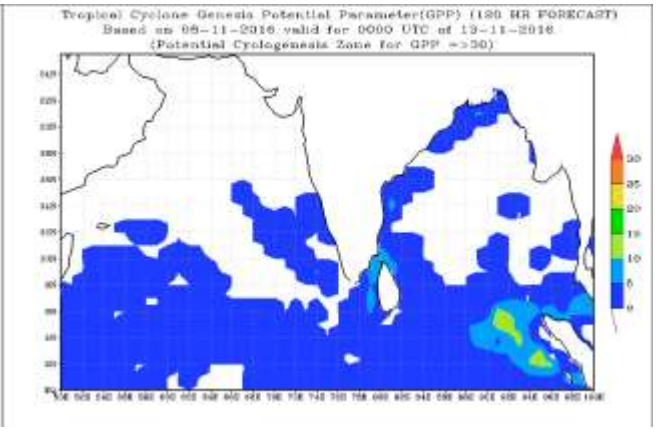

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 08-11-2016 valid for 0000 UTC of 08-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

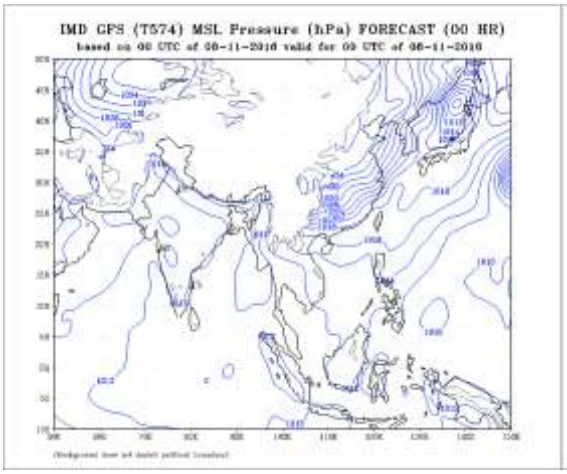

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 08-11-2016 valid for 0000 UTC of 09-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

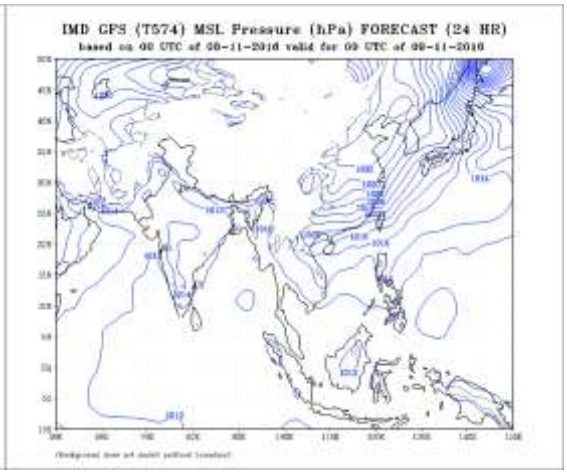

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 08-11-2016 valid for 0000 UTC of 10-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

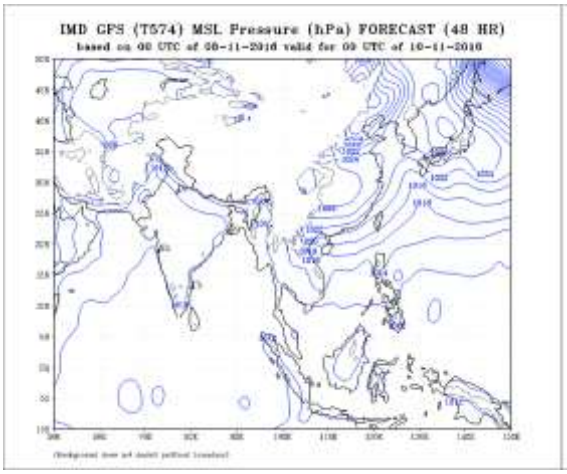

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 08-11-2016 valid for 0000 UTC of 11-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

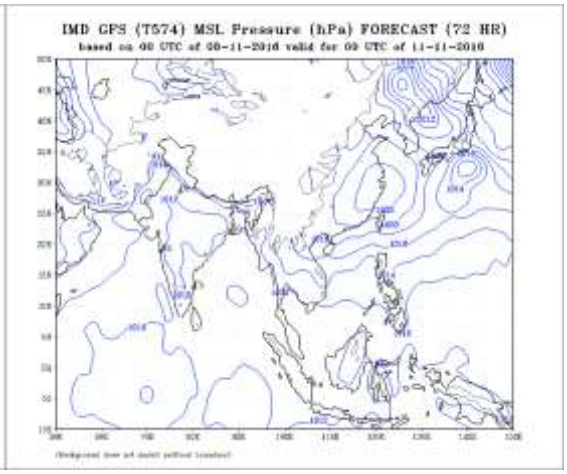

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 08-11-2016 valid for 0000 UTC of 12-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

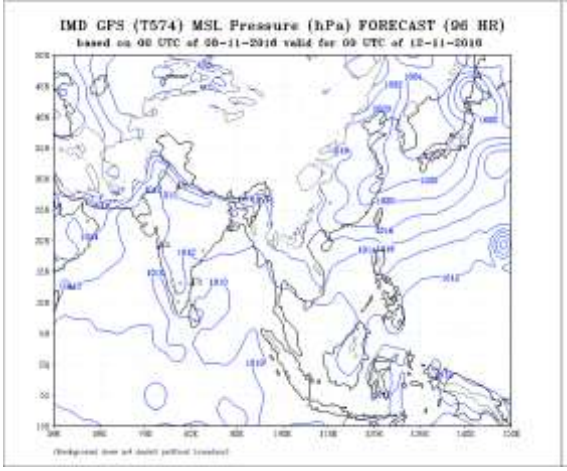

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 08-11-2016 valid for 0000 UTC of 13-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

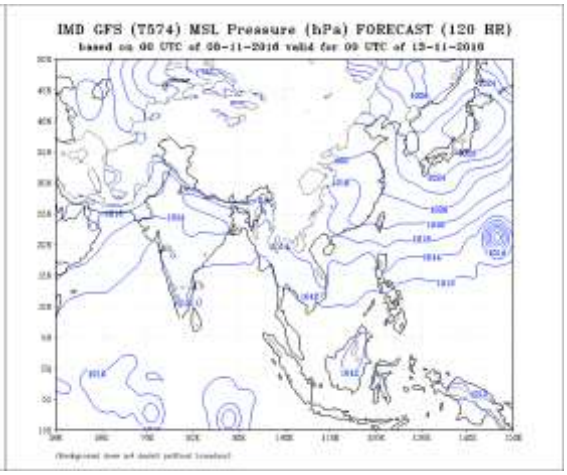

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 08-11-2010

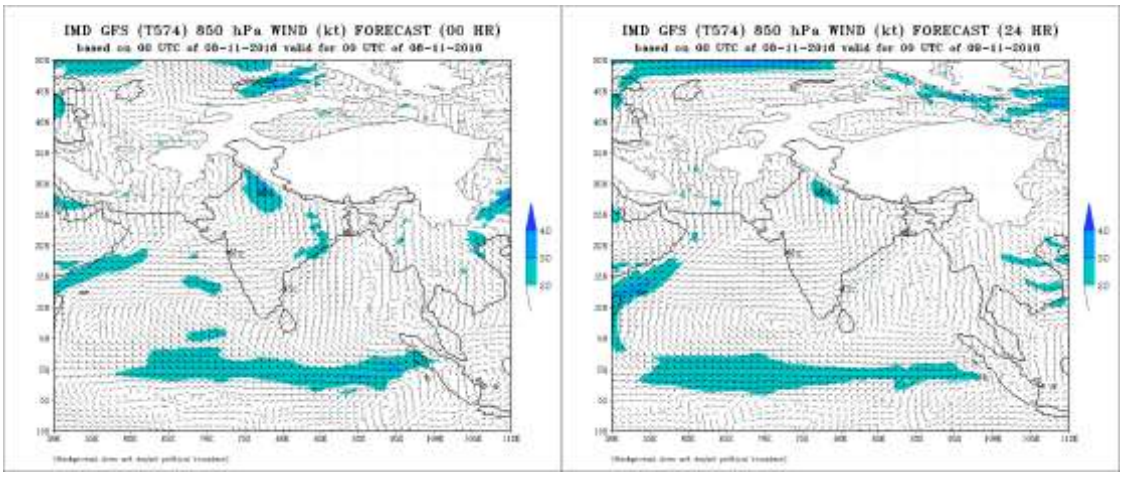

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 09-11-2010

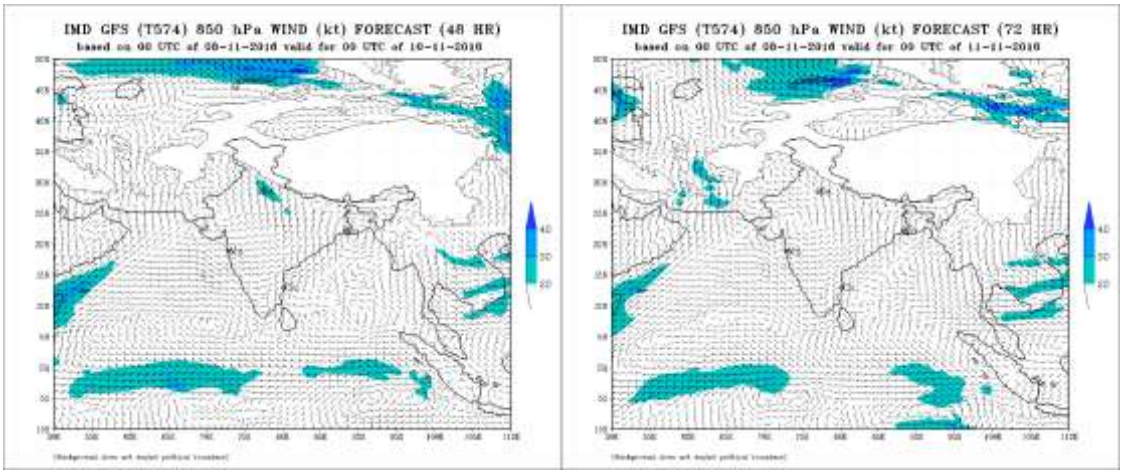

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 10-11-2010

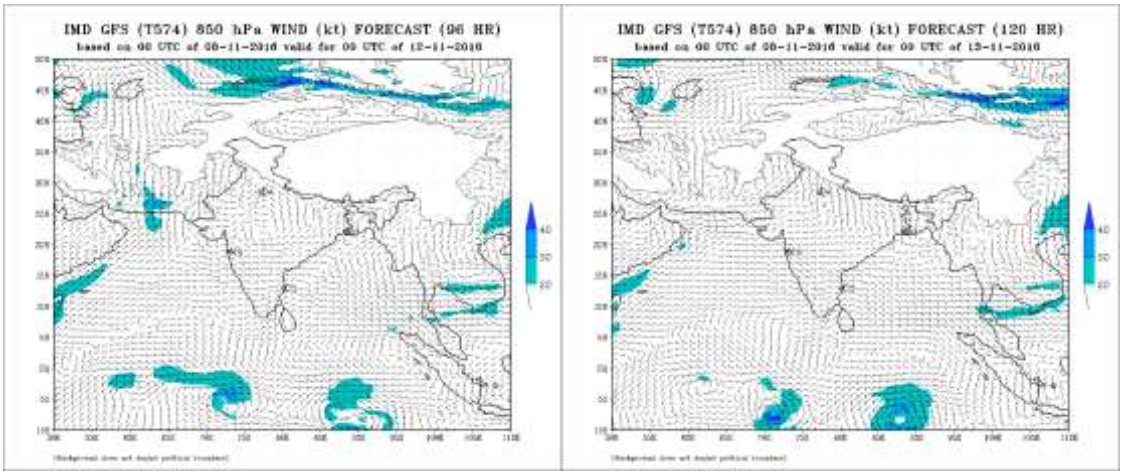

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 11-11-2010

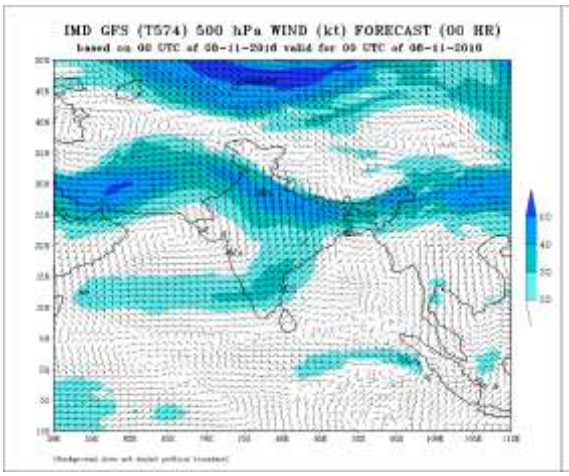

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 12-11-2010

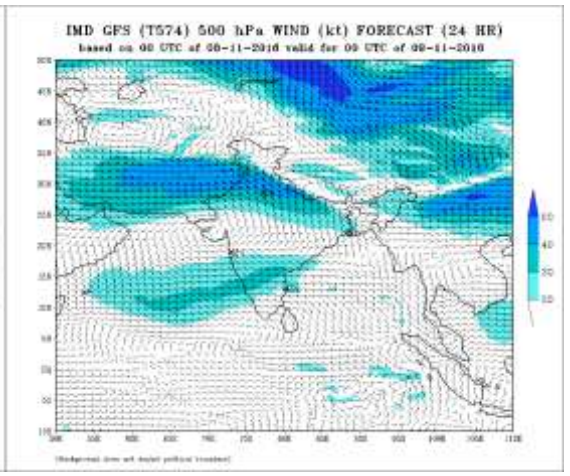

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 13-11-2010

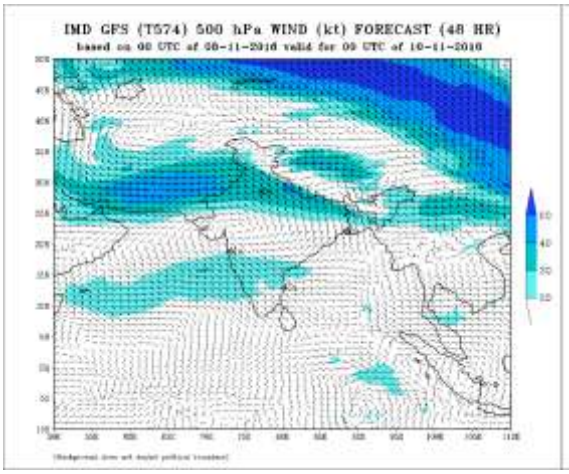

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 08-11-2010 valid for 00 UTC of 08-11-2010
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 08-11-2010 valid for 00 UTC of 09-11-2010

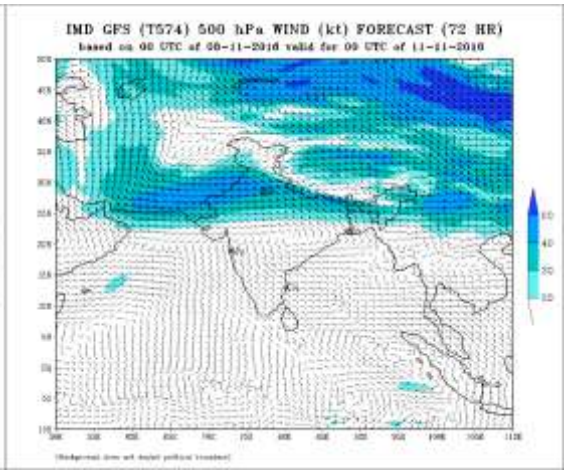

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 08-11-2010 valid for 00 UTC of 10-11-2010
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 08-11-2010 valid for 00 UTC of 11-11-2010

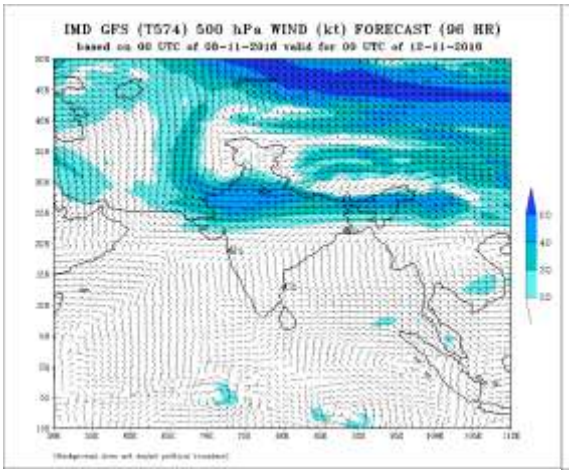

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 08-11-2010 valid for 00 UTC of 12-11-2010
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 08-11-2010 valid for 00 UTC of 13-11-2010

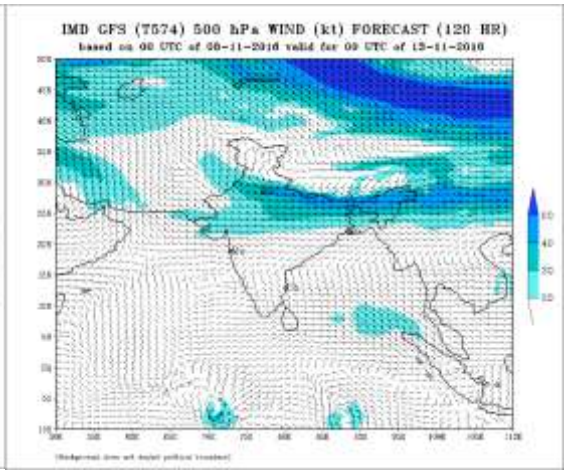

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 08-11-2010

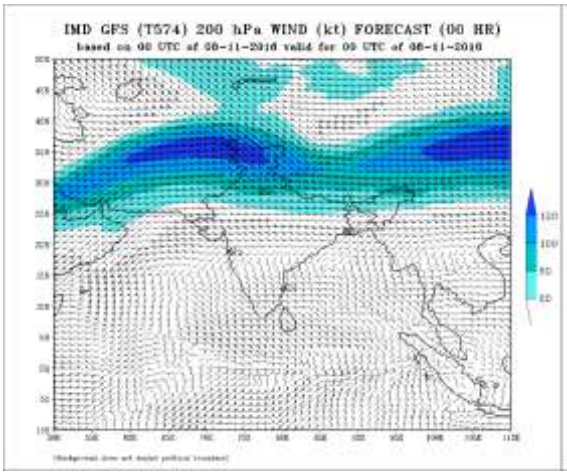

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 09-11-2010

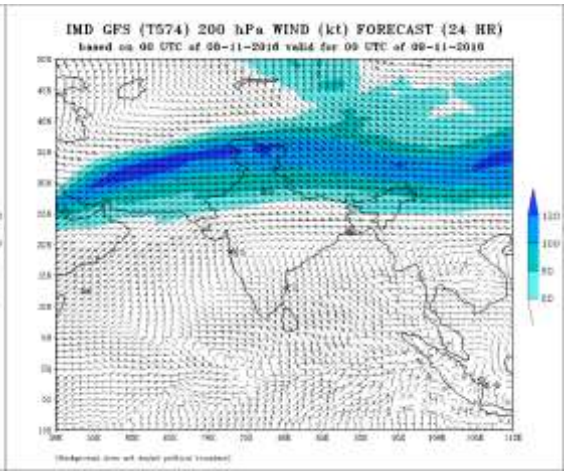

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 10-11-2010

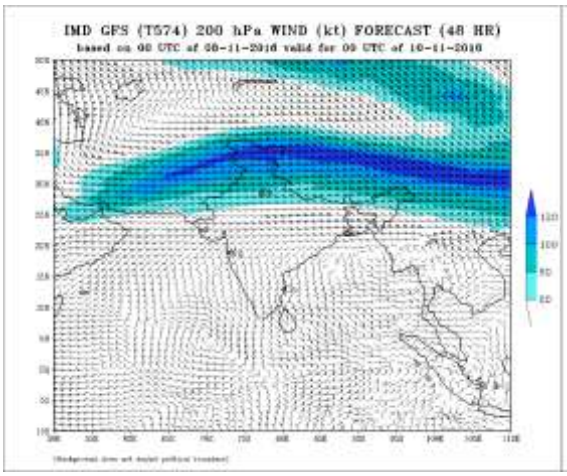

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 11-11-2010

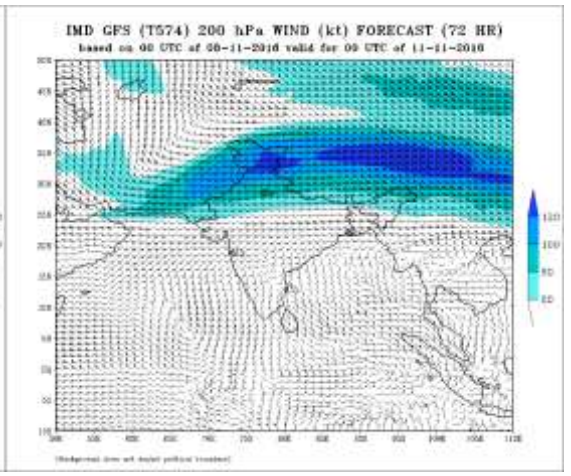

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 12-11-2010

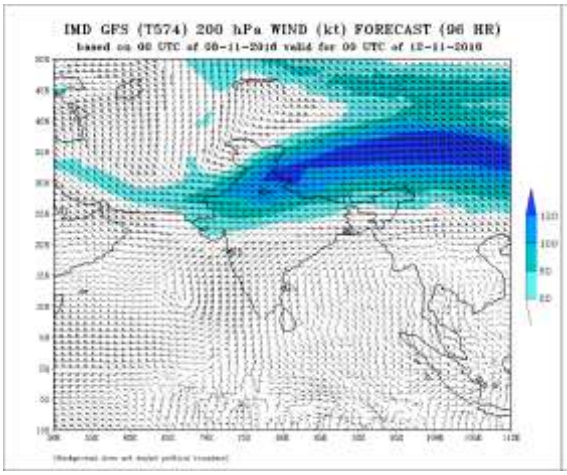

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 08-11-2010 valid for 09 UTC of 13-11-2010

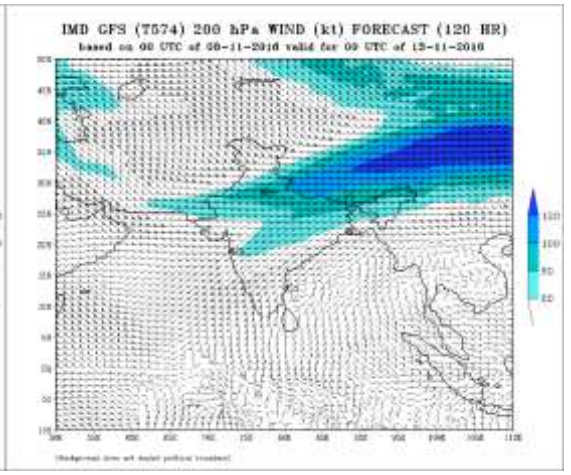

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 08-11-2016 valid for 09 UTC of 08-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 08-11-2016 valid for 09 UTC of 09-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 08-11-2016 valid for 09 UTC of 10-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 08-11-2016 valid for 09 UTC of 11-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 08-11-2016 valid for 09 UTC of 12-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 08-11-2016 valid for 09 UTC of 13-11-2016

FDP (Cyclone) NOC Report Dated 09th November, 2016

Synoptic features:

The cyclonic circulation over Gulf of Siam and neighbourhood now lies over northern parts of Malacca and extends upto 3.1 kms a. s. l. The cyclonic circulation over southeast Bay of Bengal and neighbourhood now lies over north Andaman Sea and adjoining eastcentral Bay of Bengal and extends upto 2.1 kms a. s. l. A cyclonic circulation extending upto 0.9 km a.s.l lies over Lakshadweep and neighbourhood.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of Bay of Bengal. Over Arabian Sea, SST is between 27-29˚C over most areas of north and central Arabian Sea. SST is 28-30˚C over south Arabian Sea except for the western parts of and southwest Arabian Sea where the value is between 27-29 ˚C.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for a small pocket off south Odisha coast and also over southern parts of southeast Bay of Bengal and adjoining Indian Ocean Region, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal. Over entire Arabian Sea, TCHP is less than 70 kJ/CM^2.

Relative Vorticity:

The low level relative vorticity is less than 30x10^{-6} second^{-1} over Bay of Bengal as well as over Arabian Sea.

Convergence:

There is a small area of positive convergence over south Andaman Sea extending to Gulf of Thailand.

Divergence:

The upper level divergence is about 10x10^{-5}s $^{-1}$ over Andaman Sea. There is no significant area of positive divergence over Arabian Sea.

Wind Shear:

Wind shear is low to moderate over north and adjoining central Bay of Bengal extending southeastwards to Andaman Sea. It is low to moderate over northern parts of south Arabian Sea and adjoining east central Arabian Sea. It increases to the northwest and to the southeast.

Wind Shear Tendency:

There is increasing tendency over southern parts of southwest and southeast Bay of Bengal. There is increasing tendency off Somali coast.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over southeast Bay, Andaman Sea and over Gulf of Martaban.

Arabian Sea:

No significant clouds over the region.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 18^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 6 with amplitude more than one. It would move to phase 7 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The forecasts based on 00 UTC of 9 November 2016 shows an upper air cyclonic circulation at 850 hPa over north Andaman Sea & adjoining EC Bay of Bengal and persists for the next 24 hours and then merging with the easterly waves. There is no indication for formation of any low pressure area over NIO regions.

NCEP-GFS: Similar to IMD-GFS model, the forecast based on 00 UTC of 9th November 2016 analysis of NCEP-GFS also shows an upper air cyclonic circulation at 850 hPa level over north Andaman Sea & adjoining EC Bay which persists for the next 24 hours and weakens thereafter.

ECMWF: The model charts based on 00 UTC of 9th November 2016 shows an upper air cyclonic circulation at 850 hPa over north Andaman Sea & adjoining EC Bay which persists for next 24 hours and then merging with

the easterly waves in the 48 hour forecast. There is no indication for formation of any low pressure area over NIO region.

WRF: The WRF model forecast based on 00 UTC of 9 November 2016 show a broad cyclonic circulation at 850 and 700 hPa levels over north Andaman Sea & adjoining EC Bay that persists for the next 24 hours and weakens thereafter.

JMA: Model forecast based on 09th November 00UTC analysis do not indicate formation of low pressure systems over Indian Seas for the coming three days.

Meteo-France ARP Model forecast based on 09th November 00UTC analysis do not indicate formation of low pressure systems over Indian Seas for the coming three days.

NCMRWF-NCUM: No cyclonic circulation in the analysis or in the forecasts till 19th.

NCMRWF-UM-Regional Model: The three day forecast based on analysis of 9th November do not show any low pressure system.

NCMRWF-NEPS Model: The analysis based on 09th November shows a low over southern parts of east central Bay which moves in a northwestward direction and becomes less marked over southwest and adjoining EC Bay of Bengal on 12th without appreciable intensification.

IITM-GEFS: No significant system is expected during next 9 days.

IITM -GFS T1534: The forecast fields based on the analysis of 8th do not give any indication of formation of low pressure systems over Indian Seas during next 8 days.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 9th November 2016 do not suggest any cyclogenesis over Indian seas in the coming 5 days.

Summary and Conclusion:

Some of the models are showing the presence of an upper air cyclonic circulation over north Andaman Sea and adjoining Southeast Bay of Bengal on the analysis as well forecast field for two days. However, none of the models is suggesting formation of a low pressure area under the influence of this cyclonic circulation.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	08/12	**09/00**	**09/03**
India	43	43	46
Coastal stations			
WB	9	8	9
Odisha	7	6	7
AP	9	11	11
Tamil Nadu	11	12	12
Puducherry	1	1	1
A & N	6	5	6
Bangladesh	11	10	15
Myanmar	1	1	12
Thailand	3	3	3
SriLanka	10	9	9

AWS:

Region	Date/Time (UTC)		
	08/12	**09/00**	**09/03**
WB	1	3-	5
Odisha	4	1	4
AP	6	1	3
Tamil Nadu	27	10	18
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 08 / 11 /2016 :39/43
- **No. of Ascents reaching 250 hPa levels: 31 , MISDA:-23**
- **RS/RW** (00Z) of 09 / 11 /2016 : 39/43
- **No. of Ascents reaching 250 hPa levels:31 , MISDA:5**

No. of PILOT Ascents

08/12Z	**09/00Z**
4	3

Buoy Data

08/12Z	**09/00Z**	**09/03Z**
4	3	4

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**08.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**21**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /08.11.2016 : 5

No. of Ascents reaching 250 hPa level = 5

MISDA : 3

12Z /08.11.2016 : 4

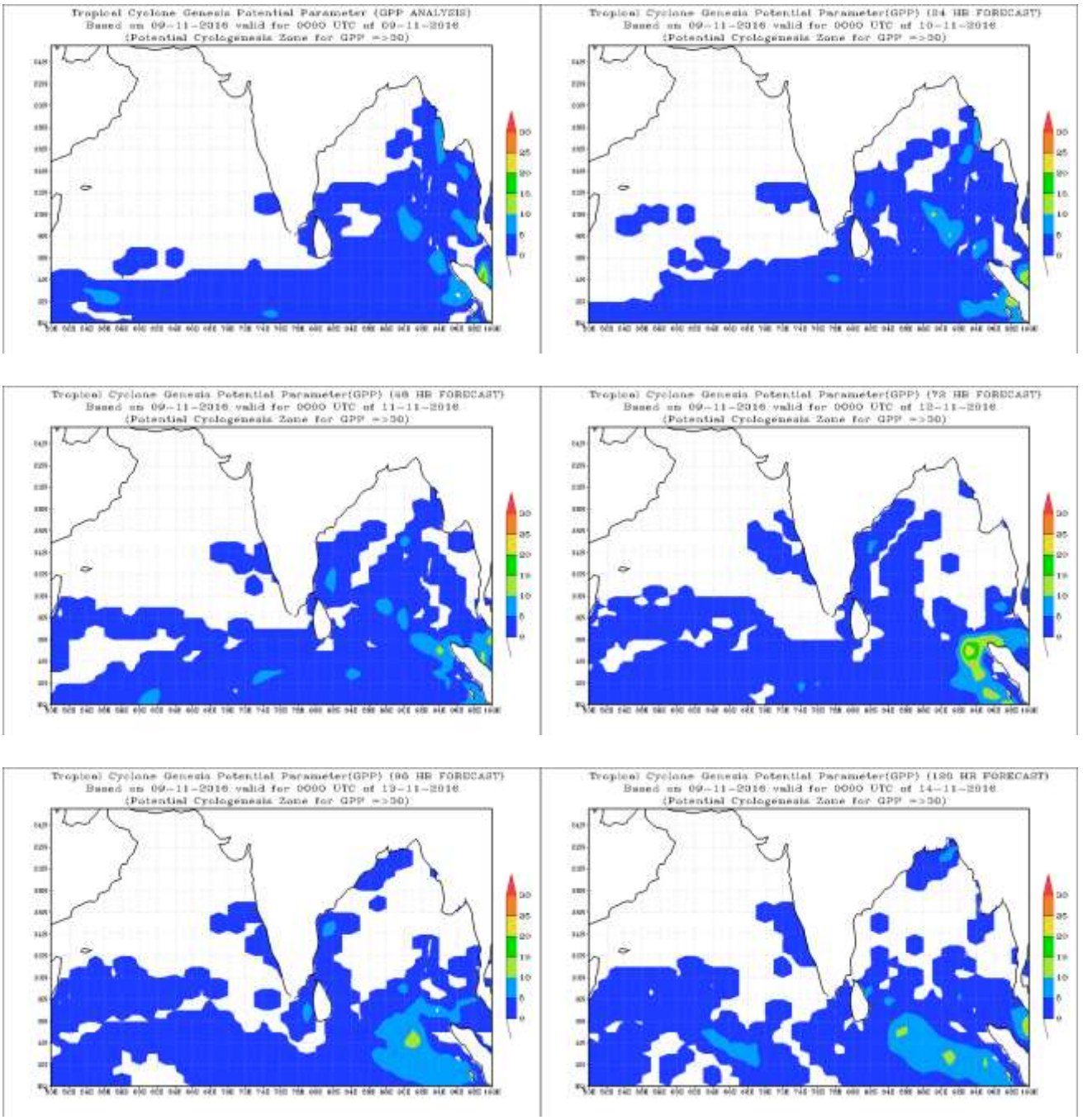
No. of Ascents reaching 250 hPa level = 4

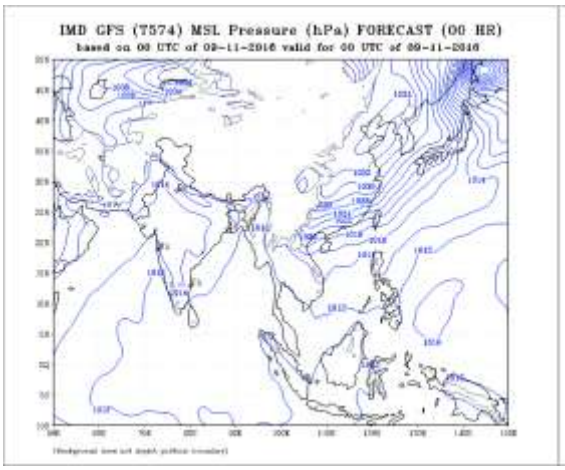
MISDA : 4

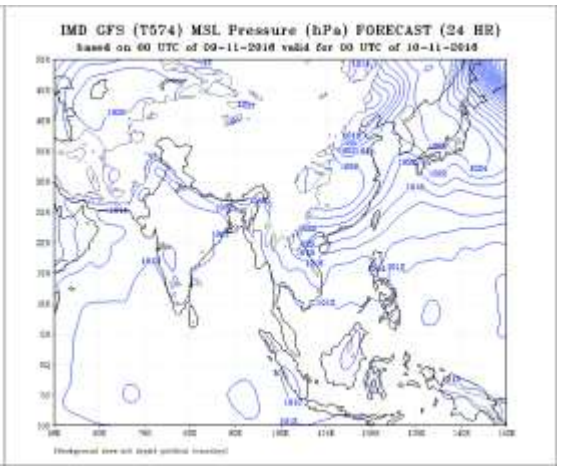
No. of PILOT Ascents:

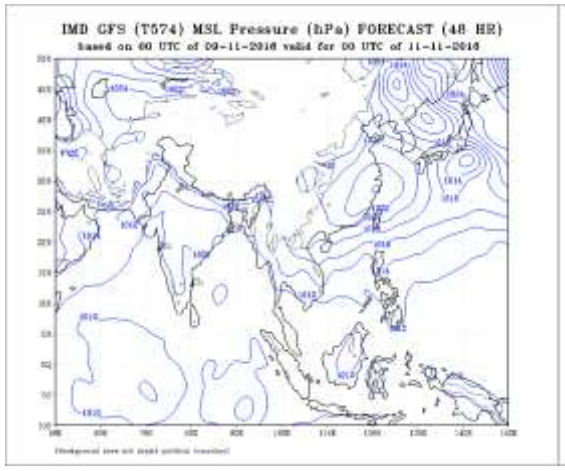
08.11.2016	
06Z	18Z
3	4

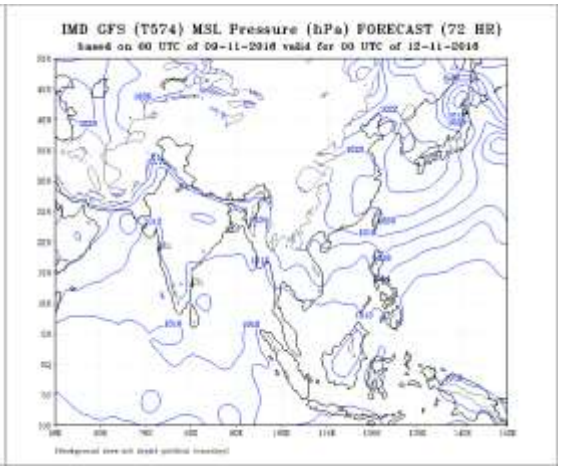
Annexure-II

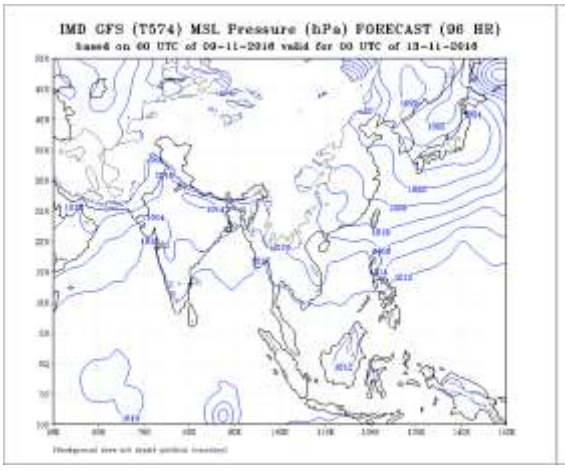

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 09-11-2016 valid for 0000 UTC of 09-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 09-11-2016 valid for 0000 UTC of 10-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 09-11-2016 valid for 0000 UTC of 11-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 09-11-2016 valid for 0000 UTC of 12-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 09-11-2016 valid for 0000 UTC of 13-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 09-11-2016 valid for 0000 UTC of 14-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

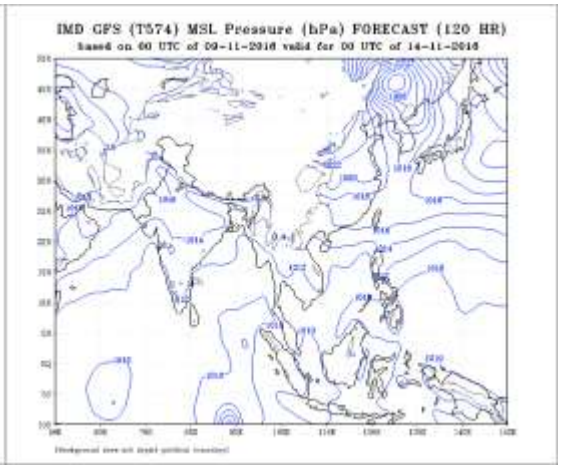

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 09-11-2016

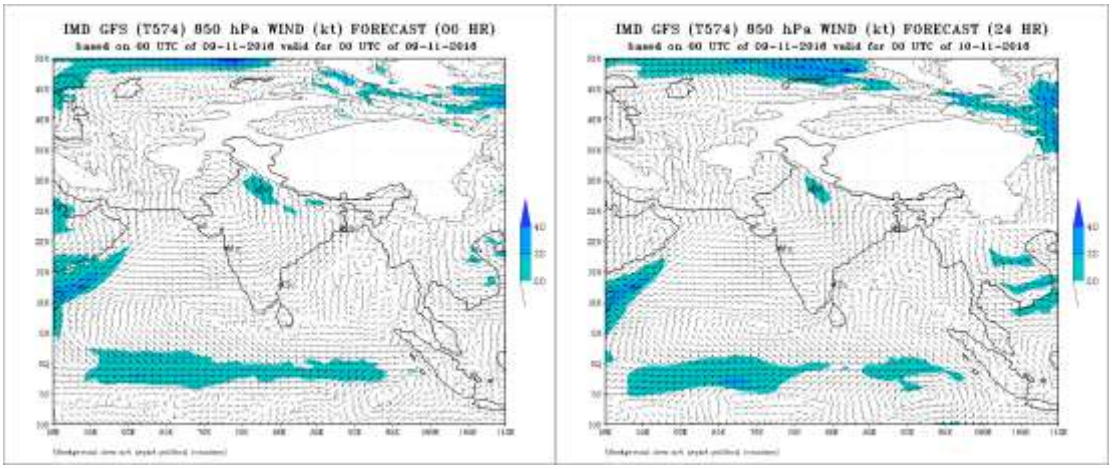

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 10-11-2016

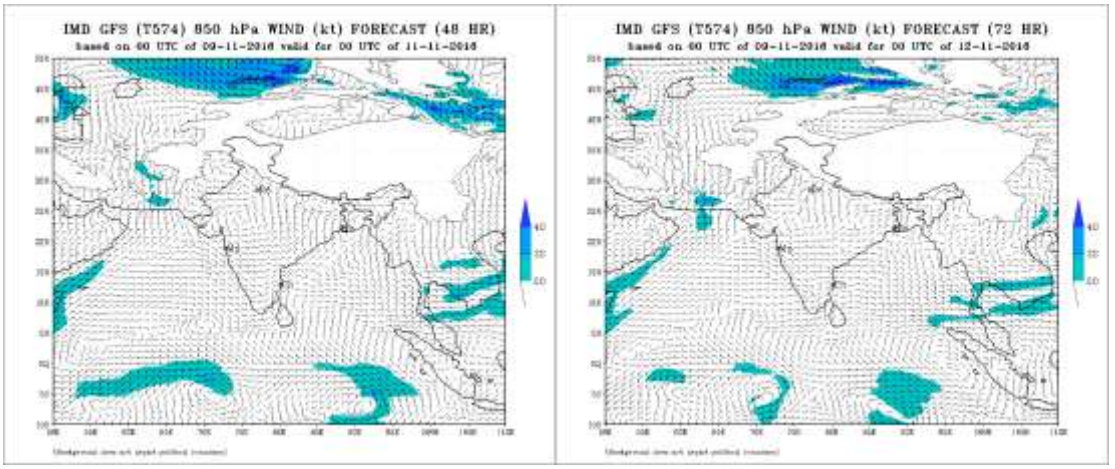

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 11-11-2016

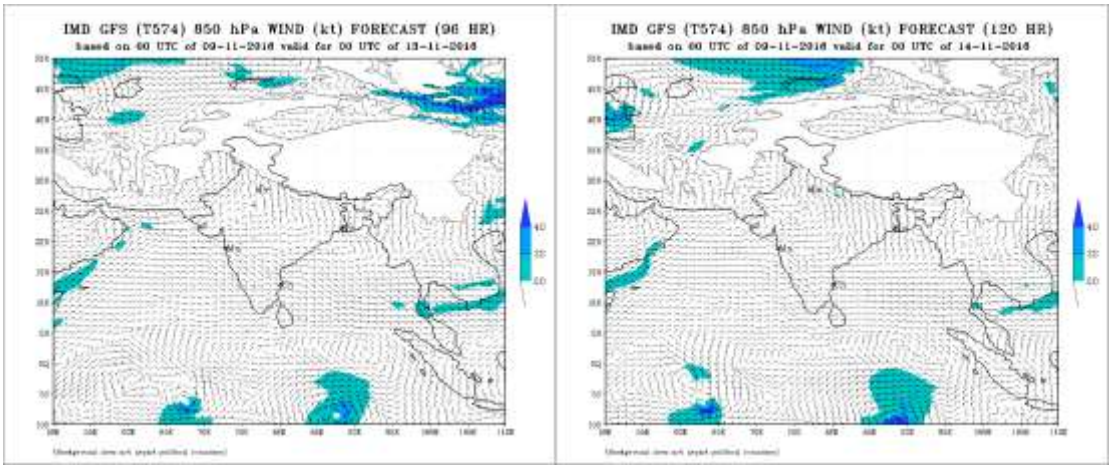

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 12-11-2016

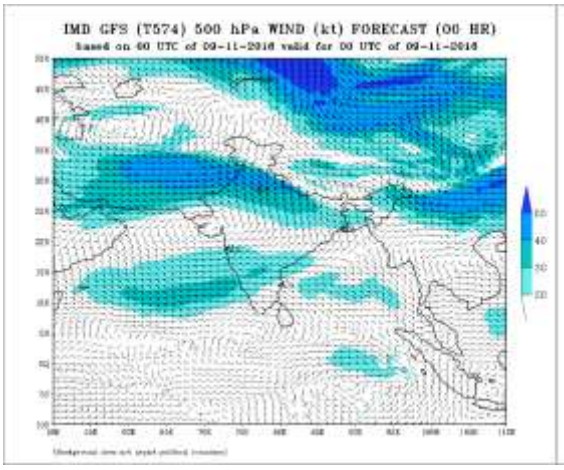

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 13-11-2016

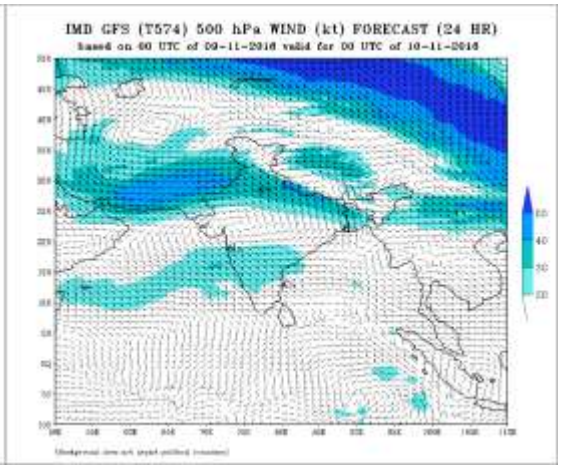

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 14-11-2016

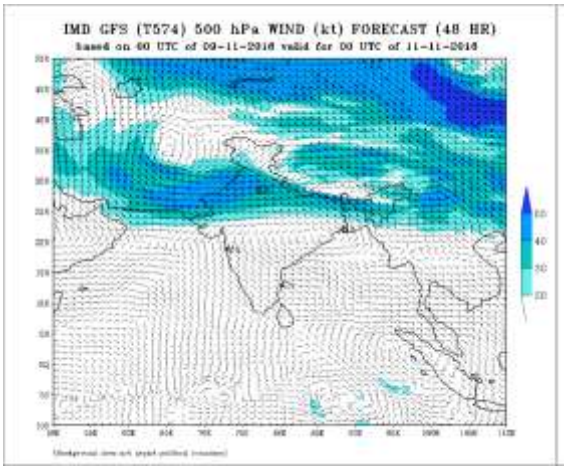

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 09-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 10-11-2016

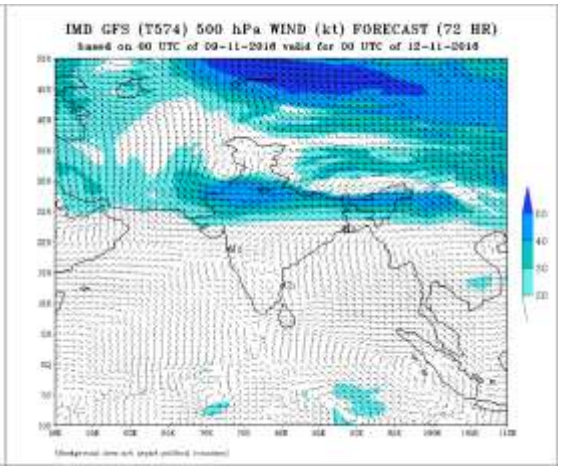

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 11-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 12-11-2016

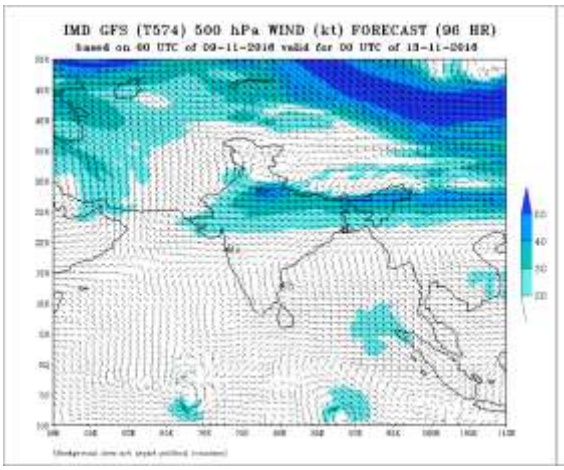

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 13-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 14-11-2016

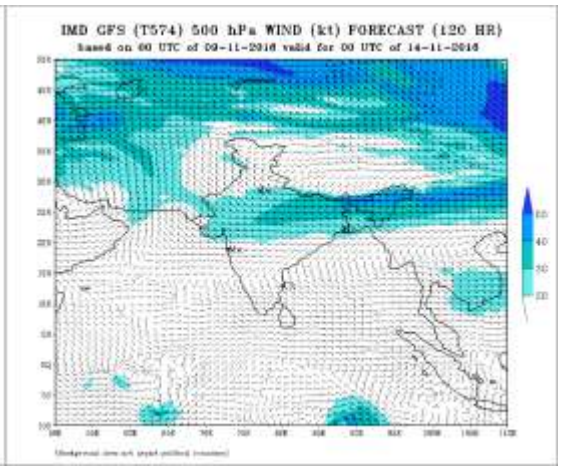

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 09-11-2016

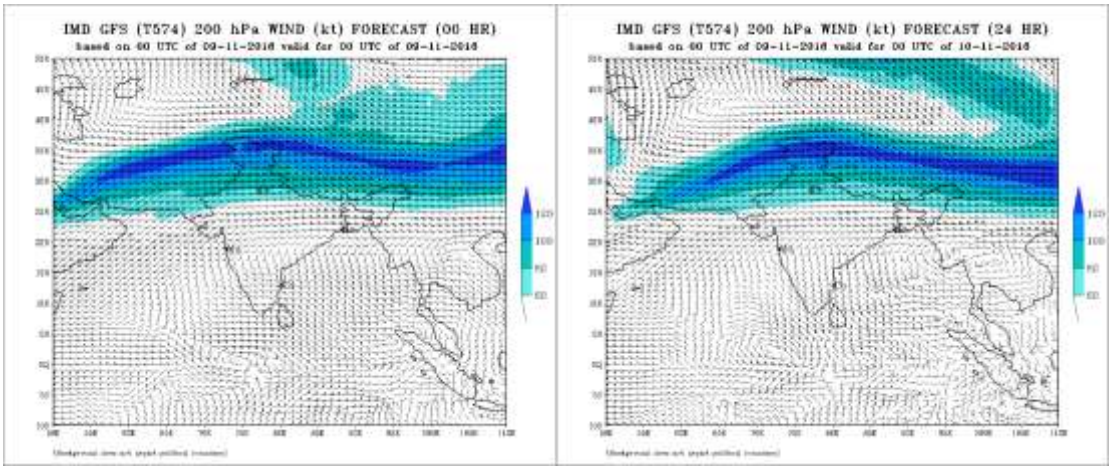

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 10-11-2016

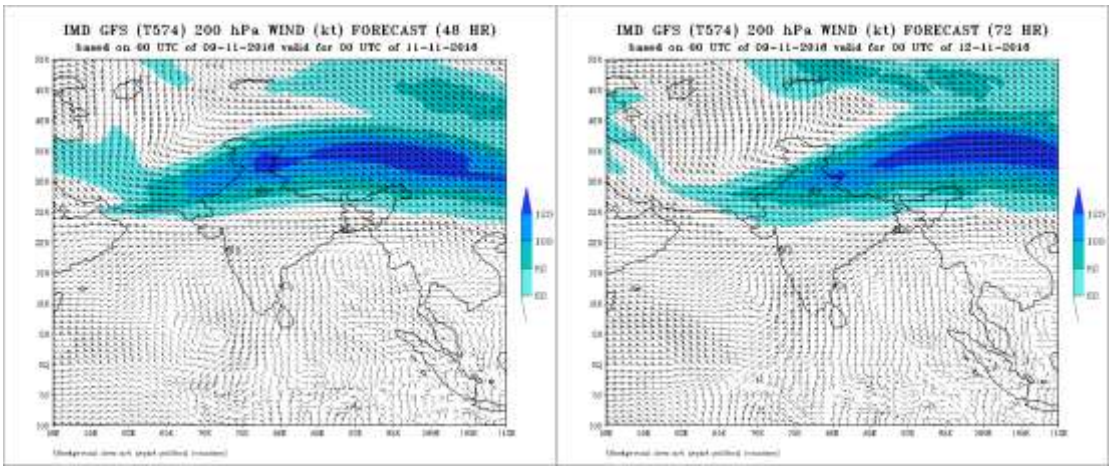

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
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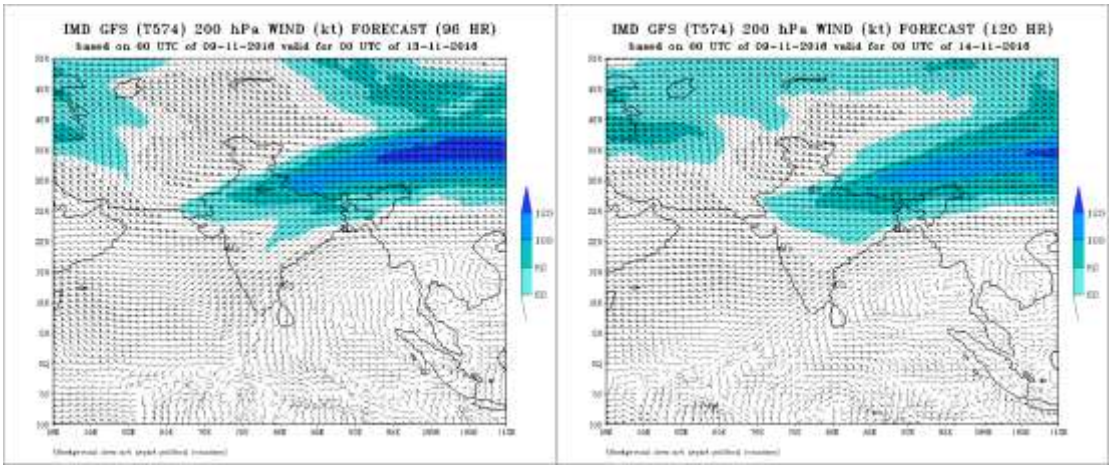

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 12-11-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 13-11-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 14-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 09-11-2016
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 10-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 11-11-2016
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IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 13-11-2016
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 09-11-2016 valid for 00 UTC of 14-11-2016

FDP (Cyclone) NOC Report Dated 10th November, 2016

Synoptic features:

The cyclonic circulation over north Andaman Sea and adjoining eastcentral Bay of Bengal now lies over southeast Bay of Bengal and neighbourhood and extends upto 3.1 kms a. s. l. The cyclonic circulation over Lakshadweep and neighbourhood now lies over Lakshadweep and adjoining Maldives areas and extends upto 3.1 kms a. s. l. tilting southwestwards with heights. The cyclonic circulation over northern parts of Malacca has become less marked.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of Bay of Bengal, except for a small pocket of lesser values in northwest Bay of Bengal. Over Arabian Sea, SST is between 27-29˚C over most areas of north and central Arabian Sea. SST is 28-30˚C over south Arabian Sea except for the western parts of and southwest Arabian Sea where the value is between 27-29˚C.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for a small pocket over South Andaman Sea, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal. Over entire Arabian Sea, TCHP is less than 70 kJ/CM^2.

Relative Vorticity:

The low level relative vorticity is less than 30x10^{-6} second^{-1} over Bay of Bengal as well as over Arabian Sea.

Convergence:

There is a small area of positive convergence 5x10^{-6} s^{-1} over northern parts of southeast Bay.

Divergence:

There is no significant area of positive upper level divergence over Bay of Bengal as well as over Arabian Sea.

Wind Shear:

Wind shear is low to moderate over north and adjoining central Bay of Bengal extending southeastwards to Andaman Sea. It is low to moderate over northern parts of south Arabian Sea and adjoining east central Arabian Sea. It increases to the northwest and to the southeast.

Wind Shear Tendency:

There is a small area of decreasing tendency over northern parts of southeast Bay of Bengal. There is increasing tendency off Somali coast.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over eastcentral BOB, Gulf of Martaban and Andaman Sea.

Arabian Sea:

No significant clouds over the region.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 18^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 7 with amplitude more than one. It would move to phase 8 during next 3 days.

Storms and Depression over South China Sea/ South Indian Ocean: A Depression lay centred over west Pacific near lat. 17^{0}N and 157^{0}E at 0600 UTC of 10th. It would move northwestwards with gradual intensification.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The forecasts based on 00 UTC of 10th November 2016 shows an upper air cyclonic circulation at 850 hPa over equatorial Indian Ocean and adjoining southesat BOB on 14th. Moving westwards, it will persist over equatorial Ocean and adjoining southwest BOB from 15th to 20th November.

NCEP-GFS: The forecasts based on 00 UTC of 10th November 2016 shows an upper air cyclonic circulation at 850 hPa over equatorial Indian Ocean and adjoining southesat BOB on 14th. It will persist over equatorial Ocean and adjoining southwest BOB from 15th to 20th November.
ECMWF: The forecast based on 00 UTC of 10th shows no significant system till 16th November.
WRF: The WRF model forecast based on 00 UTC of 10th November 2016 shows a cyclonic circulation over southeast BOB. It will move west-northwestwards and lay over southeast BOB on 11th and 12th, becoming less marked on 13th.
JMA: The forecast based on 00 UTC of 10th shows no system for next three days.
Meteo-France ARP Model: The forecast based on 00 UTC of 10th shows no system for next three days.
NCMRWF-NCUM: The analysis based on 00 UTC of 10th November shows circulation over southeast BOB on 10th. Moving west-norththwestwards, it will lie over southwest BOB off north Sri Lanka coast on 12th and over Sri Lanka & adjoining Palk Strait on 13th, becoming less marked thereafter.
NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 10th shows no system for next three days.
NCMRWF-NEPS Model: The analysis based on 00 UTC of 10th November shows development of a feeble low over southeast BOB on 10th. Moving west-northwestwards, it will intensify slightly into a low and lie over southeast BOB on 11th and over central parts of south BOB on 12th. Thereafter, it will move northwestwards and lie over central BOB off Andhra Pradesh coast on 13th becoming less marked on 14th. Another extended low is seen over south Andaman Sea and neighbourhood on 16th November. Moving west-northwestwards, it will intensify into a low over southeast & adjoining south Andaman Sea on 17th, deep depression over southeast BOB on 18th, cyclonic storm over southeast & adjoining southwest BOB on 19th & 20th.
IITM-GEFS: The analysis based on 00 UTC of 10th November shows no significant system is expected till 18th November.
IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 10th shows no significant system is expected till 18th November.
Dynamical statistical models
IMD Genesis Potential Parameter (GPP):
Analysis and forecasts of GPP based on 00 UTC of 10th November 2016 does not suggest any cyclogenesis over Indian seas in the coming 5 days.

Summary and Conclusion:

A few models show continuation of the cyclonic circulation over southeast Bay with its westward propagation during next 48 hrs and becoming less marked thereafter. No low pressure area is expected over the north Indian Ocean during next five days.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	09/12	**10/00**	**10/03**
India	42	45	46
Coastal stations			
WB	8	9	9
Odisha	6	7	7
AP	10	11	11
Tamil Nadu	12	11	12
Puducherry	1	1	1
A & N	5	6	6
Bangladesh	15	13	14
Myanmar	1	1	12
Thailand	3	3	3
SriLanka	10	7	9

AWS:

Region	Date/Time (UTC)		
	09/12	**10/00**	**10/03**
WB	4	2-4	5
Odisha	4	1	4
AP	7	3	5
Tamil Nadu	24	9	23
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 09 / 11 /2016 :36/43
- **No. of Ascents reaching 250 hPa levels: 15 , MISDA:-20**
- **RS/RW** (00Z) of 10 / 11 /2016 : 34/43
- **No. of Ascents reaching 250 hPa levels:30 , MISDA:3**

No. of PILOT Ascents

09/12Z	**10/00Z**
5	3

Buoy Data

09/12Z	**10/00Z**	**10/03Z**
3	3	3

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**09.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /09.11.2016 : 7

No. of Ascents reaching 250 hPa level = 6

MISDA : 1

12Z /09.11.2016 : 4

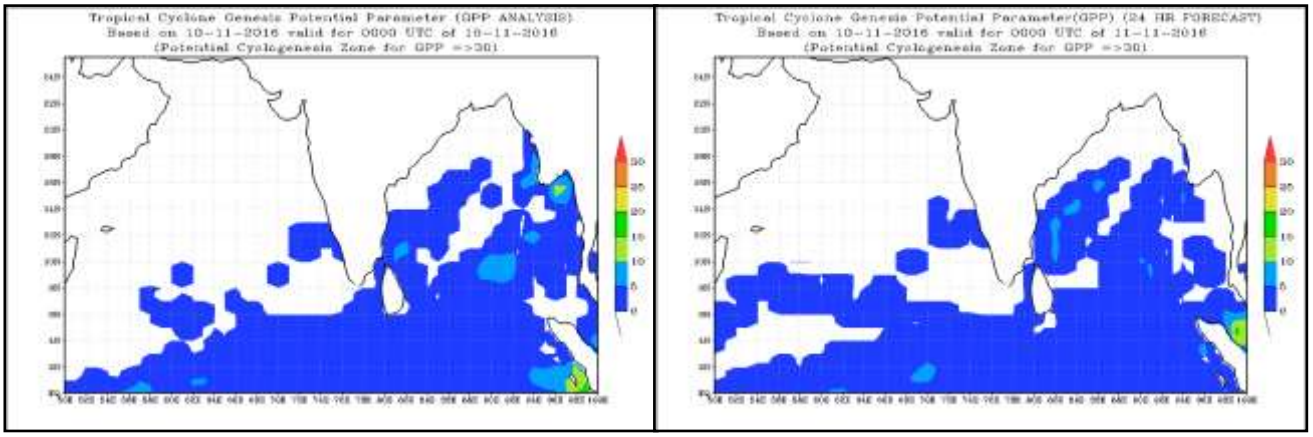
No. of Ascents reaching 250 hPa level = 4

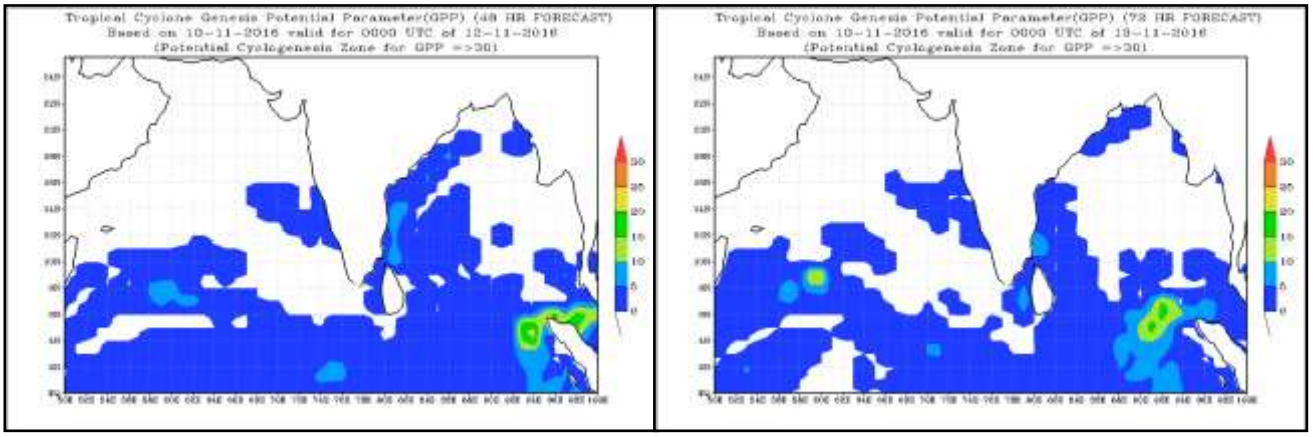
MISDA : 4

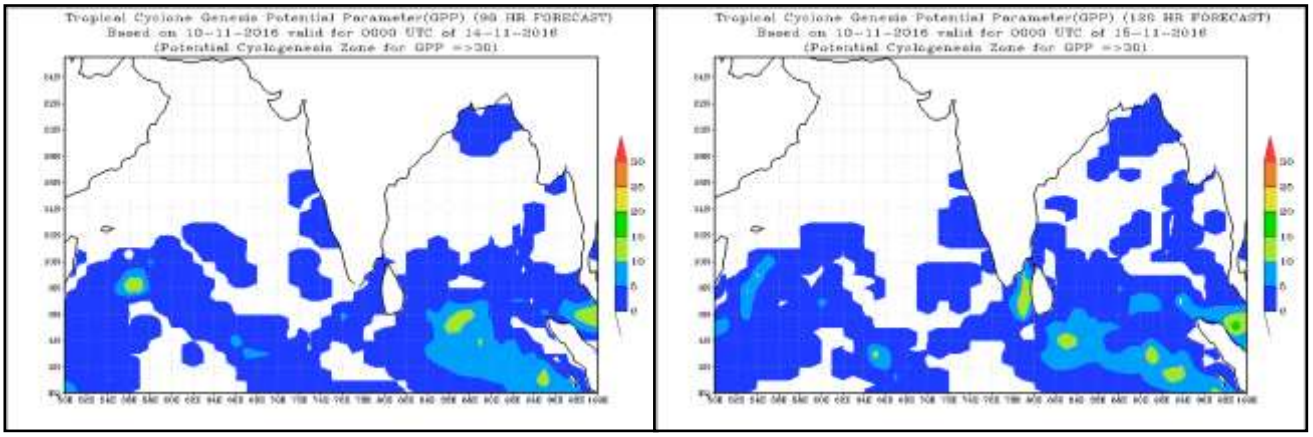
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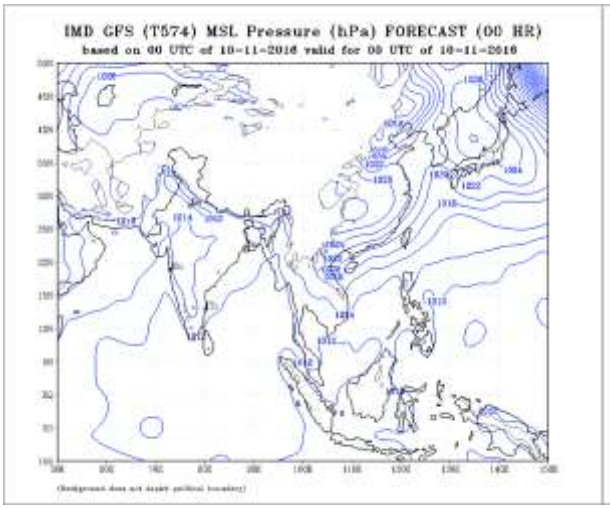
09.11.2016	
06Z	18Z
5	4

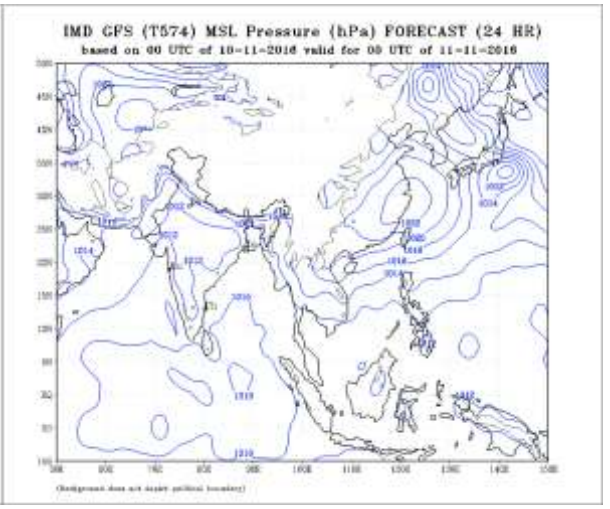
Annexure-II

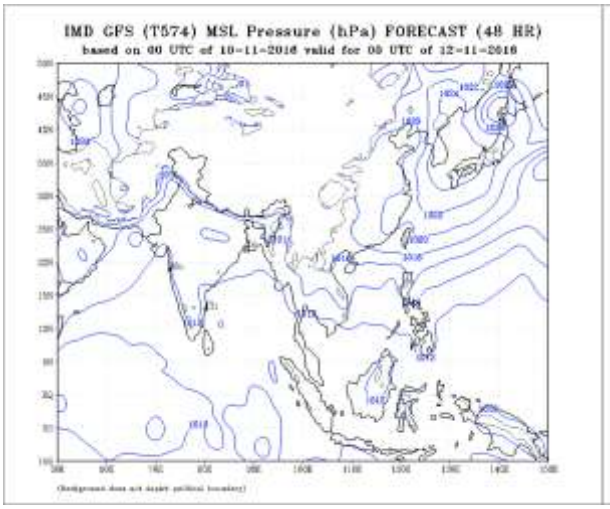

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 10-11-2016 valid for 0000 UTC of 10-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 10-11-2016 valid for 0000 UTC of 11-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

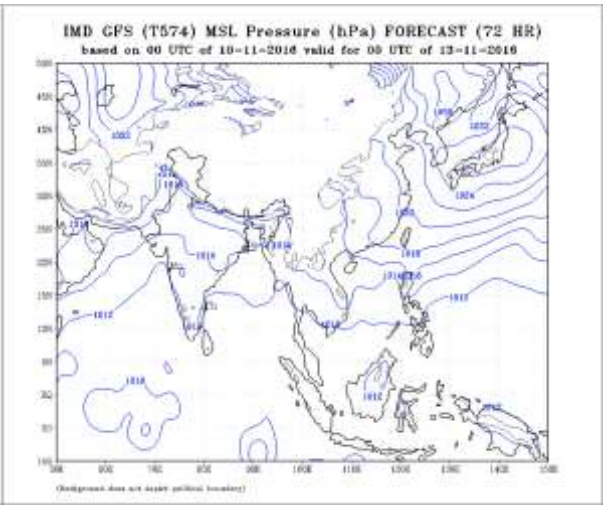

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 10-11-2016 valid for 0000 UTC of 12-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 10-11-2016 valid for 0000 UTC of 13-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

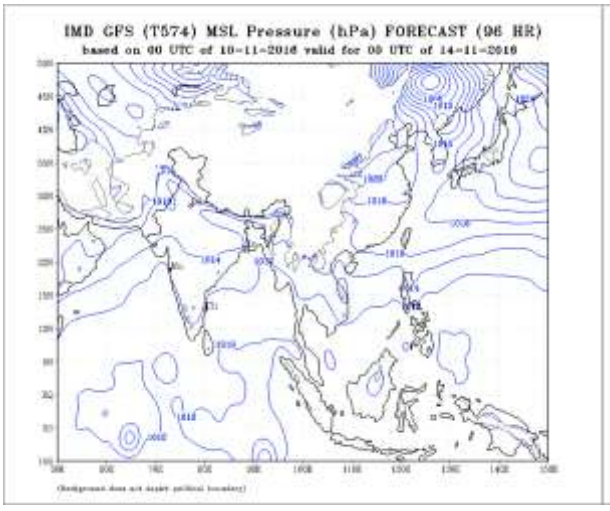

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 10-11-2016 valid for 0000 UTC of 14-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 10-11-2016 valid for 0000 UTC of 15-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

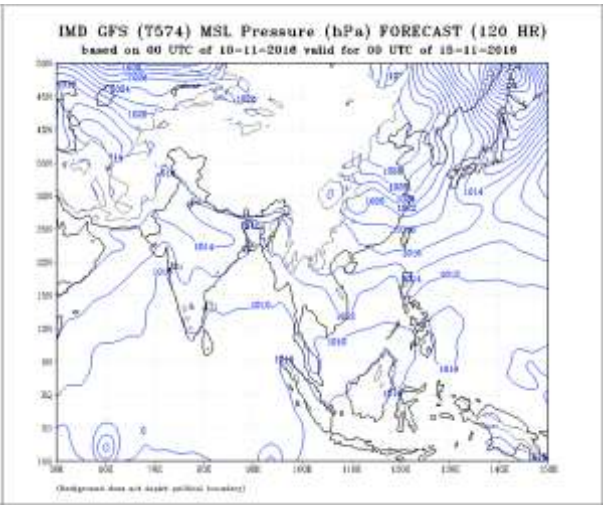

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 10-11-2016

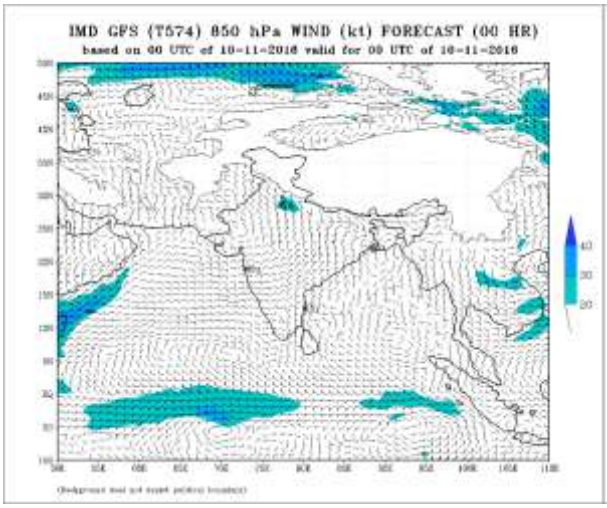

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 11-11-2016

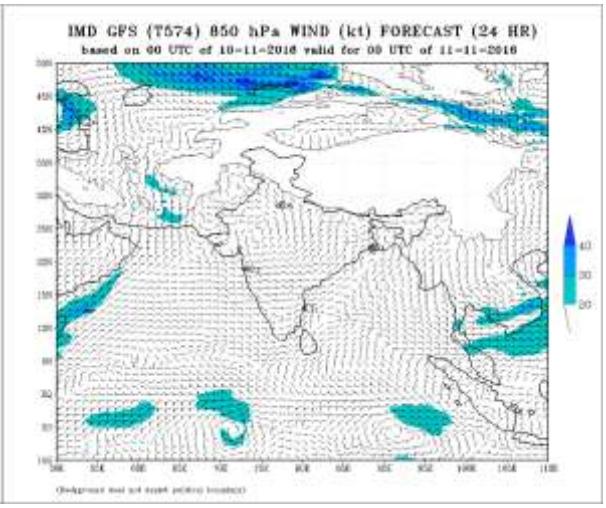

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 12-11-2016

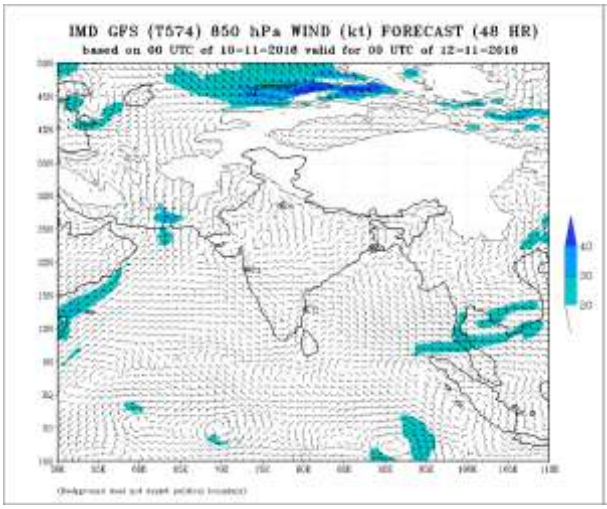

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 13-11-2016

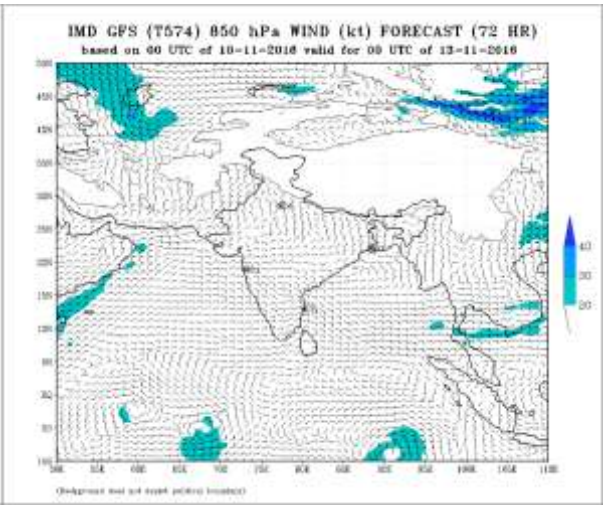

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 14-11-2016

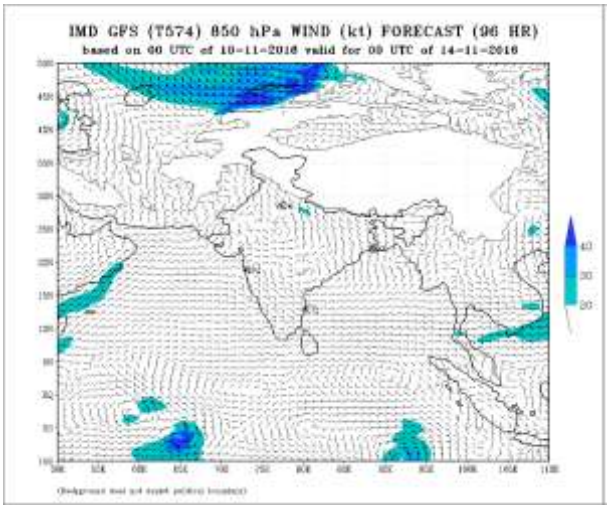

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 15-11-2016

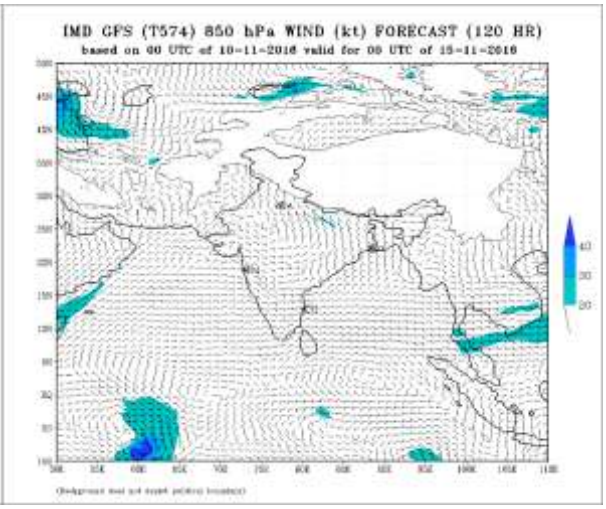

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 10-11-2016

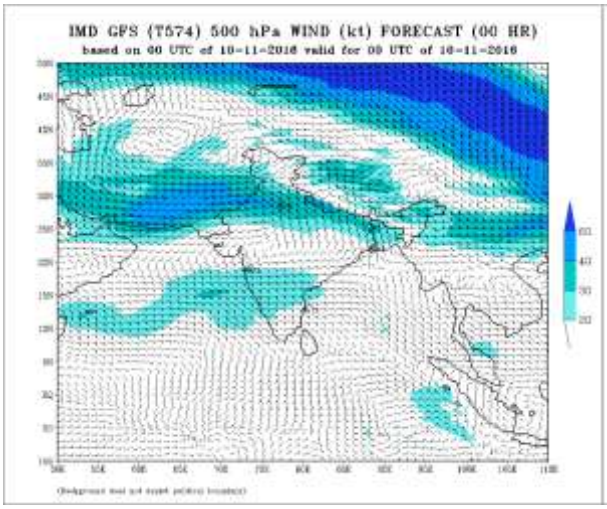

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 11-11-2016

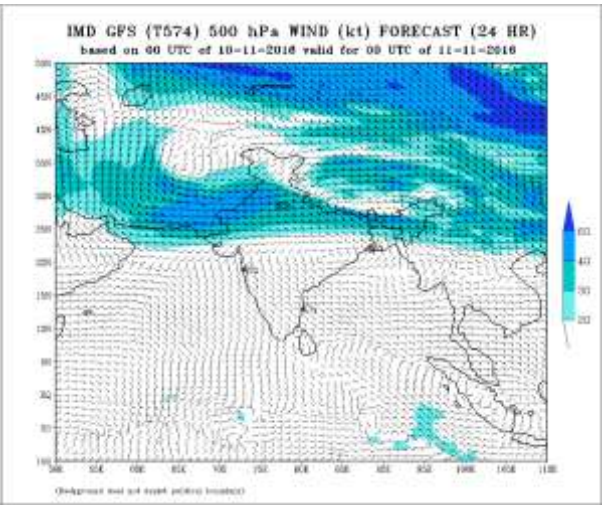

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 12-11-2016

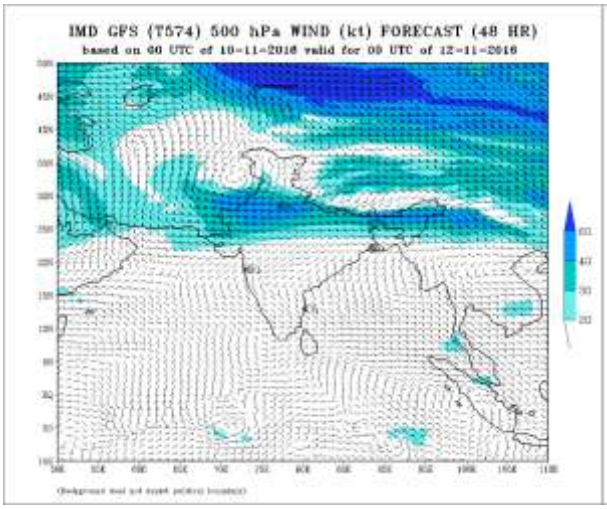

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 13-11-2016

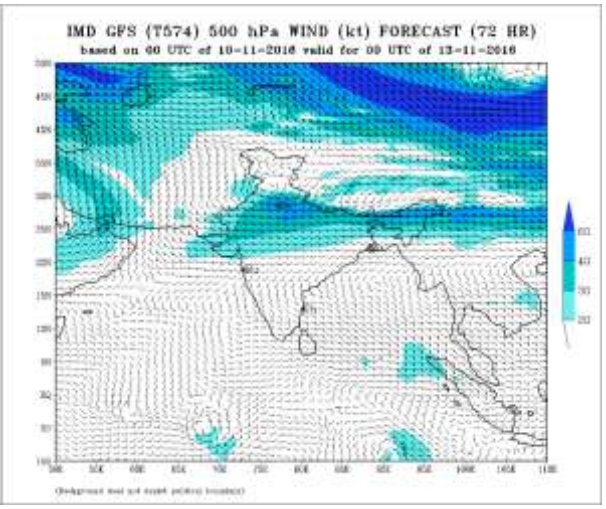

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 14-11-2016

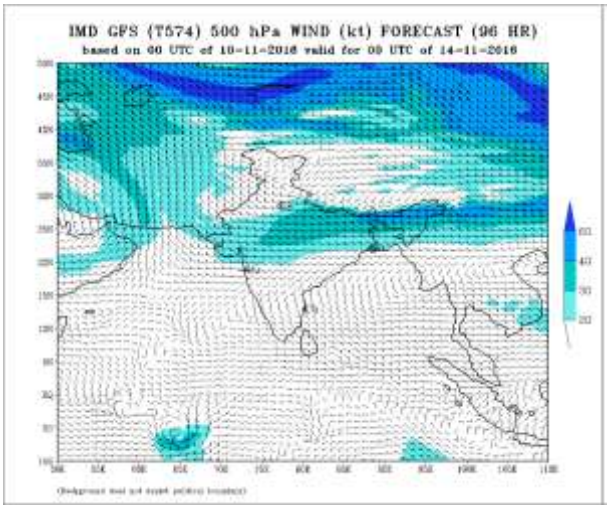

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 15-11-2016

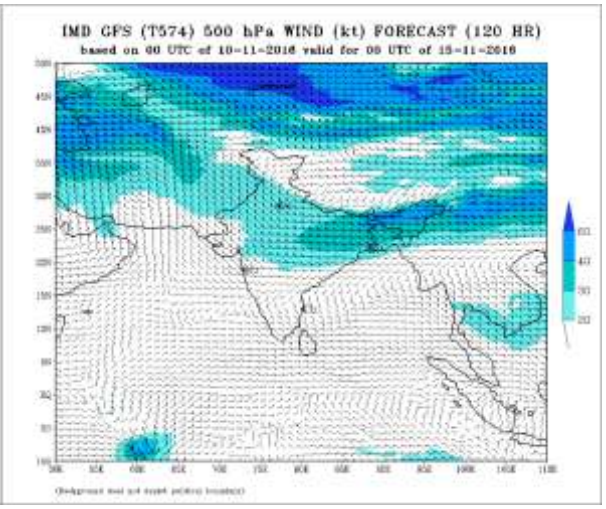

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
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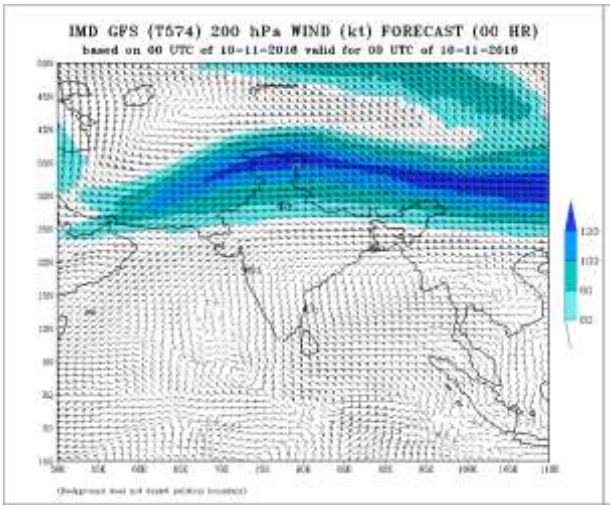

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 11-11-2016

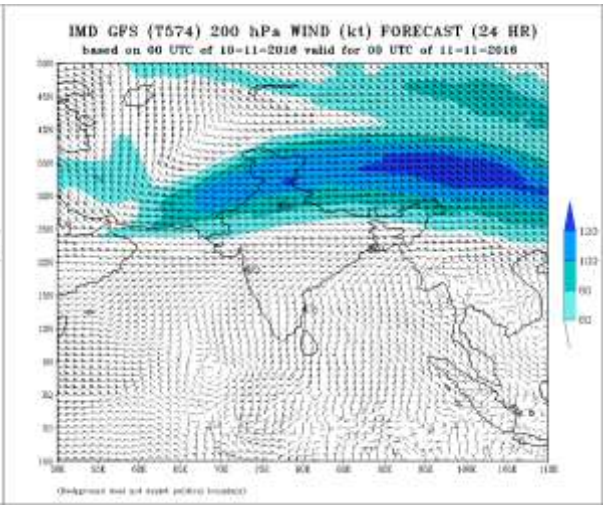

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 12-11-2016

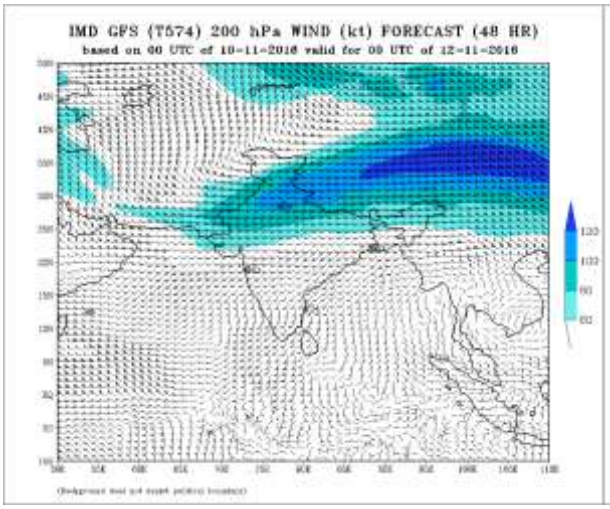

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 13-11-2016

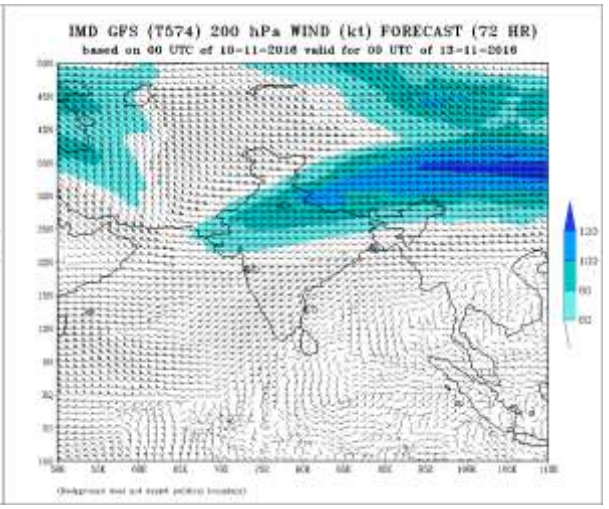

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
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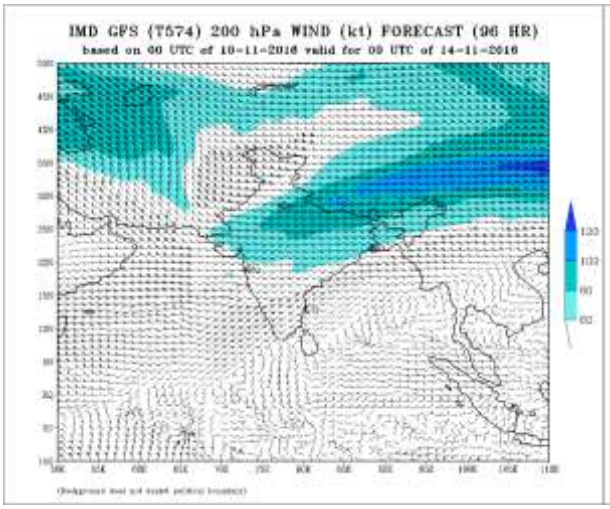

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 15-11-2016

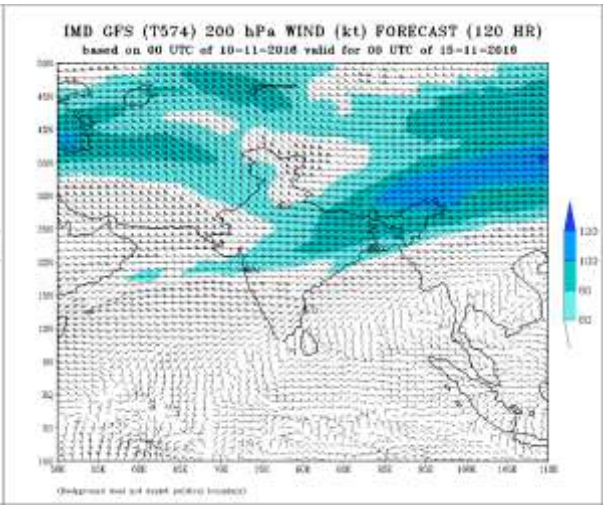

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 10-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 11-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 12-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 13-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 14-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 10-11-2016 valid for 00 UTC of 15-11-2016

FDP (Cyclone) NOC Report Dated 11th November, 2016

Synoptic features:

Yesterday's cyclonic circulation over southeast Bay of Bengal (BOB) and neighbourhood lay over south BOB extending upto 3.1 kms a. s. l. The upper air cyclonic circulation over Lakshadweep & adjoining Maldives area has merged with the east-west shear zone in the lower levels running along latitude 5.0^0N.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of BOB, except for a small pocket of lesser values in northwest BOB off West Bengal & Bangladesh coast.

The SST over Arabian Sea (AS) is between 27-29˚C over most areas of north and central AS. SST is 26˚C over westcentral & parts of southwest AS. SST is 31-32˚C over parts of northeast AS off Gujarat & adjoining north Maharashtra coast.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for a small pocket over South Andaman Sea, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal.

TCHP is less than 50 kJ/cm^2 over north and westcentral AS. It is 60-80 kJ/cm^2 over remaining parts of AS.

Relative Vorticity:

The low level relative vorticity is less about 25x10^{-6} second^{-1} over south BOB & adjoining Andaman Sea and a southwest-northeast oriented band of vorticity 25x10^{-6} second^{-1} lies along east coast of India. It is negative over eastern parts of BOB and north Andaman Sea.

The low level relative vorticity over AS is 25x10^{-6} second^{-1} over southeast & adjoining eastcentral AS off Karnataka coast and a southwest-northeast oriented band of vorticity 25x10^{-6} second^{-1} lies over parts of west AS.

Convergence:

There is an elongated zone of positive lower level convergence about 15x10^{-6} s^{-1} over equatorial region and adjoing south Andaman Sea.

Over AS, lower level convergence is 5-10x10^{-6} s^{-1} over parts of southwest AS.

Divergence:

There is no significant area of positive upper level divergence over Bay of Bengal as well as over Arabian Sea. An elongated zone of positive upper level divergence of 5-10x10^{-6} s^{-1} over equatorial & adjoining south Andaman Sea.

Wind Shear:

Wind shear is 5-10 kts (low) over entire BOB.

Wind shear is 10-15 kts (moderate) over parts of southeast & adjoining eastcentral AS. It is increasing towards west and north.

Wind Shear Tendency:

There is decreasing tendency over entire BOB.

There is an elongated southwest-northeast oriented zone of increasing tendency (5-10 kts) extending from southwest AS to northeast AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over Gulf of Martaban and south Andaman Sea.

Arabian Sea:

No significant clouds over the region.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 15^0N latitude over BoB.

M.J.O. Index: MJO index is in Phase 7 with amplitude more than one. It would move to phase 8 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean: Yesterday's depression moved west-northwestwards & intensified into a cyclonic storm MA-ON over west Pacific. At 0600 UTC of 11th, it lay centered near lat. 19.2^{0}N and 150.9^{0}E. It would move northwestwards till 12th midnight and gradually recurve west-southwestwards thereafter with weakening trend.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The forecasts based on 12 UTC of 10th November 2016 shows an upper air cyclonic circulation at 850 hPa over equatorial Indian Ocean and adjoining southwest BOB on 11th. It becomes less marked on 12th and a trough approaches TN coast on 13th. No low pressure area is expected during next 5 days

NCEP-GFS: The forecasts based on 00 UTC of 10th November 2016 shows an upper air cyclonic circulation at 850 hPa over southAndaman Sea and adjoining southesat BOB on 12 and 13th. It becomes less marked thereafter. No low pressure is expected during next five days.

ECMWF: The forecast based on 00 UTC of 11th shows no significant system (Low) till 17th November.

WRF: The WRF model forecast based on 12 UTC of 10th November 2016 shows a cyclonic circulation over southeast BOB. It will move west-northwestwards and lay over southeast BOB on 12th, becoming less marked on 13th.

JMA: The forecast based on 00 UTC of 11th shows no system for next three days.

Meteo-France ARP Model: The forecast based on 00 UTC of 11th shows no system for next three days.

NCMRWF-NCUM: The analysis based on 00 UTC of 11h November shows no circulation over BOB till 16th. A circulation develops over southwest and adjoining equatorial Indian Ocean on 17th. It moves west northwestwards and reaches southwest Bay and adjoining Sri Lanka coast on 20th.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 11th shows no system for next three days.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 11th November shows development of a low over southwest BOB on 12th, which becomes less marked on 13th. Thereafter, there is no development of low pressure system till 21 Nov. 2016.

IITM-GEFS: The analysis based on 00 UTC of 10th November shows no significant system is expected till 18th November.

IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 10th shows no significant system is expected till 18th November.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 11th November 2016 does not suggest any cyclogenesis over Indian seas in the coming 7 days.

Summary and Conclusion:

No low pressure area is expected over the north Indian Ocean during next five days.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	10/12	11/00	11/03
India	44	43	46
Coastal stations			
WB	9	8	9
Odisha	7	6	7
AP	9	11	11
Tamil Nadu	12	11	12
Puducherry	1	1	1
A & N	6	6	6
Bangladesh	14	11	15
Myanmar	9	9	8
Thailand	3	3	3
SriLanka	10	8	10

AWS:

Region	Date/Time (UTC)		
	10/12	11/00	11/03
WB	4	1	5
Odisha	5	1	3
AP	7	3	5
Tamil Nadu	23	9	26
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 10 / 11 /2016 :39/43
- **No. of Ascents reaching 250 hPa levels: 18 , MISDA:-21**

- **RS/RW** (00Z) of 11 / 11 /2016 : 37/43

- **No. of Ascents reaching 250 hPa levels:32 , MISDA:5**
-

No. of PILOT Ascents

10/12Z	11/00Z
4	4

Buoy Data

10/12Z	11/00Z	12/03Z
4	3	6

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**09.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

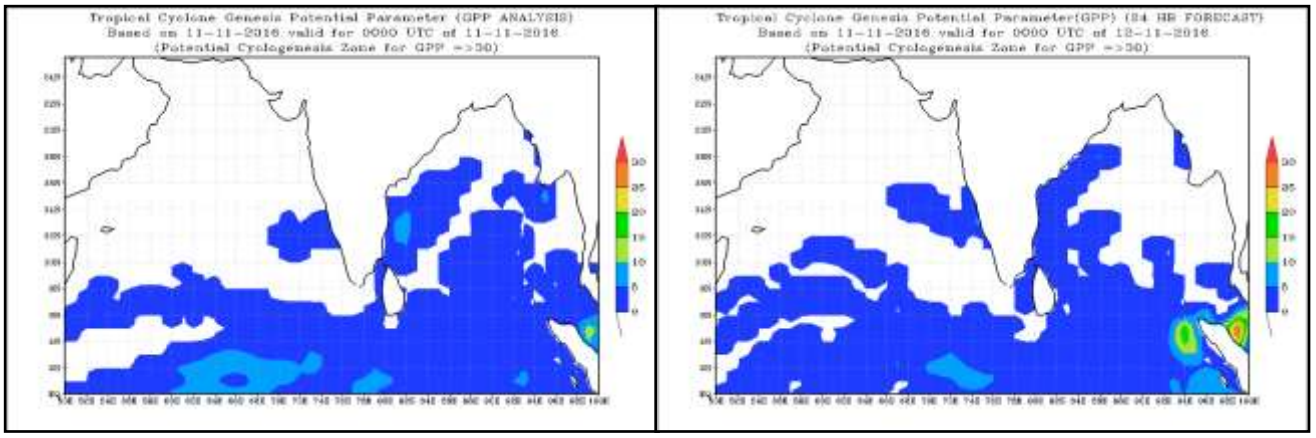
00Z /09.11.2016 : 7
No. of Ascents reaching 250 hPa level = 6
MISDA : 1

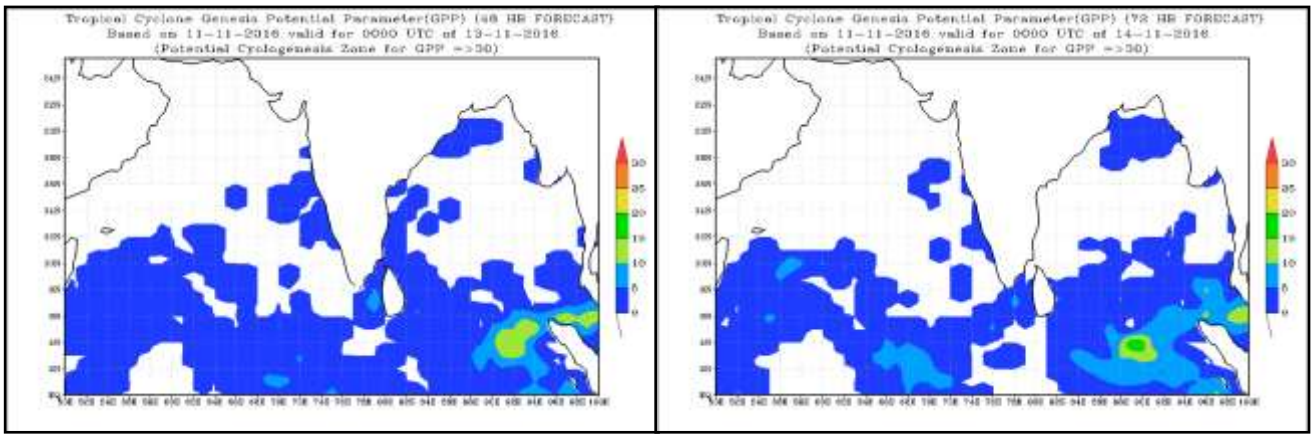
12Z /09.11.2016 : 4
No. of Ascents reaching 250 hPa level = 4
MISDA : 4

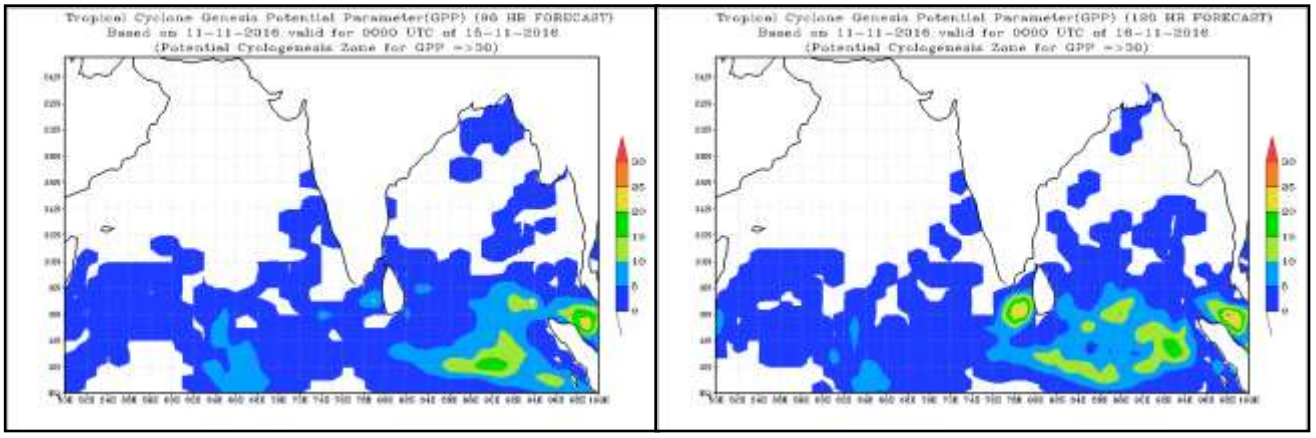
No. of PILOT Ascents:

09.11.2016	
06Z	18Z
5	4

Annexure-II


Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 11-11-2016 valid for 0000 UTC of 11-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 11-11-2016 valid for 0000 UTC of 12-11-2016
(Potential Cyclogenesis Zone for GPP =>30)


Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 11-11-2016 valid for 0000 UTC of 13-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 11-11-2016 valid for 0000 UTC of 14-11-2016
(Potential Cyclogenesis Zone for GPP =>30)


Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 11-11-2016 valid for 0000 UTC of 15-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 11-11-2016 valid for 0000 UTC of 16-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

FDP (Cyclone) NOC Report Dated 12th November 2016

Synoptic features:

Yesterday's upper air cyclonic circulation over central parts of south Bay of Bengal & neighborhood, now lies as a trough in easterlies over southwest Bay of Bengal & neighborhood and extends up to 1.5 km above mean sea level. The upper air cyclonic circulation over Coastal Karnataka & adjoining interior Karnataka, now lies over the eastcentral Arabian Sea & adjoining coastal Karnataka and extends up to 1.5 km above mean sea level.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of BOB, except for a small pocket of lesser values in northwest BOB off West Bengal & Bangladesh coast.

The SST over Arabian Sea (AS) is between 27-29˚C over most areas of north and central AS. SST is 26˚C over westcentral & over parts of southwest Arabian Sea. SST is 31-32˚C over parts of northeast AS off Gujarat & adjoining north Maharashtra coast.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for a small pocket over South Andaman Sea, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal.

TCHP is less than 50 kJ/cm^2 over north and westcentral Arabian Sea. It is 60-80 kJ/cm^2 over remaining parts of Arabian Sea.

Relative Vorticity:

The low-level relative vorticity is less than about 25x10^{-6} second^{-1} over south BOB & adjoining the Andaman Sea and a southwest-northeast oriented band of vorticity 25x10^{-6} second^{-1} lies along some parts of the east coast of India. It is negative over eastern parts of BOB and the north Andaman Sea.

The low-level relative vorticity over AS is 25x10^{-6} second^{-1} over southeast & adjoining eastcentral AS off Karnataka coast and a southwest-northeast oriented band of vorticity 25x10^{-6} second^{-1} lies over parts of west AS.

Convergence:

There is an elongated zone of positive lower level convergence about 5x10^{-6} s^{-1} over equatorial region, south Andaman Sea and north Sri Lanka off Tamil Nadu coast.

Over AS, lower level convergence is 5-15x10^{-6} s^{-1} over parts of southwest AS.

Divergence:

There is no significant area of positive upper-level divergence over the Bay of Bengal as well as over the Arabian Sea. An elongated zone of positive upper-level divergence of 5-10x10^{-6} s^{-1} over equatorial & adjoining the southeast Bay of Bengal and the south Andaman Sea.

Wind Shear:

Wind shear is 5-15 kts (low) over entire BOB.

Wind shear is 15-20 kts (moderate) over parts of southeast & adjoining eastcentral AS. It is increasing towards west and north.

Wind Shear Tendency:

There is increasing tendency (5-10 kts) over entire BOB.

There is an elongated southwest-northeast oriented zone of increasing tendency (5-10 kts) extending from southwest AS to northeast AS.

Satellite observations based on 0600 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over Eastcentral Bay of Bengal, Arakan coast and south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded weak to moderate convection are seen over southeast Arabian sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 13^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 7 with amplitude more than one. It would move to phase 8 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean: Yesterday's cyclonic storm MA-ON over west Pacific. At 0600 UTC on 12th, it lay centered near lat. 21.7^{0}N and 144.7^{0}E. It would move northwestwards till 12th midnight and gradually recurve west-southwestwards thereafter with weakening trend.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The forecasts based on 00 UTC of 12th November 2016 shows an east west shear zone to the south of 5^{0}N during next five days. An upper air cyclonic circulation at lower levels lies over southeast Bay and adjoining equatorial Indian Ocean on 15th, Moving west-northwestwards, it lies over southwest Bay and adjoining Equatorial Indian Ocean off south Sri Lanka coast on 17th Nov.

NCEP-GFS: The forecasts based on 00 UTC of 12th November 2016 shows an upper air cyclonic circulation at lower levels southeast Bay and adjoining equatorial Indian Ocean 15th, Moving west-northwestwards, it lies over southwest Bay and adjoining Equatorial Indian Ocean off south Sri Lanka coast on 17th Nov.

ECMWF: The forecast based on 00 UTC of 12th shows no significant system (Low) till 18th November.

JMA: The forecast based on 00 UTC of 12th shows no system for next three days.

Meteo-France ARP Model: The forecast based on 00 UTC of 12th shows no system for next three days.

WRF: The WRF model forecast based on 00 UTC of 12th November 2016 shows an east-west shear zone to the south of 5^{0}N during next 72 hrs

NCMRWF-NCUM: The analysis based on 00 UTC of 12h November shows no circulation over BOB till next 7 days.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 12th shows no system for next three days.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 12th November shows the development of a low over southern parts of southwest BOB, off Sri Lanka on 19th, which becomes more marked on 20th and a depression on 21st and becomes less marked on 22nd over the same area.

IITM-GEFS: The analysis based on 00 UTC of 12th November shows that no low pressure system is expected over Indian Sea until 20th November.

IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 12th November shows that no low pressure system is expected until 20th November.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 12th November 2016 do not suggest any cyclogenesis over Indian seas in the coming 7 days.

Summary and Conclusion:

No low pressure area is expected to form over the north Indian Ocean during next five days.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	11/12	12/00	12/03
India	47	41	46
Coastal stations			
WB	8	9	8
Odisha	6	7	7
AP	11	11	11
Tamil Nadu	15	11	13
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	13	15	12
Myanmar	9	0	12
Thailand	3	3	3
SriLanka	5	7	8

AWS:

Region	Date/Time (UTC)		
	11/12	12/00	12/03
WB	5	0	6
Odisha	7	1	6
AP	10	6	10
Tamil Nadu	28	8	25
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 11 / 10 /2016 15/36
- **No. of Ascents reaching 250 hPa levels: 15 , MISDA:- 20**
- **RS/RW** (00Z) of 12 / 10 /2016 35/43
- **No. of Ascents reaching 250 hPa levels: 33 , MISDA: 6**

No. of PILOT Ascents

11/12Z	12/00Z
4/69	4/69

Buoy Data

11/12Z	12/00Z	12/03Z
17	16	17

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	12.11.2016							
UTC→	00	03	06	09	12	15	18	21
Chennai Region (Coasts of AP & TN)	20	22	20	20	22	20	20	20

No. of RS/RW Ascents

00Z /12.11.2016 : 6

No. of Ascents reaching 250hPa level =6

MISDA :2

12Z /12.11.2016 : 4

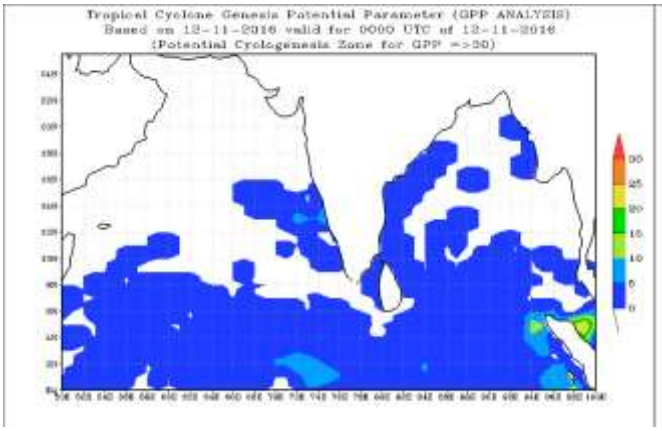
No. of Ascents reaching 250 hPa level =4

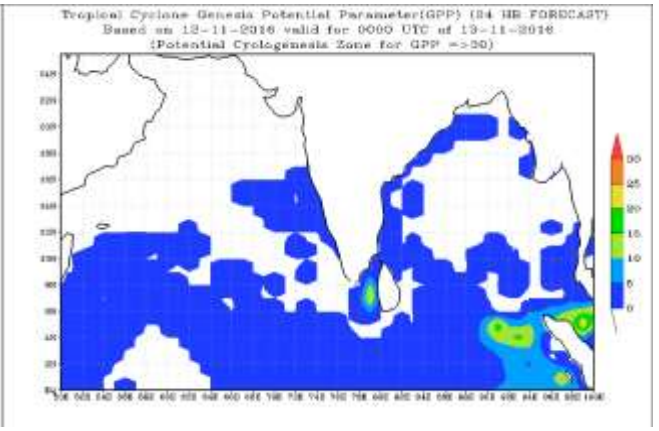
MISDA : 4

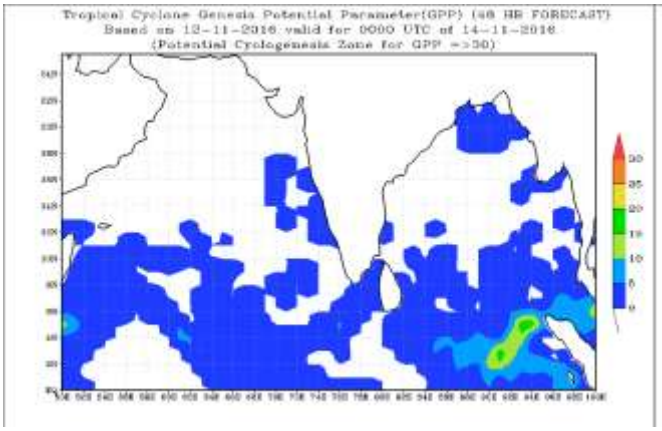
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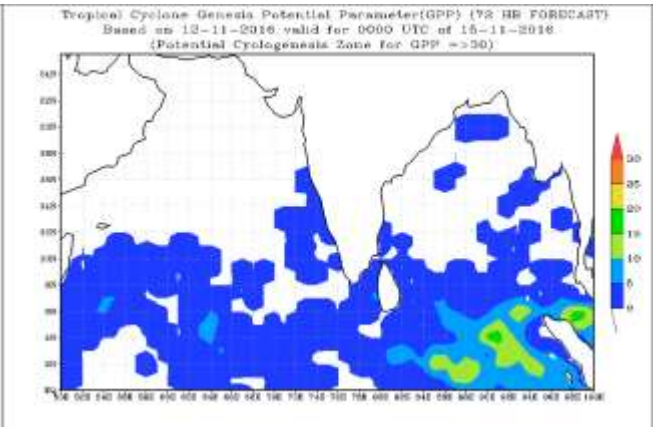
12.11.2016	
06Z	18Z
3	4

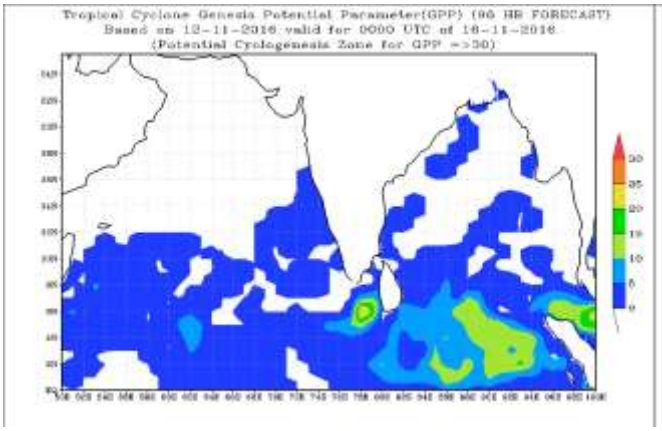
Annexure-II

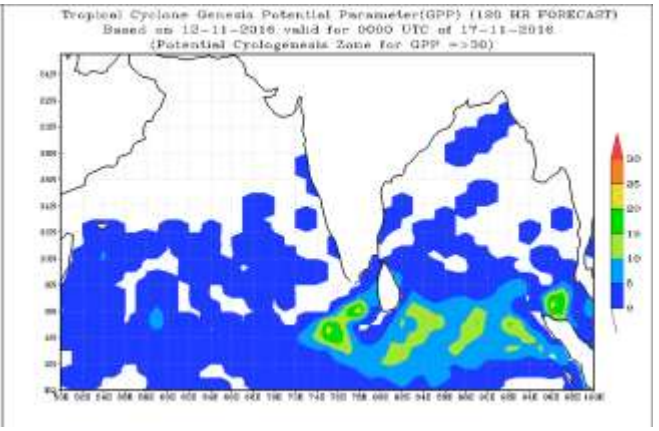

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 12-11-2016 valid for 0000 UTC of 12-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

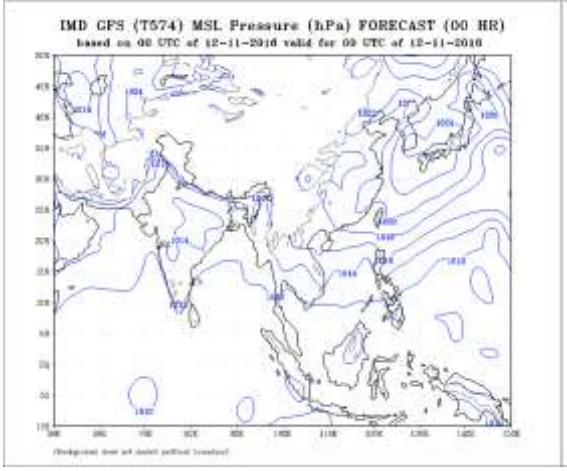

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 12-11-2016 valid for 0000 UTC of 13-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

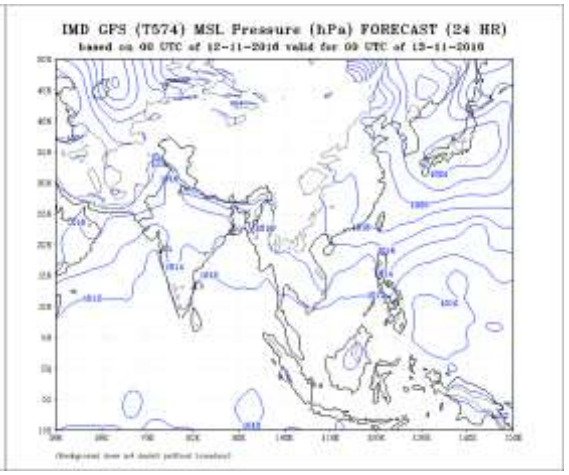

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 12-11-2016 valid for 0000 UTC of 14-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

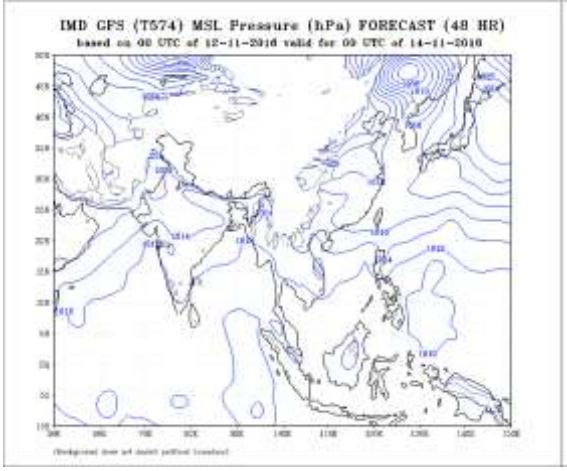

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

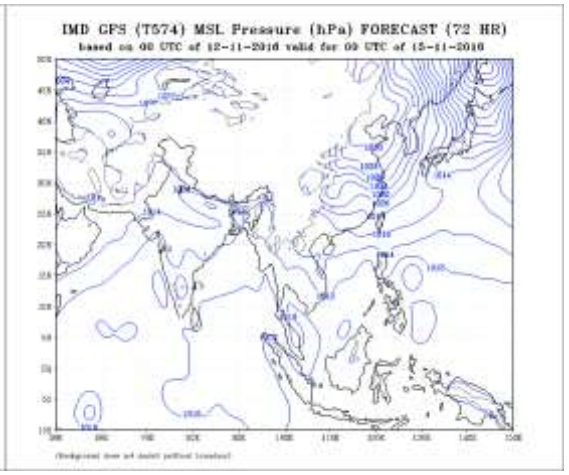

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 12-11-2016 valid for 0000 UTC of 16-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

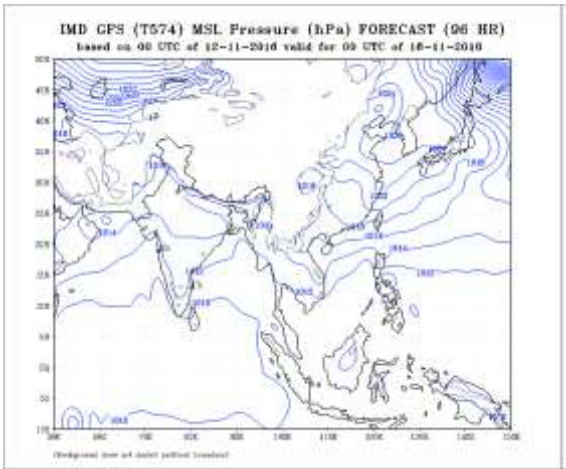

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 12-11-2016 valid for 0000 UTC of 17-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

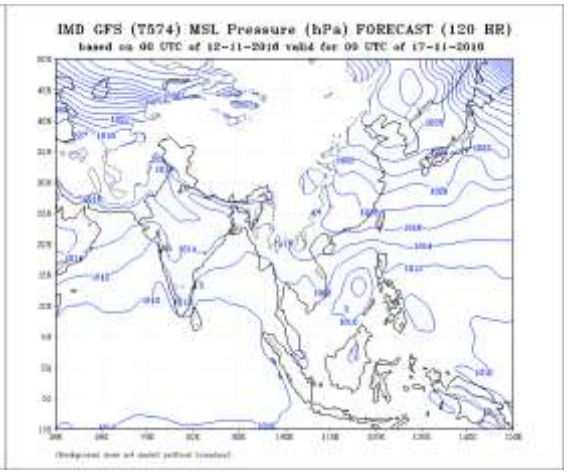

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 12-11-2016

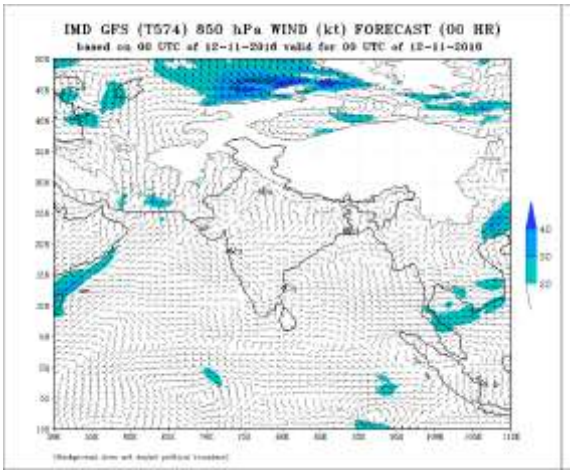

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 13-11-2016

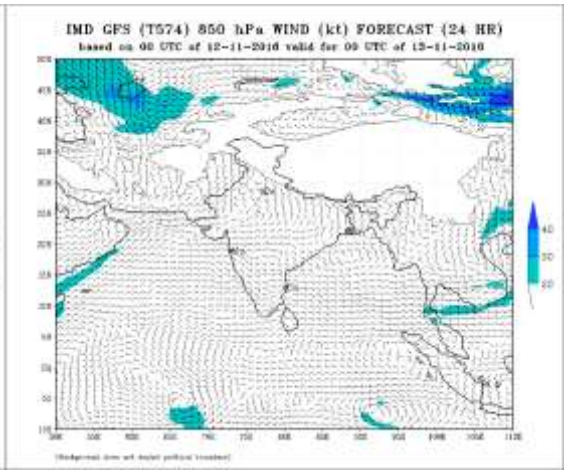

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 14-11-2016

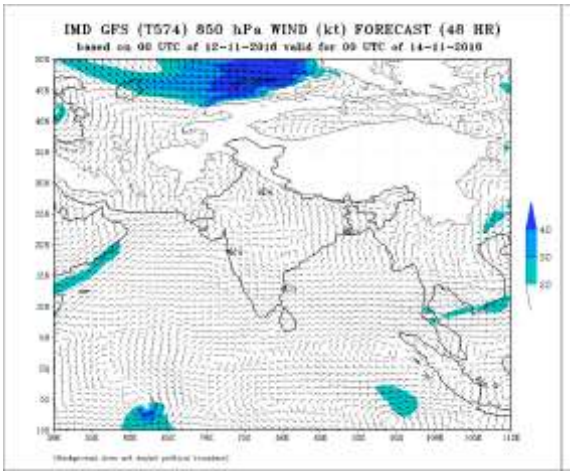

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 15-11-2016

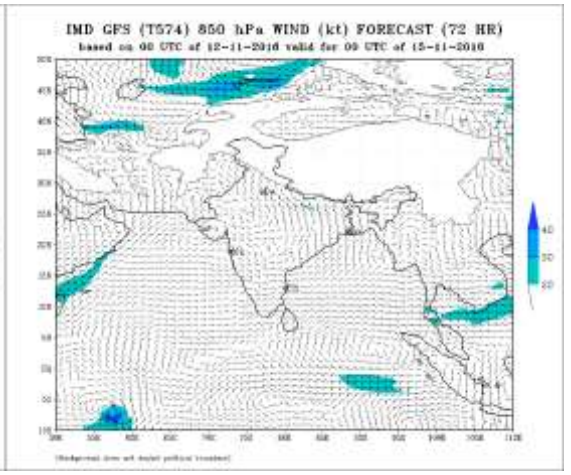

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 16-11-2016

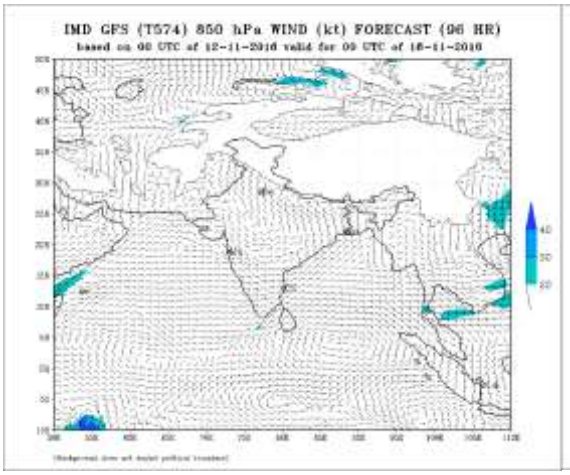

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 17-11-2016

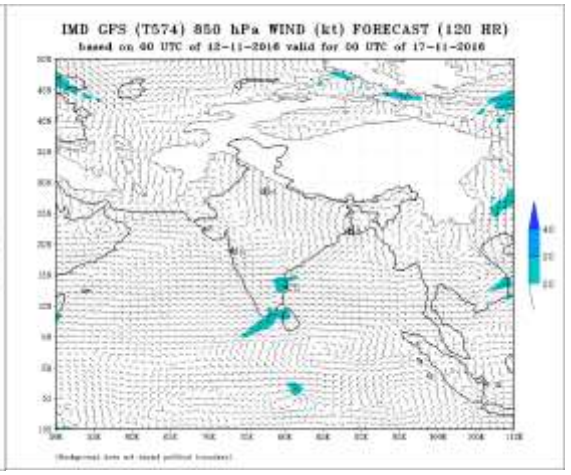

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 12-11-2016

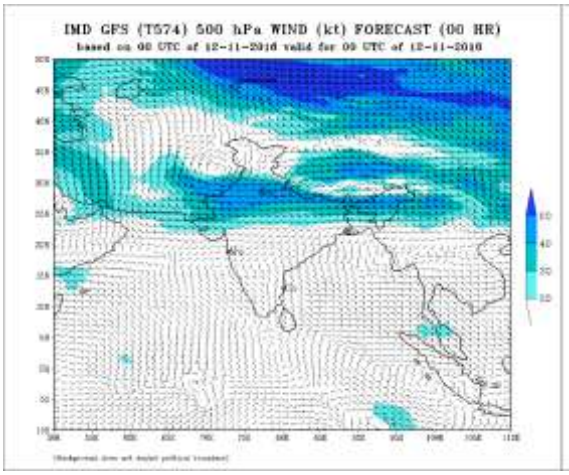

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 13-11-2016

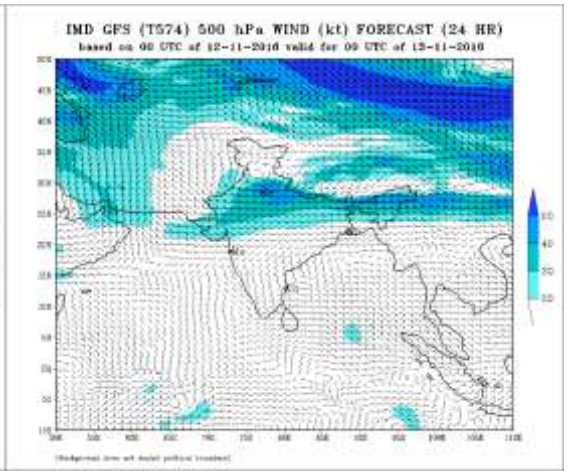

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 14-11-2016

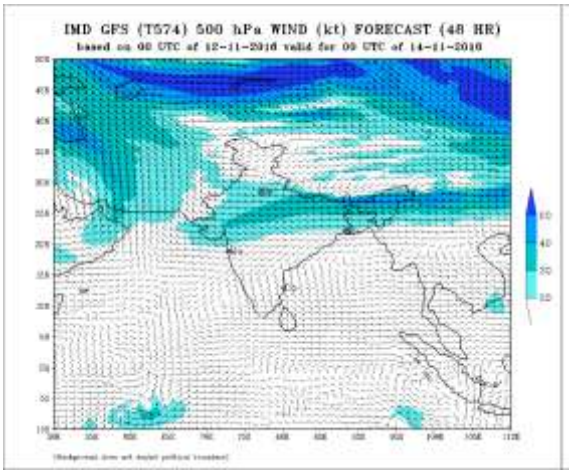

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 15-11-2016

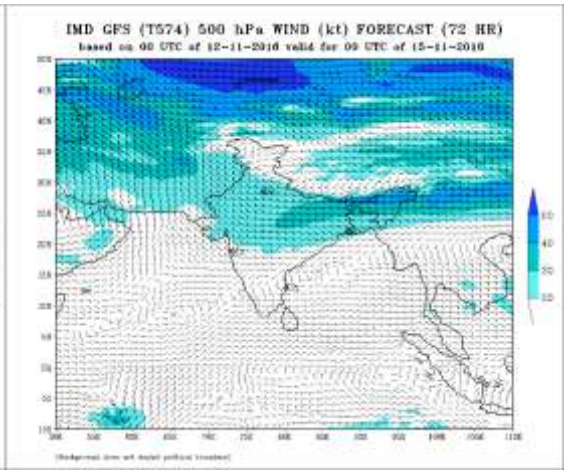

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 16-11-2016

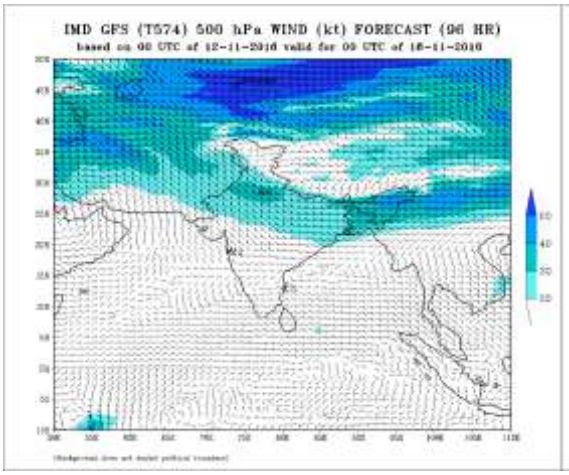

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 17-11-2016

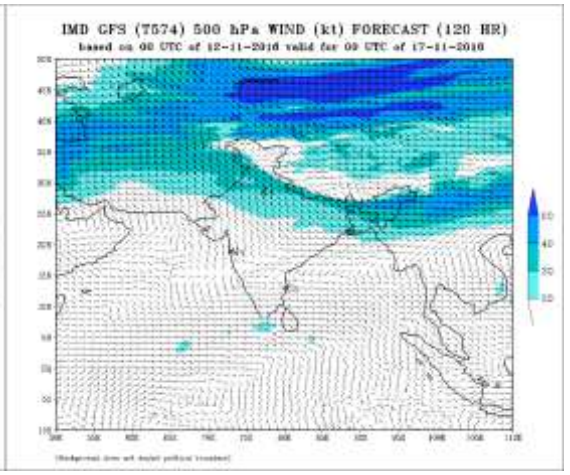

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based on 00 UTC of 12-11-2010 valid for 09 UTC of 12-11-2010

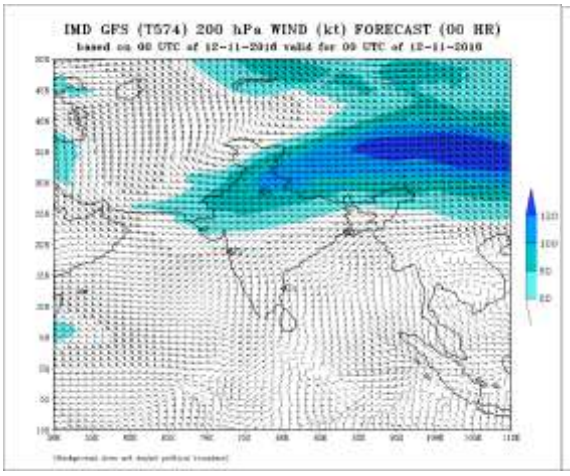

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 12-11-2010 valid for 09 UTC of 13-11-2010

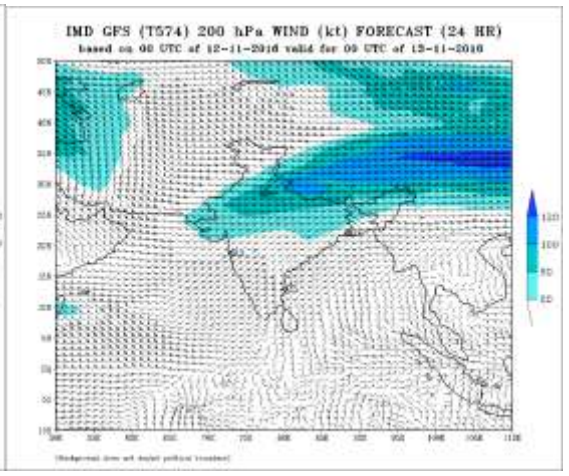

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 12-11-2010 valid for 09 UTC of 14-11-2010

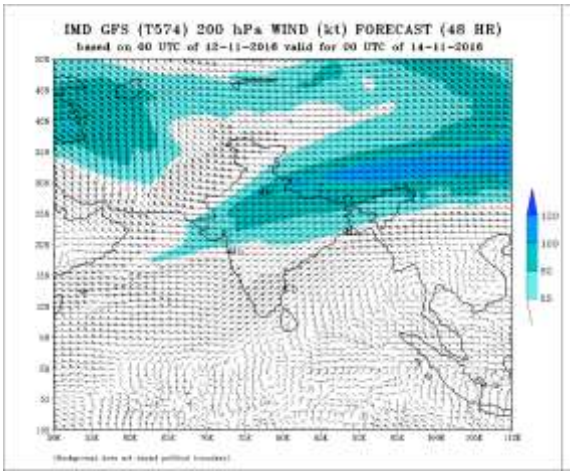

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 12-11-2010 valid for 09 UTC of 15-11-2010

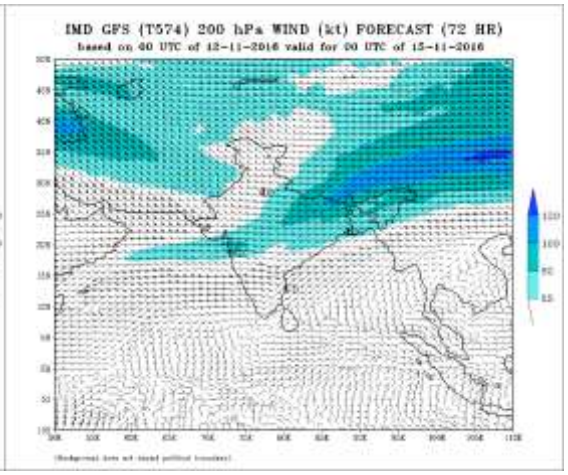

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 12-11-2010 valid for 09 UTC of 16-11-2010

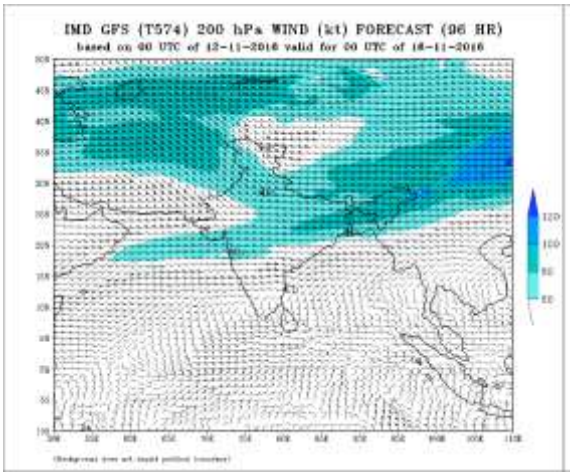

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 12-11-2010 valid for 09 UTC of 17-11-2010

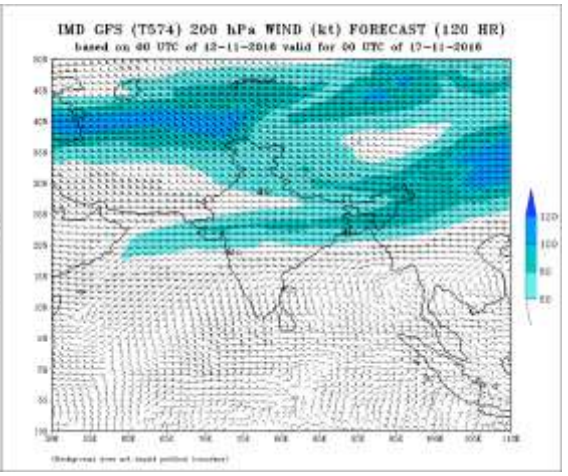

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 12-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 13-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 14-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 15-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 16-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 12-11-2016 valid for 00 UTC of 17-11-2016

FDP (Cyclone) NOC Report Dated 13th November 2016

Synoptic features:

The trough in easterlies over southwest Bay of Bengal & neighbourhood, now seen as a trough of low over southwest Bay of Bengal off Sri Lanka and Tamilnadu coast and extends upto 2.1 km above mean sea level. Another trough of low at mean sea level runs from Lakshadweep area to south Konkan coast. The upper air cyclonic circulation over eastcentral Arabian Sea & adjoining coastal Karnataka persists and now seen between 2.1 & 3.1 km above mean sea level.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of BOB, except for a small pocket of lesser values in northwest BOB off Orissa, West Bengal & Bangladesh coasts. SST of 30-31˚C are seen over in parts of North Andaman Sea.

The SST over Arabian Sea (AS) is between 27-29˚C over most areas of north and central AS. SST is 26˚C over westcentral & over parts of southwest Arabian Sea and also off South Maharashtra Coast. SST is 31-32˚C over parts of northeast AS off Gujarat & adjoining north Maharashtra coast.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for small pockets over South Andaman Sea and off South Arakan Coast, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal.

TCHP is less than 50 kJ/cm^2 over north and westcentral Arabian Sea. It is 60-80 kJ/cm^2 over remaining parts of Arabian Sea.

Relative Vorticity:

The low-level relative vorticity is over negative over south BOB & adjoining Andaman Sea. It is positive and is about 20x10^{-6} second^{-1} over north Bay.

A southwest-northeast oriented band of vorticity 25x10^{-6} second^{-1} lies over parts of west Arabian Sea. It is less than 25x10^{-6} second^{-1} over remaining parts of AS.

Convergence:

There are small pockets of positive lower level convergence about 5x10^{-6} s^{-1} over equatorial region, and over south Andaman Sea.

There are no significant zones of positive level convergence over Arabian Sea.

Divergence:

There are no significant areas of positive upper-level divergence over the Bay of Bengal as well as over the Arabian Sea.

Wind Shear:

Wind shear is high over entire BOB. It is moderate (15-20 kts) over Andaman Sea.

Wind shear is high over entire Arabian Sea.

Wind Shear Tendency:

There is increasing tendency (5-10 kts) over entire BOB except for Andaman Seas, where it is neutral.

There is increasing tendency over entire Arabian Sea.

Satellite observations based on 0600 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over westcentral Bay of Bengal off Tamil Nadu and South Andhra Coast and south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds over southeast Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 12^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 7 with amplitude more than one. It would move to phase 8 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean: Yesterday's cyclonic storm MA-ON over west Pacific at 0000 UTC on 13th, lay centered near lat. 21.6^{0}N and 141.7^{0}E as a tropical depression. It would move northwestwards.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 13 November 2016 shows an upper air cyclonic circulation at 850 hPa over south central of Bay of Bengal which persisted for the next 24 hours and thereafter weakened and merged with easterly wave. There is no indication for formation of any low pressure area over NIO regions.
NCEP-GFS: The analysis/forecast charts of the model based on 0000 UTC of 13 November, 2016 show similar features like IMD-GFS model. There is no indication for formation of any low pressure area over NIO regions.
ECMWF: N.A.
WRF: The WRF model forecast based on 00 UTC of 13 November 2016 shows an extended low level trough in association with easterly waves at 850 hPa over south central Bay of Bengal and persists for the next 24 hours and weakens thereafter. This mesoscale model also does not show any indication of formation of any low pressure area over NIO regions.
JMA: The forecast based on 00 UTC of 13th shows no system for next three days.
Meteo-France ARP Model: The forecast based on 00 UTC of 13th shows no system for next three days.
NCMRWF-NCUM: The analysis based on 00 UTC of 13th November shows a low pressure area to the south of Sri Lanka on 19th which moves northward and seen over southwest Bay off Tamil Nadu coast on 21st as a depression, as a low again on 22nd and weakens thereafter over the same area thereafter.
NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 13th shows no system for next three days.
NCMRWF-NEPS Model: The analysis based on 00 UTC of 13th November shows the development of a low over Comorin area on 20th, which becomes more marked on 21st and becomes less marked on 22nd over the same area.
IITM-GEFS: The forecast based on 00 UTC of 13th November shows that no low pressure system is expected over Indian Sea until 21st November.
IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 13th November shows that no low pressure system is expected over Indian seas until 21st November.

Dynamical statistical models
IMD Genesis Potential Parameter (GPP):
Analysis and forecasts of GPP based on 00 UTC of 13th November 2016 do not suggest any cyclogenesis over Indian seas in the coming 7 days.

Summary and Conclusion:
No low pressure area is expected to form over the north Indian Ocean during next five days.
Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	12/12	13/00	13/03
India	43	41	44
Coastal stations			
WB	8	7	8
Odisha	7	6	7
AP	10	10	11
Tamil Nadu	10	11	11
Puducherry	1	1	1
A & N	6	6	6
Bangladesh	14	11	15
Myanmar	9	9	8
Thailand	3	3	3
SriLanka	10	8	10

AWS:

Region	Date/Time (UTC)		
	12/12	13/00	13/03
WB	6	0	5
Odisha	7	1	7
AP	9	6	10
Tamil Nadu	27	8	27
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 12 / 11 /2016 :36/43
- **No. of Ascents reaching 250 hPa levels: 36 , MISDA:-7**

- **RS/RW** (00Z) of 13 / 11 /2016 : 33/43

- **No. of Ascents reaching 250 hPa levels:31 , MISDA:10**

No. of PILOT Ascents

12/12Z	13/00Z
5	5

Buoy Data

12/12Z	13/00Z	13/03Z
10	12	12

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**12.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**19**

No. of RS/RW Ascents

00Z /12.11.2016 : 5

No. of Ascents reaching 250hPa level =5

MISDA :3

12Z /12.11.2016 : 3

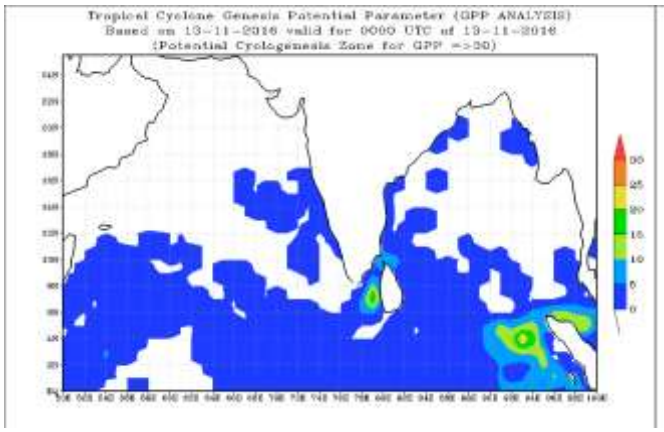
No. of Ascents reaching 250 hPa level =3

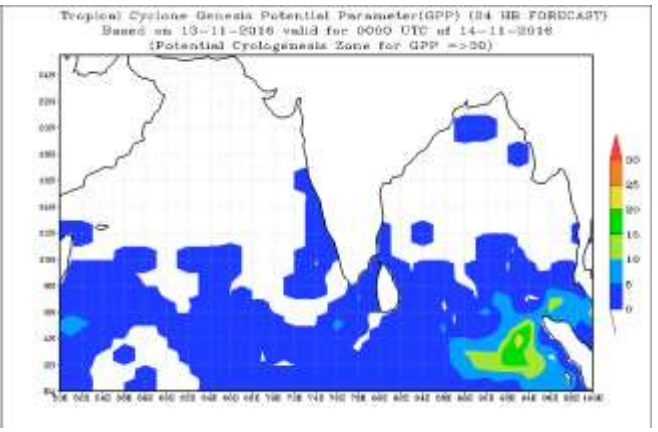
MISDA : 5

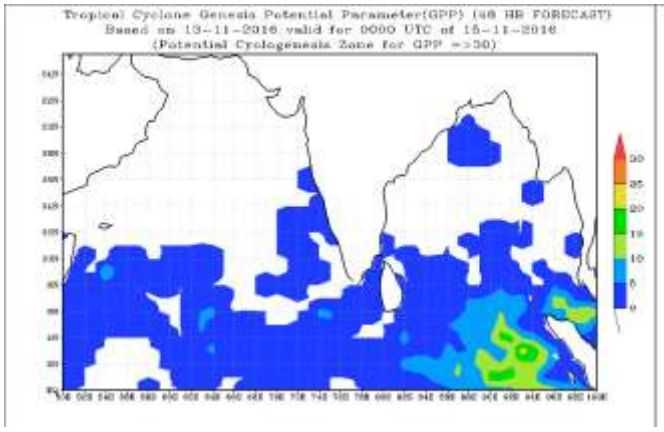
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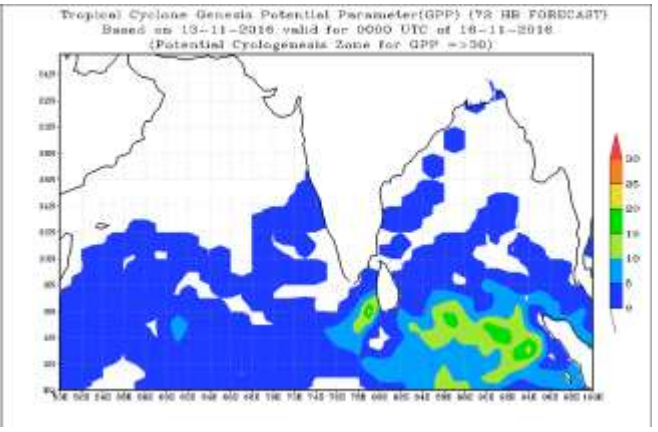
12.11.2016	
06Z	18Z
3	3

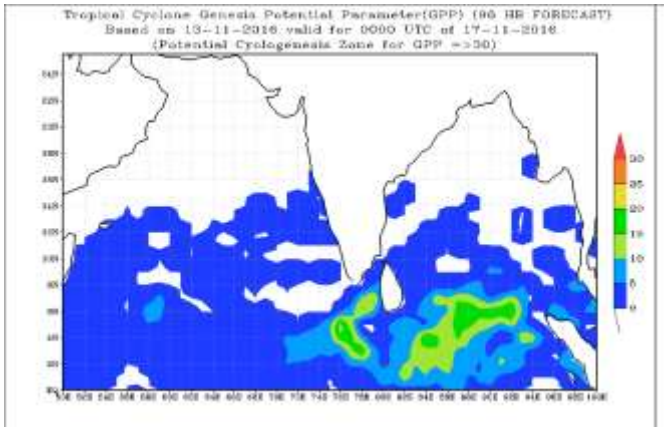
Annexure-II

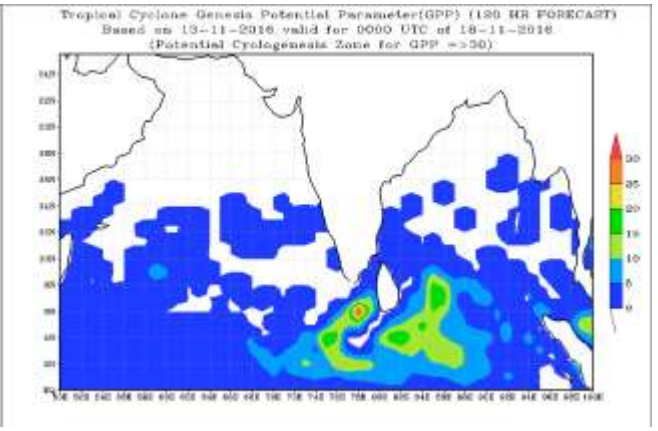

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 13-11-2016 valid for 0000 UTC of 13-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

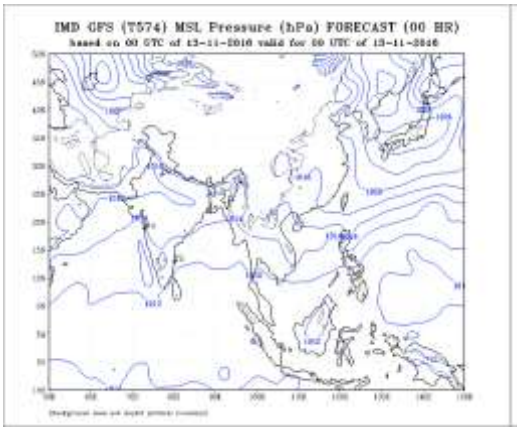

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 13-11-2016 valid for 0000 UTC of 14-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

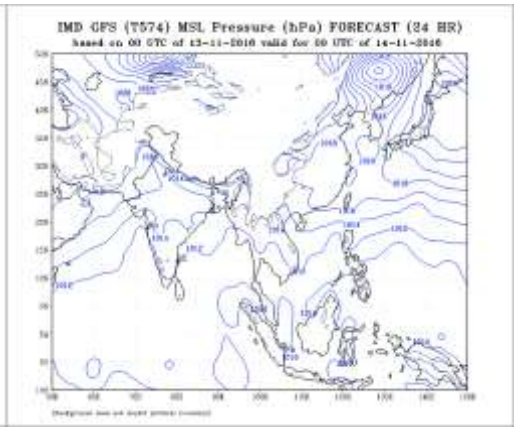

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 13-11-2016 valid for 0000 UTC of 15-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

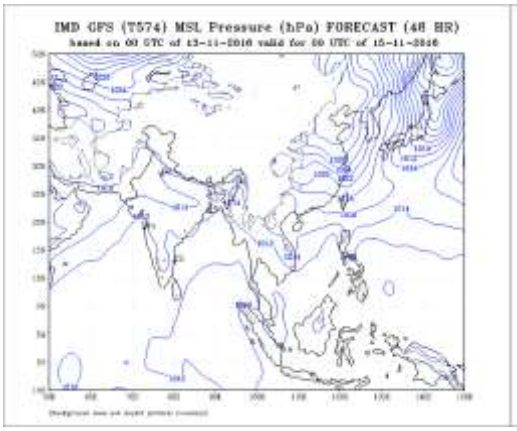

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 13-11-2016 valid for 0000 UTC of 16-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

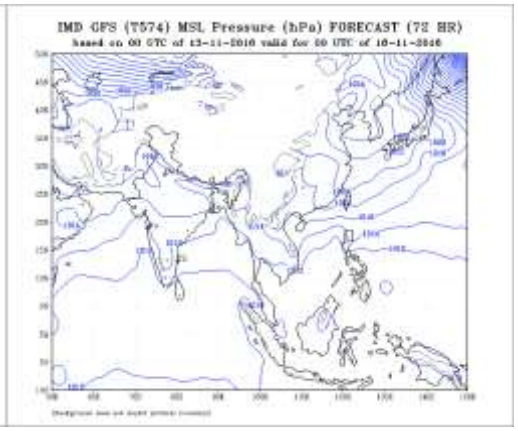

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 13-11-2016 valid for 0000 UTC of 17-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

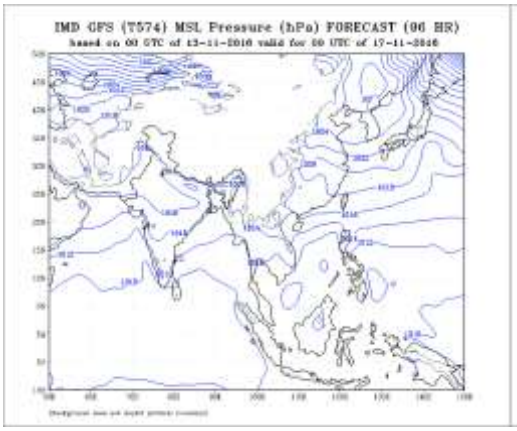

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 13-11-2016 valid for 0000 UTC of 18-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

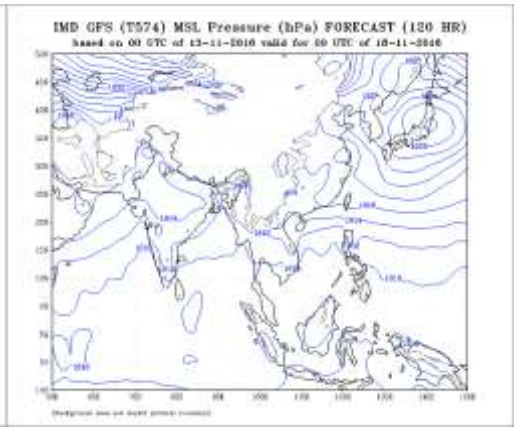

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 13-11-2016

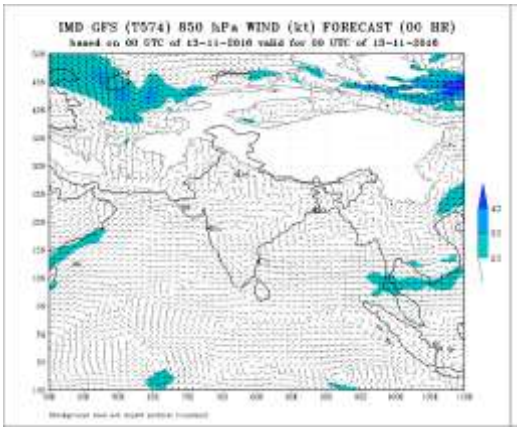

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 14-11-2016

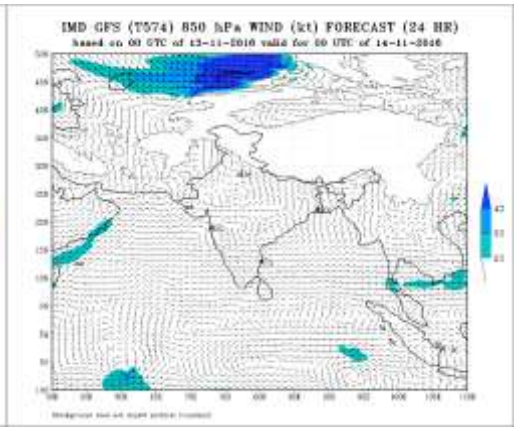

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 15-11-2016

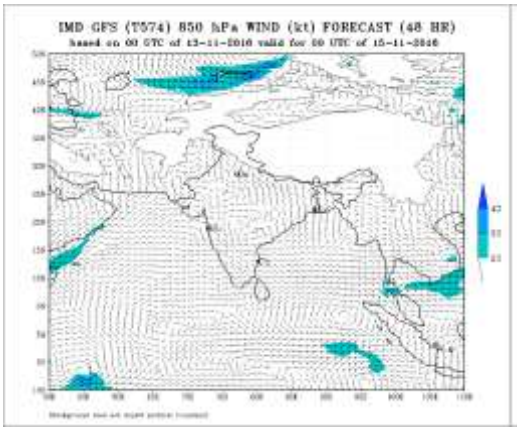

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 16-11-2016

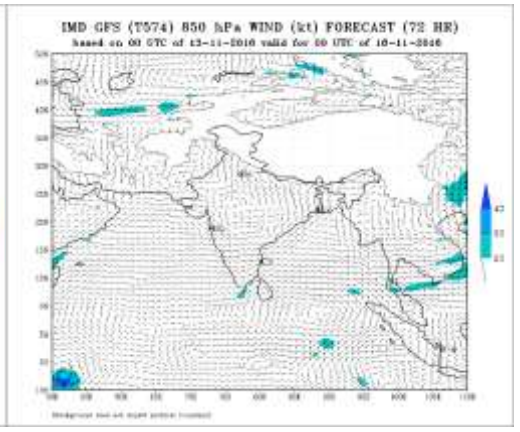

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 17-11-2016

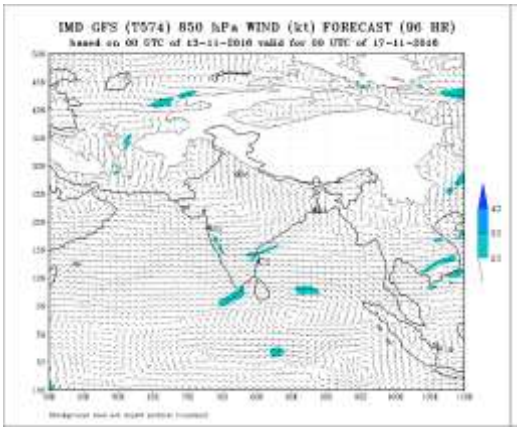

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 18-11-2016

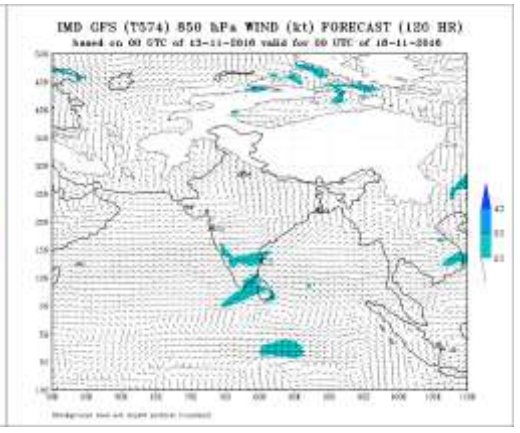

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

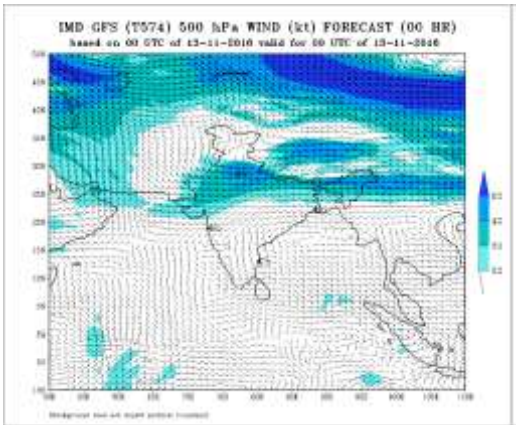

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

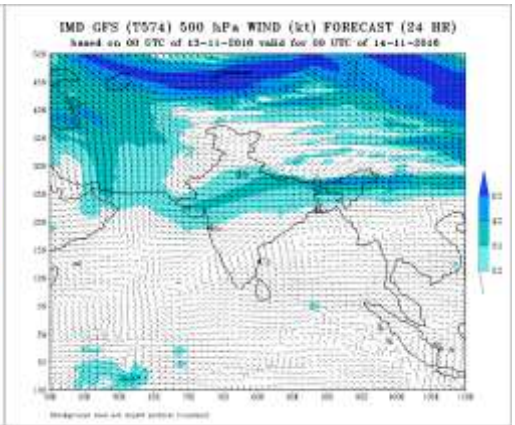

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

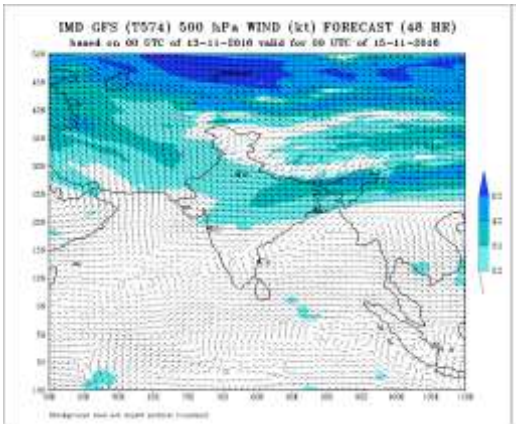

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

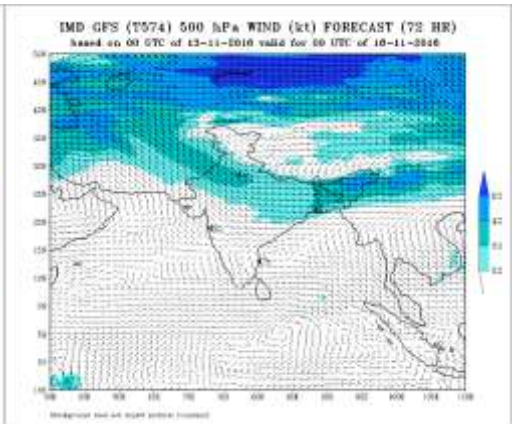

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

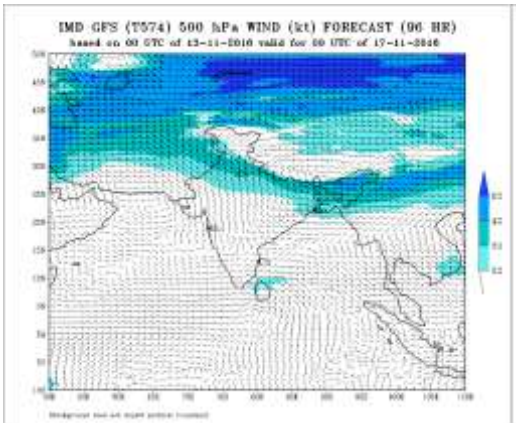

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

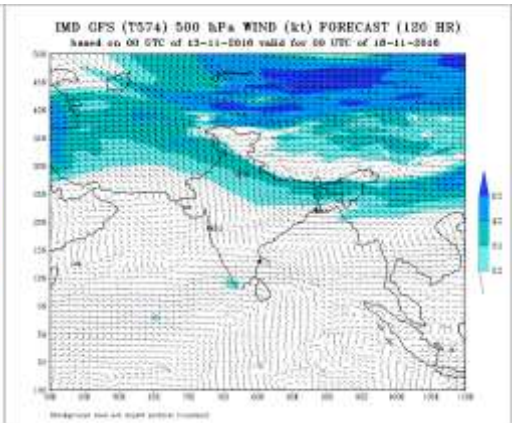

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 13-11-2016

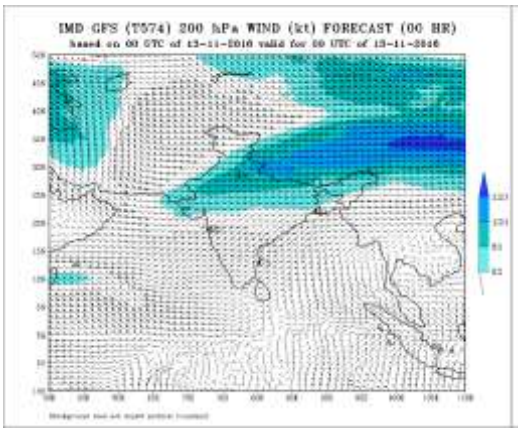

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 14-11-2016

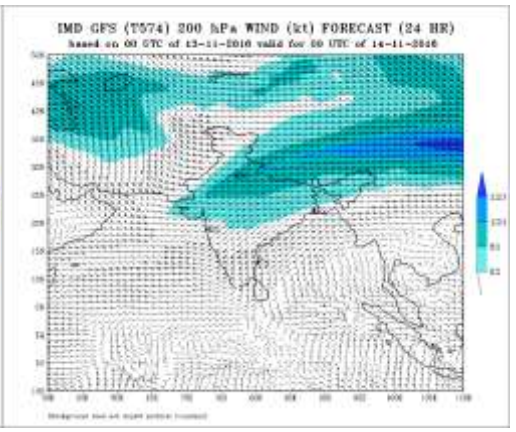

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 15-11-2016

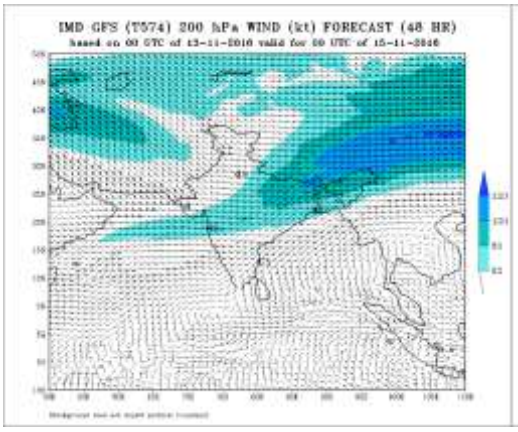

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 16-11-2016

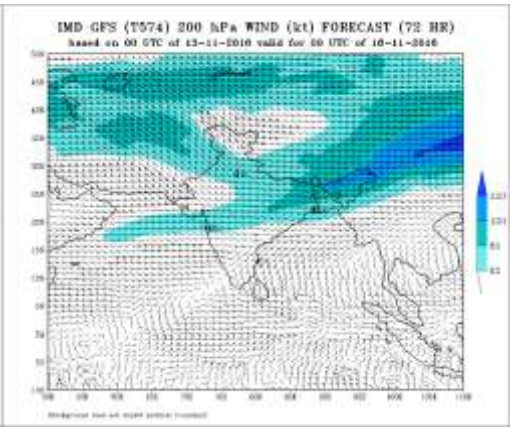

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 17-11-2016

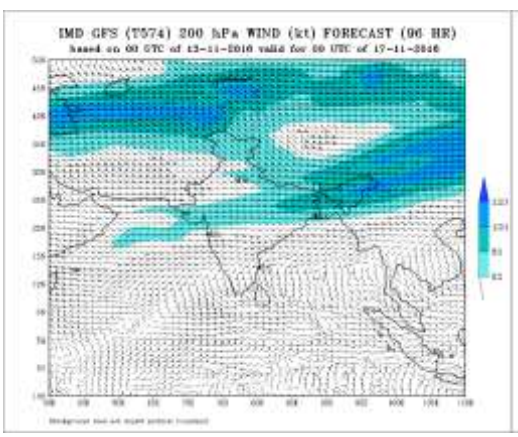

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 18-11-2016

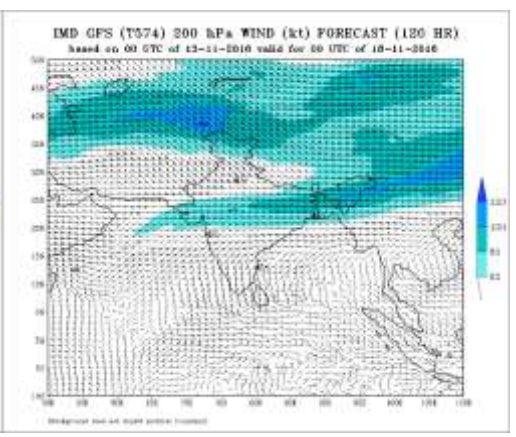

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 13-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 14-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 15-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 16-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 17-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 13-11-2016 valid for 00 UTC of 18-11-2016

FDP (Cyclone) NOC Report Dated 14th November 2016

Synoptic features:

The trough in easterlies over trough of low over southwest Bay of Bengal off Sri Lanka and Tamilnadu coast, now runs from southeast Sri Lanka to south Konkan coast across Comorin area & Kerala coast with an embedded upper air cyclonic circulation over north Kerala & neighborhood in the lower levels

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of BOB, except for a small pocket of lesser values in northwest BOB off West Bengal & Bangladesh coast.

The SST over Arabian Sea (AS) is between 27-29˚C over most areas of north and central AS. SST is 26˚C over a southwest-northeast oriented band lies over parts of west AS.

SST is 31-32˚C over parts of northeast AS off south Gujarat & adjoining north Maharashtra coast.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for., where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north and a small pockets over west central Bay of Bengal.

TCHP is less than 50 kJ/cm^2 over north and westcentral AS. It is 50-80 kJ/cm^2 over remaining parts of AS.

Relative Vorticity:

The low-level relative vorticity is less than about 25x10^{-6} second^{-1} over entire BOB & adjoining the Andaman Sea except the pocket of northeast BOB.

The low-level relative vorticity over AS is 25x10^{-6} second^{-1} over southeast & adjoining eastcentral AS off Karnataka coast and a southwest-northeast oriented band of vorticity 25x10^{-6} second^{-1} lies over parts of west AS.

Convergence:

There is an elongated zone of positive lower level convergence about 5x10^{-6} s^{-1} over equatorial region south of latitude 10°N between longitude 85.0°E to 92°.0E and south Andaman Sea.

Over AS, lower level convergence is 5-15x10^{-6} s^{-1} over parts of southwest AS.

Divergence:

There is no significant area of positive upper-level divergence over the Bay of Bengal as well as over the Arabian Sea. A zone of positive upper-level divergence of 5-10x10^{-6} s^{-1} over southeast Arabian sea and adjoining Kerala coast. An elongated zone of positive upper-level divergence of 5-10x10^{-6} s^{-1} over equatorial & adjoining the southeast Bay of Bengal and the south Andaman Sea.

Wind Shear:

Wind shear is 5-15 kts (low) over most parts of BOB except westcentral and North Bay of Bengal.

Wind shear is 15-20 kts (moderate) over parts of southeast AS & adjoining equatorial region of Indian ocean. It is increasing towards west and north.

Wind Shear Tendency:

There is increasing tendency (5-10 kts) over entire BOB.

There is an elongated southwest-northeast oriented zone of increasing tendency (5-10 kts) extending from southwest AS to northeast AS.

Satellite observations based on 0600 UTC INSAT imagery:

According to satellite imageries:-

Bay of Bengal & Andaman Sea:

scattered low/medium clouds with embedded moderate to intense convection are seen over southeast Bay of Bengal and south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over southeast Arabian sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 14^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 8 with amplitude more than one. It would move to phase 1 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean: Yesterday's cyclonic storm a tropical depression moved northwestwards and weakened into low pressure area

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The forecasts based on 00 UTC of 14th November 2016 shows an upper air cyclonic circulation at 850 hPa over south central of Bay of Bengal which persisted for the next 24 hours and thereafter weakened and merged with easterly wave. There is no indication for formation of any low pressure area over NIO regions.

NCEP-GFS: The forecasts based on 00 UTC of 14th November 2016 show similar features like IMD-GFS model. There is no indication for formation of any low pressure area over NIO regions.

ECMWF: The forecast based on 00 UTC of 14th shows an upper air cyclonic circulation at 850 hPa over west central of Bay of Bengal and costal region of Andhra and Odessa. It also shows a north-south oriented trough in easterly waves along the east coast of southern peninsular India will persist after 48 hours up to 96 hours.

JMA: The forecast based on 00 UTC of 14th shows no system for next three days.

Meteo-France ARP Model: The forecast based on 00 UTC of 14th shows no system for next three days.

WRF: The WRF model forecast based on 00 UTC of 14th November 2016 shows there is low pressure area off south Sri Lanka coast on 17th Nov and an upper air cyclonic circulation at 850 hPa over west central of Bay of Bengal and persists for during the next 24 hours and weakening thereafter. This mesoscale model also not shows any indication for formation of any low pressure area over NIO regions.

NCMRWF-NCUM: The analysis based on 00 UTC of 14h November shows no circulation over BOB till 18th.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 14th shows no system for next three days.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 14th November shows the development of a low over Comorin area on 20th, which becomes more marked on 21st and becomes less marked on 22nd over the same area.

IITM-GEFS: The analysis based on 00 UTC of 14th November shows no significant system is expected until 22nd November.

IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 14th shows no significant system is expected until 22nd November.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 14th November 2016 do not suggest any cyclogenesis over Indian seas in the coming 7 days.

Summary and Conclusion:

No low pressure area is expected over the north Indian Ocean during next five days.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	13/12	14/00	14/03
India	43	36	44
Coastal stations			
WB	8	7	8
Odisha	7	6	7
AP	11	10	11
Tamil Nadu	11	11	11
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	14	11	15
Myanmar	9	9	8
Thailand	3	3	3
SriLanka	10	8	10

AWS:

Region	Date/Time (UTC)		
	13/12	14/00	14/03
WB	6	1	5
Odisha	6	1	7
AP	10	4	8
Tamil Nadu	28	7	26
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 13 / 11 /2016 :15/43
- **No. of Ascents reaching 250 hPa levels: 15 , MISDA:-2**
- **RS/RW** (00Z) of 14 / 11 /2016 : 33/43
- **No. of Ascents reaching 250 hPa levels:33 , MISDA:5**
- **No. of PILOT Ascents**

13/12Z	14/00Z
6	3

Buoy Data

13/12Z	14/00Z	14/03Z
16	12	18

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**13.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

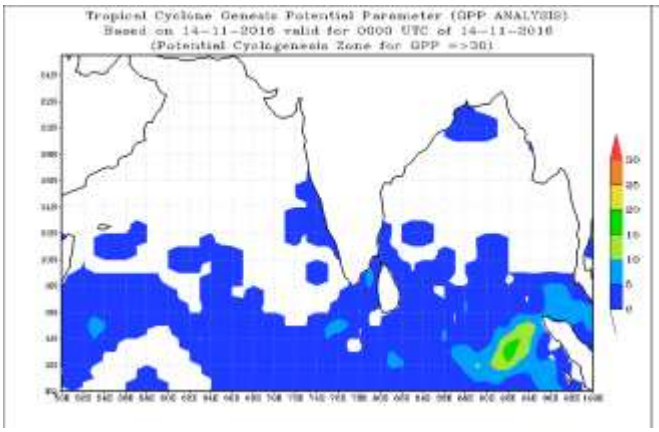
00Z /13.11.2016 : 6
No. of Ascents reaching 250 hPa level = 6
MISDA : 2

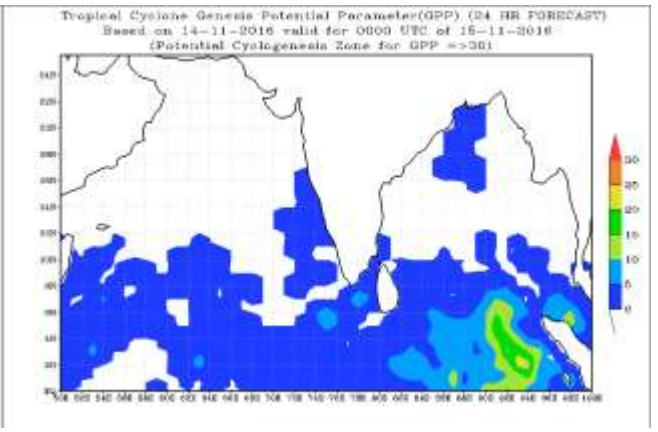
12Z /13.11.2016 : 3
No. of Ascents reaching 250 hPa level = 3
MISDA : 5

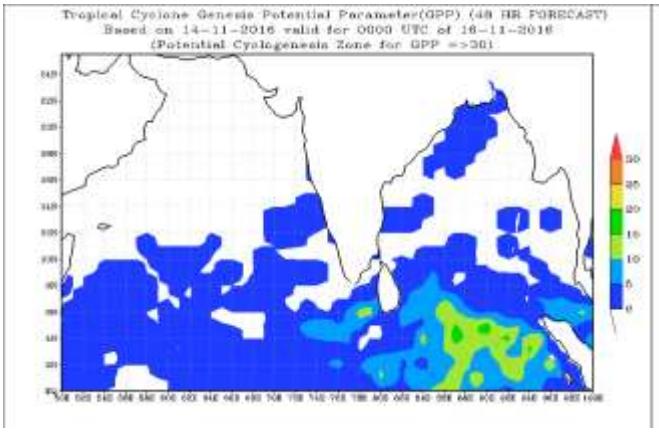
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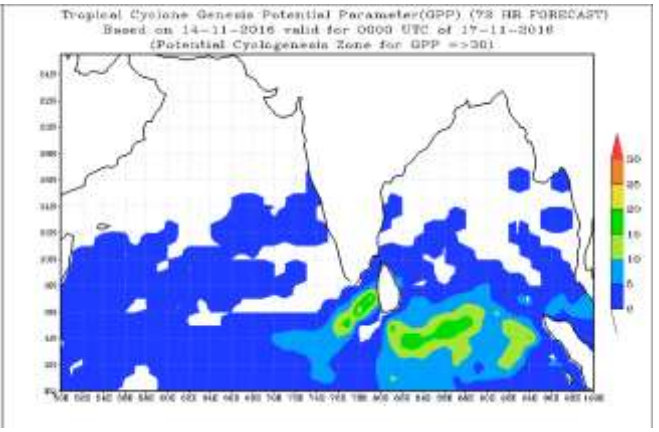
13.11.2016	
06Z	18Z
2	4

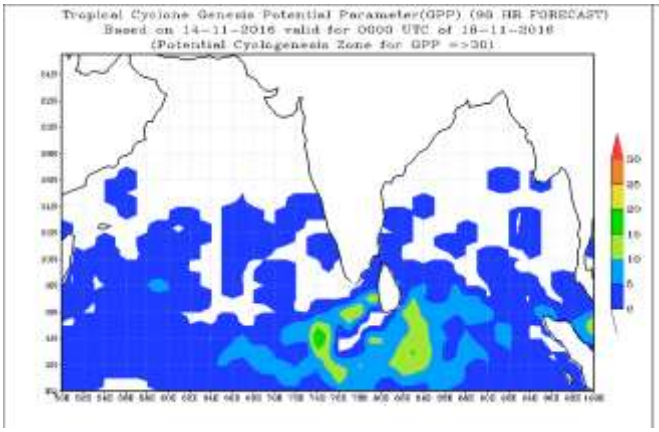
Annexure-II

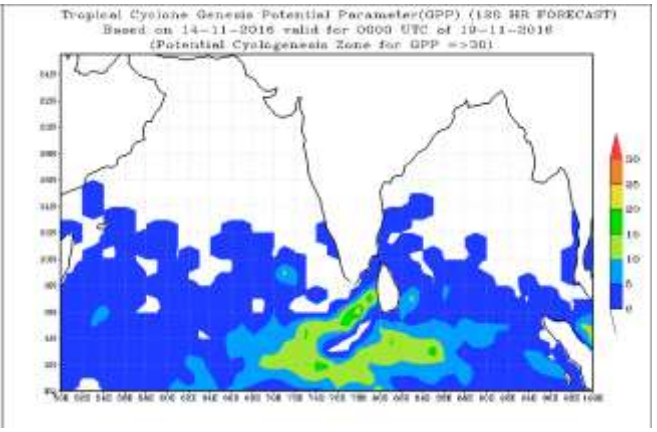

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 14-11-2016 valid for 0000 UTC of 14-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

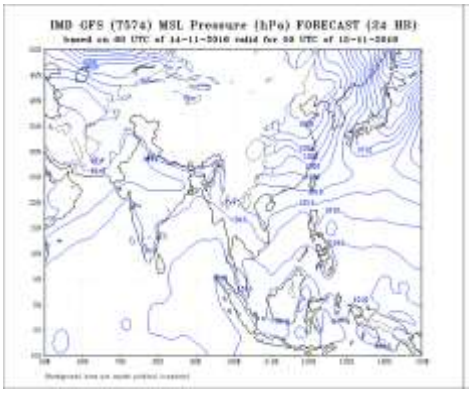

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 14-11-2016 valid for 0000 UTC of 15-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

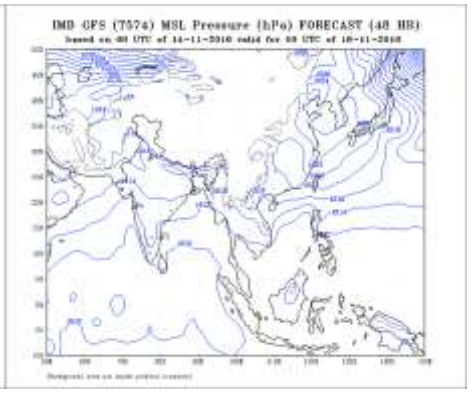

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 14-11-2016 valid for 0000 UTC of 16-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

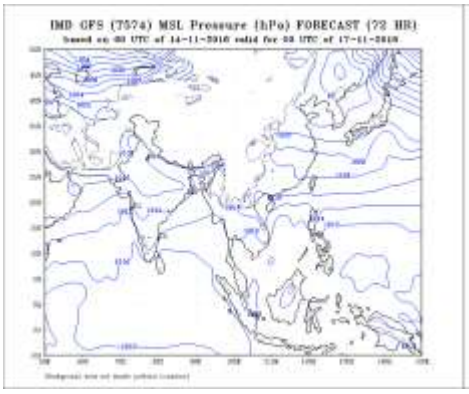

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 14-11-2016 valid for 0000 UTC of 17-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

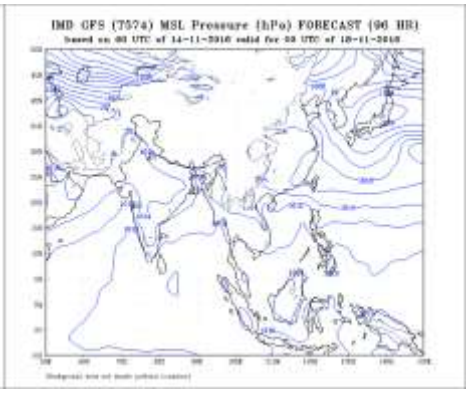

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 14-11-2016 valid for 0000 UTC of 18-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

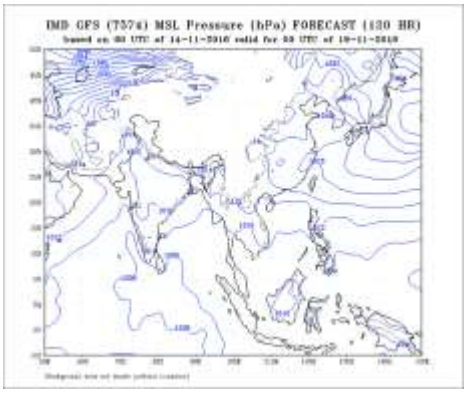

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 14-11-2016 valid for 0000 UTC of 19-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

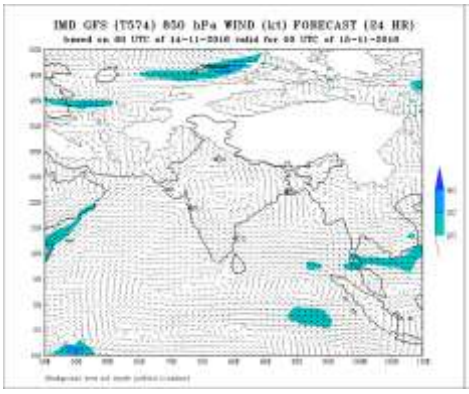

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

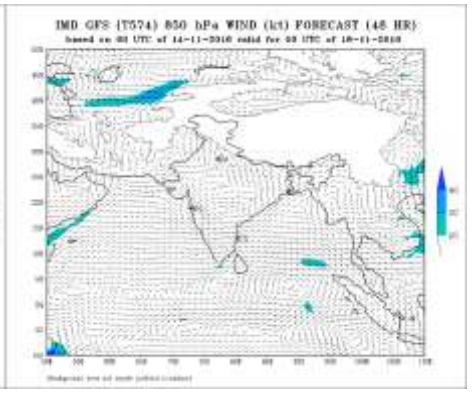

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

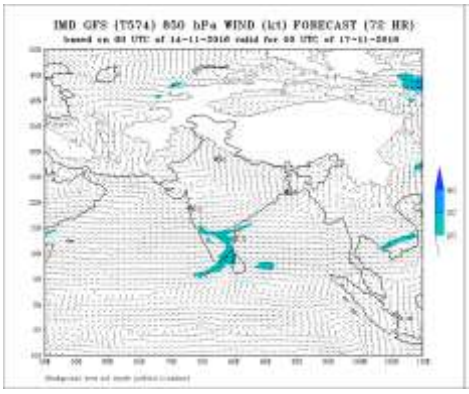

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

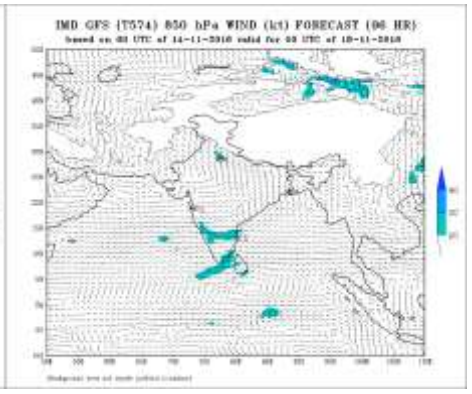

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

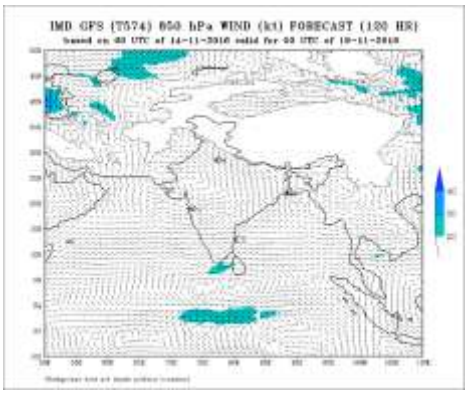

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

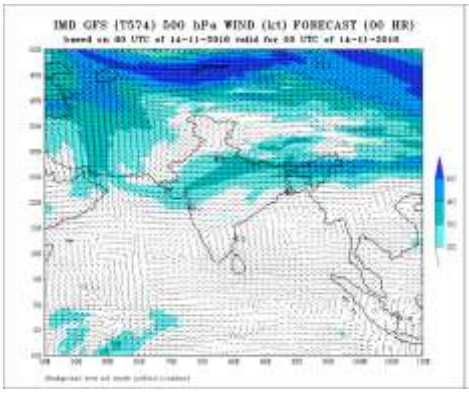

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

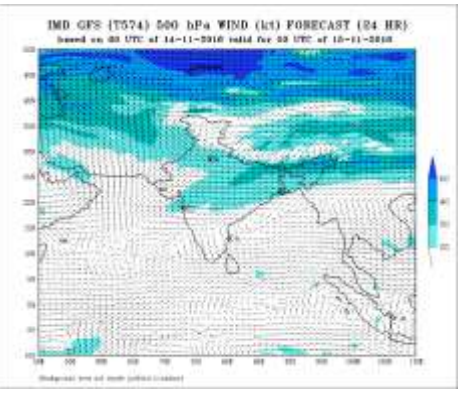

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

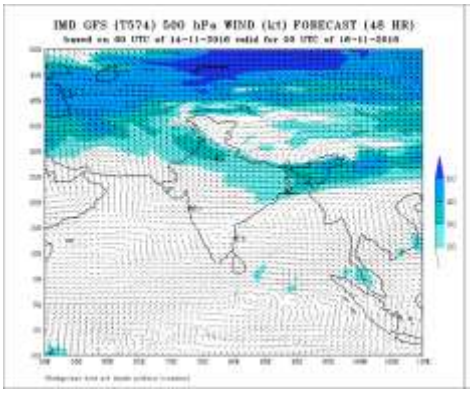

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

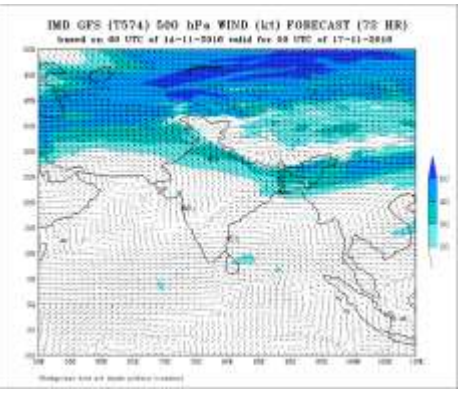

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

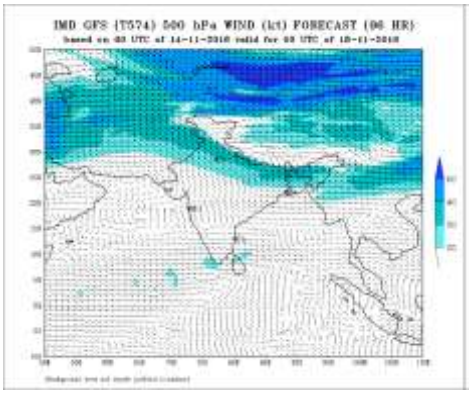

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)

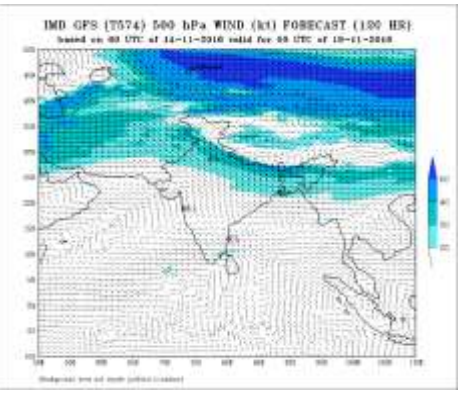

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)

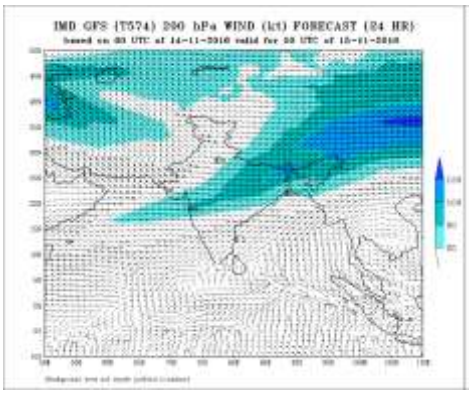

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

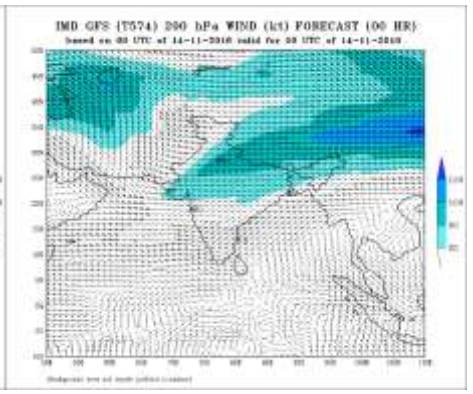

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

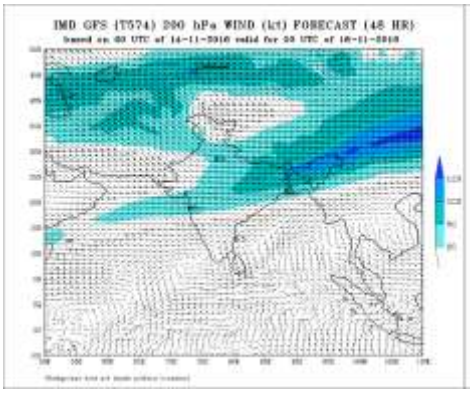

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

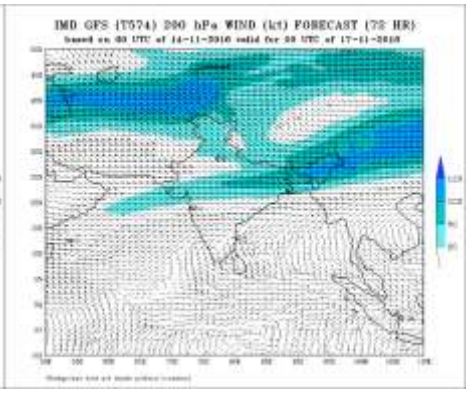

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

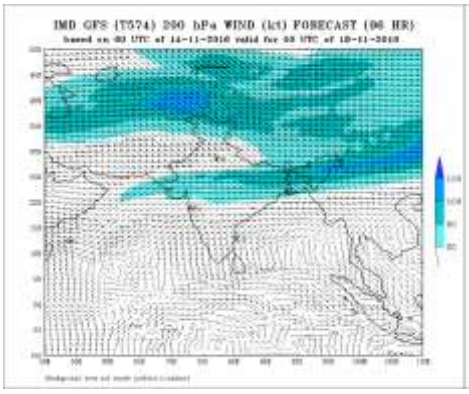

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)

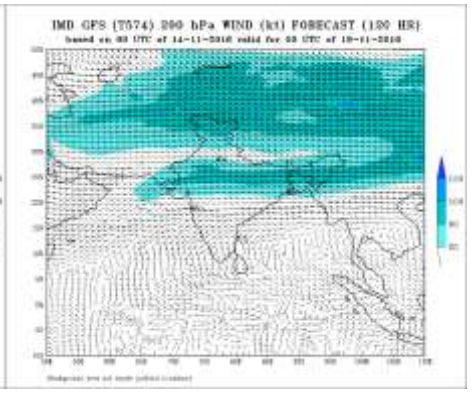

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)

FDP (Cyclone) NOC Report Dated 15th November 2016

Synoptic features:

The trough of low at mean sea level from southeast Sri Lanka to south Konkan coast across Comorin area & Kerala coast, now runs from Comorin area to south Konkan coast. The upper air cyclonic circulation over north Kerala & neighbourhood, now lies over southeast Arabian Sea off Kerala –Karnataka coasts between 0.9 &1.5 km above mean sea level. The other trough of low at mean sea level over south Andaman Sea & neighbourhood, now lies over southeast Bay of Bengal & adjoining equatorial Indian Ocean.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 29-30˚C over most parts of east central, southwest and south east Bay of Bengal. It is 26-28˚C over northwest bay and between 28-29 ˚C over west central and northeast bay. SST of 30-31˚C are seen over in parts of North Andaman Sea.

The SST over Arabian Sea (AS) is between 26-28˚C over most areas of northwest, west central and southwest Arabian Sea and also over a small pocket off the coast of South Maharashtra. SST is 31-32˚C over parts of northeast AS off Gujarat & adjoining north Maharashtra coast. SST is 28-30˚C over remaining parts of Arabian Sea.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for small pockets over South Andaman Sea and off South Arakan Coast, and the equatorial waters to the south where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal.

TCHP is less than 50 kJ/cm^2 over north and westcentral Arabian Sea. It is 60-80 kJ/cm^2 over remaining parts of Arabian Sea.

Relative Vorticity:

The low-level relative vorticity is negative over south BOB & adjoining Andaman Sea. It is positive and is about 20x10^{-6} second^{-1} over northeast Bay.

A southwest-northeast oriented band of vorticity 25x10^{-6} second^{-1} lies over parts of west Arabian Sea. It is less than 25x10^{-6} second^{-1} over remaining parts of AS.

Convergence:

There are small pockets of positive lower level convergence about 5x10^{-6} s^{-1} over equatorial region.

There are no significant zones of positive low level convergence over Arabian Sea.

Divergence:

There is a zone of positive upper level divergence over central parts of southeast Bay. There are no significant areas of positive upper-level divergence over Arabian Sea.

Wind Shear:

Wind shear is high over entire BOB. It is moderate (15-20 kts) over Andaman Sea.

Wind shear is high over entire Arabian Sea except for Comorin area where shear is moderate.

Wind Shear Tendency:

There is increasing tendency (5-10 kts) over entire BOB except for Andaman Seas, where it is neutral.

There is increasing tendency over entire Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over south Bay of Bengal and over Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over Comorin Area and southeast Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 12^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 8 with amplitude more than one. It would move to phase 1 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 15 November 2016 shows mostly anti-cyclonic circulation over entire country. There is no indication for formation of any low pressure area over NIO regions.

NCEP-GFS: The analysis/forecast charts of the model based on 0000 UTC of 15 November 2016 show similar features like IMD-GFS model. There is no indication for formation of any low pressure area over NIO regions.

ECMWF: The model analysis based on 00 UTC of 15November 2016 shows an upper air ant-cyclonic circulation at 850 hPa over Bay of Bengal and Arabian Sea. There is no indication for formation of any low pressure area over NIO regions.

WRF: The WRF model forecast based on 00 UTC of 15 November 2016 shows an upper air anti-cyclonic circulation at 850 hPa over entire country. This mesoscale model also not shows any indication for formation of any low pressure area over NIO regions

JMA: The forecast based on 00 UTC of 15th shows no system for next three days.

Meteo-France ARP Model: The forecast based on 00 UTC of 15th shows no system for next three days.

NCMRWF-NCUM: The analysis based on 00 UTC of 15th November shows a low pressure area to the south of Sri Lanka on 19th which moves northward and seen over southwest Bay off Tamil Nadu coast on 21st as a depression, as a low again on 22nd and weakens thereafter over the same area.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 15th shows no system for next three days.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 15th November shows the presence of a low over Sri Lankan area during 21st- 22nd which becomes less marked on 23rd over the same area.

IITM-GEFS: The forecast based on 00 UTC of 15th November shows that no low pressure system is expected over Indian Sea until 23rd November.

IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 13th November shows that no low pressure system is expected over Indian seas until 23rd November.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 15th November 2016 do not suggest any cyclogenesis over Indian seas in the coming 7 days.

Summary and Conclusion:

According to majority of the models no low pressure area is expected to form over the north Indian Ocean during next five days, except NCUM which indicates possible formation of a low pressure system near Sri Lanka coast during 19th -22nd November and NCMRWF-NEPS which indicates the same during 21st- 22nd . However, there is no possibility of formation of low pressure system over the north Indian Ocean during next five days.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	14/12	**15/00**	**15/03**
India	39	31	46
Coastal stations			
WB	9	3	9
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	12	9	12
Puducherry	1	1	1
A & N	1	1	6
Bangladesh	10	10	11
Myanmar	9	6	1
Thailand	3	3	3
Sri Lanka	09	8	10

AWS:

Region	Date/Time (UTC)		
	14/12	**15/00**	**15/03**
WB	3	1	4
Odisha	6	1	5
AP	5	2	5
Tamil Nadu	22	8	21
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 14 / 11 /2016 :33/43
- **No. of Ascents reaching 250 hPa levels: 14 , MISDA:-19**

- **RS/RW** (00Z) of 15 / 11 /2016 : 33/43

- **No. of Ascents reaching 250 hPa levels:28 , MISDA:4**
-

No. of PILOT Ascents

14/12Z	15/00Z
0	4

Buoy Data

14/12Z	15/00Z	15/03Z
6	4	5

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**14.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**19**

No. of RS/RW Ascents

00Z /14.11.2016 : 7

No. of Ascents reaching 250hPa level =6

MISDA :1

12Z /14.11.2016 : 3

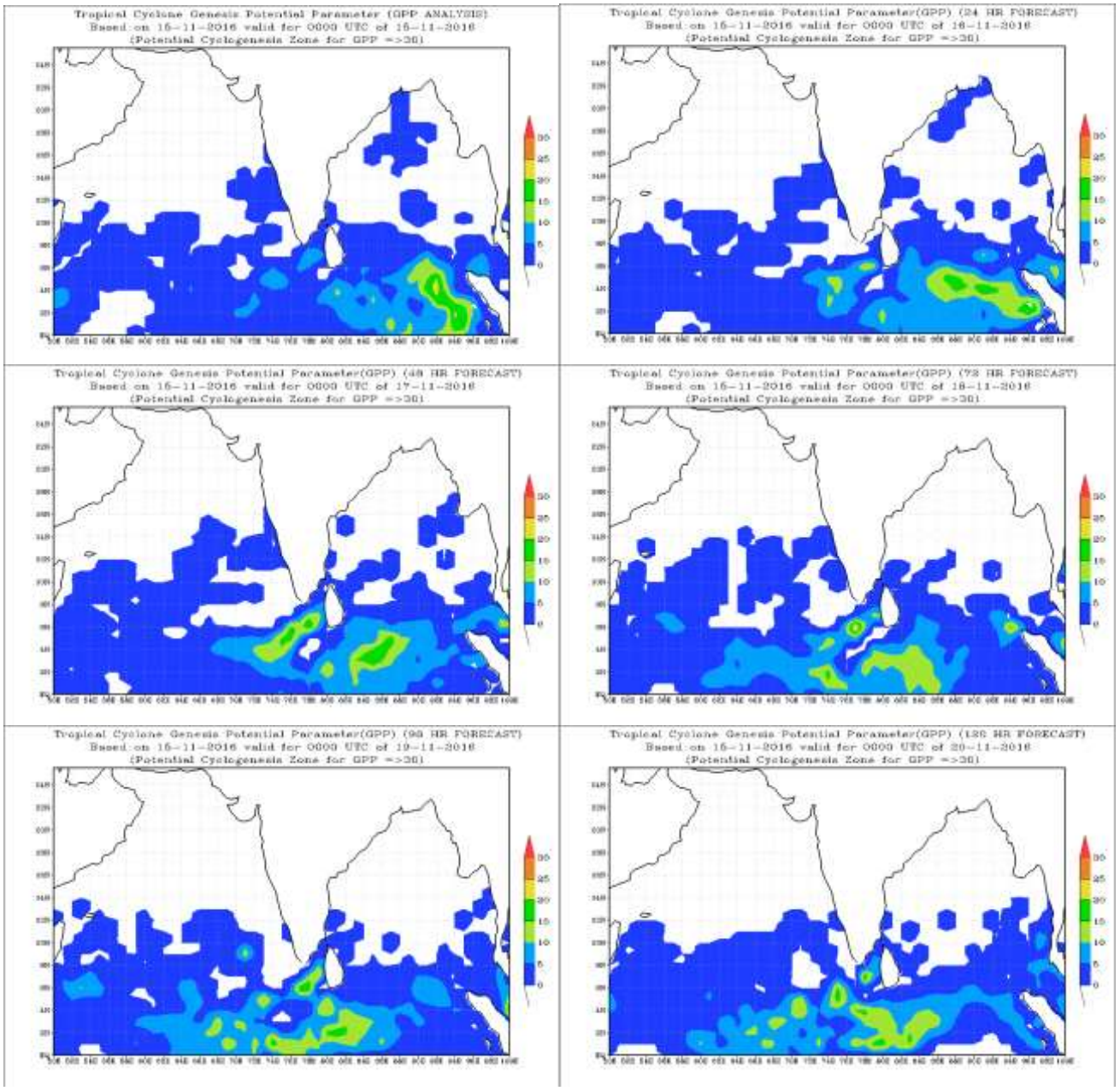
No. of Ascents reaching 250 hPa level =3

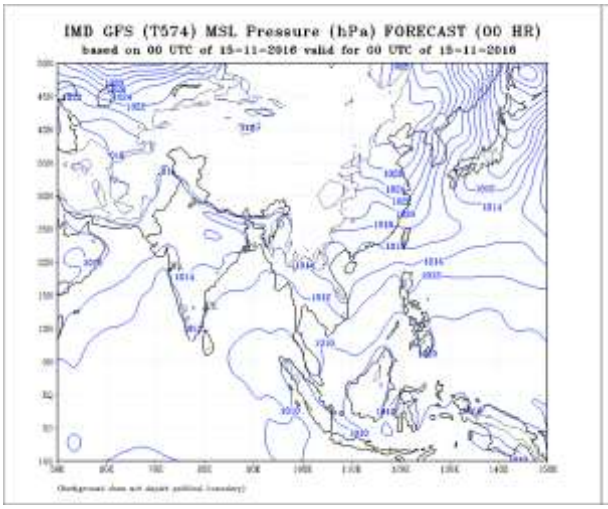
MISDA : 5

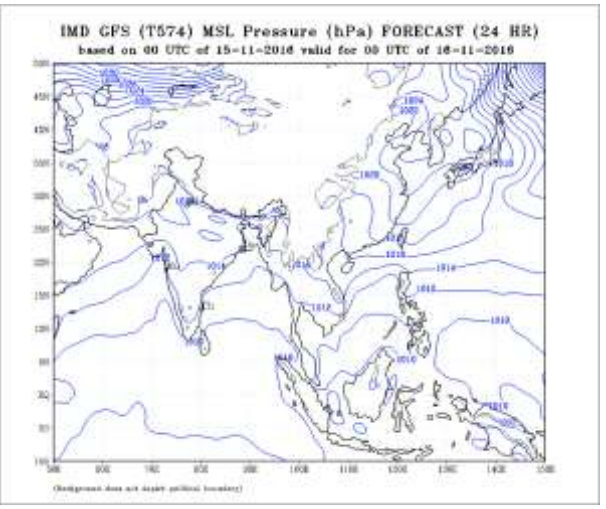
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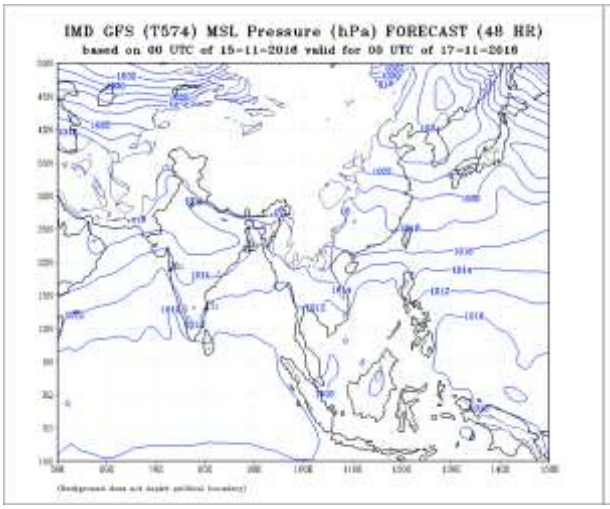
14.11.2016	
06Z	18Z
3	4

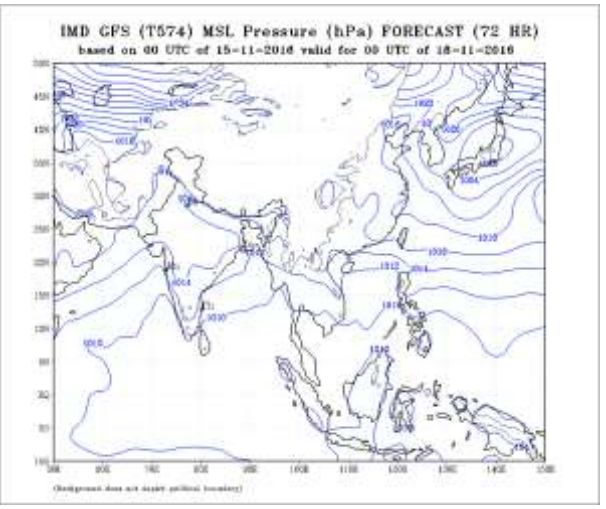
Annexure-II

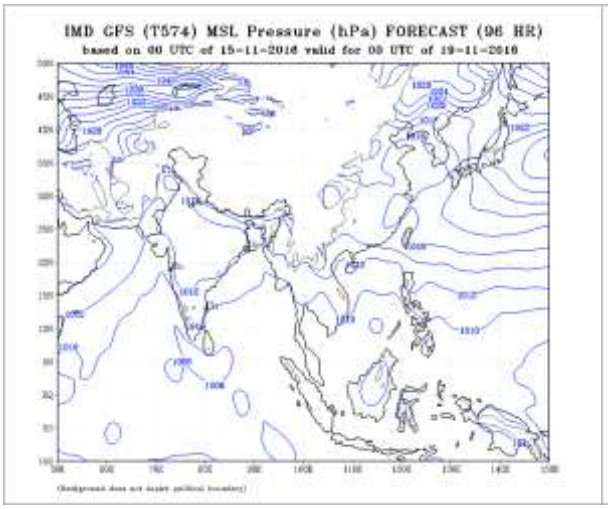

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 16-11-2016 valid for 0000 UTC of 16-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 16-11-2016 valid for 0000 UTC of 16-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 16-11-2016 valid for 0000 UTC of 17-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 16-11-2016 valid for 0000 UTC of 18-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 16-11-2016 valid for 0000 UTC of 19-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 16-11-2016 valid for 0000 UTC of 20-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

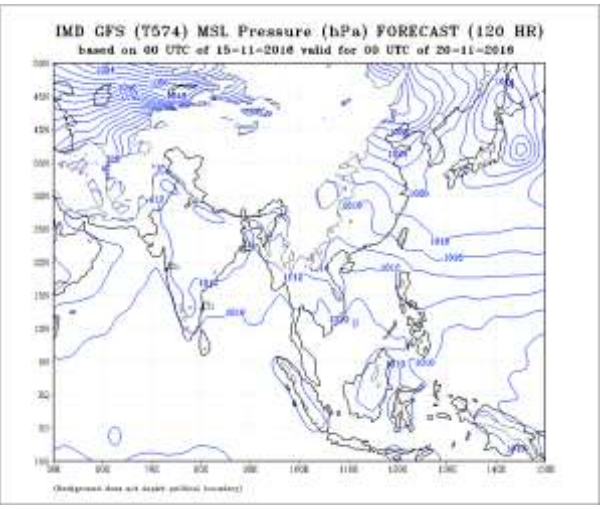

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 15-11-2016


IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 16-11-2016

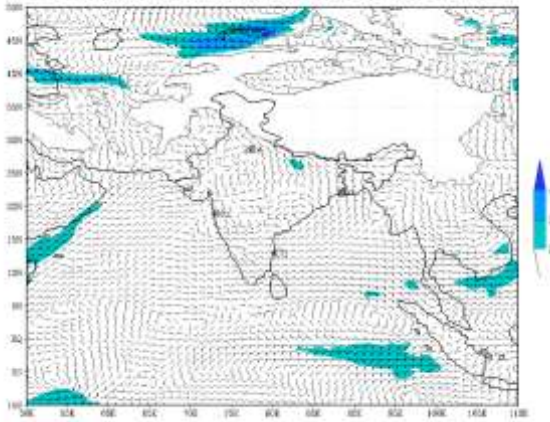

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 17-11-2016


IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 18-11-2016

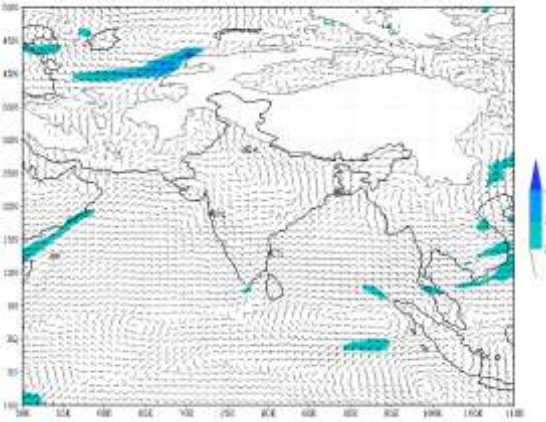

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 19-11-2016


IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
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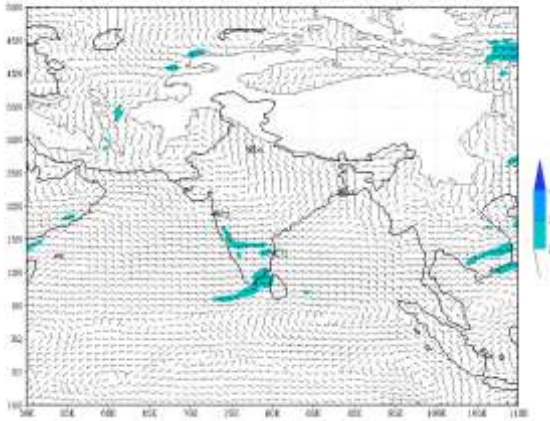
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 15-11-2016



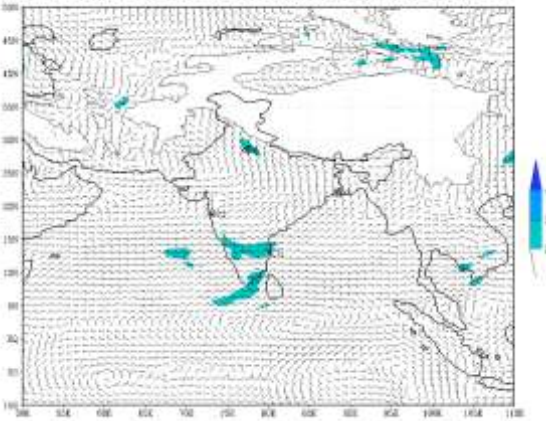
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 16-11-2016



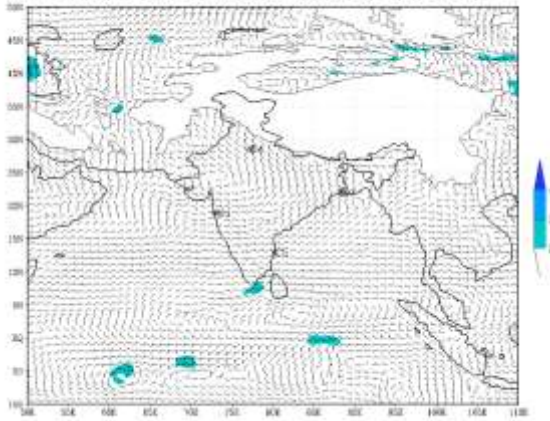
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 17-11-2016



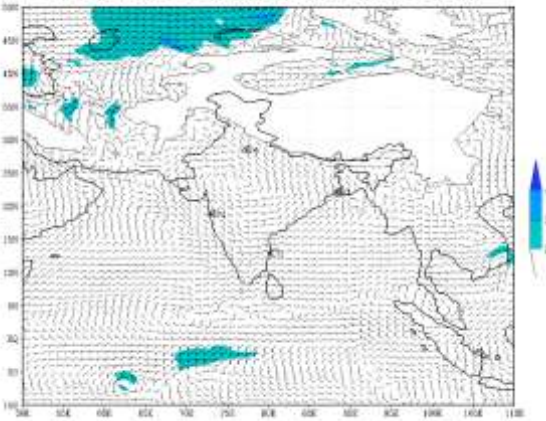
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 18-11-2016

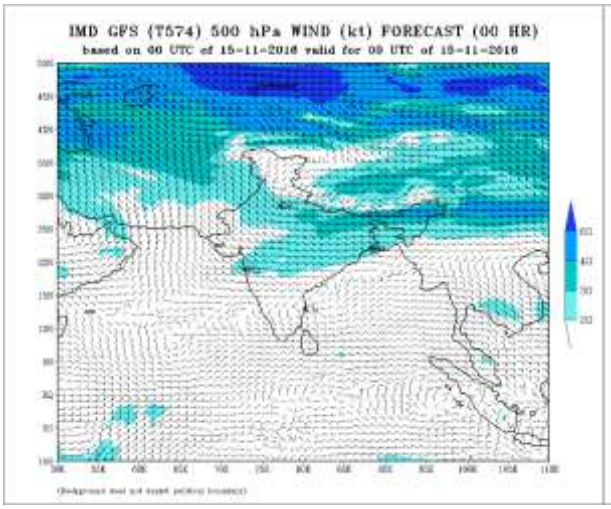


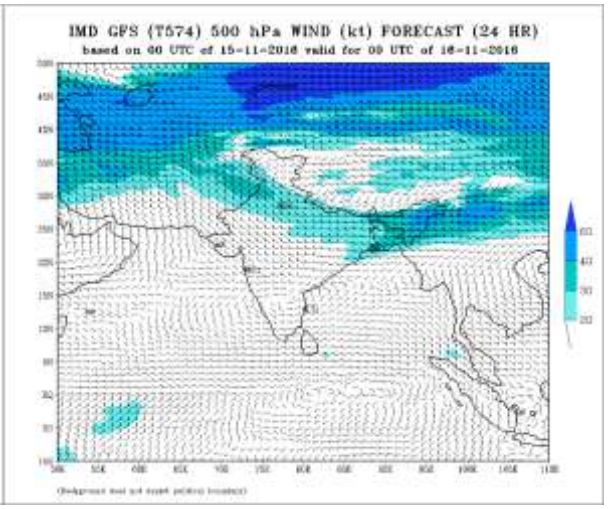
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 19-11-2016

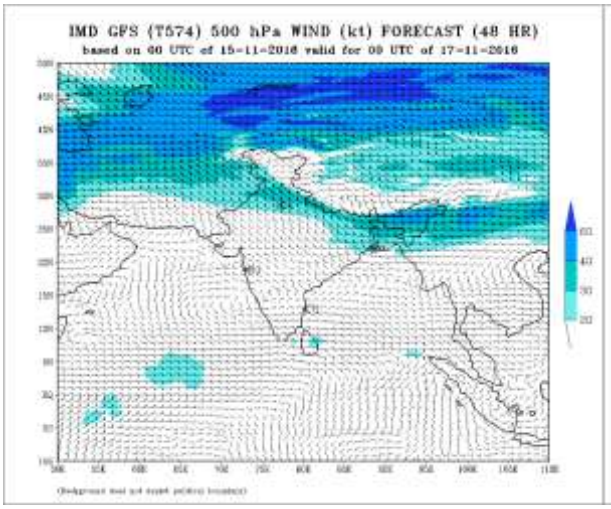


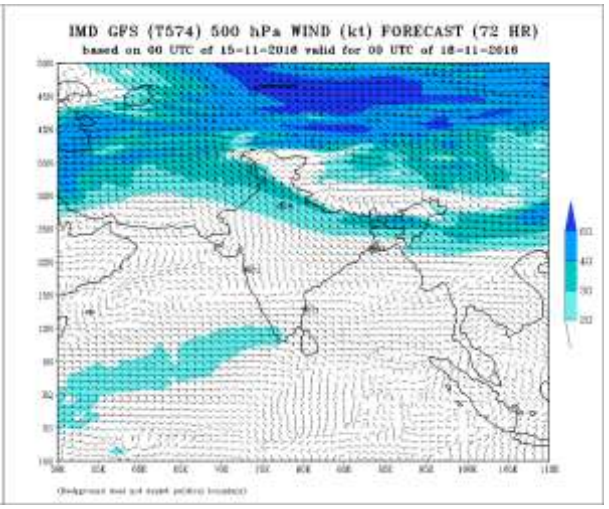
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 20-11-2016

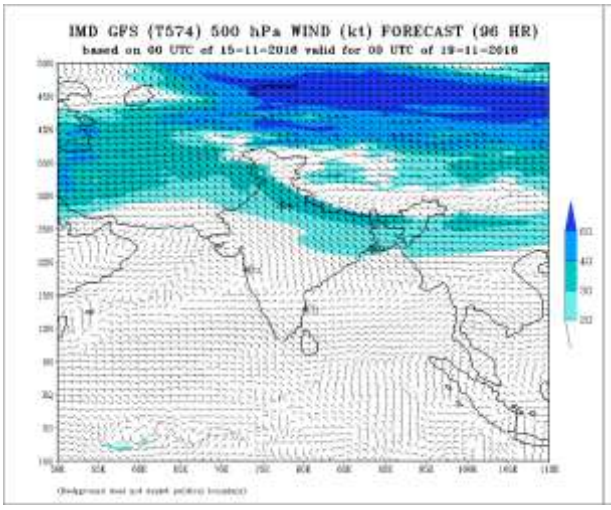


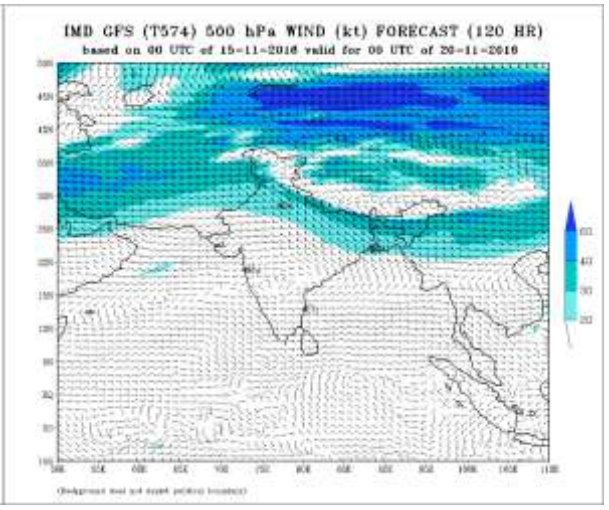

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 15-11-2016

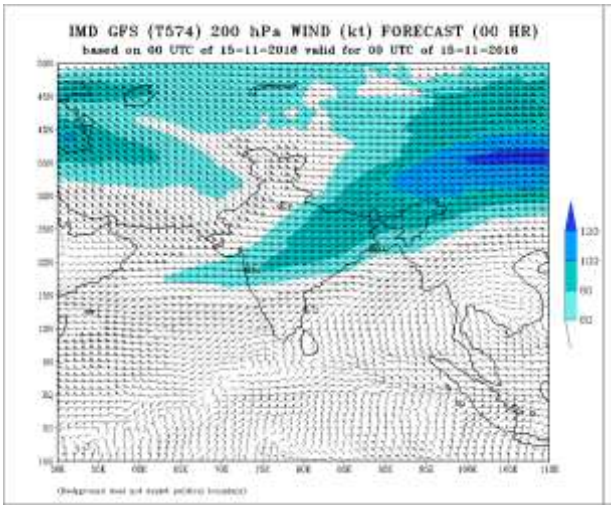

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 16-11-2016

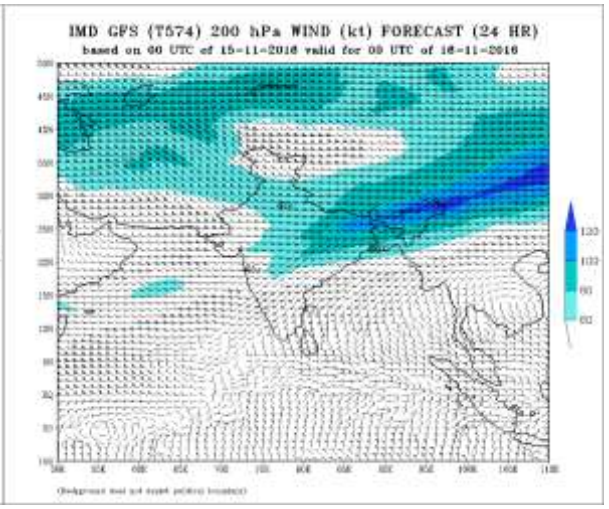

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 17-11-2016

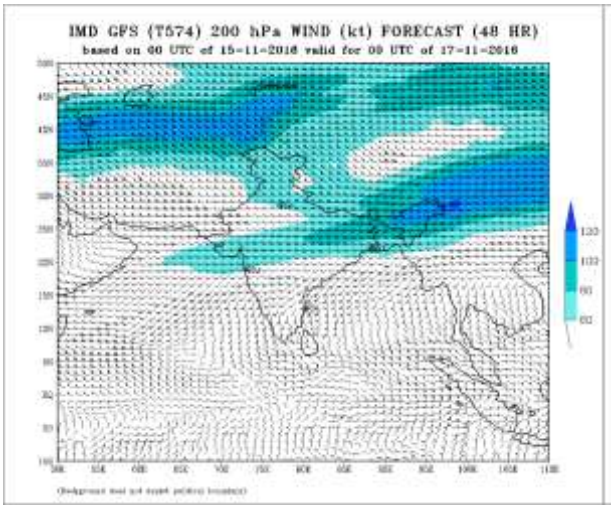

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 18-11-2016

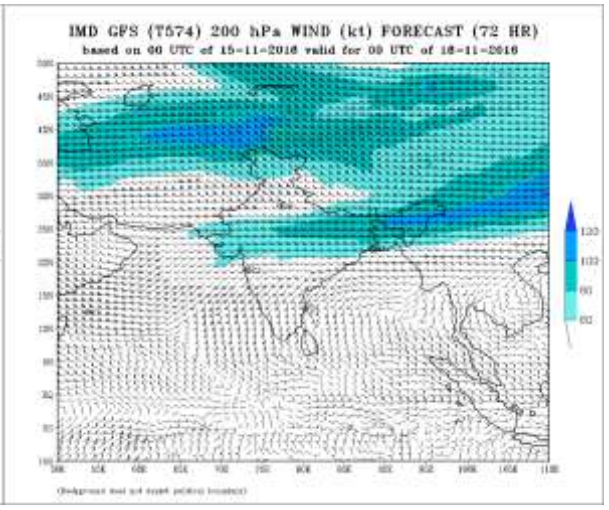

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 19-11-2016

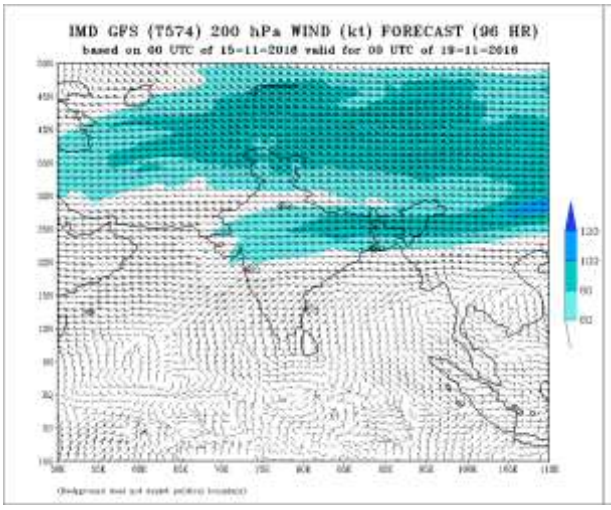

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 20-11-2016

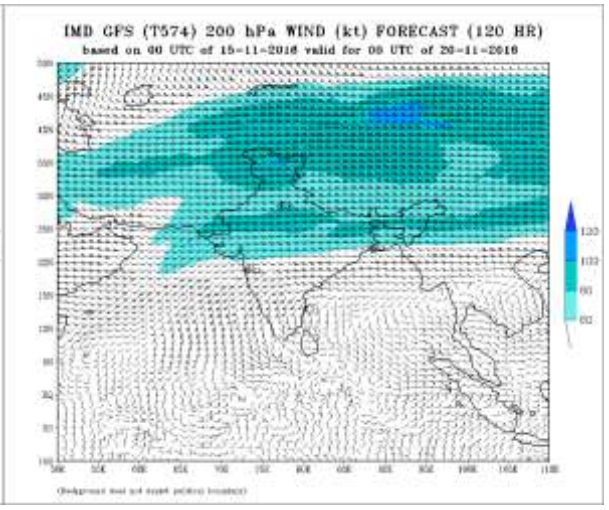

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 15-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 16-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 17-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 18-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 19-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 15-11-2016 valid for 00 UTC of 20-11-2016

FDP (Cyclone) NOC Report Dated 16th November 2016

Synoptic features:

The trough of low at mean sea level from Comorin area to south Konkan coast now extends from Lakshadweep area to Goa coast. The other trough of low at mean sea level over southeast Bay of Bengal and adjoining equatorial Indian Ocean now lies over equatorial Indian Ocean and adjoining central parts of south Bay of Bengal. The cyclonic circulation over southeast Arabian Sea off Kerala-Karnataka coasts has become less marked.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of Bay of Bengal except for a small area of lesser values over northwest BoB. SST of 30-31˚C are seen over in parts of North Andaman Sea.

The SST over Arabian Sea (AS) is between 26-28˚C over most areas of north and central Arabian Sea. SST is 31-32˚C over parts of northeast AS off Gujarat & adjoining north Maharashtra coast. SST is 28-30˚C over remaining parts of Arabian Sea.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for the equatorial waters to the south of south Bay, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal and also in patches over southwest and west central BoB.

TCHP is less than 50 kJ/cm^2 over north, westcentral, and southwest Arabian Sea. It is 60-80 kJ/cm^2 over remaining parts of Arabian Sea.

Relative Vorticity:

The low-level relative vorticity is negative over south BOB & adjoining Andaman Sea. It is positive and is about $20x10^{-6}$ second^{-1} over northeast and adjoining east central Bay.

One southwest-northeast oriented band of vorticity $25x10^{-6}$ second^{-1} lie over parts of west Arabian Sea and the other band over Lakshadweep area. It is less than $25x10^{-6}$ second^{-1} over remaining parts of AS.

Convergence:

There are small pockets of positive lower level convergence about $5x10^{-6}$ s^{-1} over south BoB and adjoining equatorial region.

There are zones of positive low level convergence over south Arabian Sea and adjoining equatorial region.

Divergence:

There is a zone of positive upper level divergence over central parts of southwest Bay. There is a small area of positive upper-level divergence over southwest Arabian Sea.

Wind Shear:

Wind shear is high over entire BOB. It is moderate (15-20 kts) over Andaman Sea.

Wind shear is high over entire Arabian Sea except for Comorin area where shear is moderate.

Wind Shear Tendency:

There is increasing tendency (5-10 kts) over entire BOB except for Andaman Seas, where it is neutral.

There is increasing tendency over entire Arabian Sea except for western parts of NW Arabian Sea and southern parts of southeast Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over southwest Bay of Bengal and over southeastern parts of Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over south Arabian Sea to the south of 9.0^{0}N.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 12^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 8 with amplitude more than one. It would move to phase 1 during next 24 hours.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 16th November 2016 shows mostly anti-cyclonic circulation over entire country. There is no indication for formation of any low pressure area over NIO regions.

NCEP-GFS: The analysis/forecast charts of the model based on 00 UTC of 16th November 2016 show similar features like IMD-GFS model. There is no indication of formation of any low pressure area over NIO regions.

ECMWF: The model analysis based on 00 UTC of 16th November 2016 shows an upper air anti-cyclonic circulations at 850 hPa over Bay of Bengal and Arabian Sea. There is no indication for formation of any low pressure area over NIO regions.

WRF: The WRF model forecast based on 00 UTC of 16th November 2016 shows an upper air anti-cyclonic circulation at 850 hPa over entire country. This mesoscale model also does not show any indication for formation of any low pressure area over NIO regions.

JMA: The forecast based on 00 UTC of 16th shows no system for next three days.

Meteo-France ARP Model: The forecast based on 00 UTC of 16th shows no system for next three days.

NCMRWF-NCUM: The analysis based on 00 UTC of 16th November shows a low pressure area to the south of Sri Lanka on 19th which shows a slight northward movement and seen over southwest Bay off Tamil Nadu coast during 21st - 22nd and weakens thereafter over the same area.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 16th shows no system for the next three days.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 16th November shows the presence of a low over Sri Lankan area during 21st- 22nd which becomes less marked on 23rd over the same area.

IITM-GEFS: The forecast based on 00 UTC of 16th November shows that no low pressure system is expected over Indian Sea until 24th November.

IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 16th November shows that no low pressure system is expected over Indian seas until 24th November.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 16th November 2016 do not suggest any cyclogenesis over Indian seas in the coming 7 days.

Summary and Conclusion:

According to majority of the models no low pressure area is expected to form over the north Indian Ocean during next five days, except NCUM which continued to indicate possible formation of a low pressure system near Sri Lanka coast during 19th -22nd November and also NCMRWF-NEPS which indicates the same during 21st- 22nd . However, there is no possibility of formation of low pressure system over the north Indian Ocean during next five days.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	15/12	16/00	16/03
India	31	31	40
Coastal stations			
WB	1	1	4
Odisha	5	6	6
AP	11	12	12
Tamil Nadu	12	10	11
Puducherry	1	1	1
A & N	1	1	6
Bangladesh	11	10	11
Myanmar	9	7	1
Thailand	3	3	3
Sri Lanka	10	9	10

AWS:

Region	Date/Time (UTC)		
	15/12	16/00	16/03
WB	1	0	3
Odisha	4	1	6
AP	5	3	5
Tamil Nadu	22	8	21
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 15 / 11 /2016 :34/43
- **No. of Ascents reaching 250 hPa levels: 15 , MISDA:-19**

- **RS/RW** (00Z) of 16 / 11 /2016 : 32/43

- **No. of Ascents reaching 250 hPa levels:27 , MISDA:5**

No. of PILOT Ascents

15/12Z	16/00Z
7	2

Buoy Data

15/12Z	16/00Z	16/03Z
7	5	6

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**15.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

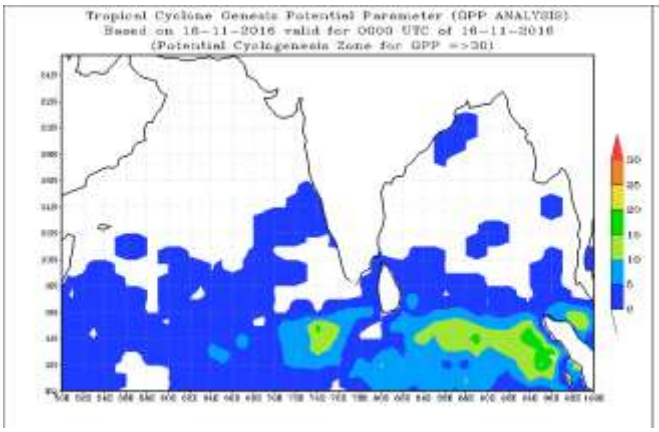
00Z /15.11.2016 : 6
No. of Ascents reaching 250hPa level =6
MISDA :2

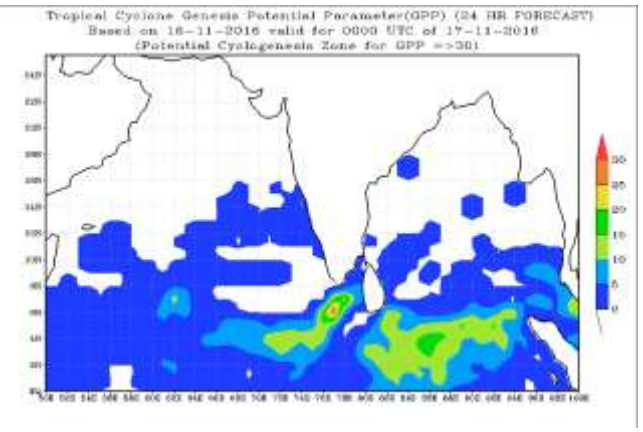
12Z /15.11.2016 : 3
No. of Ascents reaching 250 hPa level =3
MISDA : 5

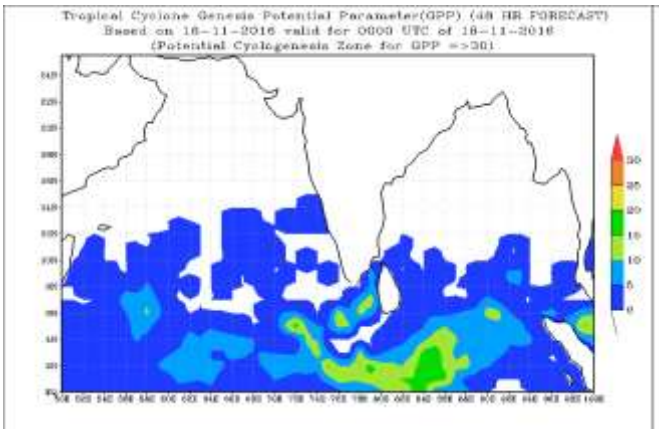
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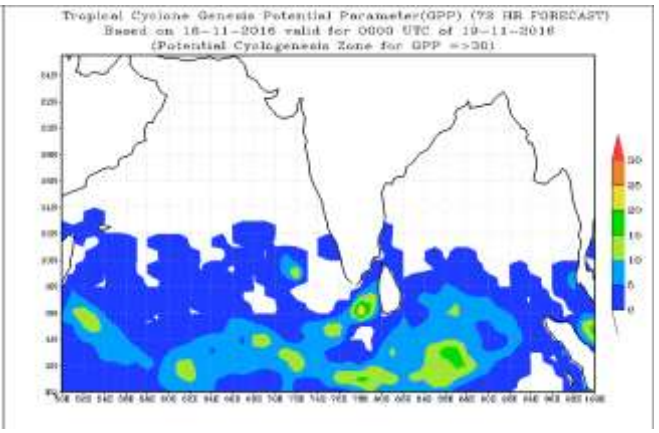
15.11.2016	
06Z	18Z
3	3

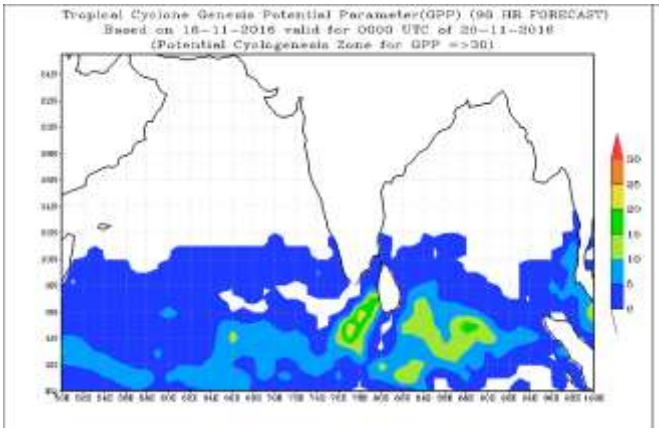
Annexure-II

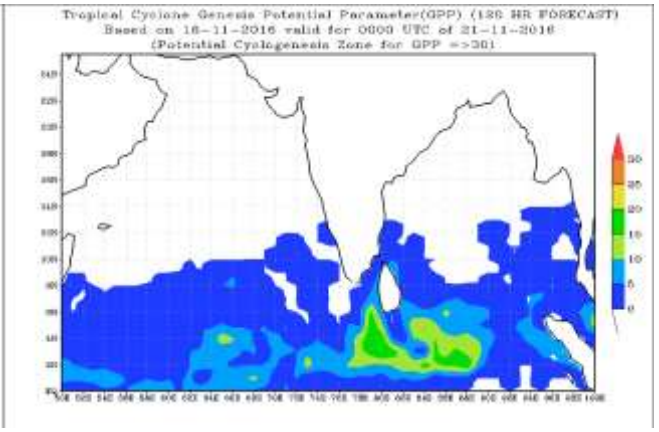

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 16-11-2016 valid for 0000 UTC of 16-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

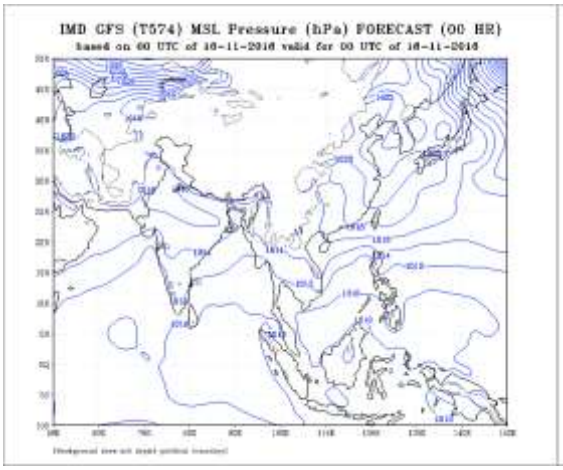

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 16-11-2016 valid for 0000 UTC of 17-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

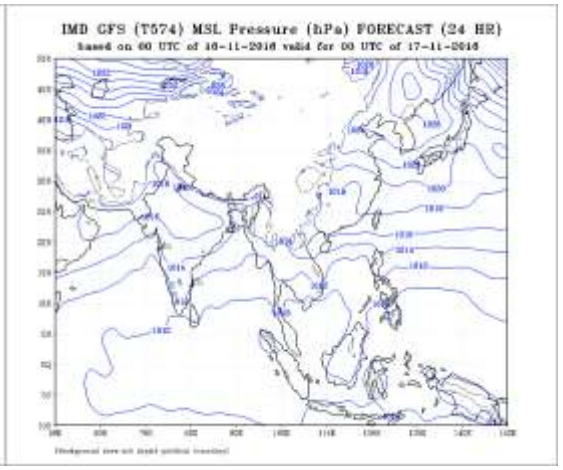

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 16-11-2016 valid for 0000 UTC of 18-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

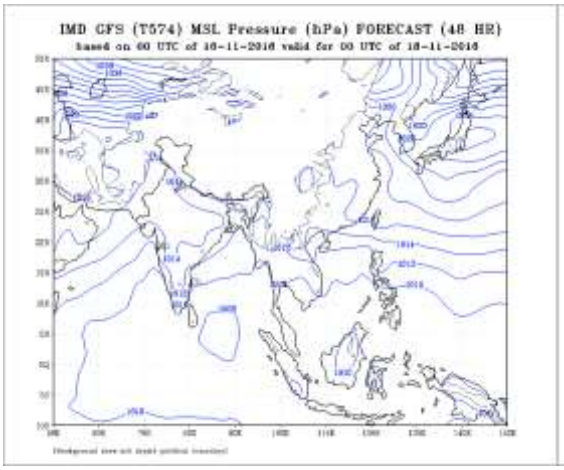

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 16-11-2016 valid for 0000 UTC of 19-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

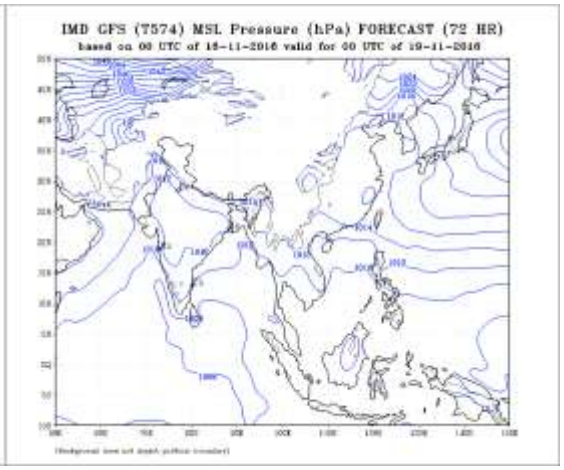

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 16-11-2016 valid for 0000 UTC of 20-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

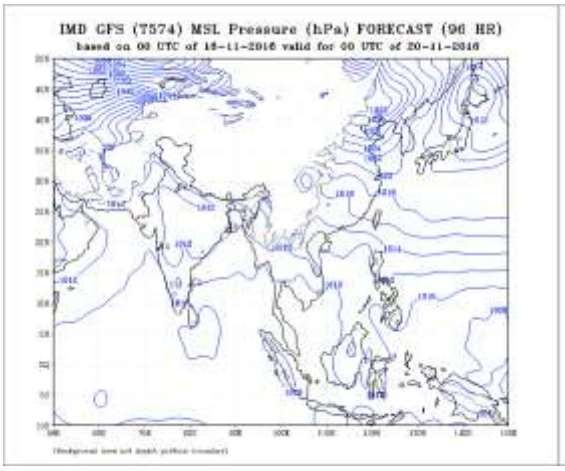

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 16-11-2016 valid for 0000 UTC of 21-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

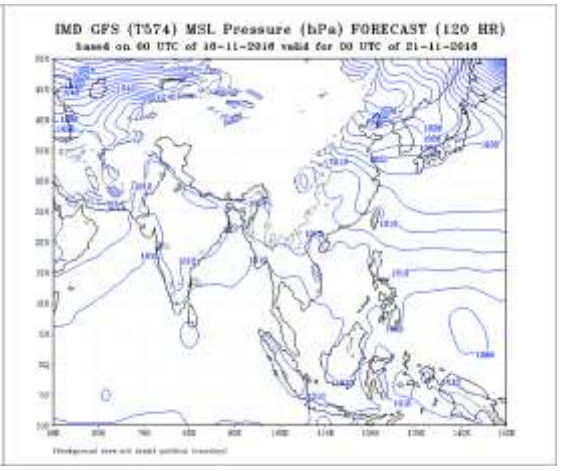

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 16-11-2016

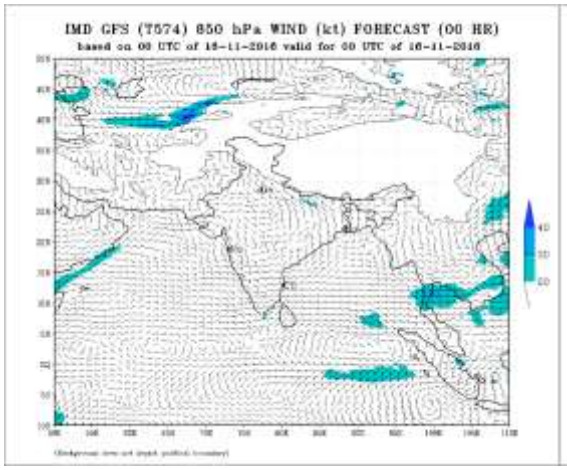

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 17-11-2016

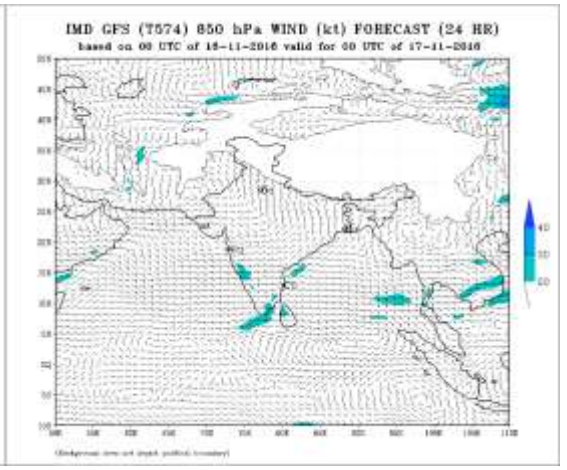

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 18-11-2016

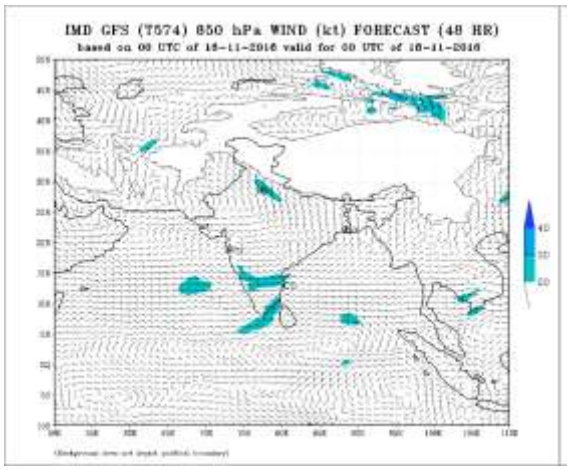

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 19-11-2016

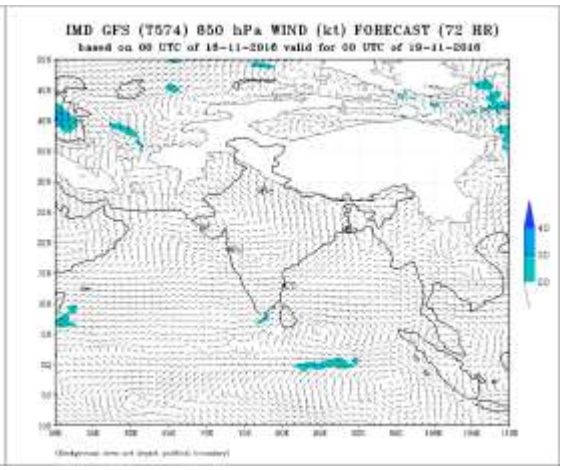

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
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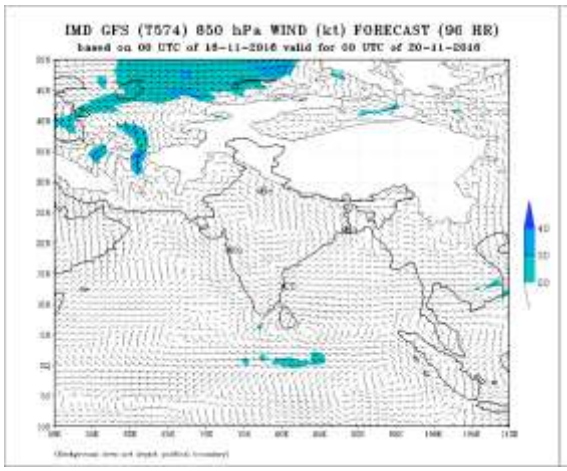

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 21-11-2016

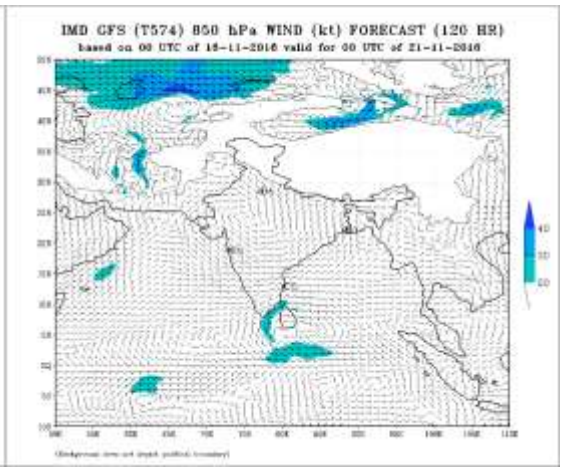

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 16-11-2016

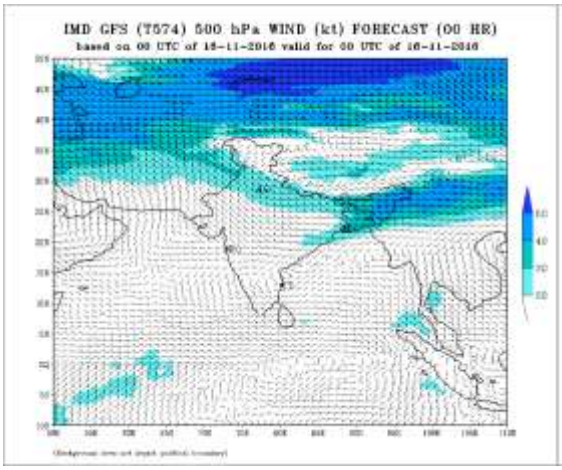

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 17-11-2016

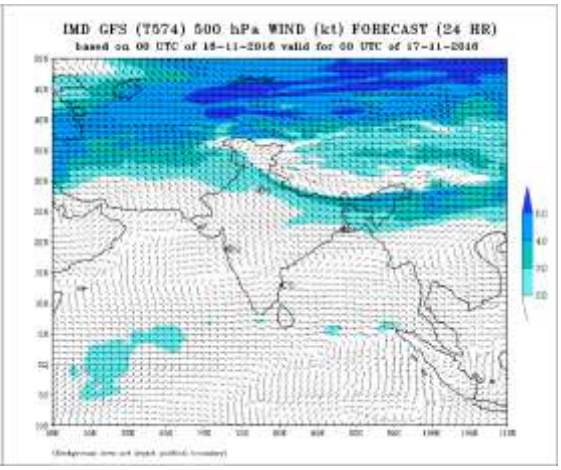

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 18-11-2016

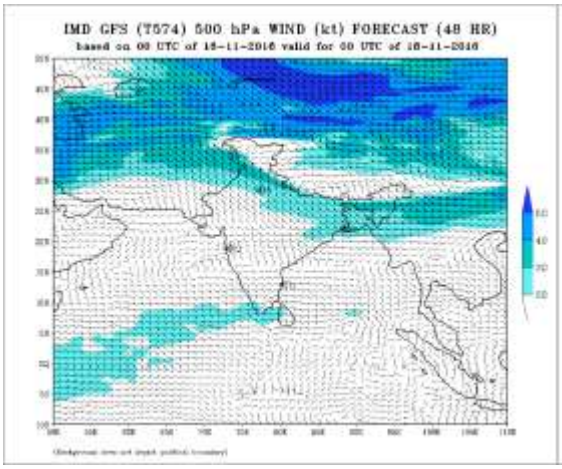

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
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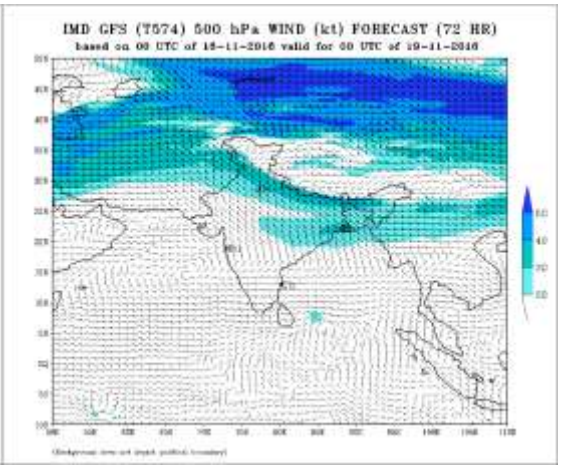

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
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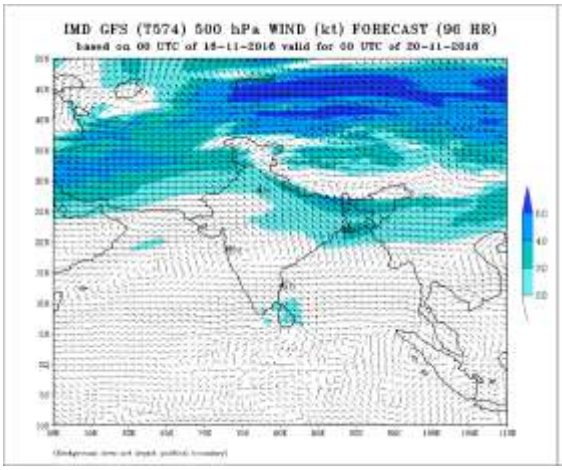

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 21-11-2016

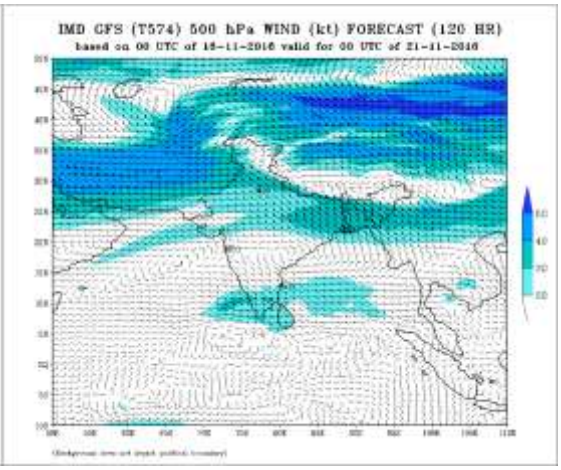

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
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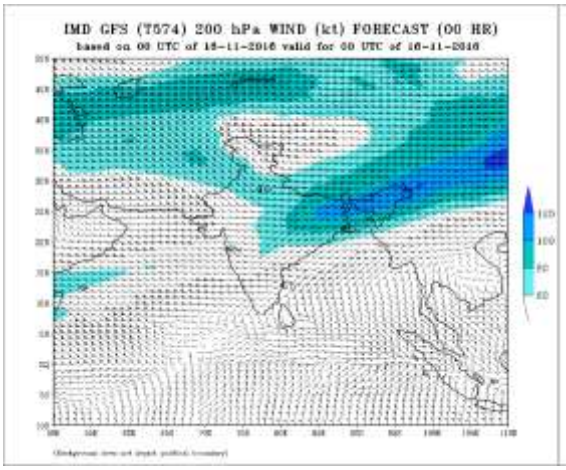

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 17-11-2016

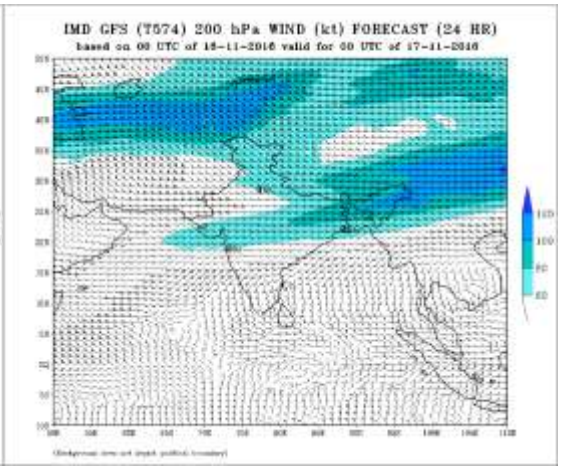

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 18-11-2016

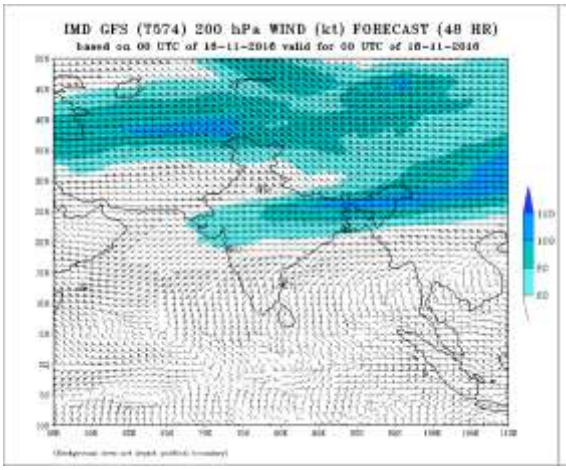

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 19-11-2016

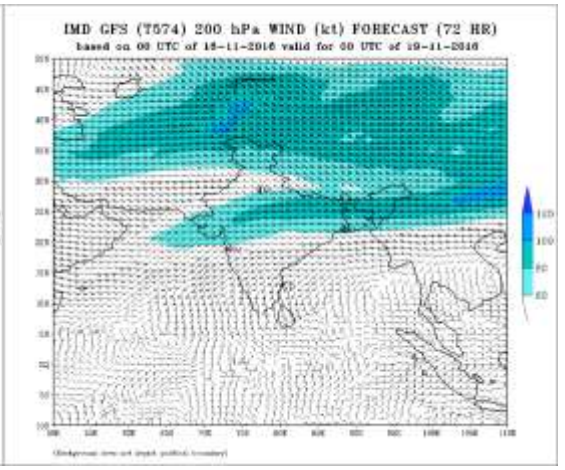

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
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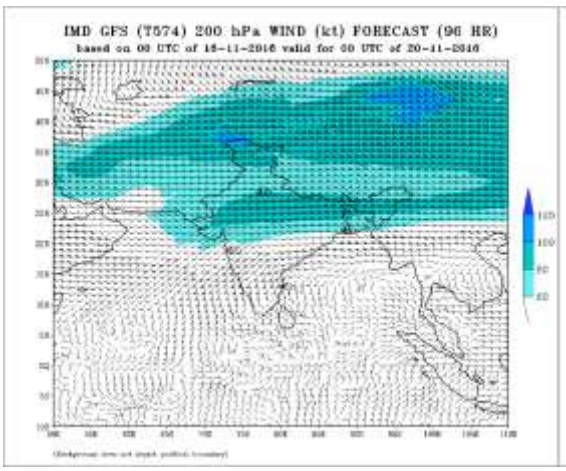

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 21-11-2016

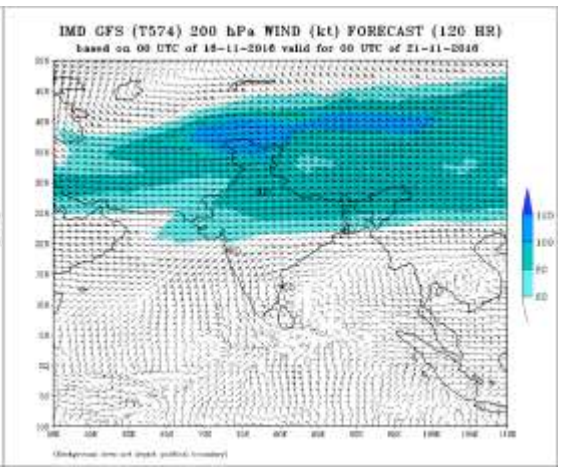

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 16-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 17-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 18-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 19-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 20-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 16-11-2016 valid for 00 UTC of 21-11-2016

FDP (Cyclone) NOC Report Dated 17th November 2016

Synoptic features:

The trough of low at mean sea level over equatorial Indian Ocean & adjoining central parts of south Bay of Bengal, now lies over equatorial Indian Ocean & adjoining southwest Bay of Bengal. Under its influence, a low pressure area is likely to develop over southwest Bay of Bengal off Sri Lanka coast around 21st.

The other trough of low at mean sea level from Lakshadweep area to Goa coast persists.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of Bay of Bengal except for a small area of lesser values over northwest BoB. SST of 30-31˚C are seen over in parts of North Andaman Sea and also over in small pockets over southern parts of southwest BoB.

The SST over Arabian Sea (AS) is between 26-28˚C over most areas of western half of Arabian Sea. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat coast. SST is 28-30˚C over remaining parts of Arabian Sea.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for the equatorial waters to the south of south Bay, where the value of TCHP is 100 kJ/cm^2 . It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal and also in patches over southwest and west central BoB.

TCHP is less than 50 kJ/cm^2 over western Arabian Sea. It is 60-80 kJ/cm^2 over remaining parts of Arabian Sea except for a small pocket over Comorin area off southwest coast of Sri Lanka.

Relative Vorticity:

The low-level relative vorticity is negative over BOB & adjoining Andaman Sea. It is positive and is about $20x10^{-6}$ $second^{-1}$ over northeast and adjoining east central Bay.

One southwest-northeast oriented band of positive vorticity of $25x10^{-6}$ $second^{-1}$ lie over parts of west Arabian Sea. Other small pockets of positive values are seen over southern parts of Arabian Sea. It is less than $25x10^{-6}$ $second^{-1}$ over remaining parts of AS.

Convergence:

There are small pockets of positive lower level convergence about $5x10^{-6}$ s^{-1} over southwest BoB near Sri Lanka.

There are no zones of positive low level convergence over Arabian Sea.

Divergence:

There is a zone of positive upper level divergence over southern parts of southwest Bay extending to Comorin area. There an area of positive upper-level divergence over south Andaman sea and adjoining southeast Bay.

There an area of positive upper-level divergence over southwest Arabian Sea and another area over west central Arabian Sea.

Wind Shear:

Wind shear is high over entire BOB. It is moderate (15-20 kts) over Andaman Sea and the area extends to southern parts of south BoB and thence to Comorin area.

Wind shear is high over entire Arabian Sea except for Comorin area where shear is moderate.

Wind Shear Tendency:

There is increasing tendency (5-10 kts) over entire BOB except for southern most parts of Andaman Sea, where it is decreasing.

There is increasing tendency over entire Arabian Sea except for western parts of NW Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over south Bay of Bengal and over Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over south Arabian Sea to the south of 13.5^0N.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 12^0N latitude over BoB.
M.J.O. Index: MJO index is in Phase 8 with amplitude more than one. It would move to phase 1 during next 3 days hours.
Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 17th November 2016 analysis shows a low level cyclonic circulation over the South west Bay of Bengal. The forecast shows the formation of a low pressure area on 19th November close to Sri Lanka which persists as low pressure area till 25th November over the same area. It becomes less marked thereafter.
NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 17 November 2016 show similar features like IMD-GFS model. It indicates the formation a low pressure area on 20th over southern parts of SW BoB near Sri Lanka which remains quasi-stationary till 24th.
ECMWF: The model analysis based on 00 UTC of 17 November 2016 shows a feeble low level cyclonic circulation over south-east Bay of Bengal. A low pressure region is seen on 23 November 2016 over the same area. Forecasts also show non-intensification of the system and the system is quasi-stationary till 25 November 2016 which becomes less marked thereafter.
WRF: The WRF model forecast based on 00 UTC of 17 November 2016 shows a slow moving low level cyclonic circulation in the south Bay. A pressure area is seen forming over SW BoB off the east coast of Sri Lanka on 19th.
JMA: The forecast based on 00 UTC of 17th shows no system for next three days.
Meteo-France ARP Model: The forecast based on 00 UTC of 17th analysis shows an extended low over southern parts of southwest Bay and adjoining equatorial ocean during 18-19th November. It is seen as a low on 20th over southwest Bay near Sri Lanka on 20th.
NCMRWF-NCUM: The analysis based on 00 UTC of 17th November shows a low pressure area to the south of Sri Lanka over southwest BoB during 20th -22nd which shows no significant movement or intensification.
NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 17th shows a low pressure system on 20th off the coast of south Sri Lanka coast.
NCMRWF-NEPS Model: The forecast based on the analysis of 00 UTC on 17th November shows the presence of a low/ extended over Sri Lankan area during 20th- 22nd which becomes less marked on 23rd over the same area.
IITM-GEFS: The forecast based on 00 UTC of 17th November shows a low pressure area/ extended low over southwest BoB near Sri Lanka during 20th -22nd November. The system does not exhibit any appreciable movement or intensification.
IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 17th November shows an extended low pressure area around Sri Lanka during 20th-21st November.
Dynamical statistical models
IMDGenesis Potential Parameter (GPP): The GPP forecast field shows a feeble cyclogenesis zone over the southern parts of southwest Bay of Bengal on 22nd November 2016 which dissipates thereafter. Forecasts show no further potential cyclogenesis zone during subsequent days till 24th November 2016.

Summary and Conclusion:
According to majority of the models a low pressure area is expected to form over the southwest Bay of Bengal near Sri Lanka on 19th /20th, except ECMWF which indicates possible formation of a low pressure system near Sri Lanka coast on 23rd November and also JMA model, which does not give any indication of formation of low pressure area during its three days forecast period. However, the models are in unison in predicting about the quasi stationery nature of the system and also in predicting no intensification. However, the formation and further intensification and movement of the system need to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours

Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	16/12	**17/00**	**17/03**
India	30	29	40
Coastal stations			
WB	1	1	4
Odisha	5	6	6
AP	11	10	12
Tamil Nadu	11	10	11
Puducherry	1	1	1
A & N	1	1	6
Bangladesh	11	10	11
Myanmar	9	7	1
Thailand	3	3	3
Sri Lanka	10	9	10

AWS:

Region	Date/Time (UTC)		
	16/12	**17/00**	**17/03**
WB	1	0	3
Odisha	4	1	6
AP	5	3	5
Tamil Nadu	18	8	21
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 16 / 11 /2016 :34/43
- **No. of Ascents reaching 250 hPa levels: 15 , MISDA:-9**

- **RS/RW** (00Z) of 17 / 11 /2016 : 32/43

- **No. of Ascents reaching 250 hPa levels:27 , MISDA:11**

No. of PILOT Ascents

16/12Z	**17/00Z**
7	2

Buoy Data

16/12Z	**17/00Z**	**17/03Z**
7	5	7

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**16.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**19**	**20**	**20**

No. of RS/RW Ascents

00Z /16.11.2016 : 6

No. of Ascents reaching 250hPa level =6

MISDA :2

12Z /16.11.2016 : 3

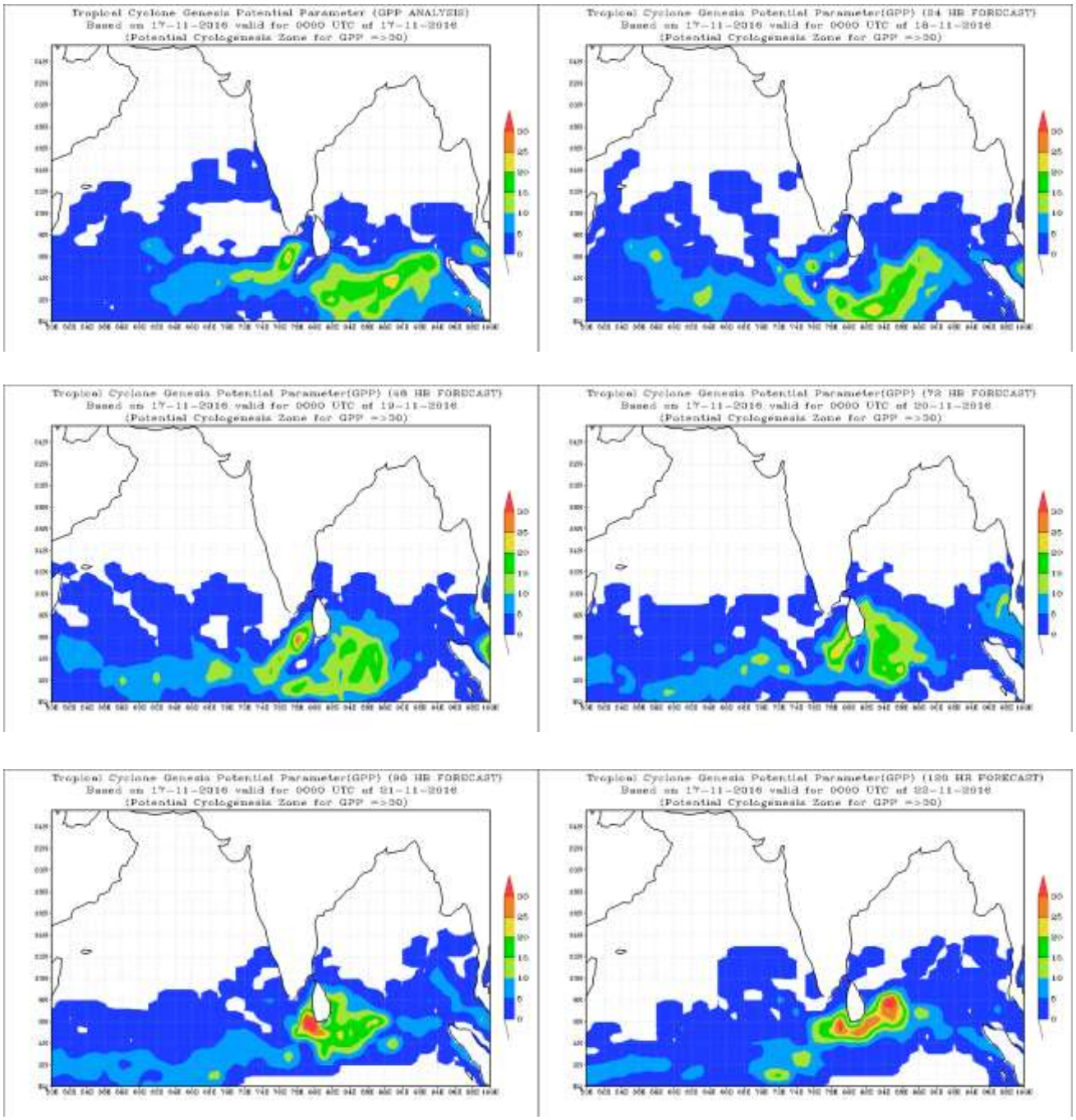
No. of Ascents reaching 250 hPa level =3

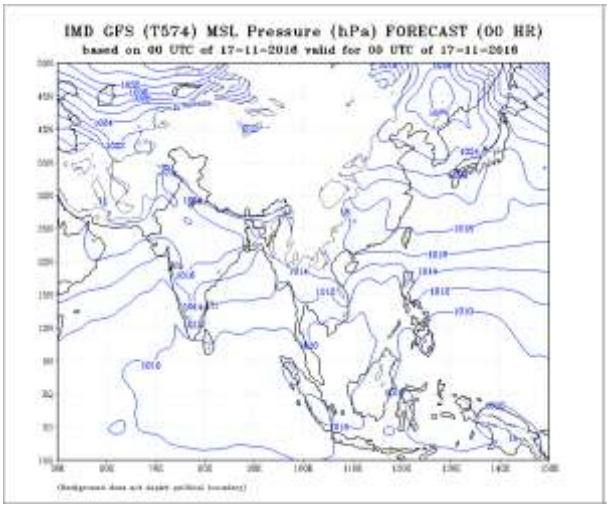
MISDA : 5

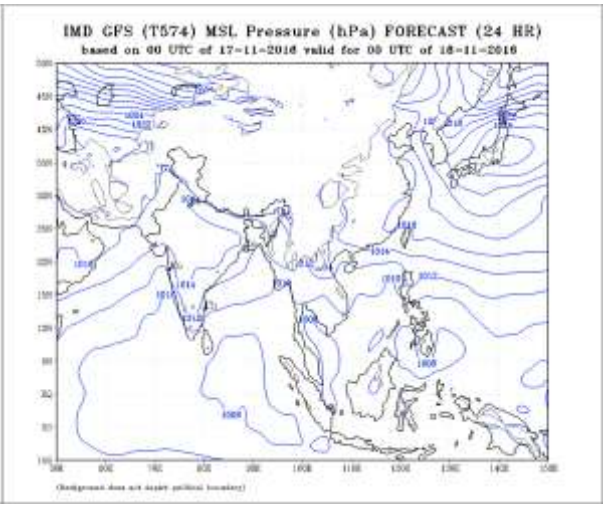
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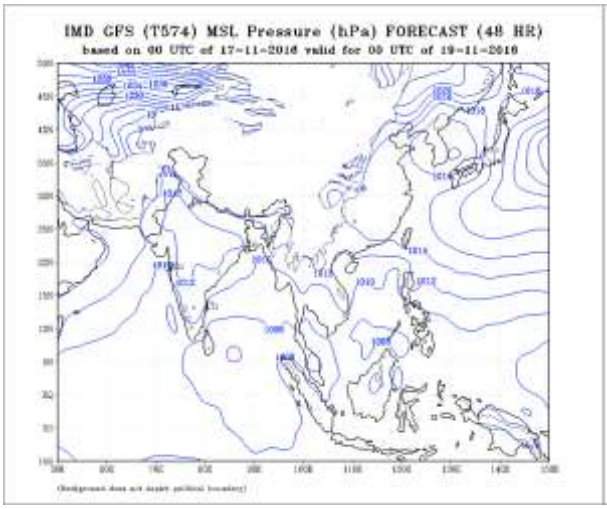
16.11.2016	
06Z	18Z
3	4

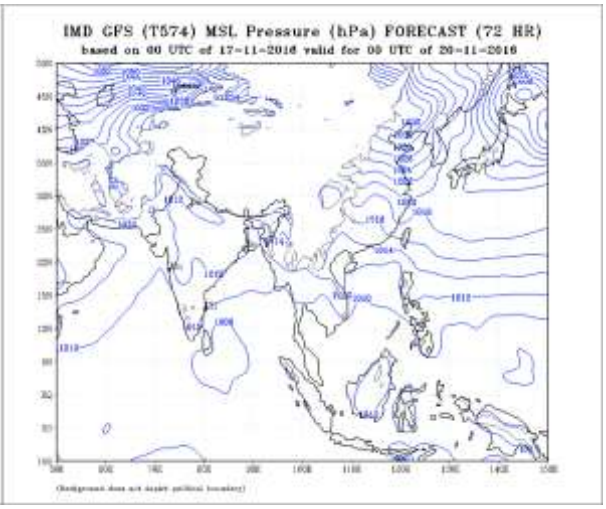
Annexure-II

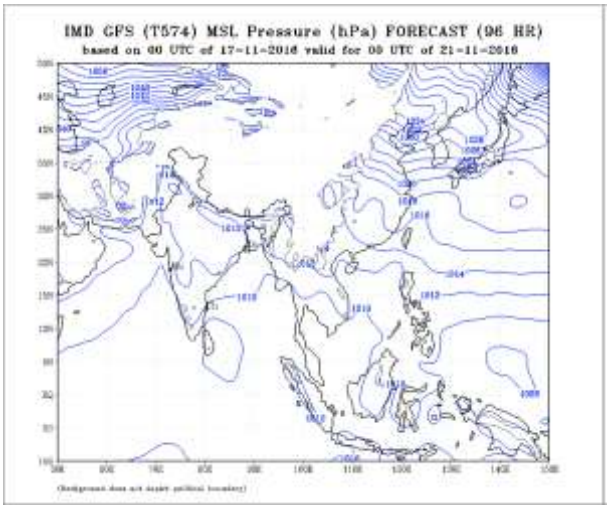

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 17-11-2016 valid for 0000 UTC of 17-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 17-11-2016 valid for 0000 UTC of 18-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 17-11-2016 valid for 0000 UTC of 19-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 17-11-2016 valid for 0000 UTC of 20-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 17-11-2016 valid for 0000 UTC of 21-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 17-11-2016 valid for 0000 UTC of 22-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

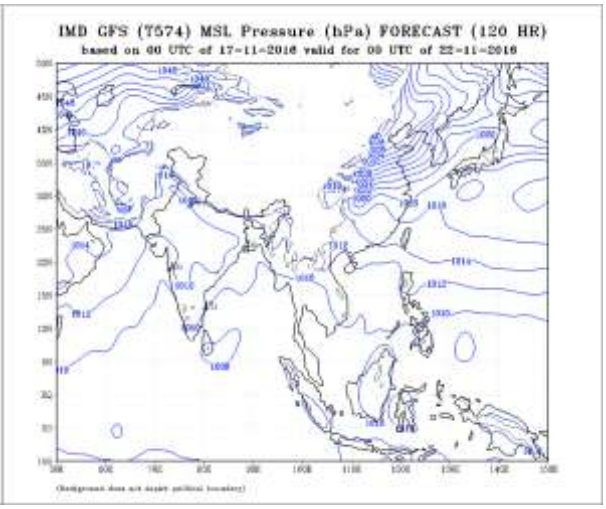

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 17-11-2016

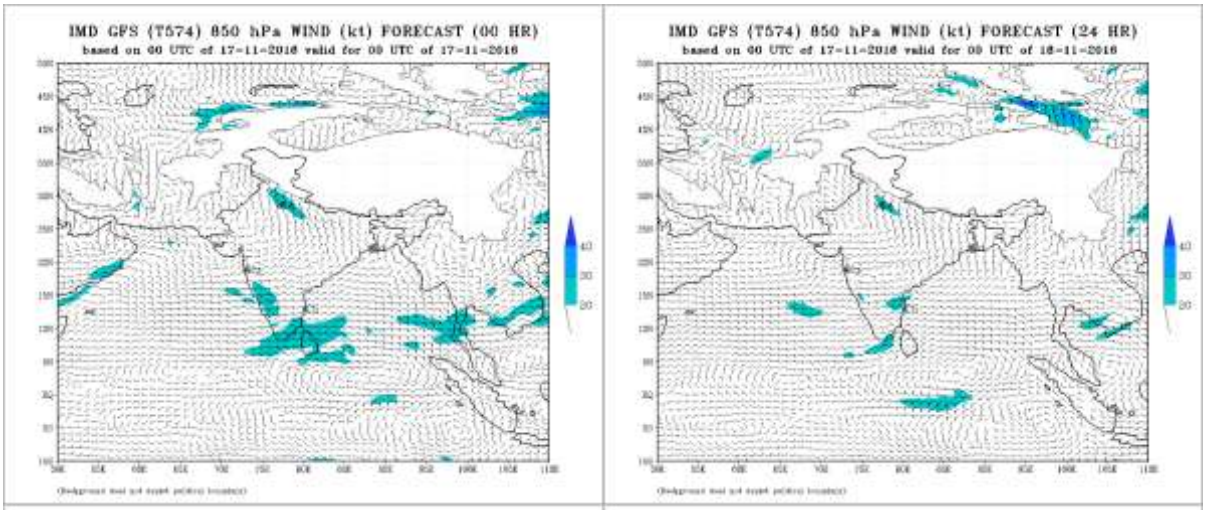

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
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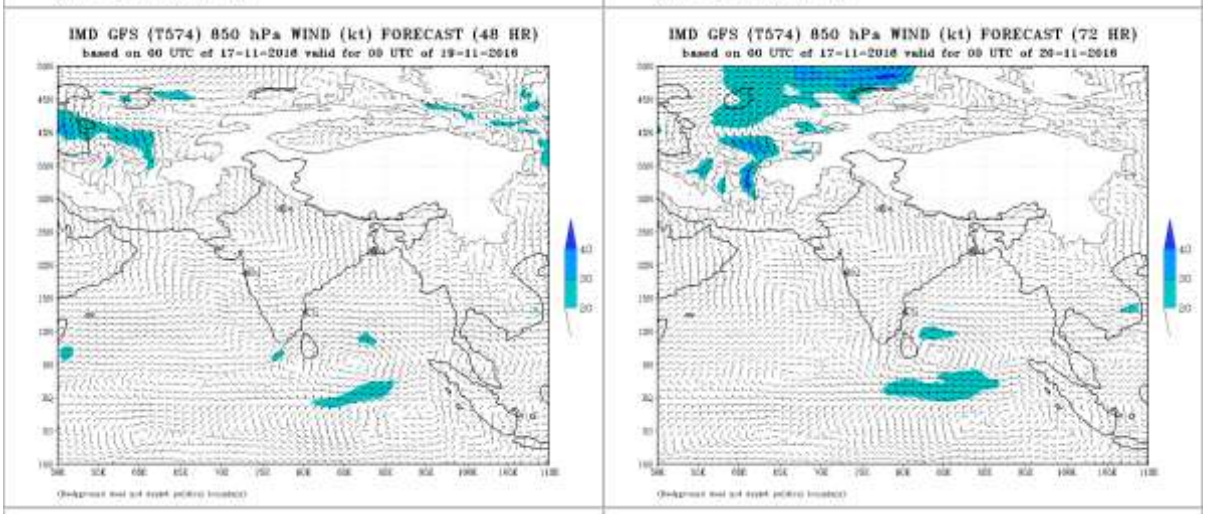

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
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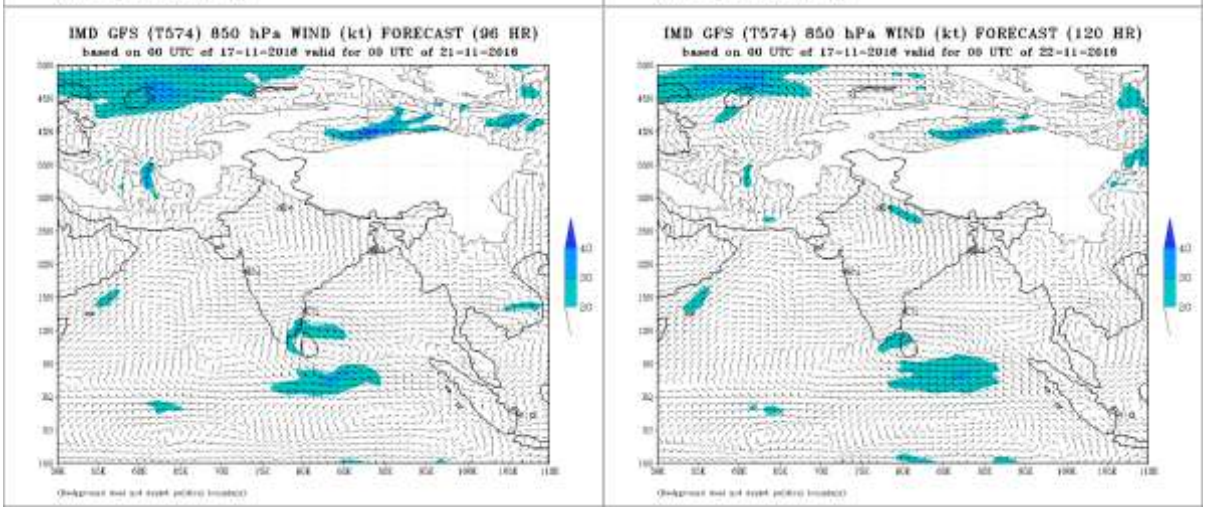

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 20-11-2016

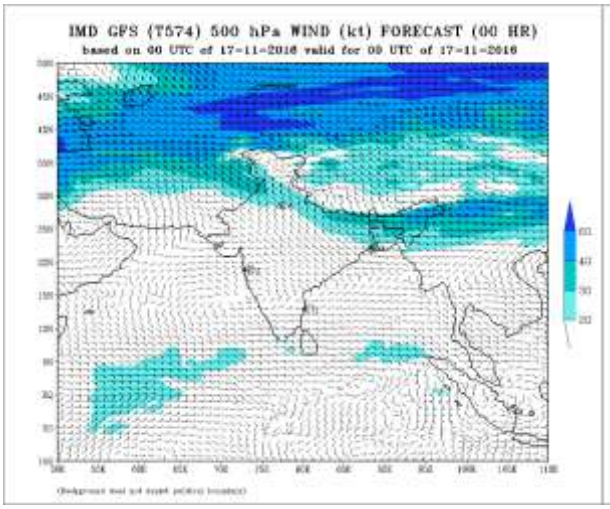

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 21-11-2016

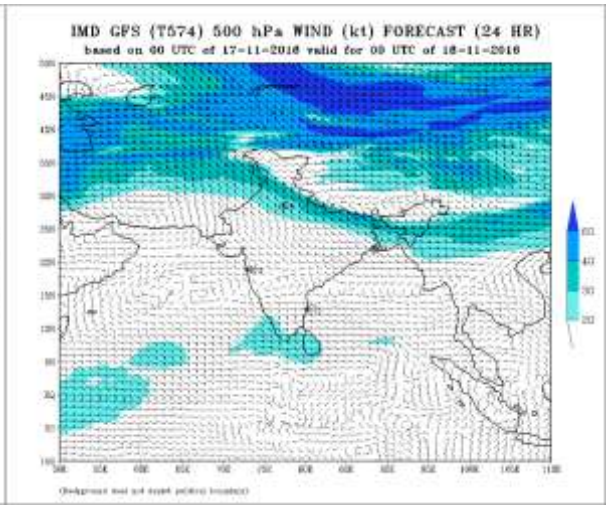

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 22-11-2016

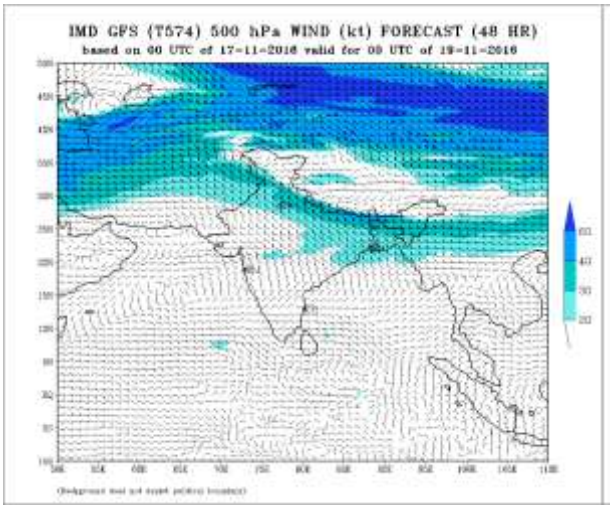

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 17-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 18-11-2016

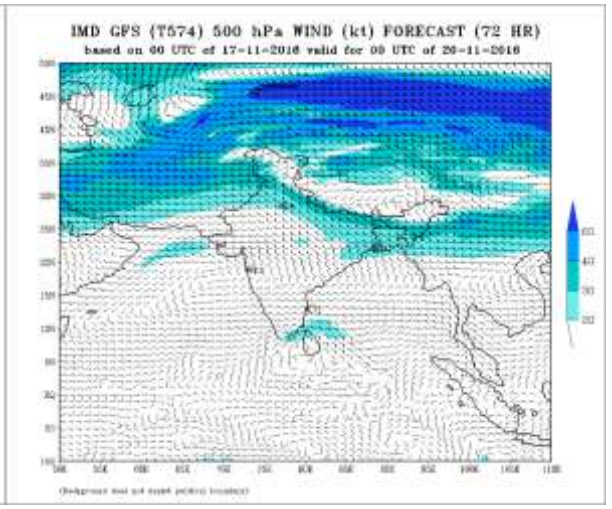

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 19-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 20-11-2016

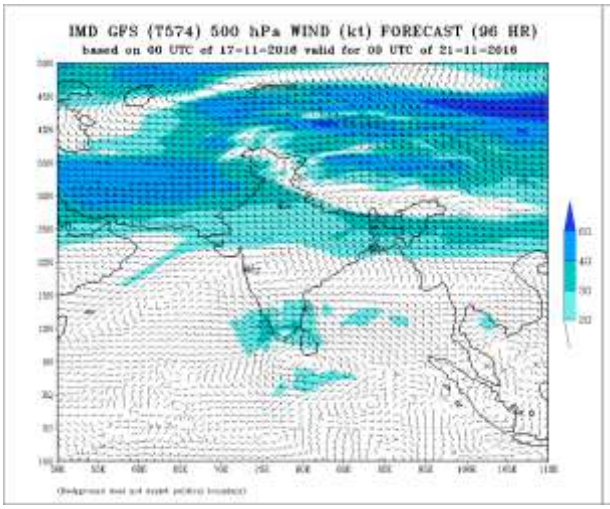

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 21-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 22-11-2016

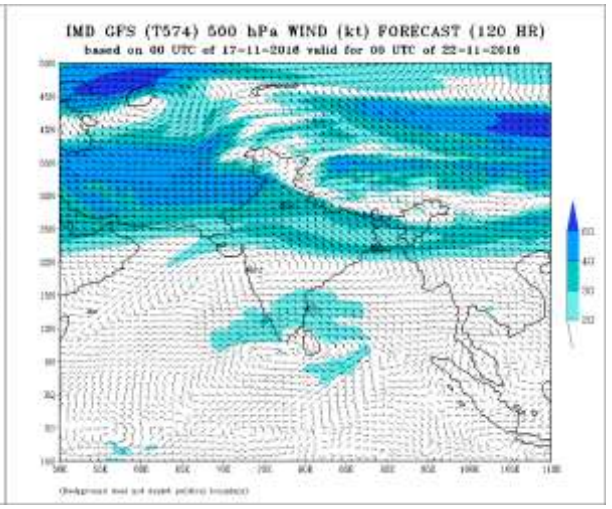

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
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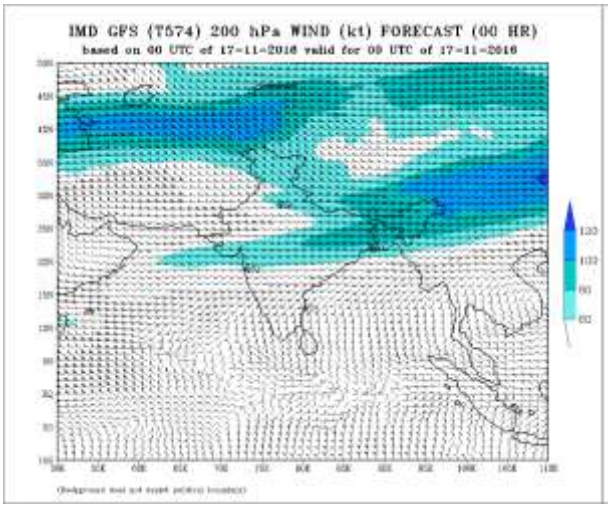

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 18-11-2016

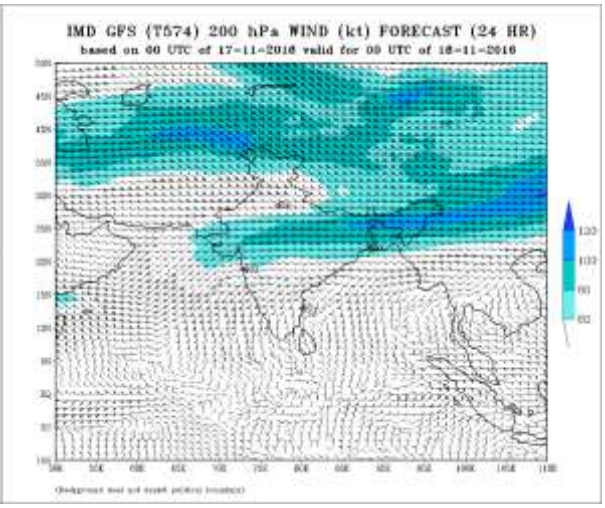

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
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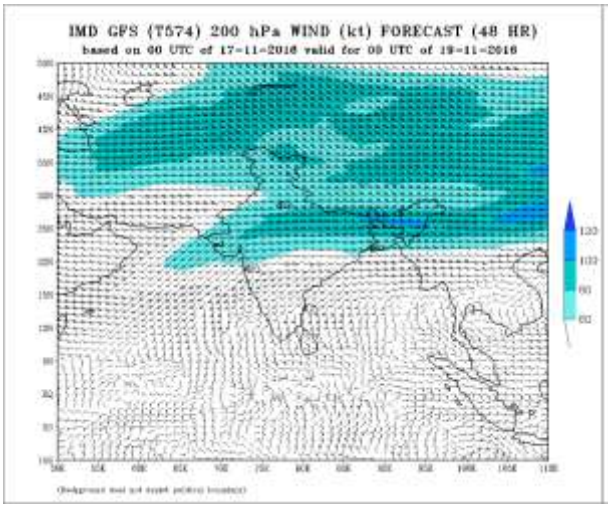

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
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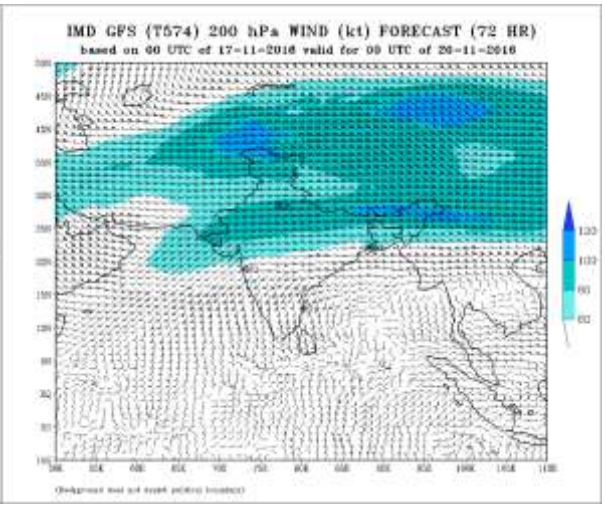

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
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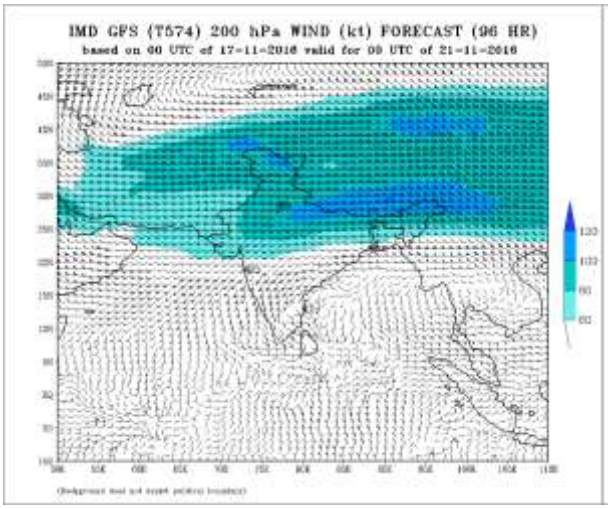

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
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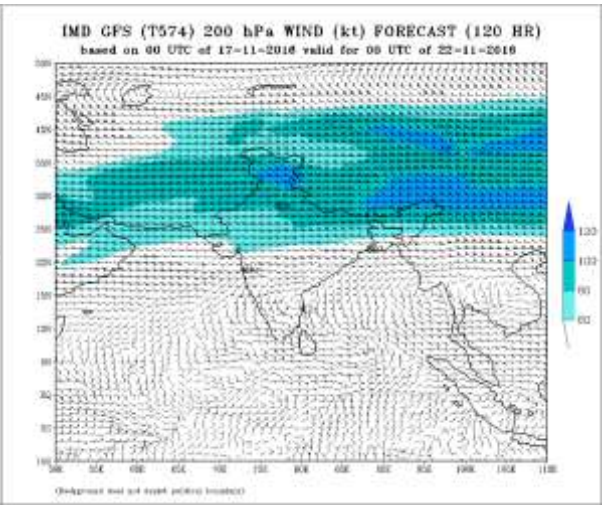

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 17-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 18-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 19-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 20-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 21-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 17-11-2016 valid for 00 UTC of 22-11-2016

FDP (Cyclone) NOC Report Dated 18th November 2016

Synoptic features:

The trough of low at mean sea level from Lakshadweep area to Goa coast persists. The other trough of low at mean sea level over equatorial Indian Ocean and adjoining southwest Bay of Bengal persists. Under its influence, a low pressure area is likely to form over southwest Bay of Bengal off Sri-Lanka coast during next 2-3 days.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of Bay of Bengal except for a small area of lesser values over northwest BoB. SST of 30-31˚C are seen over in parts of North Andaman Sea.

The SST over Arabian Sea (AS) is between 26-28˚C over most areas of north and central and also over western parts of southwest Arabian Sea. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat coast. SST is 28-30˚C over remaining parts of Arabian Sea.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for southern parts of south Andaman Sea and adjoining southeast Bay, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal and also in patches over southwest and west central BoB.

TCHP is less than 50 kJ/cm^2 over western Arabian Sea. It is 60-80 kJ/cm^2 over remaining parts of Arabian Sea.

Relative Vorticity:

The low-level relative vorticity is negative over BOB & adjoining Andaman Sea except for southern parts of south Bay. It is positive and is about 20x10^{-6} second^{-1} over northeast Bay.

One southwest-northeast oriented band of positive vorticity of 25x10^{-6} second^{-1} lie over west Arabian Sea off Saudi Peninsula. Other small pockets of positive values are seen over southern parts of Arabian Sea. It is less than 25x10^{-6} second^{-1} over remaining parts of AS.

Convergence:

There is an extended area of positive lower level convergence about 5x10^{-6} s^{-1} over southwest BoB near Sri Lanka extending to Comorin area. There is another pocket of positive lower level convergence about 5x10^{-6} s^{-1} over southern parts of south Andaman Sea.

There are no zones of positive low level convergence over Arabian Sea.

Divergence:

There is a zone of positive upper level divergence over southern parts of southeast Bay.

There an area of positive upper-level divergence over central parts of central Arabian Sea.

Wind Shear:

Wind shear is high over entire BOB. It is moderate (15-20 kts) over Andaman Sea and the area extends to southern parts of south BoB and thence to Comorin area.

Wind shear is moderate over Comorin area and the area extends southwestwards. It is high over the remaining Arabian Sea.

Wind Shear Tendency:

There is decreasing tendency (5-10 kts) over southern most parts of BOB and Andaman Sea.

There is increasing tendency over entire Arabian Sea except for southern parts of Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over south Bay of Bengal and over south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over south and east central Arabian Sea and also over Comorin area.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 13^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 1 with amplitude more than one. It would move to phase 2 during next 3 days hours.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The analysis chart on 00 UTC of 18th November 2016 shows no low pressure area over Indian seas. The forecast shows an extended low pressure area over southern parts of south Bay of Bengal on the 19th November and a low pressure area to the southeast of Sri Lanka on 20th, which becomes less marked on 21st.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 18 November 2016 show low over South west Bay of Bengal near Sri Lanka on 20th and 21st .

ECMWF: The model analysis based on 00 UTC of 18 November 2016 shows a feeble low level cyclonic circulation over south-west Bay of Bengal. Forecasts also show non-intensification of the system and becomes less marked thereafter.

WRF: The WRF model analysis on 00 UTC of 18 November 2016 shows no low pressure system in the NIO region. Forecast shows an extended low on 19th November over southern parts of southwest Bay and adjoining south east Bay.

JMA: The forecast based on 00 UTC of 18th shows no system for next three days.

Meteo-France ARP Model: The forecast based on 00 UTC of 18th analysis also shows no system for next three days.

NCMRWF-NCUM: The forecast based on analysis on 00 UTC of 18th November do not show any low pressure area for the next ten days.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 18th also not giving indication of low pressure system for the next three days.

NCMRWF-NEPS Model: The forecast based on the analysis of 00 UTC on 18th November gives no indication of formation of low pressure systems over Indian Seas.

IITM-GEFS: The forecast based on 00 UTC of 18th November analysis gives no indication of formation of low pressure systems over Indian Seas till 26th November.

IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 18th November also gives no indication of formation of low pressure systems over Indian Seas till 26th November.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP): Genesis Potential Parameter (GPP) analysis and forecast fields show no potential cyclogenesis zone over the NIO region till 25th November 2016.

Summary and Conclusion:

Most of the models except IMD GFS and NCEP-GFS do not give any indication of low pressure area formation in Indian Seas. These two models show the formation of a low to the southeast of Sri Lanka on 20th/ 21st.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	17/12	18/00	18/03
India	30	29	40
Coastal stations			
WB	1	1	4
Odisha	5	6	6
AP	11	10	12
Tamil Nadu	11	10	11
Puducherry	1	1	1
A & N	1	1	6
Bangladesh	11	10	11
Myanmar	9	7	1
Thailand	3	3	3
Sri Lanka	10	9	10

AWS:

Region	Date/Time (UTC)		
	17/12	18/00	18/03
WB	1	0	3
Odisha	4	1	6
AP	5	3	5
Tamil Nadu	18	8	21
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 17 / 11 /2016 :34/43
- **No. of Ascents reaching 250 hPa levels: 15 , MISDA:-9**

- **RS/RW** (00Z) of 18 / 11 /2016 : 32/43

- **No. of Ascents reaching 250 hPa levels:27 , MISDA:11**

No. of PILOT Ascents

17/12Z	18/00Z
7	2

Buoy Data

17/12Z	18/00Z	18/03Z
7	5	7

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**17.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /17.11.2016 : 7

No. of Ascents reaching 250hPa level =7

MISDA :1

12Z /17.11.2016 : 3

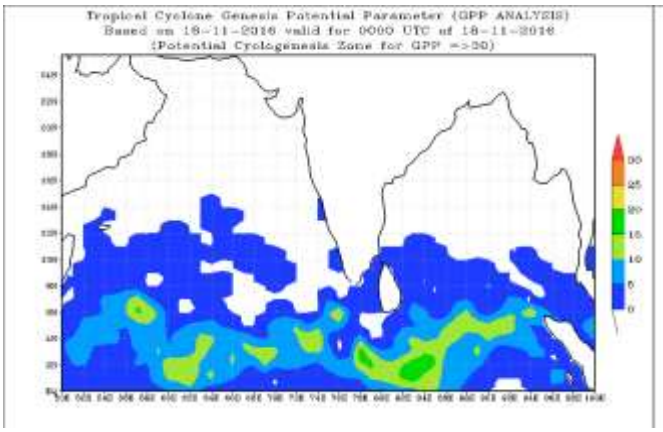
No. of Ascents reaching 250 hPa level =3

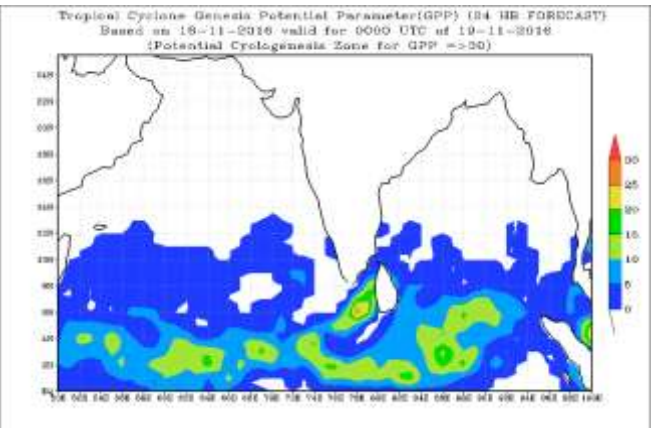
MISDA : 5

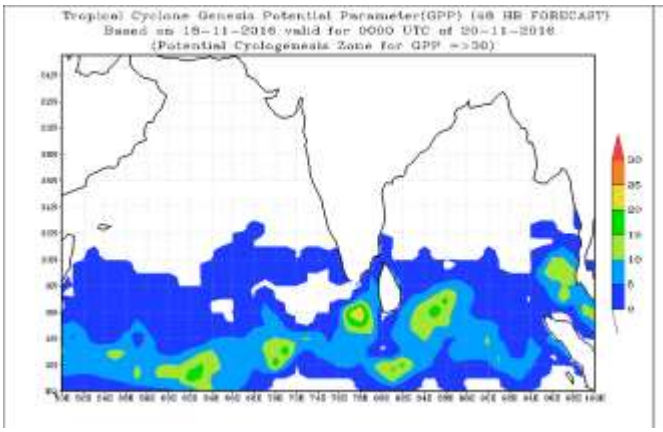
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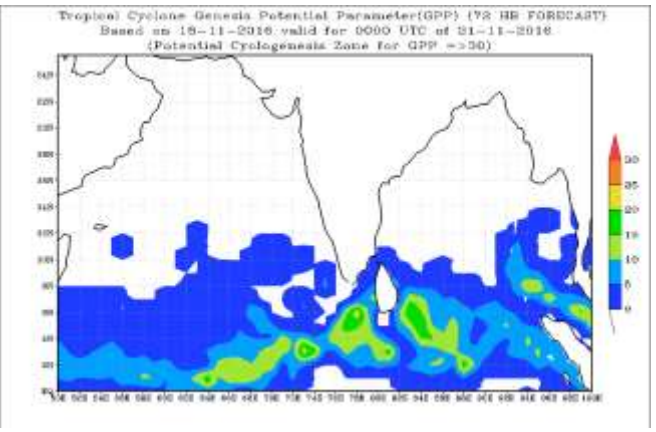
17.11.2016	
06Z	18Z
4	4

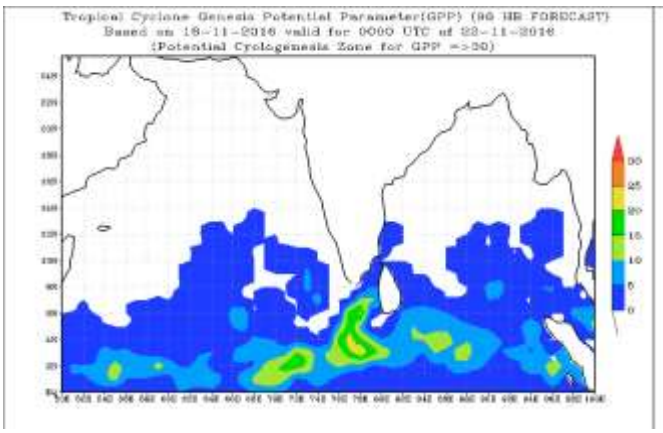
Annexure-II

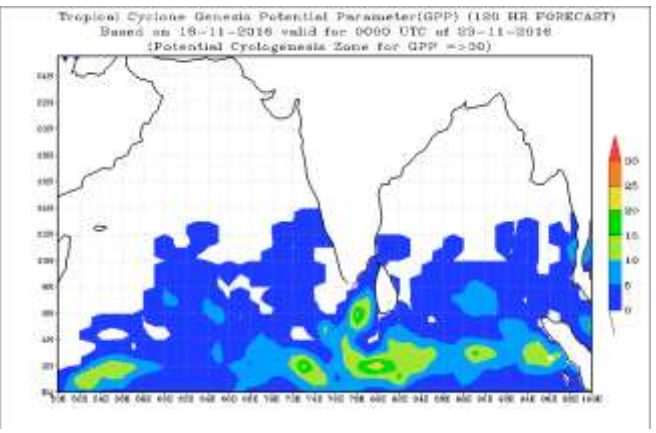

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 18-11-2016 valid for 0000 UTC of 18-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

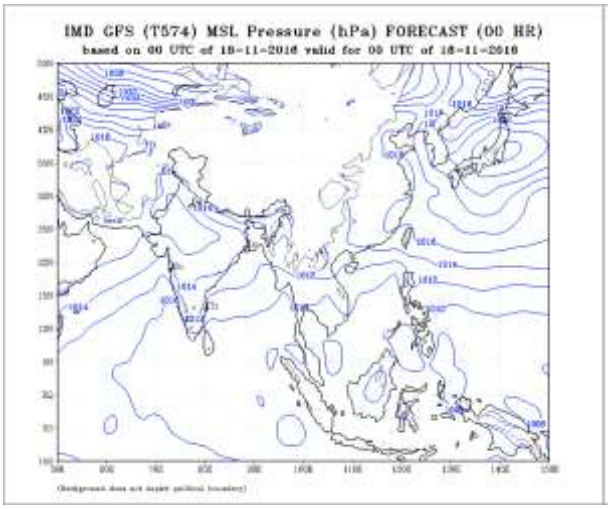

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 18-11-2016 valid for 0000 UTC of 19-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

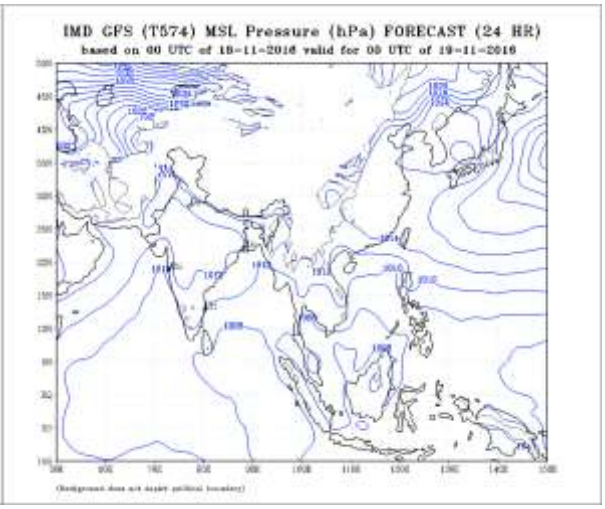

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

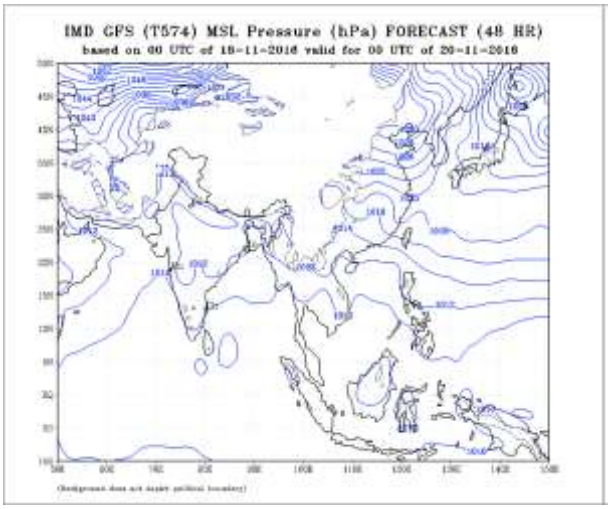

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 18-11-2016 valid for 0000 UTC of 21-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

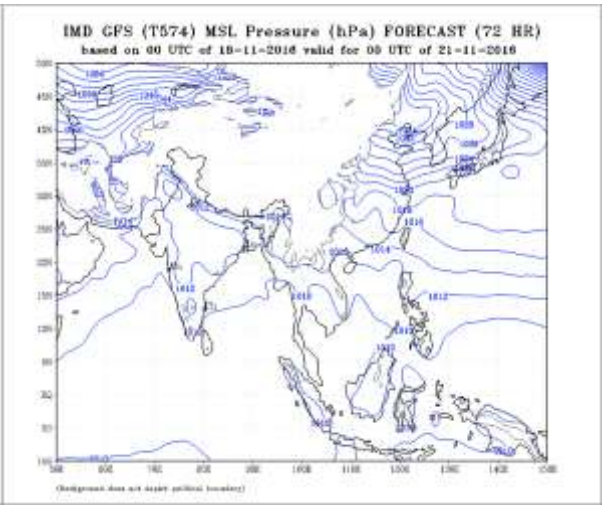

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

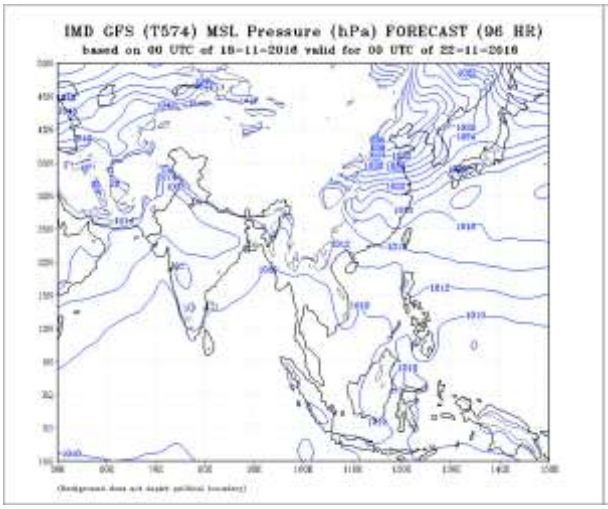

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 18-11-2016 valid for 0000 UTC of 23-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

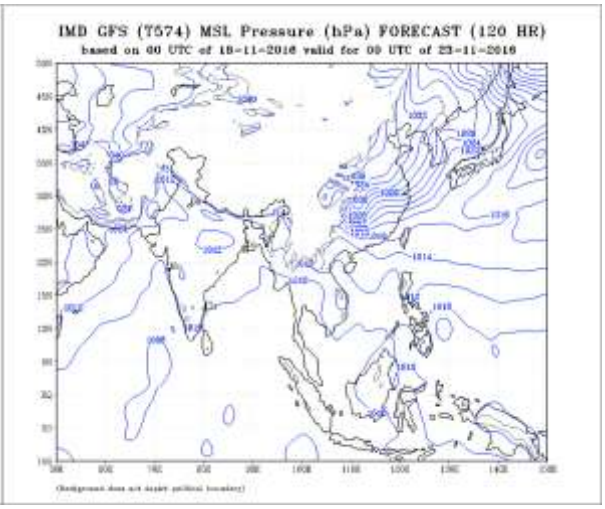

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 18-11-2016

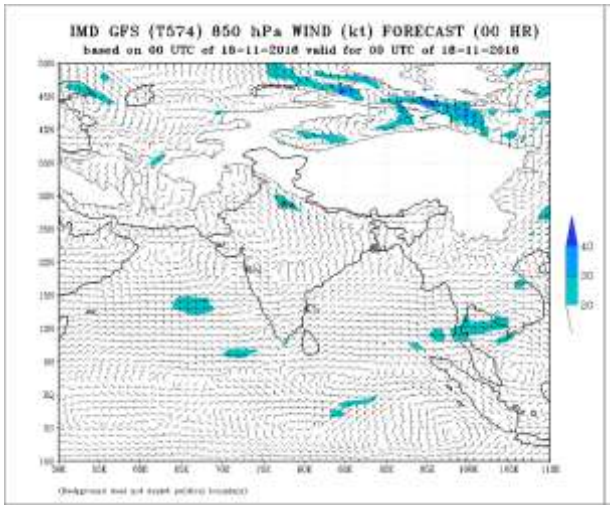

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 19-11-2016

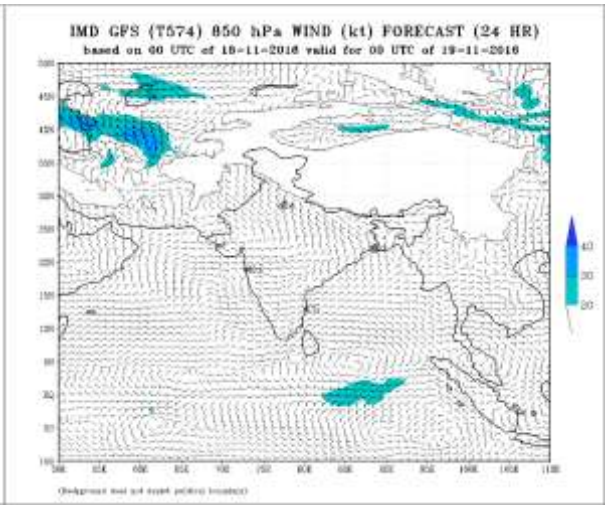

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 20-11-2016

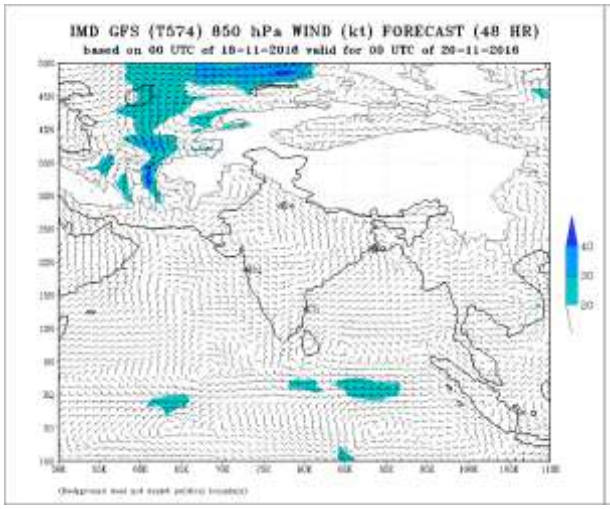

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 21-11-2016

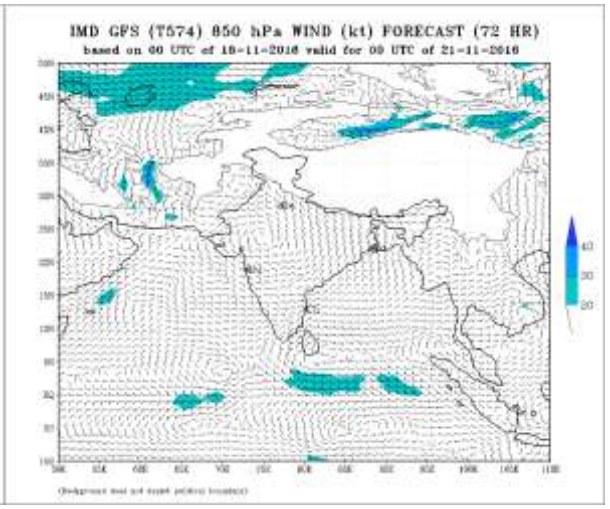

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 22-11-2016

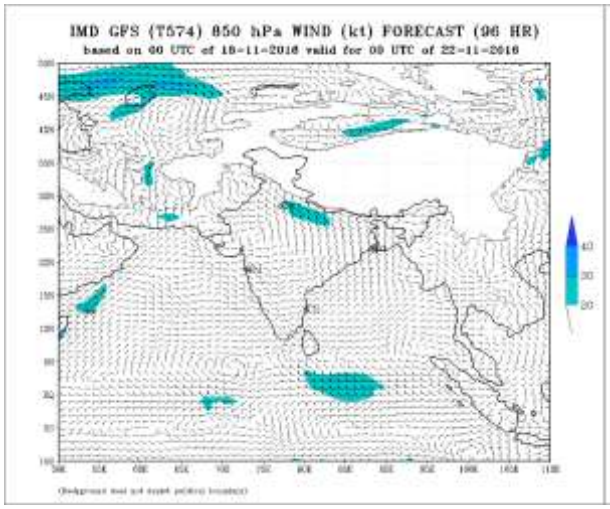

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
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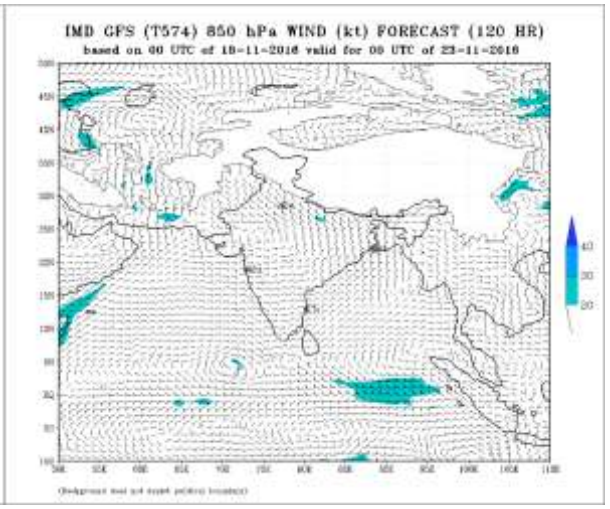

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 18-11-2016

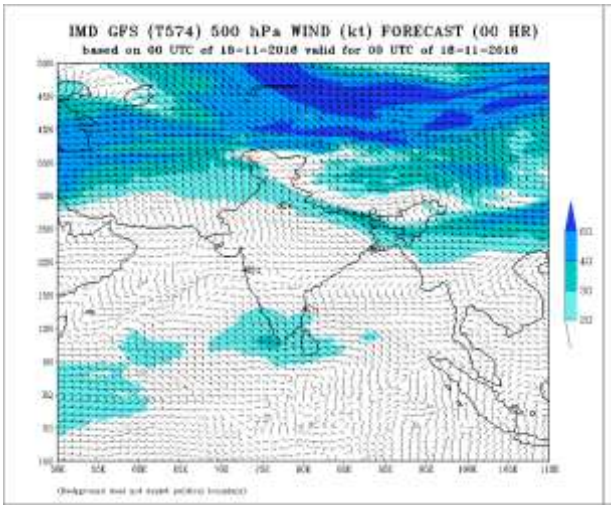

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 19-11-2016

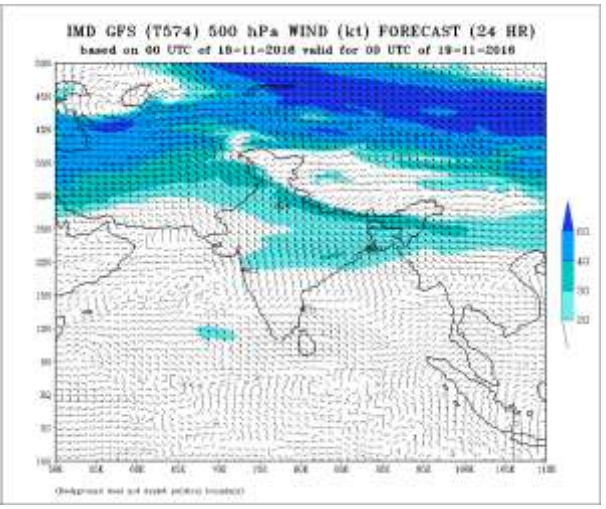

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 20-11-2016

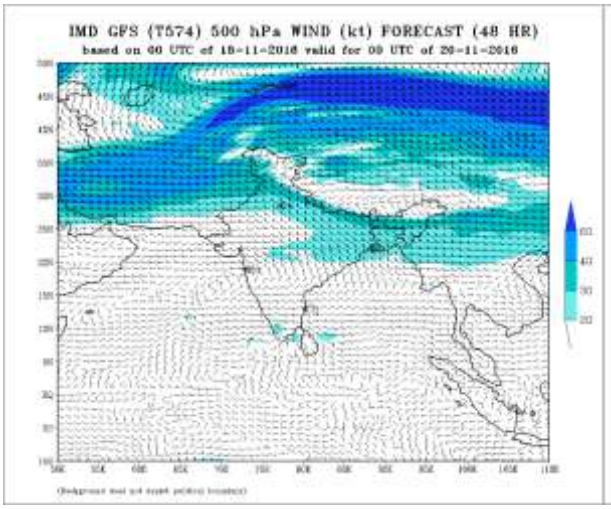

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 21-11-2016

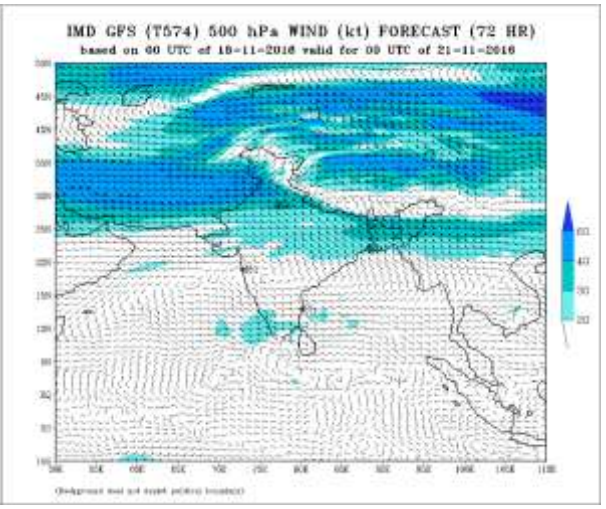

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 22-11-2016

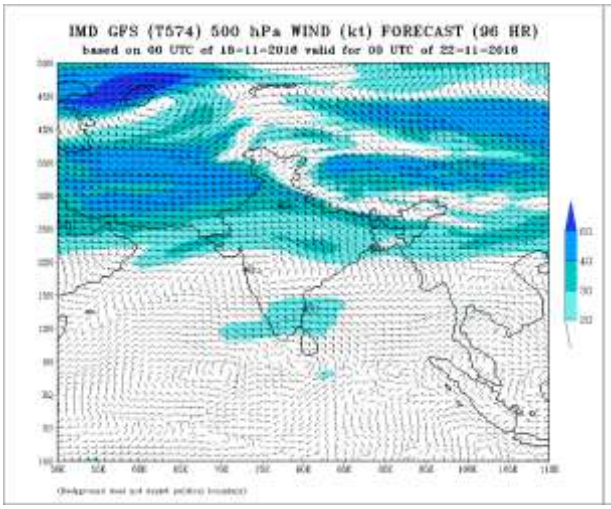

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 23-11-2016

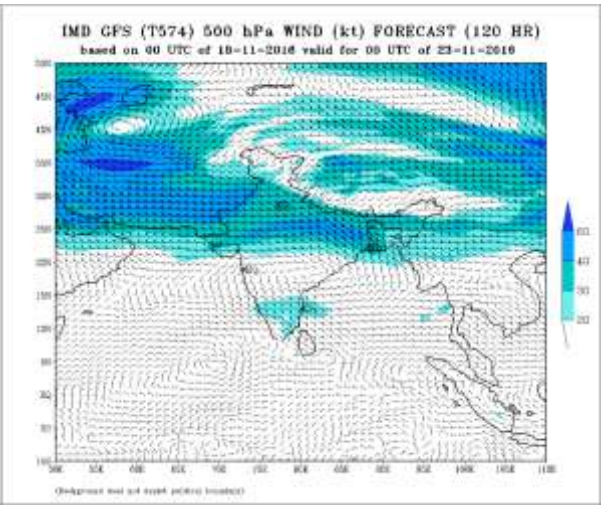

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
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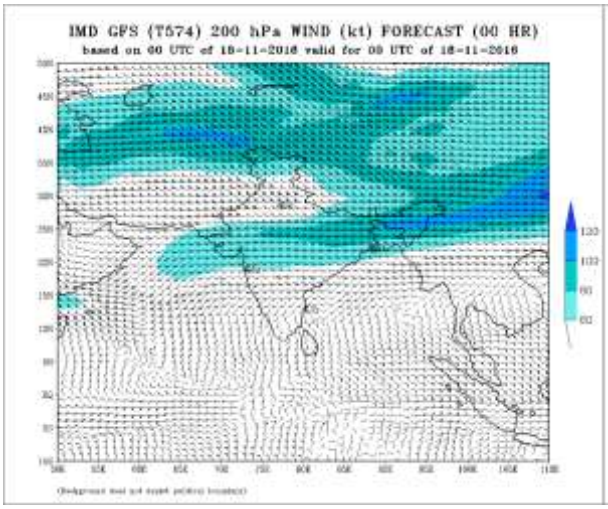

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 19-11-2016

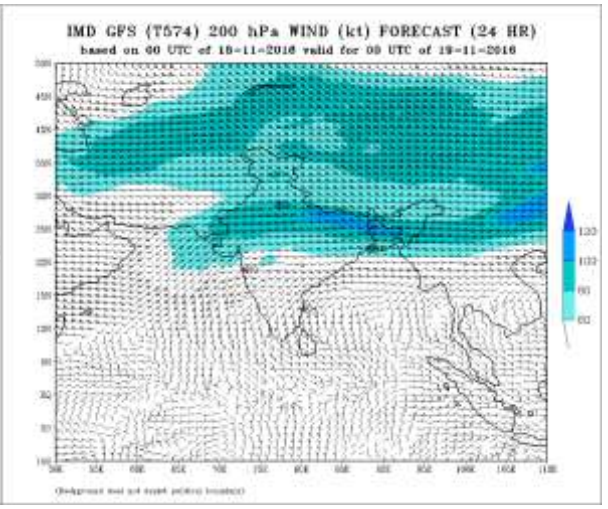

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 20-11-2016

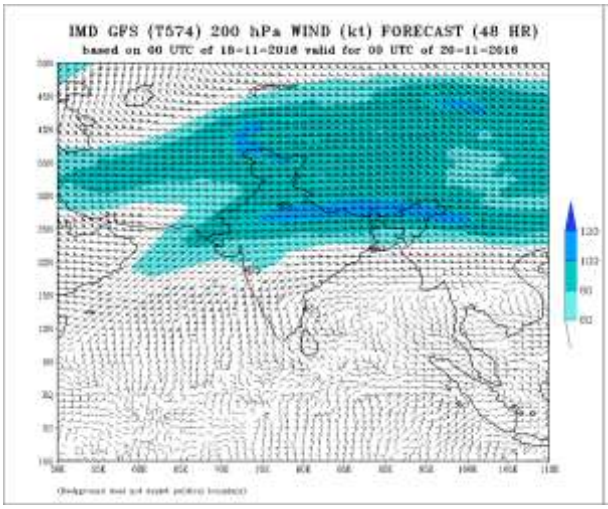

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 21-11-2016

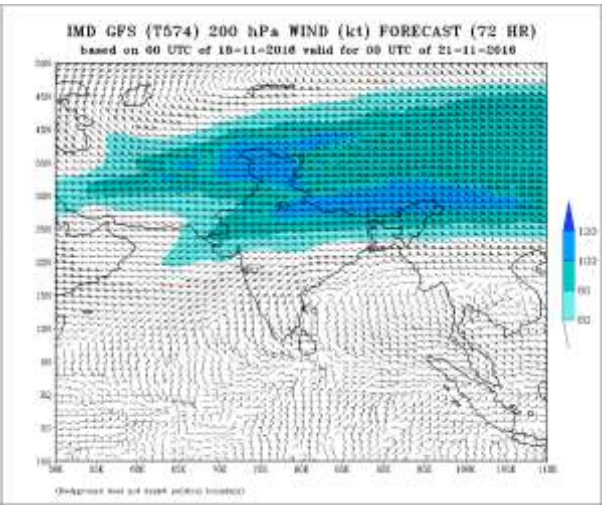

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
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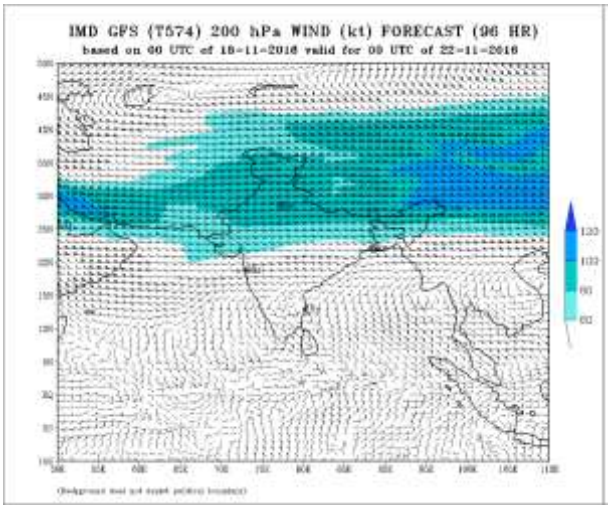

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 23-11-2016

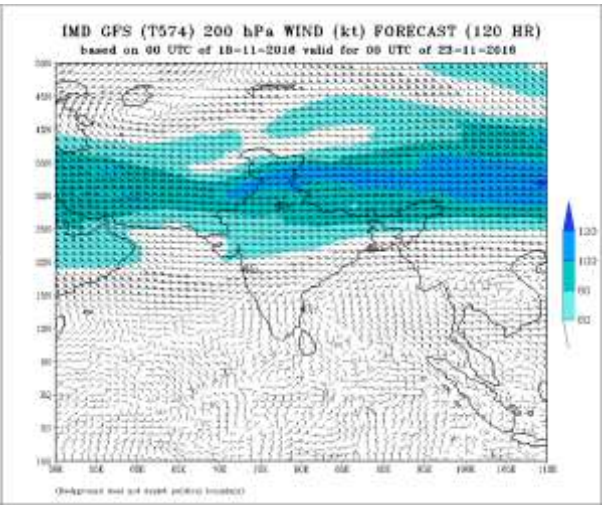

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 18-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 19-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 20-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 21-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 22-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 18-11-2016 valid for 00 UTC of 23-11-2016

FDP (Cyclone) NOC Report Dated 19th November 2016

Synoptic features:

The trough of low at mean sea level from Lakshadweep area to Goa coast now lies over Lakshadweep area and neighbourhood. The other trough of low at mean sea level over equatorial Indian Ocean and adjoining southwest Bay of Bengal now lies over equatorial Indian Ocean and adjoining southwest Bay of Bengal off south Sri-Lanka coast. Under its influence, a low pressure area is likely to form over southwest Bay of Bengal off Sri-Lanka coast during next 48hrs.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of south Bay of Bengal, and is 28-29 ˚C over central bay, except over in parts of North Andaman Sea where SST of 30-31˚C are seen. SST is 26-28 ˚Cover north Bay.

The SST over Arabian Sea (AS) is between 26-28˚C over most areas of north and central and also over western parts of southwest Arabian Sea. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat coast. SST is 28-30˚C over remaining parts of Arabian Sea and is 31-32˚C over Lakshadweep area and adjoining Kerala and Karnataka coasts.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of Bay of Bengal, except for southern parts of south Andaman Sea and adjoining southeast Bay, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal and also in some parts over southwest and west central BoB.

TCHP is less than 50 kJ/cm^2 over western Arabian Sea. It is 60-80 kJ/cm^2 over remaining parts of Arabian Sea except north Kerala coast where TCHP is 100 kJ/cm^2.

Relative Vorticity:

The low-level relative vorticity is negative over BOB & adjoining Andaman Sea except for southern parts of south Bay. It is positive and is about 10-15x10^{-6} second^{-1} over northeast Bay.

One east -west oriented band of positive vorticity of 25x10^{-6} second^{-1} lie over central Arabian Sea. Other small pockets of positive values are seen over southern parts of Arabian Sea. It is less than 25x10^{-6} second^{-1} over remaining parts of AS.

Convergence:

There is an extended area of positive lower level convergence about 15x10^{-6} s^{-1} over equatorial regions. There is a small pocket of positive lower level convergence about 5x10^{-6} s^{-1} over southwest BoB near north Sri Lanka.

There are no zones of positive low level convergence over Arabian Sea.

Divergence:

There is a zone of positive upper level divergence over southern parts of south Bay extending to Comorin area and further to Maldives area.

Wind Shear:

Wind shear is high over entire BOB. It is moderate (15-20 kts) over Andaman Sea and the area extends to southern parts of south BoB and thence to Comorin area and thence to the equatorial waters.

Wind Shear Tendency:

There is decreasing tendency (5-10 kts) over southern most parts of BOB and Andaman Sea. There is increasing tendency over north Arabian Sea and also over east central Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over south Bay of Bengal to the south of 12.5^0 N and over south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over southeast Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 13^0N latitude over BoB.

M.J.O. Index: MJO index is in Phase 1 with amplitude more than one. It would move to phase 2 during next 3 days hours.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The forecast charts based on 00 UTC of 19 November 2016 shows a low over Comorin area to the southwest of Sri Lanka on 21st and it is seen as an extended low over the same region on 22nd and becomes less marked on 23rd.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 19 November 2016 show similar features like IMD-GFS model. The forecast shows a development of extended low along the South west Bay of Bengal off southeast coast of Sri Lanka during 20-22nd.

ECMWF: The model analysis based on 00 UTC of 19 November 2016 shows a feeble low level cyclonic circulation over south-west Bay of Bengal. Forecasts also shows formation of low, along with its westward movement over the equatorial Indian Ocean.

WRF: The WRF model based on 00 UTC of 19 November 2016 shows a low level cyclonic circulation along the south west Bay of Bengal. Forecast shows the circulation moving southward, but does not show any low pressure area during the three day period.

JMA: The forecast based on 00 UTC of 19th shows no system for next three days.

Meteo-France ARP Model: The forecast based on 00 UTC of 19th analysis shows a low pressure area over southern part of southeast bay and adjoining southwest bay on 20th, which becomes well marked on 21st and 22nd with an eastward movement.

NCMRWF-NCUM: The forecasts based on analysis on 00 UTC of 19th November do not show any low pressure area for the next ten days.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 19th also not giving indication of low pressure system for the next three days.

NCMRWF-NEPS Model: The forecast based on the analysis of 00 UTC on 19th November gives no indication of formation of low pressure systems over Indian Seas.

IITM-GEFS: The forecast based on 00 UTC of 19th November analysis gives no indication of formation of low pressure systems over Indian Seas till 26th November.

IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 19th November gives indication of an extended low pressure area over southeast Sri Lanka and neighbourhood on 21st and 22nd.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP): Genesis Potential Parameter (GPP) analysis and forecast fields show no potential cyclogenesis zone over the NIO region till 26th November 2016.

Summary and Conclusion:

Most of the models except IMD GFS and Meteo-France ARP Model do not give any indication of low pressure area formation in Indian Seas. IMD GFS shows the low pressure area only on 21st, whereas Meteo-France ARP Model show the low pressure area during 20-22nd over southern parts of south Bay of Bengal.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	18/12	**19/00**	**19/03**
India	38	29	40
Coastal stations			
WB	4	1	4
Odisha	5	6	6
AP	11	10	12
Tamil Nadu	11	10	11
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	11	10	11
Myanmar	9	7	1
Thailand	3	3	3
Sri Lanka	10	9	10

AWS:

Region	Date/Time (UTC)		
	18/12	**19/00**	**19/03**
WB	7	0	5
Odisha	6	1	6
AP	9	3	7
Tamil Nadu	24	9	24
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 18 / 11 /2016 :6/43
- **No. of Ascents reaching 250 hPa levels: 5 , MISDA:-1**

- **RS/RW** (00Z) of 19 / 11 /2016 : 18/43

- **No. of Ascents reaching 250 hPa levels:16 , MISDA:2**

No. of PILOT Ascents

18/12Z	**19/00Z**
6	2

Buoy Data

18/12Z	**19/00Z**	**19/03Z**
16	15	15

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**18.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**19**	**21**	**19**	**19**	**19**	**19**	**18**	**19**

No. of RS/RW Ascents

00Z /18.11.2016 : 5

No. of Ascents reaching 250hPa level =5

MISDA : 3

12Z /18.11.2016 : 3

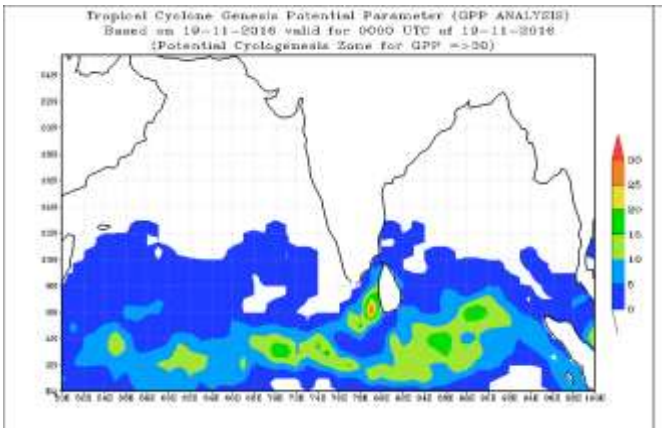
No. of Ascents reaching 250 hPa level =3

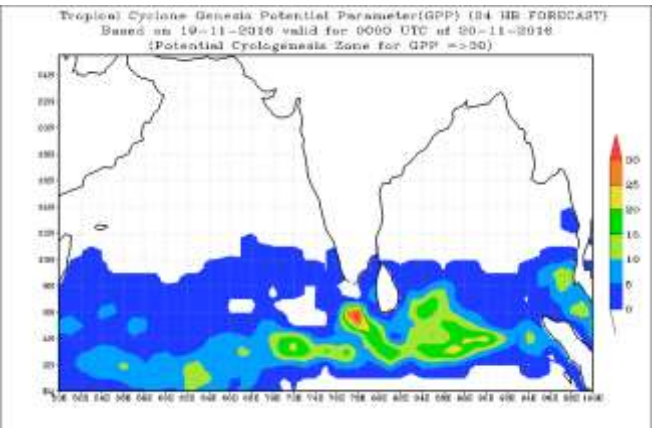
MISDA : 5

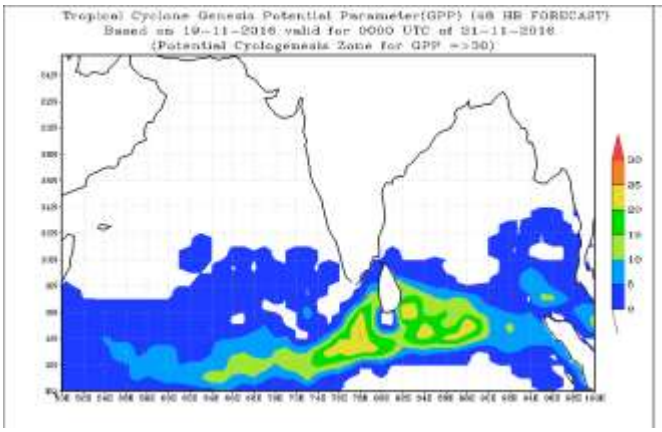
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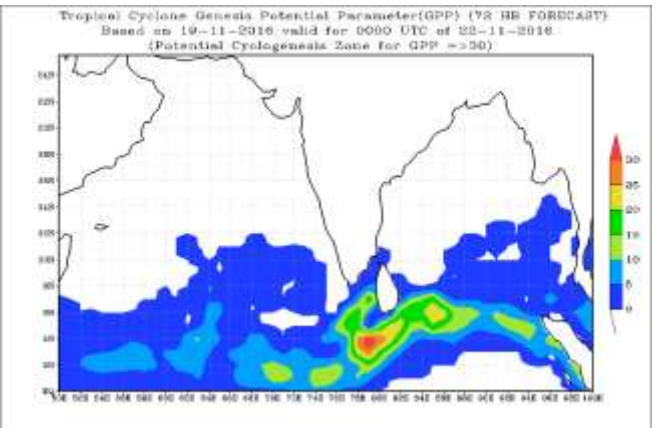
18.11.2016	
06Z	18Z
1	3

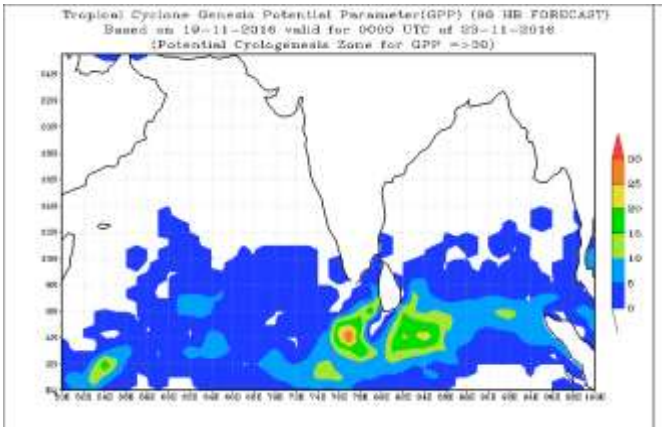
Annexure-II

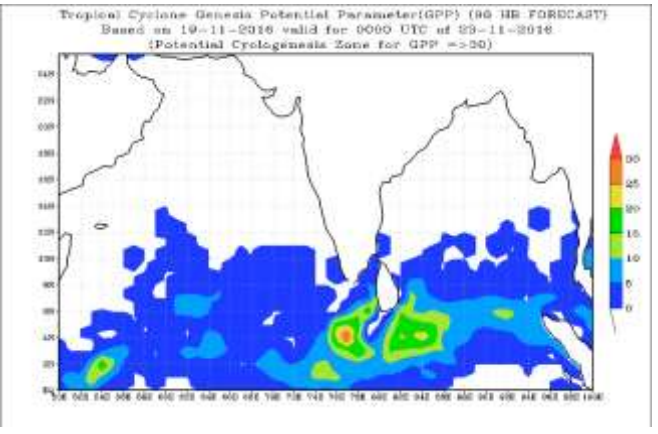

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 19-11-2016 valid for 0000 UTC of 19-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

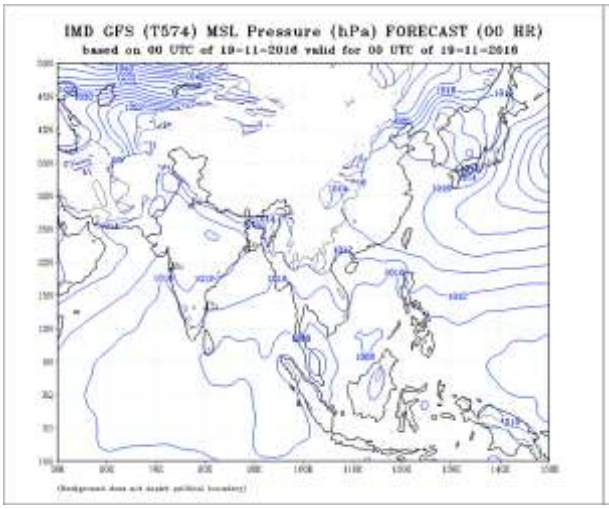

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 19-11-2016 valid for 0000 UTC of 20-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

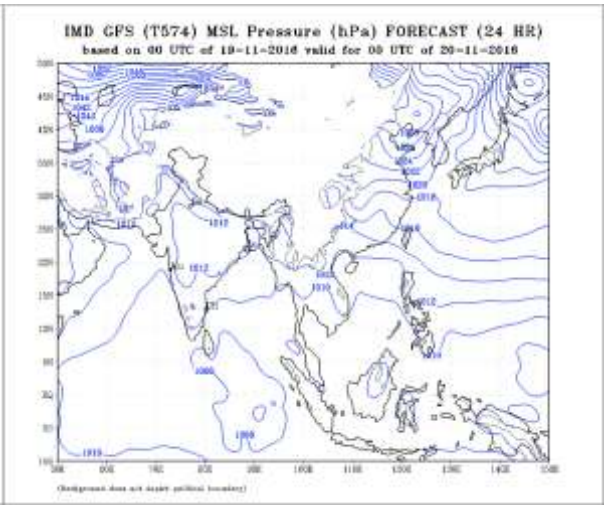

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

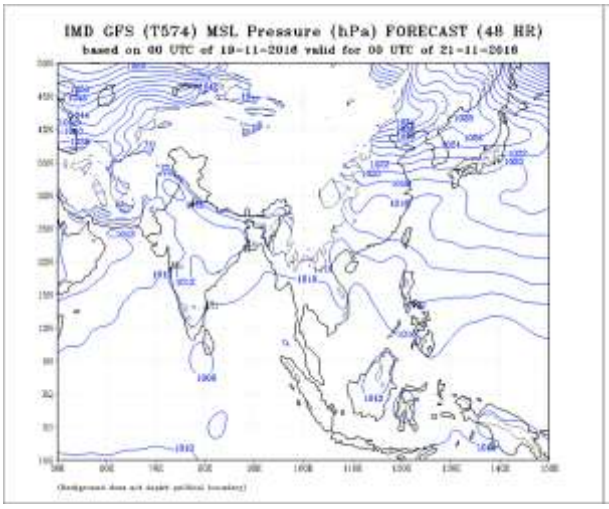

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 19-11-2016 valid for 0000 UTC of 22-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

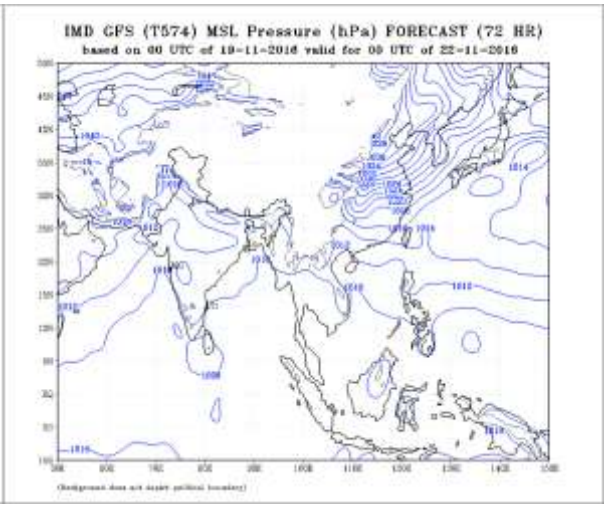

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
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(Potential Cyclogenesis Zone for GPP =>30)

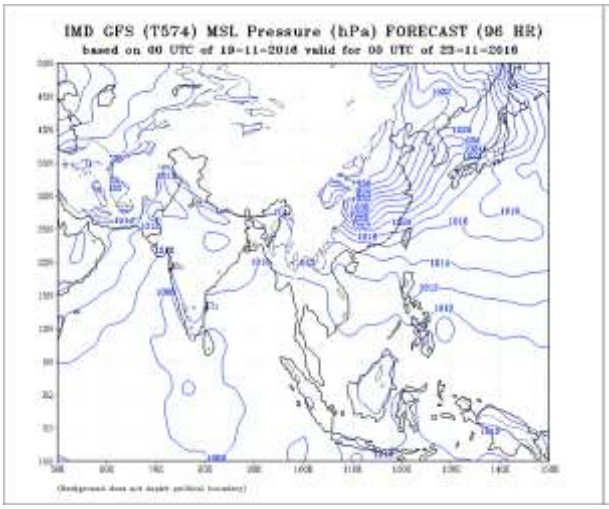

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 19-11-2016 valid for 0000 UTC of 23-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

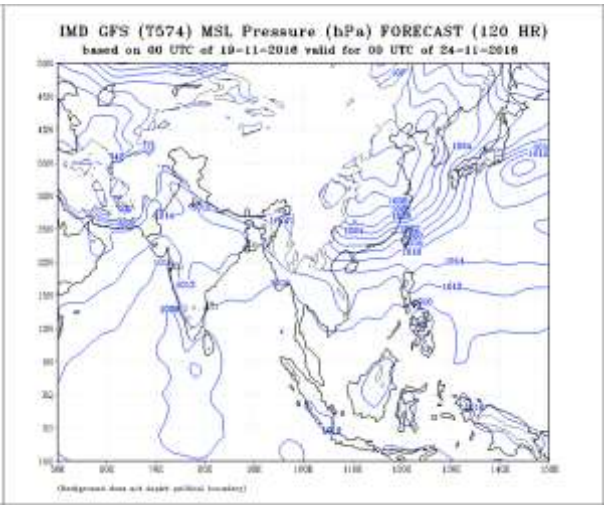

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 19-11-2016

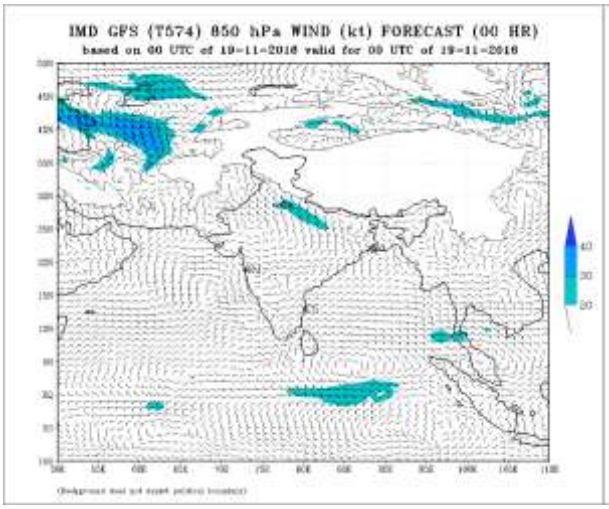

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
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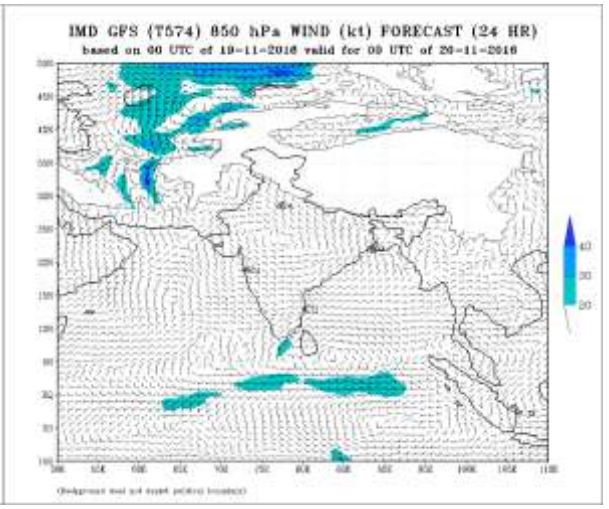

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
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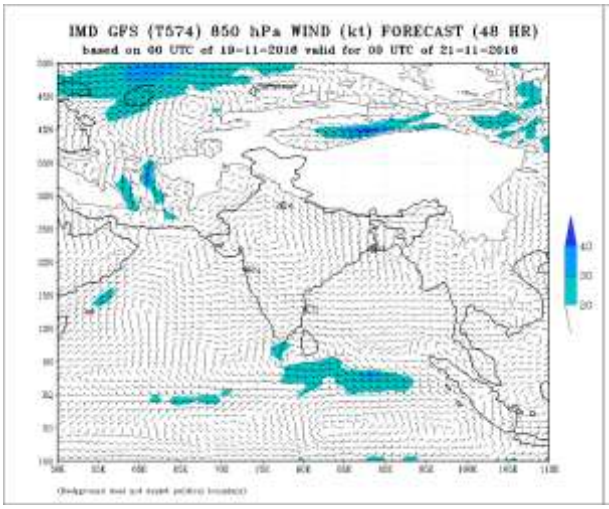

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
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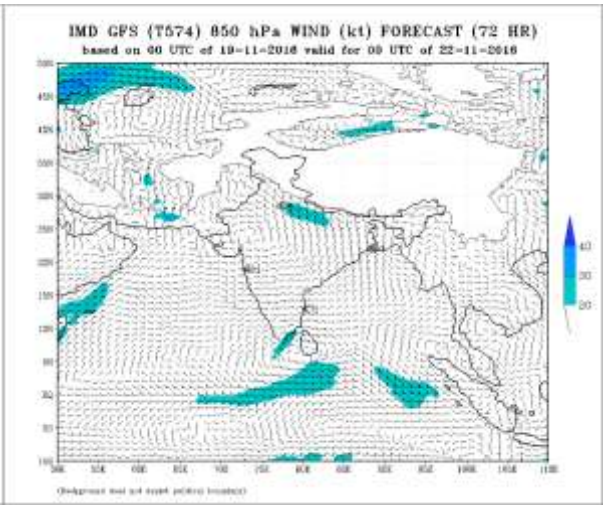

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
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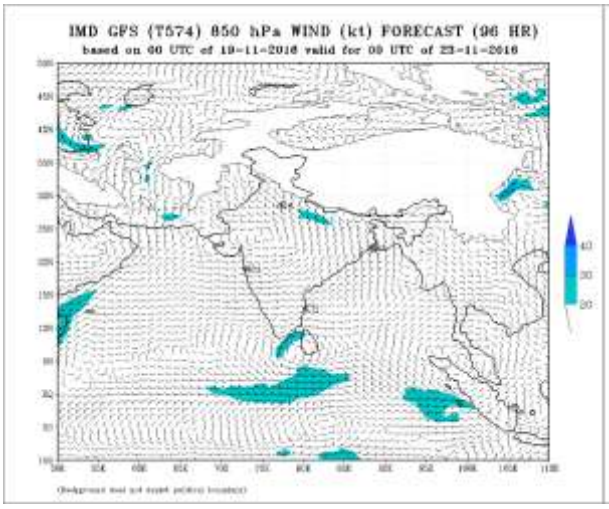

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
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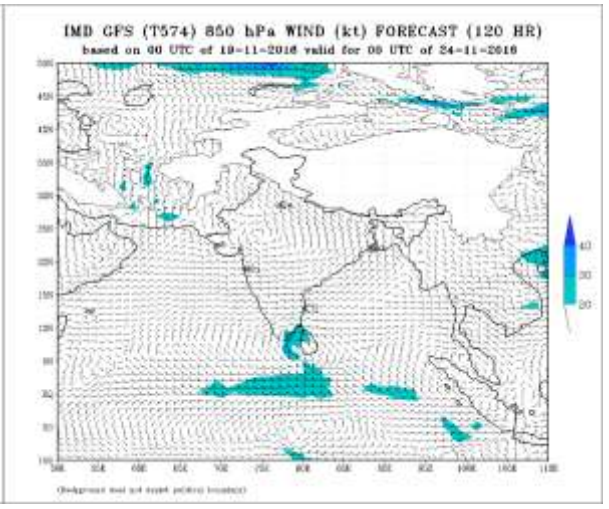

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 19-11-2016

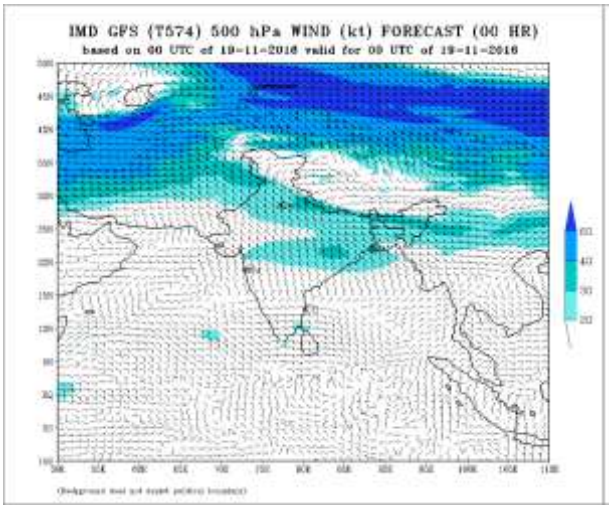

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
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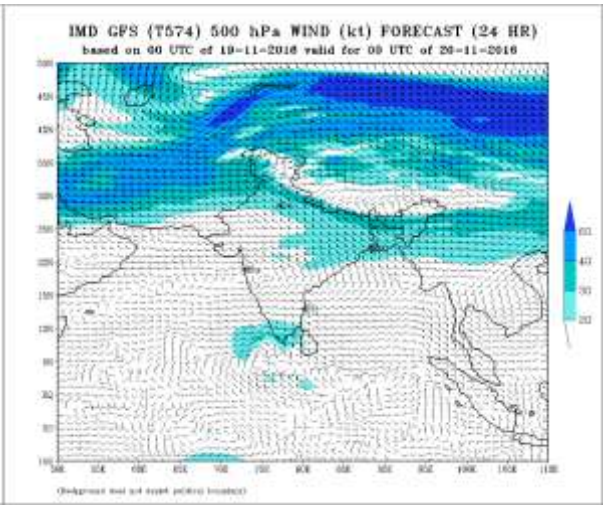

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 21-11-2016

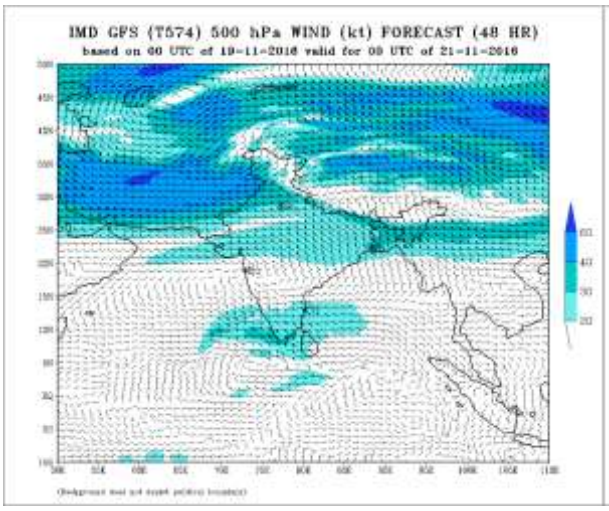

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
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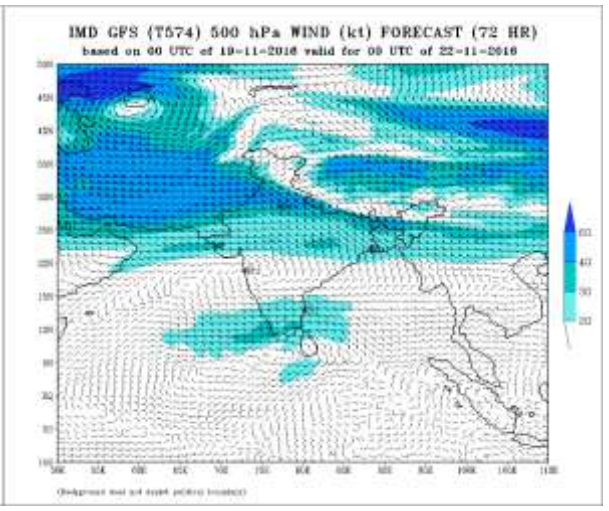

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 23-11-2016

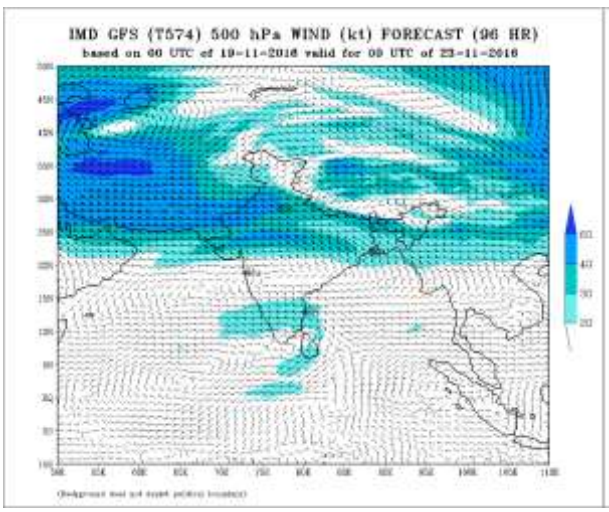

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 24-11-2016

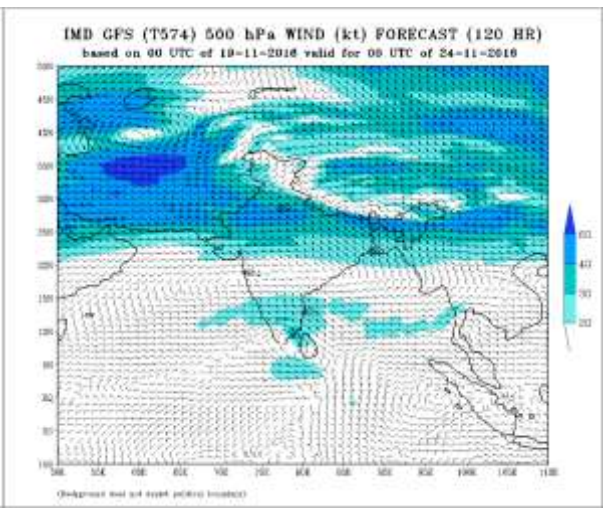

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
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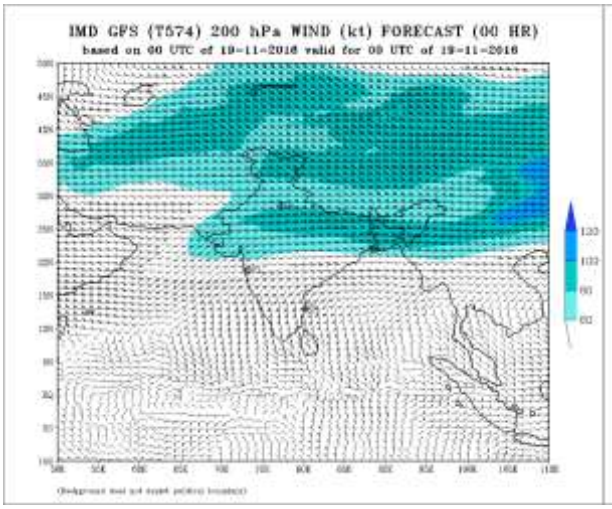

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 20-11-2016

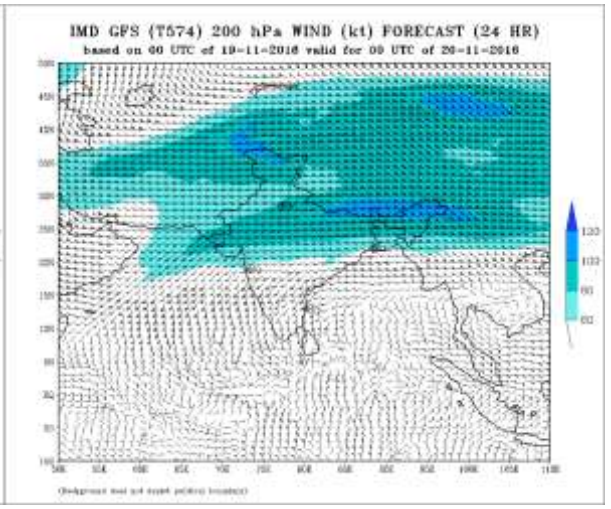

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 21-11-2016

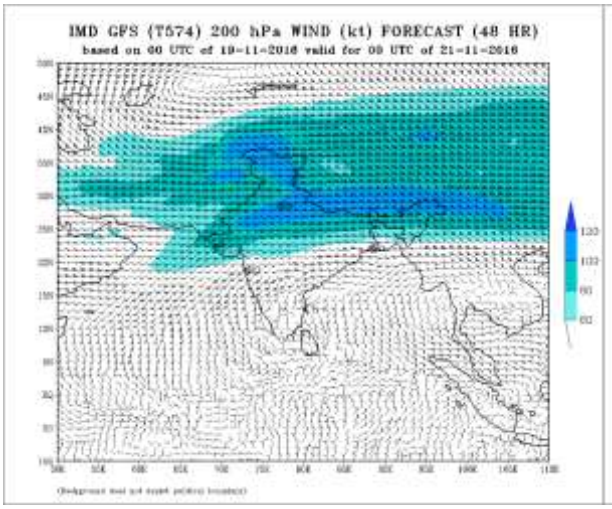

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
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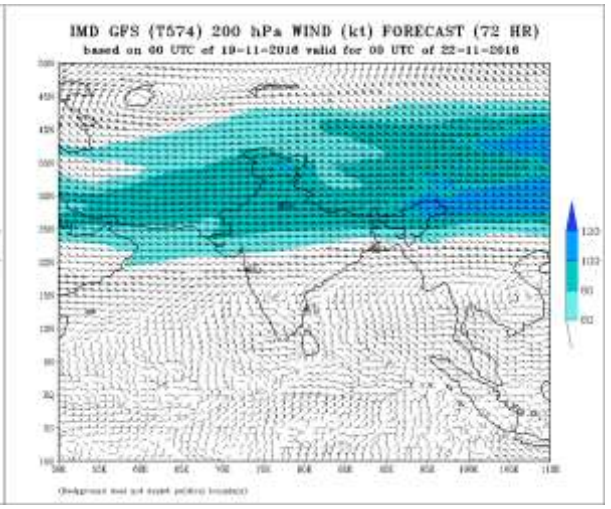

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
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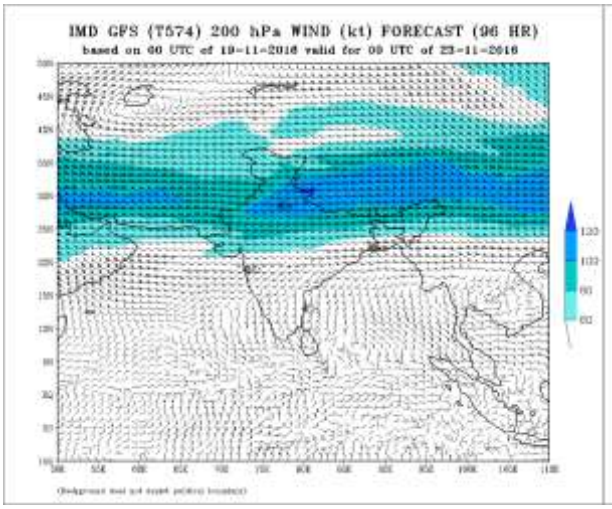

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
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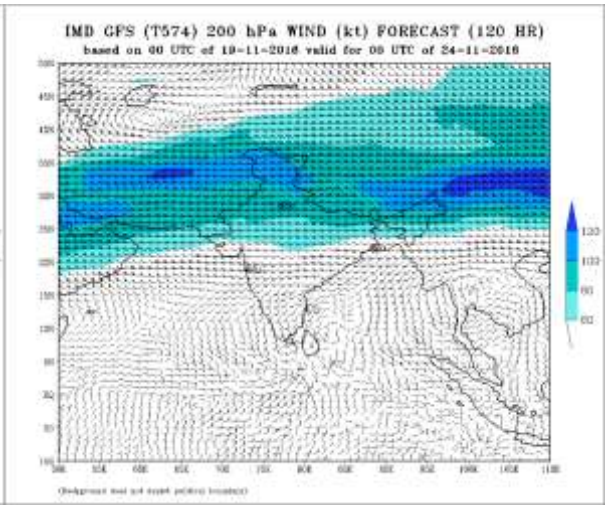

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 19-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 20-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 21-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 22-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 23-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 19-11-2016 valid for 00 UTC of 24-11-2016

FDP (Cyclone) NOC Report Dated 20th November, 2016

Synoptic features:

Yesterday's trough of low at mean sea level over equatorial Indian Ocean and adjoining southwest Bay of Bengal off Sri Lanka coast persists and the other trough of low at mean sea level over Lakshadweep area & neighbourhood, now lies over southeast Arabian Sea & adjoining Lakshadweep Maldives area. A trough of low at mean sea level lies over Malay Peninsula & neighbourhood.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of south and central BOB. It is about 30-31˚C over north Andaman Sea. It is slightly less 26-28˚C over north BOB.

The SST over Arabian Sea (AS) is between 26-28˚C over most areas of north and central and also over western parts of southwest Arabian Sea. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat coast. SST is 28-30˚C over remaining parts of Arabian Sea and is 31-32˚C over Lakshadweep area and adjoining Kerala and Karnataka coasts.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of BoBengal, except for southern parts of south Andaman Sea and adjoining southeast BoB, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north BoB of Bengal and also in some parts over southwest and west central BoB.

TCHP is less than 50 kJ/cm^2 over western AS. It is 60-80 kJ/cm^2 over remaining parts of AS except north Kerala coast where TCHP is 100 kJ/cm^2.

Relative Vorticity:

The low level relative vorticity is about 25-50x10^{-6} second^{-1} over equatorial region and adjoining south BOB and parts of Andaman Sea, It is negative over most parts of BOB and north Andaman Sea.

The low level relative vorticity over eastcentral and adjoining westcentral AS is around 15-20x10^{-6} second^{-1}. It is negative over remaining parts of AS.

Convergence:

There is an elongated zone of positive lower level convergence about 10x10^{-6} s^{-1} over equatorial region and adjoing south BOB and a small zone 5x10^{-6} s^{-1} over parts of south Andaman Sea.

No significant zone of positive low level convergence over AS.

Divergence:

There is no significant area of positive upper level divergence over Bay of Bengal as well as over Arabian Sea. An elongated zone of positive upper level divergence of about 30x10^{-6} s^{-1} over equatorial & adjoining south Andaman Sea and another zone of positive divergence of about 30x10^{-6} s^{-1} is seen over equatorial region and adjoining south BOB off southwest Srilanka coast.

Wind Shear:

Wind shear is 10-15 kts (moderate) over most parts of south BOB and Andaman Sea.

Wind shear is around 20 kts over most parts of south AS. It is increasing towards west and north.

Wind Shear Tendency:

There is increasing tendency of 10-20 kts over entire south BOB and Andaman Sea. The tendency is decreasing towards north and west.

There is increasing tendency (5-10 kts) over north, southwest and parts of southeast AS. The tendency shows decreasing trends over central AS.

Satellite observations based on 0600 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over south of latitude 12.0^0 N and and adjoining south Andaman Sea.

Arabian Sea:

Broken low/medium clouds with embedded isolated moderate ti intense convection over southeast AS and Comorin coast..

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 15^0N latitude over BoB.
M.J.O. Index: MJO index is in Phase 2 with amplitude more than one and would continue in same phase for next 7 days.
Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The forecasts based on 00 UTC of 20th November 2016 shows a low over south Andaman Sea on 21st becoming less marked on 22nd.
NCEP-GFS: The forecasts based on 00 UTC of 20th November 2016 shows a low over south Andaman Sea on 21st becoming less marked during next 24 hours.
ECMWF: The forecast based on 00 UTC of 20th shows a feeble low over southwest BOB and adjoining equatorial region on 22nd becoming less marked on 23rd . A fresh feeble low appears over south BoB appears and adjoining equatorial region becoming less marked on 26th.
WRF: The WRF model forecast based on 00 UTC of 20th November 2016 shows no significant circulation over BoB during next 3 days.
JMA: No system expected over north Indian Ocean during next three days.
Meteo-France ARP Model: No system expected over north Indian Ocean during next three days.
NCMRWF-NCUM: The analysis based on 00 UTC of 20h November shows no circulation over BOB for next 7 days.
NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 20th shows no system for next three days.
NCMRWF-NEPS Model: The analysis based on 00 UTC of 20th November shows development of a low over southwest BOB off Sri Lanka coast on 22nd becoming less marked on 24th. It also shows development of low over south Indian Ocean on 22nd, intensifying into a depression on 24th and cyclonic storm on 25th.
IITM-GEFS: The analysis based on 00 UTC of 20th shows development of an extended low over southwest BoB off southeast Sri Lanka on 00 UTC of 22nd becoming less marked on 23rd. A fresh low over southwest BoB off southeast Sri Lanka coast on 24th becoming extended on 25th and 26th over the same area and less marked on 27th.
IITM -GFS T1534: An extended low over southwest BoB off southeast Sri Lanka on 00 UTC of 22nd becoming less marked on 23rd. A fresh low over southwest BoB off southeast Sri Lanka coast on 24th becoming extended on 25th and 26th over the same area and less marked on 27th.
Dynamical statistical models
IMD Genesis Potential Parameter (GPP):
Analysis and forecasts of GPP based on 00 UTC of 20th November 2016 suggests a cyclogenesis zone over south BoB and equatorial region on 21st and 22nd becoming insignificant on 23rd.

Summary and Conclusion:

A few models suggest formation of a feeble low/extended low on 22nd over southwest BoB off southeast Srilanka coast on 22nd , becoming less marked on 23rd. A fresh low is also predicted over southwest BOB and adjoining equatorial Indian Ocean region by a few models on 24th becoming less marked over the same area on 26th Nov. Development of these low pressure areas need to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	19/12	**20/00**	**20/03**
India	40	29	40
Coastal stations			
WB	4	1	4
Odisha	6	5	6
AP	12	11	12
Tamil Nadu	11	10	11
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	10	10	11
Myanmar	9	7	7
Thailand	3	3	3
Sri Lanka	10	9	10

AWS:

Region	Date/Time (UTC)		
	19/12	**20/00**	**20/03**
WB	7	2	6
Odisha	8	2	6
AP	12	3	10
Tamil Nadu	29	8	26
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 19 / 11 /2016 :0/43
- **No. of Ascents reaching 250 hPa levels: 0 , MISDA:-0**

- **RS/RW** (00Z) of 20 / 11 /2016 : 0/43

- **No. of Ascents reaching 250 hPa levels:0 , MISDA:0**

No. of PILOT Ascents

19/12Z	**20/00Z**
7	4

Buoy Data

19/12Z	**20/00Z**	**20/03Z**
13	15	15

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**19.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**19**	**21**	**19**	**19**	**21**	**19**	**19**	**18**

No. of RS/RW Ascents

00Z /19.11.2016 : 5

No. of Ascents reaching 250hPa level =5

MISDA : 3

12Z /19.11.2016 : 2

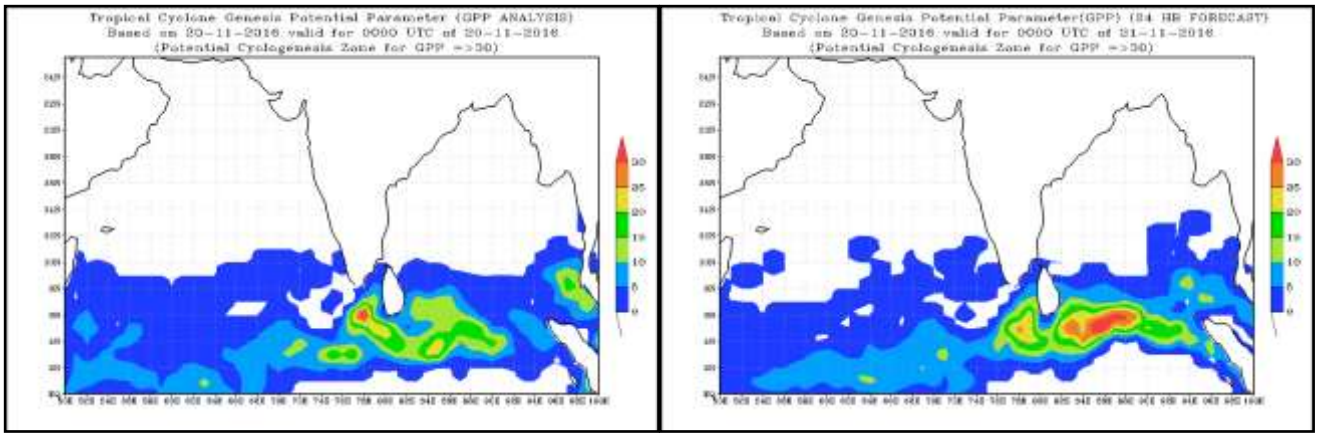
No. of Ascents reaching 250 hPa level =1

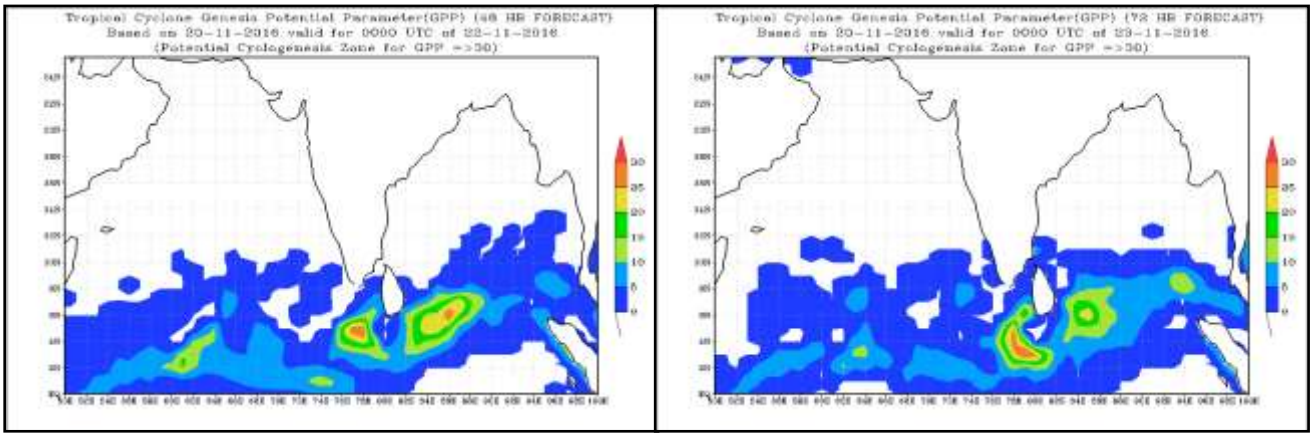
MISDA : 6

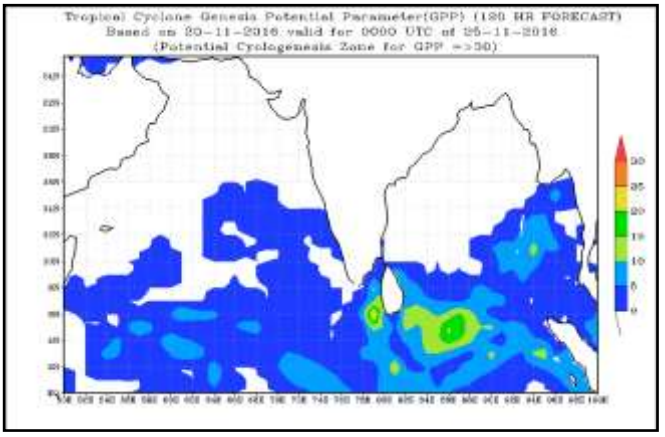
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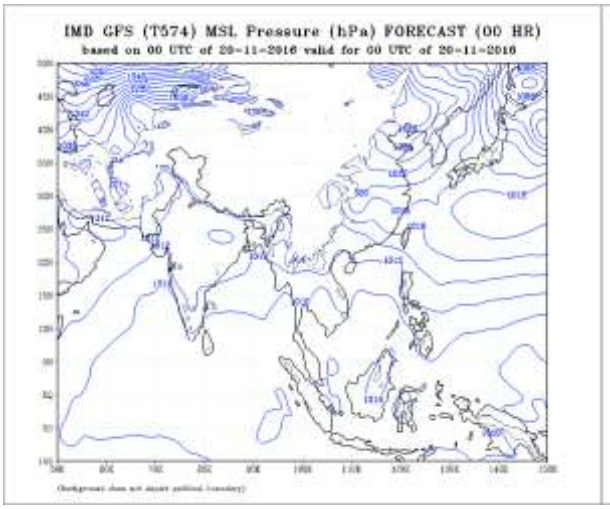
19.11.2016	
06Z	18Z
3	2

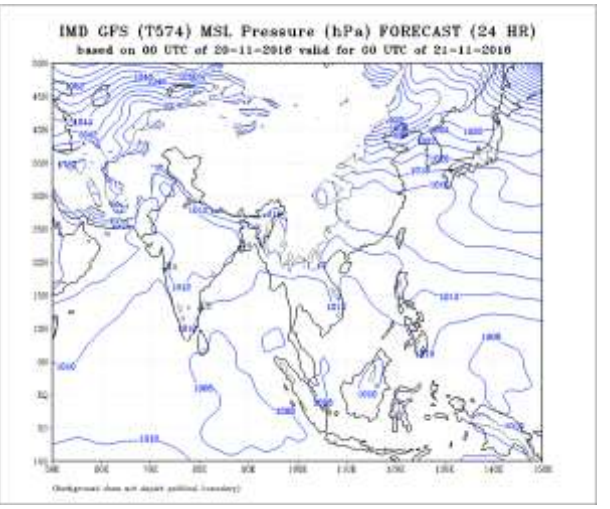
Annexure-II

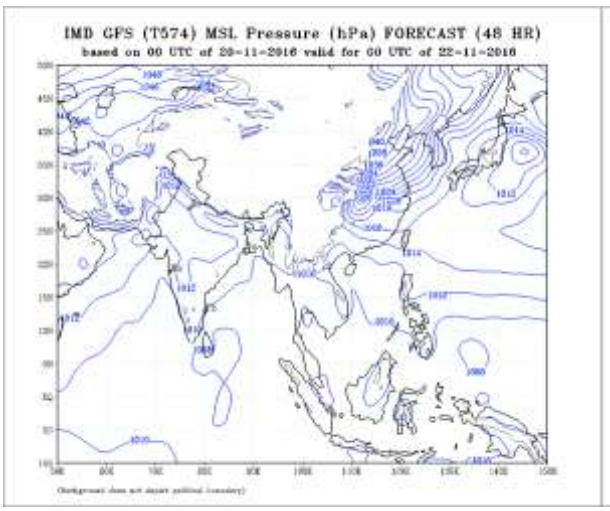

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 20-11-2016 valid for 0000 UTC of 20-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 20-11-2016 valid for 0000 UTC of 21-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

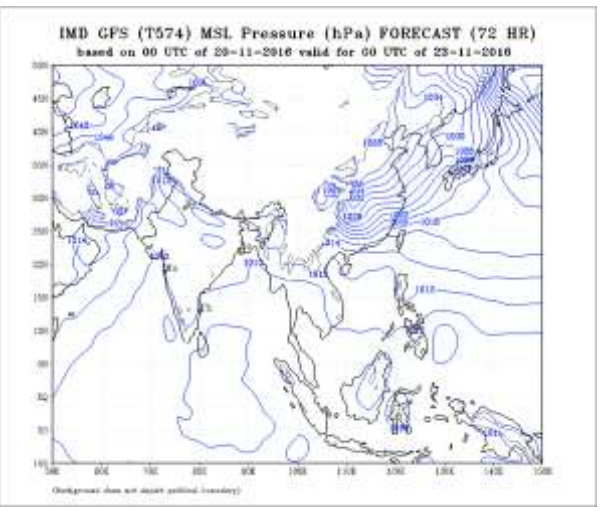

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 20-11-2016 valid for 0000 UTC of 22-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 20-11-2016 valid for 0000 UTC of 23-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

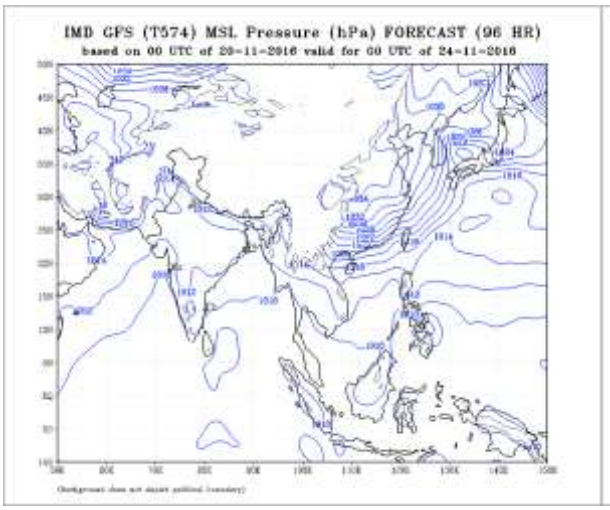

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 20-11-2016 valid for 0000 UTC of 25-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

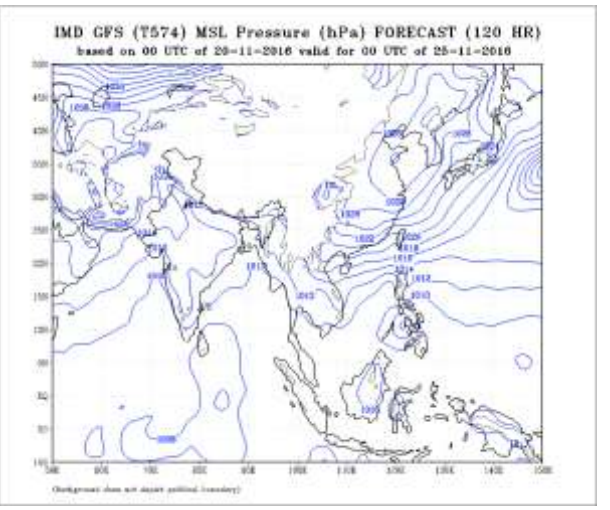

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 20-11-2016

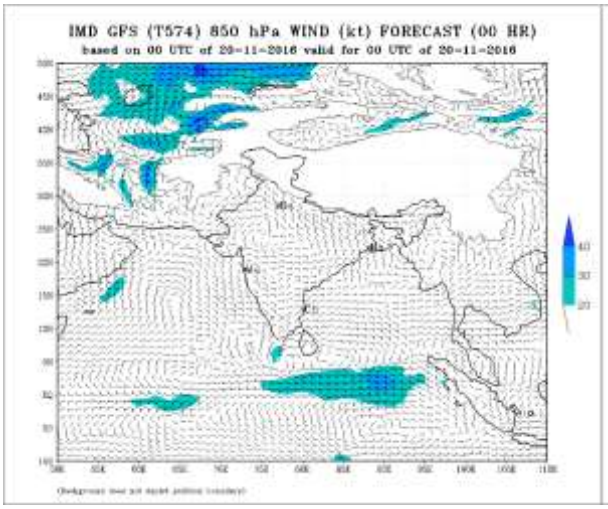

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 21-11-2016

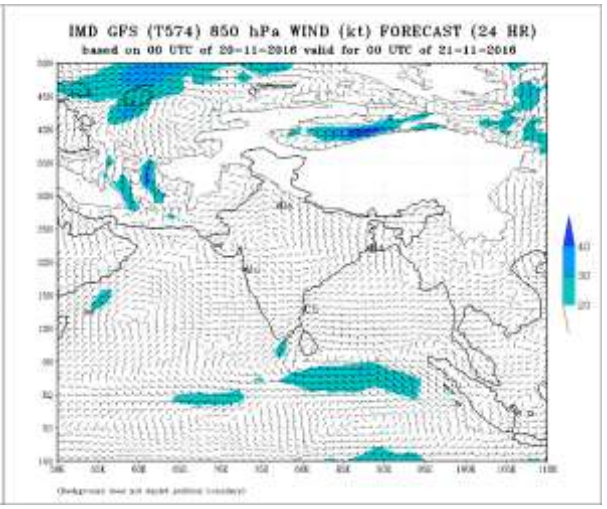

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 22-11-2016

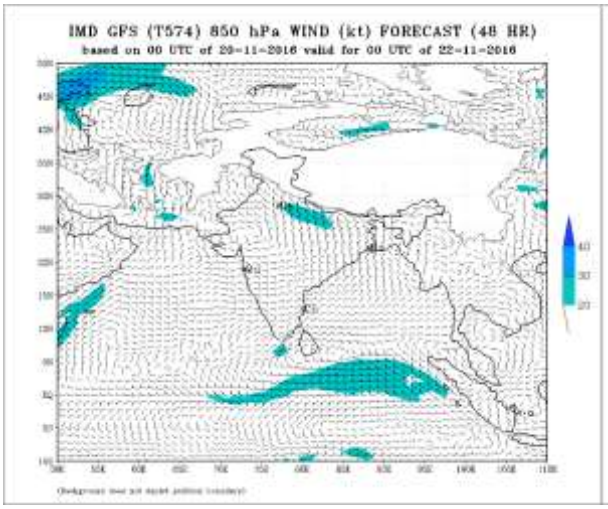

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 23-11-2016

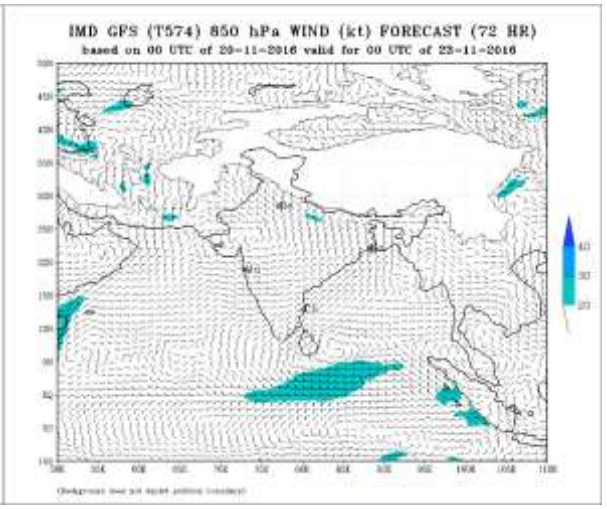

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 24-11-2016

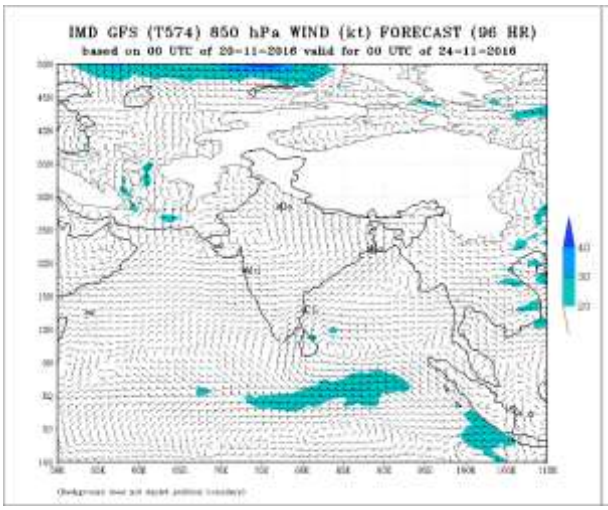

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 25-11-2016

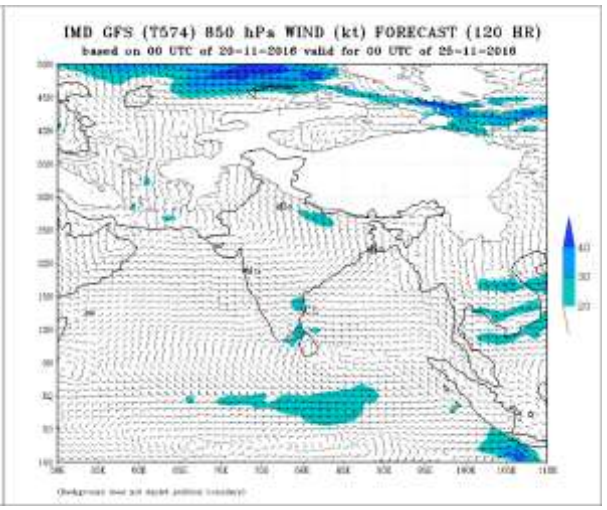

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 20-11-2016

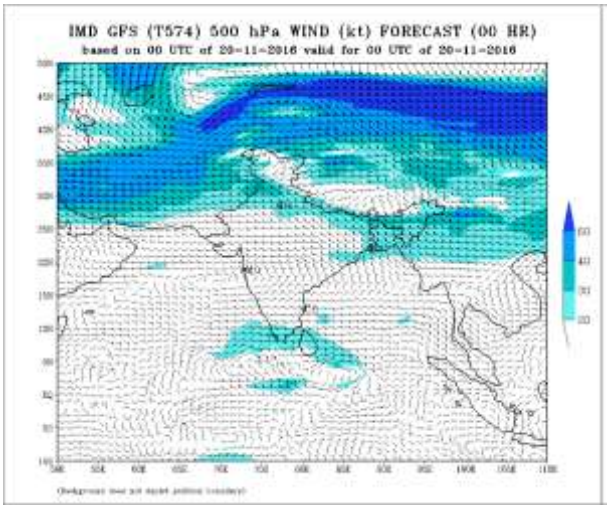

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 21-11-2016

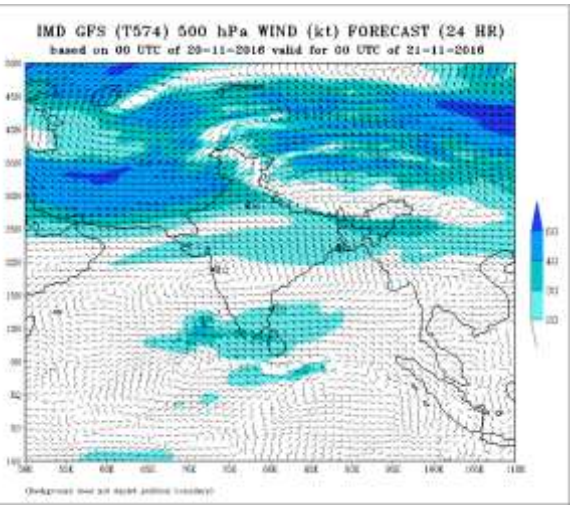

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 22-11-2016

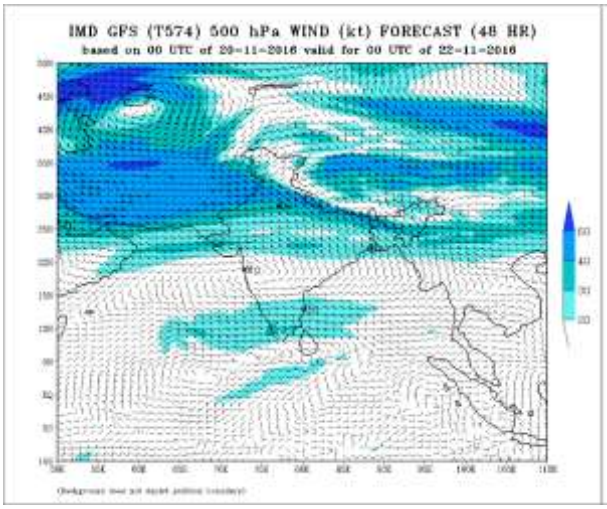

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 23-11-2016

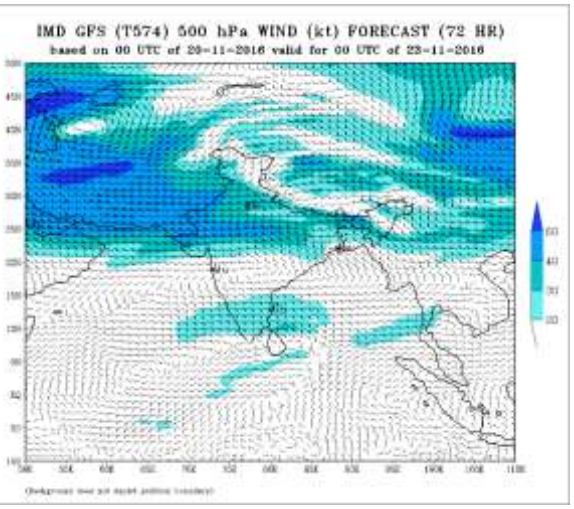

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 24-11-2016

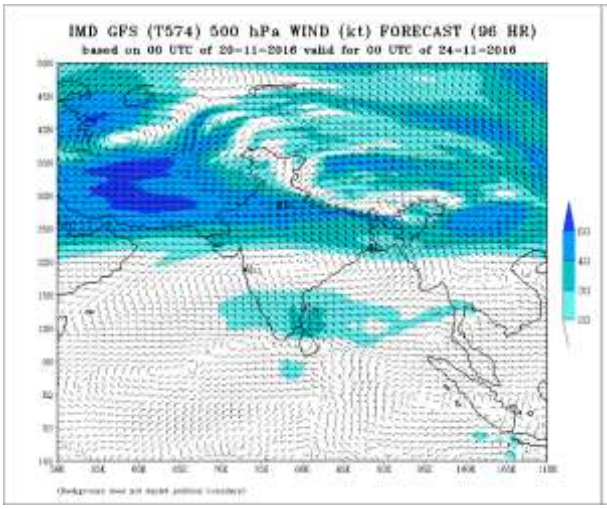

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 25-11-2016

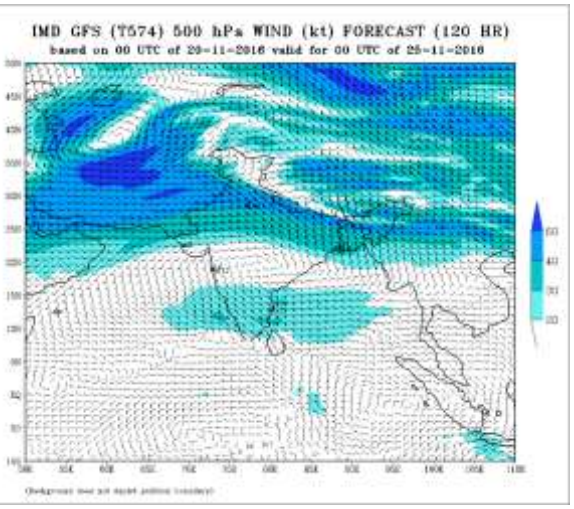

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
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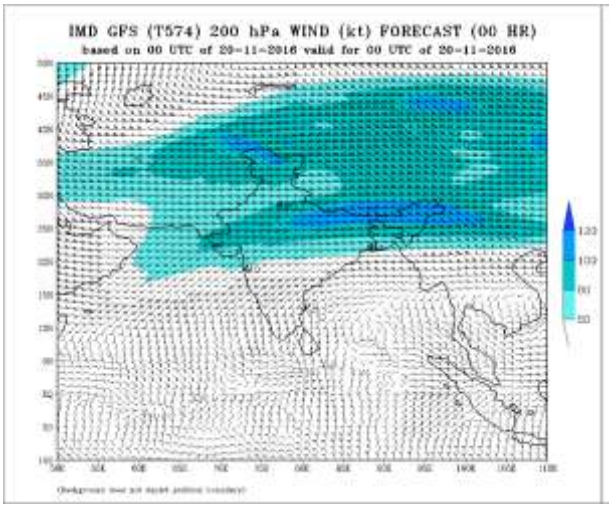

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 21-11-2016

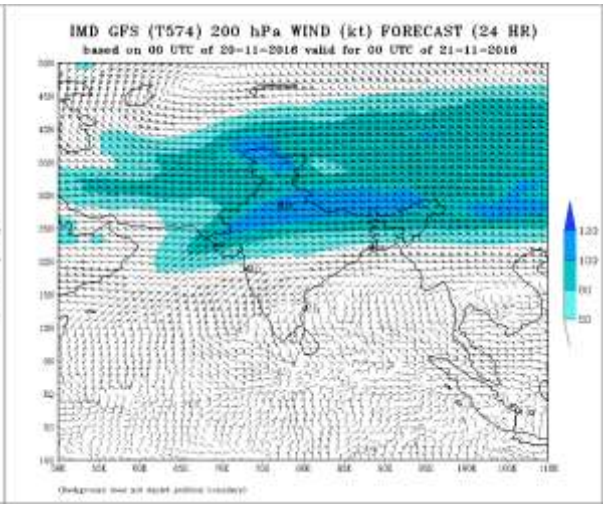

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 22-11-2016

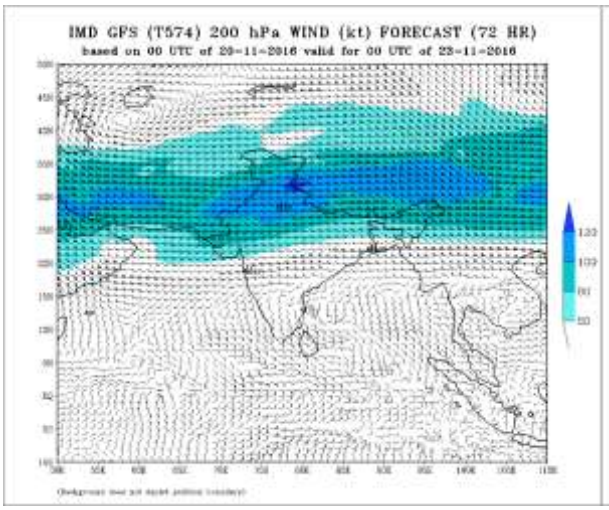

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 23-11-2016

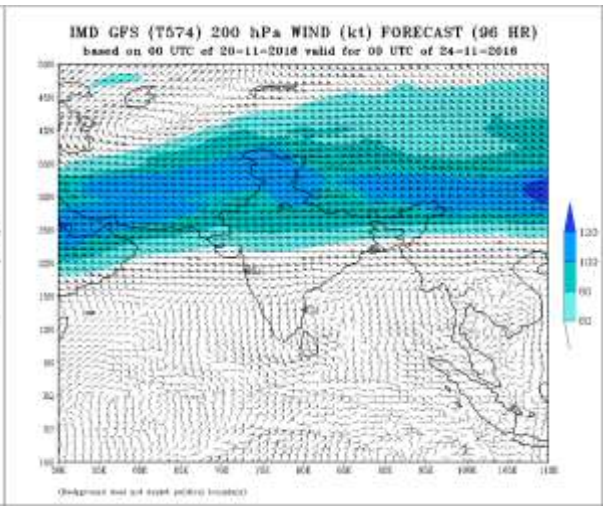

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 24-11-2016

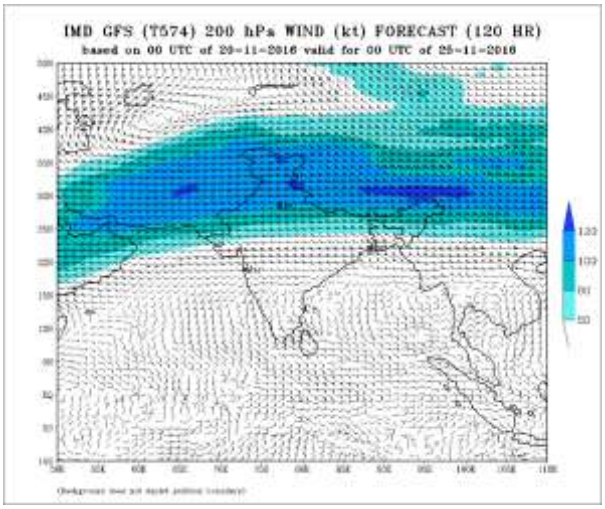

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 25-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 20-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 21-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 23-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 24-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 20-11-2016 valid for 00 UTC of 25-11-2016

FDP (Cyclone) NOC Report Dated 21st November, 2016

Synoptic features:

Yesterday's trough of low at mean sea level over equatorial Indian Ocean and adjoining southwest Bay of Bengal off Srilanka coast persists and the trough of low at mean sea level over Malay Peninsula & neighbourhood now lies over Malay Peninsula and adjoining south Andaman Sea. A trough at mean sea level runs from Comorin area to south Konkan coast.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of south and central BOB. It is about 30-31˚C over north Andaman Sea. It is slightly less 26-28˚C over north BOB.

The SST over Arabian Sea (AS) is between 26-28˚C over most areas of north and central and also over western parts of southwest Arabian Sea. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat coast. SST is 28-30˚C over remaining parts of Arabian Sea and is 31-32˚C over Lakshadweep area and adjoining Kerala and Karnataka coasts.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of BoBengal, except for southern parts of south Andaman Sea and adjoining southeast BoB, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north BoB of Bengal and also in some parts over southwest and west central BoB.

TCHP is less than 50 kJ/cm^2 over western AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala coast where TCHP is 100 kJ/cm^2.

Relative Vorticity:

The low level relative vorticity is about 40-50x10^{-6} second^{-1} over equatorial region and adjoining south BOB and parts of Andaman Sea, It is negative over most parts of BOB and north Andaman Sea.

The low level relative vorticity over parts of southwest AS is about 40-50 x10^{-6} second^{-1} over parts of southwest AS. It is about 15-20x10^{-6} second^{-1} over westcentral and adjoining eastcentral AS and over parts f eastcentral AS off north Maharashtra coast. It is negative over remaining parts of AS mainly along the coastlines.

Convergence:

There is a small zone of positive convergence 5-10x10^{-6} s^{-1} over parts of south Andaman Sea. Another zone of positive convergence 5x10^{-6} s^{-1} is seen over Comorin coast and Srilanka.

No significant zone of positive low level convergence over AS except a small zone of 5x10^{-6} s^{-1} over eastcentral AS off Karnataka coast and over northeast AS off Pakistan coast.

Divergence:

There is no significant area of positive upper level divergence over Bay of Bengal as well as over Arabian Sea. An elongated zone of positive upper level divergence of about 10x10^{-6} s^{-1} lies over equatorial & adjoining south BOB extending upto Comorin coast.

Wind Shear:

Wind shear is 10-15 kts (moderate) over most parts of south BOB and Andaman Sea. It is increasing towards north.

Wind shear is around 15-20 kts over most parts of south AS. It is increasing towards north.

Wind Shear Tendency:

There is increasing tendency of 5-10 kts over entire eastcentral and adjoining westcentral BOB. There is increasing tendency of 5-10 kts over entire AS.

Satellite observations based on 0600 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over south BOB and Andaman Sea. Scattered low/medium clouds with embedded isolated weak to moderate convection are seen over central BOB.

Arabian Sea:

Broken low/medium clouds with embedded moderate to intense convection are seen over south AS and Comorin coast.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 15^0N latitude over BoB.

M.J.O. Index: MJO index is in Phase 2 with amplitude more than one and would continue in same phase for next 5 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 21st November 2016 shows no significant system over the NIO region. The forecasts however shows, a low level cyclonic circulation from 22nd November over the south west sector of Bay of Bengal, thereby extending southward over the equatorial Indian Ocean to Malay Coast and prevalent till 27th November.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 21st November 2016 show similar features like IMD-GFS model.

ECMWF: The model analysis based on 00 UTC of 21st November 2016 shows a feeble low level cyclonic circulation over south-west Bay of Bengal on 22nd. It moves gradually westwards without any intensification

WRF: The WRF model based on 00 UTC of 21st November 2016 shows no significant system over the NIO region. Forecast shows a low level cyclonic circulation from the 22nd November over the south west sector of Bay of Bengal and it is getting further intensified into a low on 23rd.

JMA: No system expected over north Indian Ocean during next three days.

Meteo-France ARP Model: No system expected over north Indian Ocean during next three days.

NCMRWF-NCUM: The analysis based on 00 UTC of 20h November shows cyclonic circulation over SE Bay on 22 and 23rd, over south Bay on 24th, over SW Bay during 25-27th and over Sri Lanka on 28th. It also shows development of low over south Indian Ocean on 25th, intensifying into a depression on 26th and cyclonic storm on 27th.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 20th shows no system for next three days.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 21st November shows development of a low over southwest BOB on 22nd and persists slowly westward and lies over southwest Sri Lanka on 26th and becomes less marked on 27th. It also shows development of low over south Indian Ocean on 23nd, intensifying into a depression on 24th and cyclonic storm on 25th.

IITM-GEFS: The analysis based on 00 UTC of 21st shows no low pressure system over over north Indian Ocean till 0000 UTC of 29th

IITM -GFS T1534: The analysis based on 00 UTC of 21st shows no low pressure system over north Indian Ocean till 0000 UTC of 29th.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 20th November 2016 suggests an east west shear zone near to the north of equator 21st to 23rd and 22nd becoming insignificant on 24th.

Summary and Conclusion:

A few models suggest formation of a feeble low/cyclonic circulation over southwest BoB off southeast Sri Llanka coast on 22nd. It moves gradually westwards reaching southeast Sri Lanka on 26th and becomes less marked on 27th. The development of a depression/cyclonic storm is also predicted by a few models over south Indian Ocean, which is not favourable for intensification/genesis of any system over south Bay of Bengal.

Development of the above systems need to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	20/12	21/00	21/03
India	43	33	45
Coastal stations			
WB	10	3	9
Odisha	6	6	6
AP	10	12	12
Tamil Nadu	10	10	11
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	2	3
Myanmar	2	9	0
Thailand	3	2	2
Sri Lanka	5	7	8

AWS:

Region	Date/Time (UTC)		
	20/12	21/00	21/03
WB	5	5	6
Odisha	4	5	4
AP	6	5	4
Tamil Nadu	26	9	22
Puducherry	1	1	0
A & N	0	0	0

- **RS/RW** (12Z) of 20 / 11 /2016 :33/43
- **No. of Ascents reaching 250 hPa levels:17 , MISDA:-15**

- **RS/RW** (00Z) of 21 / 11 /2016 : 27/43

- **No. of Ascents reaching 250 hPa levels: 19 , MISDA: 5**
-

No. of PILOT Ascents

20/12Z	21/00Z
17	28

Buoy Data

20/12Z	21/00Z	21/03Z
12	10	12

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**20.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /20.11.2016 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /20.11.2016 : 3

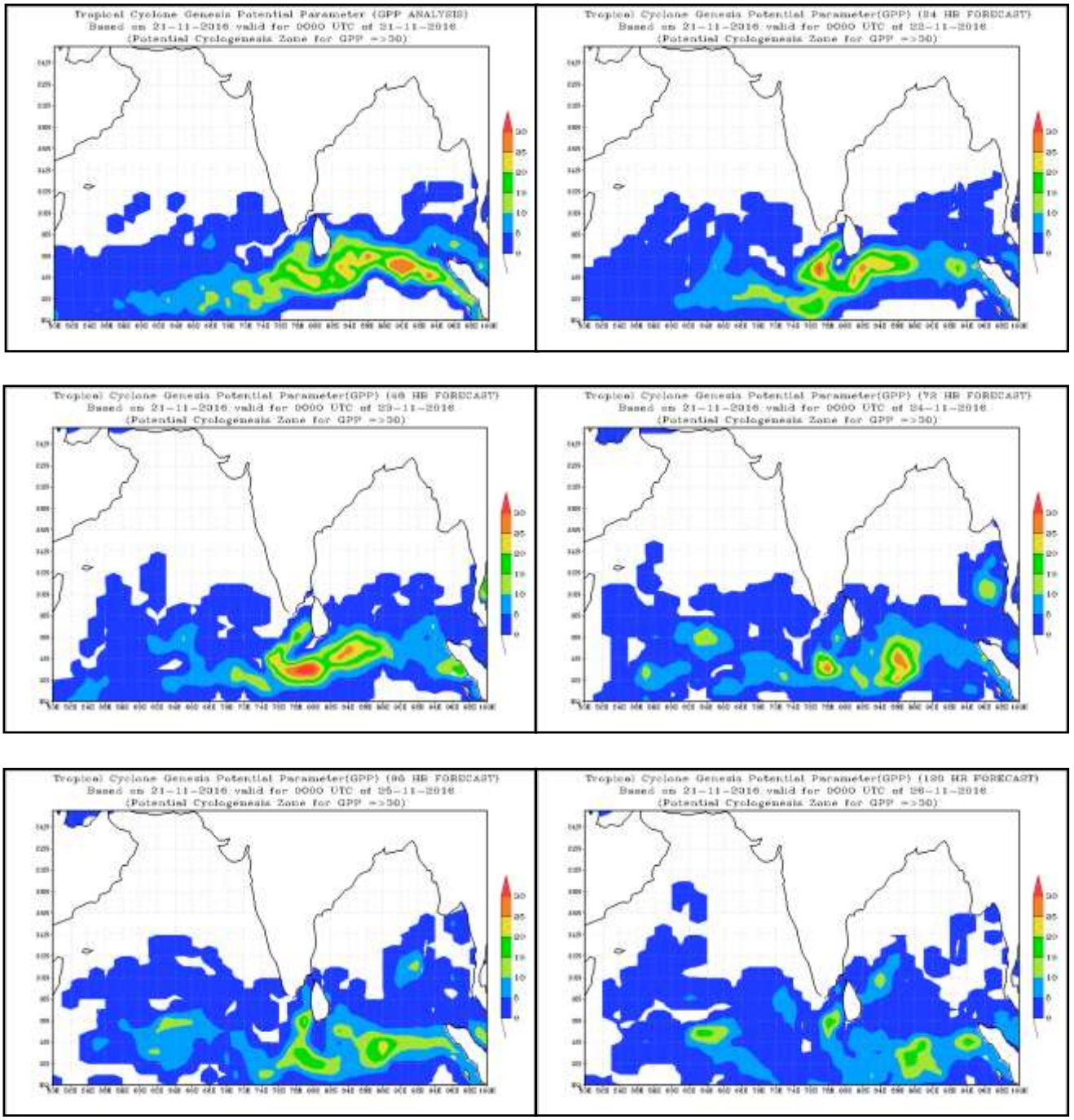
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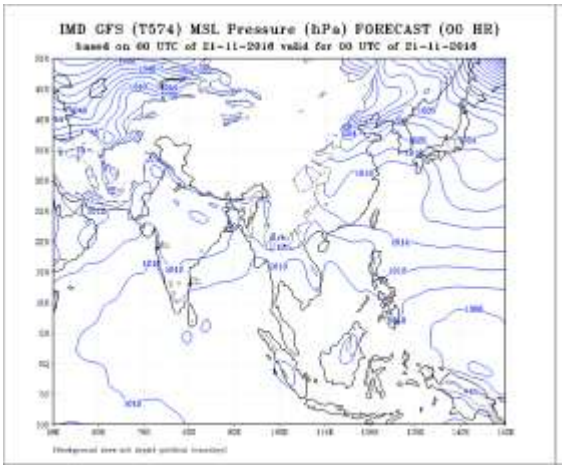
MISDA : 5

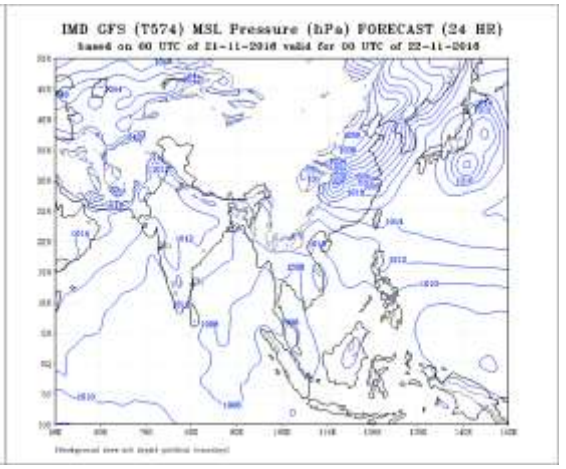
No. of PILOT Ascents:

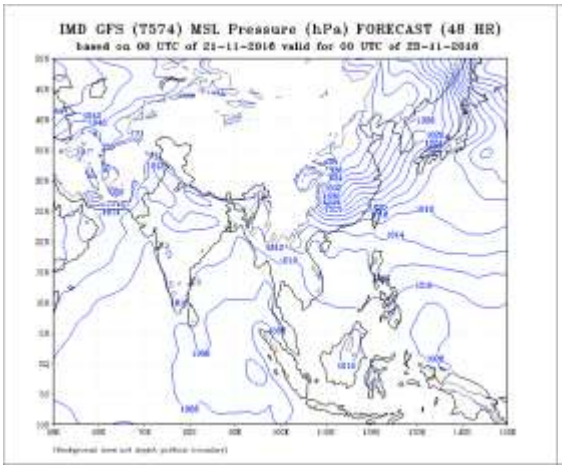
20.11.2016	
06Z	18Z
3	2

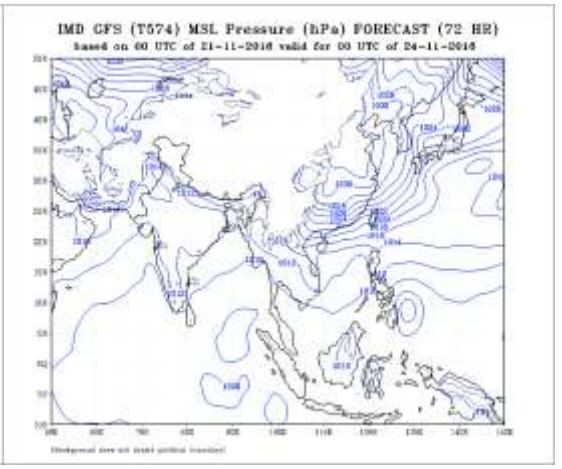
Annexure-II

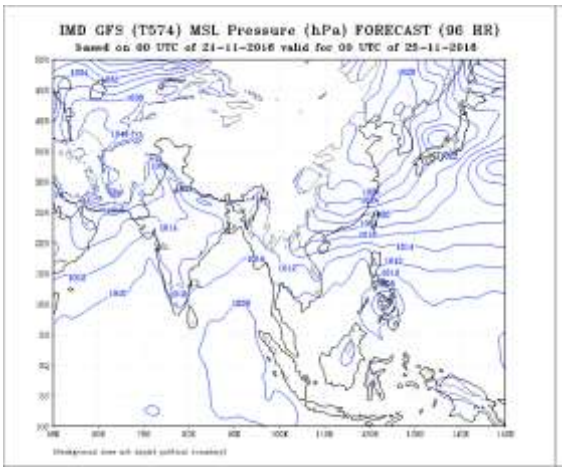

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 21-11-2016 valid for 0000 UTC of 21-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 21-11-2016 valid for 0000 UTC of 22-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 21-11-2016 valid for 0000 UTC of 23-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 21-11-2016 valid for 0000 UTC of 24-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 21-11-2016 valid for 0000 UTC of 25-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 21-11-2016 valid for 0000 UTC of 26-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

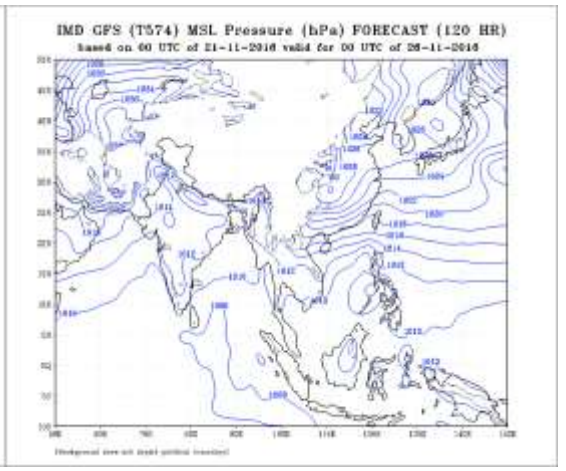

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 21-11-2016

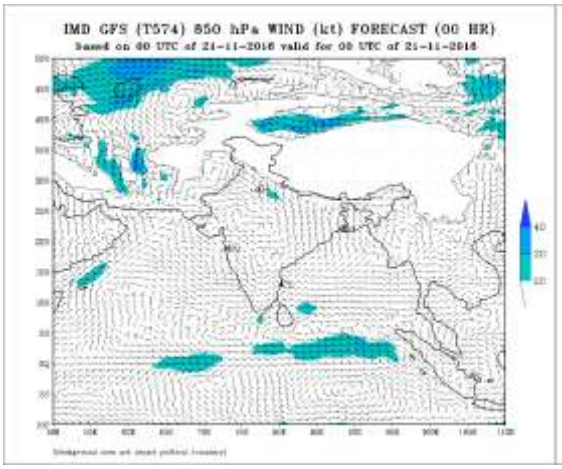

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 22-11-2016

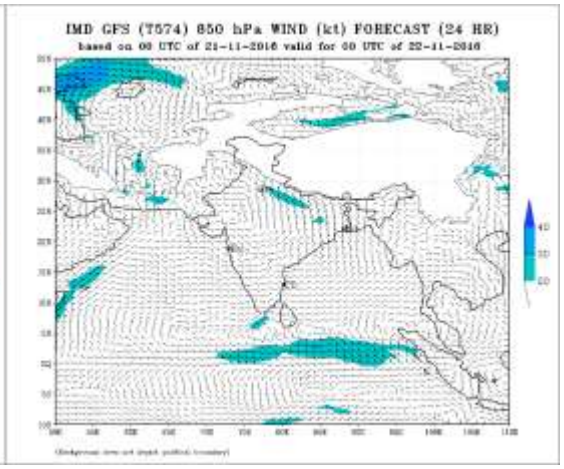

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
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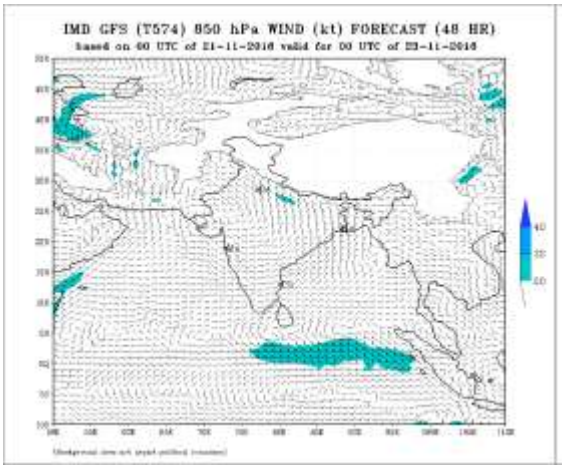

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 24-11-2016

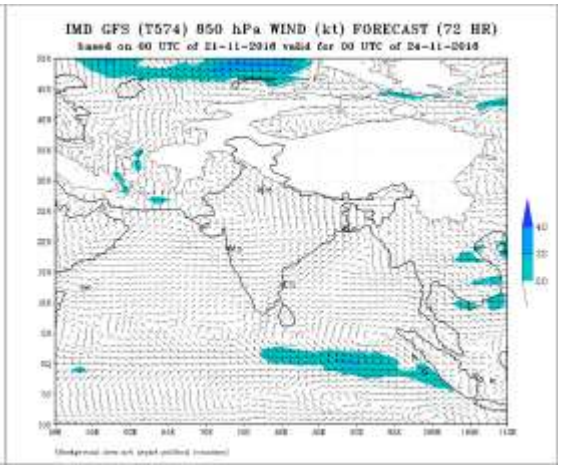

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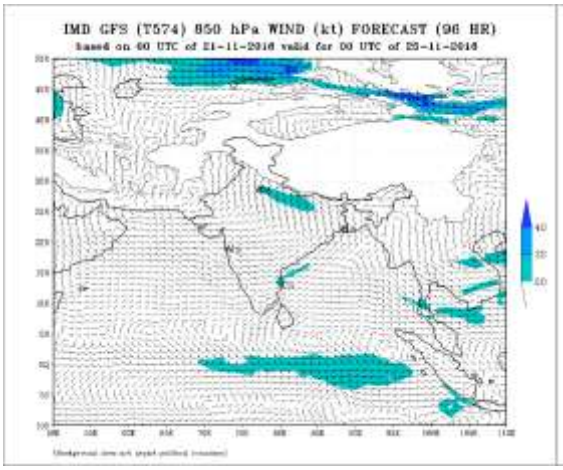

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 26-11-2016

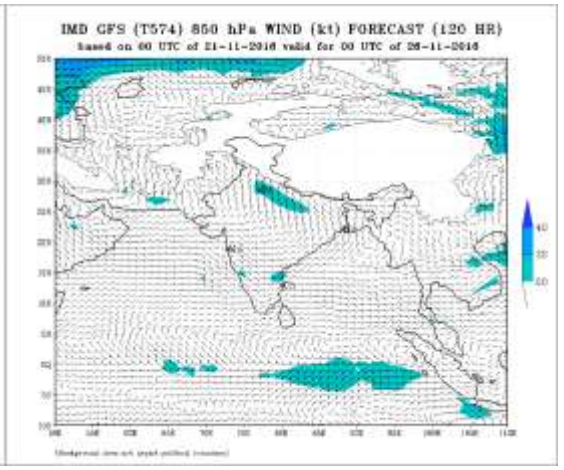

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 21-11-2016

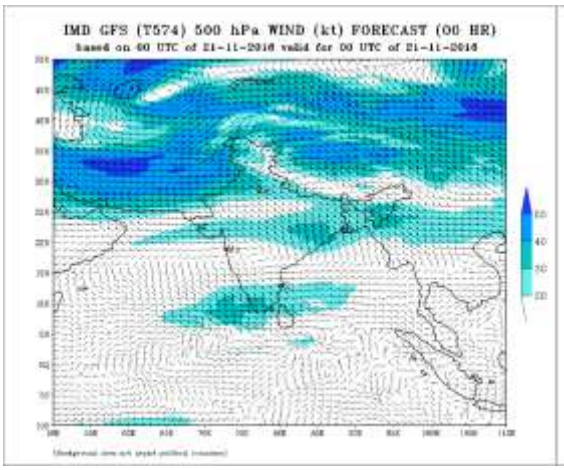

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
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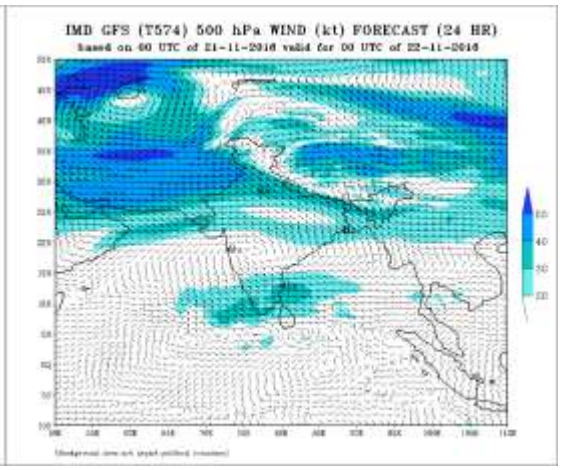

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
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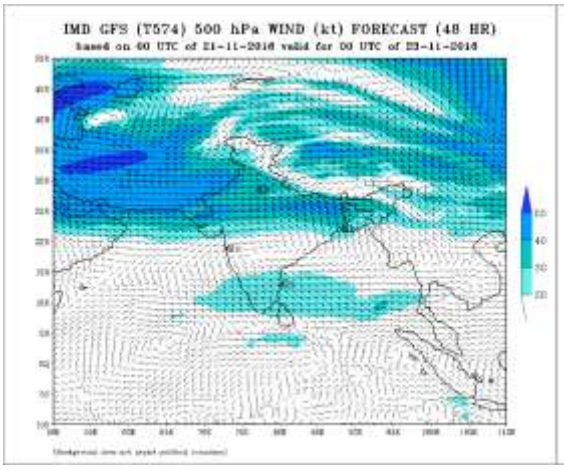

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
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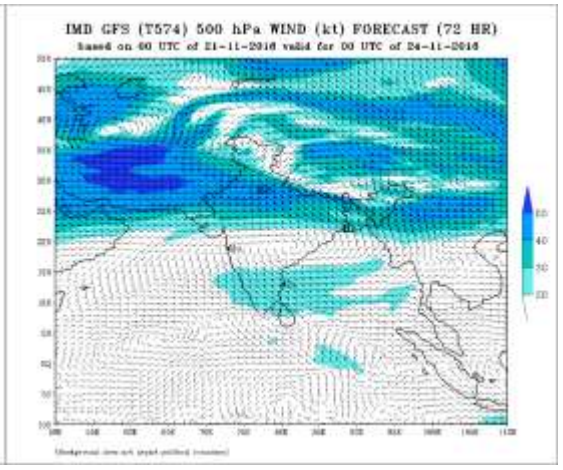

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 25-11-2016

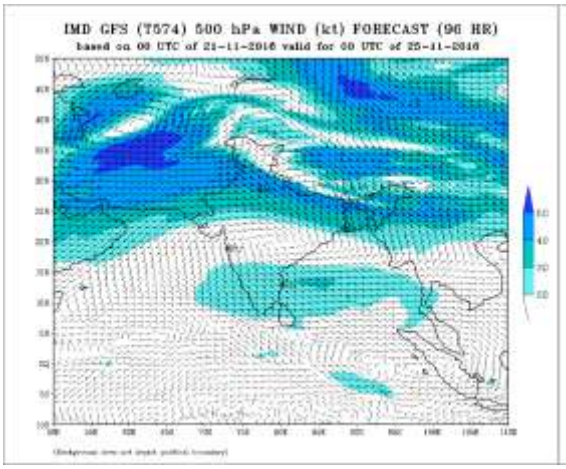

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 26-11-2016

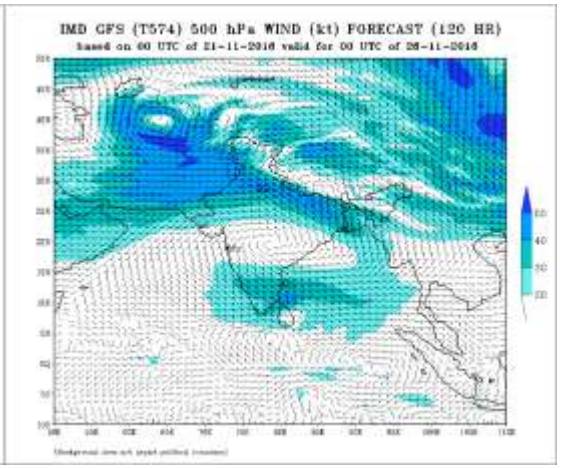

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
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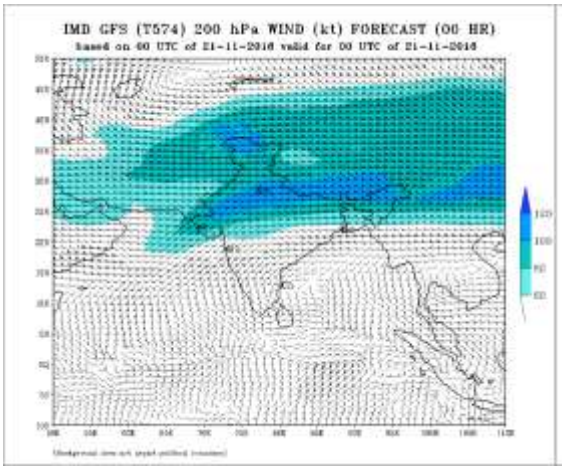

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 22-11-2016

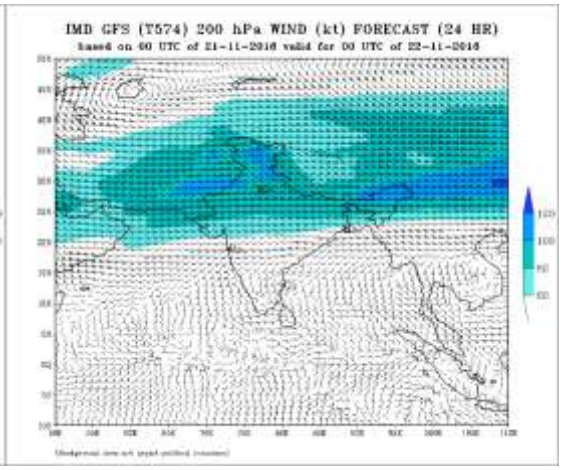

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 23-11-2016

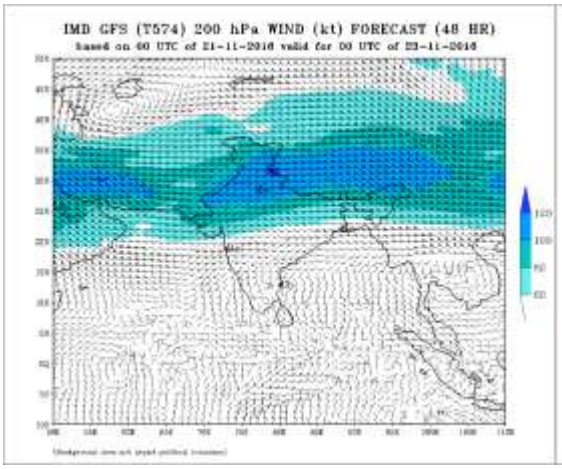

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 24-11-2016

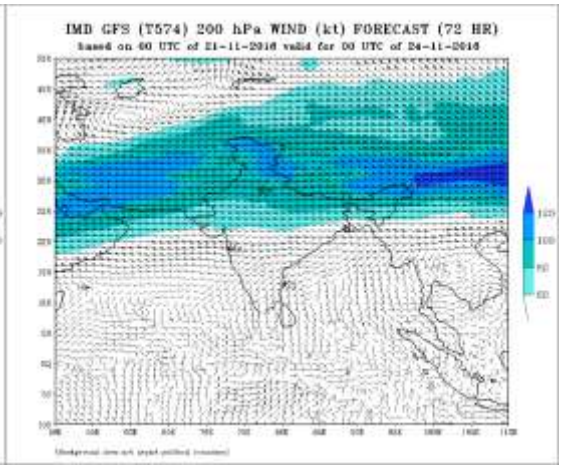

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 25-11-2016

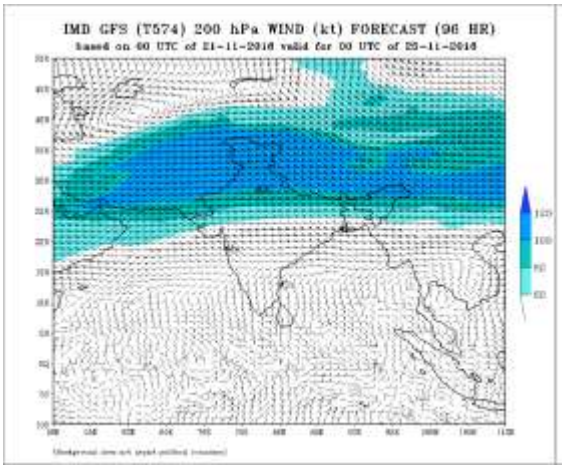

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 26-11-2016

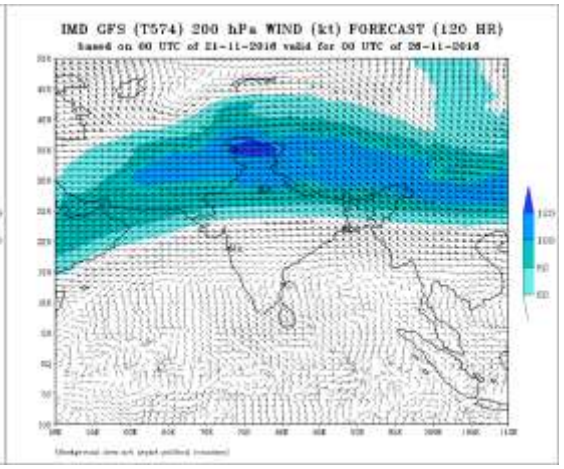

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 21-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 22-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 23-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 24-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 25-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 21-11-2016 valid for 00 UTC of 26-11-2016

FDP (Cyclone) NOC Report Dated 22nd November, 2016

Synoptic features:

Yesterday's trough of low at mean sea level over equatorial Indian Ocean and adjoining southwest Bay of Bengal off Srilanka coast persists has become well marked and the trough of low at mean sea level over Malay Peninsula and adjoining south Andaman Sea now lies over south Andaman Sea and neighbourhood. Another trough at mean sea level over Comorin area to south Konkan coast persists.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of south and central BOB. It is about 30-31˚C over north Andaman Sea. It is slightly less 26-28˚C over north BOB.

The SST over Arabian Sea (AS) is between 26-28˚C over most areas of north and central and also over western parts of southwest Arabian Sea. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat coast. SST is 28-30˚C over remaining parts of Arabian Sea and is 31-32˚C over Lakshadweep area and adjoining Kerala and Karnataka coasts.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of BoBengal, except over south Andaman Sea and adjoining southeast BoB & equatorial region, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over northern parts of north BoB of Bengal and also in some parts over southwest and west central BoB.

TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala coast and over Comorin coast where TCHP is 100 kJ/cm^2.

Relative Vorticity:

The low level relative vorticity is about 40-50x10^{-6} second^{-1} over equatorial region and adjoining south BOB. It is about 25x10^{-6} second^{-1} over parts of south BOB & adjoining south Andaman Sea and north BOB. It is negative over most parts of BOB and north Andaman Sea.

The low level relative vorticity is about 25 x10^{-6} second^{-1} over most parts of AS except over sutheast and parts of northeast BOB where it is negative.

Convergence:

There is a small zone of positive convergence 5-10x10^{-6} s^{-1} over parts of south Andaman Sea. Another zone of positive convergence 5-10x10^{-6} s^{-1} is seen over Comorin coast and Srilanka.

No significant zone of positive low level convergence over AS except a small zone of 5x10^{-6} s^{-1} over eastcentral AS off Karnataka coast, northeast AS off Pakistan coast and parts of southwest AS.

Divergence:

There is no significant area of positive upper level divergence over Bay of Bengal as well as over Arabian Sea. A small pocket of positive upper level divergence of about 5x10^{-6} s^{-1} lies over southeast BOB.An elongated zone of positive upper level divergence of about 10x10^{-6} s^{-1} lies over equatorial & adjoining south BOB extending upto Comorin coast.

Wind Shear:

Wind shear is 15-20 kts over most parts of south, central BOB and Andaman Sea. It is increasing towards north.

Wind shear is around 10-20 kts over most parts of south and central AS. It is increasing towards north.

Wind Shear Tendency:

There is increasing tendency of 5-10 kts over entire southwest BOB and eastcentral & adjoining Andaman Sea. There is decreasing tendency of 5-10 kts over south AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over south BOB and Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over southeast AS south of latitude 10.0^{0}N and Comorin.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 14^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 2 with amplitude more than one and would continue in same phase for next 5 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model charts based on 00 UTC of 22nd November 2016 shows a low level cyclonic circulation over south Andaman Sea and adjoining Malay Peninsula becoming less marked on 23rd November.

NCEP-GFS: The analysis and forecast charts of the model based on 00 UTC of 22nd November 2016 show similar features like IMD-GFS model.

ECMWF: The model analysis based on 00 UTC of 22nd November 2016 shows a feeble low level cyclonic circulation over southeast Bay of Bengal on 22nd persisting over the same area till 24th November. It shows development of a fresh low over southwest BOB on 23rd November persisting till 26th without intensification. Another low is seen over Comorin area on 23rd moving westwards without further intensification.

WRF: The WRF model based on 00 UTC of 22nd November 2016 shows a low level cyclonic circulation over the southwest Bay of Bengal becoming less marked on 23rd November.

JMA: No system expected over north Indian Ocean during next three days.

Meteo-France ARP Model: No system expected over north Indian Ocean during next three days.

NCMRWF-NCUM: The analysis based on 00 UTC of 22nd November shows no significant circulation over BOB for next 10 days.

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 22nd November shows no significant circulation over BOB for next 3 days.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 22nd November shows no significant development over BOB. However, it also shows development of low over south Indian Ocean on 23rd, intensifying into a cyclonic storm on 26th and weakening into a low on 2nd December.

IITM-GEFS: The analysis based on 00 UTC of 22nd shows no low pressure system over north Indian Ocean for next 5 days.

IITM -GFS T1534: The analysis based on 00 UTC of 22nd shows no low pressure system over north Indian Ocean for next 5 days.

Dynamical statistical models:

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 22nd November 2016 suggests persistence of a cyclonic circulation over southeast AS off Comorin coast from 22nd to 24th. .

Summary and Conclusion:

Along the east-west oriented shear zone roughly running along 5^0N across north Indian Ocean, one two cyclonic circulations/ feeble low is predicted by a few models. The development of a depression/cyclonic storm is also predicted by a few models over south Indian Ocean, which is not favourable for intensification/genesis of any system over north Indian Ocean. Development of the above systems need to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Dated: 22.11.2016

Synoptic observation:

Region	Date/Time (UTC)		
	21/12	22/00	22/03
India	43	31	46
Coastal stations			
WB	10	3	9
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	2	3
Myanmar	0	0	1
Thailand	2	3	3
Sri Lanka	5	7	8

AWS:

Region	Date/Time (UTC)		
	21/12	22/00	22/03
WB	5	3	4
Odisha	3	3	4
AP	7	5	5
Tamil Nadu	26	12	18
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 21 / 11 /2016 :30/43
- **No. of Ascents reaching 250 hPa levels:19 , MISDA:-10**

- **RS/RW** (00Z) of 22 / 11 /2016 : 32/43

- **No. of Ascents reaching 250 hPa levels: 22 , MISDA: 6**
-

No. of PILOT Ascents

21/12Z	22/00Z
16	28

Buoy Data

21/12Z	22/00Z	22/03Z
11	10	10

STATUS OF RMC, CHENNAI REGION OBSERVATION
o. of Synop data

Date→	**21.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

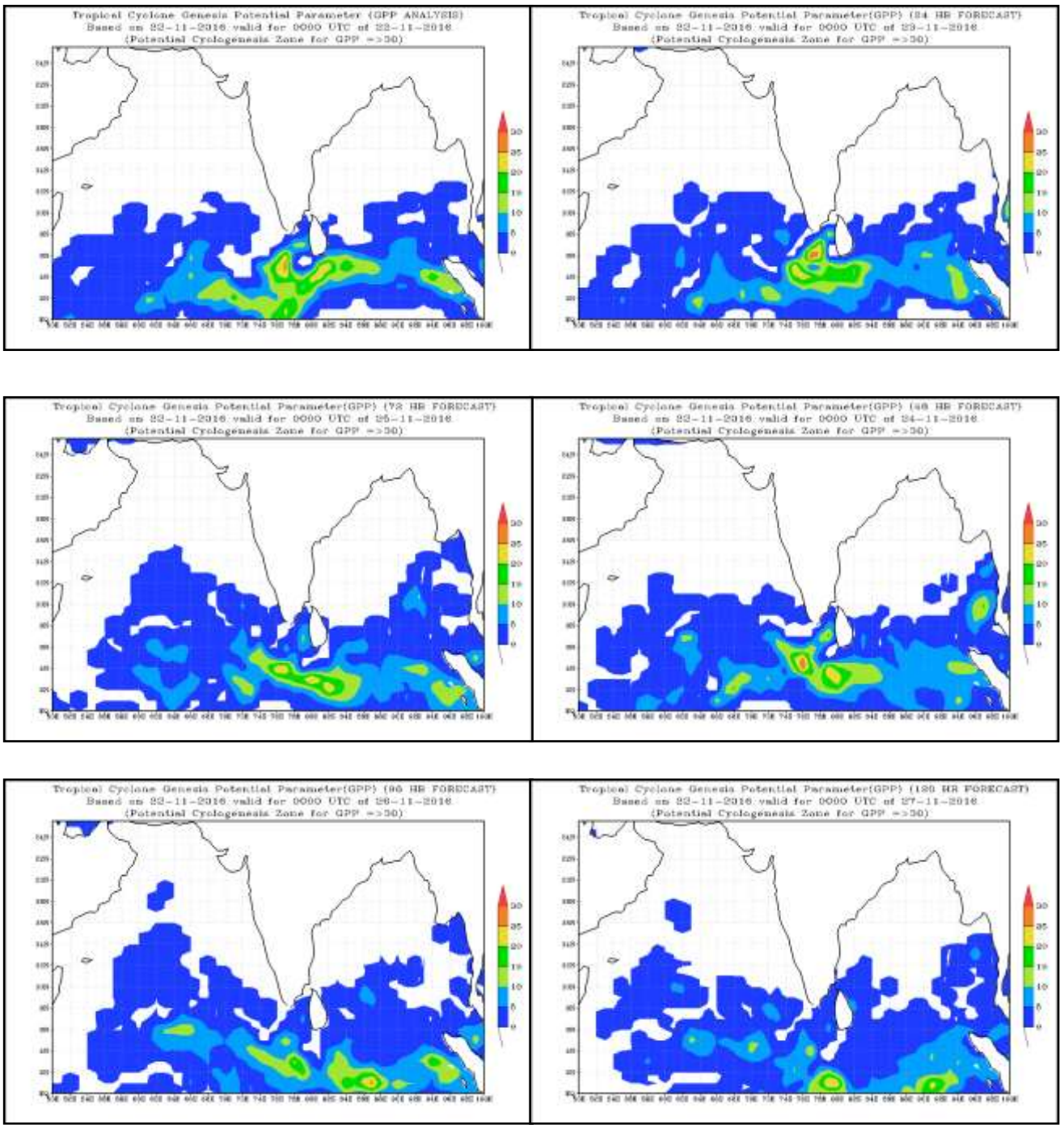
No. of RS/RW Ascents

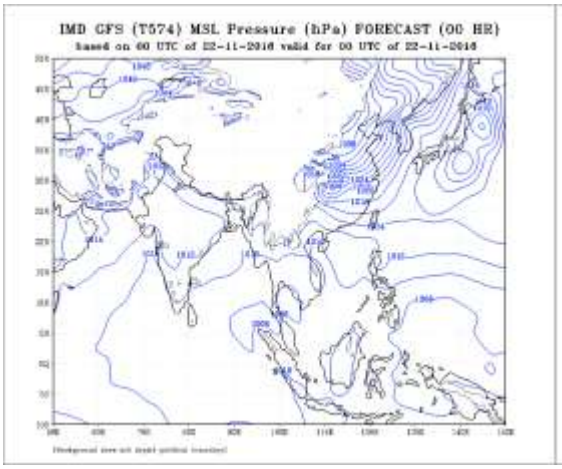
00Z /21.11.2016 : 5
No. of Ascents reaching 250 hPa level = 7
MISDA : 3

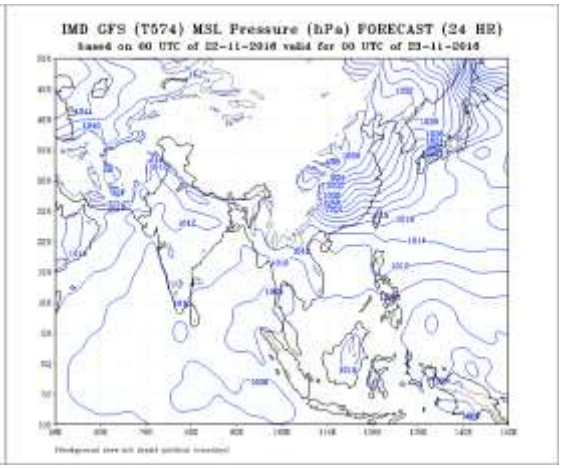
12Z /21.11.2016 : 3
No. of Ascents reaching 250 hPa level = 3
MISDA : 5
No. of PILOT Ascents:

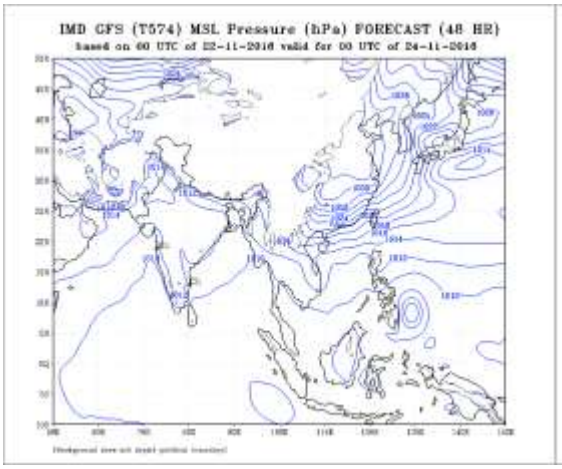
21.11.2016	
06Z	18Z
3	4

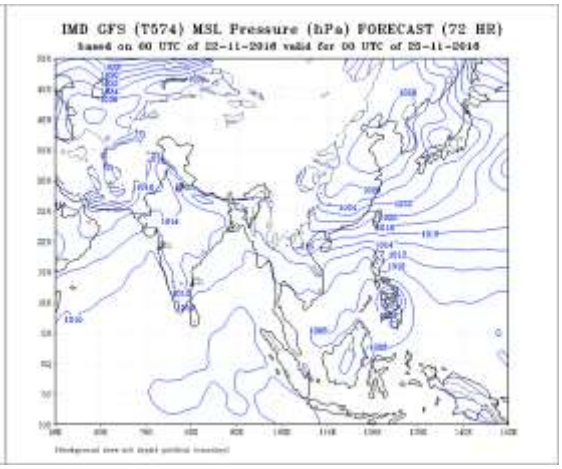
Annexure-II

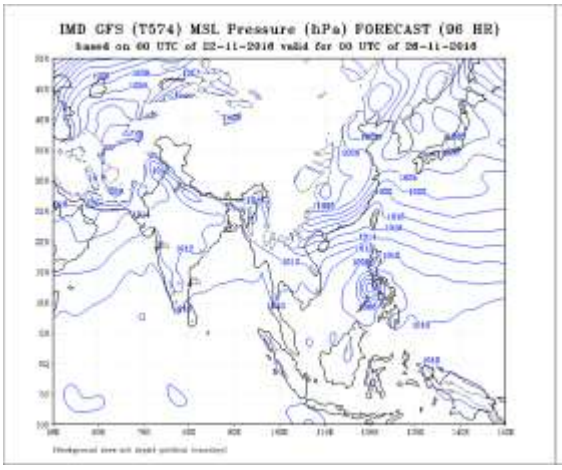

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 22-11-2016 valid for 0000 UTC of 22-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
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Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 22-11-2016 valid for 0000 UTC of 27-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

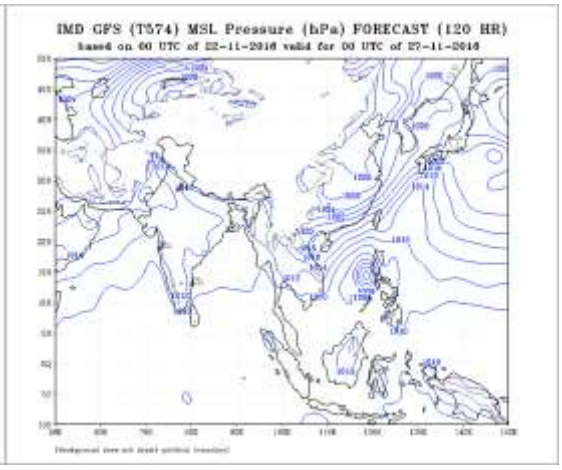

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 22-11-2016

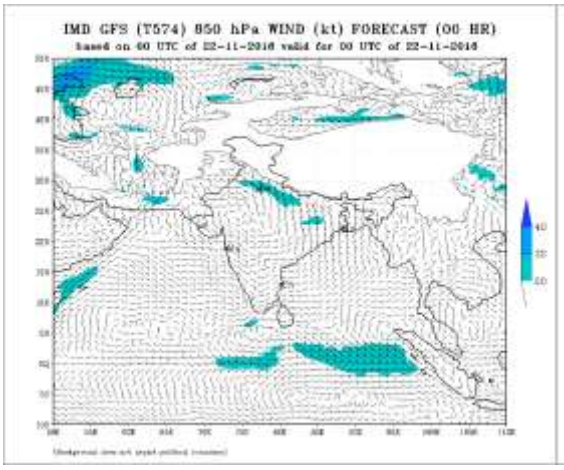

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
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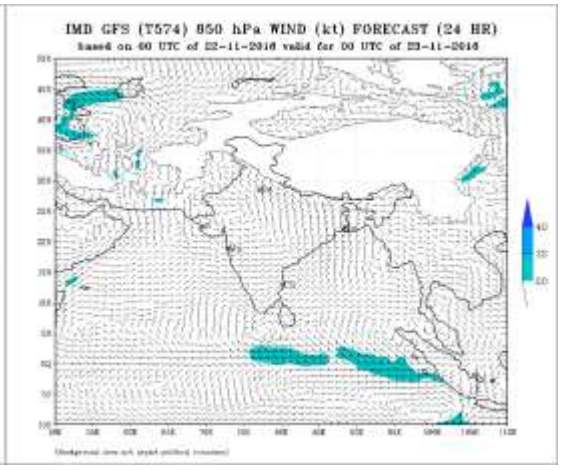

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
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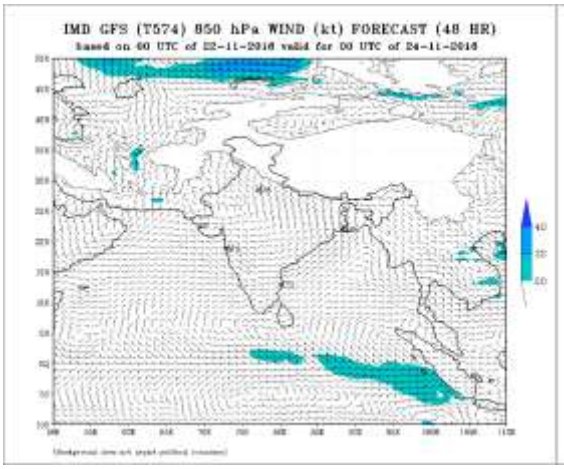

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
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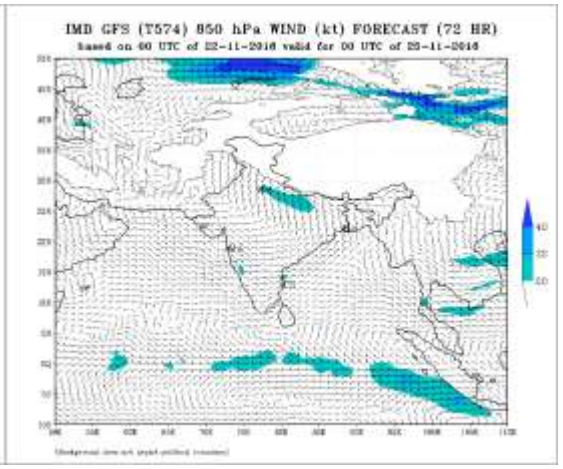

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
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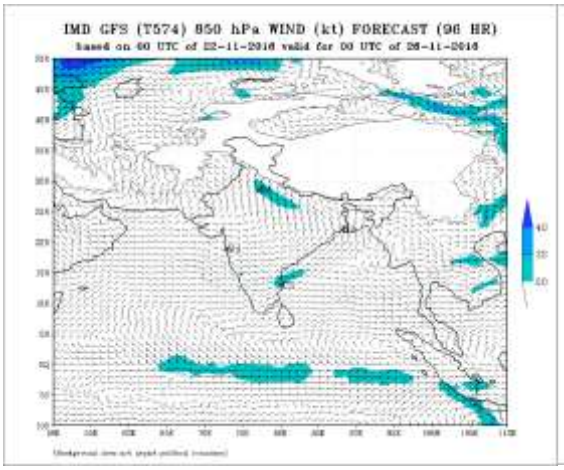

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 27-11-2016

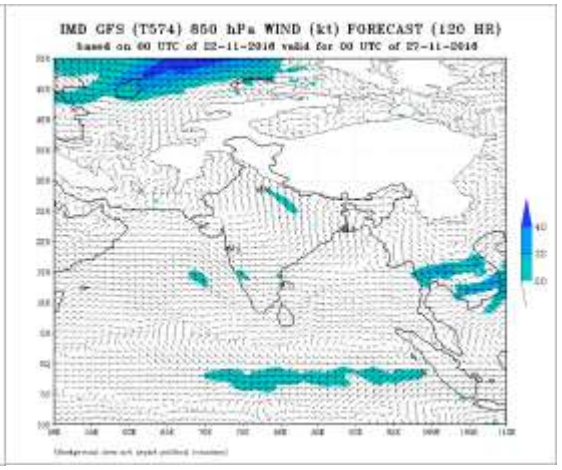

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 22-11-2016

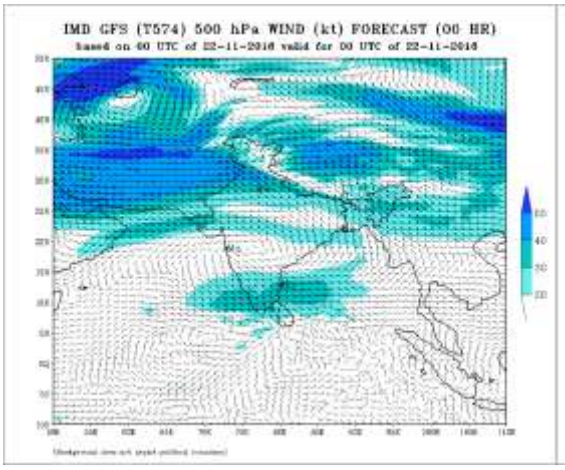

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 23-11-2016

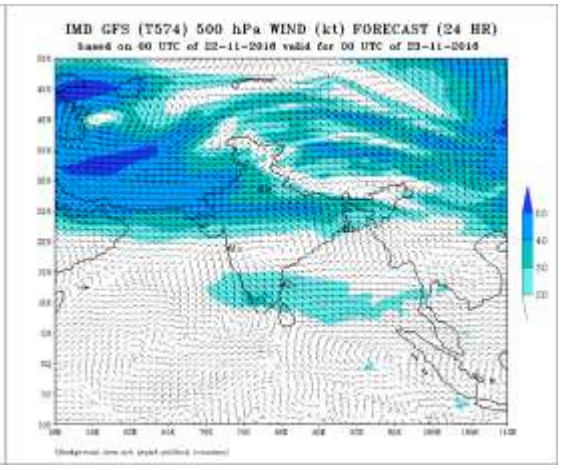

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 24-11-2016

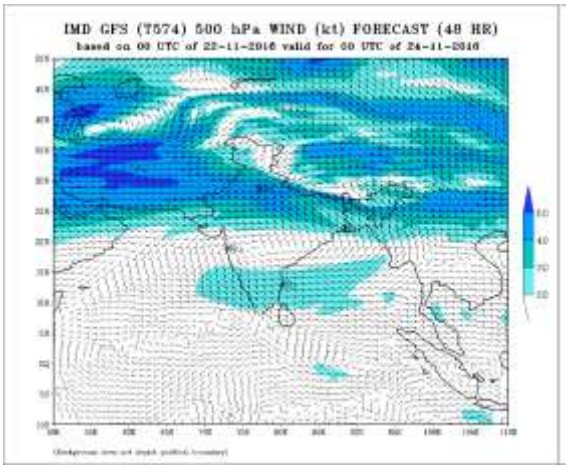

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 25-11-2016

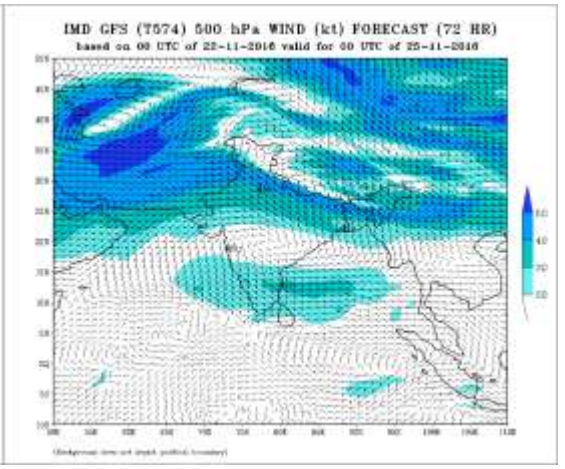

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 26-11-2016

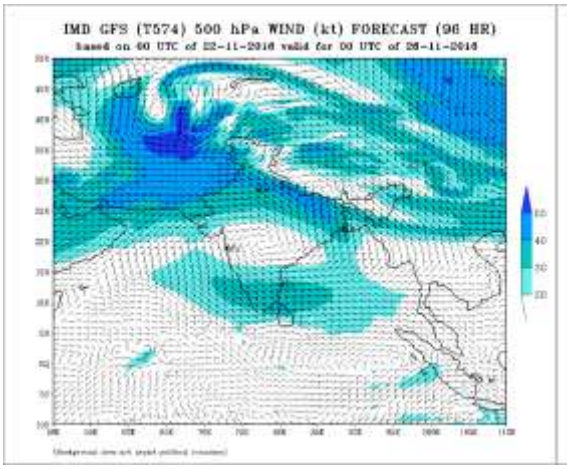

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 27-11-2016

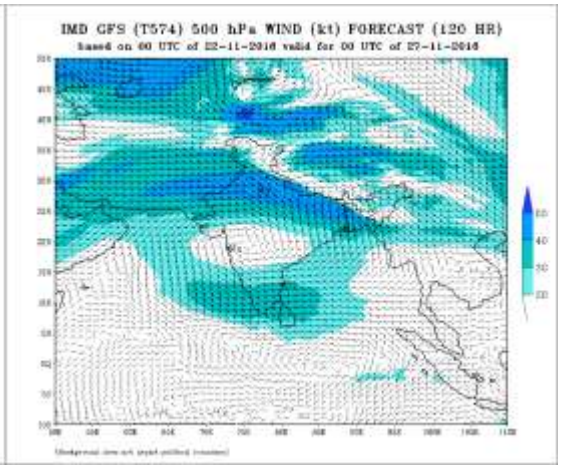

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 22-11-2016

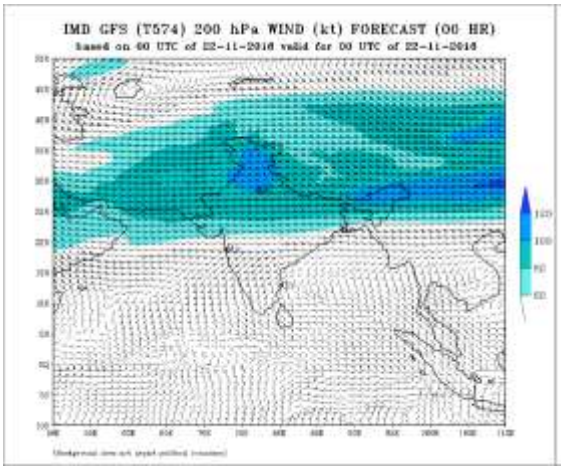

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 23-11-2016

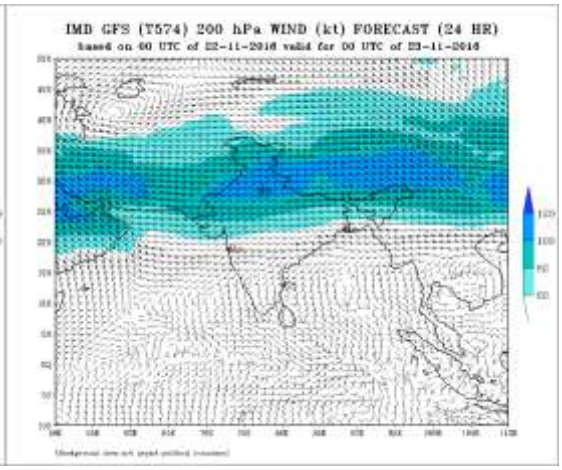

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 24-11-2016

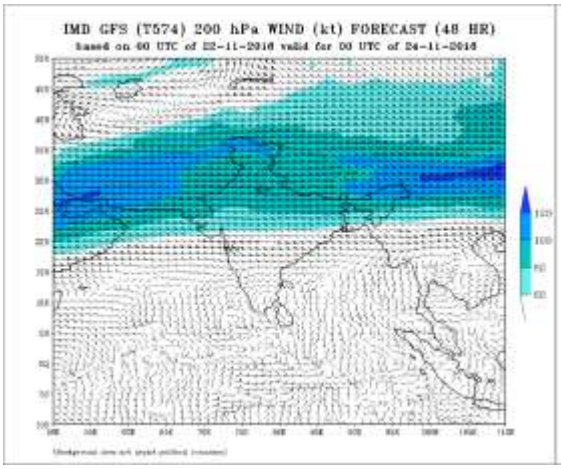

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 25-11-2016

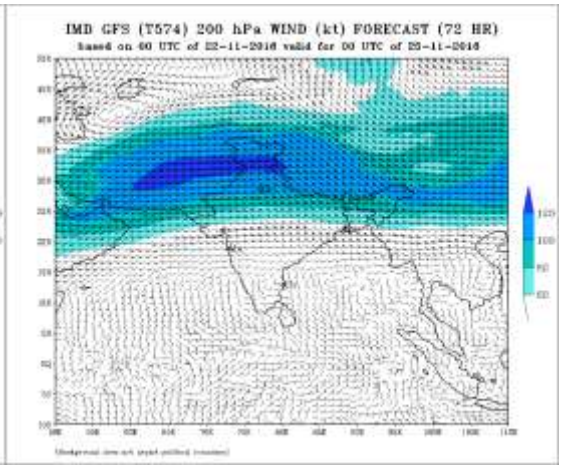

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 26-11-2016

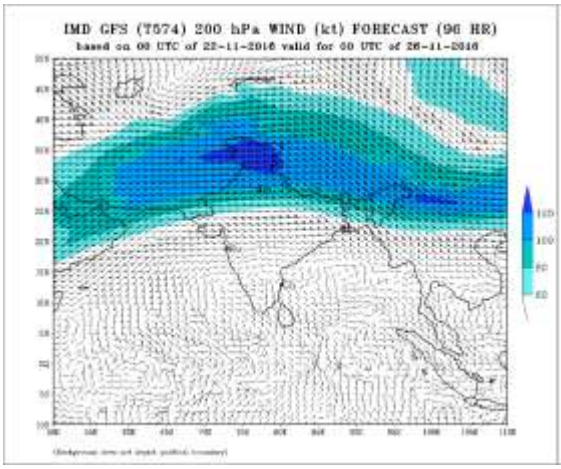

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 27-11-2016

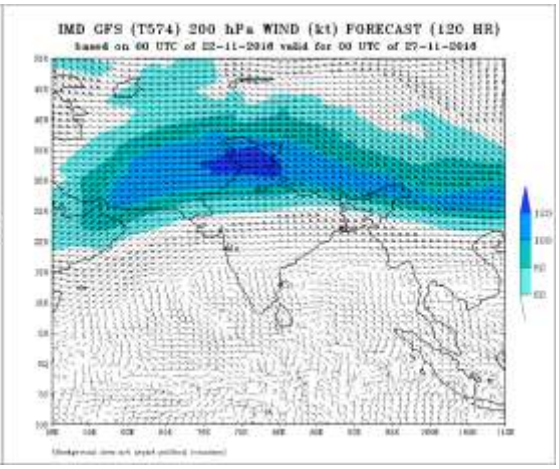

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 22-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 23-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 24-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 25-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 26-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 22-11-2016 valid for 00 UTC of 27-11-2016

FDP (Cyclone) NOC Report Dated 23rd November, 2016

Synoptic features:

Yesterday's trough of low at mean sea level over south Andaman Sea and neighbourhood now lies over southeast Bay of Bengal (BOB) and adjoining south Andaman Sea and the trough of low at mean sea level from Comorin area to south Konkan coast persists.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of BOB and Andaman Sea. It is slightly less 26-28˚C over north and adjoining parts of eastcentral BOB.

The SST over Arabian Sea (AS) is between 26-28˚C over most areas of north and westcentral AS. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast. SST is 28-30˚C over remaining parts of Arabian Sea.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of BoB and Andaman Sea, except over south Andaman Sea and adjoining southeast BoB & equatorial region, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over north BoB of Bengal and also in some parts of westcentral BoB.

TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala coast and over Comorin area where TCHP is around 100 kJ/cm^2.

Relative Vorticity:

There persists an east-west oriented low level relative vorticity area of about 25x10^{-6} second^{-1} over equatorial region and adjoining south BOB with small pockets of vorticity 40-50 x10^{-6} second^{-1} over equatorial region and adjoining parts of southeast BOB, Comorin area and southwest AS.

Convergence:

There is a small zone of positive convergence 5-10x10^{-6} s^{-1} over Malay Peninsula, south BoB and south Andaman Sea. Another zone of positive convergence 5-10x10^{-6} s^{-1} is seen over Comorin and Kerala coast.

No significant zone of positive low level convergence over AS. An elongated zone of vorticity 5x10^{-6} s^{-1} is seen over eastcentral and adjoining westcentral AS.

Divergence:

An area of positive upper level divergence of about 5x10^{-6} s^{-1} lies over north Andaman Sea. An elongated zone of positive upper level divergence of about 5-10x10^{-6} s^{-1} lies over equatorial & adjoining south BOB.

An elongated zone of positive divergence 10-20 x10^{-6} s^{-1} lies over southeast and adjoining equatorial region.

Wind Shear:

Wind shear is 15-20 kts over most parts of south, central BOB and Andaman Sea. It is increasing towards north.

Wind shear is around 10-20 kts over most parts of south and central AS. It is increasing towards north.

Wind Shear Tendency:

There is decreasing tendency of 5-10 kts over south, east BOB and Andaman Sea.

There is decreasing tendency of 5-10 kts over parts of westcentral, northeast and southeast AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over southeast BOB and Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over southeast AS south of latitude 10.0^{0}N and Comorin.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 14^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 2 with amplitude more than one and would continue in same phase for next 5 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis based on 00 UTC of 23rd November 2016 shows development of a low level cyclonic circulation over southeast AS moving westwards without further intensification till 30th. It is intensifying from 1st December over southwest AS.

NCEP-GFS: The model charts based on 00 UTC of 23rd November 2016 shows development of a low level cyclonic circulation over southwest BOB and adjoining equatorial region on 26th becoming less marked on 28th November.

ECMWF: The model analysis based on 00 UTC of 23rd November 2016 shows feeble low level cyclonic circulations in the east-west extending shear zone around 5.0^0N for next 5 days.

WRF: The WRF model based on 00 UTC of 23rd November 2016 shows no significant development over the region.

JMA: No system expected over north Indian Ocean during next three days.

Meteo-France ARP Model: No system expected over north Indian Ocean during next three days.

NCMRWF-NCUM: The analysis based on 00 UTC of 23rd November shows no significant circulation over BOB for next 10 days.

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 23rd November shows no significant circulation over BOB for next 3 days.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 23rd November shows no significant development over BOB. However, it also shows development of low over south Indian Ocean on 24th. Model forecast not available thereafter.

IITM-GEFS: The analysis based on 00 UTC of 23rd shows no low pressure system over north Indian Ocean for next 5 days.

IITM -GFS T1534: The analysis based on 00 UTC of 23rd shows no low pressure system over north Indian Ocean for next 5 days.

MME track & SCIP intensity:

At present, No low pressure system persist over north Indian Ocean.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 23rd November 2016 suggests development of a cyclonic circulation over southeast AS and adjoining southwest BoB on 24th moving nearly northwestwards till 27th towards southwest AS without intensification. .

Summary and Conclusion:

A few cyclonic circulations/ feeble lows are predicted by a few models along the east-west oriented shear zone roughly running along 5^0N across north Indian Ocean. The development of a depression/cyclonic storm is also predicted by a few models over south Indian Ocean, which is not favourable for intensification/genesis of any system over north Indian Ocean.

Development of the above systems need to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Dated: 23.11.2016

Synoptic observation:

Region	Date/Time (UTC)		
	22/12	23/00	23/03
India	42	29	43
Coastal stations			
WB	10	3	8
Odisha	6	5	6
AP	10	10	10
Tamil Nadu	9	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	11	10
Myanmar	0	2	1
Thailand	2	2	2
Sri Lanka	6	7	8

AWS:

Region	Date/Time (UTC)		
	22/12	23/00	23/03
WB	4	1	5
Odisha	3	1	6
AP	7	2	5
Tamil Nadu	26	11	21
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 22 / 11 /2016 : 18 /43
- **No. of Ascents reaching 250 hPa levels: 17 , MISDA:- 4**

- **RS/RW** (00Z) of 23 / 11 /2016 : 29 /43
- **No. of Ascents reaching 250 hPa levels: 26 , MISDA: 3**

No. of PILOT Ascents

22/12Z	23/00Z
24	18

Buoy Data

22/12Z	23/00Z	23/03Z
10	11	11

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**22.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /22.11.2016 : 5

No. of Ascents reaching 250 hPa level = 5

MISDA : 3

12Z /22.11.2016 : 3

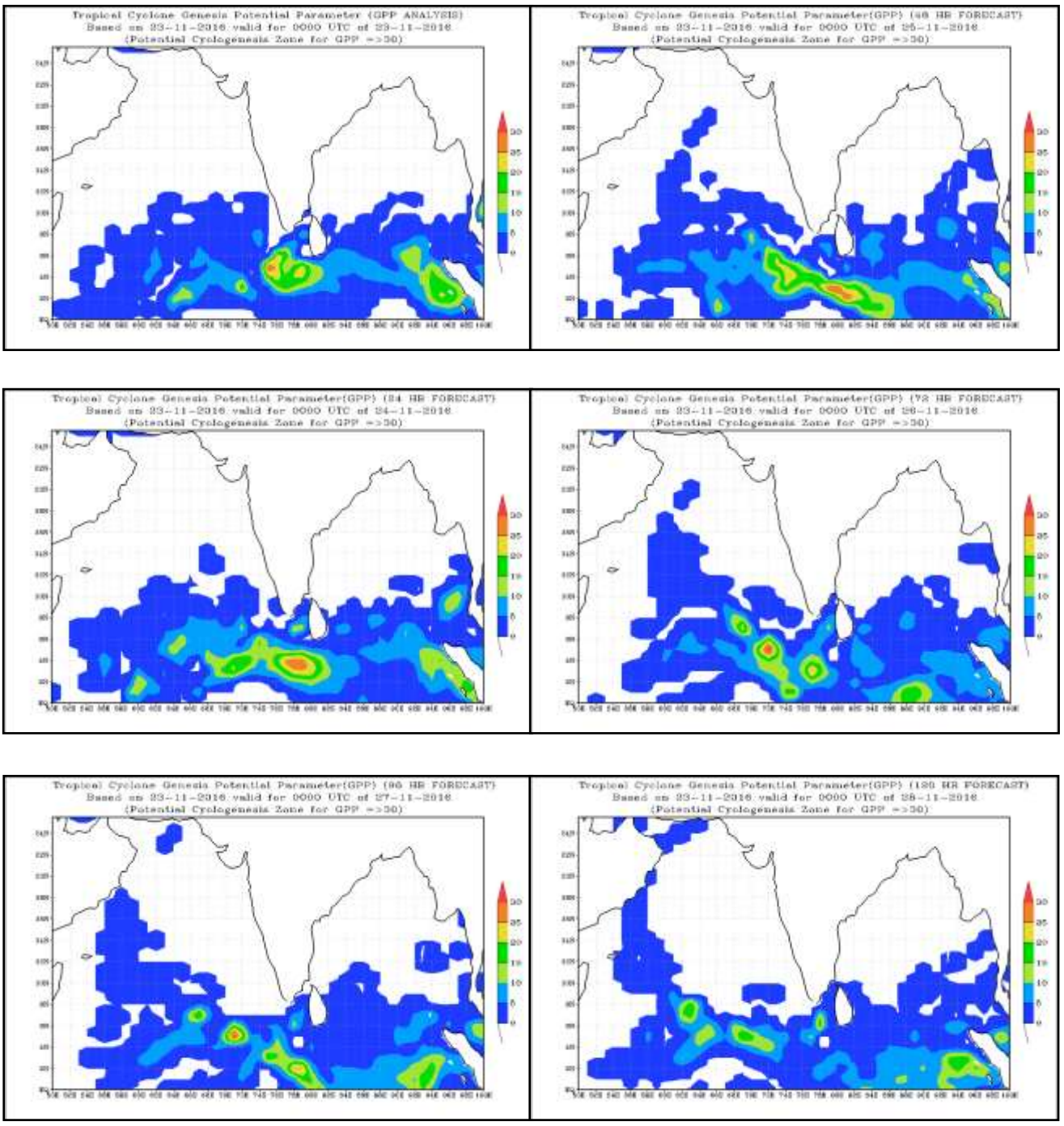
No. of Ascents reaching 250 hPa level = 3

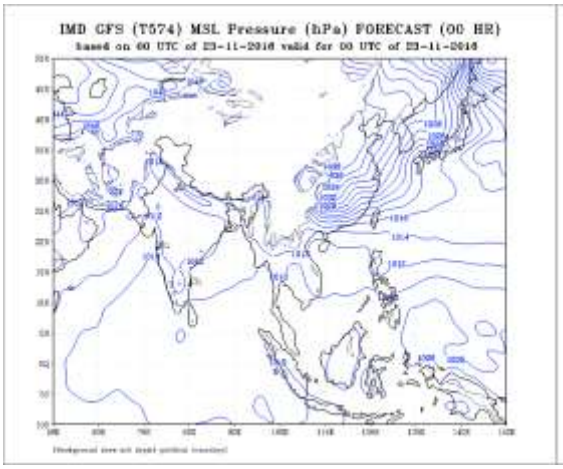
MISDA : 5

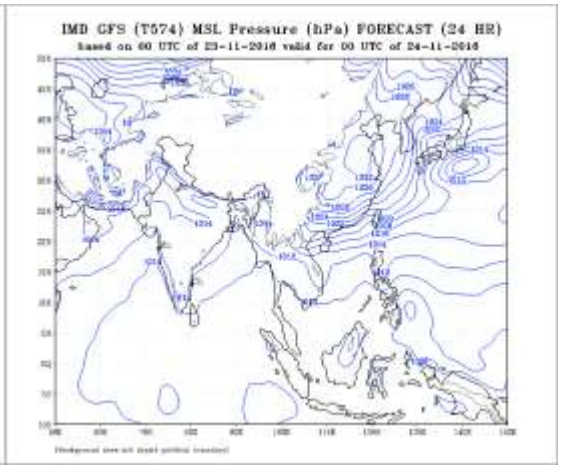
No. of PILOT Ascents:

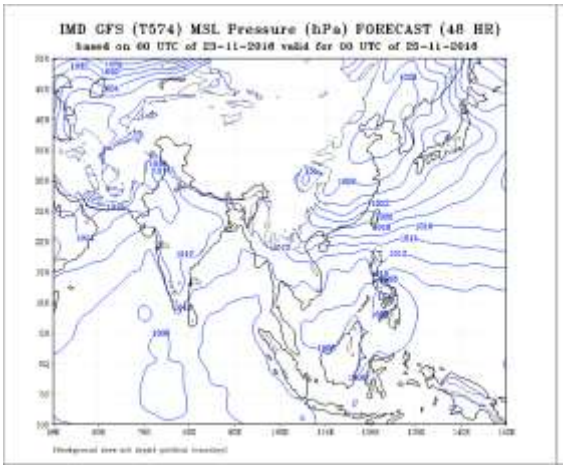
22.11.2016	
06Z	18Z
3	4

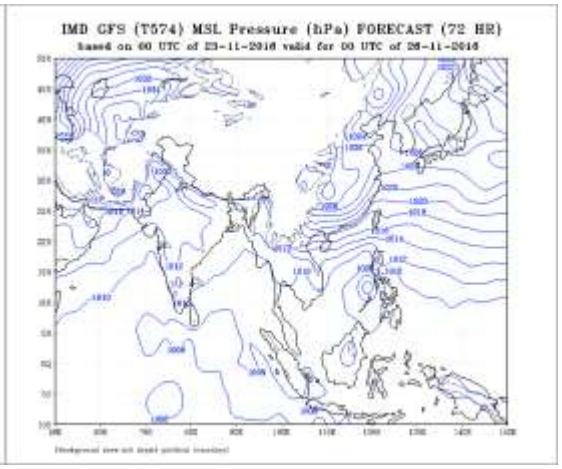
Annexure-II

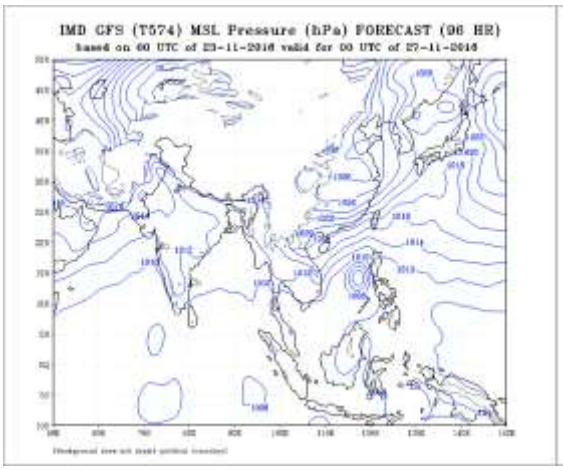

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(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 23-11-2016 valid for 0000 UTC of 28-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

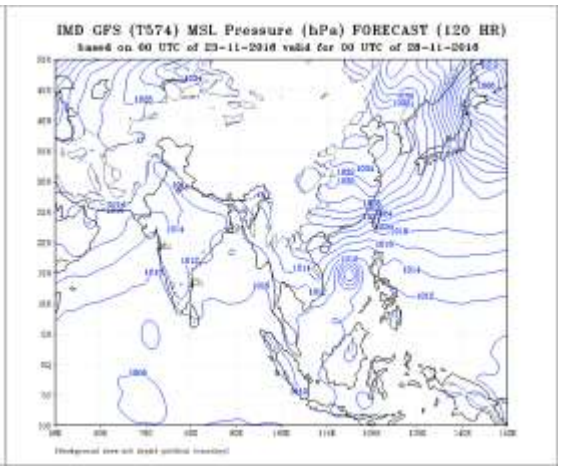

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 23-11-2016

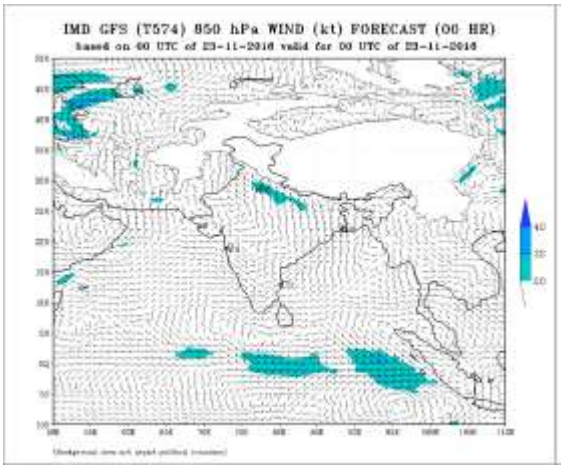

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 24-11-2016

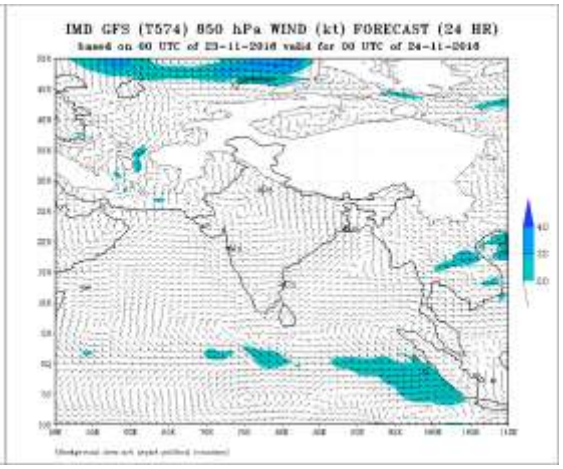

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 25-11-2016

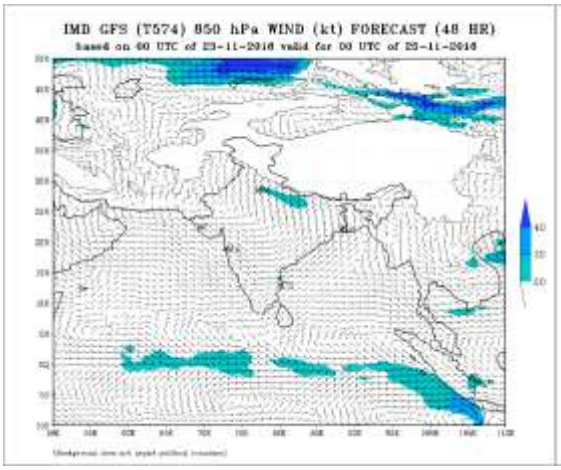

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 26-11-2016

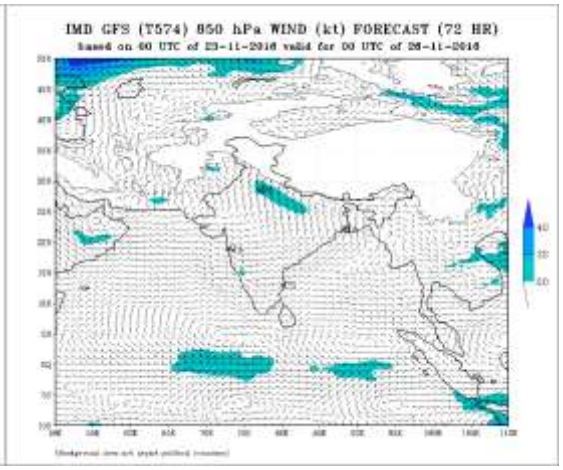

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 27-11-2016

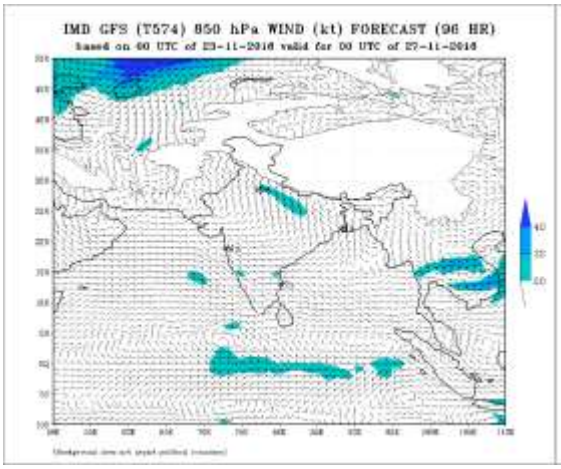

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 28-11-2016

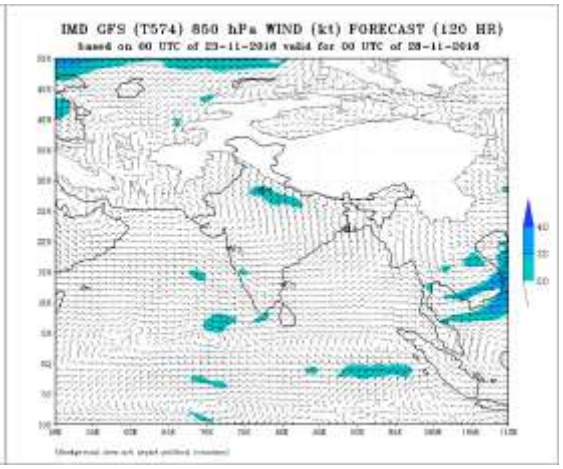

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 23-11-2016

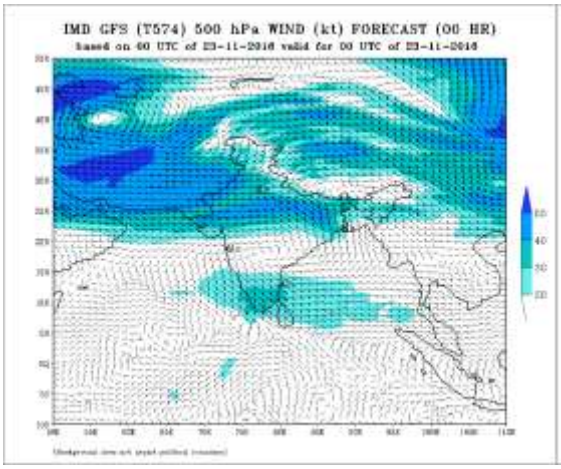

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 24-11-2016

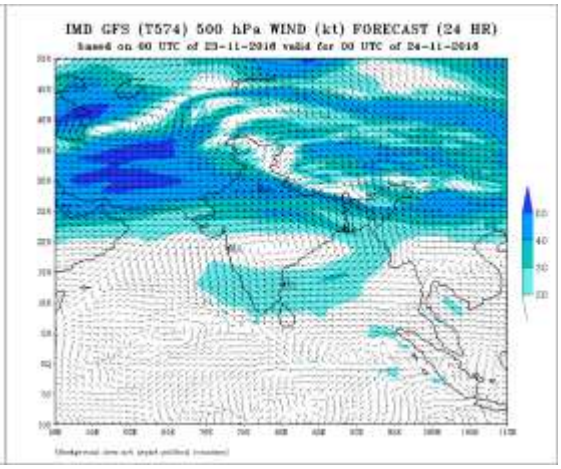

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 25-11-2016

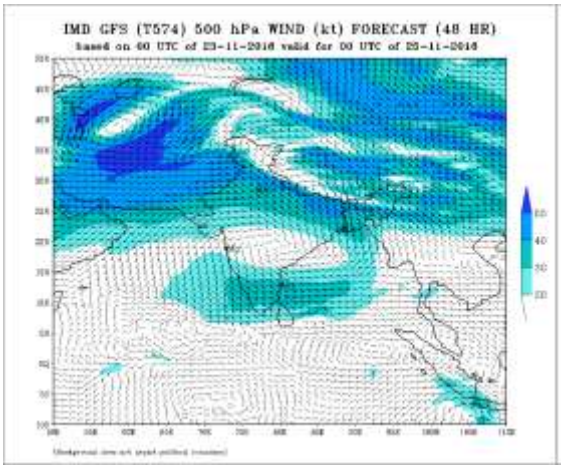

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 26-11-2016

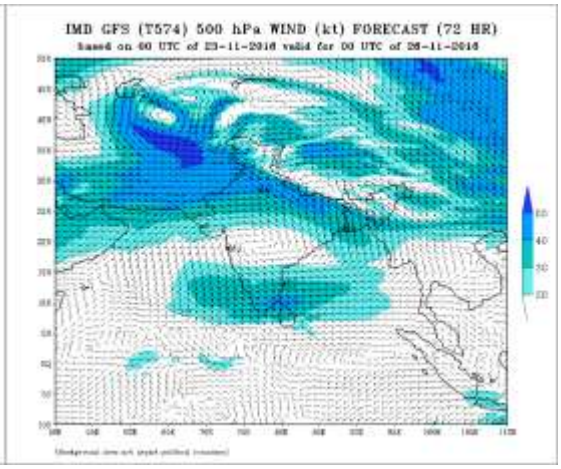

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 27-11-2016

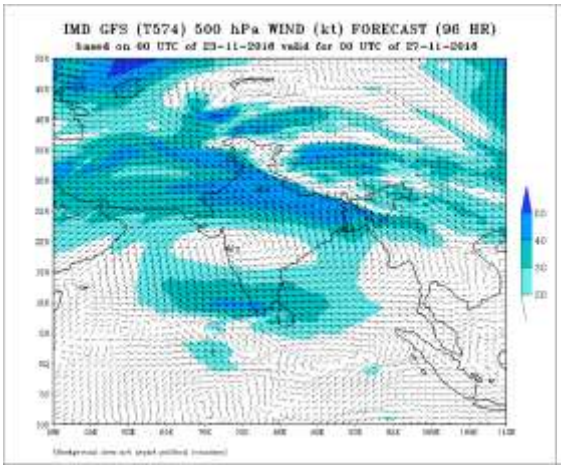

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 28-11-2016

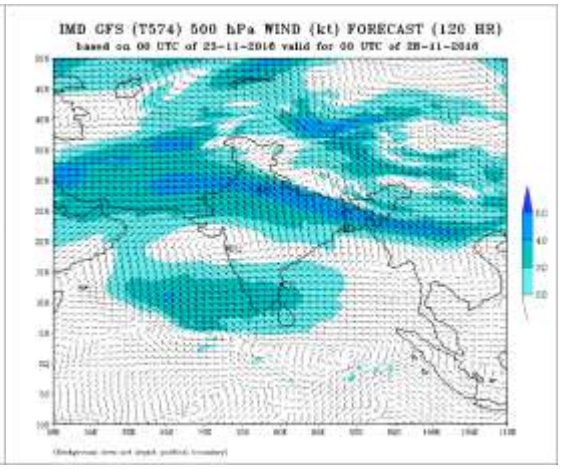

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 23-11-2016

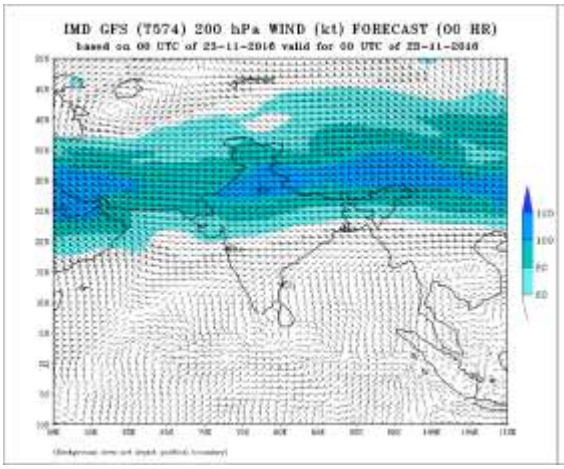

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 24-11-2016

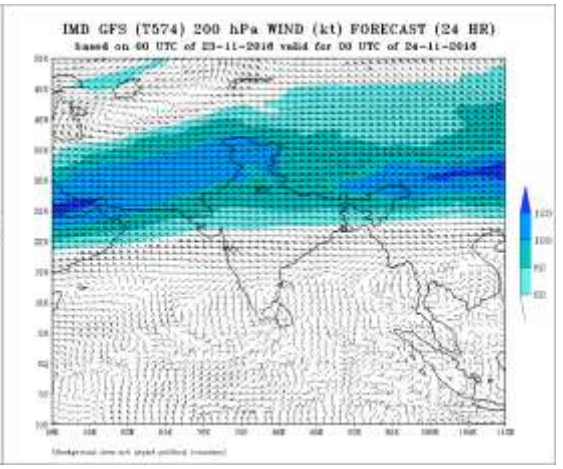

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 25-11-2016

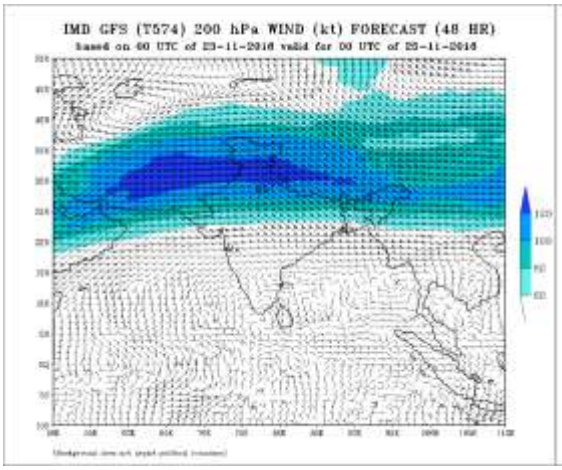

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 26-11-2016

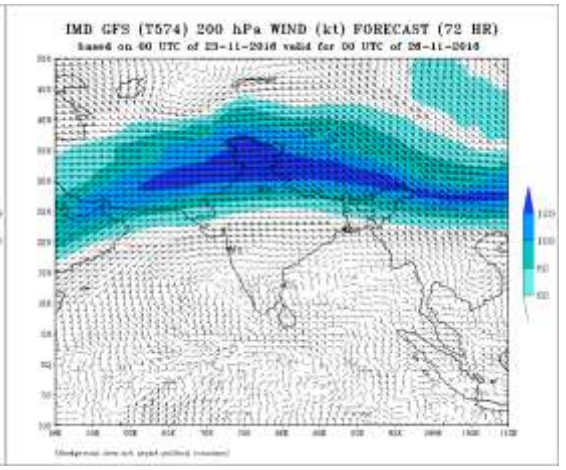

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 27-11-2016

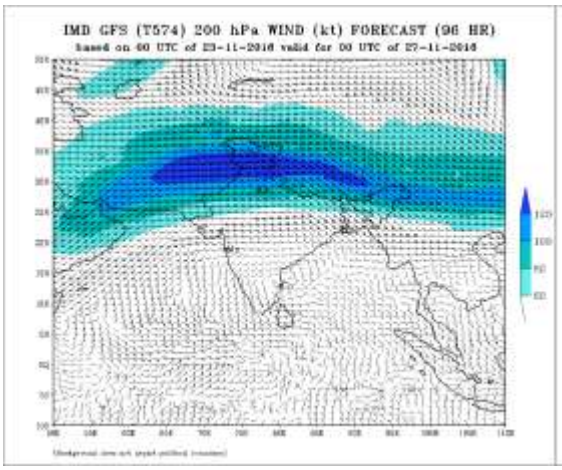

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 28-11-2016

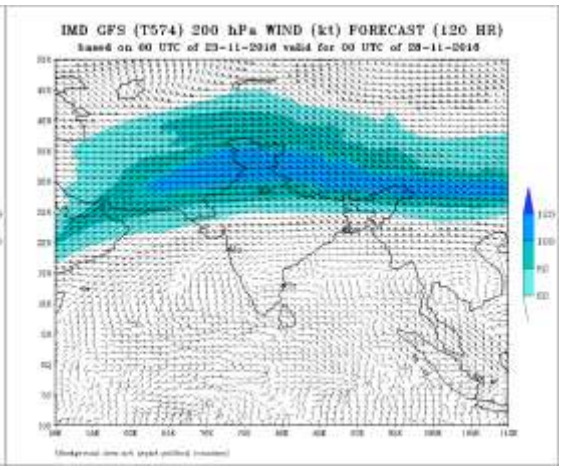

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 23-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 24-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 25-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 26-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 27-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 23-11-2016 valid for 00 UTC of 28-11-2016

FDP (Cyclone) NOC Report Dated 24th November, 2016

Synoptic features:

Yesterday's trough of low at mean sea level over southeast Bay of Bengal (BOB) and adjoining south Andaman Sea now lies over southeast BOB and neighbourhood and the trough of low at mean sea level from Comorin area to south Konkan coast persists.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of BOB and Andaman Sea. It is slightly less 26-28˚C over northwest and adjoining westcentral BOB.

The SST over most parts of west Arabian Sea (AS) is between 26-28˚C. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast. SST is 28-30˚C over most parts of east AS.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of BoB and Andaman Sea except over south Andaman Sea and adjoining southeast BoB & equatorial region, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over north BoB and also in some parts of westcentral BoB.

TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala coast and over Comorin area where TCHP is around 100 kJ/cm^2.

Relative Vorticity:

There persists an east-west oriented low level relative vorticity area of about 25x10^{-6} second^{-1} over equatorial region and adjoining south BOB with small pockets of vorticity 40-50 x10^{-6} second^{-1} over equatorial region and adjoining parts of southeast BOB, Comorin area and southwest AS.

Convergence:

Low level convergence is 5x10^{-6} s^{-1} over Malay Peninsula, south BoB off southwest Srilanka coast.

Low level convergence is 5-10x10^{-6} s^{-1} over westcentral AS and another zone of 5x10^{-6} s^{-1} is seen over parts of southeast AS.

Divergence:

Upper level divergence is about 5x10^{-6} s^{-1} over south Andaman Sea. An elongated zone of positive upper level divergence of about 5-10x10^{-6} s^{-1} lies over equatorial & adjoining Malay Peninsular region.

An elongated zone of positive divergence 10-20 x10^{-6} s^{-1} lies over south AS and adjoining equatorial region.

Wind Shear:

Wind shear is 15-20 kts over most parts of south, central BOB and Andaman Sea. It is increasing towards north.

Wind shear is around 10-20 kts over most parts of south and central AS. It is increasing towards north.

Wind Shear Tendency:

There is decreasing tendency of 5-10 kts over south Andaman Sea and adjoining Malay Peninsular region. Another zone of decreasing tendency (5-10 kts) lies over southwest BOB off Sri Lanka coast.

There is decreasing tendency of 5-10 kts over parts of eastcentral AS. Small pockets of decreasing tendency about 5 kts are also seen over Comorin Area and parts of southeast AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over southeast BOB and Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over southeast AS and Comorin.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 13^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 2 with amplitude more than one and would move to Phase 1 in next 96 hours..

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis based on 00 UTC of 24th November 2016 shows no significant system over NIO for next 6 days. It shows development of low over southwest BOB on 2nd December moving northwards and intensifying into a deep depression on 3rd December.

NCEP-GFS: The model charts based on 00 UTC of 24th November 2016 shows no significant development over the region for next 5 days.

ECMWF: The model analysis based on 00 UTC of 24th November 2016 shows small low pressure systems over the east-west oriented band along 5.0^0N with no further intensification till 30th November. It shows a low over southwest BOB on 1st moving northwestwards with slight intensification on 3rd.

WRF: The WRF model based on 00 UTC of 24th November 2016 shows a feeble circlulation over southeast BOB moving westwards for next 3 days.

JMA: No system expected over north Indian Ocean during next three days.

Meteo-France ARP Model: No system expected over north Indian Ocean during next three days.

NCMRWF-NCUM: The analysis based on 00 UTC of 24thNovember shows no significant circulation over NIO for next 10 days.

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 24th November shows no significant circulation over BOB for next 3 days.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 24th November shows no significant development over BOB for next 2 days.

IITM-GEFS: The analysis based on 00 UTC of 24th shows no low pressure system over north Indian Ocean for next 5 days.

IITM -GFS T1534: The analysis based on 00 UTC of 24th shows no low pressure system over north Indian Ocean for next 5 days.

MME track & SCIP intensity:

At present, no low pressure system persists over north Indian Ocean.

Dynamical statistical models:

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 24th November 2016 suggests no significant system over NIO for next 5 days. .

Summary and Conclusion:

No low pressure system is expected during next five days. The development of a low over southwest Bay on 1st and subsequent intensification needs to be monitored

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Dated: 24.11.2016

Synoptic observation:

Region	Date/Time (UTC)		
	23/12	**24/00**	**24/03**
India	44	32	45
Coastal stations			
WB	9	4	9
Odisha	6	5	6
AP	10	12	11
Tamil Nadu	12	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	10	11
Myanmar	2	2	5
Thailand	3	3	3
Sri Lanka	9	9	10

AWS:

Region	Date/Time (UTC)		
	23/12	**24/00**	**24/03**
WB	4	1	5
Odisha	4	1	3
AP	2	6	6
Tamil Nadu	26	8	19
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 23 / 11 /2016 : 16 /43
- **No. of Ascents reaching 250 hPa levels: - , MISDA:- 19**

- **RS/RW** (00Z) of 24 / 11 /2016 : 25 /43
- **No. of Ascents reaching 250 hPa levels: , MISDA: 8**

No. of PILOT Ascents

23/12Z	24/00Z
23	19

Buoy Data

22/12Z	23/00Z	23/03Z
5	6	4

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**23.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /23.11.2016 : 4

No. of Ascents reaching 250 hPa level = 4

MISDA : 4

12Z /23.11.2016 : 3

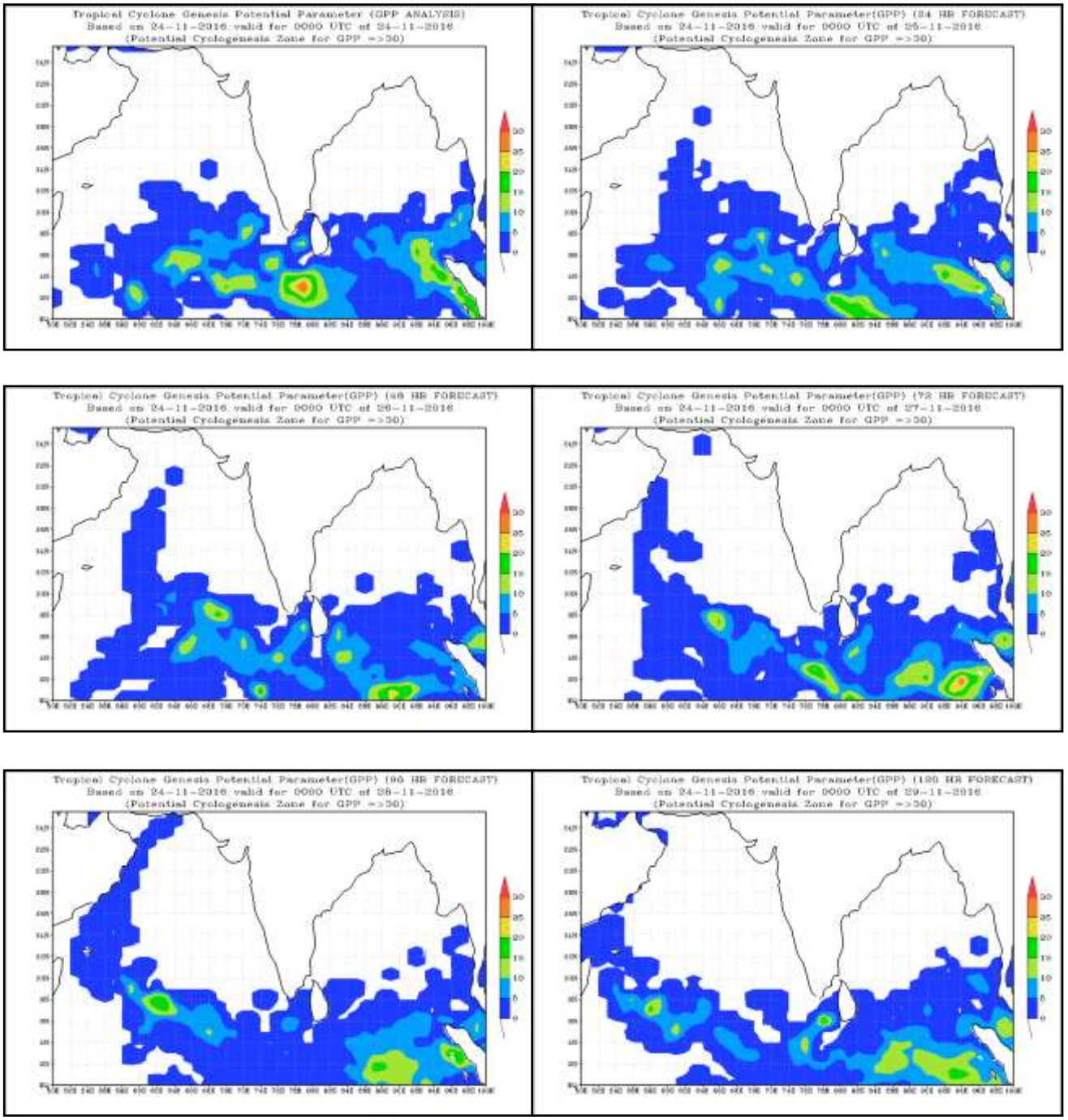
No. of Ascents reaching 250 hPa level = 3

MISDA : 5

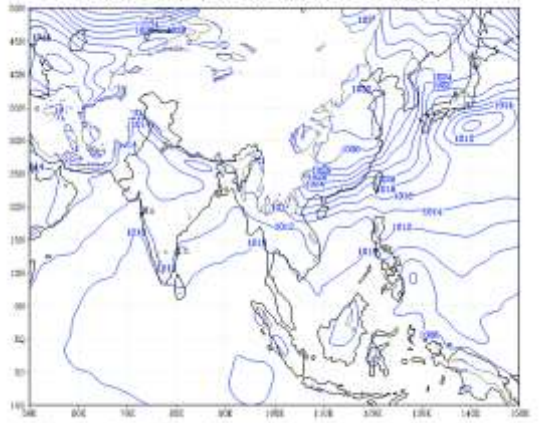
No. of PILOT Ascents:

23.11.2016	
06Z	18Z
4	5

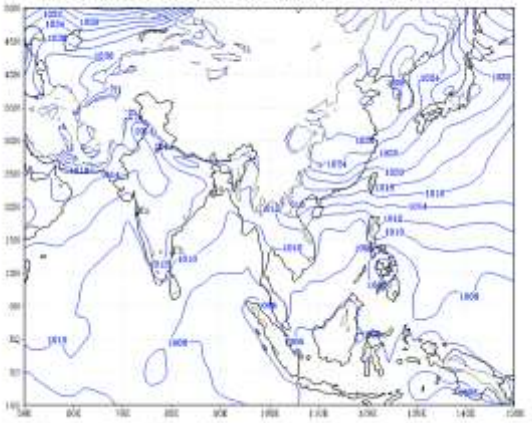
Annexure-II


Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 24-11-2016 valid for 0000 UTC of 24-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 24-11-2016 valid for 0000 UTC of 25-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 24-11-2016 valid for 0000 UTC of 26-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 24-11-2016 valid for 0000 UTC of 27-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 24-11-2016 valid for 0000 UTC of 28-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 24-11-2016 valid for 0000 UTC of 29-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

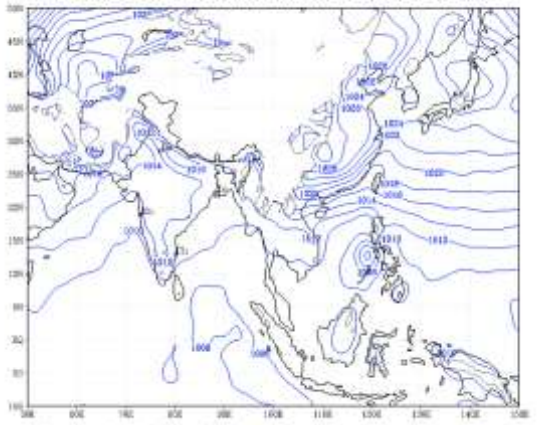
IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 24-11-2016



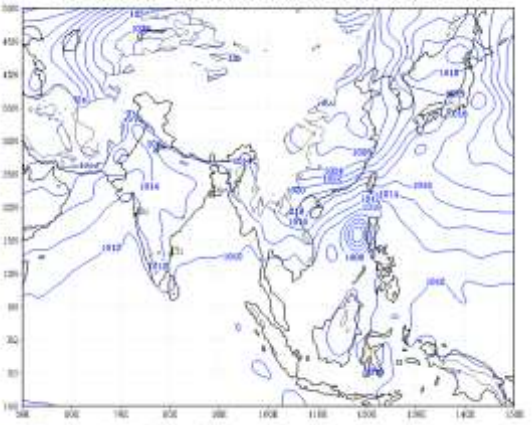
IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 25-11-2016



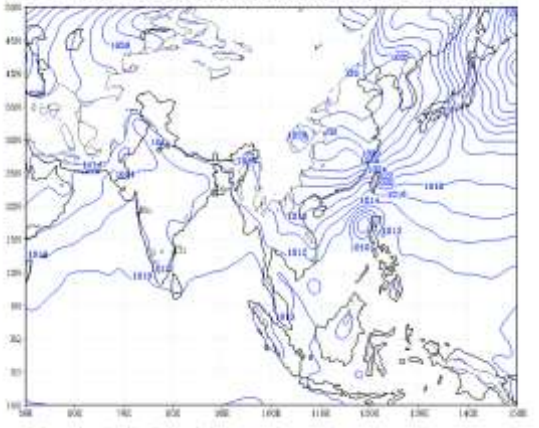
IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 26-11-2016



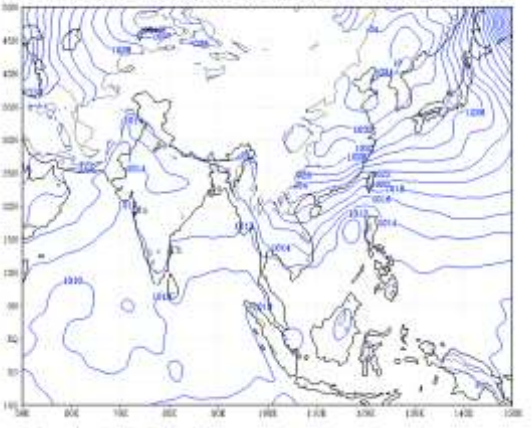
IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 27-11-2016

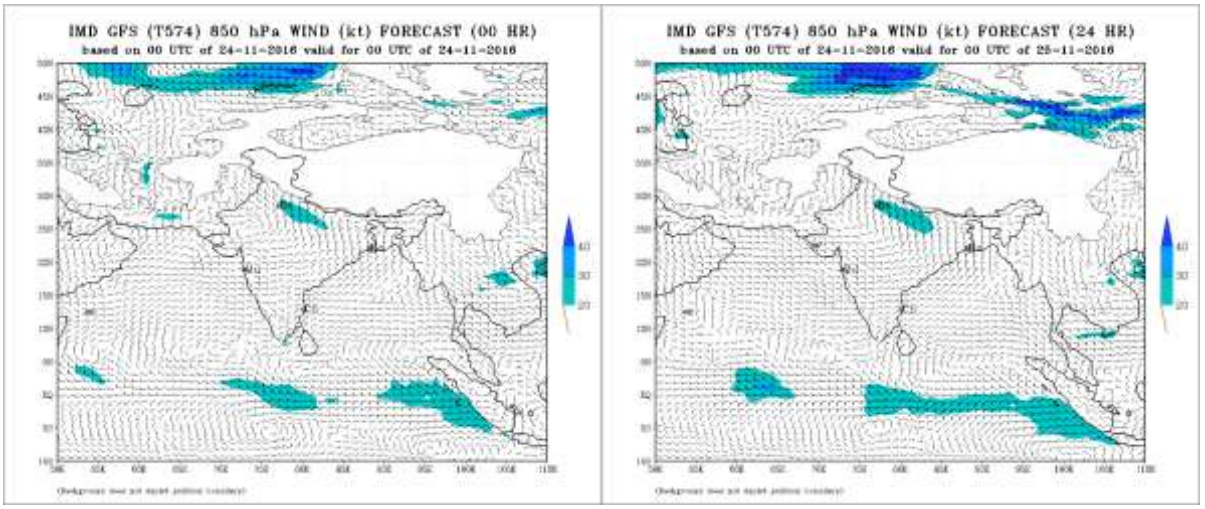


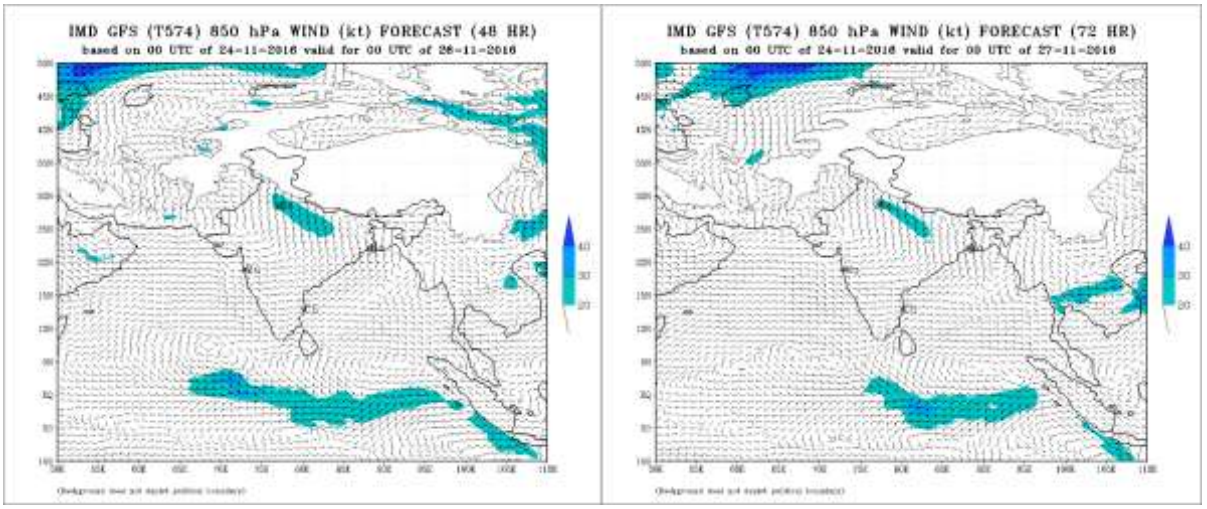
IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 28-11-2016

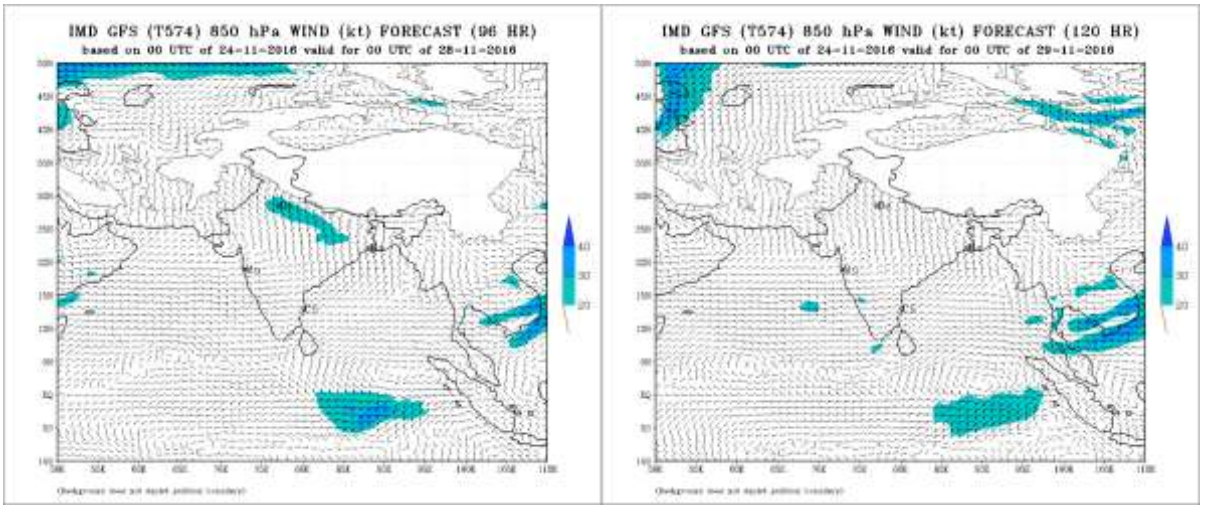


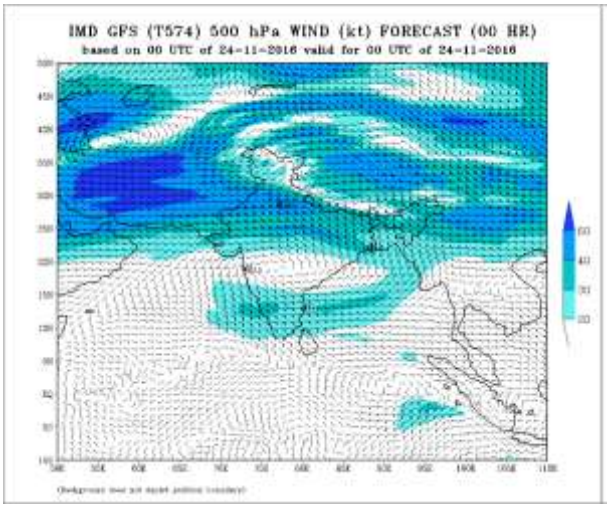
IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 29-11-2016

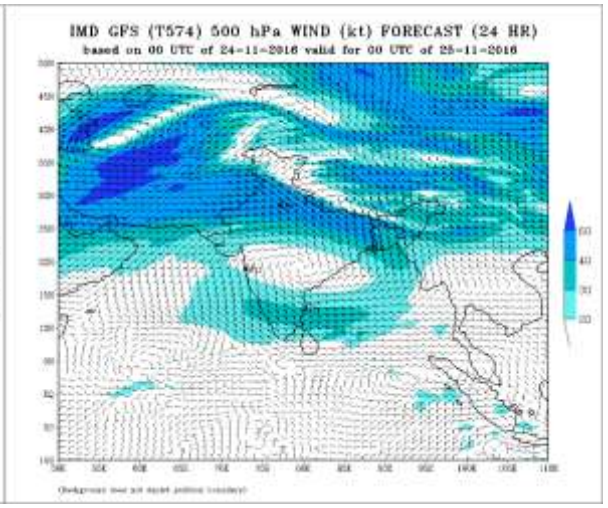


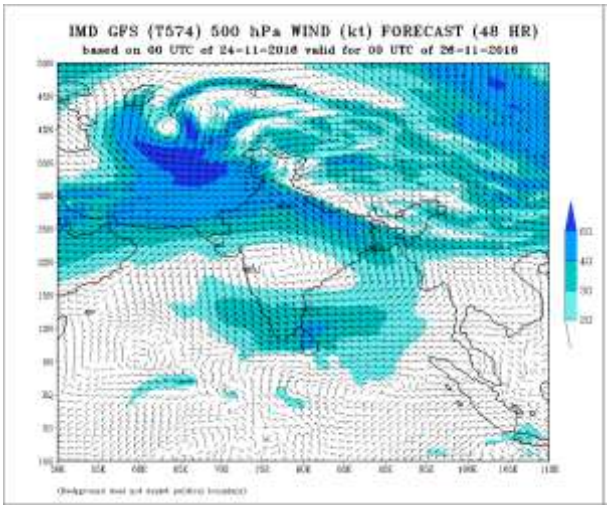

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 24-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 25-11-2016

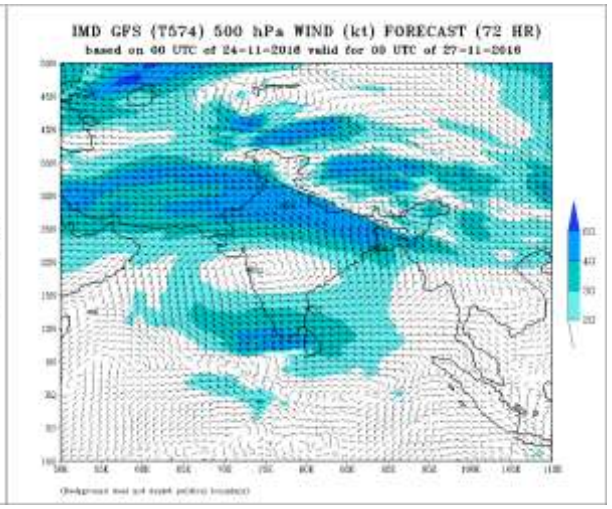

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 26-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 27-11-2016

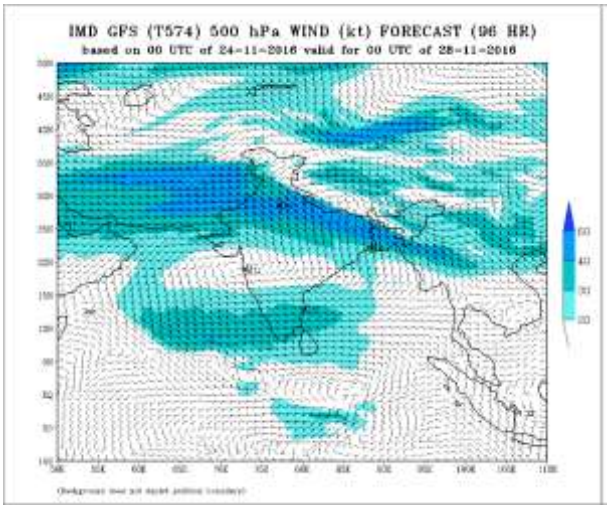

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 28-11-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 29-11-2016

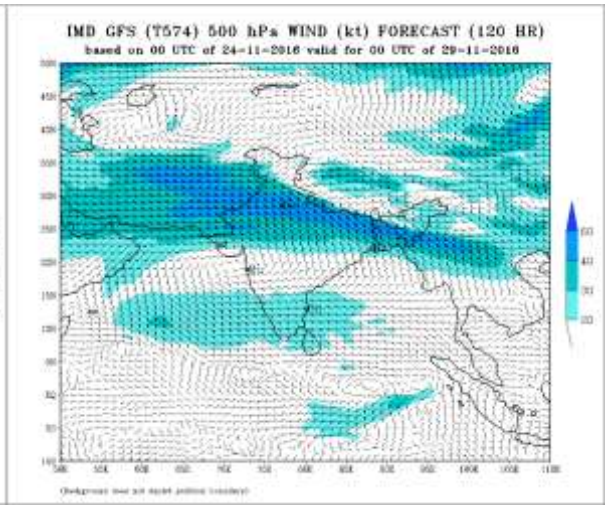

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 24-11-2016

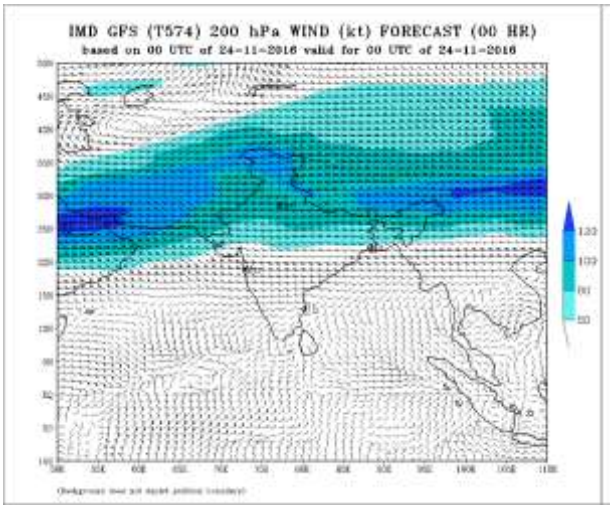

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 25-11-2016

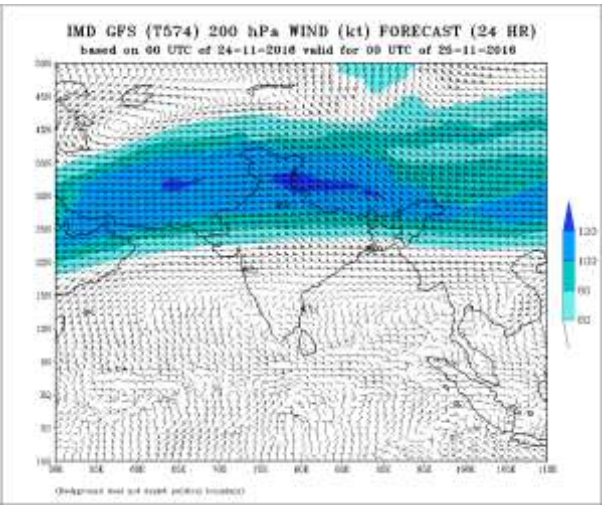

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 26-11-2016

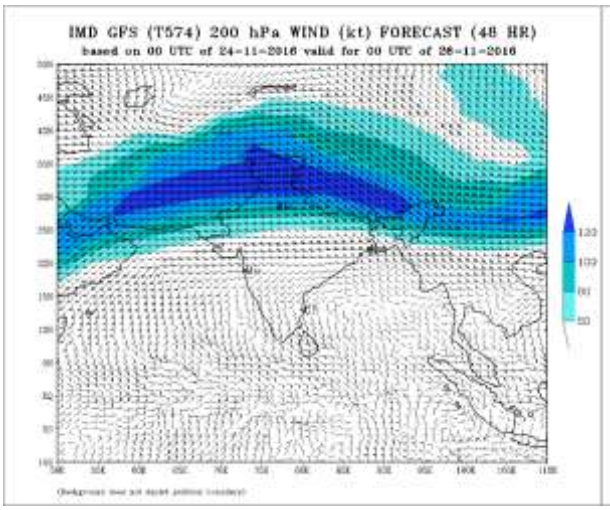

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 27-11-2016

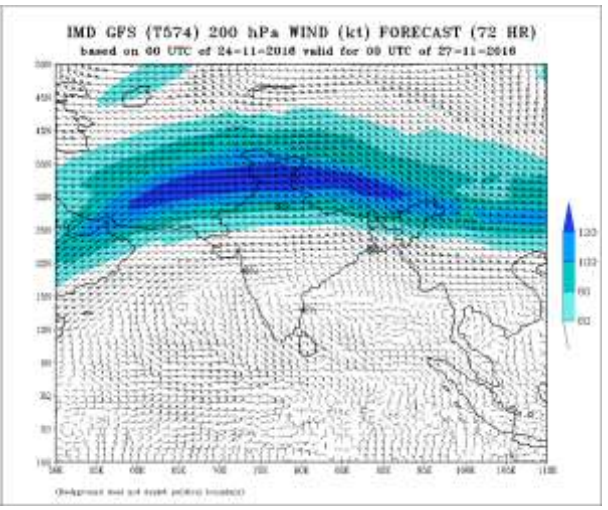

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 28-11-2016

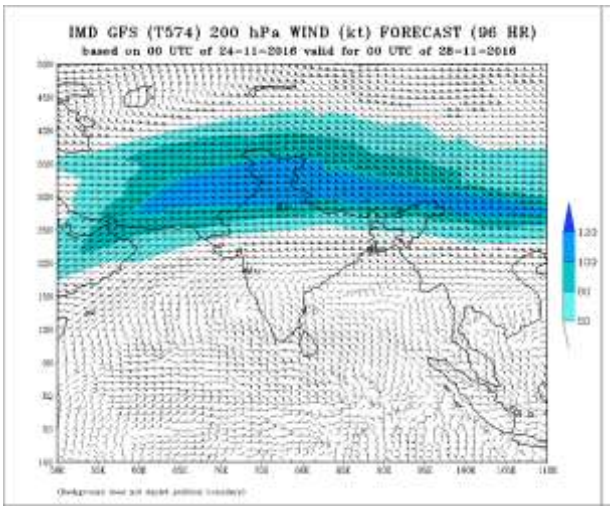

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 29-11-2016

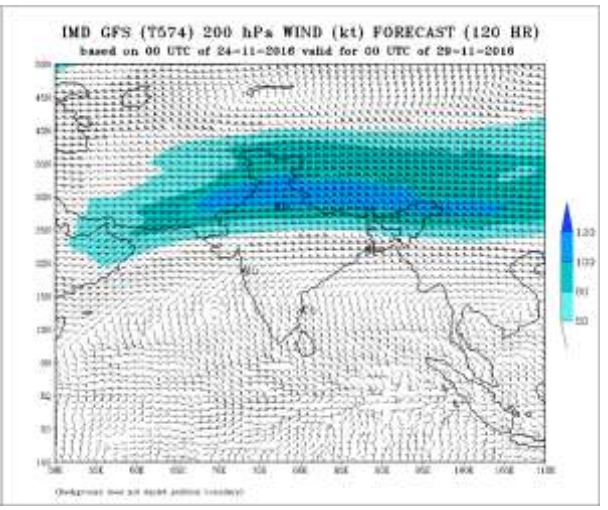

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 24-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 25-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 26-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 27-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 28-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 24-11-2016 valid for 00 UTC of 29-11-2016

FDP (Cyclone) NOC Report Dated 25th November, 2016

Synoptic features:

Yesterday's trough of low at mean sea level over southeast BOB and neighbourhood persists and the trough of low at mean sea level from Comorin area to south Konkan coast now runs from Maldives area to Karnataka coast.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of BOB and Andaman Sea. It is slightly less 26-28˚C over northwest and adjoining westcentral BOB.

The SST over most parts of west Arabian Sea (AS) is between 26-28˚C. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast. SST is 28-30˚C over most parts of east AS.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of BoB and Andaman Sea except over south Andaman Sea and adjoining southeast BoB & equatorial region, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over north BoB and also in some parts of westcentral BoB.

TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala coast and over Comorin area where TCHP is around 100 kJ/cm^2.

Relative Vorticity:

There persists an east-west oriented low level relative vorticity area of about 25x10^{-6} second^{-1} over equatorial region and adjoining south BOB with small pockets of vorticity 40-50 x10^{-6} second^{-1} over parts of southeast BOB, southwest BOB, Comorin, Maldives and southwest AS.

Convergence:

Low level convergence is 5-10x10^{-6} s^{-1} over parts of south Andaman Sea, equatorial region and adjoining southeast BoB, southwest BOB off southeast Srilanka coast.

An elongated positive low level convergence zone of 5-10x10^{-6} s^{-1} over eastcentral AS and zones of positive convergence 5x10^{-6} s^{-1} are also seen over parts of Maldives and eastcentral AS along Karnataka coast.

Divergence:

An elongated zone of positive upper level divergence of about 5-10x10^{-6} s^{-1} lies over equatorial and adjoining southwest BOB to southeasst AS. A zone of positive upper level divergence of 5-10x10^{-6} s^{-1} lies over southwest BOB off Sri Lanka. Another zone of 5x10^{-6} s^{-1} lies over equatorial region and adjoining south Andaman Sea.

A small zone of positive divergence 5 x10^{-6} s^{-1} lies over eastcentral AS.

Wind Shear:

Wind shear is 5-10 kts over south Andaman Sea and adjoining southeast BOB. It is 10-20 kts over southwest BoB and central BoB. It is increasing towards north.

Wind shear is around 10-15 kts over most parts of southeast and eastcentral AS. It is around 15-20 kts over most parts of southwest and westcentral AS. It is increasing towards north.

Wind Shear Tendency:

There is decreasing tendency of 5-10 kts over Andaman Sea, most parts of southeast & adjoining southwest BOB, westcentral and nrthwest BoB

There is increasing tendency of 5-10 kts over Comorin Area and parts of southeast & adjoining southwest AS. Another zone of increasing tendency lies over westcentral AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over south BOB south of latitude 11.5^{0}N and south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over southeast AS.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 12^0N latitude over BoB.
M.J.O. Index: MJO index is in Phase 2 with amplitude more than one and would continue in Phase 2 in next 72 hours with amplitude less than 1.
Storms and Depression over South China Sea/ South Indian Ocean: NIL.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis based on 00 UTC of 25th November 2016 shows no significant system over NIO for next 5 days. It shows development of low over southeast BOB on 28th November moving west to northwestwards, intensifying into a depression on 1st December near Sri Lanka. It would move west-northwestwards thereafter without further intensification.
NCEP-GFS: The model charts based on 00 UTC of 25th November 2016 shows a low over southwest BOB and adjoining equatorial region on 29th becoming insignificant on 30th.
ECMWF: The model analysis based on 00 UTC of 25th November 2016 shows small low pressure systems over the east-west oriented band along 5.0^0N with no further intensification till for next 5 days.
WRF: The WRF model based on 00 UTC of 25th November 2016 shows no circulation over the region for next 3 days.
JMA: No system expected over north Indian Ocean during next three days.
Meteo-France ARP Model: It shows development of low over southwest and equatorial region on 26th moving northeastwards and concentrating into a depression on 28th over northeast BOB.
NCMRWF-NCUM: The analysis based on 00 UTC of 25th November shows no significant circulation over NIO for next 5 days.
NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 25th November shows no significant circulation over NIO for next 3 days.
NCMRWF-NEPS Model: The analysis based on 00 UTC of 25th November shows no significant development over NIO for next 5 days. It however shows development of a depression over south Indian Ocean on 26th November, intensifying into DD on 27th and becoming insignificant on 29th.
IITM-GEFS: The analysis based on 00 UTC of 25th shows 2-3 lows over north Indian Ocean and adjining equatorial region for next 4 days.
IITM -GFS T1534: The analysis based on 00 UTC of 25th shows no low pressure system over north Indian Ocean for next 5 days.
Dynamical statistical models:
IMD Genesis Potential Parameter (GPP):
Analysis and forecasts of GPP based on 00 UTC of 25th November 2016 suggests no significant system over NIO for next 5 days. .
Summary and Conclusion:
A low pressure area is likely to form over southwest Bay of Bengal around 28th/29th November as predicted by a few models. It needs to be monitored.
Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : NO IOP for next five days

Annexure-I

Status of observational system:

Dated: 25.11.2016

Synoptic observation:

Region	Date/Time (UTC)		
	24/12	**25/00**	**25 /03**
India	31	28	36
Coastal stations			
WB	9	3	9
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	5	7	8
Puducherry	1	1	1
A & N	0	0	0
Bangladesh	0	12	15
Myanmar	0	0	0
Thailand	3	3	3
Sri Lanka	5	7	8

AWS:

Region	Date/Time (UTC)		
	24 /12	**25 /00**	**25 /03**
WB	2	2	4
Odisha	1	1	4
AP	5	3	5
Tamil Nadu	16	3	9
Puducherry	0	0	0
A & N	0	0	0

- **RS/RW** (12Z) of 24/11//2016 : 17 /43
- **No. of Ascents reaching 250 hPa levels:17 , MISDA:- 6**

- **RS/RW** (00Z) of 25/11 /2016 : 35 /43

- **No. of Ascents reaching 250 hPa levels: 35 , MISDA: 5**

No. of PILOT Ascents

24 /12Z	**25 /00Z**
21	12

Buoy Data

24 /12Z	**25 /00Z**	**25/03Z**
11	11	11

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**24.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**19**	**20**

No. of RS/RW Ascents

00Z /24.11.2016 : 6

No. of Ascents reaching 250 hPa level = 6

MISDA : 2

12Z /24.11.2016 : 3

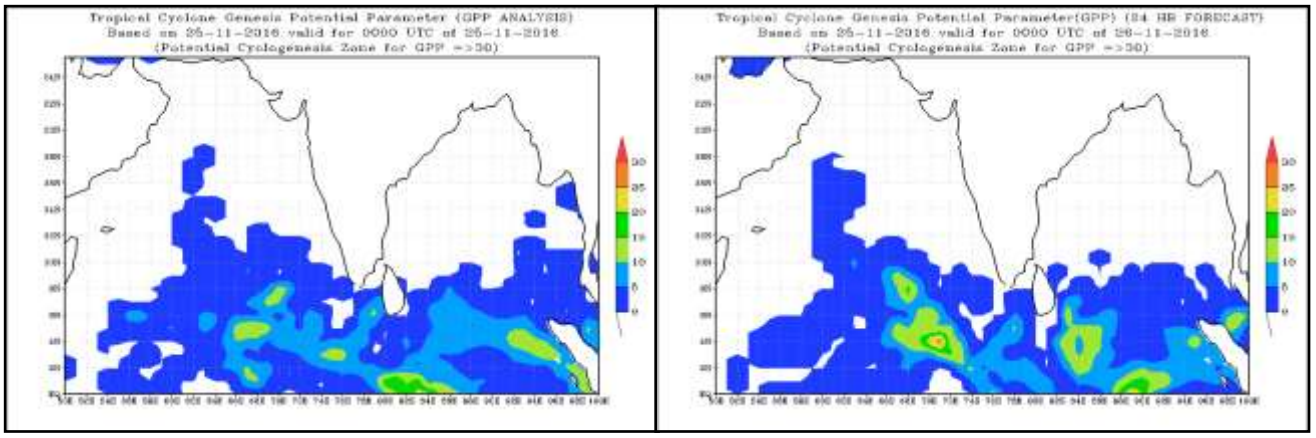
No. of Ascents reaching 250 hPa level = 3

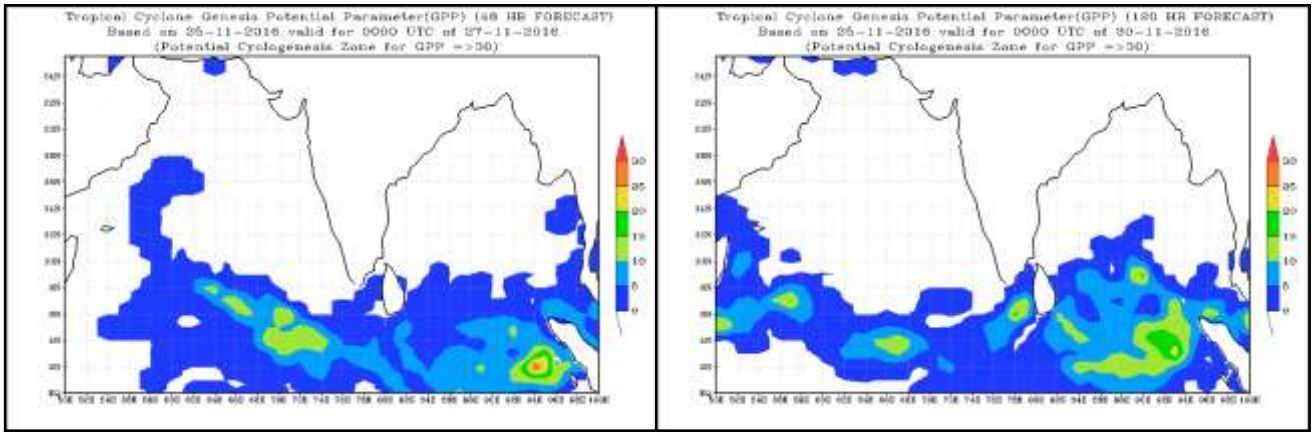
MISDA : 5

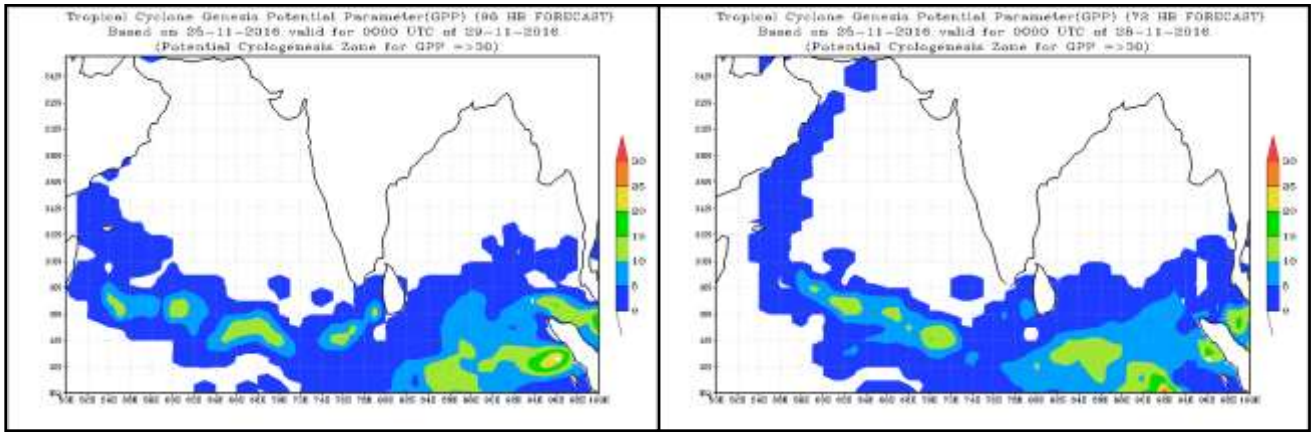
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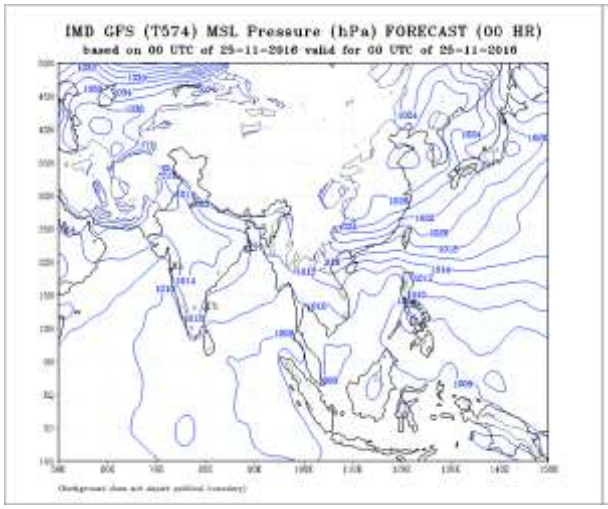
24.11.2016	
06Z	18Z
3	4

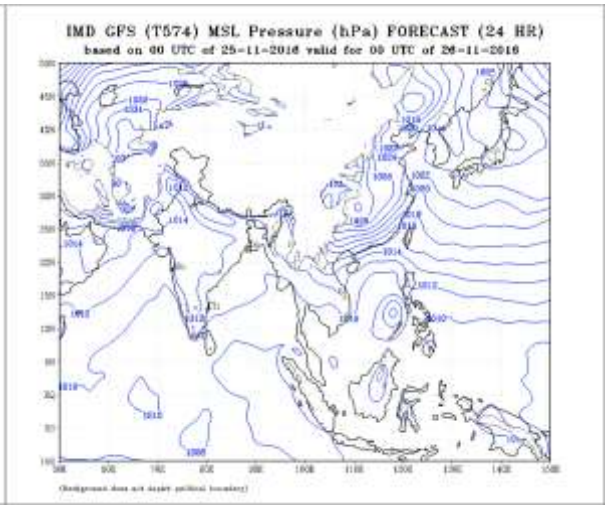
Annexure-II

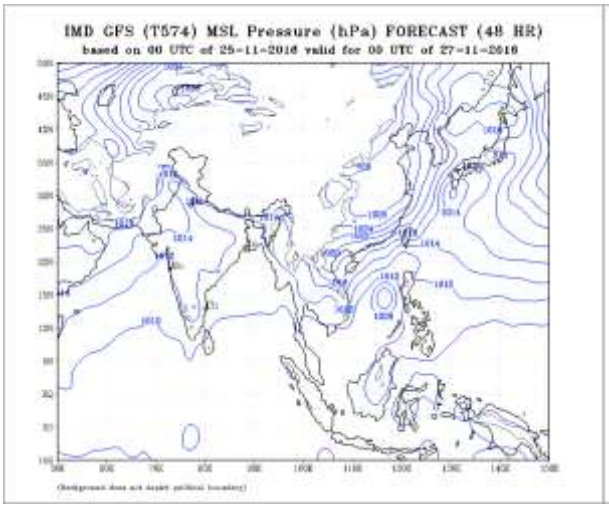

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 25-11-2016 valid for 0000 UTC of 25-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 25-11-2016 valid for 0000 UTC of 26-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

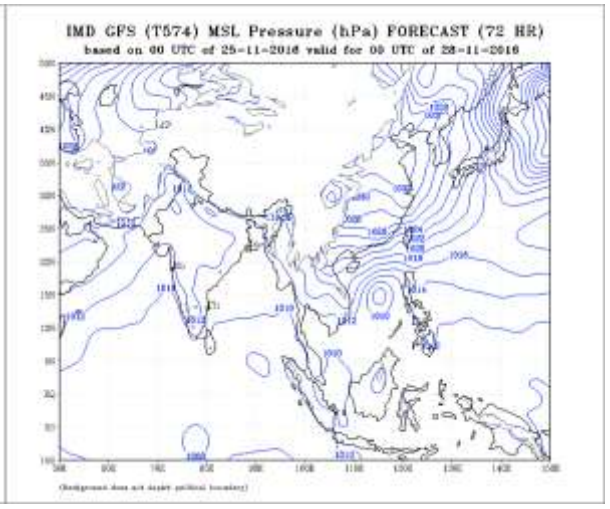

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 25-11-2016 valid for 0000 UTC of 27-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 25-11-2016 valid for 0000 UTC of 30-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

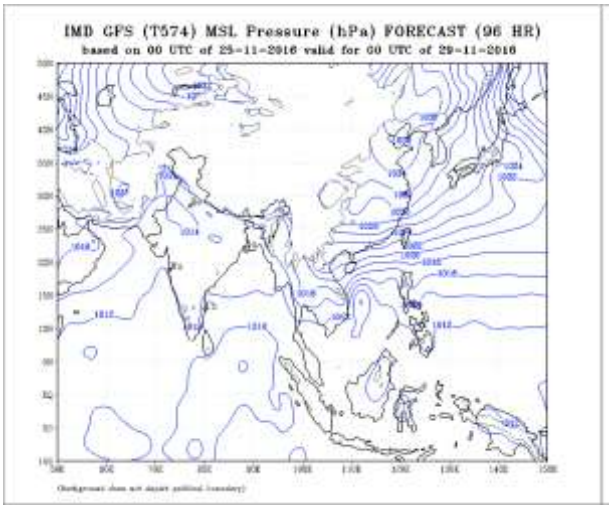

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 25-11-2016 valid for 0000 UTC of 29-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 25-11-2016 valid for 0000 UTC of 28-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

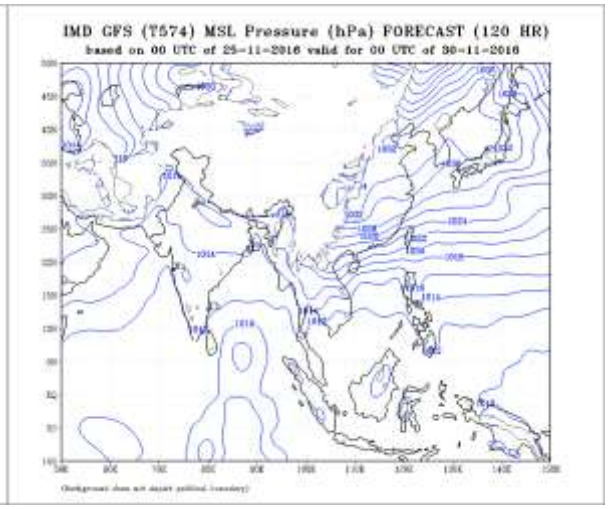

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 25-11-2016

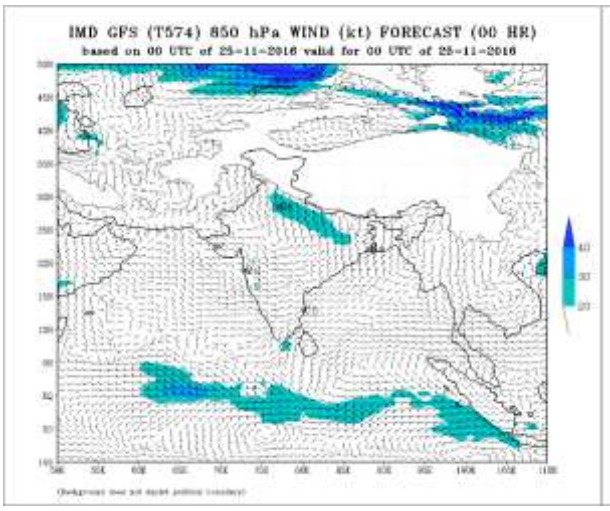

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 26-11-2016

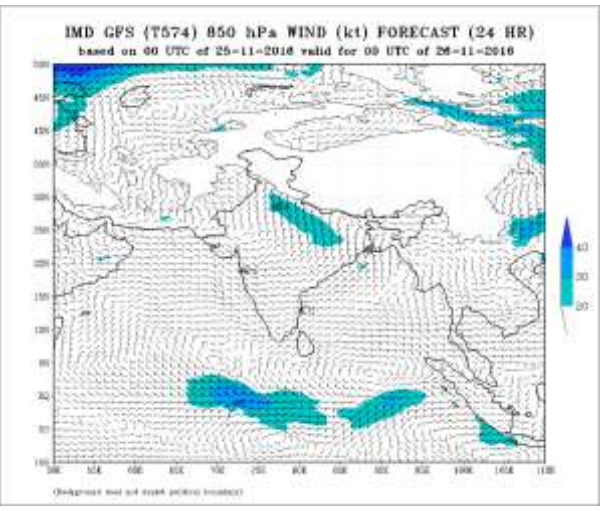

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 27-11-2016

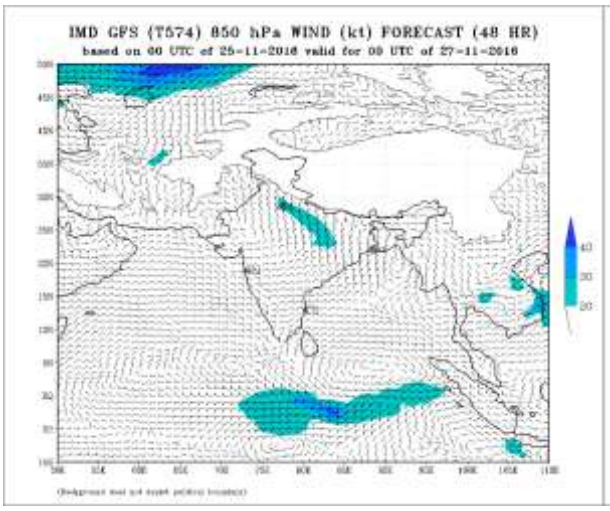

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 28-11-2016

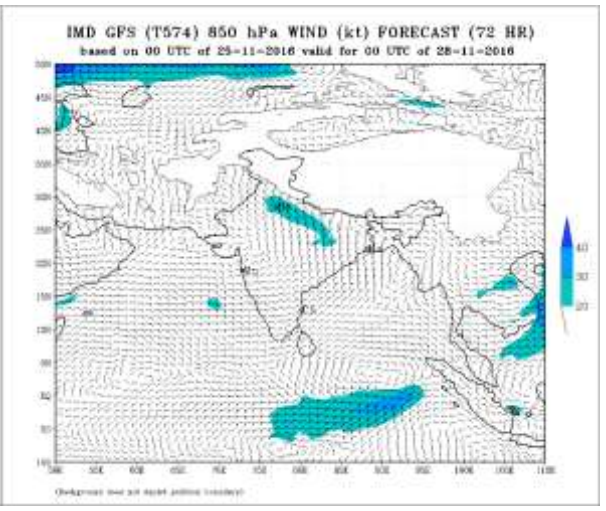

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 29-11-2016

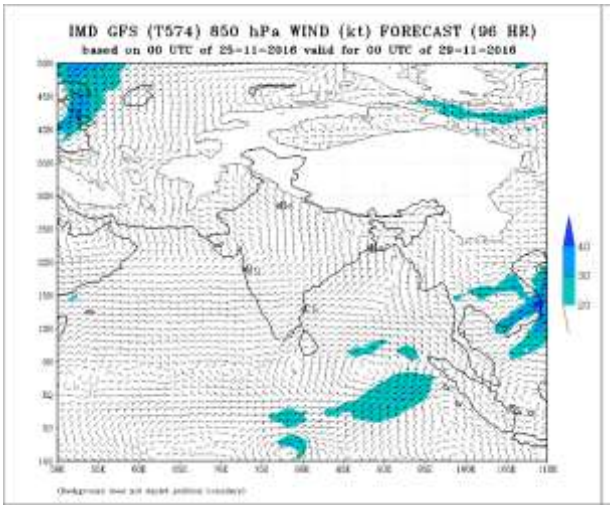

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 30-11-2016

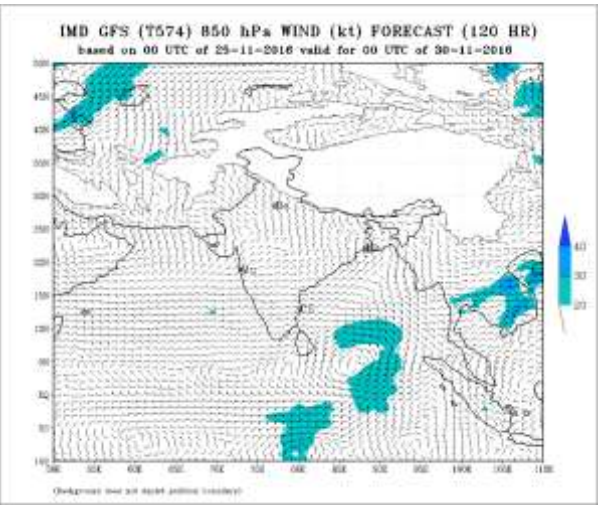

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 25-11-2016

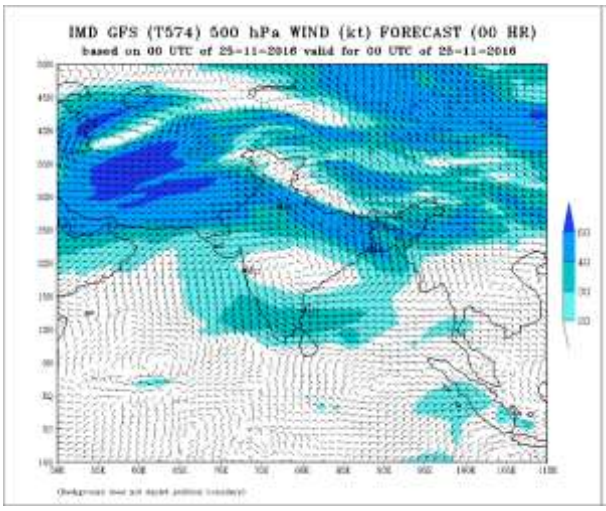

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 26-11-2016

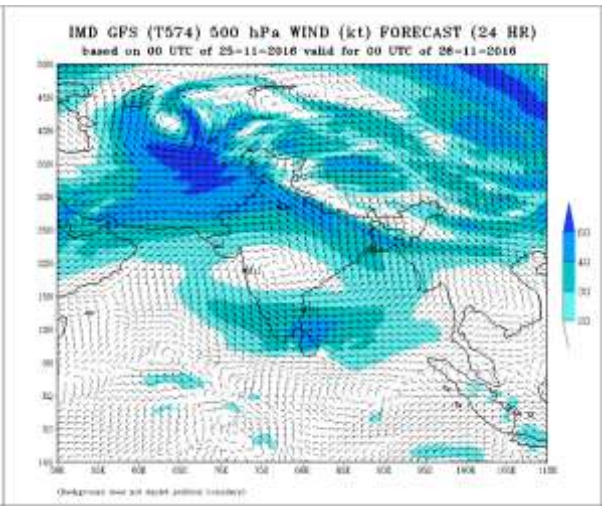

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 27-11-2016

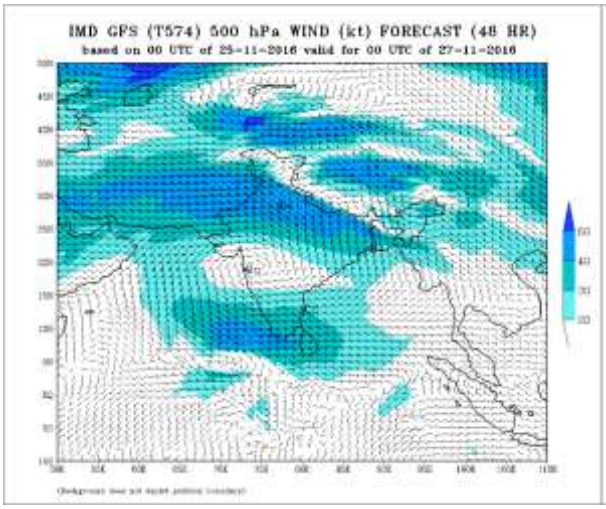

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 28-11-2016

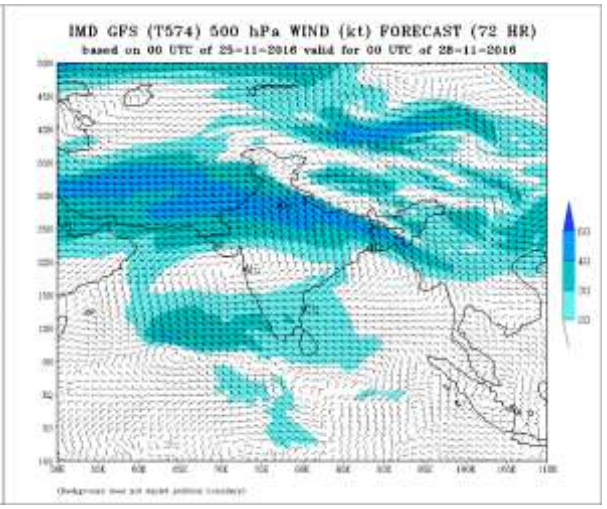

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 29-11-2016

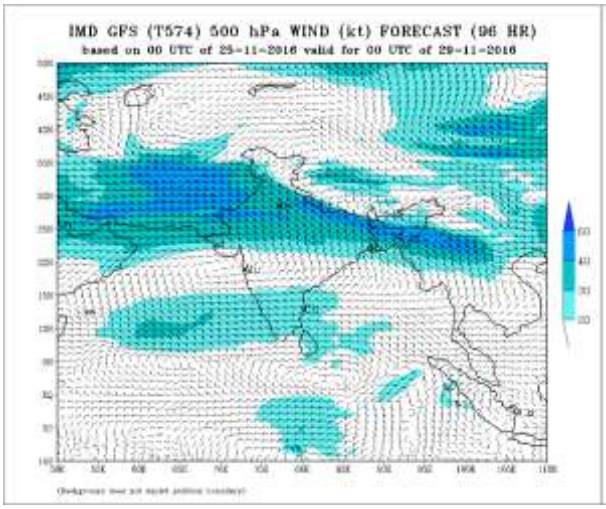

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 30-11-2016

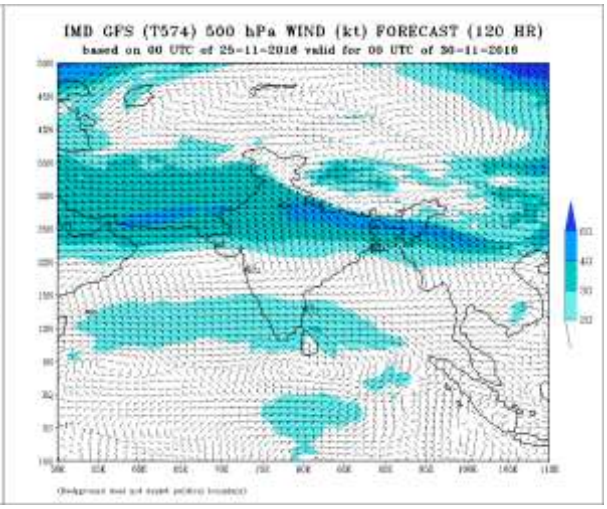

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 25-11-2016

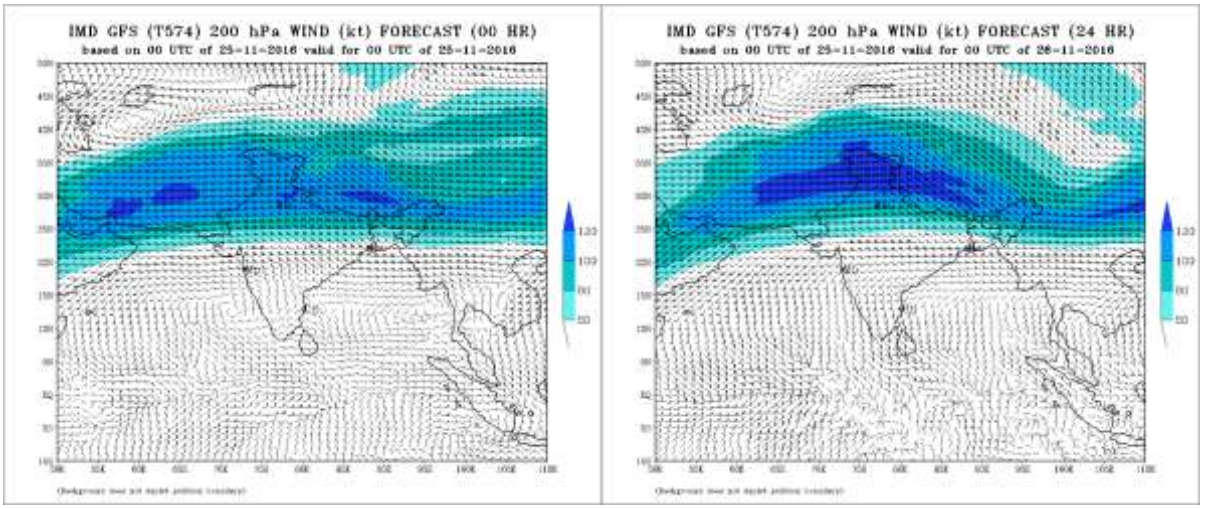

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 26-11-2016

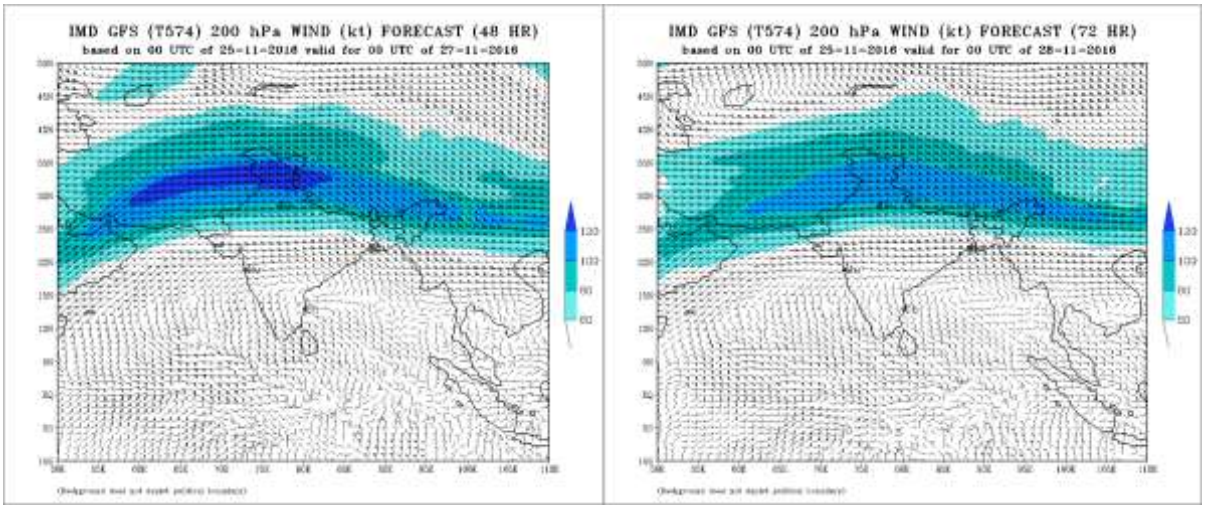

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 27-11-2016

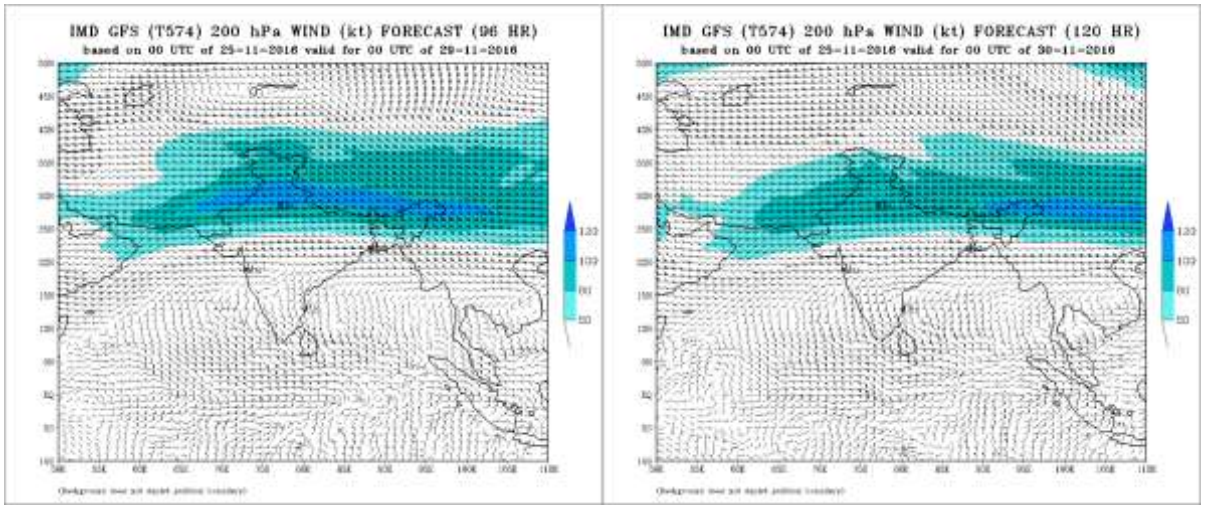

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 28-11-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 29-11-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 30-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 25-11-2016
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 26-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 27-11-2016
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 28-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 29-11-2016
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 25-11-2016 valid for 00 UTC of 30-11-2016

FDP (Cyclone) NOC Report Dated 26th November, 2016

Synoptic features:

Yesterday's trough of low at mean sea level over southeast BOB and neighbourhood persists and the trough of low at mean sea level from Comorin area to south Konkan coast now runs from Maldives area to Karnataka coast.

Dynamical and thermodynamical features:

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of BOB and Andaman Sea. It is slightly less 26-28˚C over northwest and adjoining westcentral BOB.

The SST over most parts of west Arabian Sea (AS) is between 26-28˚C. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast. SST is 28-30˚C over most parts of east AS.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of BoB and Andaman Sea except over south Andaman Sea and adjoining southeast BoB & equatorial region, where the value of TCHP is 100 kJ/cm^2. It is less than 50 kJ/cm^2 over north BoB and also in some parts of westcentral BoB.

TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala coast and over Comorin area where TCHP is around 100 kJ/cm^2.

Relative Vorticity:

There persists an east-west oriented low level relative vorticity area of about 26x10^{-6} second^{-1} over equatorial region and adjoining south BOB with small pockets of vorticity 40-50 x10^{-6} second^{-1} over parts of southeast BOB, southwest BOB, Comorin, Maldives and southwest AS.

Convergence:

Low level convergence is 5-10x10^{-6} s^{-1} over parts of south Andaman Sea, equatorial region and adjoining southeast BoB, southwest BOB off southeast Srilanka coast.

An elongated positive low level convergence zone of 5-10x10^{-6} s^{-1} over eastcentral AS and zones of positive convergence 5x10^{-6} s^{-1} are also seen over parts of Maldives and eastcentral AS along Karnataka coast.

Divergence:

An elongated zone of positive upper level divergence of about 5-10x10^{-6} s^{-1} lies over equatorial and adjoining southwest BOB to southeasst AS. A zone of positive upper level divergence of 5-10x10^{-6} s^{-1} lies over southwest BOB off Sri Lanka. Another zone of 5x10^{-6} s^{-1} lies over equatorial region and adjoining south Andaman Sea.

A small zone of positive divergence 5 x10^{-6} s^{-1} lies over eastcentral AS.

Wind Shear:

Wind shear is 5-10 kts over south Andaman Sea and adjoining southeast BOB. It is 10-20 kts over southwest BoB and central BoB. It is increasing towards north.

Wind shear is around 10-15 kts over most parts of southeast and eastcentral AS. It is around 15-20 kts over most parts of southwest and westcentral AS. It is increasing towards north.

Wind Shear Tendency:

There is decreasing tendency of 5-10 kts over Andaman Sea, most parts of southeast & adjoining southwest BOB, westcentral and nrthwest BoB

There is increasing tendency of 5-10 kts over Comorin Area and parts of southeast & adjoining southwest AS. Another zone of increasing tendency lies over westcentral AS.

Satellite observations based on 0600 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over south BOB south of latitude 11.5^{0}N and south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over southeast AS.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 11^0N latitude over BoB.
M.J.O. Index: MJO index is in Phase 3 with amplitude more than one and would continue in Phase 2 in next 72 hours with amplitude less than 1.
Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis based on 00 UTC of 26th November 2016 shows development of low over south Bay BOB on 28th November. moving west-northwestwards, it intensifies into a depression over southwest Bay on 30th and into a deep depression over SW Bay off north TN and Sri Lanka coast on 1st December, over southwest Bay off north TN coast on 2nd and close to north TN coast as a depression on 3rd and becomes less marked on 4th.
NCEP-GFS: The model charts based on 00 UTC of 26th November 2016 shows a low over south BOB and adjoining equatorial region on 28th. It gradually moves west-northwestwards and intensifies into a depression on 2 Dec over southwest Bay and continues as a depression while moving west-northwestwards. It becomes a low on 6th Dec over north TN coast
ECMWF: The model analysis based on 00 UTC of 26th November 2016 shows a low over the southwest Bay on 30th, becomes depression on 2nd Dec. over southwest Bay off north Sri Lanka and north TN coast. It again weakens into a low over TN coast on 3rd Dec. On 4th, it emerges into SE Arabian Sea as a low and moves northwestwards subsequently.
WRF: The WRF model based on 00 UTC of 26th November 2016 shows a low southwest BOB off the Sri Lankan coast on 27th and thereafter becomes less marked
JMA: No system expected over north Indian Ocean during next three days.
Meteo-France ARP Model: It shows development of low over southwest and equatorial region on 29th.
NCMRWF-NCUM: The analysis based on 00 UTC of 26th November shows a low over southwest BOB off south Sri Lanka coast on 28th. It moves west-northwestwards, becomes well marked on 29th and 30th over southwest Bay and lies over extreme north Sri Lanka, neighbourhood on 1 Dec. as low and becomes less marked on 2nd Dec.
NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 26th November shows a low pressure area over south Bay on 29th Nov.
NCMRWF-NEPS Model: The analysis based on 00 UTC of 26th November shows development of a low over southwest Bay on 28th. It becomes depression on 29th and becomes low over north Sri Lanka on 30th. It emerges into SE Arabian Sea on 1 Dec as a low and then moves northwestwards without intensification

IITM-GEFS: The analysis based on 00 UTC of 26th shows low over south Bay on 28th. It becomes depression on 1 Dec while moving west-northwestwards and becomes Deep Depression on 2 Dec, D on 3 Dec and Low on 4th Dec. near north TN coast before landfall
IITM -GFS T1534: The analysis based on 00 UTC of 26th November shows development of a low over south Bay on 28th. It becomes depression on 1 Dec, deep depression on 2nd Dec. and crossing Central TN coast. It becomes less marked on 3rd and emerges into SE Arabian Sea on 4th.
Dynamical statistical models
IMD Genesis Potential Parameter (GPP):
Analysis and forecasts of GPP based on 00 UTC of 26th November 2016 suggests no significant system over NIO for next 5 days. .

Summary and Conclusion:

A low pressure area is likely to form over south Bay of Bengal around 28th/29th November as predicted by most of the models. It would move west-northwestwards towards north Sri Lanka and north Tamil Nadu coasts and reaching/crossing these coasts by 2nd /3rd Dec. Many models suggest intensification into a Depression over southwest Bay around 1st/ 2nd Dec. 2016

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Low

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : No IOP for next three days

Annexure-I

Status of observational system:

Dated: 26.11.2016

Synoptic observation:

Region	Date/Time (UTC)		
	25/12	**26/00**	**26 /03**
India	41	28	42
Coastal stations			
WB	9	3	9
Odisha	6	5	6
AP	12	11	12
Tamil Nadu	8	7	8
Puducherry	1	1	1
A & N	5	1	6
Bangladesh	9	12	15
Myanmar	1	1	2
Thailand	3	3	3
Sri Lanka	5	7	8

AWS:

Region	Date/Time (UTC)		
	25 /12	**26 /00**	**26 /03**
WB	5	1	6
Odisha	10	3	8
AP	13	9	14
Tamil Nadu	27	13	27
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 25/11//2016 : 0 /43
- **No. of Ascents reaching 260 hPa levels:0 , MISDA:- 0**

- **RS/RW** (00Z) of 26/11 /2016 : 0 /43

- **No. of Ascents reaching 260 hPa levels: 0 , MISDA: 0**

No. of PILOT Ascents

25 /12Z	**26 /00Z**
21	12

Buoy Data

25 /12Z	**26 /00Z**	**26/03Z**
11	11	11

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**25.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**19**	**19**	**19**	**19**	**21**	**19**	**20**	**18**

No. of RS/RW Ascents

00Z /25.11.2016 : 7

No. of Ascents reaching 250hPa level =7

MISDA : 1

12Z /25.11.2016 : 3

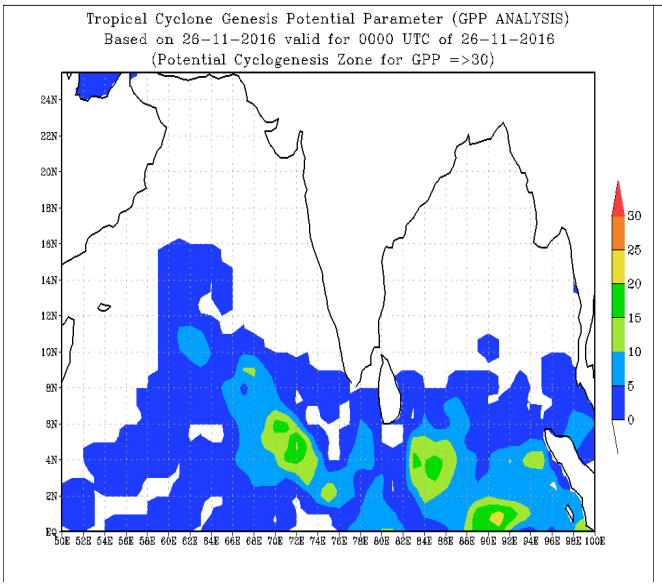
No. of Ascents reaching 250 hPa level =2

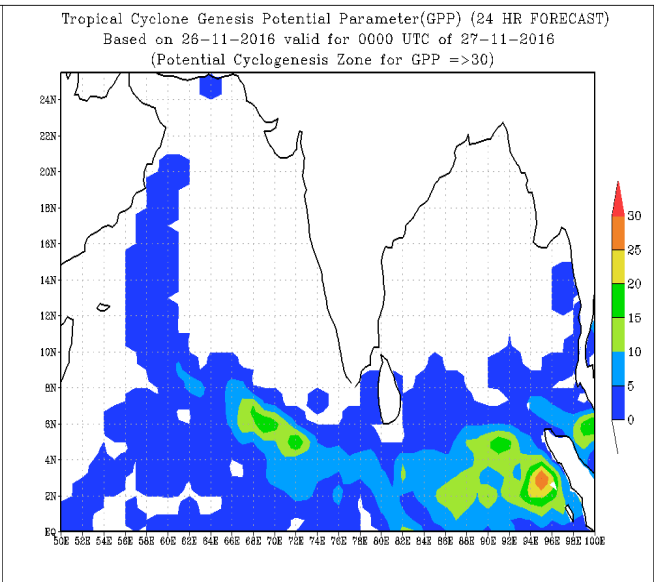
MISDA : 5

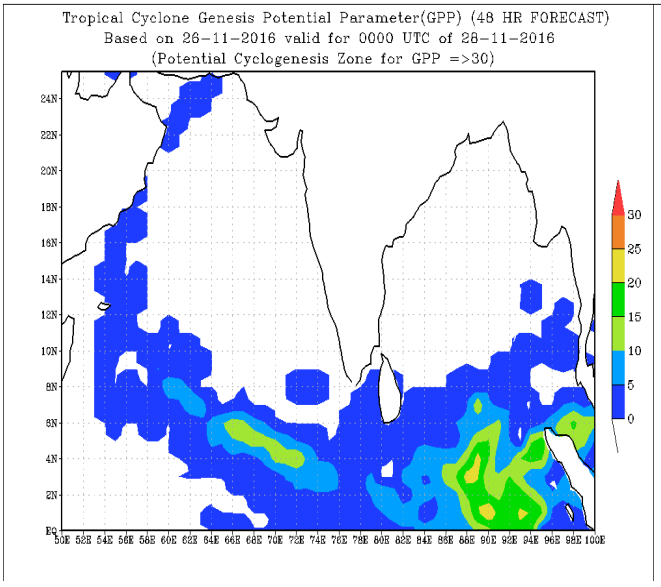
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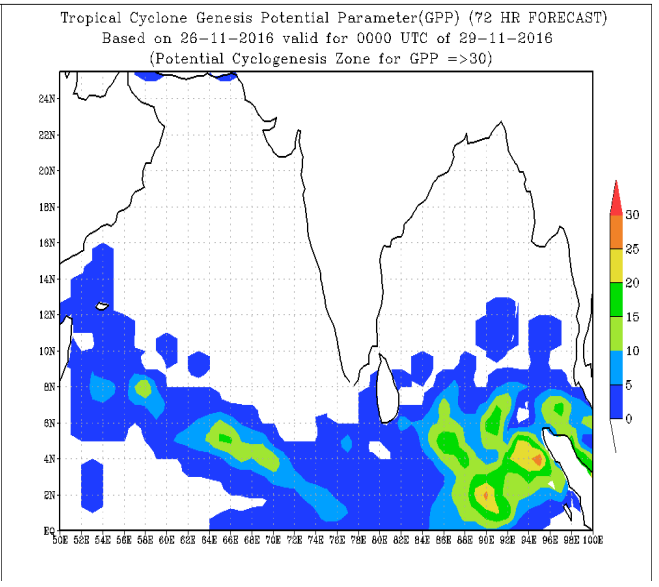
25.11.2016	
06Z	18Z
4	4

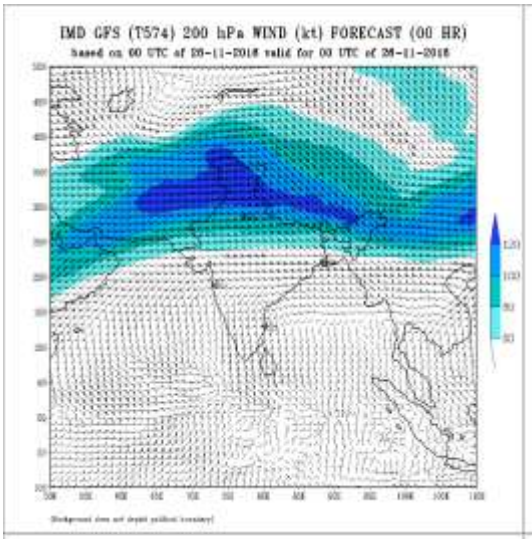
Annexure-II

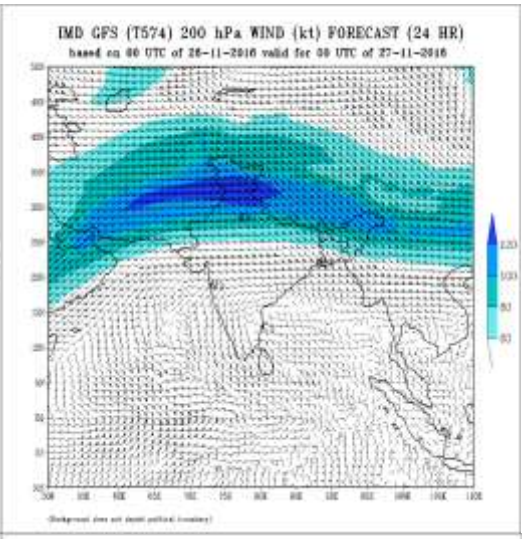

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 26-11-2016 valid for 0000 UTC of 26-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

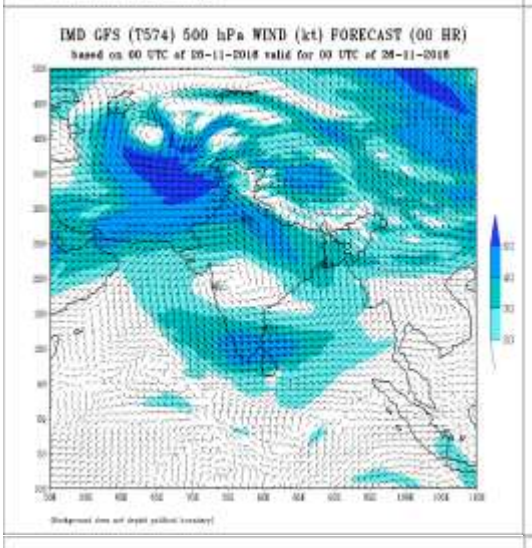

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 26-11-2016 valid for 0000 UTC of 27-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

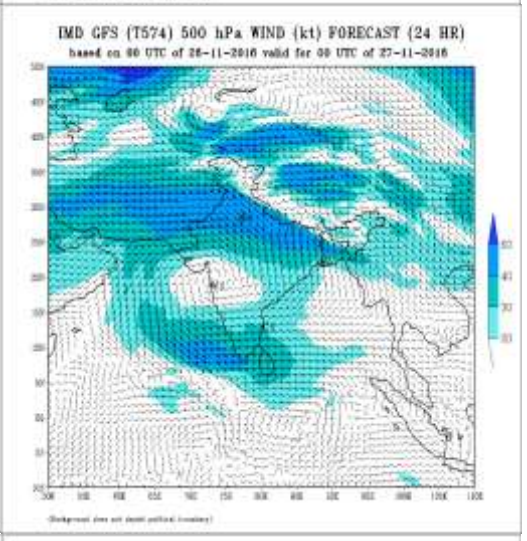

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 26-11-2016 valid for 0000 UTC of 28-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

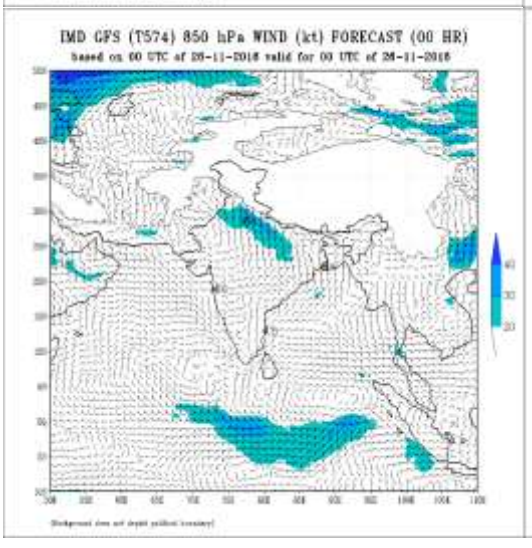

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 26-11-2016 valid for 0000 UTC of 29-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

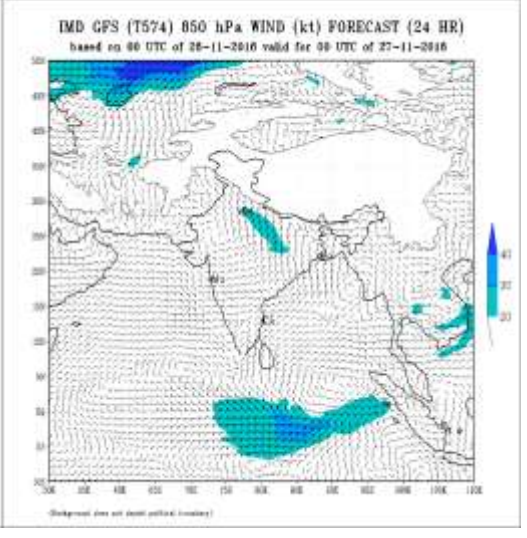

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 26-11-2016

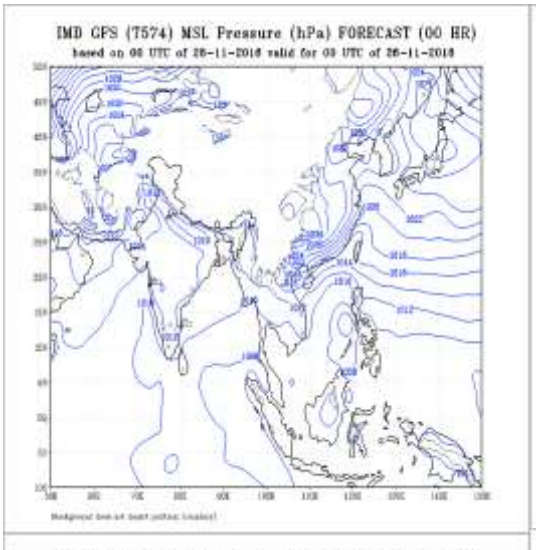

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 27-11-2016

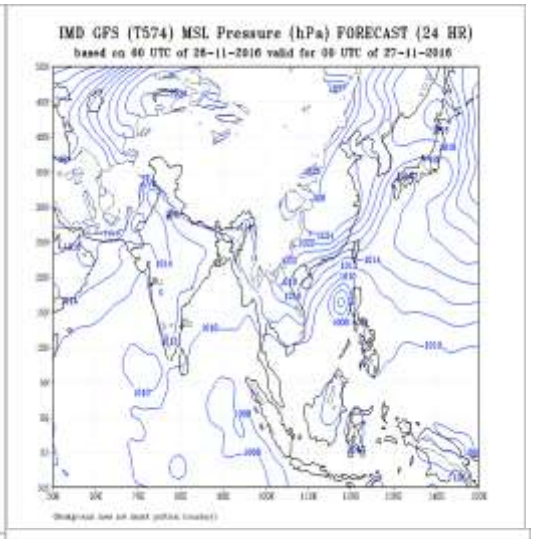

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 26-11-2016

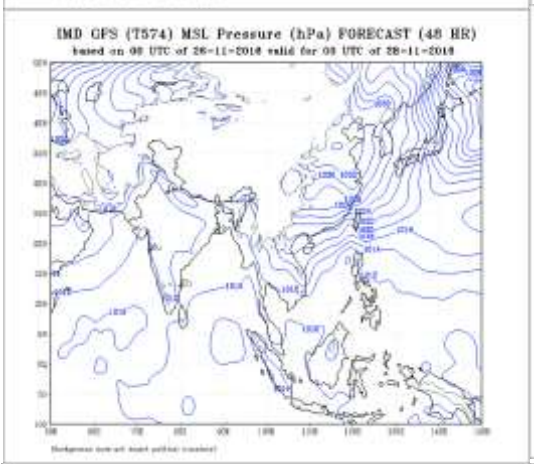

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 27-11-2016

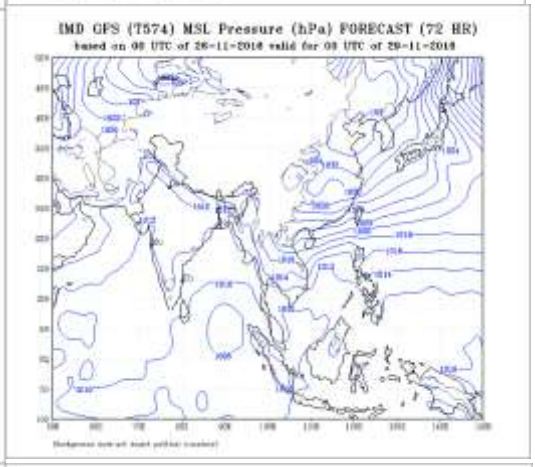

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 26-11-2016

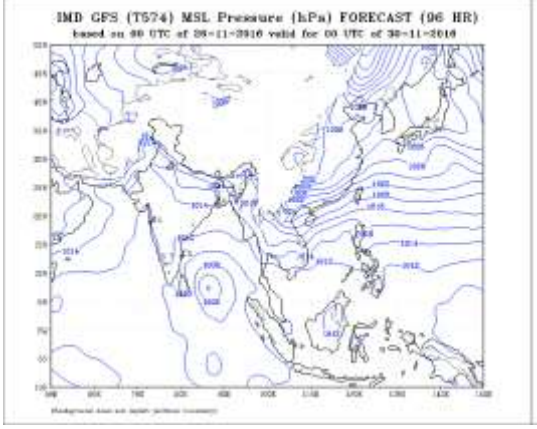

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
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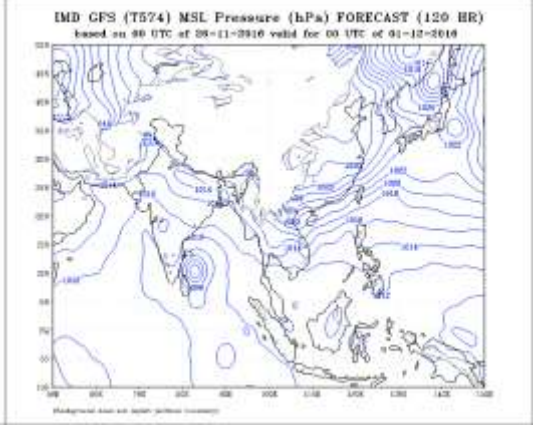

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 26-11-2016

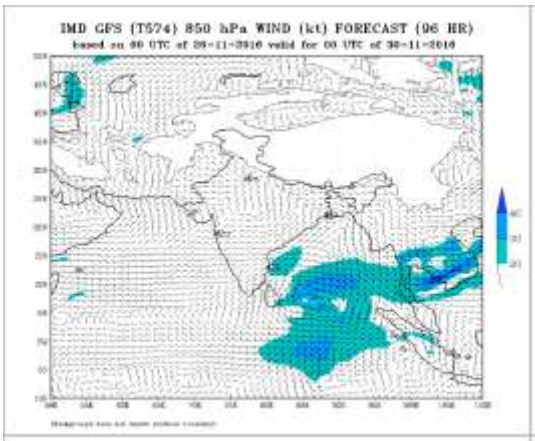

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 27-11-2016

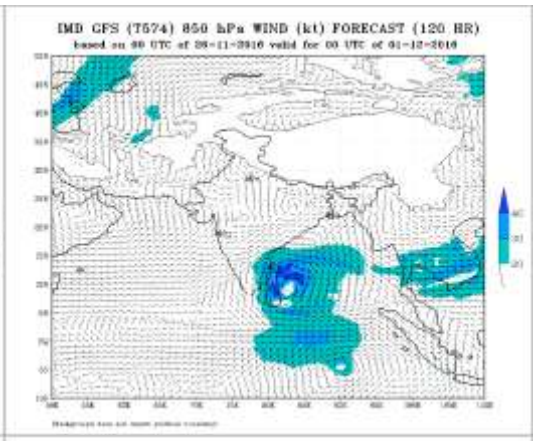

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 28-11-2016

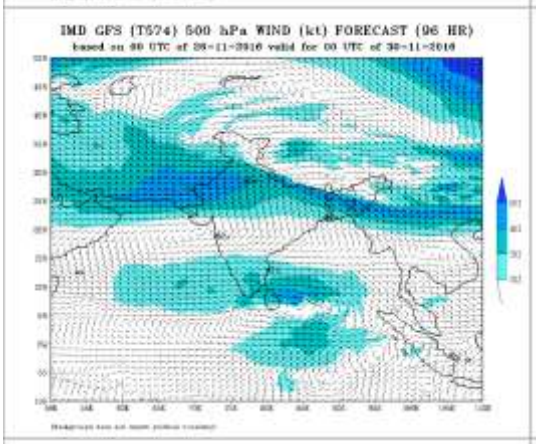

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 29-11-2016

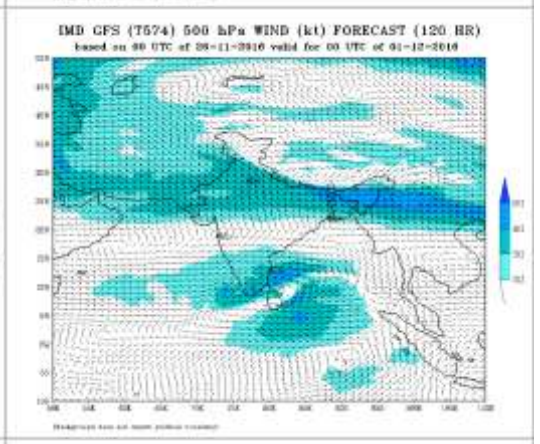

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 30-11-2016

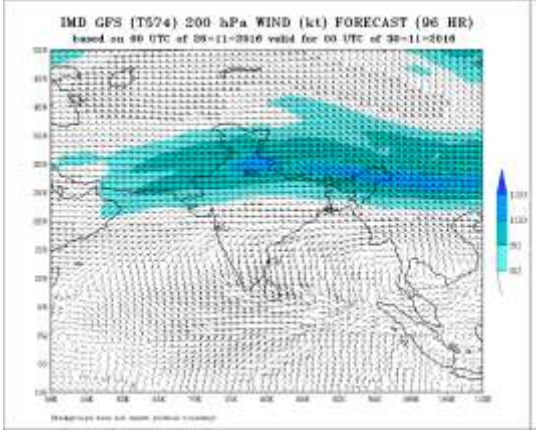

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 26-11-2016 valid for 00 UTC of 01-12-2016

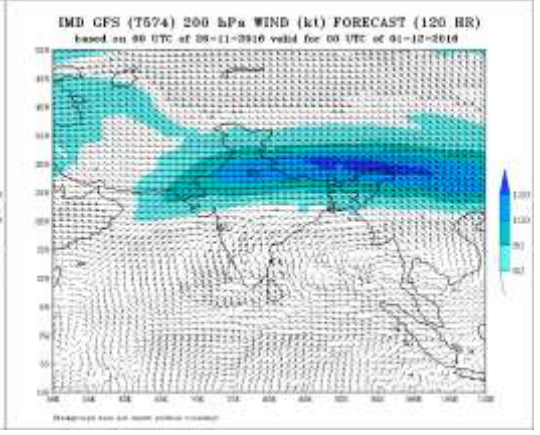

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 30-11-2016


IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 01-12-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 30-11-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 01-12-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 30-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 01-12-2016

FDP (Cyclone) NOC Report Dated 27th November, 2016

Synoptic features:

A fresh trough of low at mean sea level lies over southeast Bay of Bengal & adjoining equatorial Indian Ocean. Under its influence, a low pressure area is very likely to form over southeast Bay of Bengal & neighbourhood during next 48 hours.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 28-30˚C over most parts of BOB and Andaman Sea. It is slightly less 27-28˚C over northwest and adjoining westcentral BOB.

The SST over most parts of west Arabian Sea (AS) is between 27-28˚C. SST is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast. SST is 28-30˚C over most parts of east AS.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 50- 80 kJ/cm^2 over most parts of BoB and Andaman Sea except over south Andaman Sea and adjoining southeast BoB & equatorial region, where the value of TCHP is > 100 kJ/cm^2. It is less than 50 kJ/cm^2 over north BoB and also in some parts of westcentral BoB.

TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala coast and over Comorin area where TCHP is around 100 kJ/cm^2.

Relative Vorticity:

There persists an east-west oriented low level relative vorticity area of about 25x10^{-6} second^{-1} over equatorial region and adjoining south BOB with small pockets of vorticity 40-50 x10^{-6} second^{-1} over parts of southeast BOB, southwest BOB. The low level relative vorticity area of about 27x10^{-6} second^{-1} over equatorial region and adjoining south AS

Convergence:

Low level convergence is 10-15x10^{-6} s^{-1} over most parts of south BOB, equatorial region and off southeast Srilanka coast.

An elongated negative low level convergence zone of 5-10x10^{-6} s^{-1} over eastcentral AS and zones off KKA coast.

Divergence:

An elongated zone of positive upper level divergence of about 10-20x10^{-6} s^{-1} lies over most parts of south BOB, equatorial region and off southeast Srilanka coast.

A zone of positive upper level divergence of 10-20x10^{-6} s^{-1} lies over southcentral AS.

Wind Shear:

Wind shear is 5-10 kts over Andaman Sea and adjoining southeast BOB. It gradually increases towards west and is more than 20 kts over southwest BoB and westcentral BoB.

Wind shear is around 10-15 kts over most parts of southeast and eastcentral AS. It is around 15-20 kts over most parts of southwest and westcentral AS. It is increasing towards north.

Wind Shear Tendency:

There is increasing tendency of 5-10 kts over south Andaman Sea, most parts of southwest BOB and westcentral BoB.

There is increasing tendency of 5-10 kts over Comorin Area and parts of southeast AS. Another zone of increasing tendency lies over westcentral AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, scattered low/medium clouds with embedded moderate to intense convection are seen over south BOB south of latitude 11.5^{0}N and south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded isolated moderate to intense convection are seen over southeast AS south of latitude 10.0°N.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 12^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 3 with amplitude more than one and would continue for two more days in phase 3 and then may enter into phase 2.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

A cyclonic storm TOKAGE over S China Sea lay centred at 0300 UTC of today the 27.11.2016 near 16.0°N/117.8°E. Associated the system broken low/medium clouds with embedded intense to very intense convection lie over area between latitude 14.0°N to 19.0°N and longitude 114.5°E to 120.0°E. It is likely to move west-southwestwards and weaken gradually during next 48 hrs.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis based on 00 UTC of 27 November 2016 shows a low over south-southeast BOB along with its associated cyclonic circulation extending up to 500 hPa above mean sea level. The forecast of model shows that the low will intensify in to a depression on 29 November over south-central BOB with westward movement. According to the model forecasts, the system will intensify further to become a cyclone on 30 November with west-northwestward movement. It moves along east coast of Sri Lanka for 2 days till it dissipated over south Tamil Nadu coast and adjoining area on 2 December 2016. It emerges as a low over SE Arabian Sea on 3 Dec and moves west-nothwestwards till 7 Dec. A fresh low develops over SE Bay on 4th, becomes Depression over SE Bay on 5th, Deep Depression over SW Bay on 6th and CS over SW Bay off north TN coast on 7th

NCEP-GFS: The model charts based on 00 UTC of 27 November 2016 shows a feeble low over southeast BOB and adjoining equatorial region which does not show any significant change till 28 November. Thereafter, it becomes well marked on 29 November and moves west-northwestward to become a depression on 30 November over southwest Bay. It intensifies further on 1 December as deep depression off north Sri Lanka coast and crosses central Tamil Nadu coast on 2 December 2016. It emerges as a low over SE Arabian sea on 3 Dec and moves west-nothwestwards till 7 Dec. A fresh low develops over SE Bay on 5th, becomes Depression off north Sri Lanka coast on 6th and becomes less marked after crossing TN coast on 7th.

ECMWF: The model analysis based on 00 UTC of 27 November 2016 shows small low pressure systems over the southeast BOB along 5^{o}N which moves west-northwestward along Sri Lanka coast and intensify into a depression on 1 December, reaches northern tip of Sri Lanka and adjoining TN coast on 2 December 2016 and dissipates thereafter.

WRF: The WRF model based on 00 UTC of 27th November 2016 shows a low southwest BOB off the Sri Lankan coast on 27th and thereafter becomes less marked

JMA: A low lies over SW Bay on 30th.

Meteo-France ARP Model: It shows development of extended low over southeast Bay on 28th. It becomes depression over SE Bay on 29th and CS over SE Bay on 30th.

NCMRWF-NCUM: The analysis based on 00 UTC of 27th November shows a low over southeast BOB on 28th. It moves west-northwestwards, becomes well marked/ depression on 29th and depression/deep depression 30th, deep depression over southwest Bay off north TN coast on 1 Dec. and crosses TN coast near Chennai on 02 Dec. It becomes less marked on 3rd Dec. It emerges as a low over SE Arabian sea on 4 Dec and moves west-nothwestwards till 7 Dec. A fresh low develops over SE Bay and adjoining Andaman Sea on 5th, becomes Depression over north Andaman Sea on 7th.

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 27th November shows a low pressure area over southeast Bay on 29th Nov and deep depression over southwest Bay on 30th.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 27th November shows development of a low over southwest Bay on 28th. It becomes depression on 29th, deep depression over SW Bay on 30th, cyclonic storm over SW Bay off north TN coast on 1 Dec, weakens into a deep depression over SW Bay off north TN coast on 2 Dec., depression over the same area on 3 Dec and becomes less marked on 4th. It lies as a low over SE Arabian Sea on 5th, depression over central Arabian Sea on 6th and low ovwe WC Arabian Sea on 7th.

A fresh low develops over south Andaman Sea on 6th, and over Andaman Sea and adjoining SE Bay on 7th

IITM-GEFS: The analysis based on 00 UTC of 27th shows low over southeast Bay on 28th. It becomes depression on 30th while moving west-northwestwards and becomes low off north TN coast on 2 Dec. It emerges as a low over SE Arabian Sea on 3 Dec and moves west-nothwestwards till 5 Dec. A fresh low develops over SE Bay on 5th Dec.

IITM -GFS T1534: The analysis based on 00 UTC of 27th November shows development of a low over southeast Bay on 28th. It becomes depression on 29th Nov, Cyclonic Storm (CS) over SW Bay on 30th, CS over SW Bay off north Sri Lanka and north TN coast on 1 Dec and crossing Central TN coast. on 2nd Dec. It

emerges as a low over SE Arabian sea on 3 Dec and moves west-nothwestwards till 5 Dec. A fresh low develops over SE Bay on 5th.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP): Analysis and forecasts of GPP based on 00 UTC of 27 November 2016 show a GPP zone over southeast BOB. The zone of significant GPP appear over southeast BOB on 28 November which moves west-northwestward and becomes well organized on 30th indicating formation of a cyclonic storm on 30th over south Bay. The GPP zone moves west-northwestwards and reaches north Tamil Nadu coast on 2 December 2016.

Summary and Conclusion:

A low pressure area is likely to form over southeast Bay of Bengal around 28th November as predicted by most of the models. It would move west-northwestwards towards and become depression around 29th. A few models (IMD GFS, UM-NEPS, UMRM GFS-1534) also suggest it to become cyclonic storm while others except ECMWF suggest intensification upto a deep depression subsequently. There is unanimity about the movement and most of the models suggest the system to cross north Tamil Nadu and adjoining south Tamil Nadu coast on 2nd Dec. Thereafter continuing its west-northwestward movement, it will emerge into southeast Arabian Sea as a Low on 3rd Dec.

A fresh low pressure area is likely to velop over southeast Bay on 4th/5th Dec. 2016.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Low	Moderate	High	High

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : IOP to be undertaken for east coast of Sri Lanka and coastal Tamil Nadu during 30th Nov. to 02 Dec.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	26/12	**27/00**	**27 /03**
India	41	28	42
Coastal stations			
WB	9	3	9
Odisha	6	5	6
AP	12	11	12
Tamil Nadu	8	7	8
Puducherry	1	1	1
A & N	5	1	6
Bangladesh	9	12	15
Myanmar	1	1	2
Thailand	3	3	3
Sri Lanka	5	7	8

AWS:

Region	Date/Time (UTC)		
	26 /12	**27 /00**	**27 /03**
WB	6	3	6
Odisha	9	4	9
AP	13	6	13
Tamil Nadu	26	12	27
Puducherry	1	1	1
A & N	0	0	0

- **RS/RW** (12Z) of 26/11//2016 : 22 /43
- **No. of Ascents reaching 270 hPa levels:20 , MISDA:- 2**

- **RS/RW** (00Z) of 27/11 /2016 : 27 /43

- **No. of Ascents reaching 270 hPa levels: 27 , MISDA: 0**

No. of PILOT Ascents

26 /12Z	**27 /00Z**
10	5

Buoy Data

26 /12Z	**27 /00Z**	**27/03Z**
15	14	14

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**26.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**17**	**21**	**19**	**19**	**21**	**19**	**19**	**19**

No. of RS/RW Ascents

00Z /26.11.2016 : 5

No. of Ascents reaching 250hPa level =5

MISDA : 3

12Z /26.11.2016 : 3

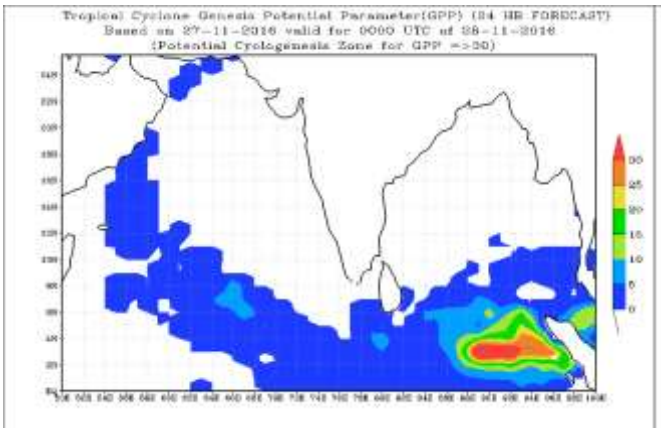
No. of Ascents reaching 250 hPa level =2

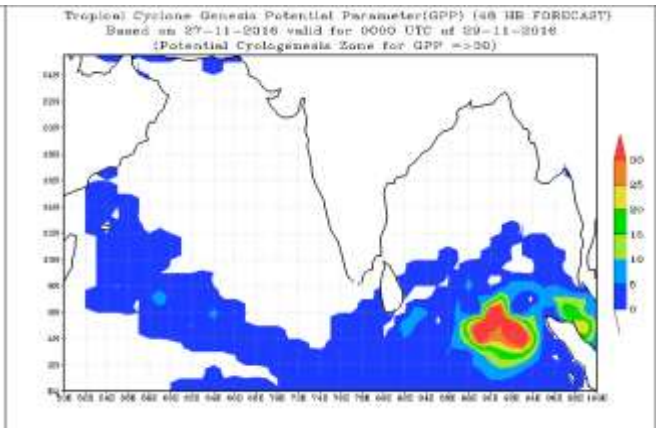
MISDA : 5

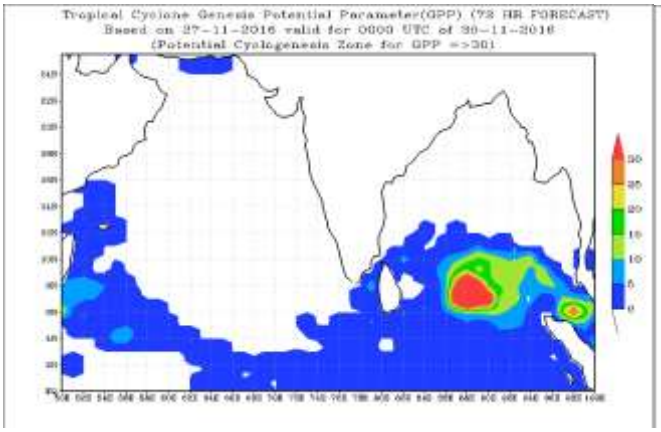
No. of PILOT Ascents:

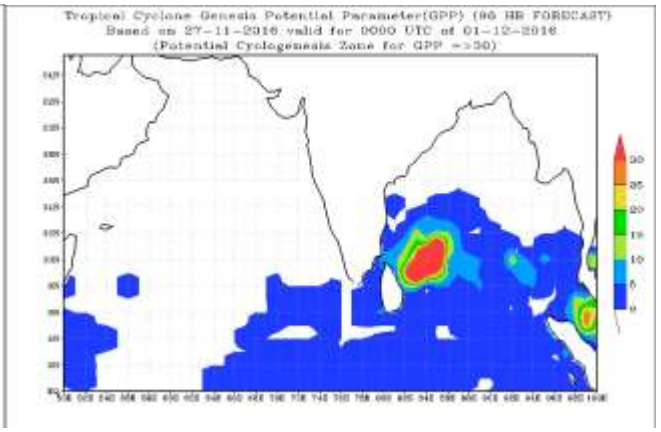
26.11.2016	
06Z	18Z
5	4

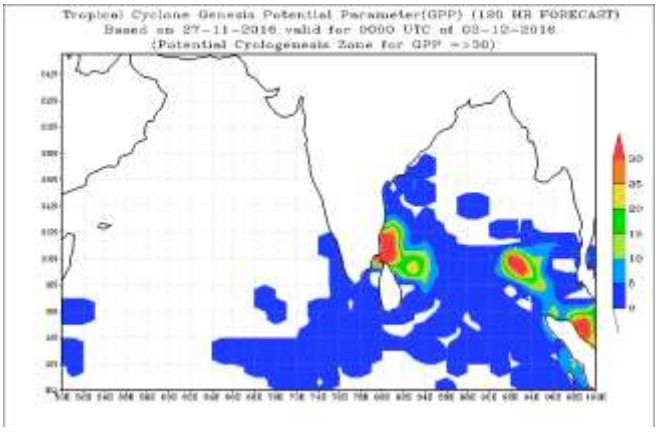
Annexure-II


Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 27-11-2016 valid for 0000 UTC of 28-11-2016
(Potential Cyclogenesis Zone for GPP =>30)


Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 27-11-2016 valid for 0000 UTC of 29-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

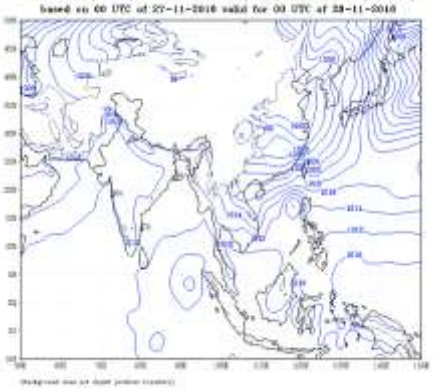

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 27-11-2016 valid for 0000 UTC of 30-11-2016
(Potential Cyclogenesis Zone for GPP =>30)


Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 27-11-2016 valid for 0000 UTC of 01-12-2016
(Potential Cyclogenesis Zone for GPP =>30)


Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 27-11-2016 valid for 0000 UTC of 02-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

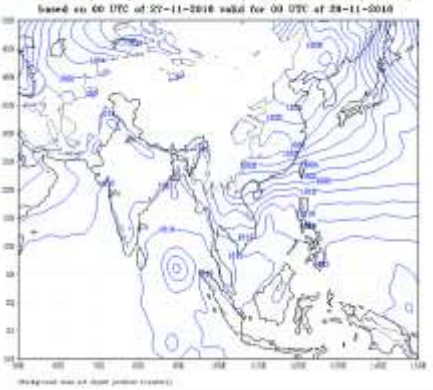
IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

based on 00 UTC of 27-11-2010 valid for 00 UTC of 28-11-2010



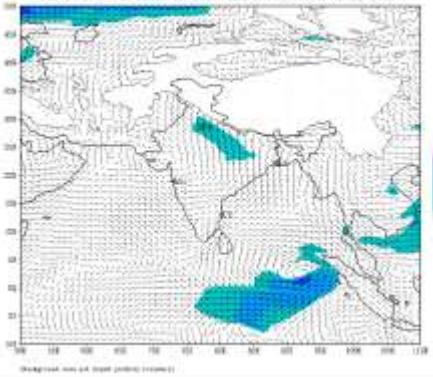
IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

based on 00 UTC of 27-11-2010 valid for 00 UTC of 29-11-2010



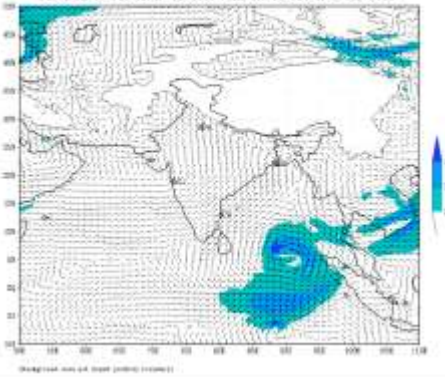
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

based on 00 UTC of 27-11-2010 valid for 00 UTC of 28-11-2010



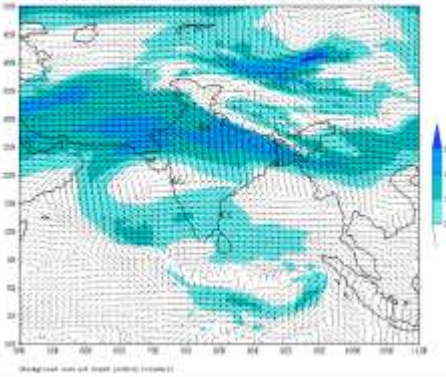
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)

based on 00 UTC of 27-11-2010 valid for 00 UTC of 29-11-2010



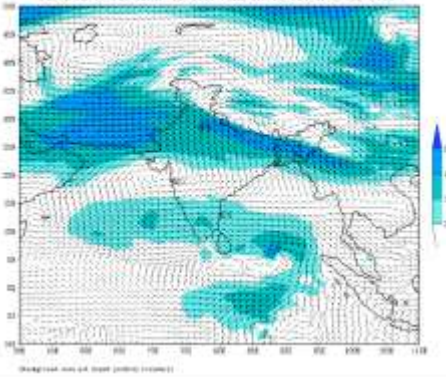
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)

based on 00 UTC of 27-11-2010 valid for 00 UTC of 28-11-2010



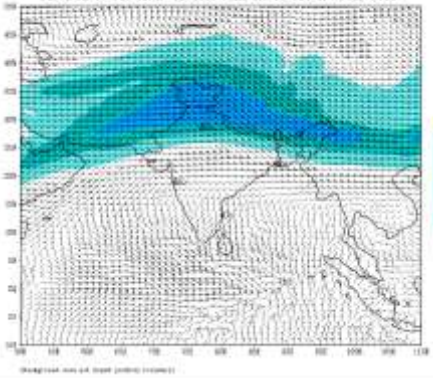
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)

based on 00 UTC of 27-11-2010 valid for 00 UTC of 29-11-2010



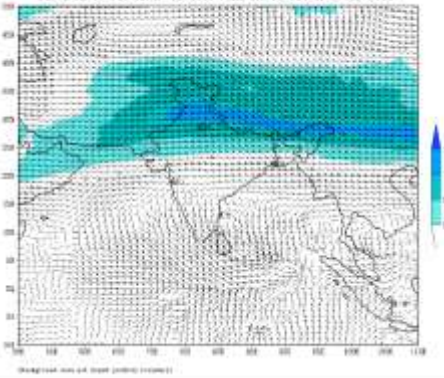
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)

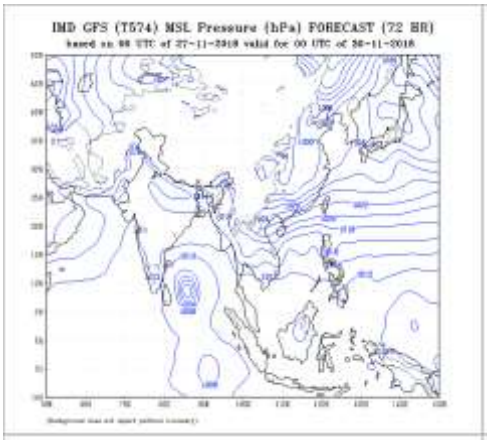
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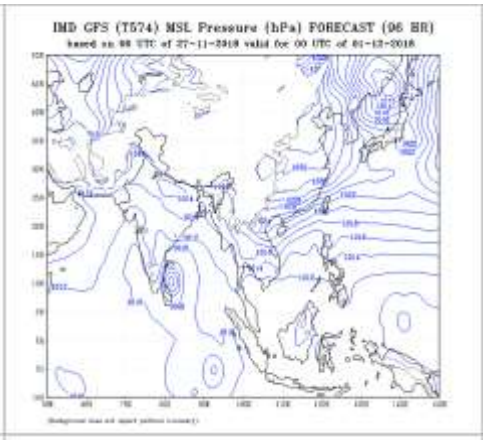


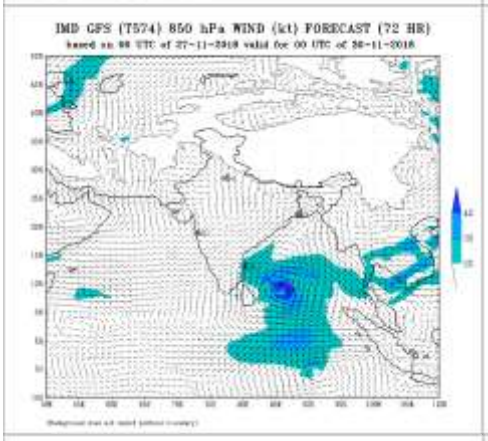
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)

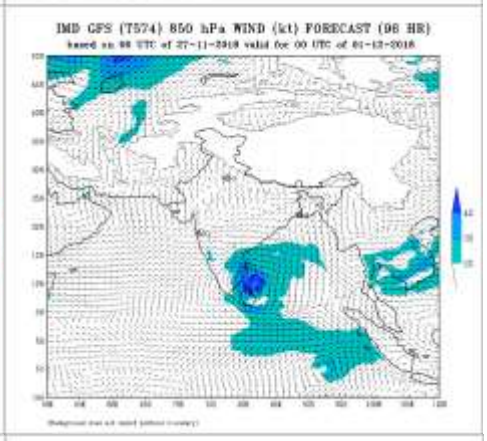
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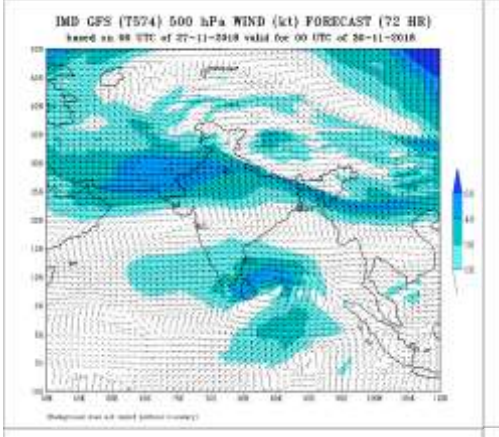


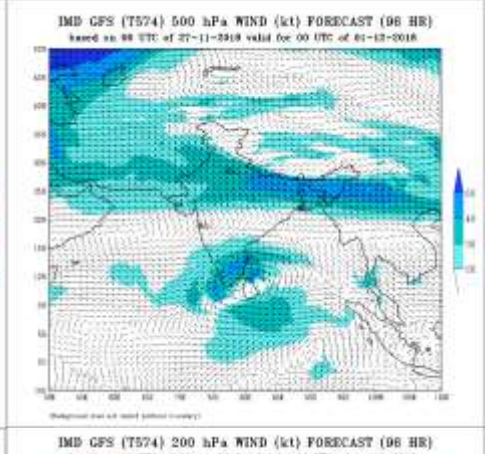

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

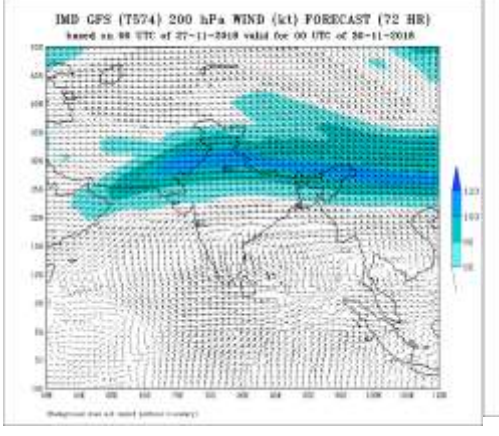

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

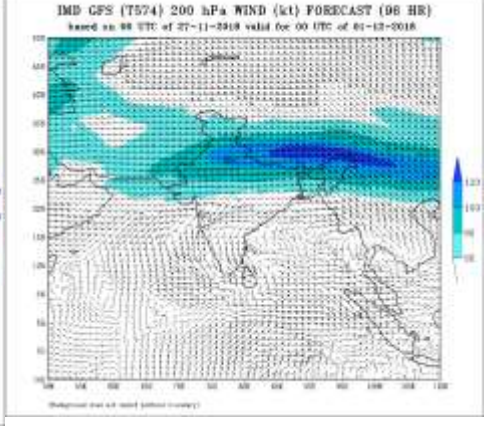

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)

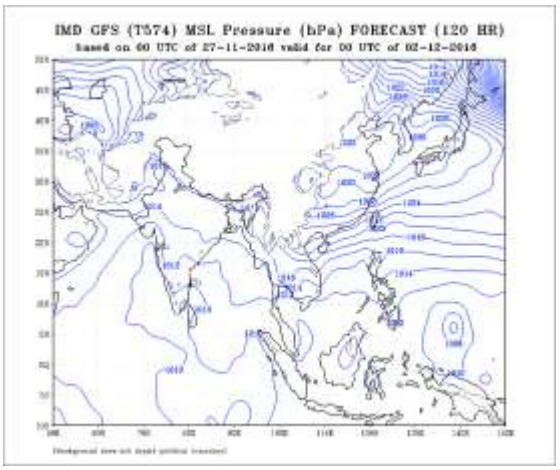

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)

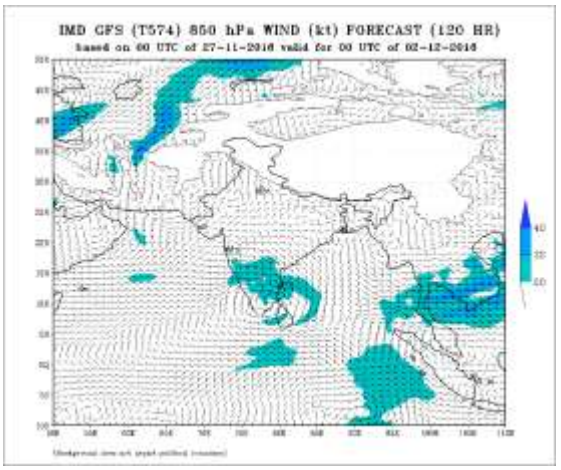

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)

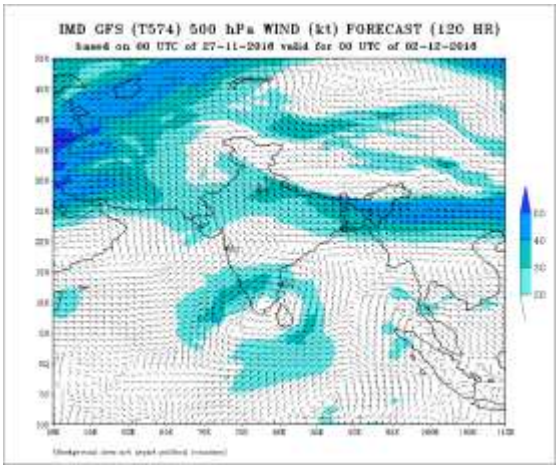

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)

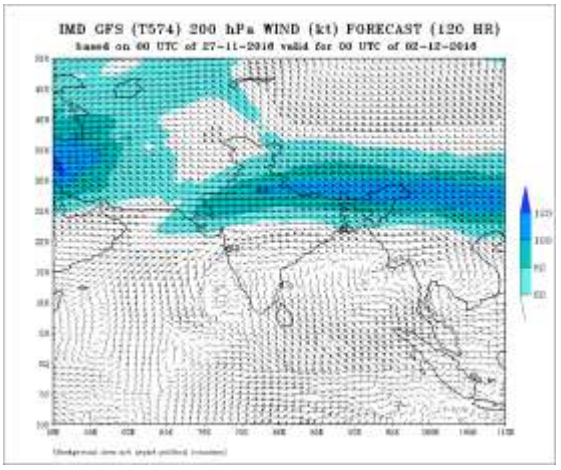

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)


IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 27-11-2016 valid for 00 UTC of 02-12-2016


IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 27-11-2016 valid for 00 UTC of 02-12-2016


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 27-11-2016 valid for 00 UTC of 02-12-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 27-11-2016 valid for 00 UTC of 02-12-2016

FDP (Cyclone) NOC Report Dated 28th November, 2016

Synoptic features:

A low pressure area lies over southeast Bay of Bengal. It is very likely to concentrate into a depression during next 24 hours.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is around 28-30˚C near the system centre. It is 28-30˚C over most parts of central and south BOB. It is decreasing towards north.

The SST over most parts of westcentral and northwest Arabian Sea (AS) is between 26-28˚C. It is 28-30˚C over most parts of southwest AS. It is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast. SST is 28-30˚C over most parts of eastcentral and southeast AS.

Tropical Cyclone Heat Potential (TCHP):

The Ocean thermal energy is about 80-100 KJ/cm^2 and decreases towards southwest BOB and near Sri Lanka and north Tamil Nadu coast. It is less than 50 kJ/cm^2 over north BoB and also in some parts of westcentral BoB.

TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala & Karnataka coast and over Comorin area where TCHP is around 100 kJ/cm^2.

Relative Vorticity:

The low level relative vorticity is about 60-80x10^{-6} Second^{-1} over southeast BOB and adjoining equatorial region.

Convergence:

Low level convergence is 15x10^{-6} s^{-1} around the low pressure area over southeast BOB and adjoining equatorial region.

Small zones of positive low level convergence zone of 5x10^{-6} s^{-1} are also seen over southeast and southwest AS.

Divergence:

The upper level divergence is around 30x10^{-5} Second^{-1} around the system centre over southeast BOB.

No significant zone of positive divergence is seen over AS.

Wind Shear:

The vertical wind shear of horizontal wind is moderate (10-15 knots) around the system centre and increases towards southwest BOB.

Wind shear is around 5-10 kts over most parts of south and eastcentral AS. It is increasing towards north.

Wind Shear Tendency:

There is increasing tendency of 5-10 kts over most parts of southeast BOB.

There is increasing tendency of 5-10 kts over parts of southeast AS. Another zone of increasing tendency lies over northwest AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, Vortex over southeast BOB & neighbouhood centred within a half deg of 03.5^{0}N/89.0^{0}E. Intensity of the system is T 1.0. The convection shows shear pattern. Minimum cloud top brightness temperature is -84.0^{0}C. Broken low/medium clouds with embedded intense to very intense convection are seen over BOB between latitude 2.0^{0}N to 8.0^{0}N and longitude 82.0^{0}E to 92.0^{0}E in association with the system. Scattered low/medium clouds with embedded moderate to intense convection are seen over rest south BOB south of latitude 9.0^{0}N and south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded isolated weak to moderate convection are seen over southeast AS.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 14^{0}N latitude over BoB.

M.J.O. Index: MJO index is in Phase 3 with amplitude more than one and would continue in Phase 3 with amplitude less than 1 for next 72 hours.

Storms and Depression over South China Sea/ South Indian Ocean:

The cyclonic storm TOKAGE over S China Sea moved west-northwestwards and lay centred at 0600 UTC of today the 28.11.2016 near 16.5°N/117.3°E as a Depression. It would move west-southwestward and weaken further during next 24 hrs.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis based on 00 UTC of 28th November 2016 shows a low over southeast BOB with associated cyclonic circulation extending upto 500 hPa above mean sea level on 28th. The forecast of model shows that the low will intensify into a depression on 29th November over southeast BOB with westward movement. The system will move westnorthwestward and intensify into a cyclonic storm on 30th November over southwest BOB off Sri Lanka coast and It will start weakening and lay over southwest BOB off north TN coast on 1st December and cross Tamil Nadu coast on 2nd December noon as a depression. It will emerge as a low over southeast AS on 4th Dec and would move west-nothwestwards till 8th Dec. A fresh low will develop over south Andaman Sea and southeast BoB on 4th, becoming Depression over southeast BoB on 5th with west-northwestward movement and intensification into a deep depression on 6th over southwest BOB, cyclonic storm over SW Bay off north TN coast on 7th and over SW and adjoining WC Bay off north TN and south AP coast on 8th.

NCEP-GFS: The model analysis based on 00 UTC of 28th November 2016 shows a low over southeast BOB with associated cyclonic circulation extending upto 500 hPa above mean sea level on 28th. The forecast of model shows that the low will intensify into a depression on 29th November over southeast BOB with westward movement. The system will move west-northwestward and intensify into a Deep Depression on 30th and into a cyclonic storm on 1st Dec. over southwest BOB off north TN coast. It crosses north TN coast on 1st and lies as a low over TN on 2nd Dec., over SE Arabian Sea on 2nd Dec. It would move west-nothwestwards till 8th Dec as a low. A fresh low will develop over southeast BoB on 4th, becoming Depression over southeast BoB on 5th with west-northwestward movement and intensification into a deep depression on 6th over south BOB, cyclonic storm over central BOB on 7th and over WC Bay off north AP coast on 8th.

ECMWF: The model analysis based on 00 UTC of 28 November 2016 shows almost similar feature with presence of a low pressure area over the southeast BOB along 4^0N which moves west-northwestward and intensify into a depression and then into a cyclonic storm by 1st December, 2016 over east off north Tamil Nadu and adjoining north Sri Lanka coast. The system is likely to cross Tamil Nadu coast on 2nd December and further move inland to the western part of Tamil Nadu and emerged over the south east Arabian Sea on 4th December. The model also indicates a fresh low pressure system over the southeast Bay of Bengal and adjoining Andaman Sea on 4th December, 2016.

JMA: A low lies over SE Bay on 29th and 30th and depression over SW Bay off Sri Lanka coast on 1st Dec.

Meteo-France ARP Model: It shows development of low over southeast Bay on 28th . It becomes depression over SE Bay on 29th and CS over SW Bay on 30th. It lies over SW Bay off north TN coast.

NCMRWF-NCUM: The analysis based on 00 UTC of 28th November shows a low over southeast BOB on 28th. It moves west-northwestwards, becomes well marked on 29th and depression 30th, deep depression over southwest Bay on 1 Dec. and over SW and adjoining WC Bay off north TN and south AP coast on 2 Dec. It crosses TN coast near Chennai on 02 Dec noon and becomes low over north TN on 3rd Dec. It emerges as a low over SE Arabian Sea on 4 Dec and moves west-nothwestwards till 8 Dec. A fresh low develops over south Andaman Sea on 5th, becomes Depression over north Andaman Sea on 6th and CS over north Andaman Sea and adjoining EC Bay and Yerawady delta on 7th.

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 28th November shows a low pressure area over southeast Bay, becoming depression on 29th Nov, deep depression over southwest Bay on 30th and cyclonic storm over southwest Bay off north TN coast on 1st Dec.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 28th November shows development of a low over southwest Bay on 28th. It becomes well marked low on 29th and 30th, depression over SW Bay on 1st, deep depression over SW Bay off north TN and south AP coast on 02nd Dec. It lies as a low over SE Arabian Sea on 5th and moving wet-northwestwards, becomes a depression over central Arabian Sea on 8th. A fresh low develops over south Andaman Sea on 6th, and over Andaman Sea and adjoining SE Bay on 7th.

IITM-GEFS: The analysis based on 00 UTC of 28th shows low over southeast Bay on 28th . It becomes depression on 29th while moving west-northwestwards and becomes Deep depression 30 Nov. and 1 Dec. and Depression off north TN coast on 2 Dec. and crosses north TN coast around noon of same day. It

emerges as a low over SE Arabian Sea on 3 Dec and moves west-nothwestwards till 6 Dec. A fresh low develops over SE Bay on 5th Dec.

IITM -GFS T1534: The analysis based on 00 UTC of 28th November shows development of a low over southeast Bay on 28th. It becomes depression on 29th Nov, Cyclonic Storm (CS) over SW Bay on 30th, CS over SW Bay off north Sri Lanka and north TN coast on 1 Dec and crossing Central TN coast. on 1st Dec night. It emerges as a low over SE Arabian Sea on 3 Dec and moves west-nothwestwards till 6 Dec. A fresh low develops over south Andaman Sea on 3rd and becomes depression on 4th Dec over southeast Bay, cyclonic storm over southeast Bay on 5th and severe cyclonic storm over southwest and adjoining west central Bay on 6th Dec. while moving northwestwards.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 28 November 2016 show a GPP zone over southeast BOB. The zone of significant GPP moves west-northwestwards and lies over southeast BOB on 29 November, becomes well organized on 30th indicating formation of a cyclonic storm on 30th over southwest Bay. The GPP zone moves west-northwestwards and reaches SW Bay off north Tamil Nadu coast on 1 Dec. 2016. It emerges into SE Arabian Sea on 3 Dec.

Summary and Conclusion:

Majority of models suggest genesis of depression by 29th and west-northwestwards movement,and further intensification upto cyclonic storm on 30th/ 1st. It will be crossing north Tamil Nadu coast on 1st night/ 02nd morning near about 12^0N. Dynamical statistical model of IMD also suggests genesis of the system (cyclonic storm) during next 48 hrs. A few models also show weakening of the system into depression while reaching north TN coast.

Considering all these, the low pressure area over SE Bay is most likely to concentrate into a Depression during next 24 hrs and into a Deep Depression in subsequent 24 hrs while moving west-northwestwards. It is very likely to cross north TN coast near lat. 12^0N.

A fresh low pressure area is likely to develop over southeast Bay on 4th/5th Dec. 2016. It would move northwestwards and concentrate into a Depression on 6th Dec.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Moderate	High	High	High	High

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Intense Observation Period (IOP) : IOP to be undertaken for Tamil Nadu and east Sri Lanka coast for 30 Nov to 02 Dec. and for south AP coast for 1-2 Dec.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	27 /12	**28/00**	**28/03**
India	42	21	54
Coastal stations			
WB	9	3	9
Odisha	6	5	6
AP	10	6	11
Tamil Nadu	10	5	11
Puducherry	1	1	11
A & N	6	1	6
Bangladesh	0	3	3
Myanmar	0	0	11
Thailand	3	3	3
Sri Lanka	8	0	6

AWS:

Region	Date/Time (UTC)		
	27 /12	**28 /00**	**28 /03**
WB	3	5	4
Odisha	4	2	4
AP	8	8	5
Tamil Nadu	22	9	10
Puducherry	1	1	0
A & N	0	0	0

- **RS/RW** (12Z) 27.11.2016 : 17 /43
- **No. of Ascents reaching 250 hPa levels:17 , MISDA:- 1**

- **RS/RW** (00Z) of 28.11.2016 :17 /43

- **No. of Ascents reaching 250 hPa levels:16 , MISDA: 11**

No. of PILOT Ascents

27/12Z	28 /00Z
18	11

Buoy Data

27/12Z	28/00Z	28 /03Z
12	12	13

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**27.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /27.11.2016 : 6

No. of Ascents reaching 250 hPa level = 6

MISDA : 2

12Z /27.11.2016 : 3

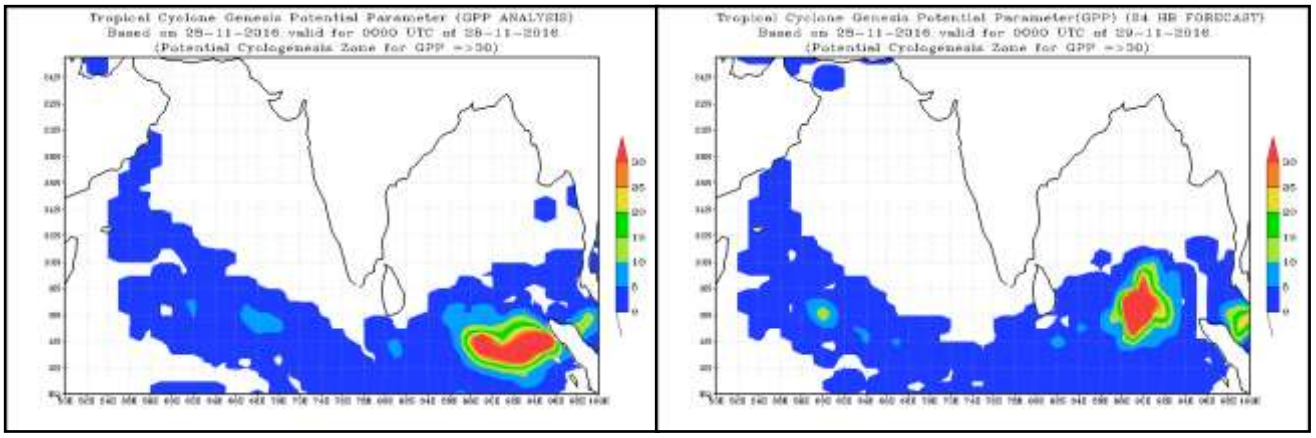
No. of Ascents reaching 250 hPa level = 3

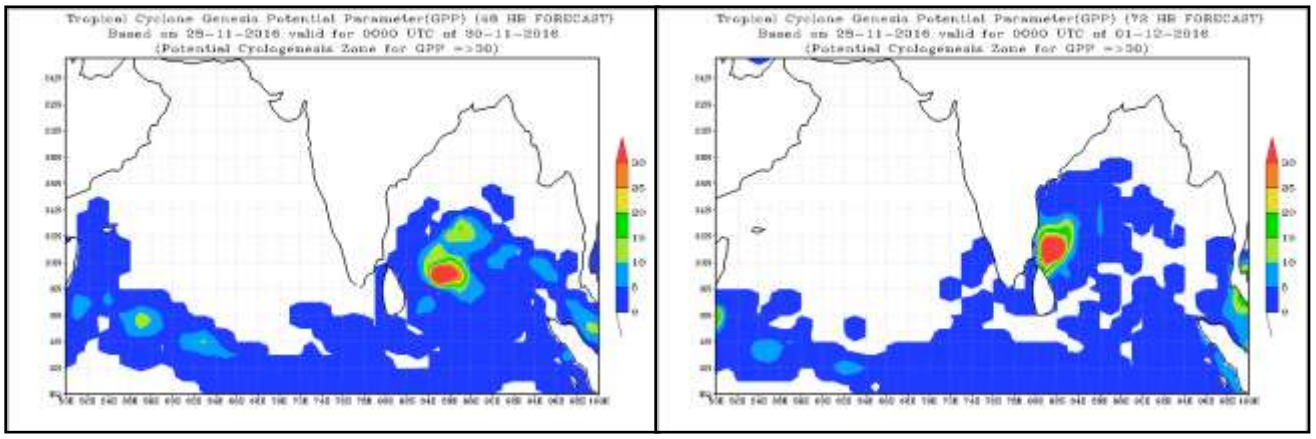
MISDA : 5

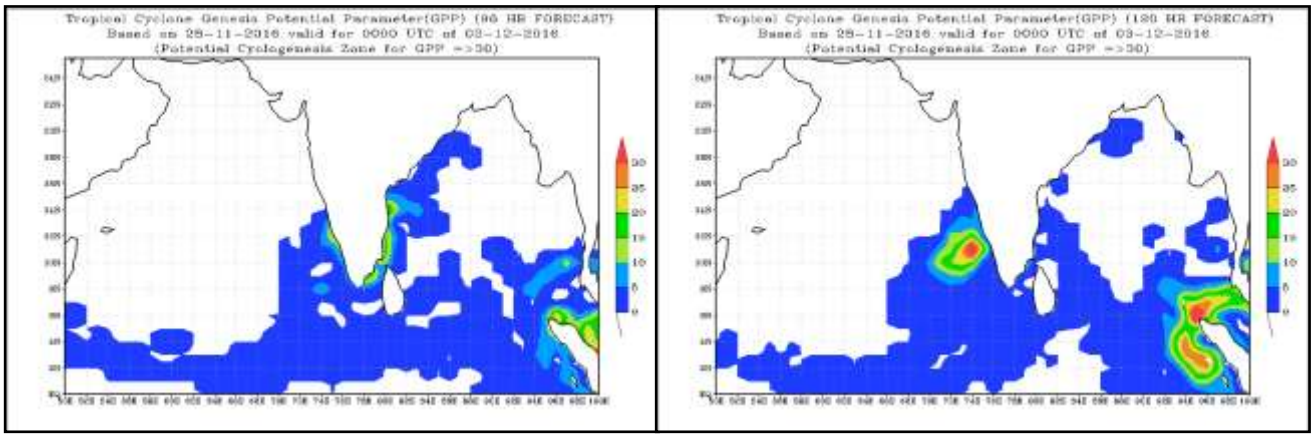
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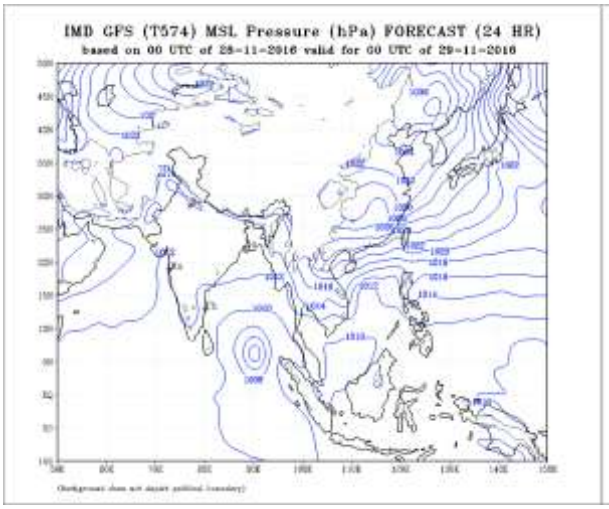
27.11.2016	
06Z	18Z
4	3

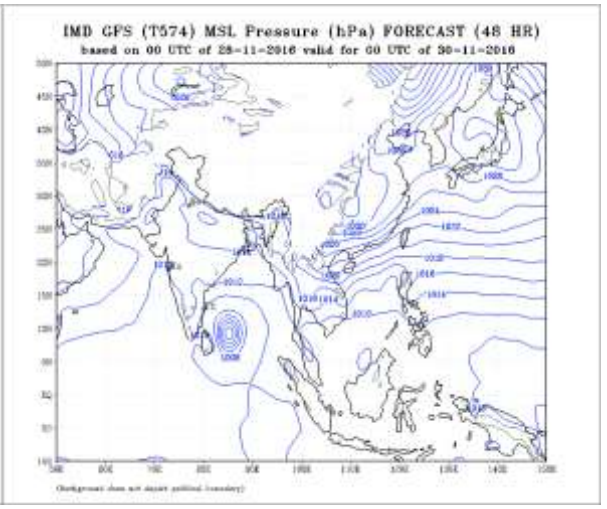
Annexure-II

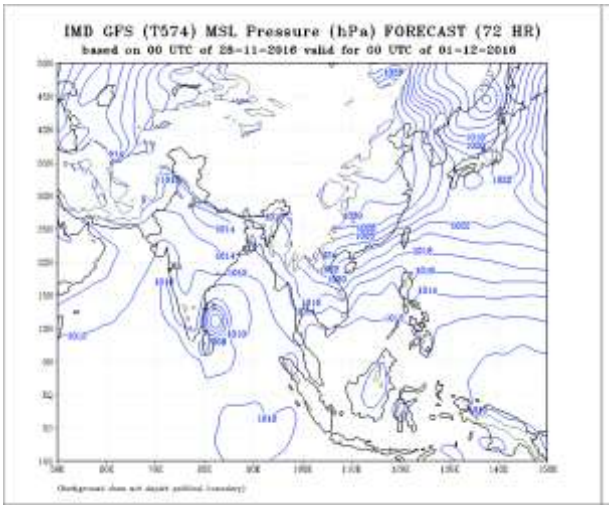

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 28-11-2016 valid for 0000 UTC of 28-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 28-11-2016 valid for 0000 UTC of 29-11-2016
(Potential Cyclogenesis Zone for GPP =>30)

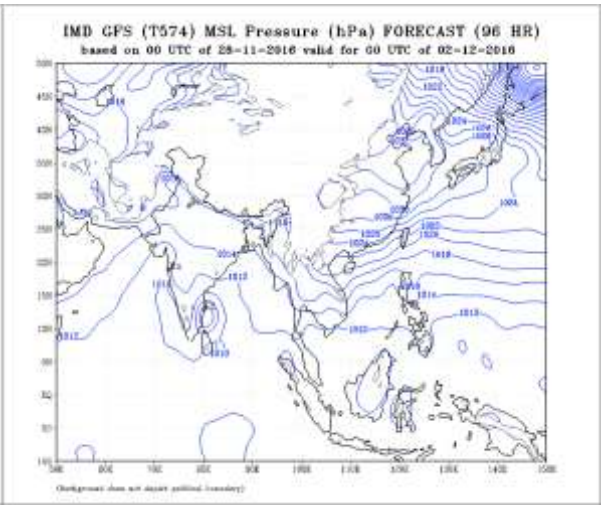

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 28-11-2016 valid for 0000 UTC of 30-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 28-11-2016 valid for 0000 UTC of 01-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

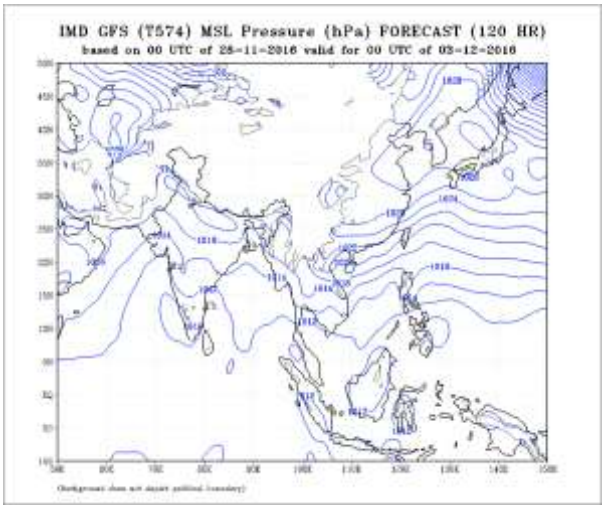

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 28-11-2016 valid for 0000 UTC of 02-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 28-11-2016 valid for 0000 UTC of 03-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

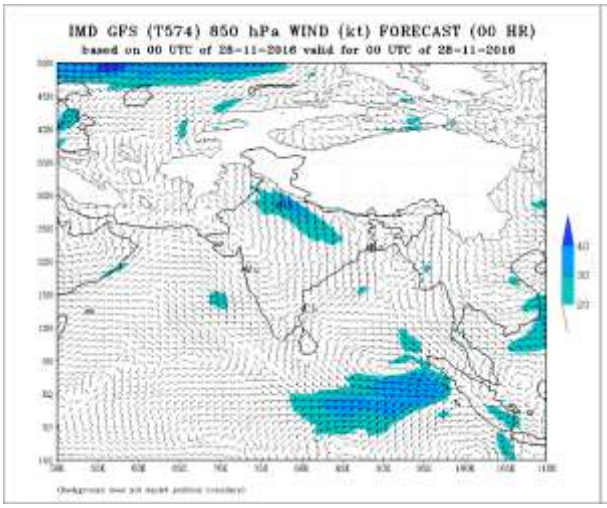

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 29-11-2016

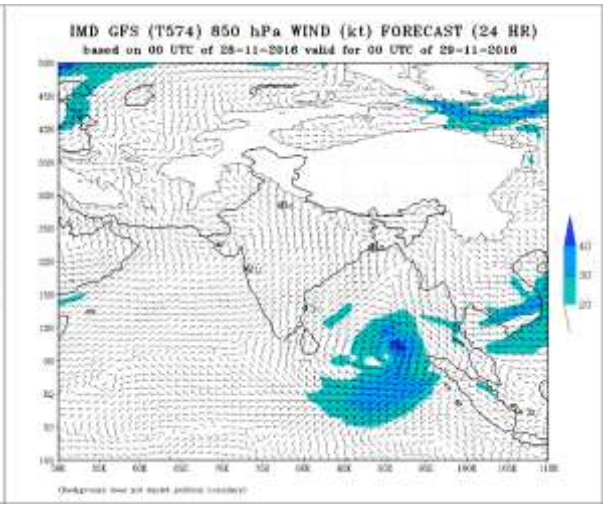

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
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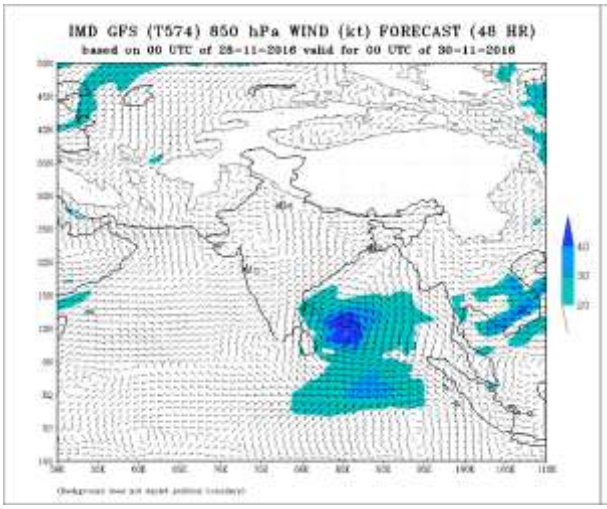

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
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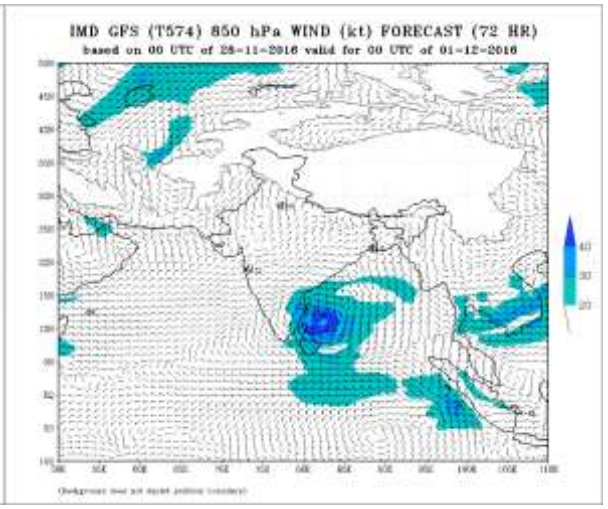

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
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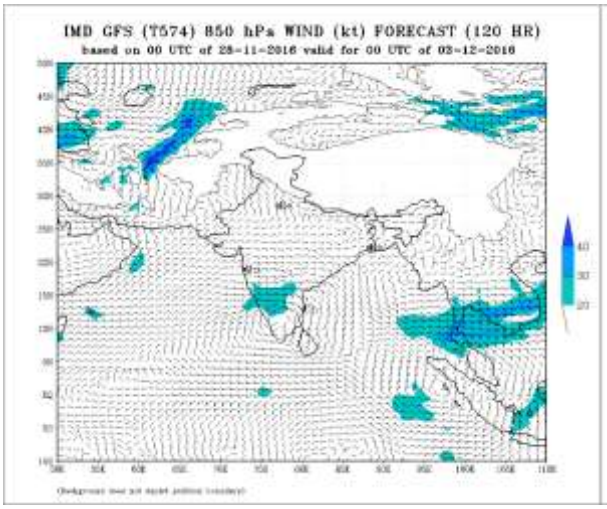

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
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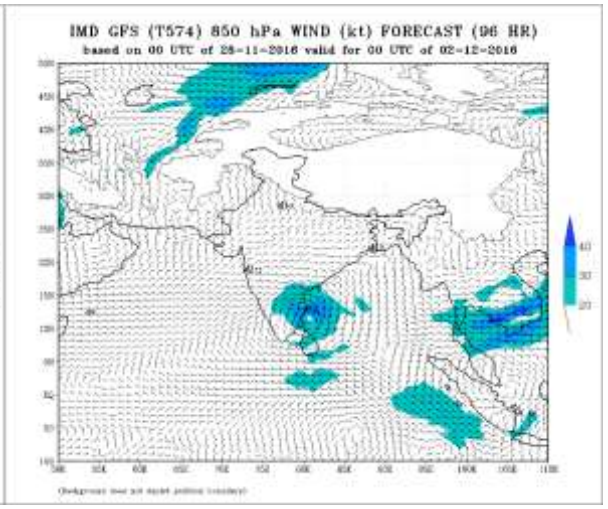

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
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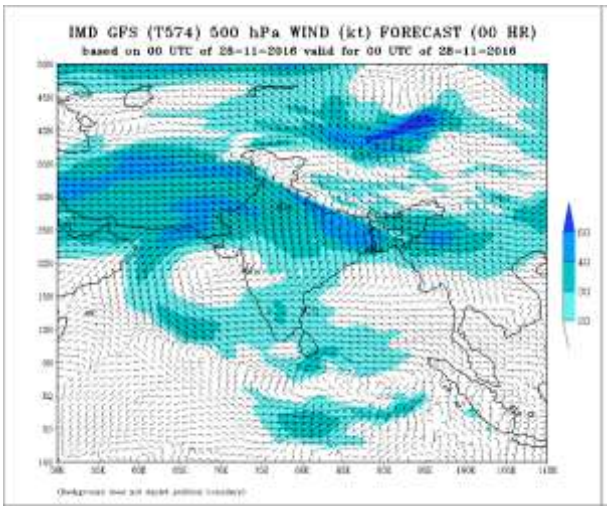

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
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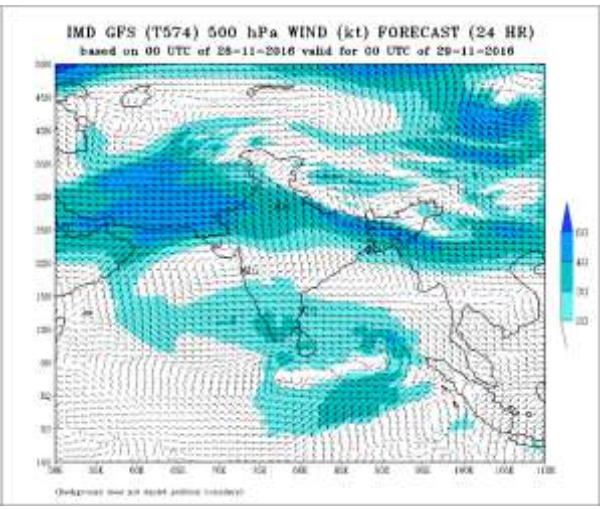

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
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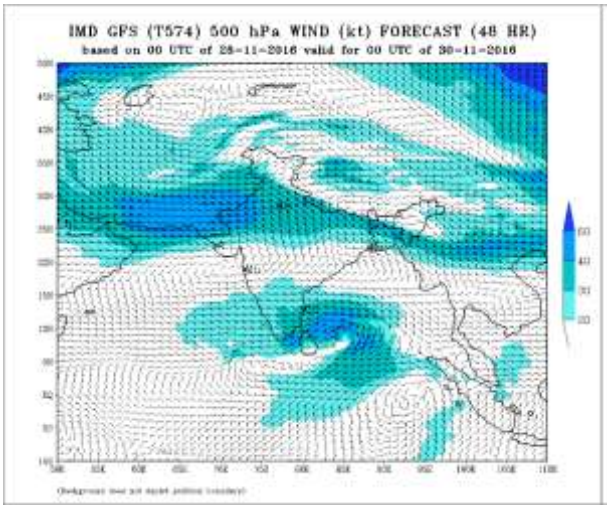

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
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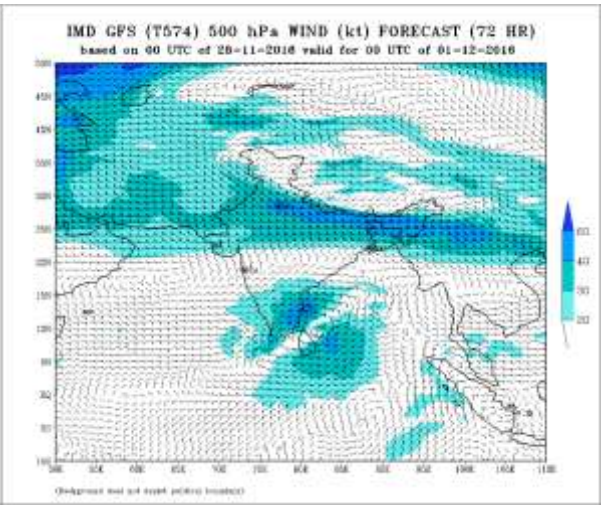

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
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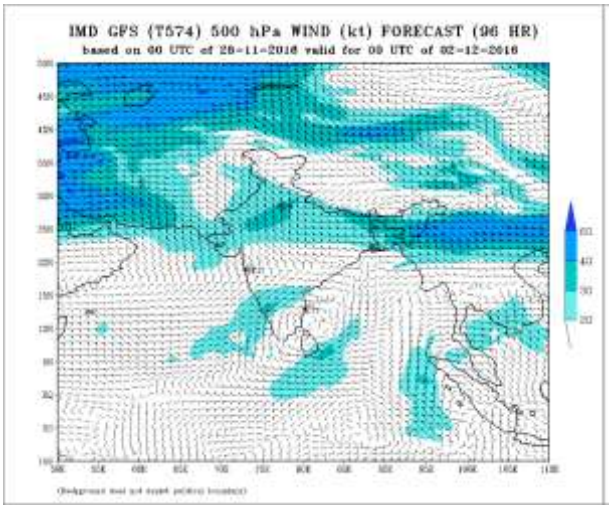

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
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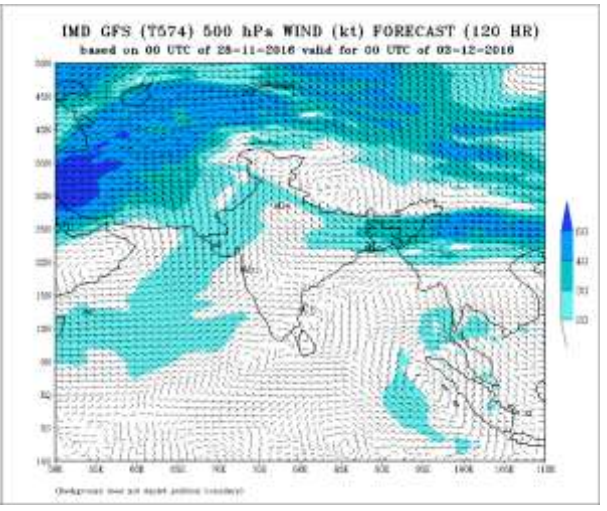

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
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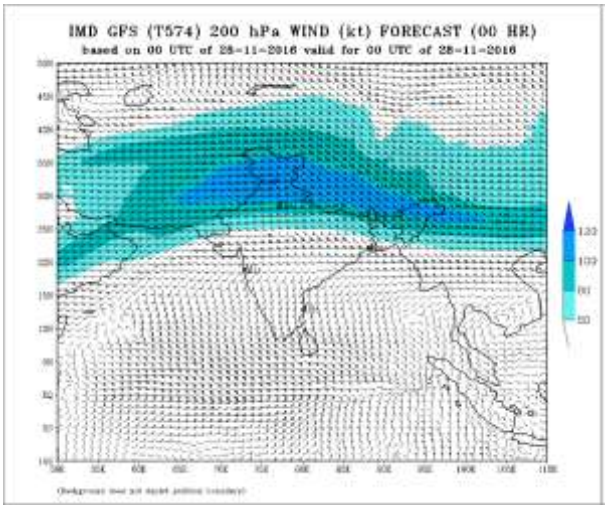

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
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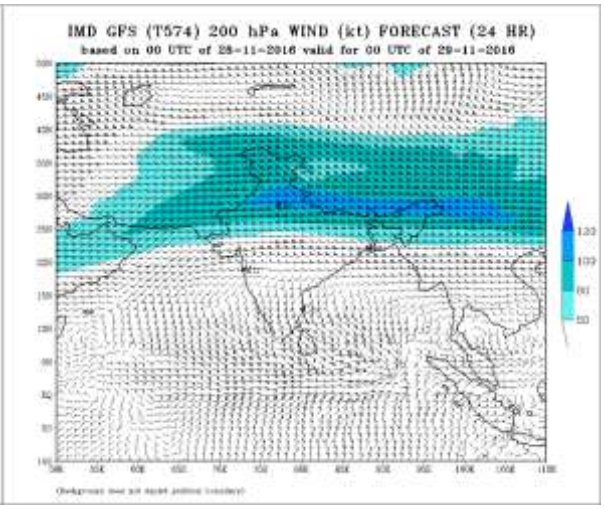

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 30-11-2016

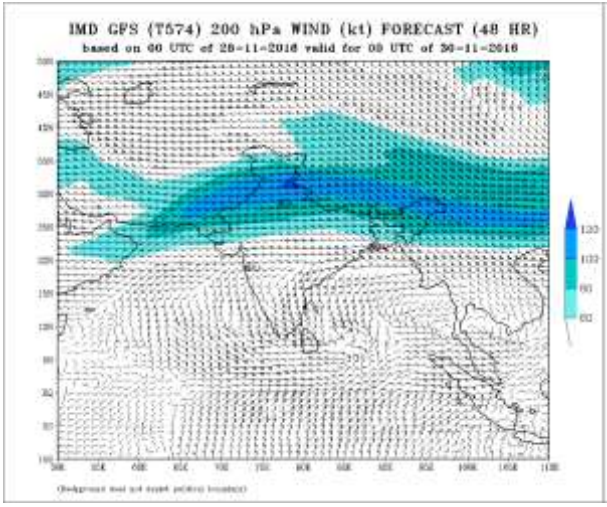

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 01-12-2016

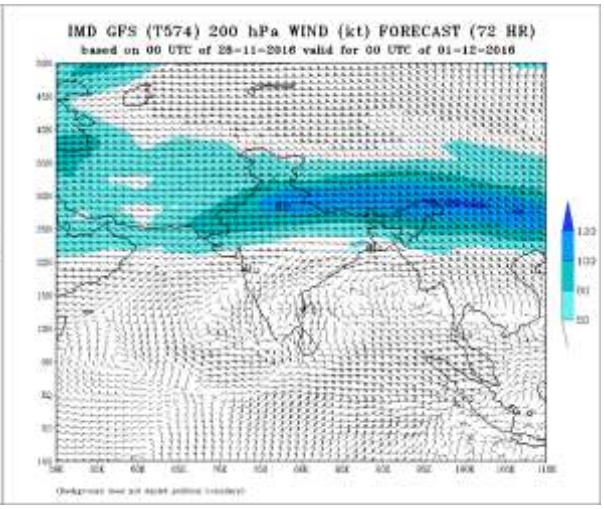

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 02-12-2016

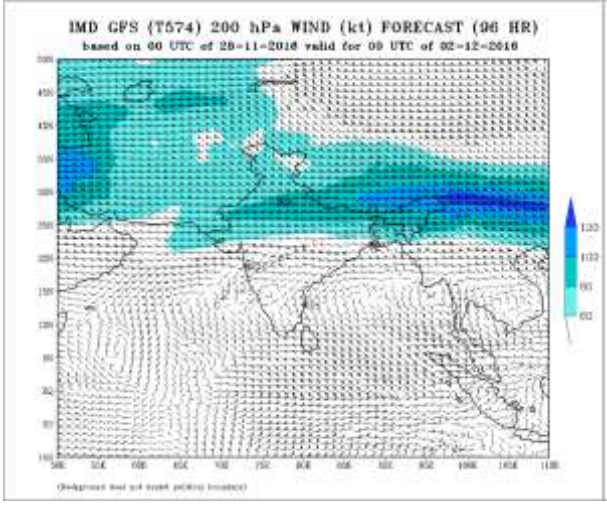

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 03-12-2016

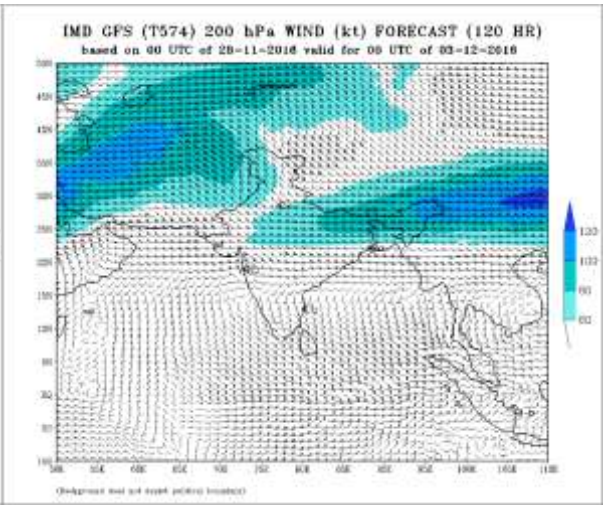

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 28-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 29-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 30-11-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 01-12-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 02-12-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 28-11-2016 valid for 00 UTC of 03-12-2016

FDP (Cyclone) NOC Report Dated 29th November, 2016

Synoptic features:

Yesterday's low pressure area over southeast Bay of Bengal persists and is well marked (WML). It is very likely to concentrate into a depression during next 24 hours.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature around WML is 29˚C. It decreases towards Sri Lanka and north Tamil Nadu coast becoming 28˚C. It is around 28˚C over most parts of central and south BOB. It is decreasing towards north BOB around 27˚C.

The SST over most parts of westcentral and northwest Arabian Sea (AS) is between 26-28˚C. It is 28-29˚C over most parts of southwest AS. It is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast. SST is 28-29˚C over most parts of eastcentral and southeast AS.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 80-100 KJ/cm^2 around the system and it decreases towards southwest BOB near Sri Lanka and north Tamil Nadu coast becoming less than 50 KJ/cm^2 over southwest BOB off north Tamil Nadu and south Andhra Pradesh coasts. It is less than 50 kJ/cm^2 over north BoB and also in some parts of westcentral BoB. TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala & Karnataka coast and over Comorin area where TCHP is around 100 kJ/cm^2

Relative Vorticity:

The low level relative vorticity is about 100-120x10^{-6} second^{-1} in the southern sector of the system. It is decreasing towards west BOB and its value is around 25 x10^{-6} second^{-1} near Sri Lanka and Tamil Nadu coasts.

The low level relative vorticity is about 25x10^{-6} second^{-1} over south AS and adjoining equatorial region. It is negative over eastern parts of AS.

Convergence:

Low level convergence is about 30x10^{-6}s^{-1} in the southwest sector of the system.

Small zones of positive low level convergence zone of 5-10x10^{-6} s^{-1} are also seen over southwest AS and Comorin Area.

Divergence:

The upper level divergence is around 30x10^{-5} second^{-1} in the southwest sector of the system.

An elongated zone of positive divergence (5-10 x10^{-5} second^{-1}) is seen over south BOB upto southeast AS.

Wind Shear:

The vertical wind shear of horizontal wind is moderate (10-20 knots) over the the WML region and increases towards southwest BOB becoming more than 20 knots.

Wind shear is around 10-20 kts over most parts of south and eastcentral AS. It is increasing towards north.

Wind Shear Tendency:

There is increasing tendency of 5-10 kts over most parts of southeast BOB.

There is an extended zone of increasing tendency of 5-10 kts over parts of southwest BOB off Sri Lanka and Tamil Nadu upto southeast AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, Vortex over southeast BOB & adjoining Indian Ocean centred within a half deg of 06.2^{0}N/88.0^{0}E. Intensity of the system is T 1.0. The convection shows shear pattern. Minimum cloud top brightness temperature is -88.0^{0}C. Broken low/medium clouds with embedded intense to very intense convection are seen over south BOB and adjoining Indian Ocean between latitude 2.5^{0}N to 12.0^{0}N and longitude 83.5^{0}E to 90.5^{0}E in association with the system. Scattered low/medium clouds with embedded moderate to intense convection are seen over rest south BOB and south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded isolated moderate to intense convection are seen over southeast AS.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 14^{0}N latitude over BoB.

Index: MJO index is in Phase 3 with amplitude about one and would continue in Phase 3 and 2 with amplitude less than 1 for next 72 hours.

Storms and Depression over South China Sea/ South Indian Ocean:

The remnant tropical depression over S China Sea moved west-southwestwards and weakened into a low pressure area.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis based on 00 UTC of 29th November 2016 shows a low over southeast BOB with associated cyclonic circulation extending upto 850 hPa above mean sea level on 29th. The forecast of model shows that the low will intensify into a depression on 30th November over southeast BOB with westward movement. The system will move westnorthwestward and intensify into a cyclonic storm on 1stDecember over southwest BOB off north Tamil Nadu coast and cross Tamil Nadu coast on 2nd December morning as a depression near lat. 11.5^0N. Moving westwards, it will emerge as a low over southeast AS on 3rd Dec and would move west-nothwestwards till 9th Dec. without any intensification.

A fresh low will develop over southeast BoB and adjoining south Andaman Sea on 5th. Moving west-northwestward, it will become Depression over southeast BoB on 6th, deep depression on 7 th & 8 th over southeast BOB and cyclonic storm over westcentral BoB on 9 th.

NCEP-GFS: The model analysis based on 00 UTC of 29 th November 2016 shows a low over southeast BOB. The forecast of model shows that the low will intensify into a depression on 30 th November and into a cyclonic storm on 1st Dec. over southwest BOB off Tamil Nadu coast. The system will cross TN coast on 2nd morning as a Depression and emerge over southeast AS on 3rd December. It would then move west-northwestwards without any intensification.

A fresh low will develop over southeast BoB and adjoining south Andaman Sea on 5th. Moving west-northwestward, it will become Depression over southeast BoB on 6th, deep depression on 7th over southeast BOB and cyclonic storm over westcentral BoB on 8th and 9th.

ECMWF: The model analysis based on 00 UTC of 29 November 2016 shows almost similar feature with presence of a low pressure area over the southeast BOB which moves west- northwestward and intensify into a depression on 30th and then into a cyclonic storm by 1st December, 2016 over southwest BOB off north Tamil Nadu and adjoining north Sri Lanka coast. The system is likely to cross Tamil Nadu coast on 2nd December morning near about 12^0 N as a depression and further move inland to the western part of Tamil Nadu and emerged over the southeast Arabian Sea on 3th December. Thereafter, it will move westwards without further intensification. The model also indicates a fresh low pressure system over the southeast Bay of Bengal and adjoining Andaman Sea on 4th December, 2016.

JMA: A low lies over SE Bay on 29 th, becomes depression over SW Bay on 30th and deep depression over SW Bay 1st Dec and on 02 Dec. it lies as a cyclonic storm ober SW Bay off north TN coast. It then shows signs of weakening while moving west-northwestwards.

Meteo-France ARP Model: It shows development of low over southeast Bay on 29th . It becomes depression over SE Bay on 30th and deep depression over SW Bay on 1st Dec. It lies as depression over SW Bay close to north TN coast on 2nd Dec. morning.

NCMRWF-NCUM: The analysis based on 00 UTC of 29th November shows a low over southeast BOB on 29th. It moves west-northwestwards, becomes depression 30th, depression over southwest Bay on 1 Dec. and over SW Bay off north TN coast on 2 Dec. It crosses TN coast near Chennai on 02 Dec morning/noon. It emerges as a low over SE Arabian Sea on 4 Dec and moves west-nothwestwards gradually intensifying into a Depression on 6th over central Arabian Sea and deep depression over west central Arabian Sea on 8 Dec, cyclonic storm over WC Arabian Sea on 9 th. A fresh low develops over south Andaman Sea on 4 th, becomes Depression over north Andaman Sea on 6 th and CS over north Andaman Sea and adjoining EC Bay and Irrawady delta on 7 th. It crosses Irrawady delta on the same day and becomes less marked on 8 th.

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 29th November shows a low pressure area over southeast Bay, becoming cyclonic storm over southwest Bay on 30 th and severe cyclonic storm over southwest Bay off north TN coast on 2 nd morning.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 29th November shows development of a low over southwest Bay on 29th. It becomes depression on 30th, cyclonic storm over SW Bay on 1 st, deep depression over SW Bay off north TN coast near 12^0 N on 02 nd Dec. It lies as a low over SE Arabian Sea on 3 rd and 4th and moving wet-northwestwards, becomes a depression over SE Arabian Sea on 5th, cyclonic storm on 6 th,

7 th and severe cyclonic storm over WC Arabian Sea on 8 th and 9 th. A fresh low develops over south Andaman Sea on 5th, and becomes Deep Depression over Andaman Sea a on 6 th and cyclonic storm over EC Bay and adjoining north Andaman Sea on 7 th.

IITM-GEFS: The analysis based on 00 UTC of 29th shows low over southeast Bay on 29th. It becomes Deep depression on 30 Nov. and 1 Dec. and Depression SW Bay off north TN coast on 2 Dec. and crosses north TN coast around morning/noon of same day. It emerges as a low over SE Arabian Sea on 3 Dec and moves west-nothwestwards and becomes depression on 6th and 7th Dec. A fresh low develops over SE Bay on 5th Dec, becoming Depression on 6th and 7th while moving northwestwards.

IITM -GFS T1534: The analysis based on 00 UTC of 29th November shows development of a low over southeast Bay on 29th. It becomes depression/deep depression on 30th Nov, Cyclonic Storm (CS) over SW Bay on 1st Dec and crossing coast near 12^0 N on same night. It emerges as a low over SE Arabian Sea on 3 Dec and moves west-nothwestwards becoming depression on 5 th and 6th over central Arabian Sea and again becomes low on 7 th over WC Arabian sea. A fresh low develops over south Andaman Sea on 4 th and becomes depression on 5 th Dec over southeast Bay, continues to move northwestwards as a depression till 7 th upto WC Bay.

WRF: The WRF model analysis on 00 UTC of 29 November 2016 presence of low pressure system over southeast Bay of Bengal. The forecast during next 3 days shows west- northwesterly movement along with gradual intensification of the system into a Depression and into a cyclonic storm by late 1st December, 2016 over east off south Tamil Nadu coast and adjoining north Sri Lanka coast. The system is likely to cross Tamil Nadu coast on 2nd December.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 29 November 2016 show a GPP zone over southeast BOB. The zone of significant GPP moves west-northwestwards and lies over over southwest BoB off Tamil Nadu coast on 1st December. It lies over Tamil Nadu coast on 2 nd December and emerges into SE Arabian Sea on 3 Dec. with weaker intensity. A fresh potential zone of cyuclogenesis is seen over south Andaman Sea on 3 rd Dec. It will move west- northwestwrads during subsequent 72 hours.

Summary and Conclusion:

Majority of models suggest genesis of depression by 29 th /30 th and west-northwestwards movement. It would further intensification upto cyclonic storm on 1st Dec. It will be crossing north Tamil Nadu coast on 02th morning near about 11.5-120N. Dynamical statistical model of IMD also suggests genesis of the system (cyclonic storm) during next 48 hrs. A few models also show weakening of the system into depression while reaching north TN coast.

Considering all these, the low pressure area over SE Bay is most likely to concentrate into a Depression during next 12 hrs and into a Deep Depression and subsequently a cyclonic storm in subsequent 24 hrs while moving west-northwestwards. It is very likely to cross north TN coast near lat. 12^0 N with slight weakening and hence as a deep depression.

The emergence of the remnant low into SE Arabian sea and its possible intensification needs to be monitored.

A fresh low pressure area is likely to develop over southeast Bay on 4th/5th Dec. 2016. It would move northwestwards and concentrate into a Depression on 6th Dec.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	High	High	High	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Intense Observation Period (IOP) : IOP to be undertaken for Tamil Nadu and east Sri Lanka coast for 30 Nov to 02 Dec. and for south AP coast for 1-2 Dec.

Annexure- I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	28 /12	29/00	29/03
India	31	24	48
Coastal stations			
WB	5	3	6
Odisha	7	5	6
AP	10	9	10
Tamil Nadu	7	5	9
Puducherry	1	1	11
A & N	1	1	6
Bangladesh	11	13	14
Myanmar	9	6	7
Thailand	3	3	3
Sri Lanka	10	8	10

AWS:

Region	Date/Time (UTC)		
	28 /12	29 /00	29 /03
WB	3	4	4
Odisha	3	3	3
AP	4	6	9
Tamil Nadu	24	9	20
Puducherry	1	1	0
A & N	0	0	0

RS/RW (12Z) 28.11.2016 : 23 /43

- **No. of Ascents reaching 250 hPa levels:11 , MISDA:- 12**

RS/RW (00Z) of 29.11.2016 : 21/43

- **No. of Ascents reaching 250 hPa levels:21 , MISDA: 2 No. of PILOT Ascents**

28/12Z	29 /00Z
9	3

Buoy Data

28/12Z	29/00Z	29 /03Z
5	6	4

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	28.11.2016							
UTC→	00	03	06	09	12	15	18	21
Chennai Region (Coasts of AP & TN)	20	22	20	20	22	20	20	20

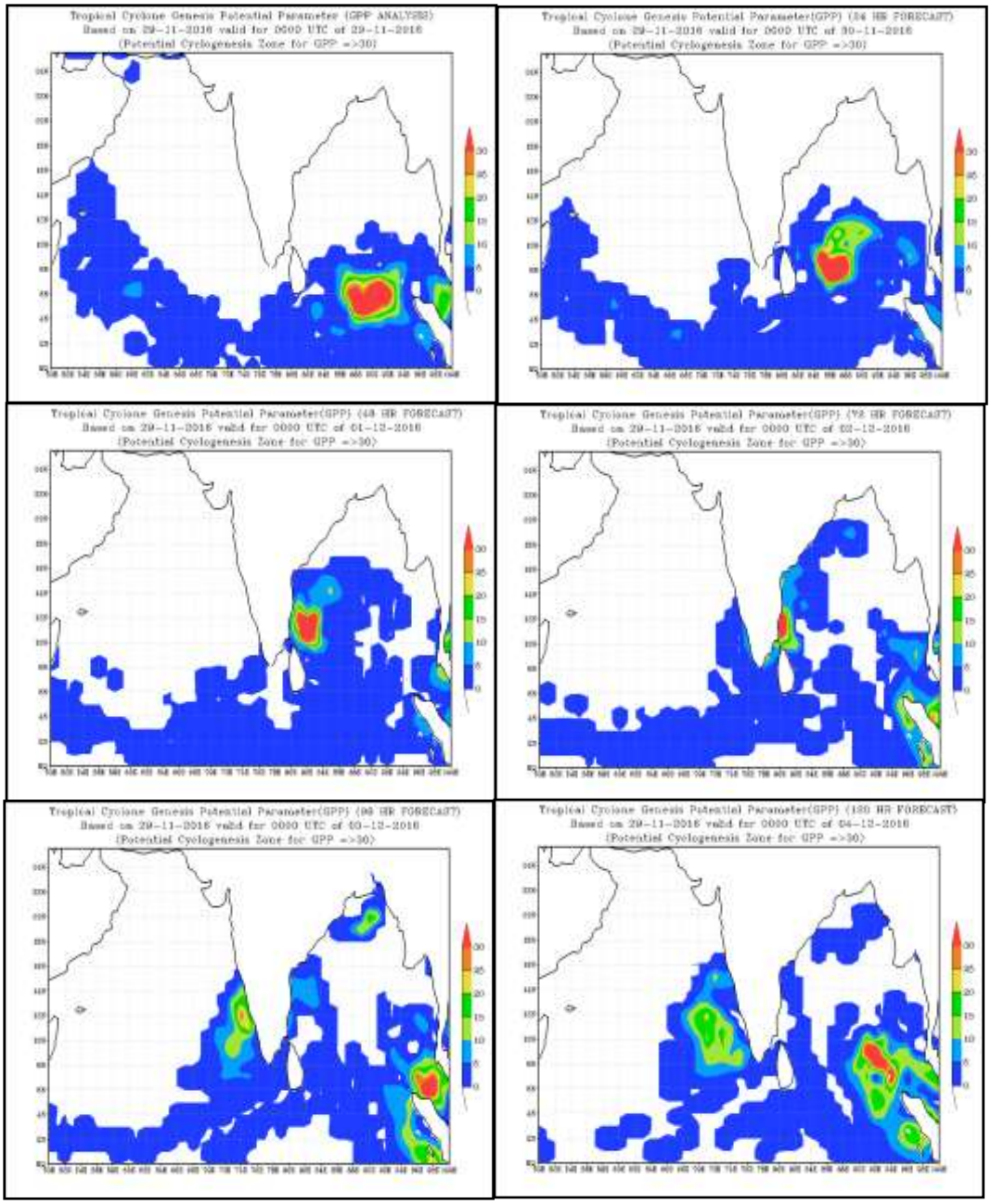
No. of RS/RW Ascents

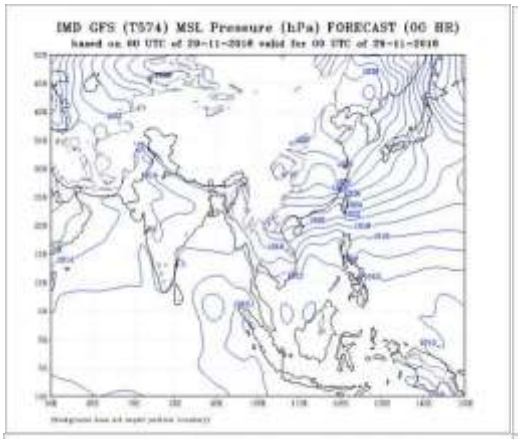
00Z /28.11.2016 :7
No. of Ascents reaching 250 hPa level = 7
MISDA: 1
12Z /28.11.2016 :3
No. of Ascents reaching 250 hPa level = 3
MISDA5

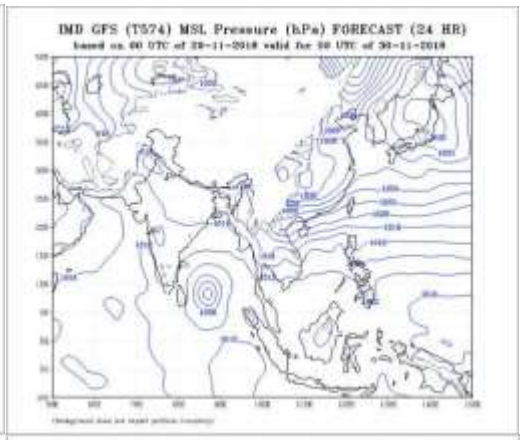
No. of PILOT Ascents:

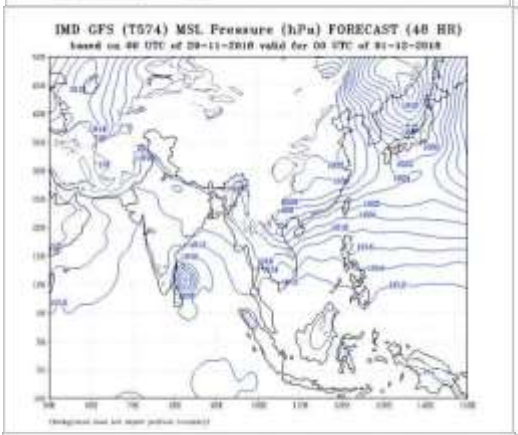
28.11.2016	
06Z	18Z
5	3

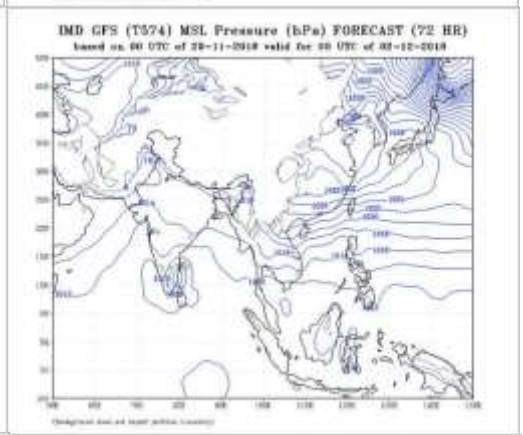
Annexure-II

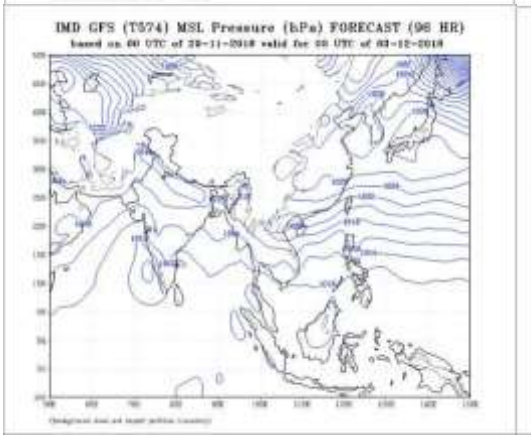

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 29-11-2016 valid for 0600 UTC of 29-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 29-11-2016 valid for 0600 UTC of 30-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 29-11-2016 valid for 0000 UTC of 01-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 29-11-2016 valid for 0000 UTC of 02-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 29-11-2016 valid for 0000 UTC of 03-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 29-11-2016 valid for 0000 UTC of 04-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

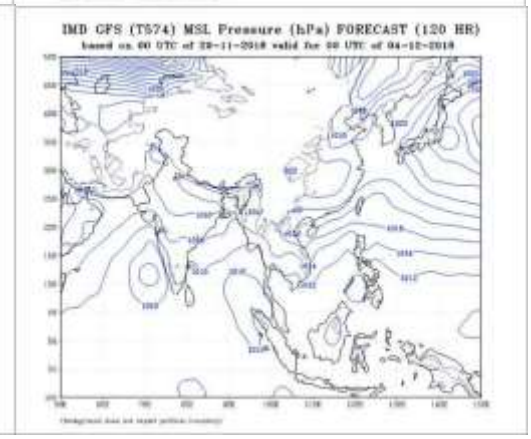

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)

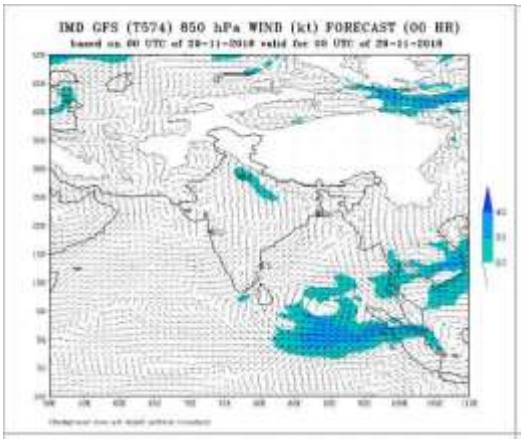

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)

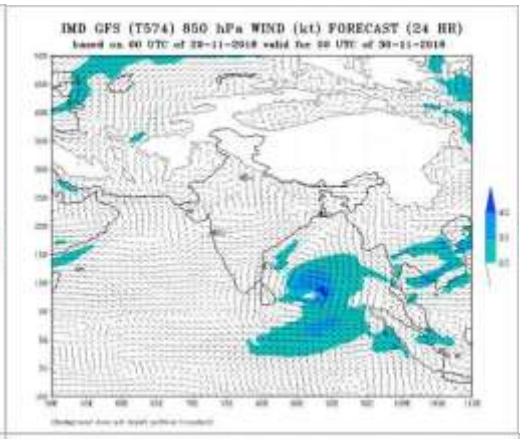

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)

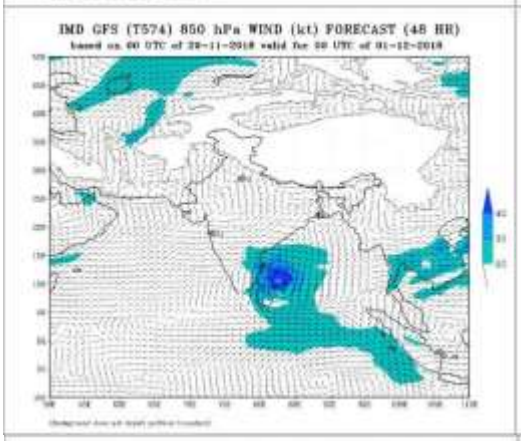

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)

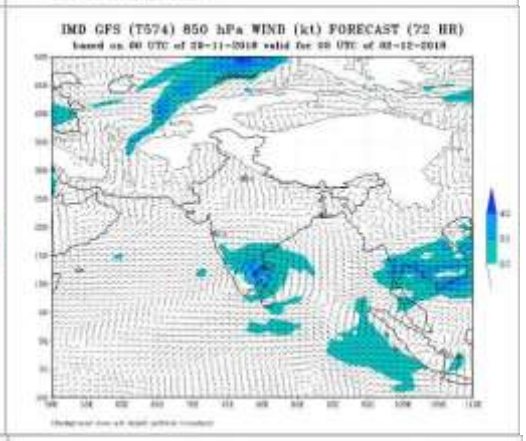

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)

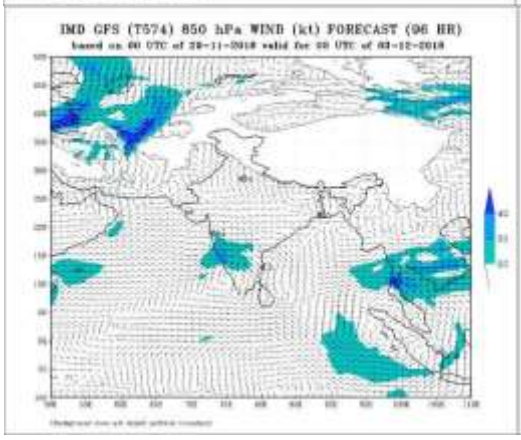

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)

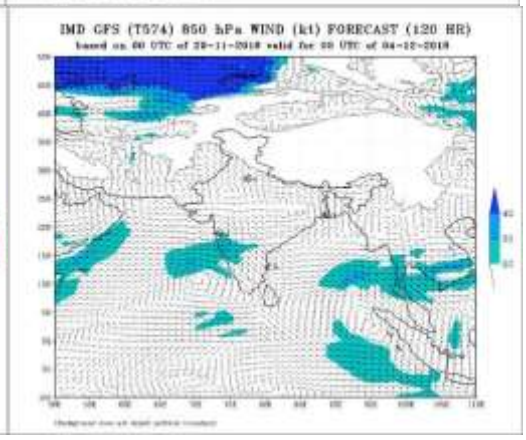

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)

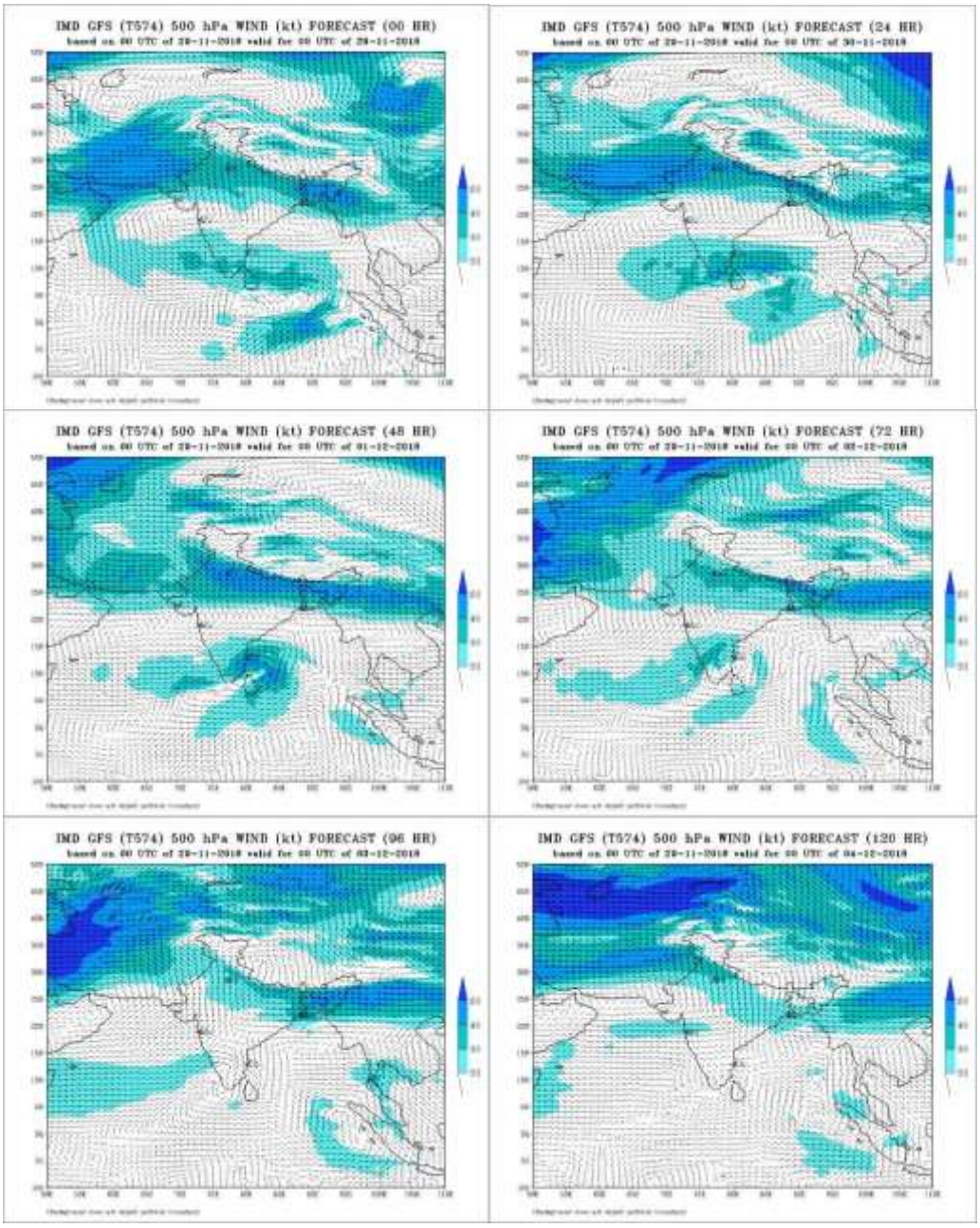

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)

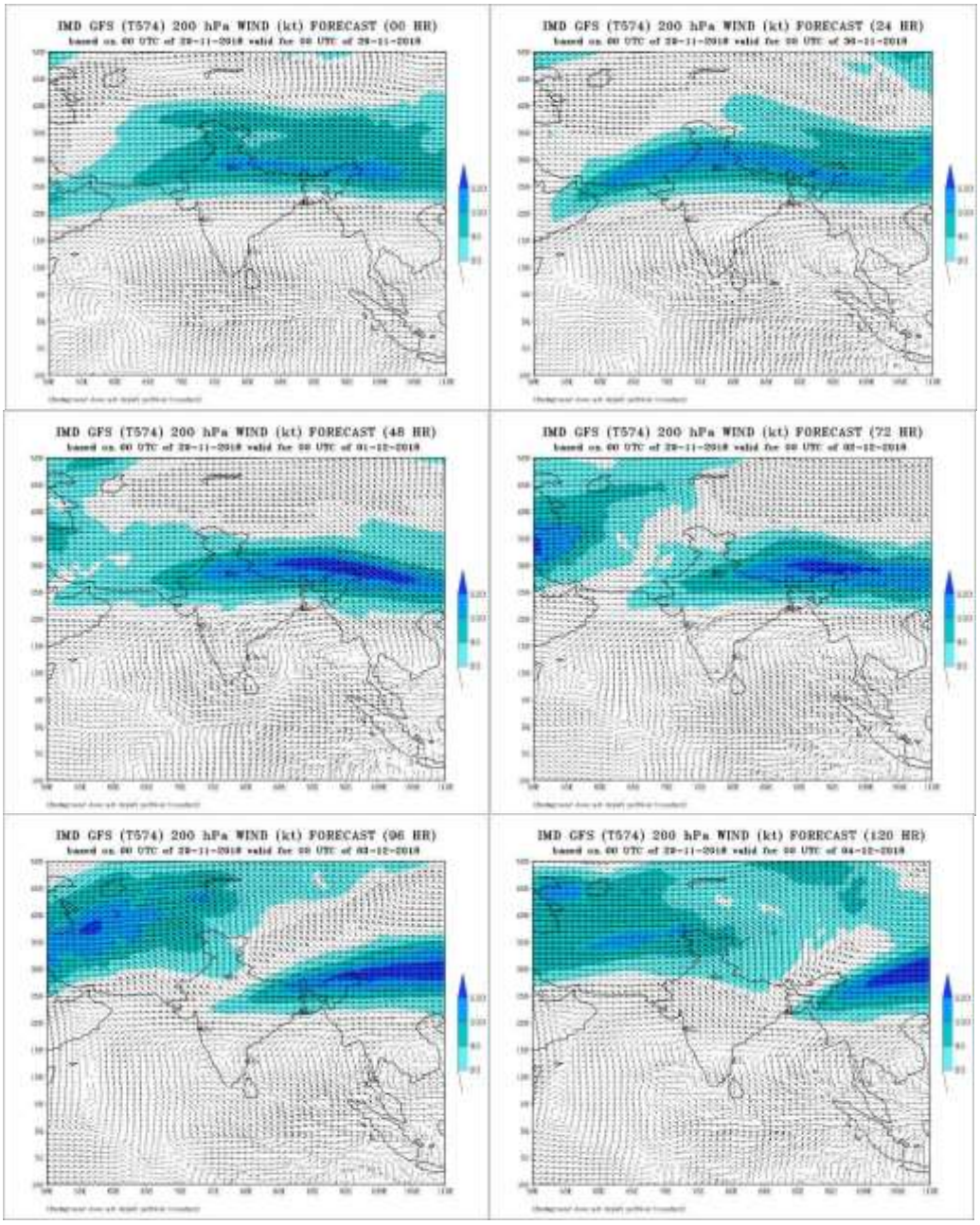

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)


IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)


IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)


IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 28-11-2018 valid for 00 UTC of 28-11-2018
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 28-11-2018 valid for 00 UTC of 30-11-2018
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
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IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 28-11-2018 valid for 00 UTC of 05-12-2018
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 28-11-2018 valid for 00 UTC of 04-12-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 28-11-2018 valid for 00 UTC of 28-11-2018
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 28-11-2018 valid for 00 UTC of 29-11-2018
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 28-11-2018 valid for 00 UTC of 01-12-2018
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based on 00 UTC of 28-11-2018 valid for 00 UTC of 02-12-2018
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 28-11-2018 valid for 00 UTC of 03-12-2018
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 28-11-2018 valid for 00 UTC of 04-12-2018

FDP (Cyclone) NOC Report Dated 30th November, 2016

Synoptic features:

Yesterday's low pressure area over southeast Bay of Bengal concentrated into a depression over southeast Bay of Bengal (BOB) at 1200 UTC of 29th November. Moving west-northwestwards, it intensified into a deep depression over southeast BOB at 0000 UTC of 30th and further into a cyclonic storm **"Nada"** over southwest and adjoining southeast BoB at 0300 UTC of today, the 30th November. Thereafter, it moved nearly northwestwards during past six hours with a speed about 21 kmph and lay centred at 0600 UTC of today, the 30th november, 2016 near latitude 8.7ºN and longitude 85.0ºE, about 710 km southeast of Chennai, 670 km east-southeast of Puducherry and 410 km east of Trincomalee. The system is very likely to move west-northwestward, intensify further and cross north Tamil Nadu coast between Vedaranniyam and Puducherry close to Cuddalore by early hours of 2nd December.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29˚C near the system centre. It decreases towards Sri Lanka and north Tamil Nadu coast becoming 28˚C. It is around 28˚C over most parts of central and south BOB. It is decreasing towards north BOB around 27˚C.

The SST over most parts of westcentral and northwest Arabian Sea (AS) is between 26-28˚C. It is 28-29˚C over most parts of southwest AS. It is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast. SST is 28-29˚C over most parts of eastcentral and southeast AS.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 80-100 KJ/cm^2 around the system and it decreases towards southwest BOB near Sri Lanka and north Tamil Nadu coast becoming less than 50 KJ/cm^2.over southwest BOB off north Tamil Nadu and south Andhra Pradesh coasts. It is less than 50 kJ/cm^2 over north BoB and also in some parts of westcentral BoB.

TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala & Karnataka coast and over Comorin area where TCHP is around 100 kJ/cm^2.

Relative Vorticity:

The low level relative vorticity is about 150x10^{-6} second^{-1} near the system centre. It is decreasing towards west BOB and its value is around 25 x10^{-6} second^{-1} near Sri Lanka and along the east coast of India.

The low level relative vorticity is about 25x10^{-6} second^{-1} over south AS and adjoining equatorial region. It is negative over eastern parts of AS.

Convergence:

Low level convergence is about 50x10^{-6} s^{-1} in the southwest sector of the system.

Small zones of positive low level convergence zone of 5-10x10^{-6} s^{-1} are also seen over southwest AS and Comorin Area.

Divergence:

The upper level divergence is around 40x10^{-5} second^{-1} in the southwest sector of the system.

An elongated zone of positive divergence (5-10 x10^{-5} second^{-1}) is seen over south BOB upto southeast AS.

Wind Shear:

The vertical wind shear of horizontal wind is moderate (10-20 knots) around the system centre and increases towards southwest BOB near Sri Lanka and north Tamil Nadu becoming more than 20 knots.

Wind shear is around 10-20 kts over most parts of south AS. It is increasing towards north.

Wind Shear Tendency:

The shear tendency of 5-10 kts over parts of southwest BOB and is almost zero towards Sri Lanka and Tamil Nadu coasts..

There is an extended zone of increasing tendency of 5-10 kts over parts of southwest BOB off Sri Lanka and Tamil Nadu upto southeast AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, Vortex "NADA" over southwest and adjoining southeast BOB is centred near 09.5^0N/84.5^0E. Intensity of the system is T 2.5. The convection shows curved band pattern. Minimum cloud top brightness temperature is -83.0^0C. Broken low/medium clouds with embedded intense to very intense convection are seen over south BOB and adjoining Indian Ocean between latitude 7.0^0N to 13.5^0N and longitude 80.0^0E to 87.0^0E and adjoining Sri Lanka. Scattered low/medium clouds with embedded moderate to intense convection are seen over rest south BOB and south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded isolated moderate to intense convection are seen over southeast AS.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 14^0N latitude over BoB.

M.J.O. Index: MJO index is in Phase 3 with amplitude less than one and would continue in Phase 3 and 2 with amplitude less than 1 for next 72 hours.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis based on 00 UTC of 30 November 2016 shows the Depression over southwest Bay of Bengal and adjoining equatorial Indian Ocean. The forecast during next 5 days gradual intensification of the system into a cyclonic storm by late 30 November or early 1st December, 2016 over east off south Tamil Nadu coast and adjoining north Sri Lanka coast with west-northwest movement. The system is likely to cross Tamil Nadu coast on 2nd December, 2016 and move westward over the Tamil Nadu region till 3rd December, 2016 and emerged over the southeast Arabian Sea on 3rd/4th December.

The model also indicates a fresh low pressure system over the southeast Bay of Bengal and adjoining Andaman Sea on 4th December, 2016, which likely to intensify further while moving in west-north-west direction.

NCEP-GFS: The model charts based on 00 UTC of 30th November 2016 shows the system over southwest BOB and adjoining equatorial Indian Ocean. Like in the other model this model also indicates west-northwestward movement of the system along with the intensification into a cyclone by 01 December and likely to cross Tamil Nadu coast on 2nd December, 2016.

ECMWF: The model analysis based on 00 UTC of 30th November 2016 shows the Depression over southwest BOB, which likely to move in west-northwestward direction and intensify into a cyclonic storm by 1st December, 2016 over east off south Tamil Nadu coast and adjoining north Sri Lanka coast. The system is likely to cross Tamil Nadu coast on 2nd December and further move inland to the western part of Tamil Nadu and emerged over the south east Arabian Sea on 3rd/4th December.

The model also indicates a fresh low pressure system over the southeast Bay of Bengal and adjoining Andaman Sea on 3rd/4th December, 2016

JMA: A low lies over SE Bay on 30th, becomes depression over SW Bay on 30th and deep depression over SW Bay near TN coast(11^{0}N/ 80.7^{0}E) on 02 Dec and less marked on 3rd.

Meteo-France ARP Model: It shows development of depression over SW Bay on 30th and deep depression over SW Bay near Sri Lanka coast on 1st Dec. It lies as deep depression over SW Bay close to north TN coast (10.6^{0}N/ 80.7^{0}E) on 2nd Dec. and low over SE Arabian Sea on 3rd Dec.morning.

NCMRWF-NCUM: The analysis based on 00 UTC of 29th November shows deep depression 30th, cyclonic storm over southwest Bay on 1 Dec. and over SW Bay off north TN coast on 2 Dec. It lies as alow over interior TN on 3rd morning.

A fresh low develops over north Andaman Sea on 4th, becomes cyclonic storm over SE Bay on 6th and SCS over EC Bay on 7th and 8th, VSCS over north Bay on 9th and crossing Bangladesh coast on 10th morning

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 30th November shows a Deep Depression over SW Bay, becoming cyclonic storm over southwest Bay on 1st and deep depression over southwest Bay off north TN coast on 2nd morning and crossing coast near Cuddalore on 3rd morning.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 30th November shows development of a depression on 30th, deep depression over SW Bay on 1st, CS over SW Bay off north TN coast on 02nd Dec, CS over SW and adjoining WC Bay off north TN and south AP coast on 3rd. It lies over the same area as AS SCS on 4th, as CS on 5th and asa low on 6th.

IITM-GEFS: The analysis based on 00 UTC of 30th shows Deep depression on 30 Nov. and 1 Dec. and low over SW Bay off north TN coast on 2 Dec. and crosses north TN coast around morning/noon of same day. It emerges as a low over SE Arabian Sea on 3 Dec and moves west-nothwestwards and becomes depression on 6th and 7th Dec. A fresh low develops over SE Bay on 4th Dec, becoming Depression on 5th and deep depression on 6th and cyclonic storm on 7th and CS over WC Bay off north AP coast on 8th.

IITM -GFS T1534: The analysis based on 00 UTC of 30th November shows development of a CS on 30th Nov and 1st Dec., deep depression over SW Bay near north TN coast and crossing coast near 11-12^{0}N on same night. It emerges as a low over SE Arabian Sea on 3 Dec and moves west-nothwestwards. A fresh low develops over southeast Bay on 4th and becomes depression on 5th Dec over southeast Bay, CS on 6th, SCS on 7th and VSCS on 8th while moving northwestwards.

WRF: The WRF model analysis on 00 UTC of 30 November 2016 shows almost similar feature like that is seen in IMD GFS model with Depression over southwest Bay of Bengal. The forecast during next 3 days shows west-northwesterly movement along with gradual intensification of the system into a cyclonic storm by 1st December, 2016 over east off south Tamil Nadu coast and adjoining north Sri Lanka coast. The system is likely to cross Tamil Nadu coast on 2nd December, which reappeared in the Arabian Sea on 3rd December, 2016.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 30 November 2016 suggests a zone of significant GPP appear (> 30) over southwest BOB which moves west-northwestward towards Sri Lanka coast and Tamil Nadu coast thereafter till 1st December over the east of Tamil Nadu coast and cross TN coast by 2nd December

A fresh belt of higher GPP (> 30) appears over the southeast BoB on 3rd/4th December, 2016.

Summary and Conclusion:

Majority of models suggest landfall over north TN coast near 10.5-11.5^0 N around 02 Dec. 0000 UTC.

The emergence of the remnant low into SE Arabian sea on 3rd Dec.and its possible intensification needs to be monitored.

A fresh low pressure area is likely to develop over southeast Bay on 4th Dec. 2016. It would move northwestwards and concentrate into a cyclonic storm on 6th Dec.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Low

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Intense Observation Period (IOP) : IOP to be undertaken for Tamil Nadu and east Sri Lanka coast for 30 Nov to 02 Dec. and for south AP coast for 1-2 Dec.

Annexure-I

Status of observational system:

Dated:30.11.2016

Synoptic observation:

Region	Date/Time (UTC)		
	29	**30/0**	**30/03**
India	41	31	45
Coastal stations			
WB	8	3	8
Odisha	6	5	6
AP	1	11	12
Tamil Nadu	1	10	12
Puducherr	1	1	1
A & N	6	1	6
Banglades	0	3	3
Myanmar	0	0	0
Thailand	3	3	3
Sri Lanka	8	6	6

AWS:

Region	Date/Time (UTC)		
	29	**30**	**30/03**
WB	2	2	5
Odisha	5	1	7
AP	7	3	5
Tamil Nadu	1	9	21
Puducherr	0	1	1
A & N	0	0	0

RS/RW (12Z) 29.11.2016 : 30 /43

No. of Ascents reaching 250 hPa levels:14 , MISDA:- 16

RS/RW (00Z) of 30.11.2016 :30 /43

No. of Ascents reaching 250 hPa levels:22 , MISDA: 3

No. of PILOT Ascents

27/12Z	**28 /00Z**
16	12

Buoy Data

27/12Z	**28/00Z**	**28 /03Z**
13	11	12

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**29.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**19**

No. of RS/RW Ascents

00Z /29.11.2016 : 7

No. of Ascents reaching 250 hPa level = 7

MISDA : 1

12Z /29.11.2016 : 3

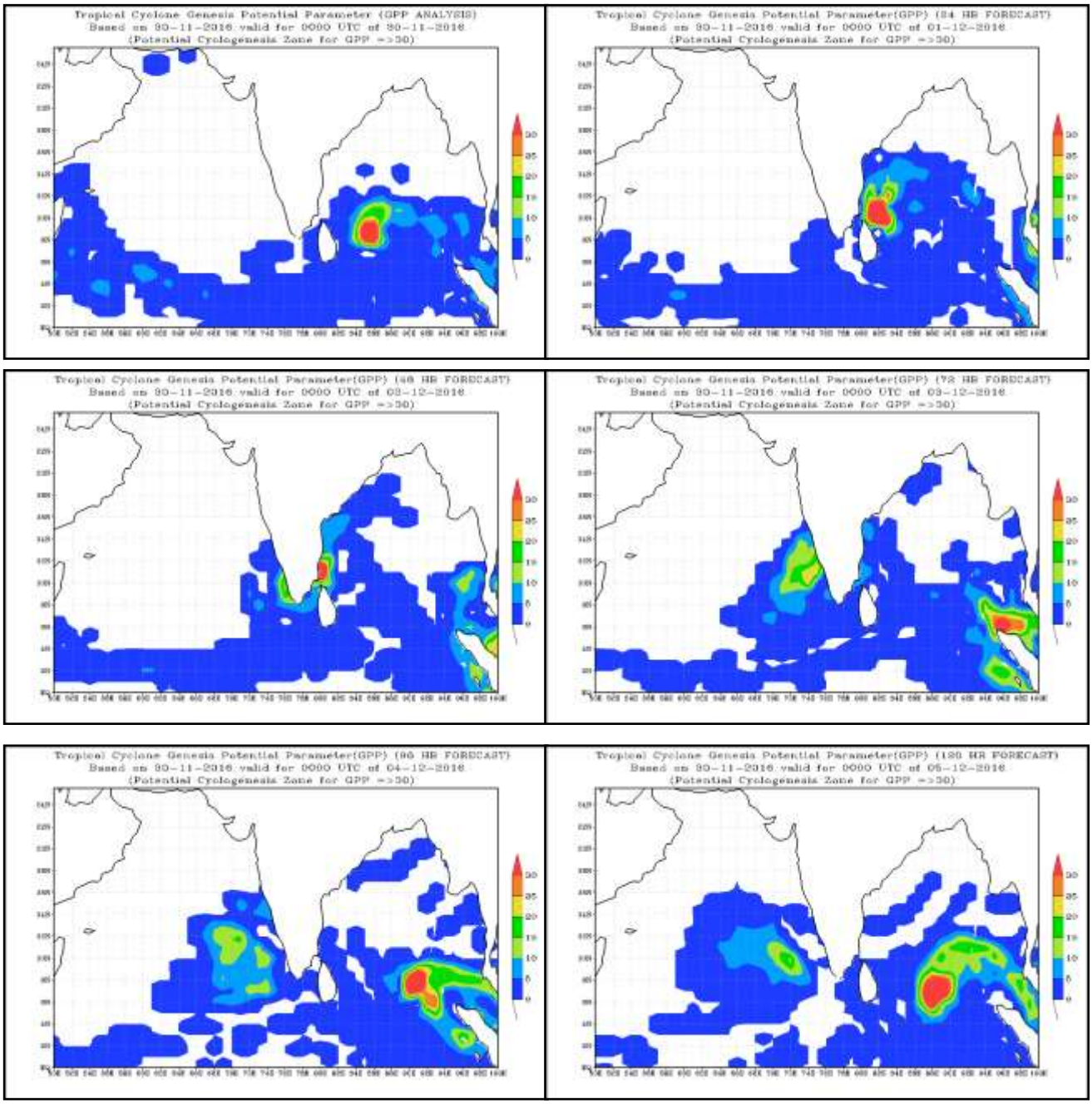
No. of Ascents reaching 250 hPa level = 3

MISDA : 5

No. of PILOT Ascents:

29.11.2016	
06Z	18Z
5	3

Annexure-II


Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 30-11-2016 valid for 0000 UTC of 30-11-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 30-11-2016 valid for 0000 UTC of 01-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 30-11-2016 valid for 0000 UTC of 02-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 30-11-2016 valid for 0000 UTC of 03-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 30-11-2016 valid for 0000 UTC of 04-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 30-11-2016 valid for 0000 UTC of 05-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

FDP (Cyclone) NOC Report Dated 1st December, 2016

Synoptic features:

Yesterday's cyclonic storm **"Nada"** over southwest and adjoining southeast BoB moved west-northwestwards during past 24 hours, weakened into a deep depression at 0600 UTC of today the 1st December and lay centered near Latitude 10.6ºN and Longitude 81.2ºE over southwest Bay of Bengal, about 290 km south-southeast of Chennai, 210 km southeast of Puducherry and 220 km north of Trincomalee (Srilanka). The system is very likely to continue to move west-northwestward, weaken further gradually into a depression during next 24 hours and cross north Tamil Nadu coast between Vedaranniyam and Puducherry, south of Cuddalore by early hours of 2nd December.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature is 29˚C near the system centre. It decreases towards Sri Lanka and north Tamil Nadu coast becoming 28˚C. It is around 28˚C over most parts of central and south BOB. It is decreasing towards north BOB and is around 27˚C.

The SST over most parts of westcentral and northwest Arabian Sea (AS) is between 26-28˚C. It is 28-29˚C over most parts of southwest AS. It is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast. SST is 28-29˚C over most parts of eastcentral and southeast AS.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 80-100 KJ/cm^2 around the system and it decreases towards southwest BOB near Sri Lanka and north Tamil Nadu coast becoming less than 50 KJ/cm^2.over southwest BOB off north Tamil Nadu and south Andhra Pradesh coasts. It is less than 50 kJ/cm^2 over north BoB and also in some parts of westcentral BoB.

TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala & Karnataka coast and over Comorin area where TCHP is around 100 kJ/cm^2.

Relative Vorticity:

The low level relative vorticity is about 200x10^{-6} $second^{-1}$ in the southwest sector of the system. It is decreasing towards west BOB and its value is around 25 x10^{-6} $second^{-1}$ along the east coast of India.

The low level relative vorticity is about 25x10^{-6} $second^{-1}$ over parts of eastcentral AS, south AS and adjoining equatorial region. It is negative over western parts of AS.

Convergence:

Low level convergence is about 5-10x10^{-6} s^{-1} over southwest BOB. Another positive convergence zone of 10-20x10^{-6} s^{-1} is seen over Malay Peninsular region.

Small zone of positive low level convergence zone of 5x10^{-6} s^{-1} is seen over southeast AS.

Divergence:

The upper level divergence is around 20x10^{-5} $second^{-1}$ in the southwest sector of the system.

An elongated zone of positive divergence (20-30 x10^{-5} $second^{-1}$) is seen over Malay Peninsular region.

Wind Shear:

The vertical wind shear of horizontal wind is moderate (15-20 knots) around the system centre and increases towards southwest BOB near Sri Lanka and north Tamil Nadu becoming more than 20 knots.

Wind shear is around 25 kts over southeast AS. It is increasing towards north. It is 10-20 kts over most parts of southwest and adjoining southeast AS.

Wind Shear Tendency:

Decreasing shear tendency of 5-10 kts is seen over southwest BOB, Sri Lanka, Tamil Nadu, Kerala and adjoining southeast AS. Increasing wind shear tendency of 5-10 kts is seen over Peninsular region.

There is an extended zone of increasing tendency of 5-10 kts over most parts of southwest AS and northeast AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, Vortex "NADA" over southwest BOB is centred near 10.6^0N/81.1^0E. Intensity of the system is T 1.5. The convection shows curved band pattern. Minimum cloud top brightness temperature is -80.0^0C. Broken low/medium clouds with embedded moderate to intense convection are seen over Tamil Nadu, Palk Strait, north Sri Lanka and over between latitude 8.8^0N to 13.0^0N and longitude 74.3^0E to 78.0^0E. Scattered low/medium clouds with embedded moderate to intense convection are seen over central BOB and south Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded weak to moderate convection are seen over southeast AS off Kerala-Karnataka coasts and Comorin.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 14^0N latitude over BoB.

M.J.O. Index: MJO index is in Phase 3 with amplitude less than one and would continue in Phase 3 and then in phase 2 for next 3-4 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis based on 00 UTC of 01 December 2016 shows the cyclone over east off south Tamil Nadu coast and is likely to weaken over the same region by 2nd December and likely to cross the Tamil Nadu coast by 2nd December, 2016 as a depression and emerged over the southeast Arabian Sea on 3rd/4th December.

The model also indicates a fresh low pressure system over the southeast Bay of Bengal and adjoining Andaman Sea on 3rd and intensifies into a depression on 4th and into a cyclonic storm on 5th, further intensifies on 6th December, 2016, while moving initially west-north-west and then northwestwards to WC Bay on 8th. Then it recurves northwards and weaken gradually.

NCEP-GFS: The model charts based on 00 UTC of 01st December 2016 shows the CS becoming less marked on 2nd Dec. and re-emerged over the Arabian Sea on 3rd/4th December, 2016.

A fresh low will form over the south-east Andaman Sea on 3rd Dec. It is likely to become depression on 5th and CS on 6th and SCS on 7th while moving initially west-north-west and then northwestwards. It would cross north AP coast on 8th night and will lie as Deep depression over north AP on 9th and low over Odisha on 10th

ECMWF: The model analysis based on 00 UTC of 1st December 2016 shows the cyclonic storm over east off Tamil Nadu on 1st December, 2016. The system is likely to cross Tamil Nadu coast by 2nd December with slight weakening of the system.

The model also indicates a fresh low pressure system over the adjoining Andaman Sea on 4th December, 2016, which likely to move in west-northwest and intensify into a depression on 6th, CS then northwestwards and becomes CS over Central Bay on 7th.

WRF: The WRF model analysis on 00 UTC of 01 December 2016 shows Depression over east off south Tamil Nadu coast and adjoining north Sri Lanka coast on 1st December, 2016. The system is likely to cross Tamil Nadu coast by 2nd December, which reappeared in the Arabian Sea on 3rd December, 2016.

JMA: A depression lies over SW Bay on 1st and crossed TN coast on 2nd morning. It lies as a low on 3rd and 4th over SE Arabian Sea

Meteo-France ARP Model: It shows depression over SW Bay on 1st and crossed TN coast on 2nd morning. It lies as a low over SE Arabian Sea on 3rd and 4th.

NCMRWF-NCUM: The analysis based on 00 UTC of 1st Dec. shows deep depression over SW Bay on 1st and Depression near TN coast on 2nd and low over TN on 3rd It emerges over SE Arabian Sea on 4th and moves westwards becoming less marked on 9th.

A fresh low develops over north Andaman Sea on 4th, becomes depression on 5th, Deep depression on 6th and Depression over EC Bay near Myanmar coast on 8th and weakens on 9th

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 30th November shows a CS over SW Bay, weakens into DD over southwest Bay and adjoining TN on 2nd and lies over TN on 3rd as a low. It emerges into SE Arabian Sea on 4th

NCMRWF-NEPS Model: The analysis based on 00 UTC of 1 Dec shows a deep depression on 1st and CS on 2nd over SW Bay and low over TN on 3rd Dec. The remanant loe emerges into SE Arabian Sea and becomes deep depression on 6th and CS on 7th and 8th and again becomes DD on 9th and less marked on 10th while moving westward.

A fresh low develops over South Andaman Sea on 4th and 5th and deep depression over same area on 6th. It moves north-northwestwards during next 3 days ad DD and then weakens

IITM-GEFS: The analysis based on 00 UTC of 1 Dec. shows deep depression on 1st and low over coastal TN on 2nd, emerges to SE Arabian Sea on 3rd and 4th.

A fresh low develops over South Andaman Sea low over 3rd and depression over SE Bay on 4th, CS on 5th over SE Bay, SCS on 6th to 8th, crosses as DD on 9th morning over north AP coast

IITM-GFS(1534): The analysis based on 00 UTC of 1 Dec.Depression on 2nd ober TN, low over SE Arabian Sea and less marked thereafter

A fresh low develops over South Andaman Sea low over 3rd and deep depression over SE Bay on 4th, CS on 5th over SE Bay, SCS on 6th over central part of south Bay, SCS over SW ands adjoining WC Bay on 7th, SCS over WC Bay off South AP coast on 8th. It crosses north AP coast and lies as CS over north AP on 9th.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 01 December 2016 suggests a zone of significant GPP appear (> 30) over east off Tamil Nadu coast and cross TN coast by 2nd December.

A fresh belt of higher GPP (> 30) appears over the southeast BoB on 3rd/4th December, 2016, which will have Northwesterly movement for next 2/3 days .

Summary and Conclusion:

The emergence of the remnant low from the existing deep depression over SW Bay into SE Arabian sea on 3rd Dec. and its possible intensification needs to be monitored.

A fresh low pressure area is likely to develop over southeast Bay on 3th Dec. 2016. It would move initially west-northwestwards and then northwestwards and concentrate into a depression during 4-6th as predicted by all the models. The day of genesis of depression varies from model to model ranging from 4th to 6th Dec. Further majority of the models suggest intensification into a cyclonic storm by 7th. Most of the models suggest initial west-northwest and then northwestward movement towards west-central Bay of Bengal.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5

	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Nil	Nil	Nil	Low	Moderate

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Intense Observation Period (IOP) : IOP to be undertaken for Tamil Nadu and east Sri Lanka coast till 2nd December morning.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	30 /12	01/00	02/03
India	41	28	45
Coastal stations			
WB	8	3	9
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	6	11
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	9	11
Myanmar	0	0	0
Thailand	3	3	3
Sri Lanka	5	7	9

AWS:

Region	Date/Time (UTC)		
	30 /12	01/00	02/03
WB	3	0	4
Odisha	3	1	6
AP	6	2	9
Tamil Nadu	21	0	20
Puducherry	1	0	1
A & N	0	0	0

RS/RW (12Z) of 30/11/2016 :34/43
No. of Ascents reaching 250 hPa levels:17 , MISDA:- 16

RS/RW (00Z) of 01/12/2016 :32 /43
No. of Ascents reaching 250 hPa levels: 20 , MISDA: 4

No. of PILOT Ascents

30 /12Z	01 /00Z
16	31

Buoy Data

30/12Z	01 /00Z	01/03Z
12	11	11

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**30.11.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

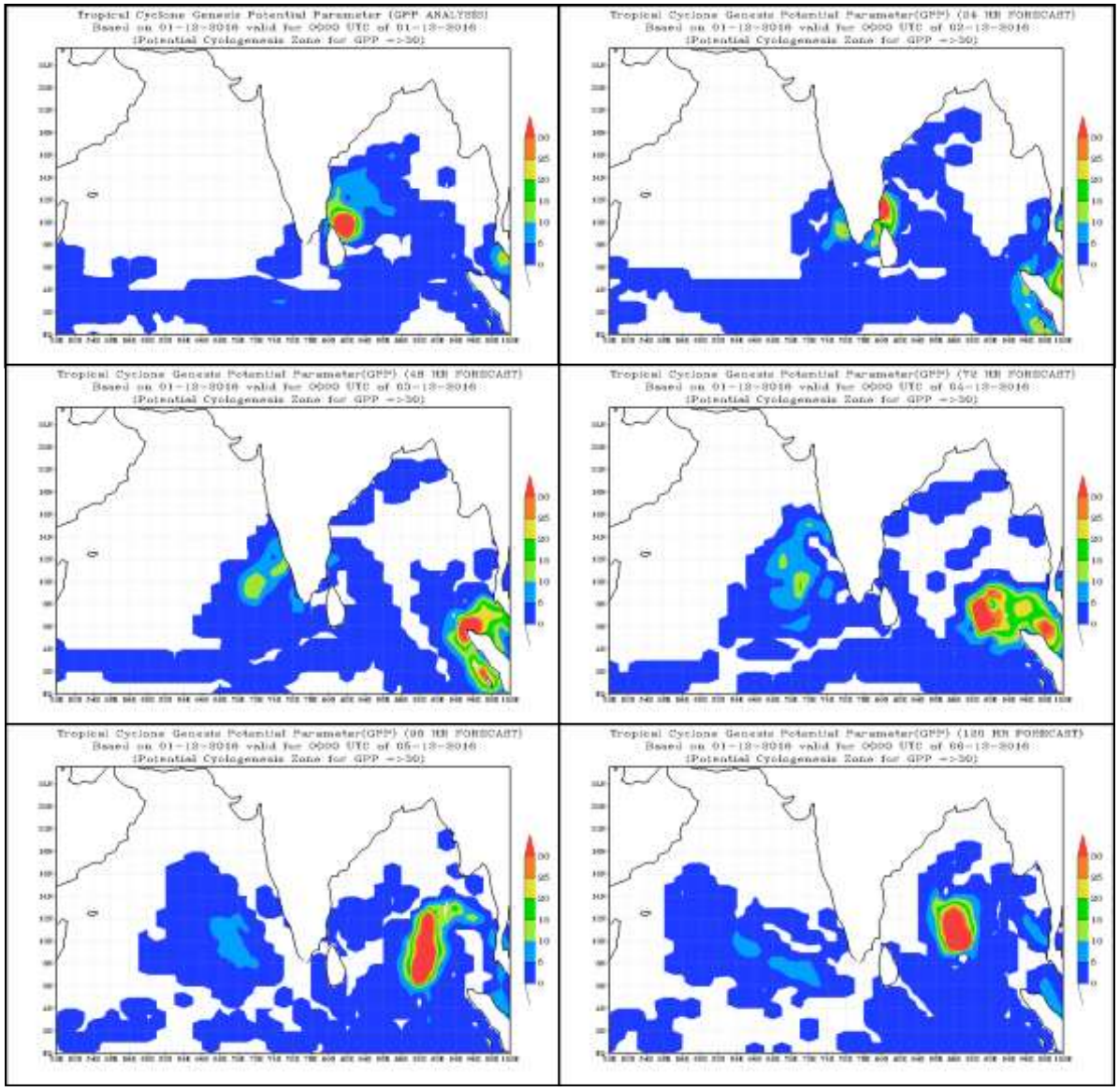
00Z /30.11.2016 : 6
No. of Ascents reaching 250 hPa level = 6
MISDA : 2

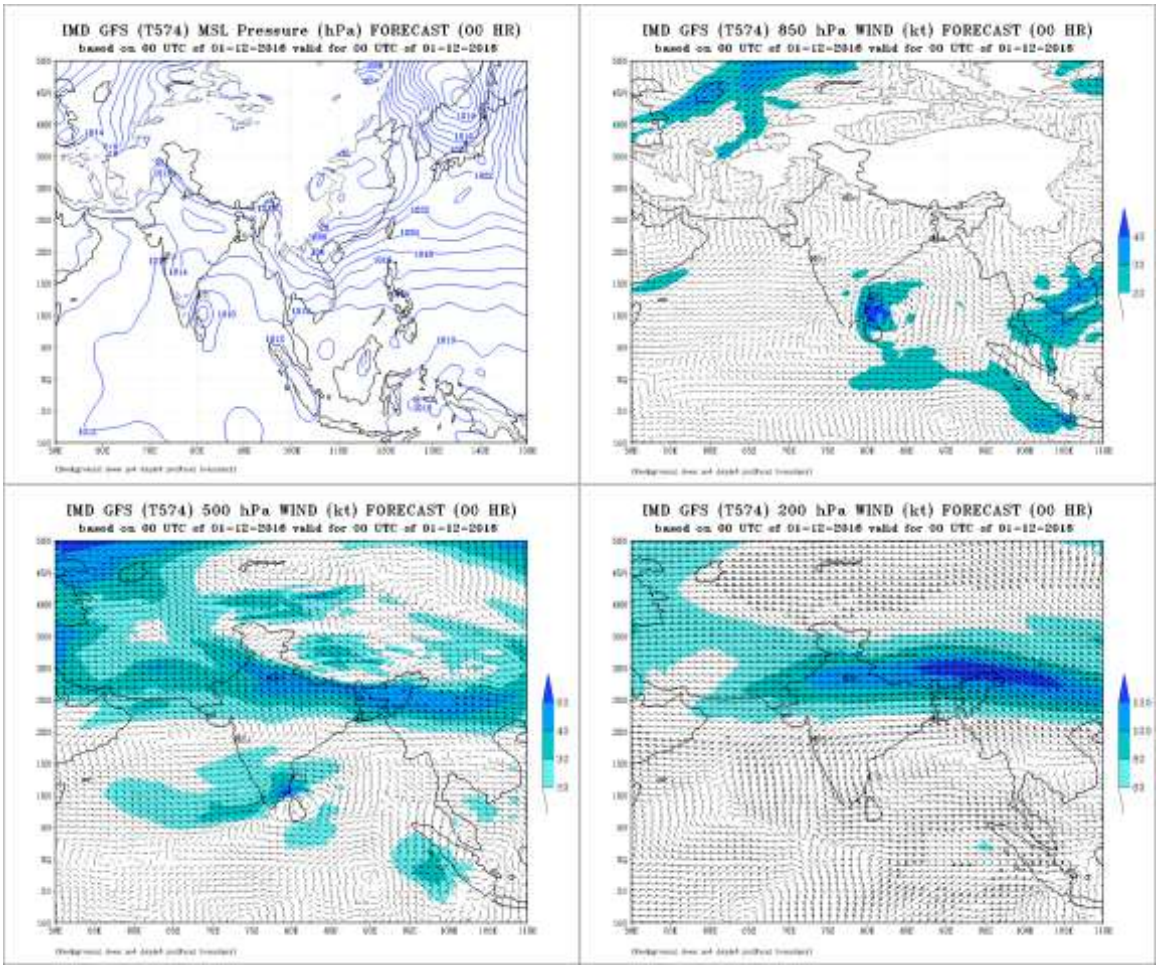
12Z /30.11.2016 : 4
No. of Ascents reaching 250 hPa level = 4
MISDA : 4

No. of PILOT Ascents:

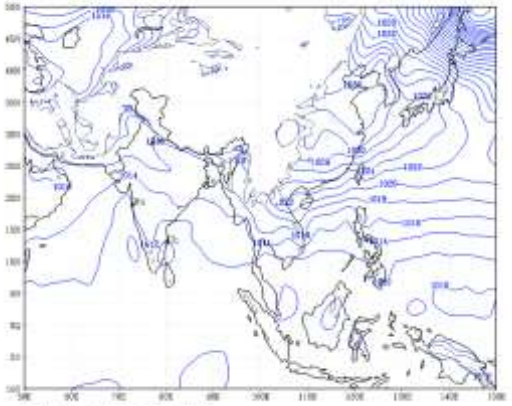
30.11.2016	
06Z	18Z
2	3

Annexure-II

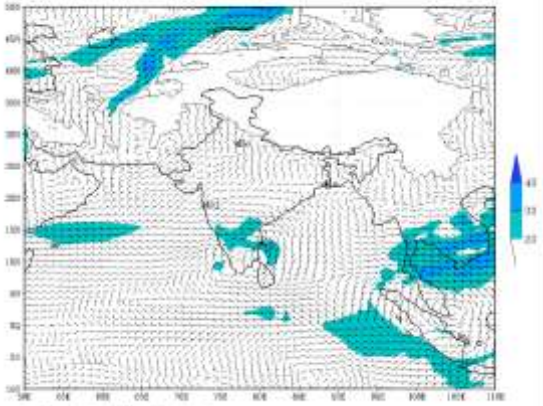

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 01-12-2016 valid for 0000 UTC of 01-12-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 01-12-2016 valid for 0000 UTC of 02-12-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 01-12-2016 valid for 0000 UTC of 03-12-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 01-12-2016 valid for 0000 UTC of 04-12-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 01-12-2016 valid for 0000 UTC of 05-12-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 01-12-2016 valid for 0000 UTC of 06-12-2016
(Potential Cyclogenesis Zone for GPP =>50)


IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 01-12-2016
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 01-12-2016
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 01-12-2016
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 01-12-2016

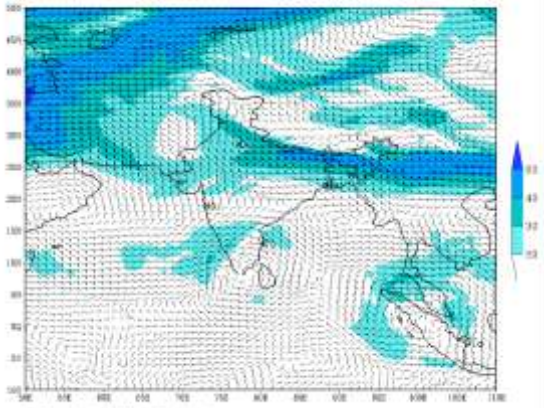
IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 02-12-2016



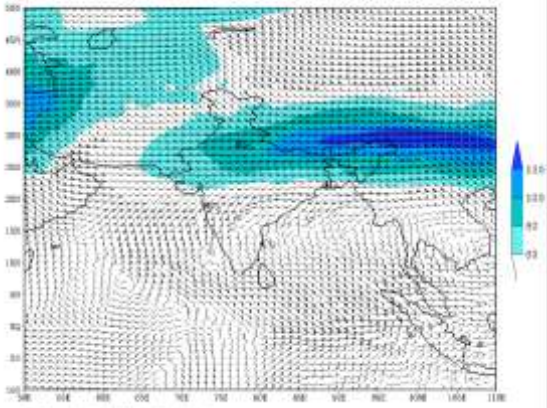
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 02-12-2016



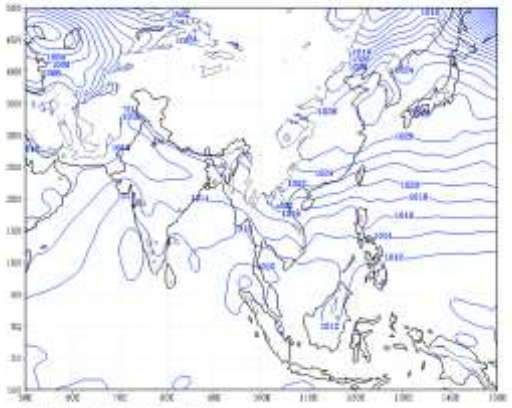
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 02-12-2016



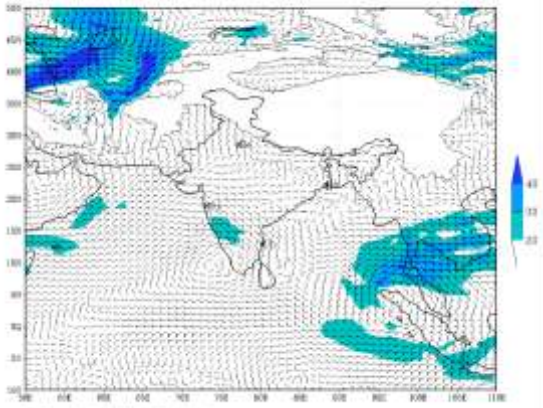
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based on 00 UTC of 01-12-2016 valid for 00 UTC of 02-12-2016



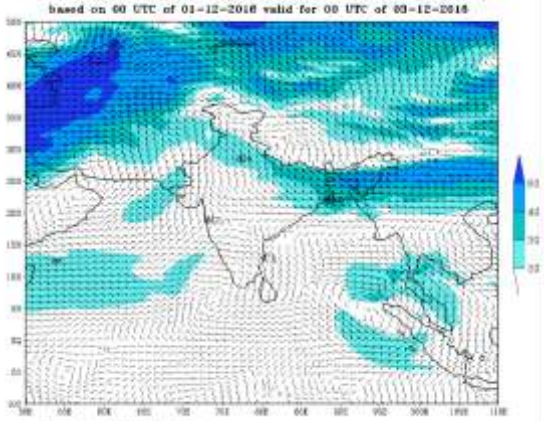
IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 03-12-2016



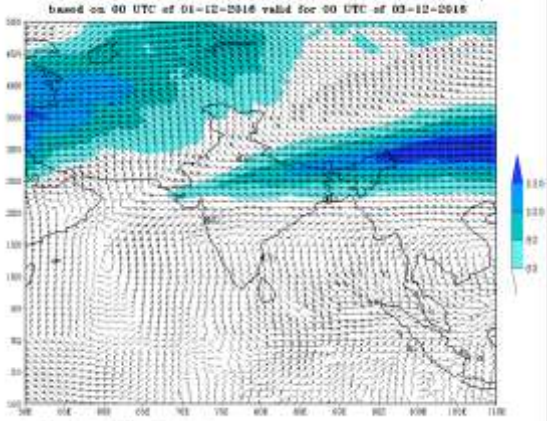
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 03-12-2016



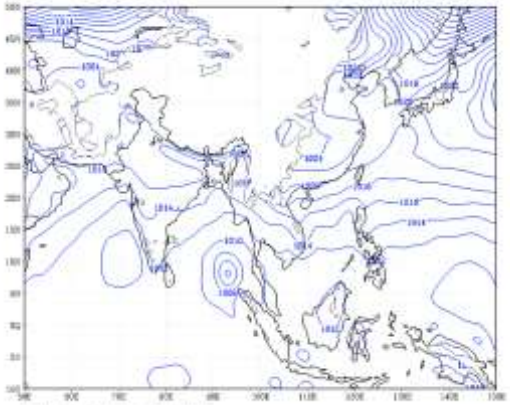
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 03-12-2016



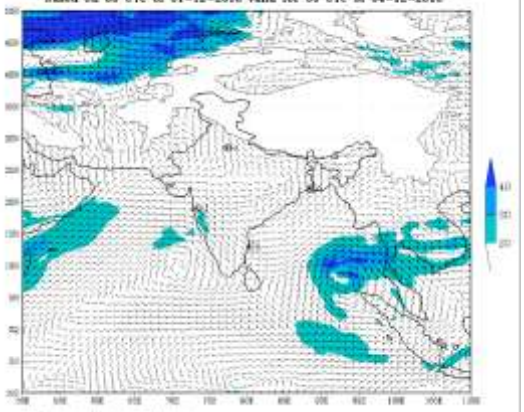
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 03-12-2016



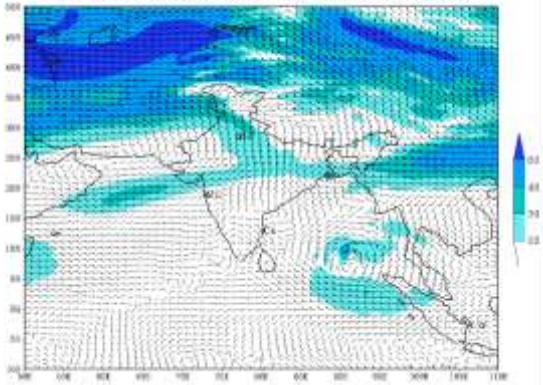
IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 04-12-2016



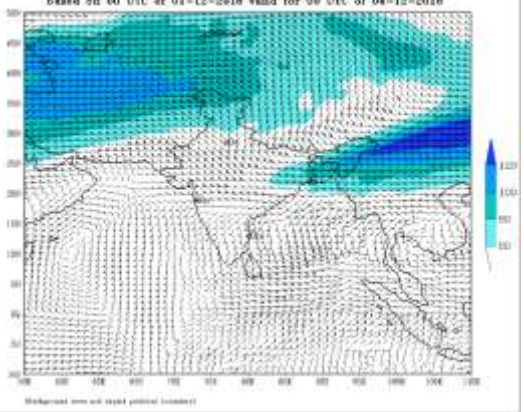
IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 04-12-2016



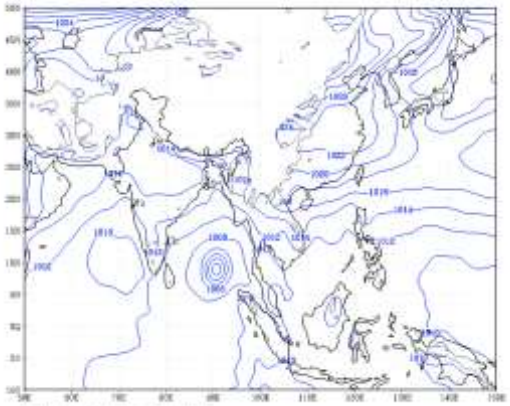
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 04-12-2016



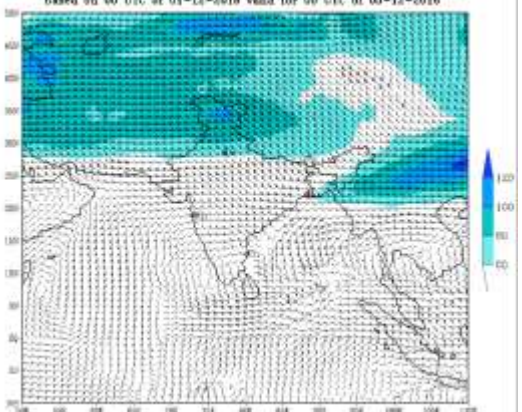
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 04-12-2016



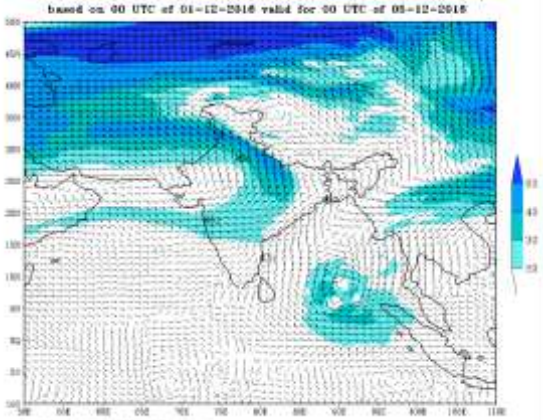
IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 05-12-2016



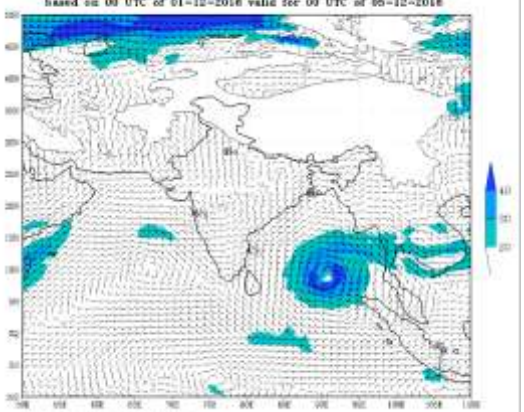
IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 05-12-2016



IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 05-12-2016



IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 01-12-2016 valid for 00 UTC of 05-12-2016



FDP (Cyclone) NOC Report Dated 2nd December, 2016

Synoptic features:

Yesterday's cyclonic storm **"Nada"** over southwest Bay of Bengal (BoB) moved west-northwestwards, weakened into a deep depression in the noon and further into a depression in the midnight of same day, the 1st December 2016 over southwest BOB. While moving west-northwestwards, it crossed north Tamilnadu coast near Nagapattinam (about 20 km south of Karaikal) between 0400 to 0500 hours IST of today, the 2nd December. Thereafter, it weakened into a well marked low pressure area and lay over Interior Tamilnadu & neighbourhood at 0830 hours IST of today, the 2nd December.

An upper air cyclonic circulation lies over Malay Peninsula & neighbourhood and extends upto mid-tropospheric levels. Under its influence, a low pressure area is very likely to develop over south Andaman Sea & neighbourhood during next 24 hours. It is very likely to concentrate into a depression in subsequent 48 hours

Dynamical and thermodynamical features

Surface Temperature (SST):

It is around 28-29˚C over most parts of central and south BOB. It is decreasing towards north BOB and is around 27˚C.

The SST over most parts of westcentral and north Arabian Sea (AS) is between 26-27˚C. It is 28-29˚C over most parts of southeast, eastcentral and southwest AS. It is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 80-90 KJ/cm^2 over most parts of south and central BoB and Andaman Sea except southwest BoB off TN and AP coasts where it is less than 50 KJ/cm^2. It is less than 50 kJ/cm^2 over north BoB and also in some parts of westcentral BoB. TCHP is 100 KJ/cm^2 over extreme southeast BoB and adjoining equatorial region.

TCHP is less than 50 kJ/cm^2 over western and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala & Karnataka coast and over Comorin area where TCHP is around 80-90 kJ/cm^2.

Relative Vorticity:

The low level relative vorticity is about 40-50x10^{-6} $second^{-1}$ over southeast BOB, Malay Peninsular region and adjoining equatorial region. Another region of positive vorticity of value 40-50x10^{-6} $second^{-1}$ lies over southwest BoB off Tamilnadu coast.

The low level relative vorticity is about 25x10^{-6} $second^{-1}$ over parts of eastcentral AS, south AS and adjoining equatorial region. It is negative over western parts of AS.

Convergence:

Low level convergence is about 10x10^{-6} s^{-1} over southeast BOB, Malay Peninsular region and adjoining equatorial region.

A small zone of positive low level convergence zone of 5-10x10^{-6} s^{-1} is seen over southeast AS and adjoining equatorial region.

Divergence:

The upper level divergence is around 5-10x10^{-5} $second^{-1}$ over southeast BOB, Malay Peninsular region and adjoining equatorial region.

A zone of positive divergence 5-10x10^{-6} s^{-1} is seen over southeast AS and adjoining equatorial region.

Wind Shear:

The vertical wind shear of horizontal wind is moderate (10-15 knots) over most parts of eastcentral & southeast BoB and Malay Peninsular region.

Wind shear is around 15-20 kts over southwest and adjoining southeast AS. It is increasing towards north and east.

Wind Shear Tendency:

Decreasing shear tendency of 5-10 kts is seen over southwest BOB & adjoining Tamil Nadu and Malay Peninsular region.

There is an extended zone of increasing tendency of 5-10 kts over most parts of southeast AS and Comorin Area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, Vortex "NADA" over Tamilnadu and neighbourhood. Broken low/medium clouds with embedded isolated weak to moderate convection is seen over south interior Karnataka, Tamilnadu adjoining Bay of Bengal and Sri Lanka. Scattered low/medium clouds with embedded moderate to intense convection are seen over north BOB and Andaman Sea.

Arabian Sea:

Scattered low/medium clouds with embedded isolated weak to moderate convection are seen over southeast AS.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 14^0N latitude over BoB.

M.J.O. Index: MJO index is in Phase 1 with amplitude less than one and would continue in Phase 1 for next 3-4 days.

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The remnant of CS, Nada emerges over the southeast Arabian Sea as low on 3rd December and then moves westwards without intensification.

The model also indicates a fresh low pressure system over the southeast Bay of Bengal and adjoining Andaman Sea on 3rd and intensifies into a depression on 4th and into a cyclonic storm on 5th, further intensifies to SCS on 7th December, 2016, while moving initially west-north-west and then northwestwards to WC Bay on 8th. Then it crosses AP coast on 8th forenoon and lies as a low over Chhattisgarh on 9th.

NCEP-GFS: The model charts based on 00 UTC of 02nd December 2016 shows low over the SE Arabian Sea on 3rd/4th December, 2016.

A fresh low will form over the south Andaman Sea on 4th Dec. It is likely to become depression on 5th and deep depression on 6th and CS on 7th while moving initially west-north-west and then northwestwards. It would cross north AP coast on 8th morning near 16^0N and will lie as low over Chhattisgarh on 9th.

ECMWF: The model also indicates a fresh low pressure system over the south Andaman Sea on 5th December, 2016, which likely to move in west-northwest and intensify into a depression on 6th, DD on 7th and 8th over EC bay while moving northwestwards.

WRF: The WRF model analysis on 00 UTC of 02 December 2016 shows low over SE Arabian Sea on 3rd December, 2016 which then moves westwards without intensification.

The model also indicates a fresh low pressure system over the south Andaman Sea on 3rd and intensifies into a depression on 4th and into a cyclonic storm on 5th and 6th while moving initially west-north-west and then northwestwards.

JMA: A depression lies over SW Bay on 1st and crossed TN coast on 2nd morning. It lies as a low on 3rd and 4th over SE Arabian Sea

Meteo-France ARP Model: The model also indicates a fresh extended low pressure system over the south Andaman Sea on 4th and low over SE Bay on 5th while moving initially west-north-west and then northwestwards.

NCMRWF-NCUM: A fresh low develops over north Andaman Sea on 5th, becomes depression on 6th, Deep depression on 7th to 9th while moving towards EC Bay near Myanmar coast and weakens on 10th

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 02 Dec November shows a Depression over south Andaman Sea on 4th and Deep depression over the same area on 5th. The remnant of CS, Nada appears as a low over SE Arabian Sea on 3rd. Moving westwards, it becomes less marked on 5th.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 2 Dec shows a fresh low over South Andaman Sea on 5-7thh and deep depression over same area on 8th. It moves northwards near Myanmar coast on 9th.

IITM-GEFS: The analysis based on 00 UTC of 2 Dec. shows deep depression on 1st and low over coastal TN on 2nd, emerges to SE Arabian Sea on 3rd and 4th.

A fresh low develops over South Andaman Sea on 3rd and becomes depression over SE Bay on 4th, becoming CS on 5th and SCS on 6th persisting as SCS up to 8th while moving northwestwards and crosses north AP coast on 8th night and lies as a Depression over AP on 9th morning.

IITM-GFS(1534): The analysis based on 00 UTC of 1 Dec.Depression on 2nd ober TN, low over SE Arabian Sea and less marked thereafter

A fresh low develops over South Andaman Sea low over 3rd and deep depression over SE Bay on 4th, CS on 5th over SE Bay, SCS on 6th over central part of south Bay, SCS over SW and adjoining WC Bay on 7th, SCS over WC Bay off South AP coast on 8th. It crosses north AP coast and lies as CS over north AP on 9th.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 01 December 2016 suggests a zone of significant GPP appear (> 30) over east off Tamil Nadu coast and cross TN coast by 2nd December.

A fresh belt of higher GPP (> 30) appears over the southeast BoB on 3rd/4th December, 2016, which will have Northwesterly movement for next 2/3 days .

Summary and Conclusion:

The emergence of the remnant low into SE Arabian sea on 3rd Dec. and its possible intensification needs to be monitored.

A fresh low pressure area is likely to develop over southeast Bay on 3th Dec. 2016. It would move initially west-northwestwards and then northwestwards and concentrate into a depression during 4/5th Dec. Further it may intensify into a cyclonic storm by 6th. Most of the models suggest initial west-northwest and then northwestward movement reaching north AP coast on 8th.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Nil	Nil	Low	Moderate	High

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Intense Observation Period (IOP) : IOP to be undertaken for Andhra Pradesh coast during 6-8 Dec. 2016.

Annexure-I

Status of observational system:

Dated: 01.12.2016

Synoptic observation:

Region	Date/Time (UTC)		
	30 /12	01/00	02/03
India	41	28	45
Coastal stations			
WB	8	3	9
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	6	11
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	9	11
Myanmar	0	0	0
Thailand	3	3	3
Sri Lanka	5	7	9

AWS:

Region	Date/Time (UTC)		
	30 /12	01/00	02/03
WB	3	0	4
Odisha	3	1	6
AP	6	2	9
Tamil Nadu	21	0	20
Puducherry	1	0	1
A & N	0	0	0

- **RS/RW** (12Z) of 30/11/2016 :34/43
- **No. of Ascents reaching 250 hPa levels:17 , MISDA:- 16**
- **RS/RW** (00Z) of 01/12/2016 :32 /43
- **No. of Ascents reaching 250 hPa levels: 20 , MISDA: 4**

No. of PILOT Ascents

30 /12Z	01 /00Z
16	31

Buoy Data

30/12Z	01 /00Z	01/03Z
12	11	11

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	01.12.2016							
UTC→	00	03	06	09	12	15	18	21
Chennai Region (Coasts of AP & TN)	20	22	20	20	22	20	20	19

No. of RS/RW Ascents

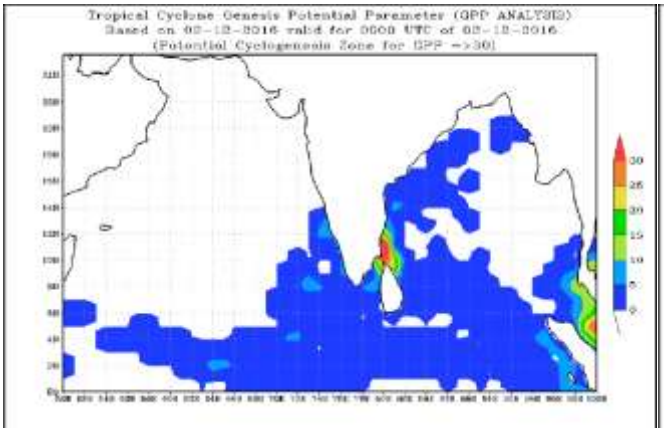
00Z /01.12.2016 : 6
No. of Ascents reaching 250 hPa level = 6
MISDA : 2

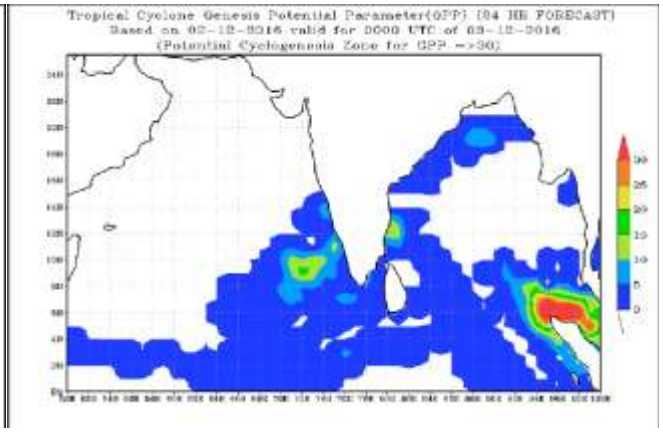
12Z /01.12.2016 : 3
No. of Ascents reaching 250 hPa level = 3
MISDA : 3

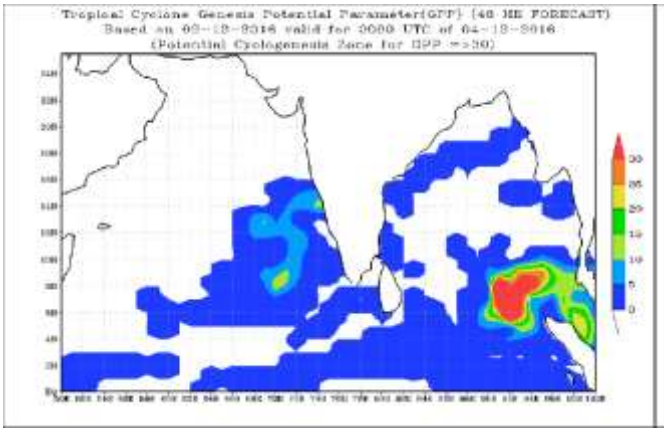
No. of PILOT Ascents:

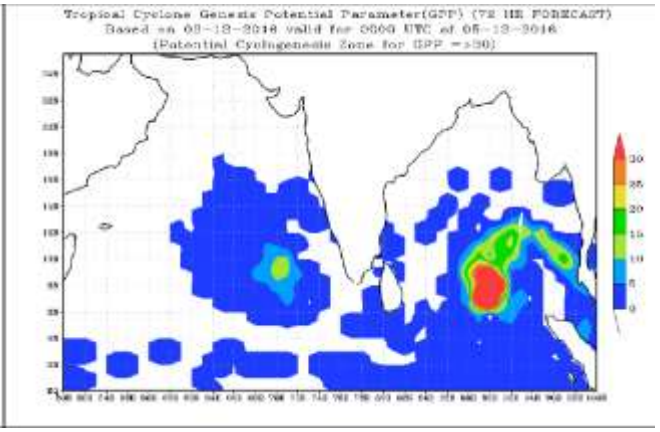
01.12.2016	
06Z	18Z
3	2

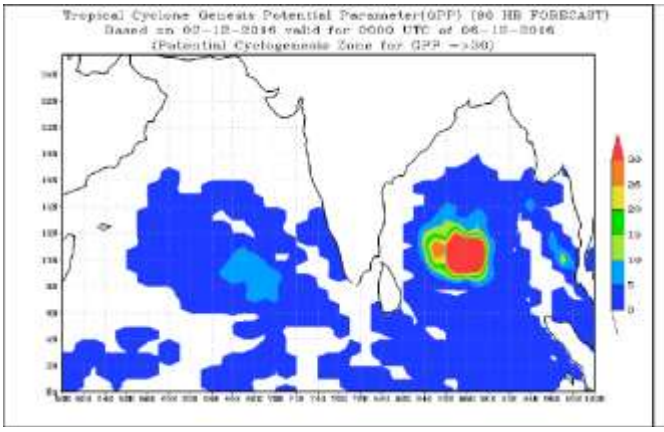
Annexure- II

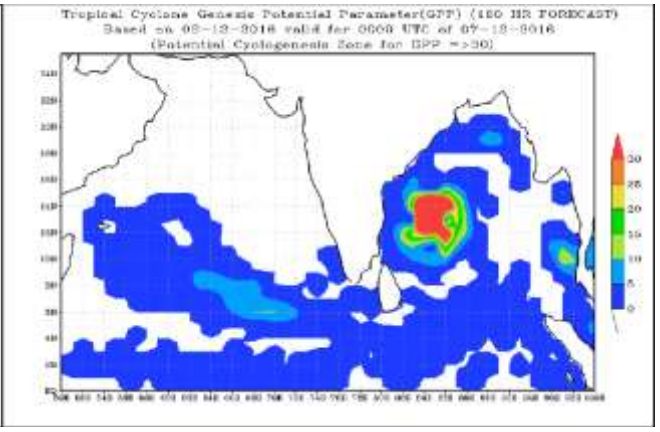

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 02-12-2016 valid for 0000 UTC of 03-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

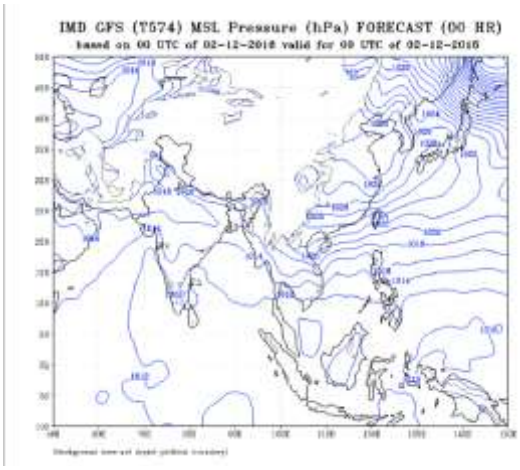

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 02-12-2016 valid for 0000 UTC of 03-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

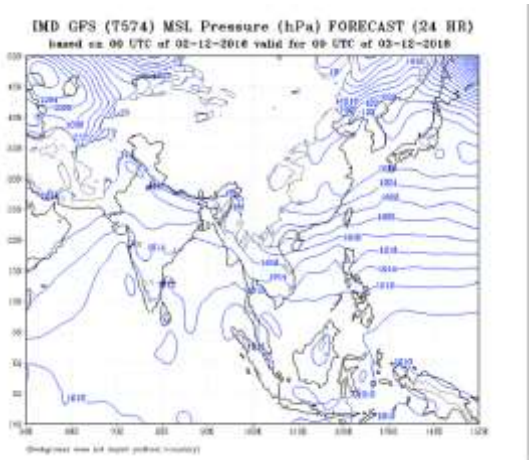

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 02-12-2016 valid for 0000 UTC of 04-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

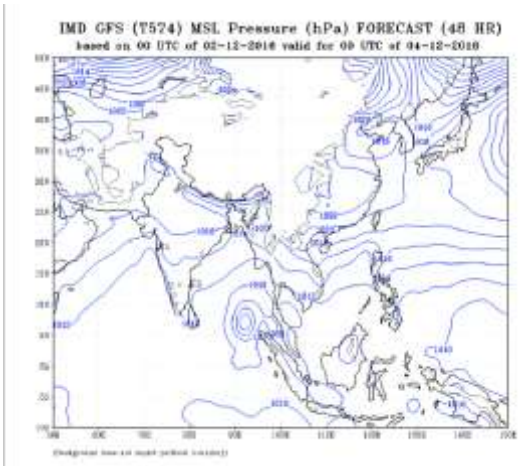

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 02-12-2016 valid for 0000 UTC of 05-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

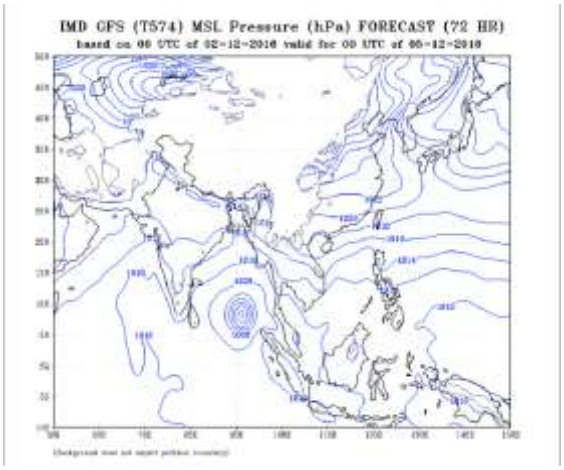

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 02-12-2016 valid for 0000 UTC of 06-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

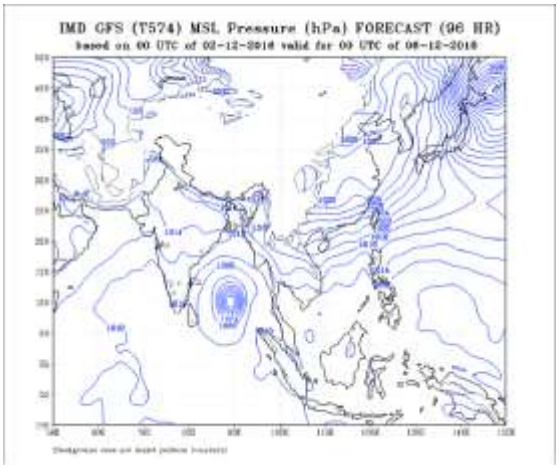

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 02-12-2016 valid for 0000 UTC of 07-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

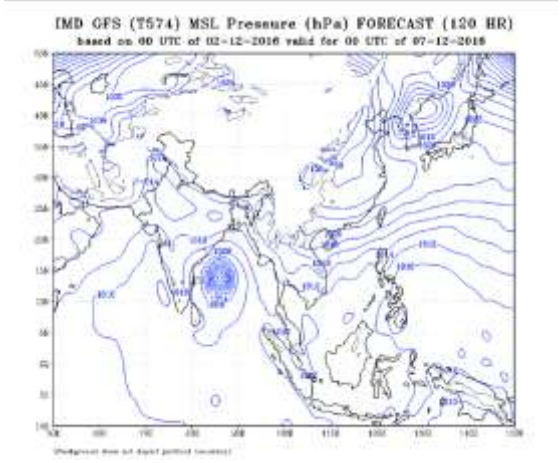

IMD GFS (T574) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 02-12-2016

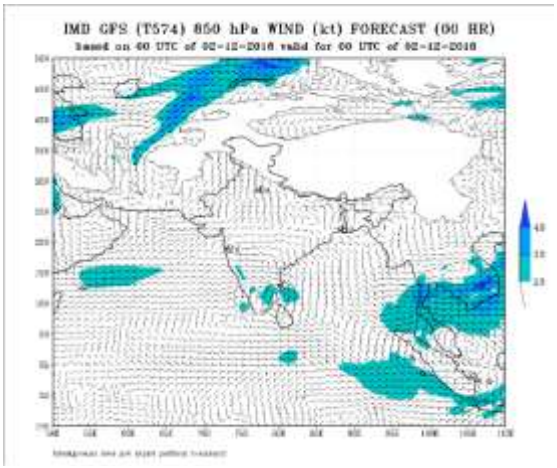

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 03-12-2016

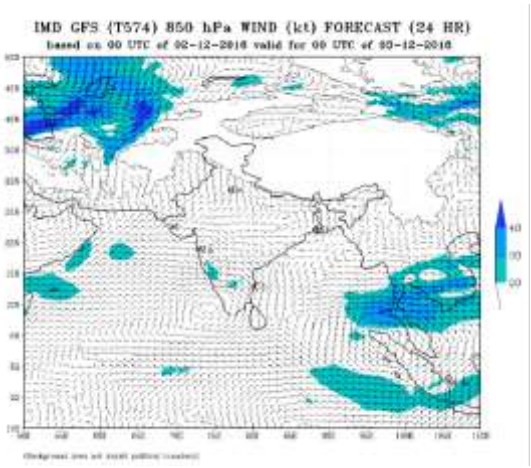

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 04-12-2016

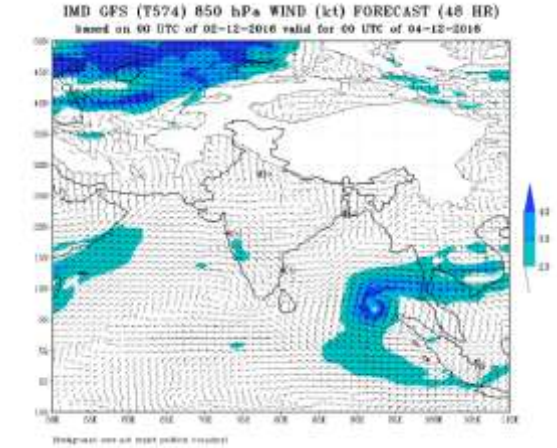

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 05-12-2016

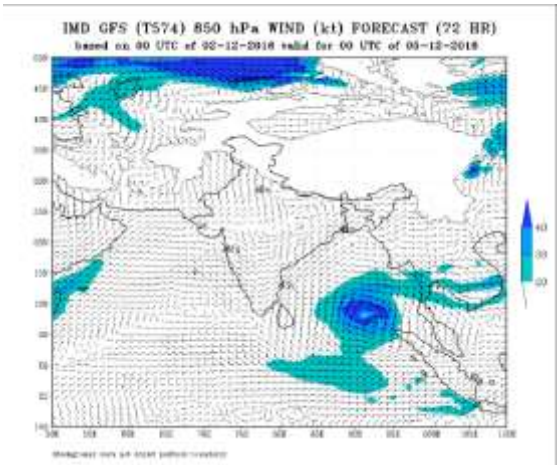

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 06-12-2016

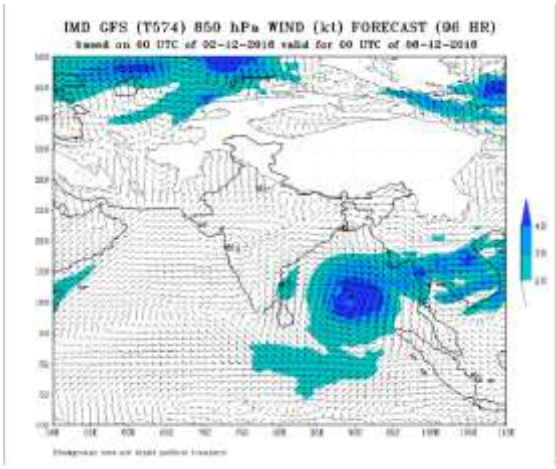

IMD GFS (T574) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 07-12-2016

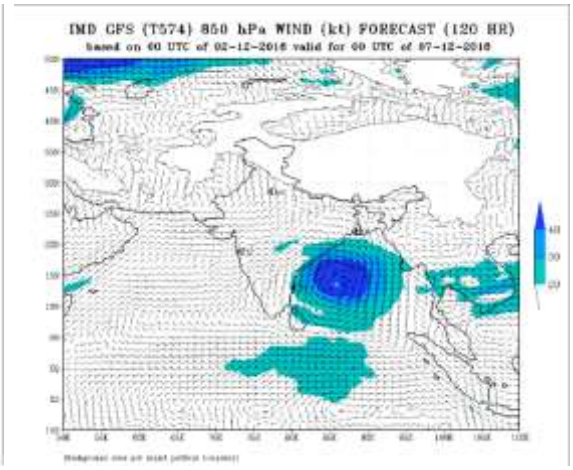

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 02-12-2016

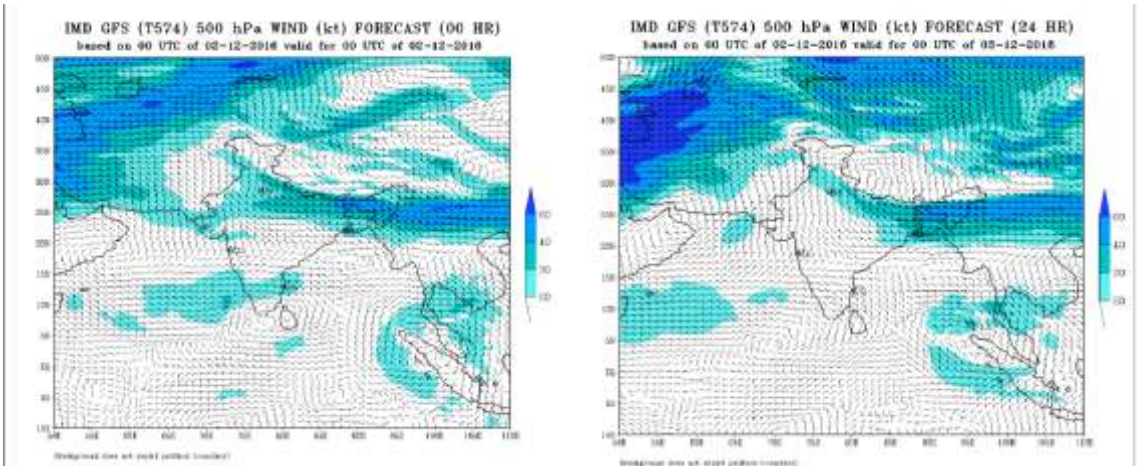

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 03-12-2016

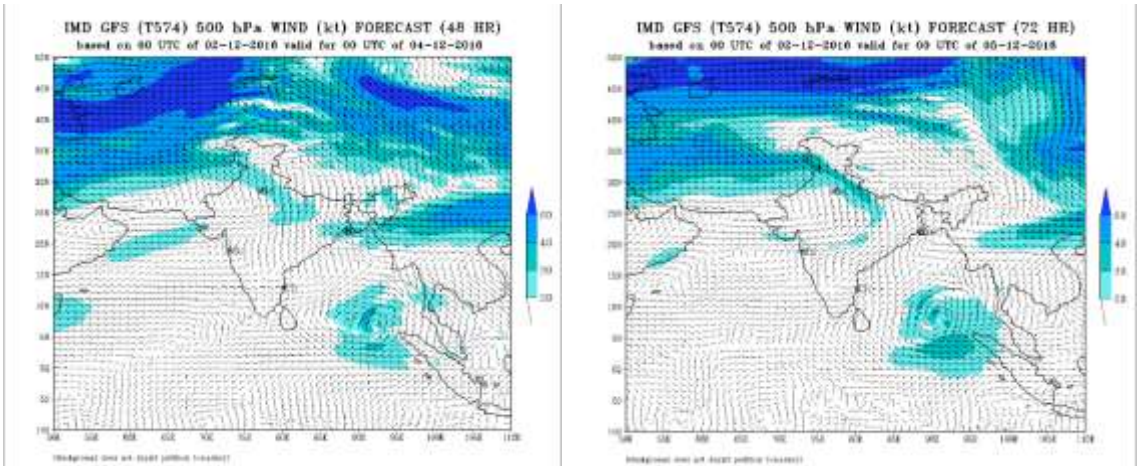

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 04-12-2016

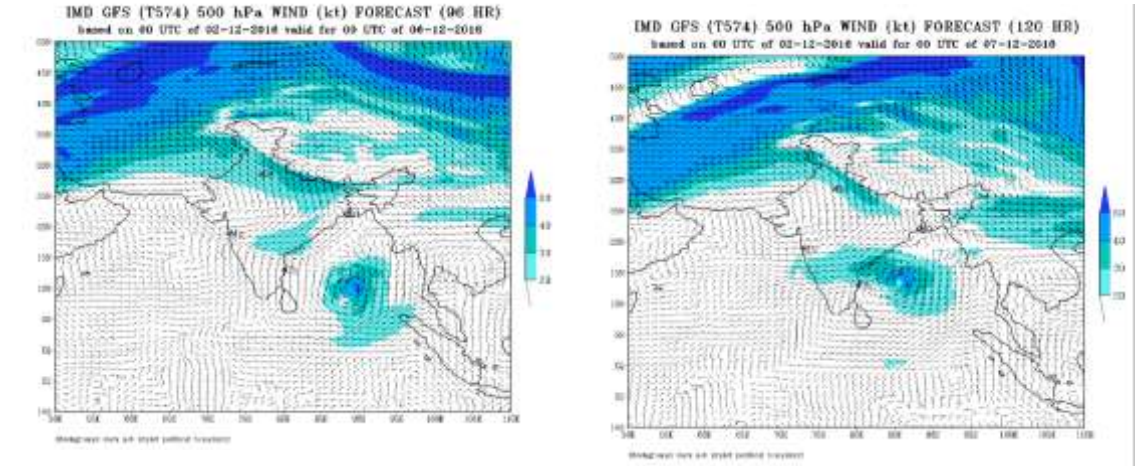

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 05-12-2016

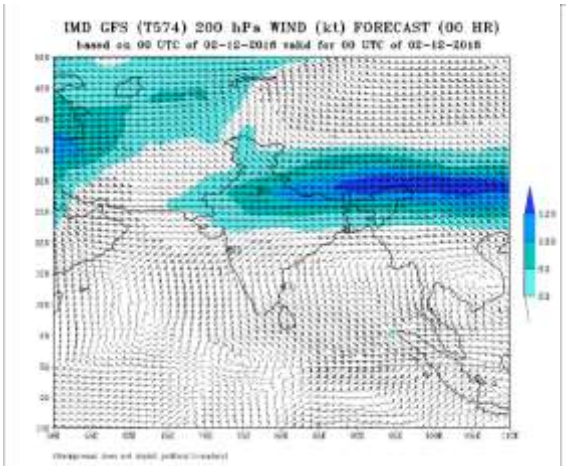

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 06-12-2016

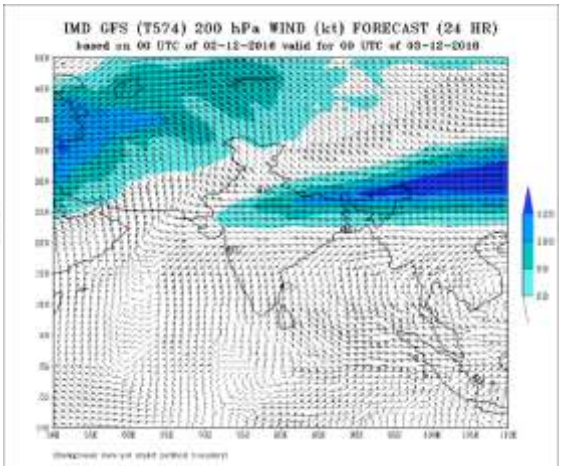

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 07-12-2016

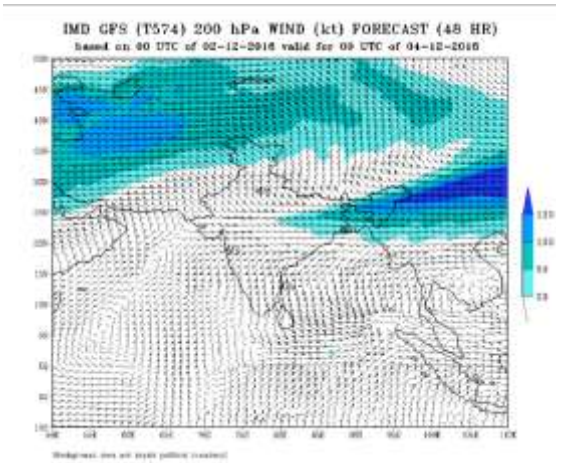

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 02-12-2016
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 03-12-2016

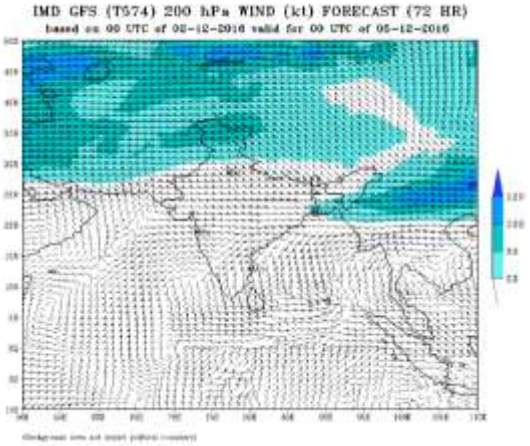

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 04-12-2016
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 05-12-2016

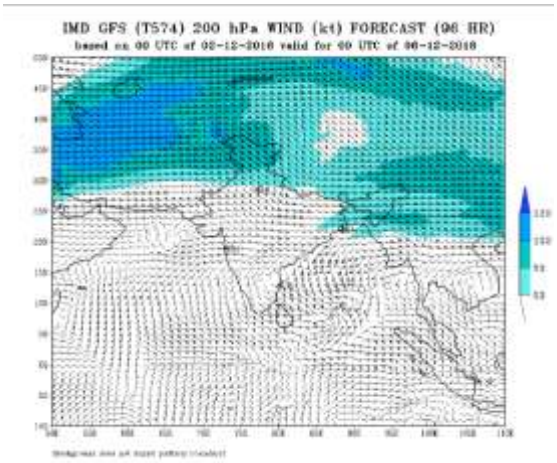

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 06-12-2016
IMD GFS (T574) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 07-12-2016

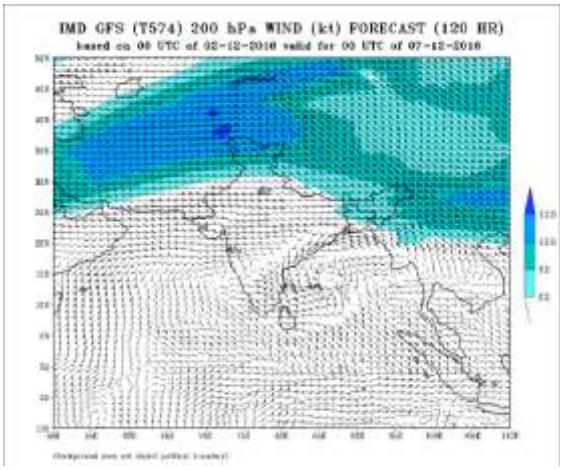

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 02-12-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 03-12-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 04-12-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 05-12-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 06-12-2016


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 02-12-2016 valid for 00 UTC of 07-12-2016

FDP (Cyclone) NOC Report Dated 3rd December, 2016

Synoptic features:

Yesterday's upper air cyclonic circulation over Malay Peninsula & neighbourhood, now lies over northern parts of Sumatra & neighbourhood and extends upto mid-tropospheric levels.

Under its influence, a low pressure area is very likely to develop over south Andaman Sea & neighbourhood during next 24 hours. It is very likely to concentrate into a depression in subsequent 48 hours.

Dynamical and thermodynamical features

Surface Temperature (SST):

It is around 28-29˚C over most parts of central and south BOB. It is decreasing towards north BOB and is around 27˚C.

The SST over most parts of westcentral and north Arabian Sea (AS) is between 26-27˚C. It is 28-29˚C over most parts of southeast, eastcentral AS. It is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 80-90 KJ/cm^2 over most parts of south and central BoB and Andaman Sea except southwest BoB off TN, AP coasts, north BoB and westcentral BoB where it is less than 50 KJ/cm^2. In some parts of. TCHP is 100 KJ/cm^2 over extreme southeast BoB and adjoining equatorial region.

TCHP is less than 50 kJ/cm^2 over eastern and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala & Karnataka coast and over Comorin area where TCHP is around 80-90 kJ/cm^2.

Relative Vorticity:

The low level relative vorticity is about 40-50x10^{-6} $second^{-1}$ over southeast BOB, Malay Peninsular region and adjoining equatorial region.

The low level relative vorticity is about 25x10^{-6} $second^{-1}$ over parts of eastcentral AS, south AS and adjoining equatorial region. It is negative over western parts of AS.

Convergence:

Low level convergence is about 10-15x10^{-6} s^{-1} over southeast BOB, South Andaman sea and Malay Peninsular region.

A small zone of positive low level convergence zone of 5x10^{-6} s^{-1} is seen over southeast AS and Lakshadweep islands, Kerala and Kokan-Goa coast.

Divergence:

The upper level divergence is around 20-40x10^{-5} $second^{-1}$ over southeast BOB, South Andaman sea, Malay Peninsular region and adjoining equatorial region.

A zone of negative divergence 5x10^{-6} s^{-1} is seen over some pockets of AS.

Wind Shear:

The vertical wind shear of horizontal wind is moderate (10-15 knots) over most parts of westcentral & southeast BoB and Malay Peninsular region.

Wind shear is around 15-20 kts over most parts of south AS and adjoining southeast AS. It is extending towards northwest AS..

Wind Shear Tendency:

Increasing shear tendency of 5-10 kts is seen over most parts of BOB and north Andaman sea & adjoining and Malay Peninsular region.

There is an extended zone of decreasing tendency of 10-20 kts over most parts of AS and Comorin Area and increasing tendency over southwest AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, Scattered low/medium clouds with embedded moderate to intense convection are seen over southeast BOB and Andaman Sea. Scattered low/medium clouds are seen over central BOB.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over Lakshadweep Islands. Scattered low/medium clouds are seen over Scattered low/medium clouds are seen over Scattered low/medium clouds are seen over southeast AS.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 14^0N latitude over BoB.

M.J.O. Index: MJO index is in Phase 1 with amplitude less than one and would continue in Phase 1 for next 2-3 days..

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis shows the remnant of CS, Nada over the southeast Arabian Sea as a low. It would move west-northwestwards and weaken gradually. The model analysis also indicates a fresh low pressure system over the southeast BoB and adjoining south Andaman Sea. In the models forecasts, while moving northwestward the system intensifies into a depression on 4, into a cyclonic storm on 5 and into an SCS on 7 December, 2016. Thereafter, moving further in northwestward direction it approaches Orissa coast on 8 and crosses West Bengal coast on 9 December 2016 morning. The system shows highest intensity on 7 December 2016 to become a VSCS.

NCEP-GFS: The model analysis and forecasts show a low over southeast BoB on 3 and 4 December, 2016. It is likely to become a depression on 5, a deep depression on 6 and a CS on 7 December 2016 with initial northwestward and then west-northwestwards movement. It approaches Orissa coast on 8 and cross Orissa coast south of Paradeep on 9 December 2016 morning.

ECMWF: The model analysis and forecasts indicate a low pressure system over the south east BoB which becomes well marked on 4 December, 2016. The system intensifies into a depression on 6 December with an initial north-northwestward movement over west-central BoB. Then the system is likely to move in northwest direction over central BoB and intensify into a CS on 7 December 2016. Thereafter, moving west-northwestward direction the system intensifies further to become SCS on 9 December 2016 over WC Bay and lies over WC Bay off north AP and adjoining Odisha coast on 11th morning and crosses these coasts on 11th evening. Overall, the model forecasts show slow movement and rather moderate intensification of the system compared to other models.

WRF: The WRF model analysis shows a low over SE BoB which in the model forecasts moves northwestwards, intensifies in to depression on 5 December 2016. The system continues to move northwestward over west-central BOB and becomes a cyclonic storm on 6 December 2016.

JMA: It lies as a low on 3rd and 4th over SE Arabian Sea. It shows low over south Andaman Sea on 5th and depression over SE Bay on 6th and over SE and adjoining EC Bay as Depression on 7th.

Meteo-France ARP Model: The model also indicates a fresh low pressure system over the south Andaman Sea on 4th and depression over SE Bay on 5th while moving initially west-north-west and then northwestwards. It becomes CS over SE bay on 6th.

NCMRWF-NCUM: A fresh low develops over south Andaman Sea on 5th. Moving north-northwestwards, it becomes depression on 6th, Deep depression/ CS on 7th It then recurves

northeastwards becomes Deep Depression over EC bay off Myanmar coast on 9th, depression over the same area on 10th, low over same area on 11th.

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 02 Dec November shows a Depression over south Andaman Sea on 4th and Deep depression over the same area on 5th and CS on 6th.

The remnant of CS, Nada appears as a low over SE Arabian Sea on 3rd. Moving westwards, it becomes less marked on 5th.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 3 Dec shows a fresh low over South Andaman Sea on 5th and deep depression over same area on 6th, CS on 7th over SE Bay and adjoining south Andaman sea, CS over north Andaman Sea on 8th and 9th, SCS over north Andaman sea and adjoining EC Bay on 10th, CS over EC Bay on 11th, CS over central Bay on 12th, CS over WC and adjoining NW Bay off north AP coast on 13th.

IITM-GEFS: A depression develops over South Andaman Sea on 4th and becomes CS over SE Bay on 5th, SCS on 5th and SCS on 6th, VSCS on 7th, SCS on 8th, Depression on 9th and crossing Odisha coast near 20^0N in the morning.

IITM-GFS(1534): A well marked low develops over South Andaman Sea low over 4th. Moving NWwards, it becomes CS on 5th over SE Bay, SCS on 6th over central part of south Bay, VSCS on 7th, VSCS over NW Bay on 8th. It crosses Odisha coast on 8th evening and weakens to SCS on 9th morning.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 03 December 2016 suggests a zone of significant GPP appear (> 30) over south Andaman Sea on 4 and 5 December, 2016, which has northwesterly movement. It shows northwestward movement till 8 December to approach Orissa coast and finally with a north-northwestward it crosses over Orissa and West Bengal coast on 9 December 2016.

Summary and Conclusion:

The remnant low over SE Arabian sea on 3rd Dec. and its gradual movement towards west-northwest direction and becoming less marked.

A fresh low pressure area is likely to develop over southeast Bay on 4th Dec. 2016. It would move initially west-northwestwards and then northwestwards and concentrate into a depression during 5th Dec as per majority of models and by 6 th Dec. as suggested by all the models. Further it will intensify into a cyclonic storm by 6th as per majority of models and by 7th Dec. by most of the models. There is large divergence regarding the movement and landfall. While IMD GFS suggests landfall north Odisha-West Bengal coast on 9th morning, NCEP GFS and IITM GEFS suggests near Odisha (near 20^0N) on 9 th morning, GFS91534) suggests near Odisha (near 20^0N) on 8th evening, ECMWF suggests near north AP and adjoining south Odisha coast on 11th evening, NCUM suggests near Myanmar coast on 9th morning.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Nil	Low	Moderate	High	High

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Intense Observation Period (IOP) : IOP to be undertaken for Andhra Pradesh and Odisha coasts during 7-9 Dec. 2016.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	02/12	03/00	03/03
India	43	29	43
Coastal stations			
WB	9	3	9
Odisha	6	5	5
AP	12	10	11
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	9	11
Myanmar	1	1	1
Thailand	3	3	3
Sri Lanka	8	7	8

AWS:

Region	Date/Time (UTC)		
	02/12	03/00	03/03
WB	6	0	6
Odisha	7	2	7
AP	9	5	11
Tamil Nadu	25	10	20
Puducherry	1	1	0
A & N	0	0	0

- **RS/RW** (12Z) of 02/12/2016 :33/43
- **No. of Ascents reaching 250 hPa levels:14 , MISDA:- 2**

- **RS/RW** (00Z) of 03/12/2016 :32 /43

- **No. of Ascents reaching 250 hPa levels: 27 , MISDA: 1**
- **No. of PILOT Ascents**

02 /12Z	03 /00Z
17	30

Buoy Data

02/12Z	03 /00Z	03/03Z
14	14	16

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	02.12.2016							
UTC→	00	03	06	09	12	15	18	21
Chennai Region (Coasts of AP & TN)	20	22	20	20	22	20	20	20

No. of RS/RW Ascents

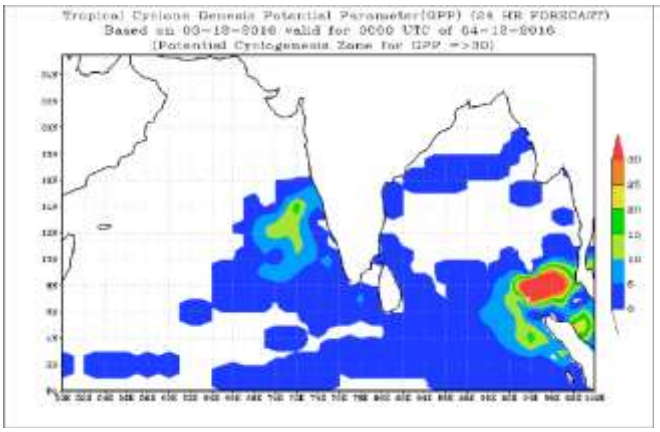
00Z /02.12.2016 : 6
No. of Ascents reaching 250 hPa level = 6
MISDA : 2

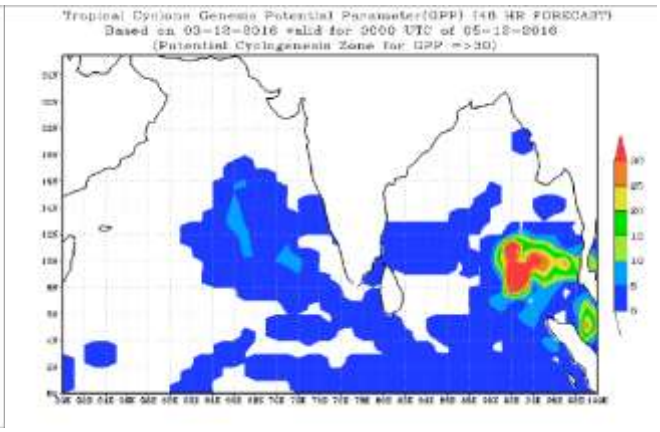
12Z /02.12.2016 : 2
No. of Ascents reaching 250 hPa level = 2
MISDA : 6

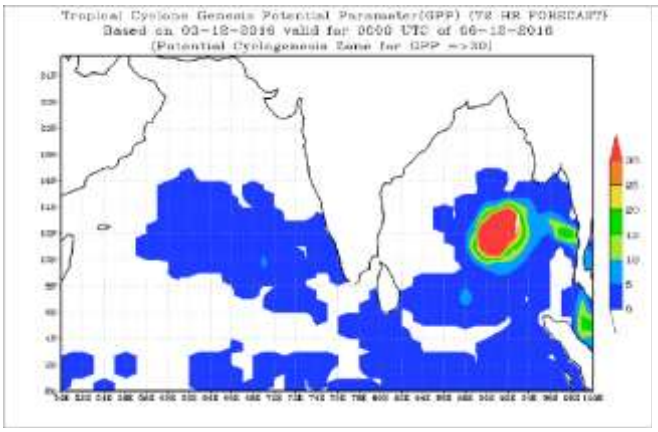
No. of PILOT Ascents:

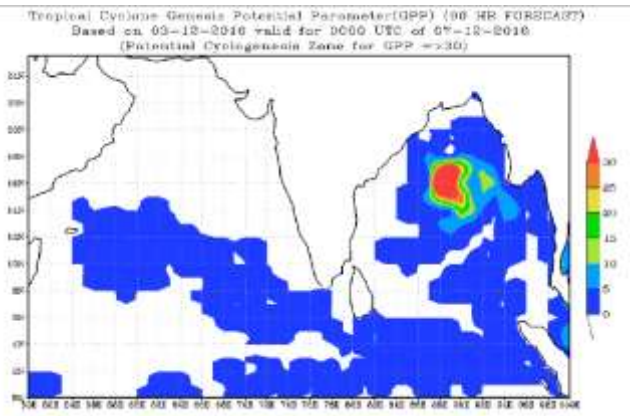
02.12.2016	
06Z	18Z
2	3

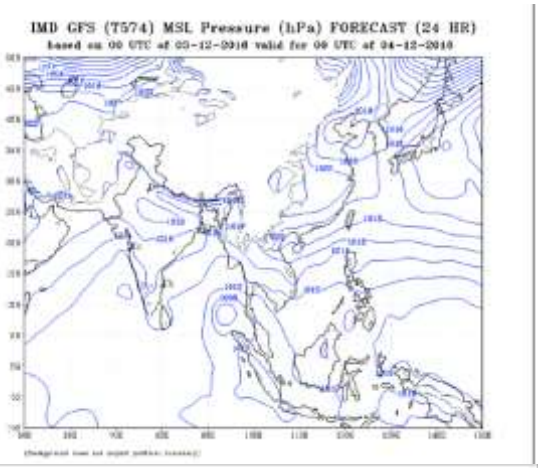
Annexure- II

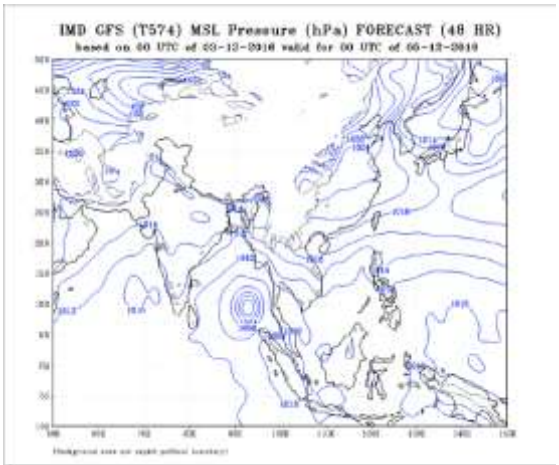

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 03-12-2016 valid for 0000 UTC of 04-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

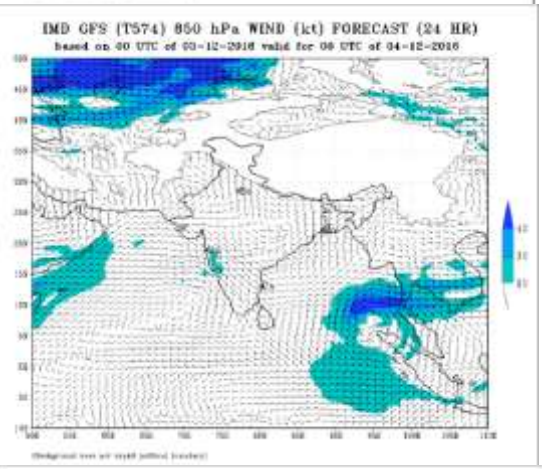

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 03-12-2016 valid for 0000 UTC of 05-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

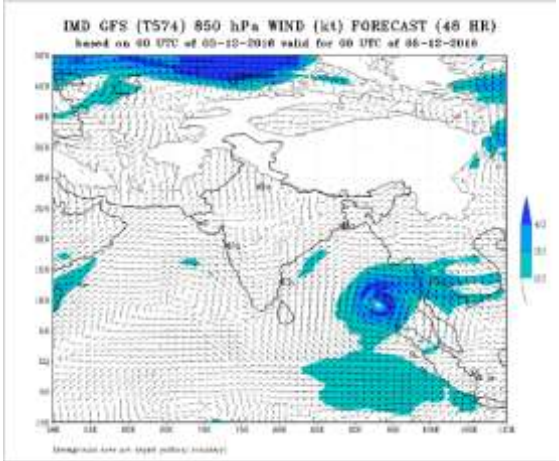

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 03-12-2016 valid for 0000 UTC of 06-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

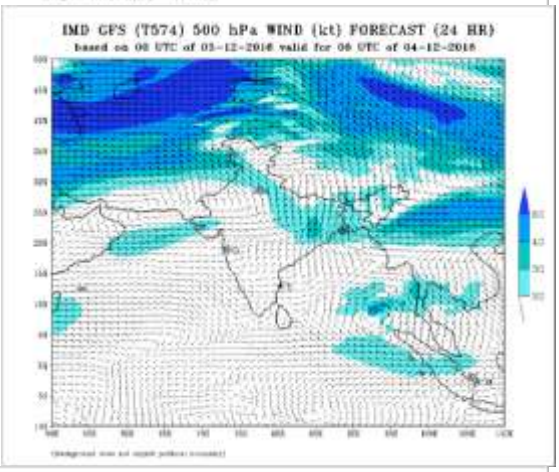

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 03-12-2016 valid for 0000 UTC of 07-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

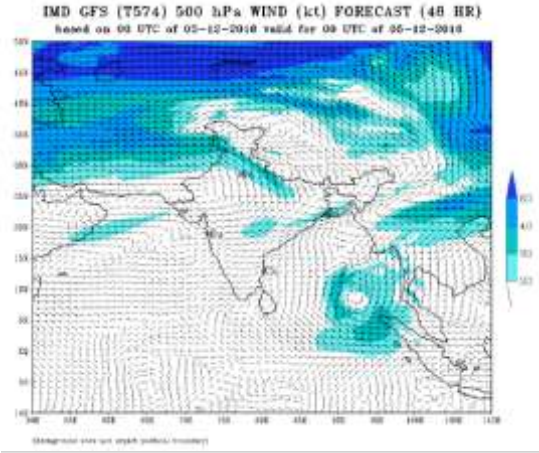

IMD GFS (T574) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 03-12-2016 valid for 00 UTC of 04-12-2016

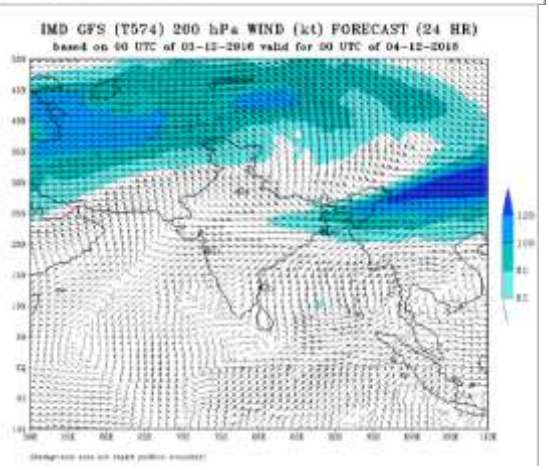

IMD GFS (T574) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 03-12-2016 valid for 00 UTC of 05-12-2016

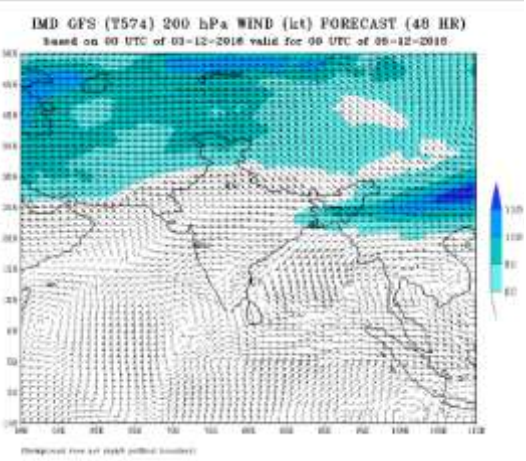

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 03-12-2016 valid for 00 UTC of 04-12-2016

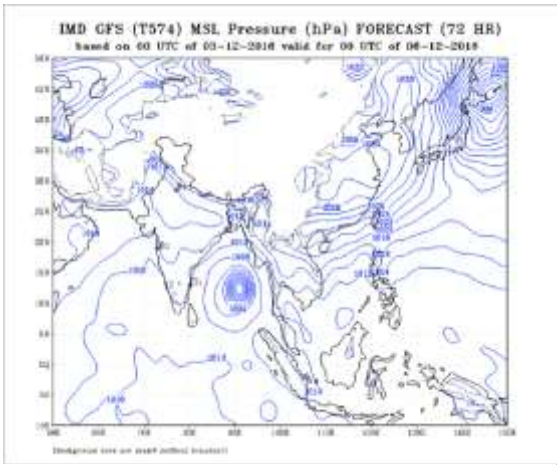

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 03-12-2016 valid for 00 UTC of 05-12-2016

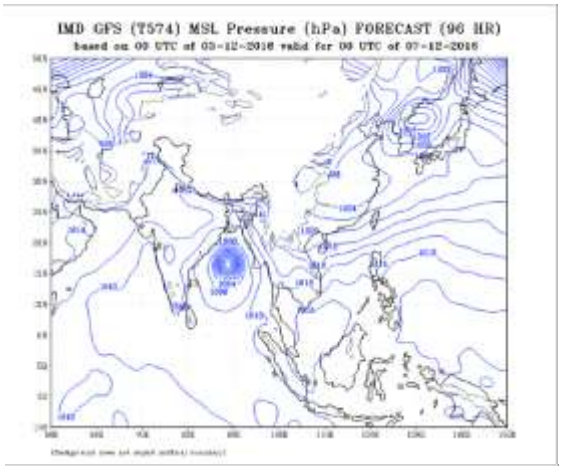

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 03-12-2016 valid for 00 UTC of 04-12-2016

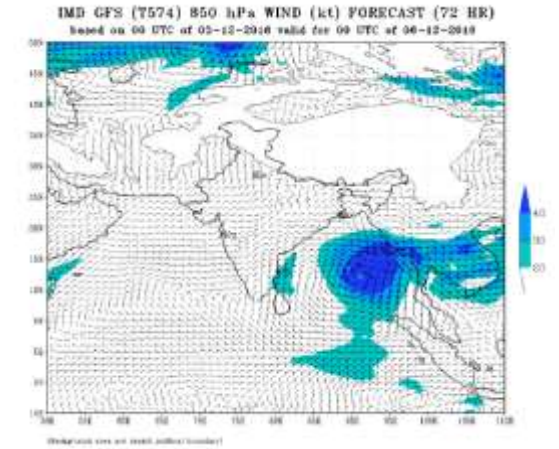

IMD GFS (T574) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 03-12-2016 valid for 00 UTC of 05-12-2016

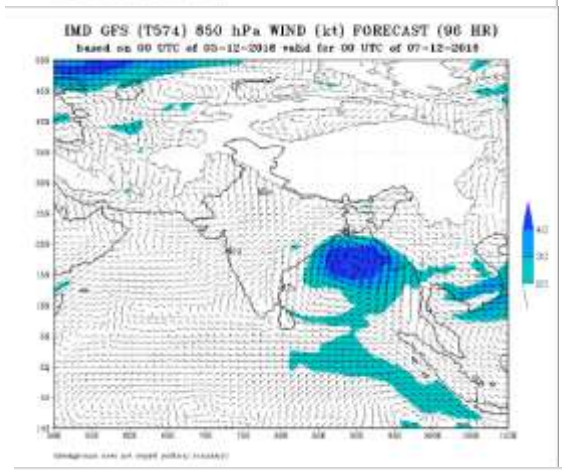

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 03-12-2016 valid for 00 UTC of 04-12-2016

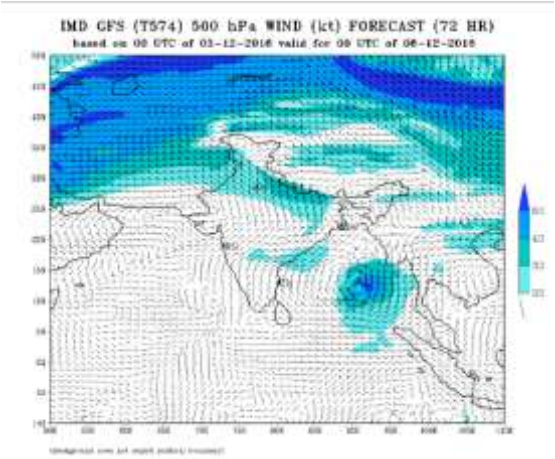

IMD GFS (T574) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 03-12-2016 valid for 00 UTC of 05-12-2016

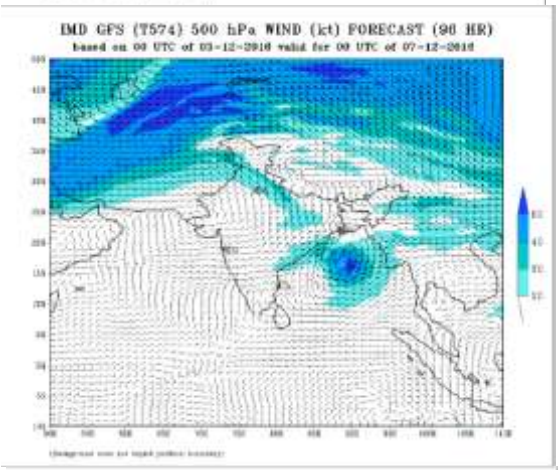

IMD GFS (T574) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 03-12-2018 valid for 00 UTC of 06-12-2018

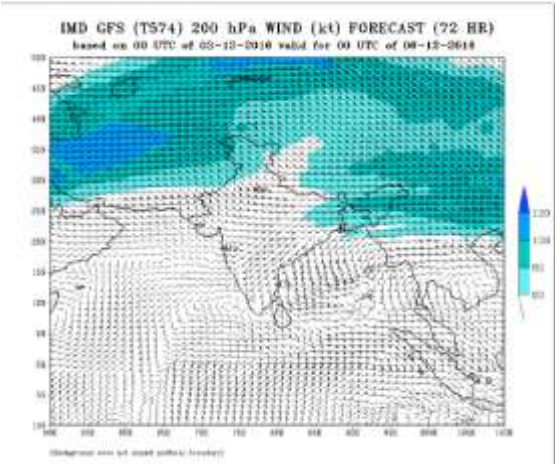

IMD GFS (T574) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 03-12-2018 valid for 00 UTC of 07-12-2018

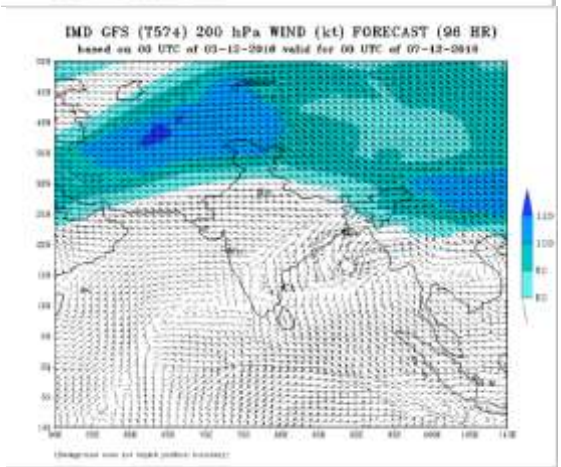

IMD GFS (T574) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 03-12-2018 valid for 00 UTC of 06-12-2018


IMD GFS (T574) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 03-12-2018 valid for 00 UTC of 07-12-2018


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 03-12-2018 valid for 00 UTC of 06-12-2018


IMD GFS (T574) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 03-12-2018 valid for 00 UTC of 07-12-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 03-12-2018 valid for 00 UTC of 06-12-2018


IMD GFS (T574) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 03-12-2018 valid for 00 UTC of 07-12-2018

FDP (Cyclone) NOC Report Dated 4th December 2016

Synoptic features:

Under the influence of yesterday's upper air cyclonic circulation over northern, parts of Sumatra & adjoining south Andaman sea, a low-pressure area has formed over south Andaman sea & adjoining Sumatra and extends up to mid-tropospheric levels. It is very likely to concentrate into a depression during next 24 hours and into a deep depression during subsequent 24 hours.

Dynamical and thermodynamical features

Surface Temperature (SST):

It is around 30˚C over the system and decreases towards the northwest bay of Bengal about 26-27°C over north Andhra Pradesh, Odisha, west Bengal and Bangladesh coast.

The SST over most parts of westcentral and north Arabian Sea (AS) is between 26-27˚C. It is 28-29˚C over most parts of southeast, eastcentral AS. It is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast.

Tropical Cyclone Heat Potential (TCHP):

Ocean thermal energy is about 100-120 over the low pressure area but <50 KJ/cm^2 lie over north bay adjoining west central bay of Bengal.

TCHP is less than 50 kJ/cm^2 over eastern and north AS. It is 60-80 kJ/cm^2 over remaining parts of AS except off north Kerala & Karnataka coast and over Comorin area where TCHP is around 80-90 kJ/cm^2.

Relative Vorticity:

The low-level relative vorticity is about 100x10^{-6} second^{-1} over west sector of the low pressure area.

The low-level relative vorticity is about 25x10^{-6} second^{-1} over parts of eastcentral AS, south AS and adjoining equatorial region. It is negative over western parts of AS.

Convergence:

Low-level convergence is about 30x10^{-6} s^{-1} over northwest sector of the system and southeast BOB, South Andaman sea and Malay Peninsular region.

A small zone of positive low-level convergence zone of 5x10^{-6} s^{-1} is seen over southeast AS and Lakshadweep islands, Kerala and Kokan-Goa coast.

Divergence:

The upper-level divergence is about 40x10^{-6} s^{-1} over northwest sector of the system and southeast BOB, South Andaman sea and Malay Peninsular region.

A zone of negative divergence 5x10^{-6} s^{-1} is seen over some pockets of AS.

Wind Shear:

The vertical wind shear of horizontal wind is moderate (5-15 knots) around the system and increases towards the northwest and westcentral Bay of Bengal.

Wind shear is around 15-20 kts over most parts of south AS and adjoining southeast AS. It is extending towards northwest AS.

Wind Shear Tendency:

Increasing shear tendency of 5-10 kts is seen over most parts of BOB and north Andaman sea & adjoining and Malay Peninsular region.

There is an extended zone of decreasing tendency of 10-20 kts over most parts of AS and Comorin Area and increasing tendency over southwest AS.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, Scattered low/medium clouds with embedded moderate to intense convection are seen over southeast BOB, Andaman Sea, and Tenasserim coast. Scattered low/medium clouds are seen over central BOB.

Arabian Sea:

Scattered low/medium clouds with embedded isolated weak to moderate convection are seen over rest southeast AS.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 13^0N latitude over BoB.

M.J.O. Index: MJO index lies in phase 2 with amplitude <1. it will continue in phase 2 for next 3-4 days with increasing amplitude

Storms and Depression over South China Sea/ South Indian Ocean: NIL

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis shows a well-marked low pressure system over the southeast BoB and adjoining the south Andaman Sea. In the model's forecasts, while moving northwestward, the system intensifies into a deep depression on 5, into a cyclonic storm on 6 and to a SCS on 7 December 2016. The system becomes VSCS on 8 December as it reaches its maximum intensity. It continues as VSCS till 9th morning and then weakens into a CS on 10th over north coastal AP and adjoining south coastal Odisha on 10th morning after landfall around 09/2100 UTC near about 18^0N (north AP).

NCEP-GFS: The model analysis and forecasts show a well-marked low over southeast BoB on 4 December 2016. It is likely to become a depression on 5, a deep depression on 6 and a CS on 7 and VSCS on 8 December 2016 over central BoB with persistent northwestwards movement. It weakens into an SCS on 9th over WC Bay off north AP and south Odisha coasts. It lies as CS on 10th over north coastal AP and adjoining south coastal Odisha after landfall around 09/2100 UTC near about 18^0N (north AP coast). It is less marked on 11th morning

ECMWF: The model analysis and forecasts indicate a low pressure system over the southeast BoB which becomes well marked low over the south Andaman Sea on 5 December 2016. The system intensifies into a depression on 6 and into a CS on 7 December 2016 with northwestward movement over west-central BoB. Then the system is likely to intensify further over central BoB to become a SCS on 8 and a VSCS on 9 December 2016. Thereafter, moving northwestward direction the system intensifies further on 10 and approaches south Andhra coast with west-northwestward movement on 11 December 2016. It lies a Depression over north AP on 12th after crossing the north AP coast near 17^0N around 2100 UTC of 11th.

WRF: The WRF model analysis shows a low over the eastern part of southeast BoB which in the model forecasts moves initially westward and then northwestwards with gradual intensification to become a depression on 5, a CS on 6 and a SCS on 7 December 2016.

JMA: It shows well marked low over the south Andaman Sea on 5th and depression over SE Bay on 6th and over SE and adjoining EC Bay as a cyclonic storm on 7th.

Meteo-France ARP Model: The model also indicates a well marked low over the south Andaman Sea on 5th and depression over SE Bay on 6th while moving initially west-north-west and then northwestwards. It becomes CS over SE bay on 7th.

NCMRWF-NCUM: A fresh low develops over the south Andaman Sea on 4th. Moving north-northwestwards, it becomes depression on 5th, CS on 6th, SCS on 7th. It lies as SCS over north Bay off west Bengal and Bangladesh coast on 12th and crosses Bangladesh coast near about 91^0E in the morning of 13th.

NCMRWF-UM-Regional Model: The analysis based on 00 UTC of 04 Dec November shows a low over the south Andaman Sea on 4th and depression over the same area on 5th while

moving slightly west-northwestwards, CS on 6th over SE Bay and SCS on 7th over SE and adjoining EC Bay.

NCMRWF-NEPS Model: The analysis based on 00 UTC of 4 Dec shows a depression over South Andaman Sea on 6th Moving north-northwestwards, it becomes deep depression on 7th, CS on 8th, SCS on 9th. It lies as SCS close to Myanmar coast (Irrawaddy delta) on 11 th. It then moves northwestwards, becomes CS on 13th over WC Bay and Deep Depression over WC Bay off north AP and south Odisha coast on 14th.

IITM-GEFS: A depression develops over South Andaman Sea on 5th. Moving initially west-northwestwards and then northwestwards, it becomes deep depression on 6th, CS on 7th, SCS on 8th over central Bay. It then weakens to CS on 9th, Well Marked Low off Odisha coast on 10th and becomes less marked on 11th.

IITM-GFS(1534): A CS develops over South Andaman Sea low over 5th. Moving NWwards, it becomes SCS on 6th over SE Bay, VSCS on 7th over central Bay. It continues as VSCS till 9th morning and then weakens into a CS on 10th over north coastal AP and adjoining south coastal Odisha on the 10th morning after landfall around 09/2100 UTC near about 18^0N. It is less marked on 11th morning

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 04 December 2016 suggest a zone of significant GPP (> 30) over the south Andaman Sea on 5 and 6 December 2016. The organized significant GPP zone continually moves northwestward direction from 7 to 10 December 2016 to cross Andhra Pradesh coast.

Summary and Conclusion:

The low pressure area over the south Andaman Sea is very likely to concentrate into a Depression over the south Andaman Sea and adjoining SE Bay by 5 Dec. 2016. It would intensify into a cyclonic storm over SE Bay on 6th Dec. There is still divergence regarding the movement and landfall. While GFS based models and ECMWF suggests landfall over north AP coast around 2100 UTC of 9th near 18^0N and 2100 UTC of 11th near 17^0N, NCUM suggests landfall over Bangladesh coast near 91^0E , NEPS does not show landfall till 14th, though it moves to WC Bay off north AP coast.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Moderate	High	High	High	High

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1	Day 2	Day-3	Day-4	Day-5
	24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Intense Observation Period (IOP) : IOP to be undertaken for Andhra Pradesh and Odisha coasts during 7-9 Dec. 2016 and over Andaman and Nicobar Islands during 5-6th Dec. 2016.

Annexure-II

Status of the observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	03/12	04/00	04/03
India	43	29	43
Coastal stations			
WB	9	3	9
Odisha	6	5	5
AP	12	10	11
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	9	11
Myanmar	1	1	1
Thailand	3	3	3
Sri Lanka	8	7	8

AWS:

Region	Date/Time (UTC)		
	03/12	04/00	04/03
WB	6	0	6
Odisha	7	2	7
AP	9	5	11
Tamil Nadu	25	10	20
Puducherry	1	1	0
A & N	0	0	0

- **RS/RW** (12Z) of 03/12/2016 :33/43
- **No. of Ascents reaching 250 hPa levels:14 , MISDA:- 2**

- **RS/RW** (00Z) of 04/12/2016 :32 /43

- **No. of Ascents reaching 250 hPa levels: 27 , MISDA: 1**
- **No. of PILOT Ascents**

03 /12Z	04 /00Z
17	20

Buoy Data

03/12Z	04 /00Z	04/03Z
14	15	16

STATUS OF RMC, CHENNAI REGION OBSERVATIO

No. of Synop data

Date→	03.12.2016							
UTC→	00	03	06	09	12	15	18	21
Chennai Region (Coasts of AP & TN)	20	22	20	20	22	20	20	20

No. of RS/RW Ascents

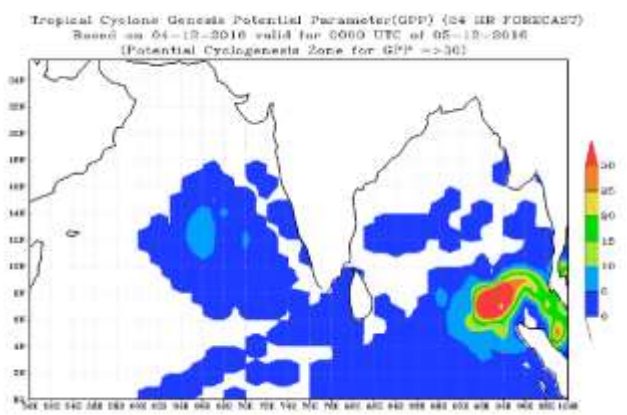
00Z /03.12.2016 : 5
No. of Ascents reaching 250hPa level =5
MISDA :3

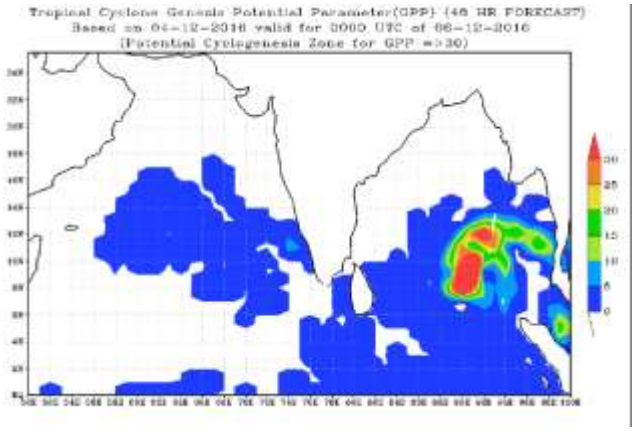
12Z /03.12.2016 : 1
No. of Ascents reaching 250 hPa level =1
MISDA : 7

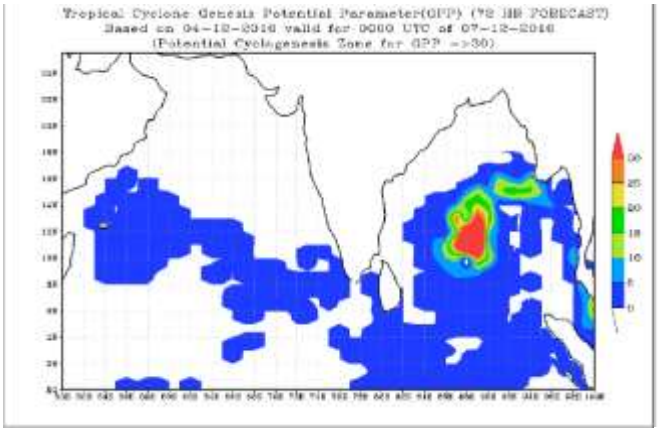
No. of PILOT Ascents:

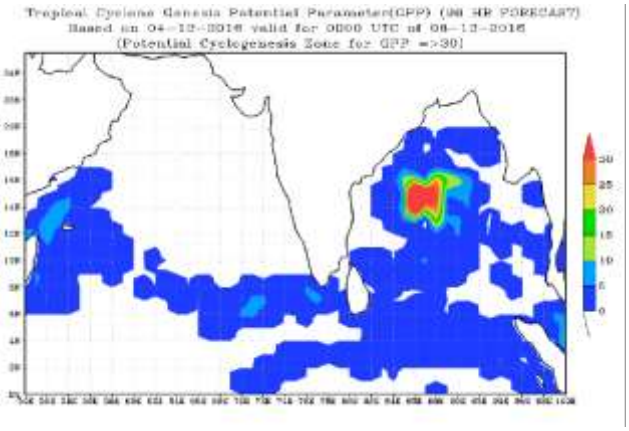
03.12.2016	
06Z	18Z
2	2

Annexure-II

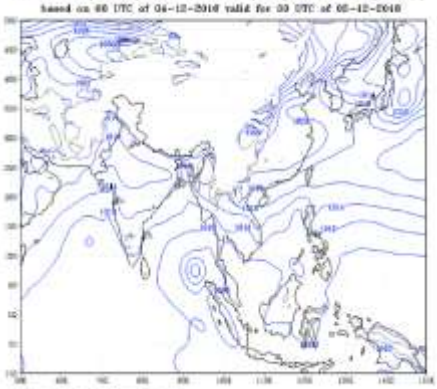

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 04-12-2016 valid for 0000 UTC of 05-12-2016
(Potential Cyclogenesis Zone for GPP =>30)


Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 04-12-2016 valid for 0000 UTC of 06-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

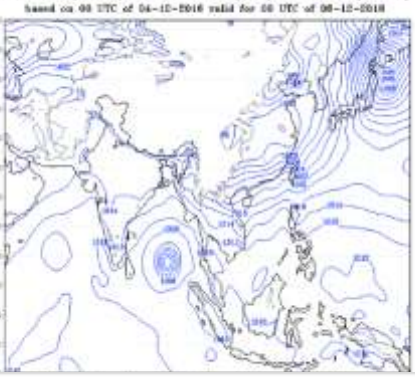

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 04-12-2016 valid for 0000 UTC of 07-12-2016
(Potential Cyclogenesis Zone for GPP =>30)


Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 04-12-2016 valid for 0000 UTC of 08-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

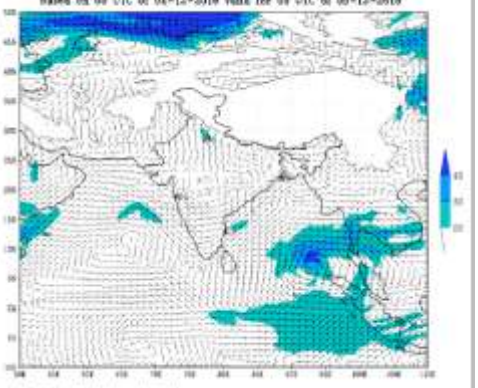
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)



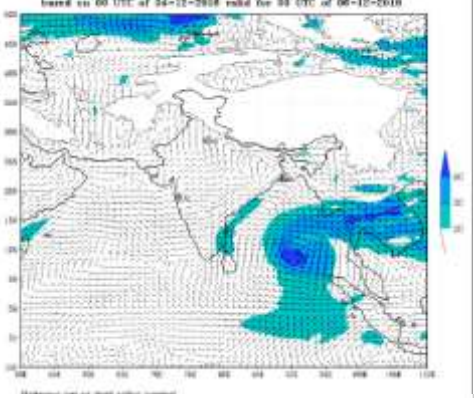
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)



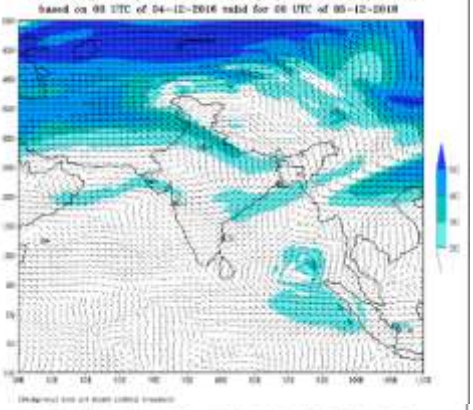
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)



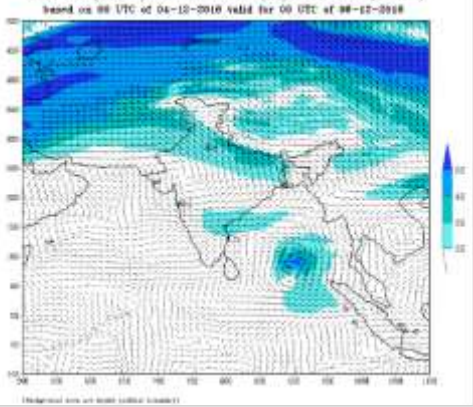
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)



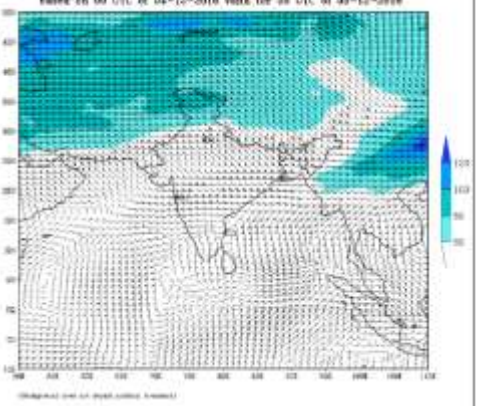
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)



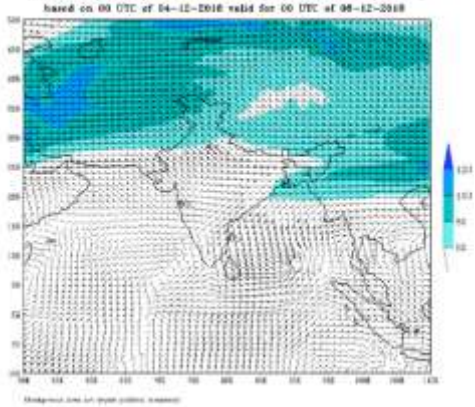
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)

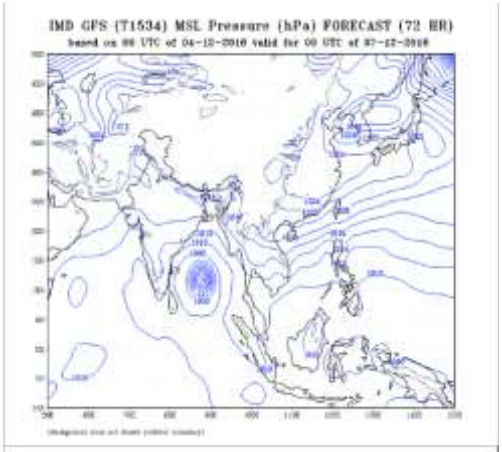


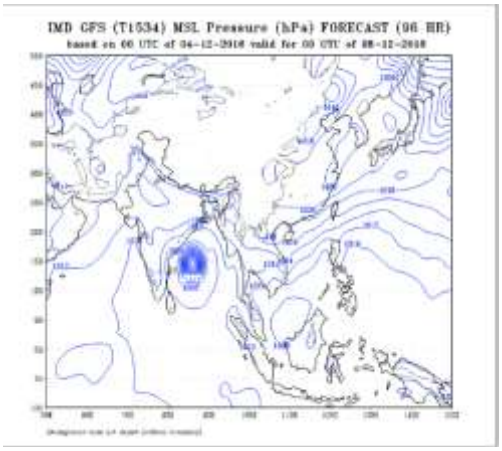
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)

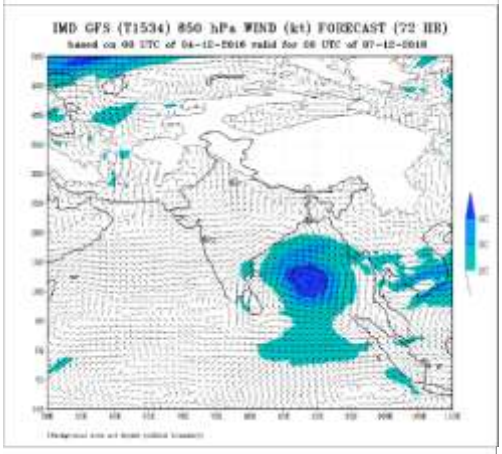


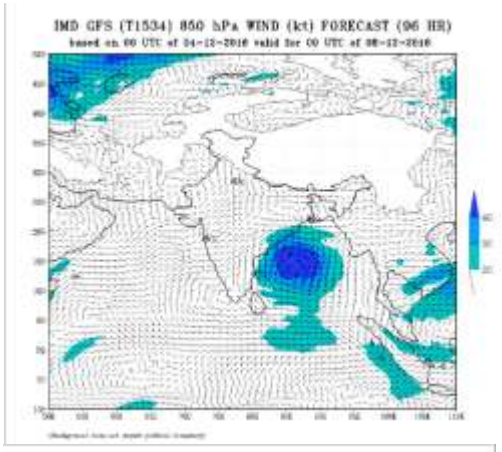
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)

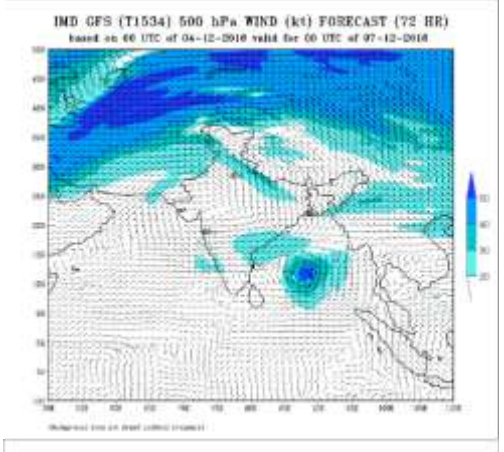


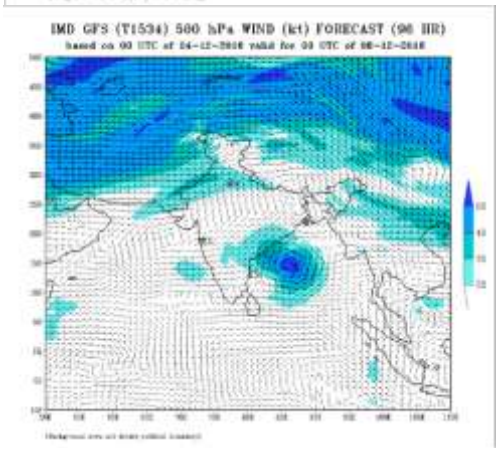

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 04-12-2016 valid for 00 UTC of 07-12-2016

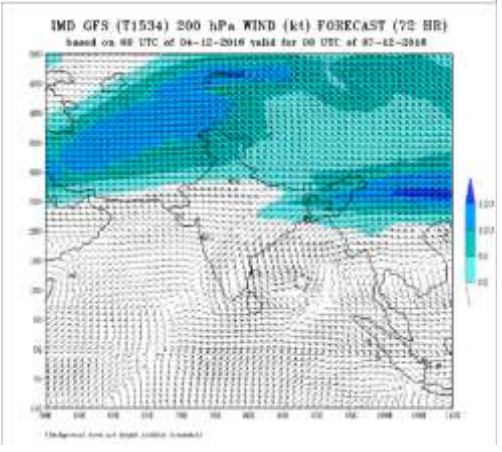

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 04-12-2016 valid for 00 UTC of 08-12-2016

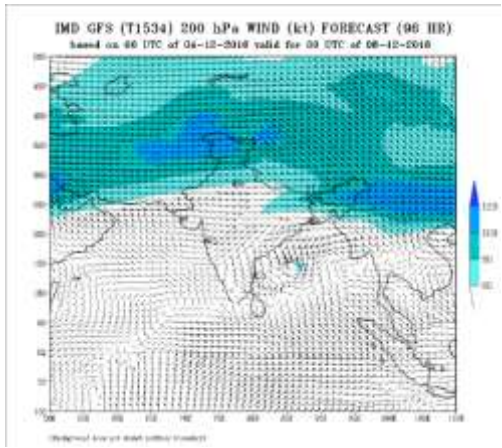

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 04-12-2016 valid for 00 UTC of 07-12-2016


IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 04-12-2016 valid for 00 UTC of 08-12-2016


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 04-12-2016 valid for 00 UTC of 07-12-2016


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 04-12-2016 valid for 00 UTC of 08-12-2016


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 04-12-2016 valid for 00 UTC of 07-12-2016


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 04-12-2016 valid for 00 UTC of 08-12-2016

FDP (Cyclone) NOC Report Dated 05th December 2016

Synoptic features:

The low pressure area over south Andaman Sea and adjoining Sumatra lay as a well marked low pressure area over the same region, yesterday evening. It now lies over south Andaman Sea and adjoining southeast Bay of Bengal. Associated cyclonic circulation extends upto 5.8 kms a. s. l. System is very likely to concentrate into a Depression during next 24 hrs, which is very likely to intensify into a Deep Depression during the subsequent 24 hrs. The cyclonic circulation over southeast Arabian Sea and adjoining Lakshadweep area now lies over southeast Arabian Sea and adjoining eastcentral Arabian Sea and extends upto 3.6 kms a. s. l.

Dynamical and thermodynamical features

Surface Temperature (SST):

It is around 30˚C over the system and decreases towards the northwest bay of Bengal and is about 26- 27°C off the coasts of north Andhra Pradesh, Odisha, west Bengal and Bangladesh. The SST over most parts of westcentral and north Arabian Sea (AS) is between 26-27˚C. It is 28-29˚C over most parts of southeast and eastcentral Arabian Sea. It is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 100 kJ/cm^2 over the system area and also to its southwest. . It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal and also off the Tamil Nadu coast over southwest BoB.

TCHP is less than 50 kJ/cm^2 over western Arabian Sea. It is 100 kJ/cm^2 over some pockets over off the coasts of Karnataka and Kerala and also over Maldives area.

Relative Vorticity:

The low-level relative vorticity is about 120 x10^{-6} s^{-1} over the system area. It is negative over remaining BOB & adjoining north Andaman Sea.

One southwest-northeast oriented band of positive vorticity of 30x10^{-6} second^{-1} lie over east central Arabian Sea.

Convergence:

There is an extended area of positive lower level convergence south Andaman Sea. The convergence value is 30 x10^{-6} s^{-1} over the system area.

There is a zone of positive low level convergence over Lakshadweep area and neighbouring southeast Arabian Sea.

Divergence:

There is a zone of positive upper level divergence over southern parts of southeast Bay and over south Andaman sea with a high of 30 x10^{-6} s^{-1} over the system area.

There an area of positive upper-level divergence of 10 x10^{-6} s^{-1} over central parts of central Arabian Sea.

Wind Shear:

Wind shear is 15-20 kts over the system area. It is high over the remaining BOB.

Wind shear is moderate over Comorin area and the area extends westwards. There is a band of low wind shear off Somali and Arabian Peninsula. It is high over the remaining Arabian Sea.

Wind Shear Tendency:

There is decreasing tendency (5-10 kts) over the system area and also over southern most parts of BOB and Andaman Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, vortex over South Andaman Sea and adjoining SE Bay centred within half a degree of 7.5˚N/93.8˚E (.) Intensity T1.0 (.) Minimum CTT is -82˚C (.) Associated

broken low/medium clouds with embedded intense to very intense convection over South Andaman Sea and adjoining SE Bay between lat 5.5˚N to 12.5˚N to the east of long 90.0˚N.

Scattered low/medium clouds with embedded moderate to intense convection over rest SE Bay, rest Andaman Sea and south Tenasserim coast.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over EC and adjoining WC and SE Arabian Sea between lat 10˚N to 17.5˚N and long 62.5˚E to 75.0˚E.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 13^0N latitude over BoB.

M.J.O. Index: MJO index is in Phase 1 with amplitude less than one. It would move to phase 2 during next 3 days with increase in amplitude.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis shows a well-marked low pressure system over the southeast BoB and adjoining south Andaman Sea. In the models forecasts, while moving west-northwestward direction and then northwestward it becomes a depression on 6th, deep depression on 7th, CS on 8th, SCS on 9th, VSCS on 10th, SCS on 11th, DD on 12th off Odisha coast and D off north Odisha coast on 13rg and D over north Bay December on 14th and less marked over north Bay on 15th.

NCEP-GFS: The model analysis shows a well-marked low over southeast BoB. It is likely to become a depression on 6th, a deep depression on 7th and a CS on 8th December 2016 over central BoB with persistent northwestwards movement. The system intensifies further on 9th and 10th December, approaches Andhra Pradesh coast on 11th and crosses the north Andhra Pradesh coast in the early morning of 11th December 2016 as a weaker system (CS/DD). After landfall, it dissipates rapidly to become a low on 12th December 2016.

ECMWF: The model analysis indicates a well-marked low pressure system over south Andaman Sea on 5 December, 2016. In the forecasts, the system intensifies into a depression on 6 and into a CS on 7 December 2016 with northwestward movement over central BoB. Then the system is likely to intensify over central BoB to become a SCS on 8 and a VSCS on 9 December 2016. Thereafter, moving west-northwestward direction the system intensifies further on 10 December, approaches towards south Andhra coast on 11 and made landfall near Machilipatnam in the morning of 12 December 2016.

WRF: The WRF model analysis shows a well-marked low over southeast BoB. In model forecasts, the system moves initially westward to become a depression on 6 and then moving northwestwards with gradual intensification to become a CS on 7 and a SCS over south-central BoB on 8 December 2016.

JMA: The forecast based on 00 UTC of 5th shows an extended low over south Andaman sea and adjoining SE Bay. On 6th a low pressure area forms over the same region, which moving in a NW direction concentrates into depression on 7th. It further intensifies into a CS on 8th over central parts of SE Bay.

Meteo-France ARP Model: The forecast based on 00 UTC of 5th analysis also shows the presence of a low pressure system over South Andaman Sea and adjoining Sumatra region. It further concentrates into a depression on 06th with NW movement and intensifies into a cyclonic storm on 7th and into a SCS on 8th over northern parts of SE Bay.

NCMRWF-NCUM: The forecast based on analysis on 00 UTC of 5th December shows a low pressure area over south Andaman Sea and adjoining Sumatra region which becomes a depression on 6th with a slight west northwestward movement. Continuing to move in the same direction, it intensifies into a CS on 7th over central parts of SE Bay. Further it recurves in a north northeastward direction and further intensifies to a SCS on 8th and moves in a NNE direction on 9th and 10th also.

On 11th the system is seen over central parts of north Bay and on 12th it crossed Bangladesh coast (near 91^0E) as a CS and became less marked by 13th.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC of 5th December shows indication of low pressure system over south Andaman Sea and adjoining Sumatra region which rapidly intensifies into a CS on 6th with NW movement. The system shows further intensification on 7th and on 8th.

NCMRWF-NEPS Model: The forecast based on the analysis of 00 UTC on 5th December shows the presence of an extended low on 6th over south Andaman Sea and adjoining Sumatra region which concentrates into a depression on 7th over SE Bay and adjoining Andaman Sea. Further it intensifies into CS on 8th over the same area and moves in NE direction towards Irrawaddy Delta on 9th and 10th. On 11th it is seen to recurve and move in a westward direction. Continuing to move in westward direction it weakens to a CS over west central Bay on 12th. It reaches near central Andhra coast on 13th and weakens further to a low on 14th while moving over to land area.

IITM-GEFS: The forecast based on 00 UTC of 5th December shows low pressure area over south Andaman and adjoining south Bay on 6th, which concentrates into depression on 7th and intensifies to a CS on 8th with northwestward movement. It continues to move in the same direction on 9th and lies off north Andhra coast on 10th and weakens into D/WML on 11th over the same area without landfall and becomes less marked thereafter.

IITM -GFS T1534: The forecast fields based on the analysis of 00 UTC of 5th December gives shows a well marked low pressure area over southern parts of SE Bay on 6th , which moving in a WNW direction concentrates into a depression on 7th and rapidly intensifies into a SCS on 8th over northern parts of south Bay. The system further moves in a NW direction towards North Andhra coast on 9th and 10th and is seen lying off the coast of south Orissa and north Andhra on 11th . The system weakened into a WML over the same area on 12th without making a landfall.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 05 December 2016 suggests a zone of significant GPP (> 30) over south Andaman Sea on 5 and 6 December, 2016. The organized significant GPP zone continually moves northwestward direction from 7 to 10 December to cross north Andhra Pradesh coast on 11 December 2016. The consistent higher value of GPP suggests that the low pressure system over southeast BoB has potential to become a cyclonic storm.

Summary and Conclusion:

Majority of the models indicates that the well marked low pressure area south Andaman Sea and adjoining southeast Bay of Bengal will concentrate into a depression on 6th December and further intensify into a cyclonic storm on 7th / 8th. Few models (JMA, NEPS, IITM GEFS and HRS GFS) shows the formation of the depression to be on 7th . By and large all the models are in agreement about the rapid intensification over central Bay. However, majority of models also suggest weakening of the system over the sea while approaching the east coast of India. There is large divergence about the landfall point, time and landfall intensity of the system ranging from central AP coast to Bangladesh coast as a well marked low to severe cyclonic storm. A few models also suggest no landfall as depression/cyclone.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	High	High	High	-	-

Probability of cyclogenesis (formation of depression) over the Arabian Sea during

next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : IOP for AP and Odisha coast 8-11 Dec. and over Andaman and Nicobar Islands during 6-7 Dec. 2016

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	04/12	05/00	05/03
India	41	31	45
Coastal stations			
WB	9	3	9
Odisha	6	5	5
AP	10	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	5	1	6
Bangladesh	0	6	7
Myanmar	0	0	0
Thailand	3	3	3
Sri Lanka	1	7	8

AWS:

Region	Date/Time (UTC)		
	04/12	05/00	05/03
WB	6	2	4
Odisha	5	2	5
AP	4	3	5
Tamil Nadu	20	12	22
Puducherry	0	1	0
A & N	0	0	0

RS/RW (12Z) of 04/12/2016 :20/43

No. of Ascents reaching 250 hPa levels:13 , MISDA:- 16

RS/RW (00Z) of 05/12/2016 :32 /43

No. of Ascents reaching 250 hPa levels: 26, MISDA: 3

- **No. of PILOT Ascents**

04 /12Z	05 /00Z
17	15

Buoy Data

04/12Z	05 /00Z	05/03Z
12	10	10

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**04.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**21**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

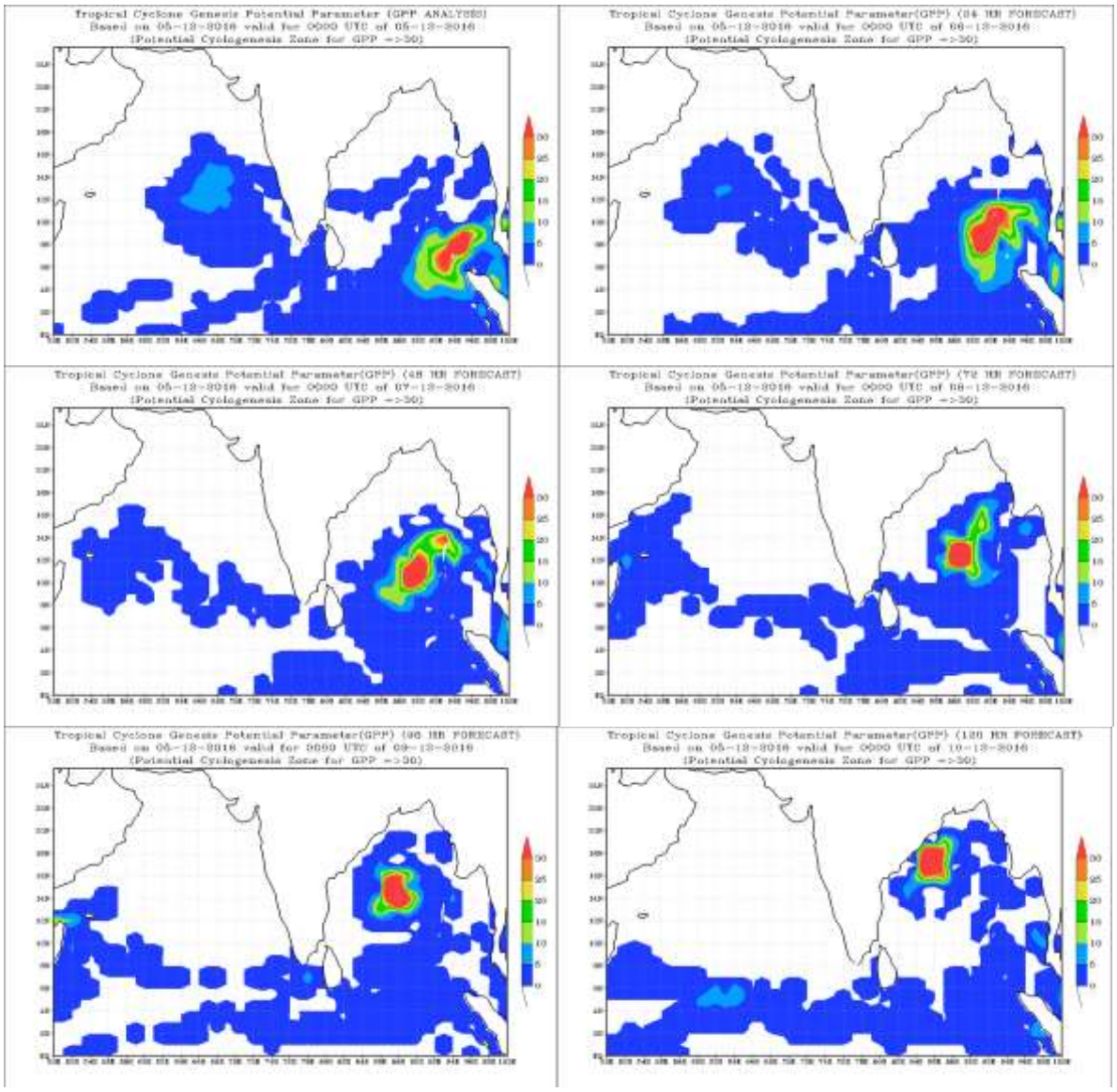
00Z /04.12.2016 : 7
No. of Ascents reaching 250hPa level =7
MISDA :1

12Z /04.12.2016 : 2
No. of Ascents reaching 250 hPa level =2
MISDA : 6

No. of PILOT Ascents:

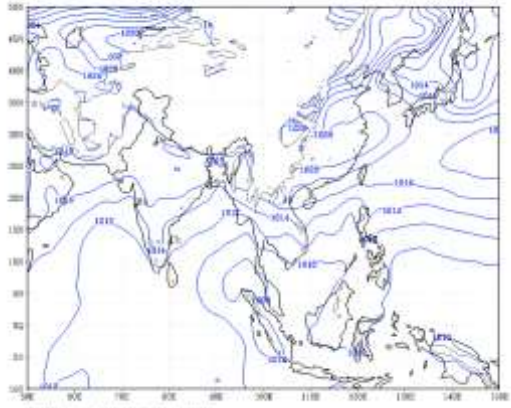
04.12.2016	
06Z	18Z
2	2

Annexure-II


Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 05-12-2016 valid for 0000 UTC of 05-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 05-12-2016 valid for 0000 UTC of 06-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 05-12-2016 valid for 0000 UTC of 07-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 05-12-2016 valid for 0000 UTC of 08-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 05-12-2016 valid for 0000 UTC of 09-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 05-12-2016 valid for 0000 UTC of 10-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

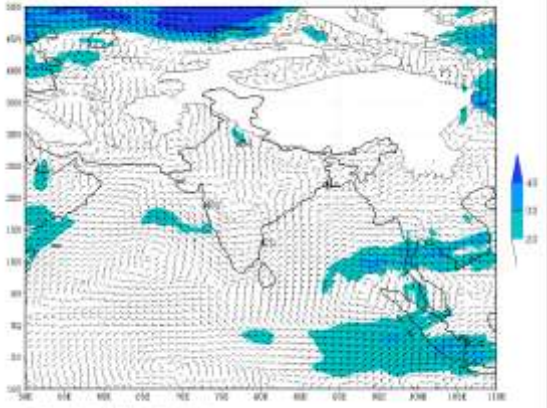
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)

based on 00 UTC of 05-12-2016 valid for 00 UTC of 05-12-2016



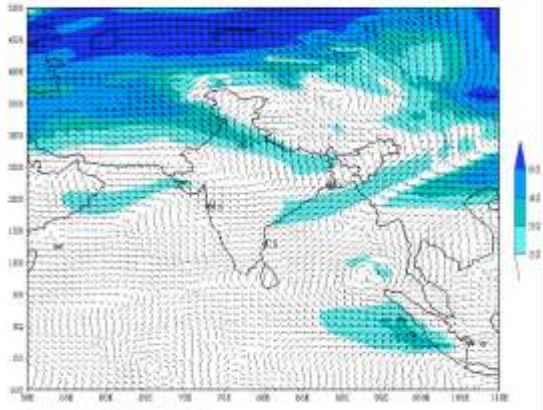
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)

based on 00 UTC of 05-12-2016 valid for 00 UTC of 05-12-2016



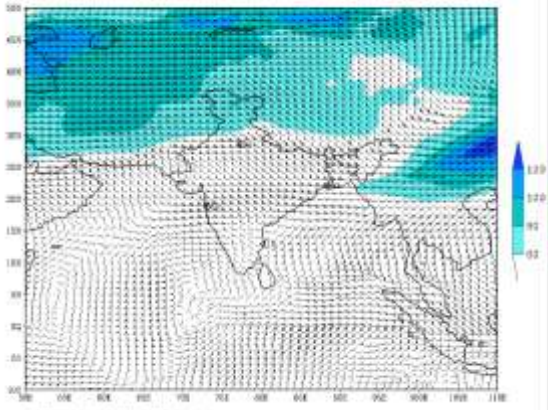
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)

based on 00 UTC of 05-12-2016 valid for 00 UTC of 05-12-2016



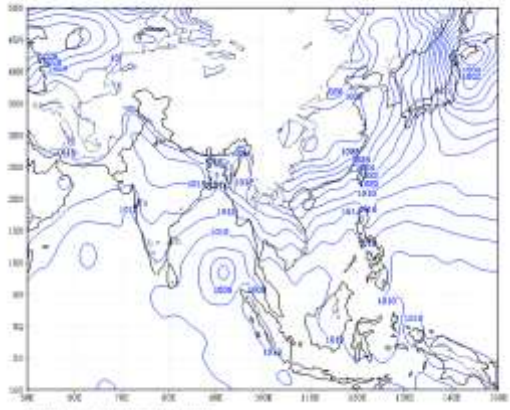
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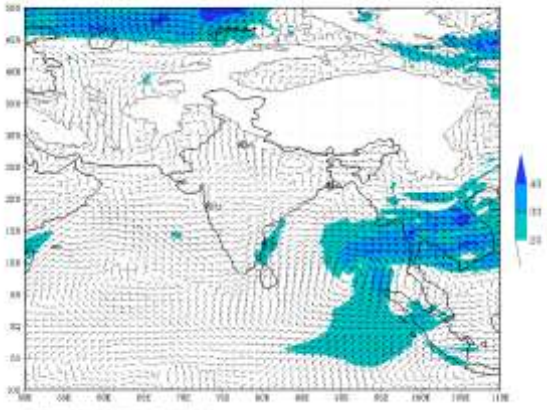
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)

based on 00 UTC of 05-12-2016 valid for 00 UTC of 06-12-2016



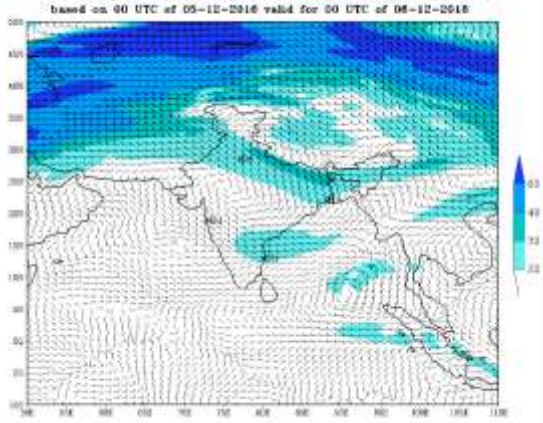
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)

based on 00 UTC of 05-12-2016 valid for 00 UTC of 06-12-2016



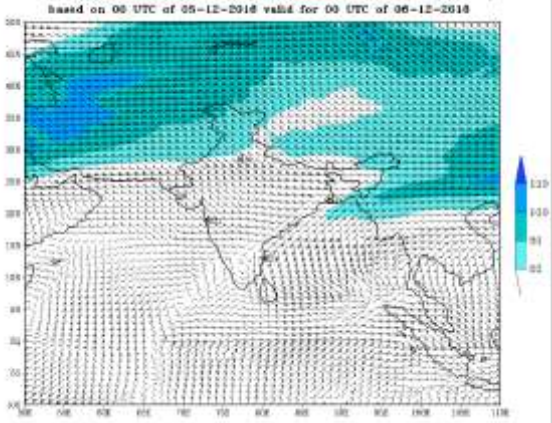
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)

based on 00 UTC of 05-12-2016 valid for 00 UTC of 06-12-2016

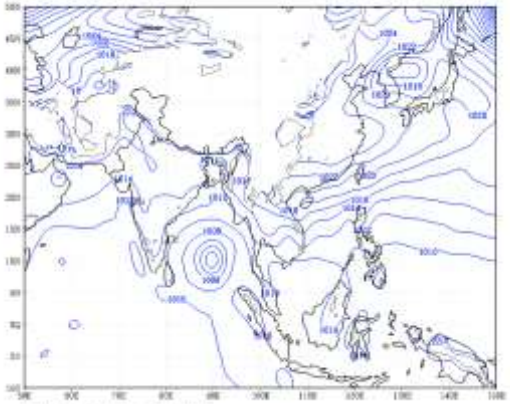


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)

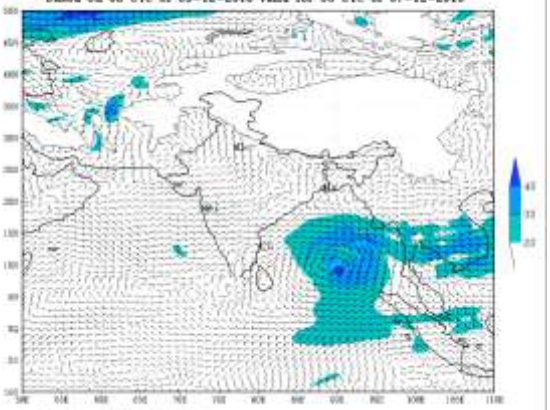
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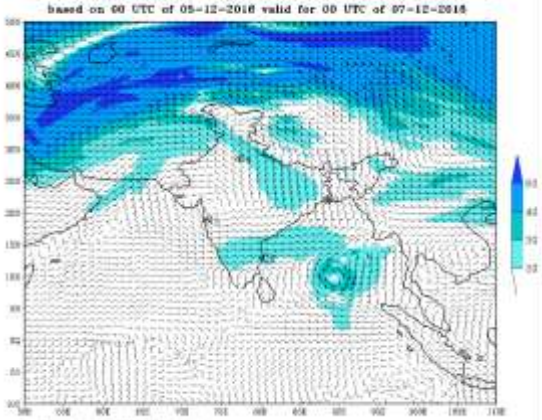
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 05-12-2016 valid for 00 UTC of 07-12-2016



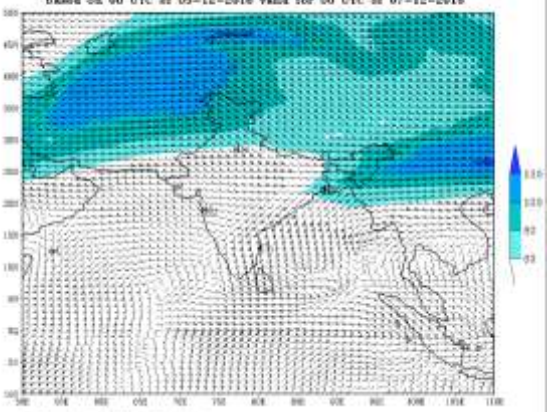
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 05-12-2016 valid for 00 UTC of 07-12-2016



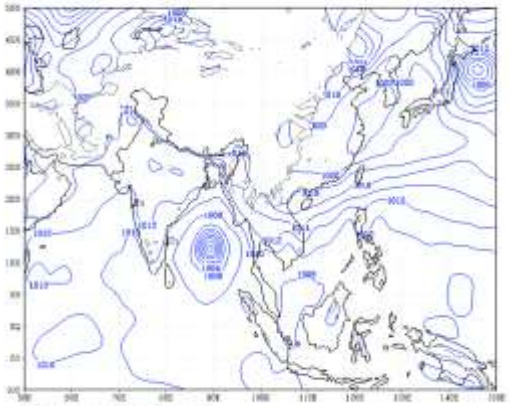
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 05-12-2016 valid for 00 UTC of 07-12-2016



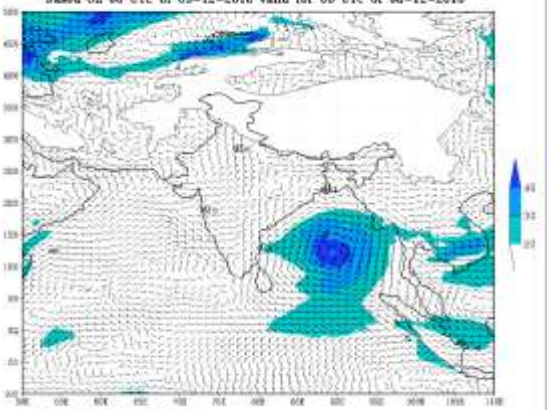
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 05-12-2016 valid for 00 UTC of 07-12-2016



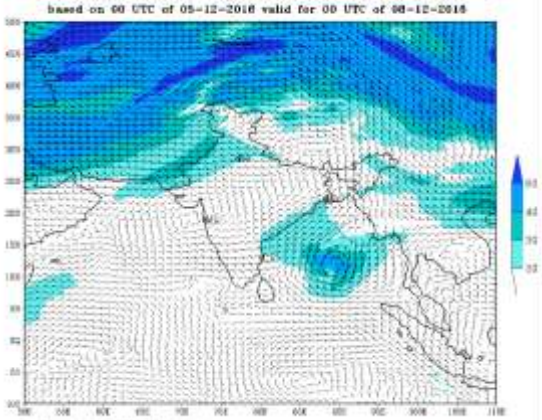
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 05-12-2016 valid for 00 UTC of 08-12-2016



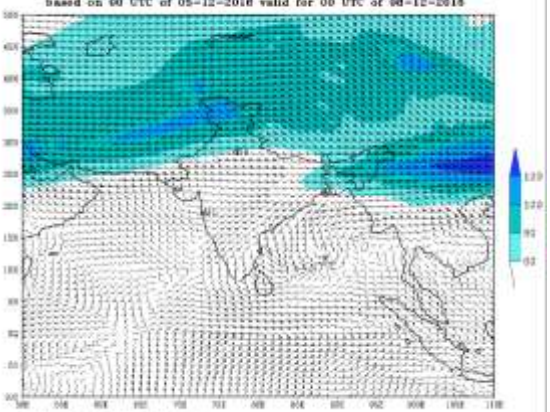
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 05-12-2016 valid for 00 UTC of 08-12-2016



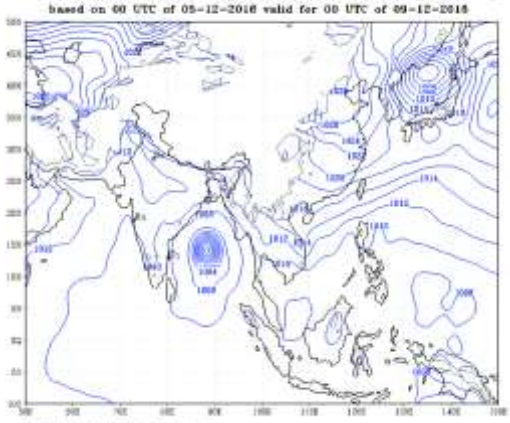
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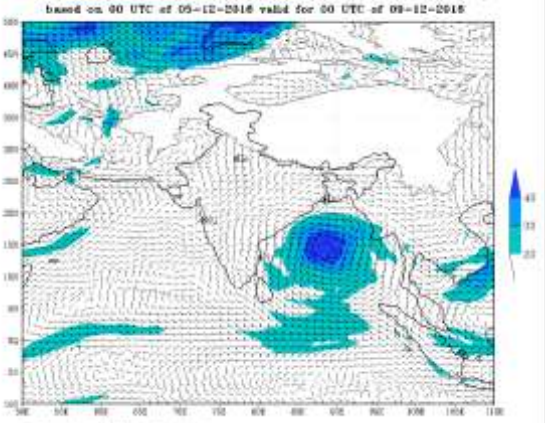
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based on 00 UTC of 05-12-2016 valid for 00 UTC of 08-12-2016



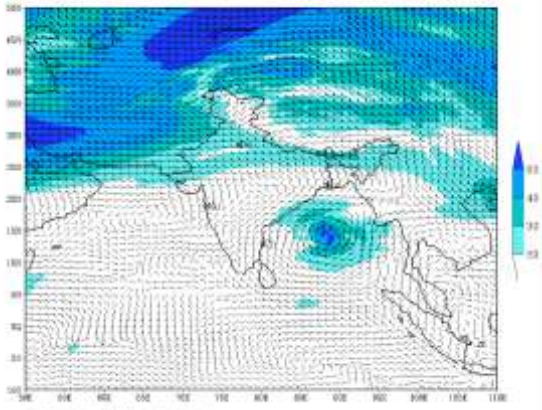
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
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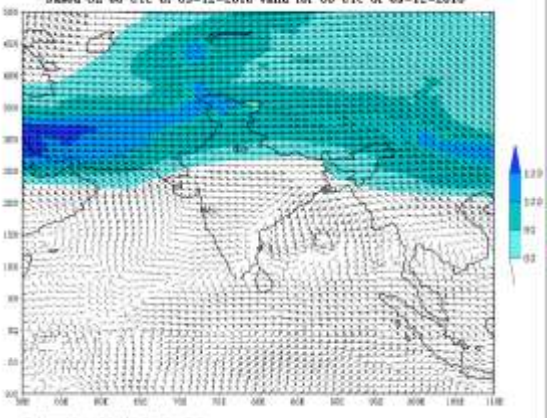
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based on 00 UTC of 05-12-2018 valid for 00 UTC of 09-12-2018



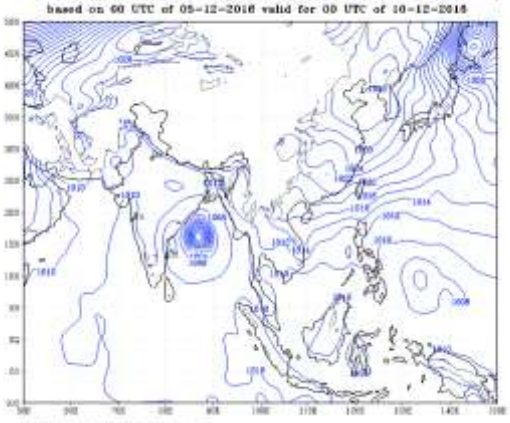
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based on 00 UTC of 05-12-2018 valid for 00 UTC of 09-12-2018



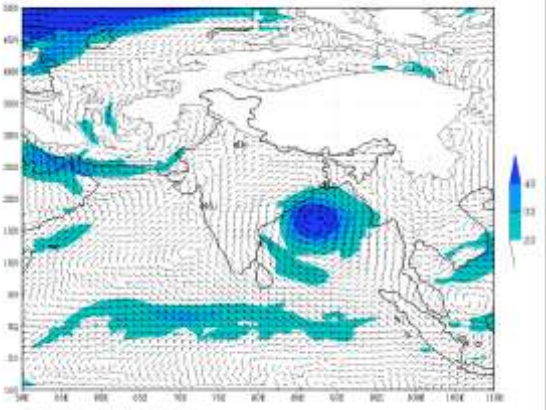
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 05-12-2018 valid for 00 UTC of 09-12-2018



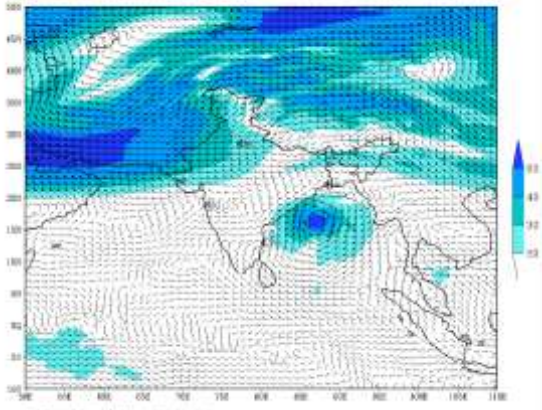
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 05-12-2018 valid for 00 UTC of 10-12-2018



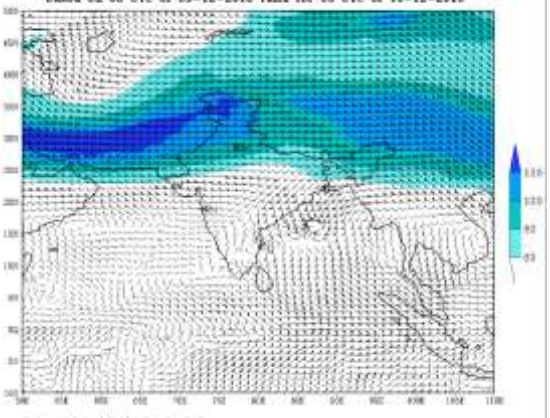
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 05-12-2018 valid for 00 UTC of 10-12-2018



IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 05-12-2018 valid for 00 UTC of 10-12-2018



IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 05-12-2018 valid for 00 UTC of 10-12-2018



FDP (Cyclone) NOC Report Dated 06th December 2016

Synoptic features:

The well marked low pressure area over southeast Bay of Bengal and adjoining Andaman sea concentrated into a Depression at 0900 UTC of today, the 6th Dec. 2016. It is very likely to intensify further into a Deep Depression during the next 24 hrs and into a cyclonic storm during subsequent 24 hrs.

Dynamical and thermodynamical features

Surface Temperature (SST):

It is around 30˚C over the system area and decreases towards the north bay of Bengal and is about 26- 27°C off the coasts of north Andhra Pradesh, Odisha, and Myanmar. The SST over most parts of westcentral and north Arabian Sea (AS) is between 26-28˚C. It is 28-30˚C over most parts of southeast and eastcentral Arabian Sea. It is 31-32˚C over a small pocket of northeast AS off south Gujarat and adjoining Maharashtra coast.

Tropical Cyclone Heat Potential (TCHP):

The ocean thermal energy is about 100 kJ/cm^2 over the system area and also to its south. It is less than 50 kJ/cm^2 over northern parts of north Bay of Bengal and also off the Tamil Nadu coast over southwest BoB.

TCHP is less than 50 kJ/cm^2 over western Arabian Sea. It is 100 kJ/cm^2 over some pockets over off the coasts of Karnataka and also over Maldives- Comorin area.

Relative Vorticity:

The highest values of low-level relative vorticity about 100 $x10^{-6}$ s^{-1} lies to the southwest of the system area. It is negative over remaining BOB & adjoining north Andaman Sea.

A small area of positive vorticity of $30x10^{-6}$ $second^{-1}$ lie over southwest Arabian Sea.

Convergence:

There is an extended area of positive lower level convergence over south Andaman Sea. The convergence value is 20 $x10^{-6}$ s^{-1} over the system area.

There is a small area of positive low level convergence over west Arabian Sea.

Divergence:

There is a zone of positive upper level divergence over southern parts of southeast Bay and over south Andaman sea with a high of 30 $x10^{-6}$ s^{-1} over the system area.

There is no area of positive upper-level divergence over Arabian Sea.

Wind Shear:

Wind shear is 15-20 kts over the system area. It is high over the remaining BOB.

Wind shear is low to moderate over Kerala coast and neighbouring Comorin area and the area extends westwards. There is a band of low wind shear off Somali and Arabian Peninsula. It is high over the remaining Arabian Sea.

Wind Shear Tendency:

There is decreasing tendency (5-10 kts) over the system area and also over southern most parts of BOB and Andaman Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, vortex over SE Bay and adjoining South Andaman Sea has intensified and centred near 8.5˚N/91.0˚E (.) Intensity T1.5 (.) Minimum CTT is -92˚C (.) Associated broken low/medium clouds with embedded intense to very intense convection is seen over SE Bay and adjoining South Andaman Sea.

Scattered low/medium clouds with embedded moderate to intense convection over rest SE Bay, rest Andaman Sea, Gulf of Martaban and south Tenasserim coast.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over EC SE Arabian Sea, off Kerala coast. Scattered low/medium clouds with embedded weak to moderate convection is seen over rest EC Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 13^0N latitude over BoB.

M.J.O. Index: MJO index is in Phase 2 with amplitude less than one. It would move to phase 2 during next 3 days with increase in amplitude.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST574: The model analysis shows a depression over the southeast BoB and adjoining south Andaman Sea. In the models forecasts, while moving northwestward direction crosses over west-central BoB and become a CS on 7 December 2016. It reaches over central BoB on 8 December and becomes a SCS. Thereafter, the system moves slowly in northwestward direction for next two days and it approaches north Andhra Pradesh coast on 11 December 2016. The system crosses north Andhra Pradesh coast in the early morning of 12 and dissipates quickly to become a low over the region on 13 December 2016.

NCEP-GFS: The model analysis shows a well-marked low pressure system over the southeast BoB and adjoining south Andaman Sea. In the models forecasts, while moving west-northwestward direction crossing over west-central BoB as a depression on 6 December, the system reaches over central BoB on 7 December and becomes a CS on 8 December 2016. Thereafter, the system moves in west-northwestward direction for next two days and it approaches north Andhra Pradesh coast on 11 and crosses north Andhra Pradesh coast in the night of 11 December and dissipates quickly to become a low on 12 December 2016.

ECMWF: The model analysis indicates a well-marked low pressure system over south Andaman Sea on 6 December, 2016. In the forecasts, the system intensifies into a depression within 24 hours and into a CS on 7 December 2016 with northwestward movement over central BoB. Then the system is likely to intensify over central BoB with slow north-northwestward movement to become a SCS on 8 and a VSCS on 9 December 2016. Thereafter, moving northwestward direction the system organizes further on 10 December, approaches towards south Andhra coast with westward movement on 11 December 2016. The system weakens on 12 December with a west-southwestward movement before it made landfall over south Andhra Pradesh coast south of Machilipatnam and north of Chennai in the morning of 13 December 2016. Overall, the model forecasts show slow movement but higher intensification and weakening before landfall of the system compared to other models.

WRF: The WRF model analysis shows a depression over southeast BoB. In model forecasts, the system moves initially northwestward to become CS on 7 and then moving west-northwestwards with gradual intensification to become a SCS on 8 and a VSCS over south-central BoB on 9 December 2016.

JMA: The forecast based on 00 UTC of 6^{th} shows a low over south Andaman sea and adjoining SE Bay. On 7^{th} it concentrates into depression over central parts of SE Bay and moving in a NW direction further intensifies into a CS on 8^{th} over northern parts of SE Bay. It further intensifies into a SCS on 9^{th} around the same area.

Meteo-France ARP Model: The forecast based on 00 UTC of 6^{th} analysis shows that the low pressure system over South Andaman Sea and adjoining SE Bay concentrates into a depression on

07th. With a NW movement and it intensifies into a cyclonic storm on 8th over western parts of SE Bay and into a SCS on 9th over SW Bay and adjoining parts of SE Bay.

NCMRWF-NCUM: The analysis on 00 UTC of 6th December shows a low pressure area over southern parts of SE Bay, which concentrates into a deep depression/CS on 7th over central parts of SE Bay. Moving in a NW direction it further intensifies to a SCS on 8th and continues to move in NW direction on 9th and 10th also. On 11th the system is seen over western parts of WC Bay near Andhra coast and on 12th it weakened into a CS off north Andhra- South Odisha coast and became a low on 13th without making a landfall.

NCMRWF-UM-Regional Model: N.A.

NCMRWF-NEPS Model: The forecast based on the analysis of 00 UTC on 6th December shows the presence of an extended low on 6th over south Andaman Sea and adjoining SE Bay region which concentrates into a depression on 7th over SE Bay and adjoining Andaman Sea. Further moving NW, it intensifies into CS on 8th and continues to move in the same direction on 9th,10th and on 11th and intensifies further. It is seen over west central Bay off Andhra coast on 12th and crosses the central AP coast in the night of 12th. On 13th it weakens to a low while moving over to land area.

IITM-GEFS: The forecast based on 00 UTC of 6th December shows depression over south Andaman and adjoining south Bay on 7th, which moving northwestward intensifies into a CS on 8th. It continues to move in the same direction on 9th and lies off north Andhra coast on 10th and weakens into D on 11th over the same area without landfall and becomes less marked thereafter.

IITM -GFS T1534: N.A

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 06th December 2016 suggests a zone of significant GPP (> 30) over south Andaman Sea on 6th and 7th December, 2016. The organized significant GPP zone continually moves in northwestward direction from 8th to 11th December to cross north Andhra Pradesh coast on 12th December 2016. The consistent higher value of GPP suggests that the low pressure system over southeast BoB has potential to become a cyclonic storm.

Summary and Conclusion:

Half of the models indicate that the depression formed on 6th December will further intensify into a cyclonic storm on 7th. The other half is indicating the intensification to a CS on 8th December. However, all the models are in agreement about the northwestward movement and all of them indicates the system to intensify to a SCS on 8th / 9th. The large divergence about the landfall time and landfall intensity of the system ranging no landfall to land fall as an SCS from 11th night to 13th morning continues to be displayed by the models. However, some consensus has developed regarding landfall region, as majority of them suggest landfall over AP coast or weakening near AP coast.

All the environmental parameters are favourable for intensification of system. The upper tropospheric ridge lies along 13 ^{0}N and hence the southeasterly to east-southeasterly winds prevail over the region of depression in middle and upper tropospheric levels. It would steer the system northwestwards.

Considering all the above, the depression will intensify into a deep depression during next 24 hrs and further into a cyclonic storm in subsequent 24 hrs while moving northwestwards towards AP coast during next 5 days.

IOP : IOP for AP and south Odisha coast 9-11 Dec. and over Andaman and Nicobar Islands during 7 Dec. 2016

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	05/12	06/00	06/03
India	42	30	48
Coastal stations			
WB	9	3	11
Odisha	6	5	6
AP	10	11	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	6	6
Myanmar	0	0	0
Thailand	3	3	3
Sri Lanka	6	7	8

AWS:

Region	Date/Time (UTC)		
	05/12	06/00	06/03
WB	5	2	4
Odisha	5	1	5
AP	5	3	5
Tamil Nadu	20	13	22
Puducherry	0	1	1
A & N	0	0	0

RS/RW (12Z) of 05/12/2016 :21/43

No. of Ascents reaching 250 hPa levels:12 , MISDA:- 4

RS/RW (00Z) of 06/12/2016 :28 /43

No. of Ascents reaching 250 hPa levels: 20, MISDA: 5

- **No. of PILOT Ascents**

05 /12Z	06 /00Z
17	15

Buoy Data

05/12Z	06 /00Z	06/03Z
11	12	12

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**05.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

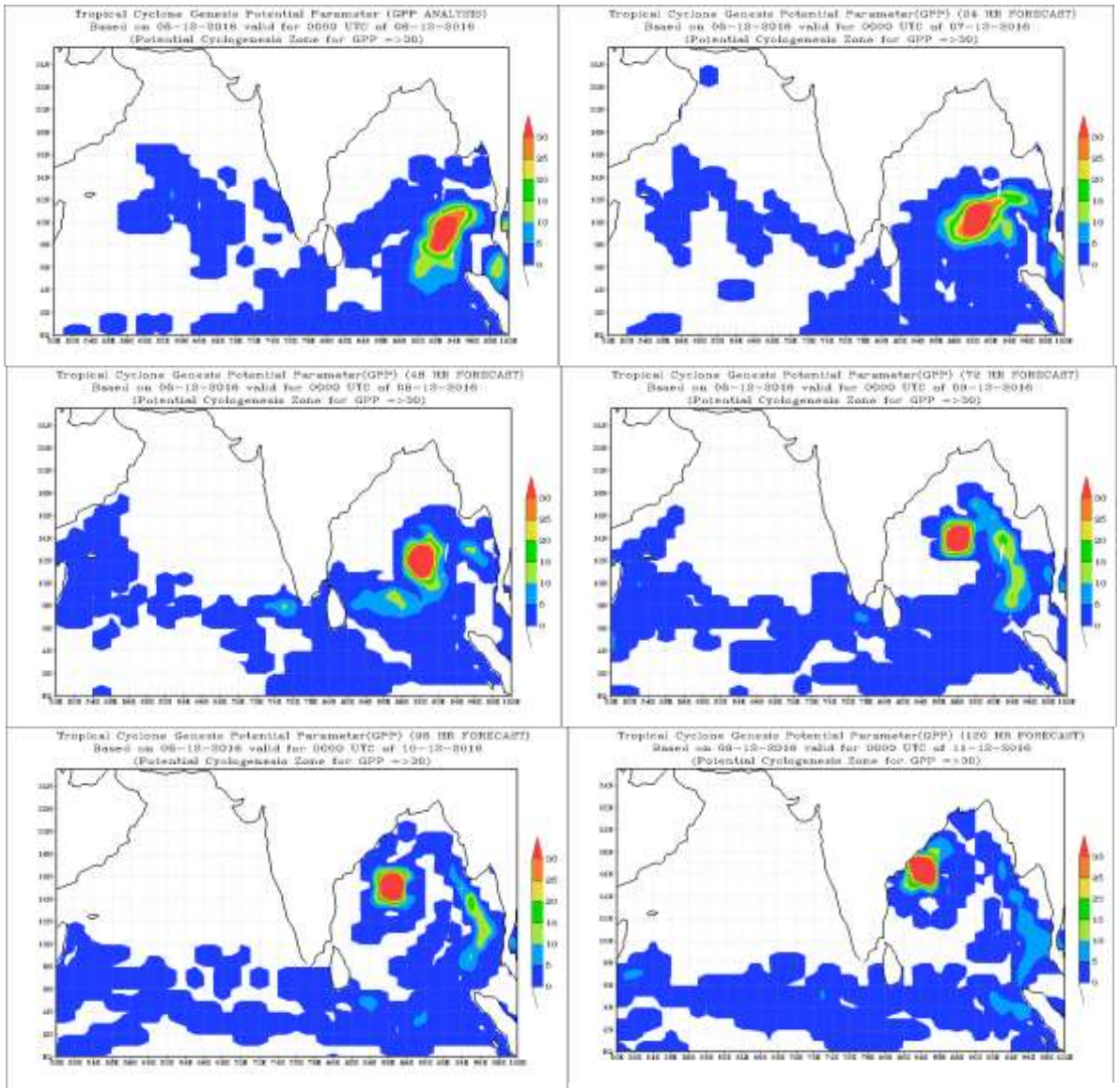
00Z /05.12.2016 : 6
No. of Ascents reaching 250 hPa level = 6
MISDA : 2

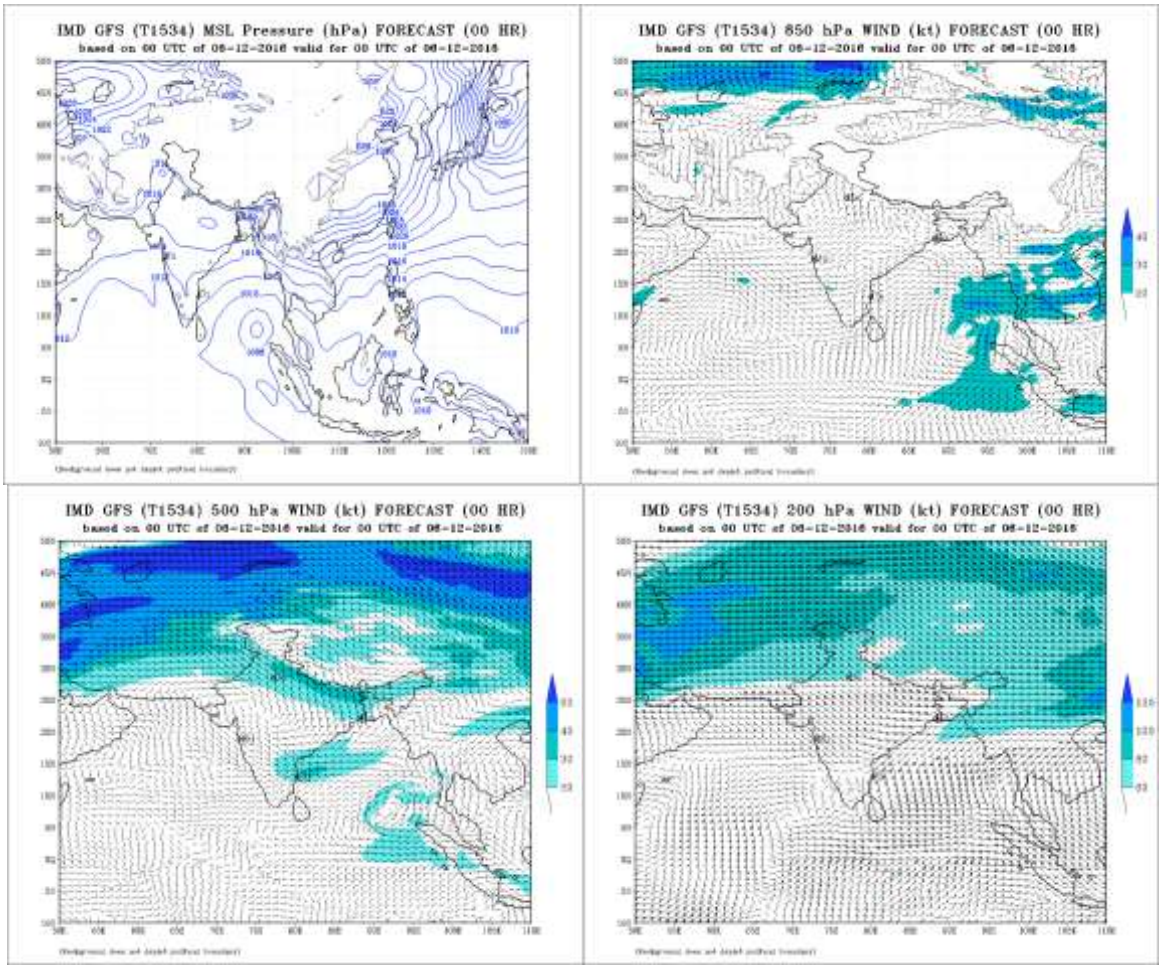
12Z /05.12.2016 : 2
No. of Ascents reaching 250 hPa level = 2
MISDA : 6

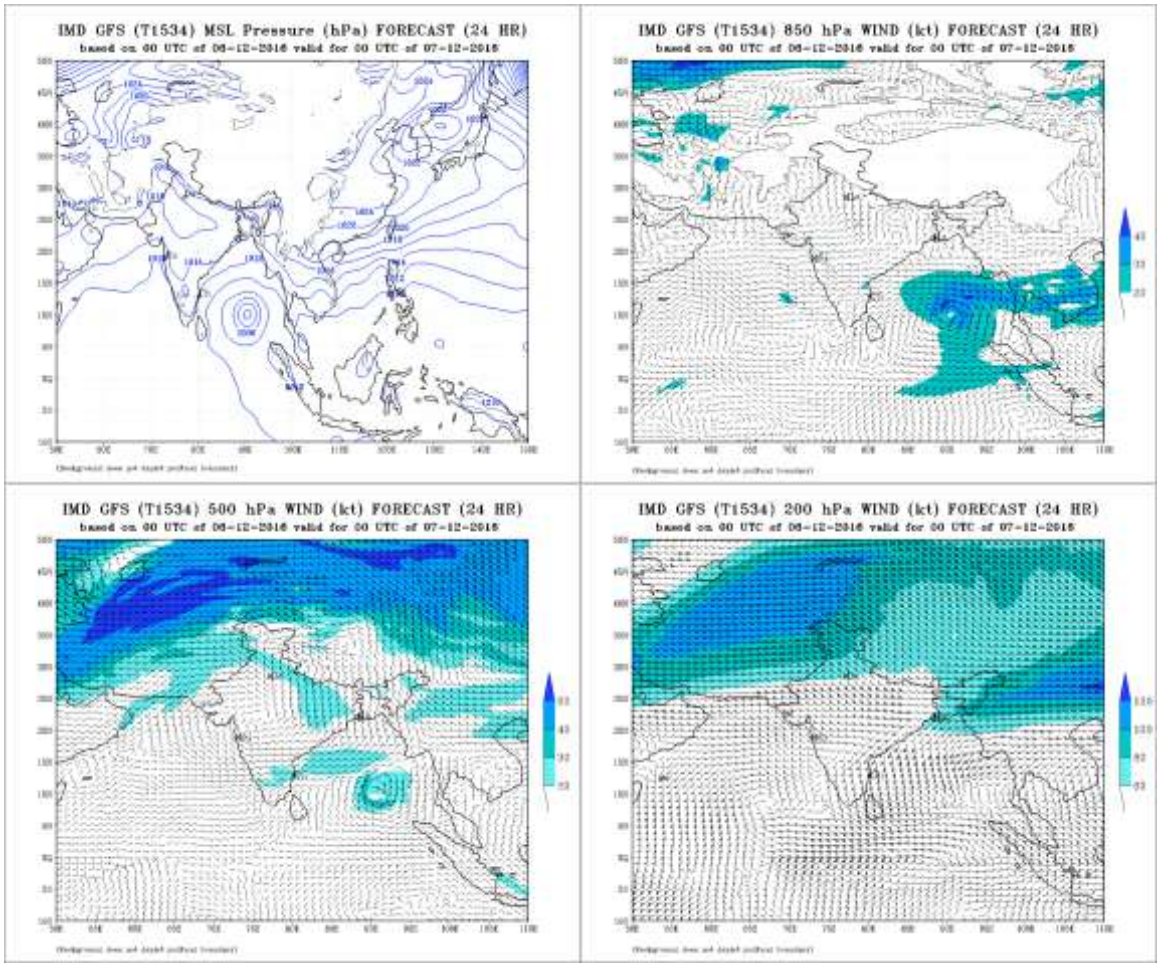
No. of PILOT Ascents:

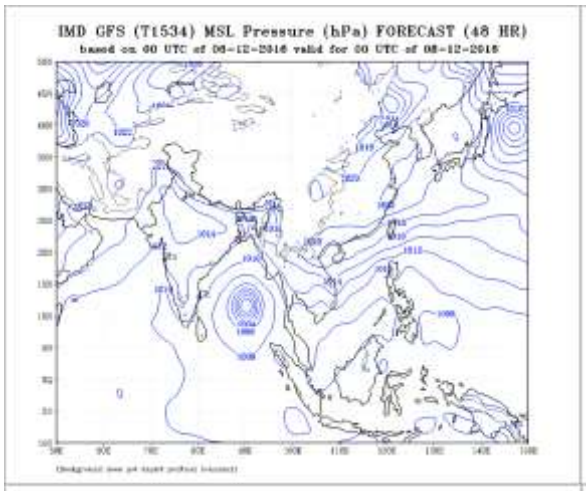
05.12.2016	
06Z	18Z
4	2

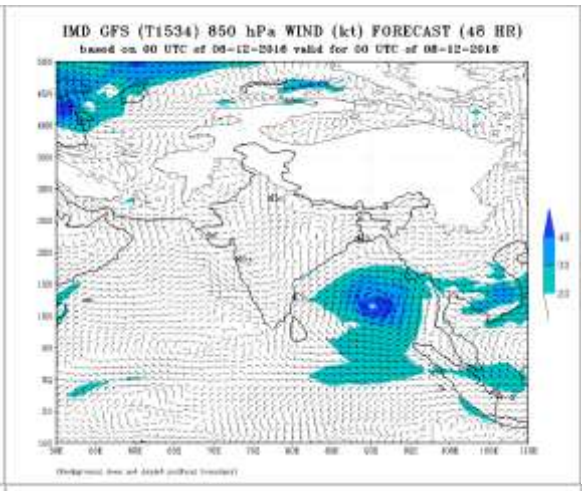
Annexure-II

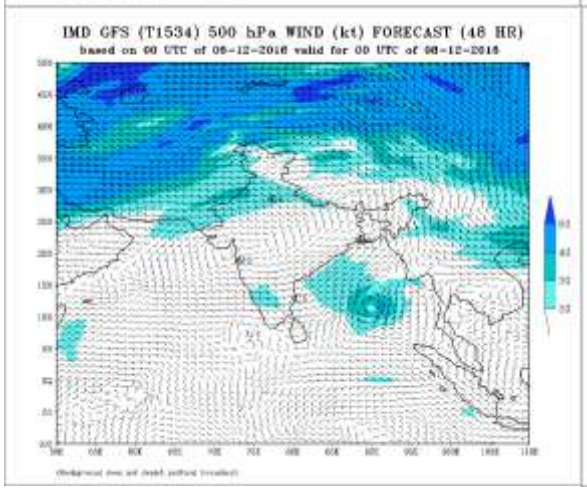

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 06-12-2016 valid for 0000 UTC of 06-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 06-12-2016 valid for 0000 UTC of 07-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 06-12-2016 valid for 0000 UTC of 08-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 06-12-2016 valid for 0000 UTC of 09-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 06-12-2016 valid for 0000 UTC of 10-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 06-12-2016 valid for 0000 UTC of 11-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

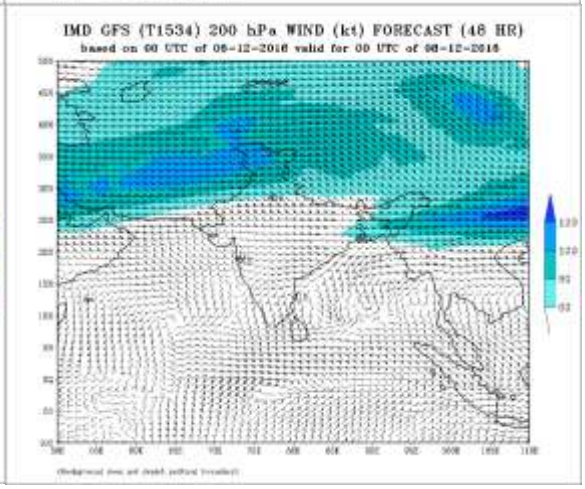

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 06-12-2018 valid for 00 UTC of 06-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 06-12-2018 valid for 00 UTC of 06-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 06-12-2018 valid for 00 UTC of 06-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 06-12-2018 valid for 00 UTC of 06-12-2018

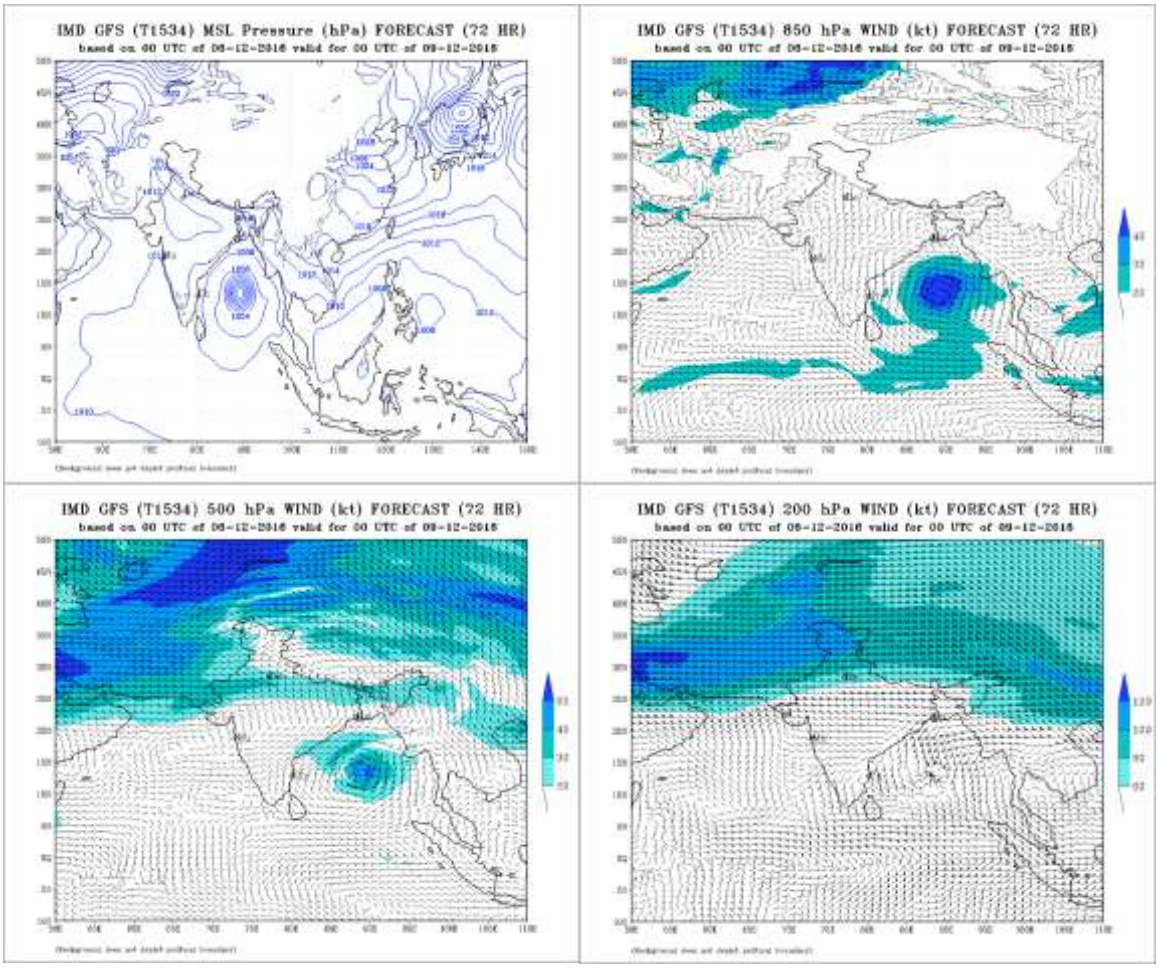

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 07-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 07-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 07-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 07-12-2016

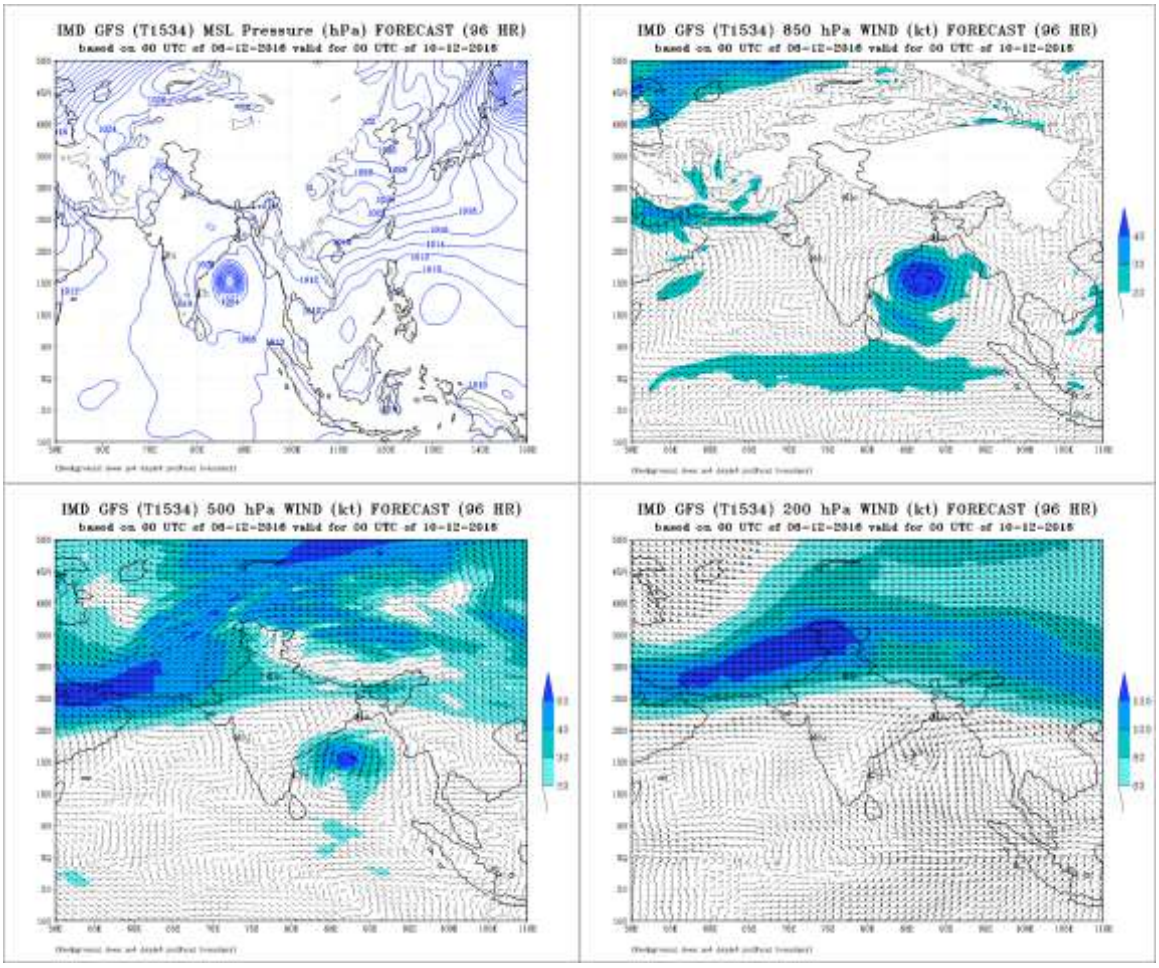

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 08-12-2016

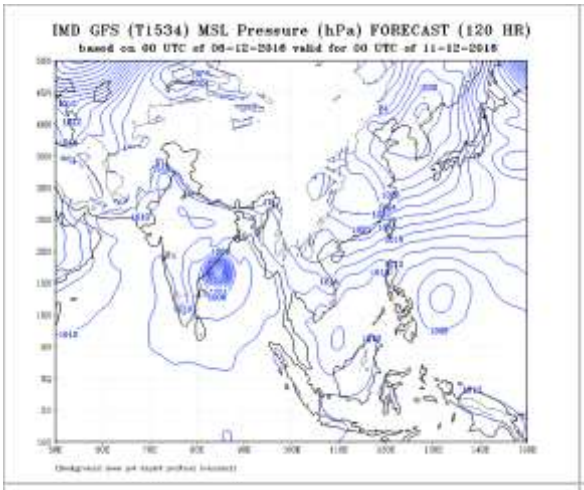

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 08-12-2016

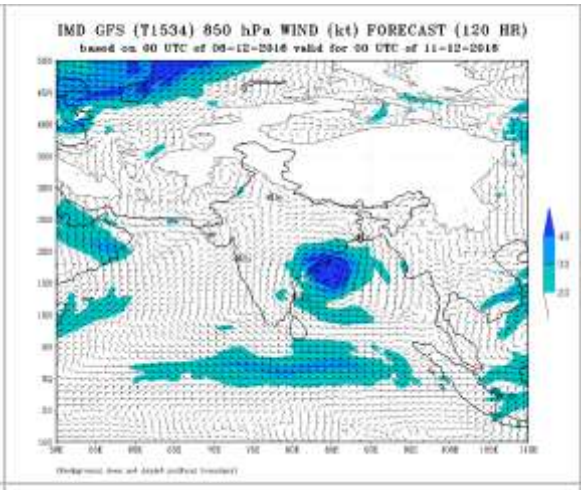

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 08-12-2016

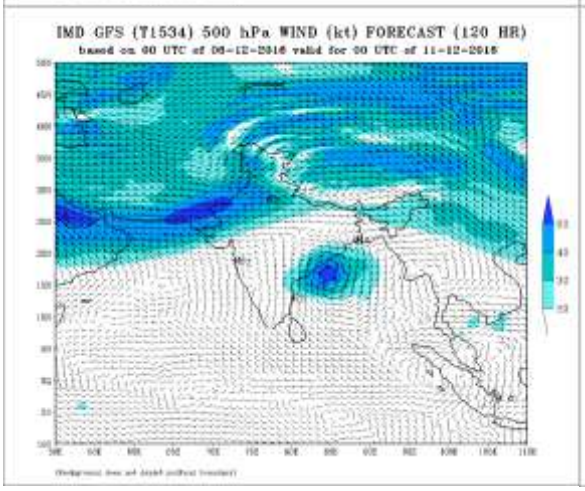

IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
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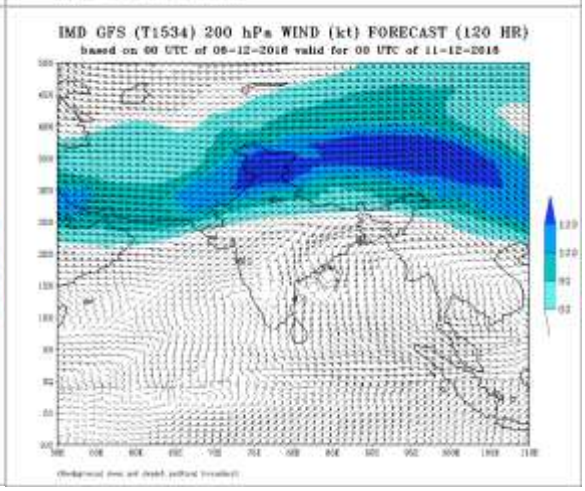

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 09-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 09-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 09-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 09-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 10-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 10-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 10-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 06-12-2016 valid for 00 UTC of 10-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 08-12-2018 valid for 00 UTC of 11-12-2018


IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 08-12-2018 valid for 00 UTC of 11-12-2018


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 08-12-2018 valid for 00 UTC of 11-12-2018


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 08-12-2018 valid for 00 UTC of 11-12-2018

FDP (Cyclone) NOC Report Dated 07th December 2016

Synoptic features:

The depression over southeast Bay of Bengal moved northwards with a speed of about 10 kmph and lay centred at 0830 hrs IST today, the 7th December, 2016 over southeast Bay of Bengal near latitude 9.8ºN and longitude 90.5ºE, about 1180 km south-southeast of Vishakhapatnam (43149), 1210 km southsoutheast of Gopalpur (43049), 260 km west-northwest of Car Nicobar (43368) and 310 km south-southwest of Port Blair. The system is very likely to move northwestwards during next 72 hrs. It is very likely to intensify into a deep depression during next 24 hrs and into a cyclonic storm in subsequent 24 hrs.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 28-29˚C around the system area. the SST decreases towards northwest and west central Bay of Bengal becoming 26-27˚C near north Andhra Pradesh, Odisha, West Bengal and Bangladesh coast.

Tropical Cyclone Heat Potential (TCHP):

The ocean heat content is about 70-80 kJ/cm^2 over the area of depression and gradually decreases towards northwest, becoming less than 50 kJ/cm^2 near, Odisha, adjoining north Andhra Pradesh, West Bengal and Bangladesh coast except over a small pocket of westcentral Bay off central Andhra Pradesh coast where it is 60-70 kJ/cm^2.

Relative Vorticity:

The low-level relative vorticity about 150 x10^{-6} s^{-1} to the southwest of the system centre.

Convergence:

The highest value of low level convergence is about 20 x10^{-6} s^{-1} and is to the east of the system area.

Divergence:.

The upper level divergence is around 40 x10^{-6} s^{-1} to the northeast of the system area.

Wind Shear:.

Wind shear is moderate (15-20 kts) around the system centre and increases towards northwest and westcentral Bay of Bengal.

Wind Shear Tendency:

The wind shear tendency is neutral over the system area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imageries, vortex is seen centred near 10.0˚N/90.5˚E (.) Intensity T1.5 (.) Minimum CTT is -92˚C (.) Associated broken low/medium clouds with embedded intense to very intense convection is seen over SE Bay and adjoining EC Bay and parts of Andaman Sea and Bay Islands.

Arabian Sea:

Scattered low/medium clouds with embedded moderate to intense convection are seen over west Comorin area and adjoining SE Arabian Sea.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 13^{0}N latitude over BoB.

M.J.O. Index: .

MJO index lies in Phase 2 with amplitude 1. It would move to phase 3 during next 3 days with amplitude 1.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFST1534: The model analysis shows a depression over the southeast BoB and parts of Andaman Sea. In the models forecasts, the system moves northwestward initially to enter into west-central BoB and becomes DD on 8th and CS on 9 December 2016. Thereafter, the system moves slowly in west-northwestward direction during 10 and becomes SCS on 11th December and approaches south Andhra Pradesh coast. The system with a westward movement weakens into a CS and is seen making landfall near Machilipatnam in the early morning of 12th and moving inland dissipates quickly to become a low over the region on 13th December 2016.

NCEP-GFS: The model analysis shows a depression over the southeast BoB and adjoining Andaman Sea similar to IMDGFS. Initially, the system moves slowly in northwestward direction over west-central BoB as a depression during 8 and 9 December 2016. Thereafter, the system intensifies into a CS with west-northwestward movement for next two days and it approaches north Andhra Pradesh coast with westward movement. It crosses south Andhra Pradesh coast in the early morning of 12 December near Kakkinada and dissipates quickly to become a low on same day.

ECMWF: The model analysis indicates a deep depression system over southeast BoB. In the forecasts, the system intensifies into a CS within 24 hours with slow north-northwestward movement. It becomes a SCS over east-central BoB on 9 December 2016 with northwestward movement it reaches over west-central BoB. Then, the system is likely to intensify over west-central BoB during 10 December and becomes a VSCS on 11. Thereafter, moving westward direction, the system weakens as it approaches towards south Andhra Pradesh coast on 12 December 2016. With further westward movement the system makes landfall over south Andhra Pradesh coast south of Machilipatnam and north of Chennai in the afternoon of 12 December and dissipates quickly on 13 December 2016. Overall, the model forecasts show slow movement but higher intensification and weakening before landfall of the system compared to other models.

WRF: The WRF model analysis shows a depression over southeast BoB adjoining Andaman Sea. In model forecasts, the system moves initially northwestward to become CS on 8 and then moving west-northwestwards with gradual intensification to become a SCS on 9 and a VSCS over southeast BoB and west-central BoB on 10 December 2016.

JMA: The forecast based on analysis of 00 UTC on 7th shows a depression over SE Bay which moving in a NW direction becomes DD on 8th and into a CS on 9th over northern parts of SE Bay. It further intensifies into a SCS on 10th over northern parts of SE Bay.

Meteo-France ARP Model: The forecast based on 00 UTC of 7th analysis shows that the depression over central parts of SE Bay with a NW movement intensifies into a cyclonic storm on 8th and into a SCS on 10th over northern parts of SE Bay.

NCMRWF-NCUM: The forecast based on the analysis for 00 UTC of 7th December shows the depression on 7th over central parts of SE Bay moving in a WNW direction intensifies to a CS on 8th and continues to move in WNW direction becomes a SCS on 9th and 10th also. On 11th the system is seen over western parts of WC Bay and on 12th it weakened into a CS off central parts of coastal Andhra and crossed south coastal AP near Machilipatnam as a depression on 13th morning.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC analysis of 7th shows that the depression over SE Bay and adjoining south Andaman Sea moving in a NW direction intensifies into a CS on 8th and further seen moving in a WNW direction to intensify into a SCS on 9th which was seen over eastern parts of SW Bay and adjoining SE Bay on 10th.

NCMRWF-NEPS Model: The forecast based on the analysis of 00 UTC on 7th December shows the low over south Andaman Sea and adjoining SE Bay region concentrates into a depression on 8th over SE Bay and adjoining Andaman Sea. Further moving northward, it intensifies into CS on 9th and then moves in a northwest direction on 10th and on 11th and intensifies further. It is seen over west central Bay off Andhra coast on 12th and weakens to DD on 13th off the coast of central AP and further to a low on 14th and becomes less marked without making land fall.

IITM-GEFS: The forecast based on 00 UTC of 7th December shows depression over south Andaman and adjoining south Bay on, which moving northwestward deepens into a DD on 9th continues to move in the same direction and intensifies into a CS on 10th and weakens into DD on 11th off central Coastal AP and crosses coast near Machilipatnam as a depression in the morning of 12th and becomes less marked thereafter.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 07 December 2016 suggests a zone of significant GPP (> 30) over southeast BoB and adjoining south Andaman Sea. The organized significant GPP zone continually moves northwestward direction initially and then moves west-northwestward from 9 to 12 December to cross Andhra Pradesh coast on 12th December 2016.

Summary and Conclusion:

Most of the models indicate that the depression over SE Bay to intensify into a cyclonic storm on 8th. Few of the models are indicating the intensification to be on 9th, while NCEP GFS and IITM GEFS indicate the intensification on 10th.

There is convergence about the direction of movement of the system and landfall point as all of them indicate the movement to be between WNW to NW and most of them indicate the landfall to be over south coastal Andhra Pradesh, near Machilipatnam. Most of the models show weakening of the system as it approaches the coast. However, there is no convergence about the landfall intensity and IITM GEFS shows the weakening of the system over Bay itself.

Considering the environmental parameters, these are favourable for intensification of the system and its northwestward movement towards westcentral Bay of Bengal off AP coast. However, high vertical wind shear and lower SST and Ocean thermal energy near AP coast are unfavourable factors which may lead to weakening of the system to some extent before landfall.

Considering all the above, the depression will intensify into a deep depression during next 24 hrs and further into a cyclonic storm in subsequent 24 hrs while moving northwestwards towards AP coast during next 3-4 days. There is possibility of gradual weakening thereafter alongwith the continued west-northwestwards movement.

IOP : IOP for AP and south Odisha coast 9-12 Dec. IOP for Andaman and Nicobar Islands to continue till 8th December afternoon.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	06/12	07/00	07/03
India	42	28	44
Coastal stations			
WB	9	3	9
Odisha	6	5	6
AP	10	9	10
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	3	3
Myanmar	0	1	1
Thailand	3	3	3
Sri Lanka	10	7	8

AWS:

Region	Date/Time (UTC)		
	06/12	07/00	07/03
WB	2	2	4
Odisha	3	3	4
AP	8	7	7
Tamil Nadu	25	14	19
Puducherry	1	1	1
A & N	0	0	0

RS/RW (12Z) of 06/12/2016 : 17 /43

No. of Ascents reaching 250 hPa levels:12 , MISDA:- 10

RS/RW (00Z) of 07/12/2016 : 31 /43

No. of Ascents reaching 250 hPa levels: 20, MISDA: 9

- **No. of PILOT Ascents**

06 /12Z	07 /00Z
16	18

Buoy Data

06/12Z	07 /00Z	07/03Z
6	5	6

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**06.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

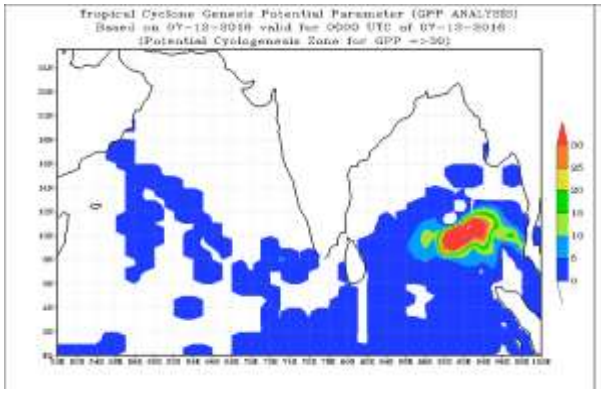
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MISDA :2

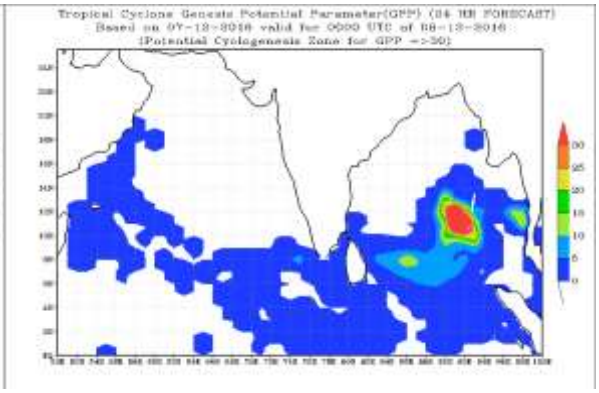
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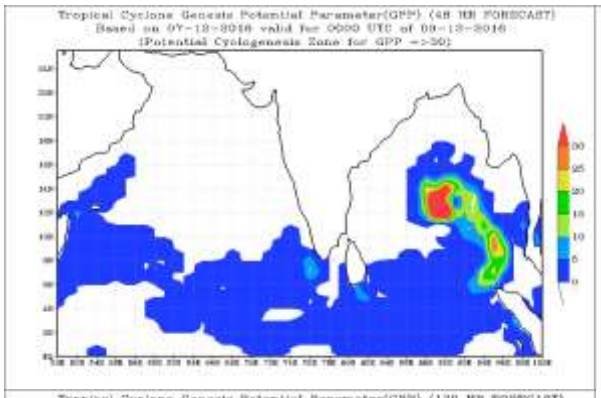
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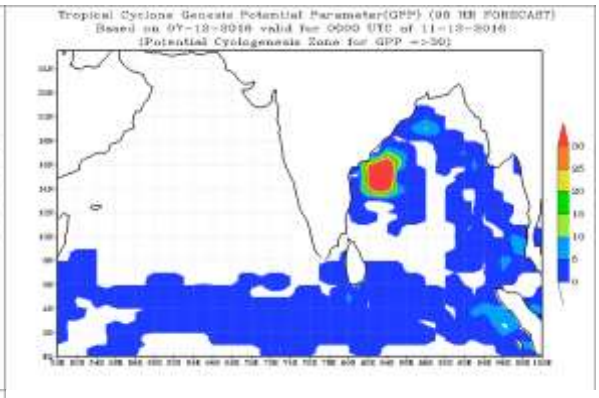
06.12.2016	
06Z	18Z
5	3

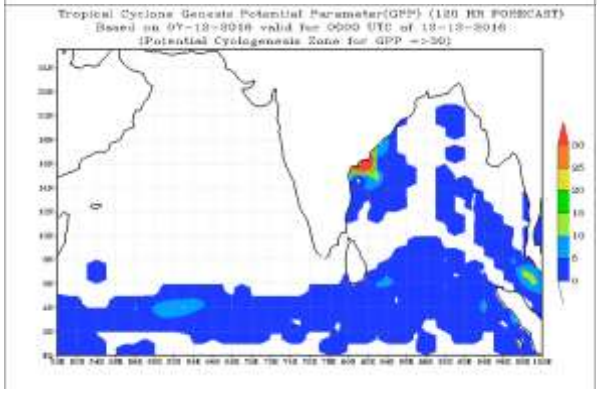
Annexure-II

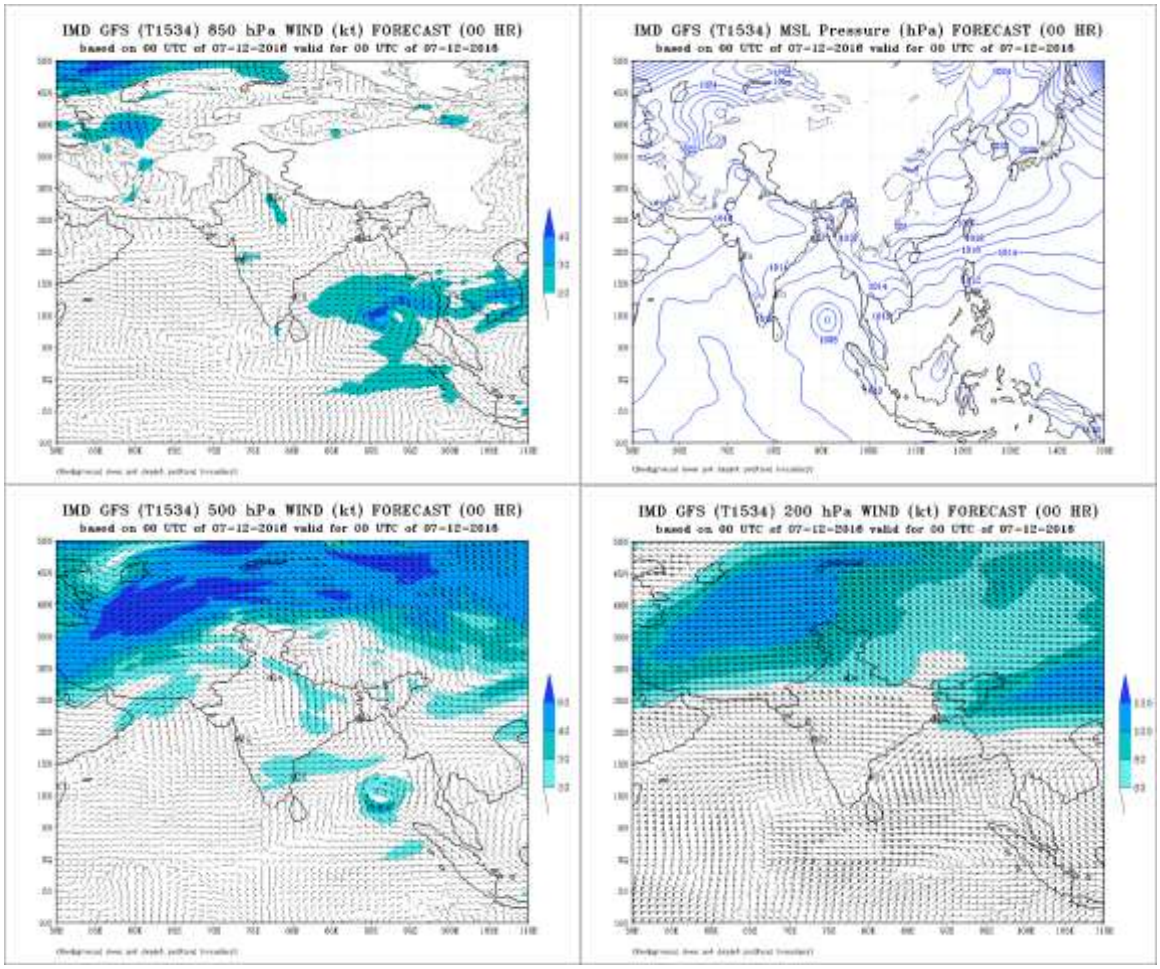

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 07-12-2016 valid for 0000 UTC of 07-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

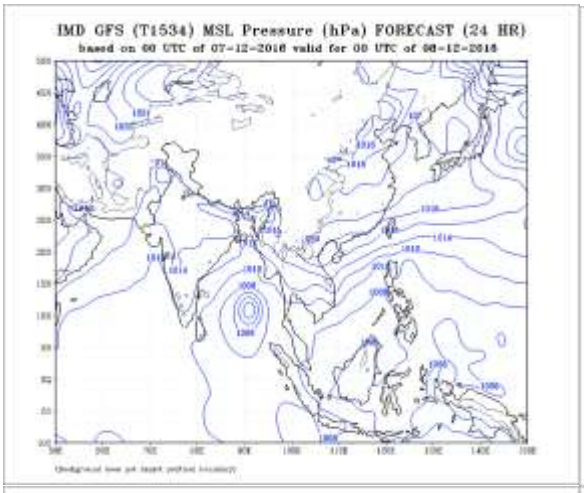

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 07-12-2016 valid for 0000 UTC of 08-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

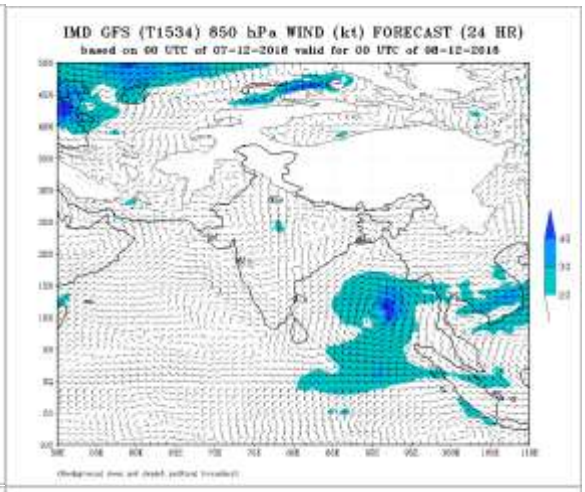

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 07-12-2016 valid for 0000 UTC of 09-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

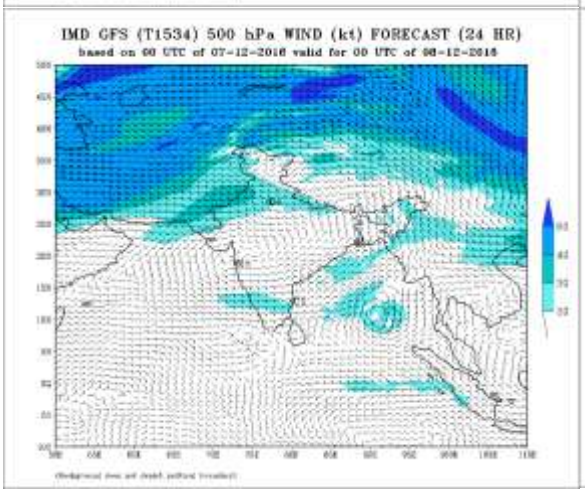

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 07-12-2016 valid for 0000 UTC of 11-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

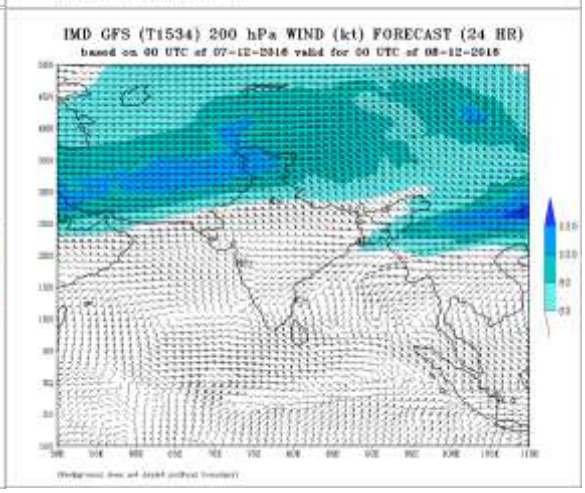

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 07-12-2016 valid for 0000 UTC of 12-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

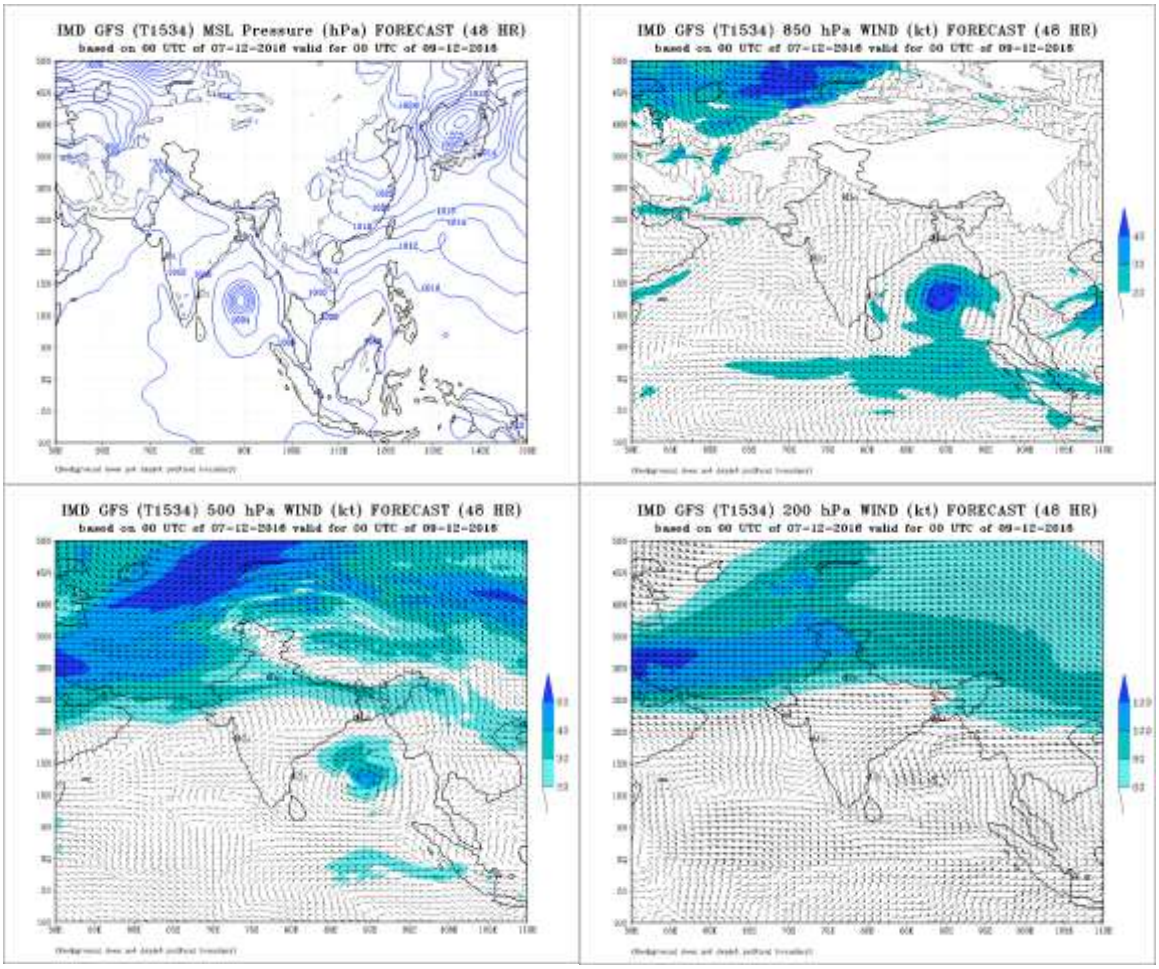

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 07-12-2016
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 07-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 07-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 07-12-2016

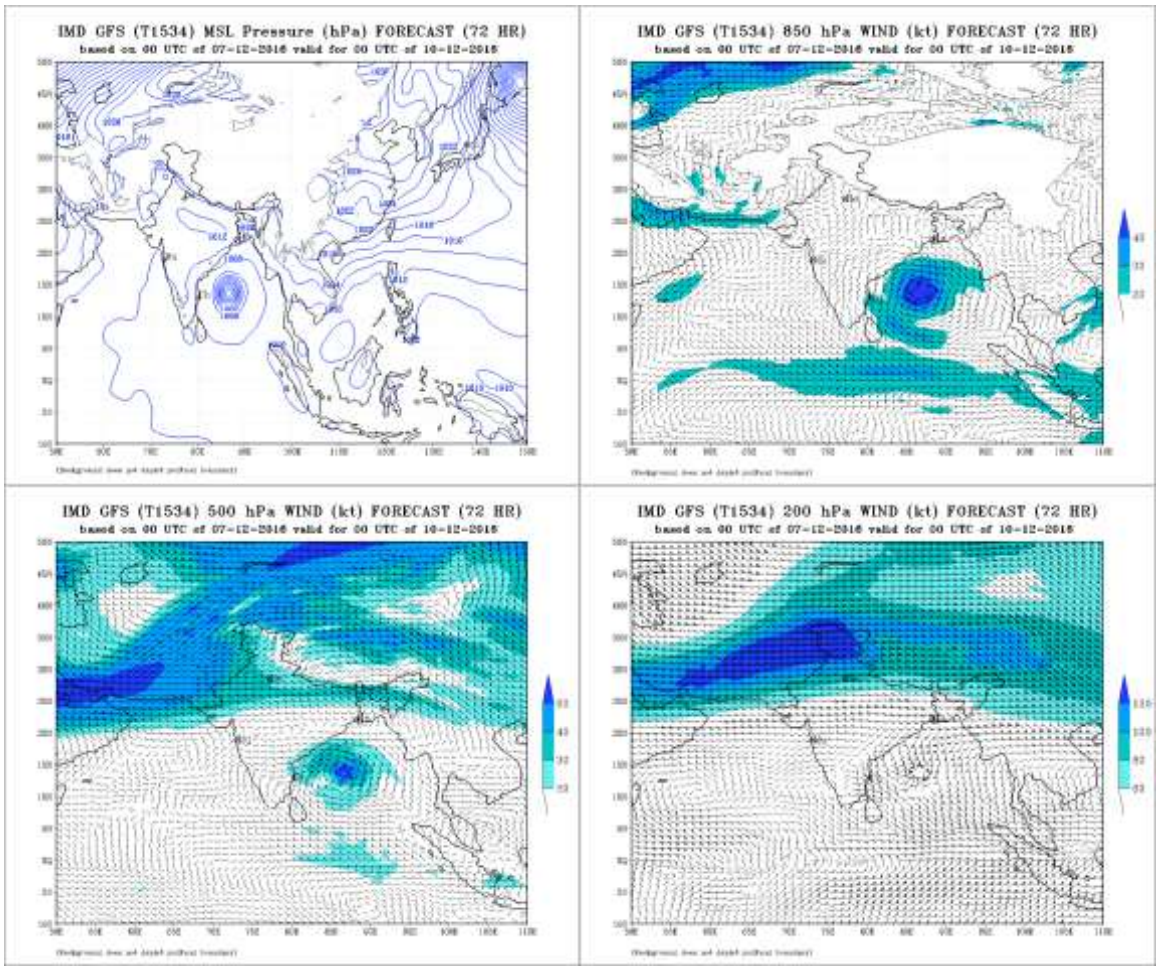

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 07-12-2018 valid for 00 UTC of 08-12-2018

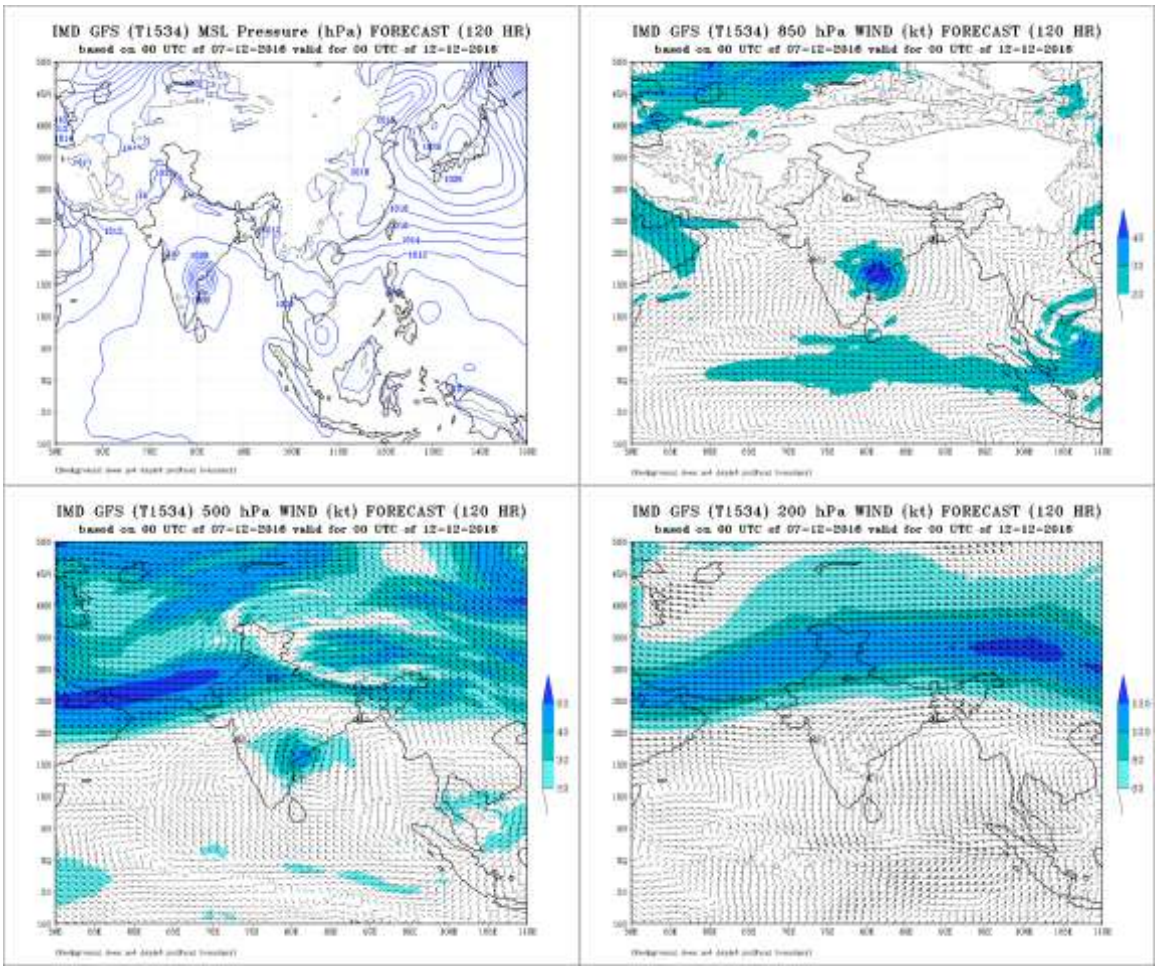

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 07-12-2018 valid for 00 UTC of 08-12-2018


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 07-12-2018 valid for 00 UTC of 08-12-2018


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 07-12-2018 valid for 00 UTC of 08-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 09-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 09-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 09-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 09-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 10-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 10-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 10-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 10-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 12-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 12-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 12-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 07-12-2016 valid for 00 UTC of 12-12-2016

FDP (Cyclone) NOC Report Dated 08th December 2016

Synoptic features:

The Depression over southeast Bay of Bengal moved slightly northwards and lay centred at 1730 hrs IST of yesterday, the 7th Dec. 2016 over the same region near Lat. 10.0°N / Long. 90.5°E, about 1160 kms southeast of Vishakhapatnam, 1220 kms east-southeast of Machilipatnam, 270 kms west-northwest of Car Nicobar and 300 kms south-southwest of Portblair. It further moved northwards, intensified into a Deep Depression and lay centred at 2330 hours IST of today, the 8th Dec. 2016 over the same region near Lat. 10.8°N / Long. 90.5°E, about 1090 kms southeast of Vishakhapatnam, 1170 km east-southeast of Machilipatnam, 260 kms southeast of Portblair. It further moved northwards and intensified into a Cyclonic Storm (VARDAH) and lay centred at 0530 hrs IST of today, the 8th Dec. 2016 over southeast Bay of Bengal near Lat. 11.2°N / Long. 90.5°E about 1060 kms southeast of Vishakhapatnam, 1150 kms east-southeast of Machilipatnam and 240 kms of west-southwest of Portblair. It further moved northwards and lies over the same region at 0830 hrs of IST near Lat.11.5º N / Long. 90.5º E, about 1040 kms east-southeast of Visakhapatnam, 1135 kms east-southeast of Machilipatnam and 240 kms westsouthwest of Port Blair. The system is very likely to intensify further into a severe Cyclonic Storm during next 24 hours. It is very likely to move nearly northwards for some more time, then northwestwards and cross Andhra Pradesh coast between Nellore and Kakinada around forenoon/ noon of 12th Dec. 2016.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 28-29˚C around the system area. the SST decreases towards northwest and west central Bay of Bengal becoming 26-27˚C near north Andhra Pradesh, and Odisha coasts.

Tropical Cyclone Heat Potential (TCHP):

The ocean heat content is about 70-80 kJ/cm^2 over the system area and gradually decreases towards northwest, becoming less than 50 kJ/cm^2 near, Odisha, and adjoining north Andhra Pradesh coasts except for a small pocket of westcentral Bay off central Andhra Pradesh coast where it is 60-70 kJ/cm^2.

Relative Vorticity:

The low-level relative vorticity about 150 x10^{-6} s^{-1} to the southeast of the system centre.

Convergence:

The low level convergence is about 40 x10^{-6} s^{-1} and is to the eastnortheast of the system centre.

Divergence:

The upper level divergence is around 40 x10^{-6} s^{-1} to the northeast of the system centre.

Wind Shear:

Wind shear of horizontal wind is moderate to high (15-25 kts) around the system centre and increases towards northwest and westcentral Bay of Bengal.

Wind Shear Tendency:

The wind shear tendency is neutral over the system area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, the system intensity is T2.5. Convection shows central dense overcast (CDO) pattern. Minimum cloud top temperature (CTT) is minus 90 deg C. Associated broken low/medium clouds with embedded intense to very intense convection lie over southeast and adjoining eastcentral Bay of Bengal, and over western parts of Andaman Sea & bay islands.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 13^{0}N latitude over BoB.

M.J.O. Index: .

MJO index lies in Phase 2 with amplitude 1. It would move to phase 3 during next 3 days with amplitude 1.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The model analysis shows the CS, Vardah over the southeast BoB and east of Andaman & Nicobar Islands. In the models forecasts, the system moves northward initially to enter into east-central BoB on 9 and becomes a SCS on 9 December 2016. Thereafter, the system moves slowly in west-northwestward direction over west-central BoB and becomes a VSCS during 10 December which continues to move in the same direction on 11 December 2016. As it approaches Andhra Pradesh coast, the system starts weakening in the afternoon of 11 December 2016. The system is seen to make landfall as a CS over south Andhra Pradesh coast near Machilipatnam with a westward movement in the early morning of 12th. Moving inland it dissipates quickly to become a low on 13th December 2016.

NCEP-GFS: The model analysis shows a deep depression over the southeast BoB east of Anadaman and Nicobar islands rather a CS as it is observed. The system moves slowly in northward direction over east-central BoB till 9 December 2016 and becomes a CS over east-central BoB. Thereafter, the system moves northwestward for next two days over west-central BoB. Its shows further intensification during 10 December but as it approaches Andhra Pradesh coast with west-northwestward movement, it weakens after evening of 11 December 2016. It crosses Andhra Pradesh coast in the early morning of 12 December as a depression and dissipates quickly to become a low on same day.

ECMWF: The model analysis indicates the CS, Vardah over southeast BoB. In the forecasts, the system with slow west-northwestward movement intensifies further over east-central BoB during 9 December 2016. It becomes a SCS over east-central BoB on 10 December 2016 with west-northwestward movement it reaches over west-central BoB. Then, the system is likely to move in westward direction over west-central BoB during 11 and 12 December to reach Andhra Pradesh coast. The system starts weakening after the morning of 11 December and crosses south Andhra Pradesh coast south of Nellore and to the north of Chennai in the morning of 13 December 2016. The system dissipates quickly after landfall on 13 December 2016.

WRF: The WRF model analysis shows the CS, Vardah over southeast BoB adjoining east-central BoB. In model forecasts, the system moves mostly west-northwestward direction with gradual intensification to become a SCS on 10 over west-central BoB and a VSCS on 11 December 2016 over west-central BoB off north Tamilnadu coast.

JMA: The forecast based on analysis of 00 UTC on 8th shows a cyclonic storm over SE Bay which moving in a NNW direction intensifies into a SCS on 10th over northern parts of SE Bay and is seen moving towards south Andhra coast on 11th December.

Meteo-France ARP Model: The forecast based on 00 UTC analysis of 8th December shows that the CS over SE Bay is seen to move in a NNW direction till 11th December without any further significant intensification.

NCMRWF-NCUM: The cyclonic storm in the analysis field on 00UTC of 8th December further intensifies with a NW movement on 9th and is seen as a SCS on 10th and 11th December. On 12th morning it is seen off the south AP coast as CS and crossed the coast in the evening of 12th and is seen as a depression by 13th morning over the coastal region.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC analysis of 8th shows the cyclonic storm over SE Bay moving slowly in a WNW direction intensifies into a SCS on 9th and continued to move the same way on 10th and 11th also towards south Andhra coast and neighbouring North Tamil Nadu coast.

NCMRWF-NEPS Model:

The forecast based on the analysis for 00 UTC of 8th December shows a CS on over SE Bay and adjoining South Andaman Sea is moving in a WNW direction on 9th to become a SCS on 10th over northern parts of SE Bay. Then it moved in a WNW direction and weakened to a CS over eastern parts of SW Bay on 11th. The system is seen over western parts of WC Bay on 12th off the coast of North Tamil Nadu and neighbouring South Andhra coast and crosses south coastal AP south of Machilipatnam as a depression on 13th morning.

IITM-GEFS: The forecast based on 8th December 00 UTC analysis, indicates a cyclonic storm over south Bay on 9th, which moving west-northwestward reaches south coastal AP on 11th and weakens into a depression on 12th morning crosses coast near Kakinada.

Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 08 December 2016 suggests a zone of significant GPP (> 30) over southeast BoB and adjoining east-central BoB. The organized significant GPP zone continually moves northwestward direction initially and then moves west-northwestward from 10 to 12 December to cross Andhra Pradesh coast in the morning of 12 December 2016.

Summary and Conclusion:

Most of the models indicate that the cyclonic storm over SE Bay will further initially and move in a WNW to NW direction and reach south coastal Andhra Pradesh. Most of the models show weakening of the system as it approaches the coast. However, there is not much consensus about the landfall intensity.

The environmental parameters are favourable for intensification of the system and its northwestward movement towards Andhra Pradesh coast. However, high vertical wind shear and lower SST and ocean thermal energy near Andhra Pradesh coast are unfavourable factors which may lead to weakening of the system to some extent before landfall. Considering all the above, the cyclonic storm, 'VARDAH' will intensify further and move initially northwards and then northwestwards during next 3 days and reach Andhra coast between Nellore and Kakinada by 12th evening. There is possibility of gradual weakening thereafter along with the continued west-northwestwards movement towards Andhra Pradesh coast.

IOP : IOP for AP and north Tamil Nadu coast 9-12 Dec. IOP for Andaman and Nicobar Islands to continue till 9th December afternoon.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	07/12	08/00	08/03
India	41	34	46
Coastal stations			
WB	10	3	9
Odisha	6	5	6
AP	9	12	12
Tamil Nadu	9	12	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	5	4
Myanmar	0	0	0
Thailand	3	3	3
Sri Lanka	0	5	8

AWS:

Region	Date/Time (UTC)		
	07/12	08/00	08/03
WB	3	2	3
Odisha	3	1	3
AP	8	3	6
Tamil Nadu	25	13	17
Puducherry	1	1	0
A & N	0	0	0

RS/RW (12Z) of 07/12/2016 : 14 /43
No. of Ascents reaching 250 hPa levels:14 , MISDA:- 9
RS/RW (00Z) of 07/12/2016 : 27/43
No. of Ascents reaching 250 hPa levels: 26, MISDA: 3

- **No. of PILOT Ascents**

07 /12Z	08 /00Z
18	12

Buoy Data

07/12Z	08 /00Z	08/03Z
12	12	13

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**07.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

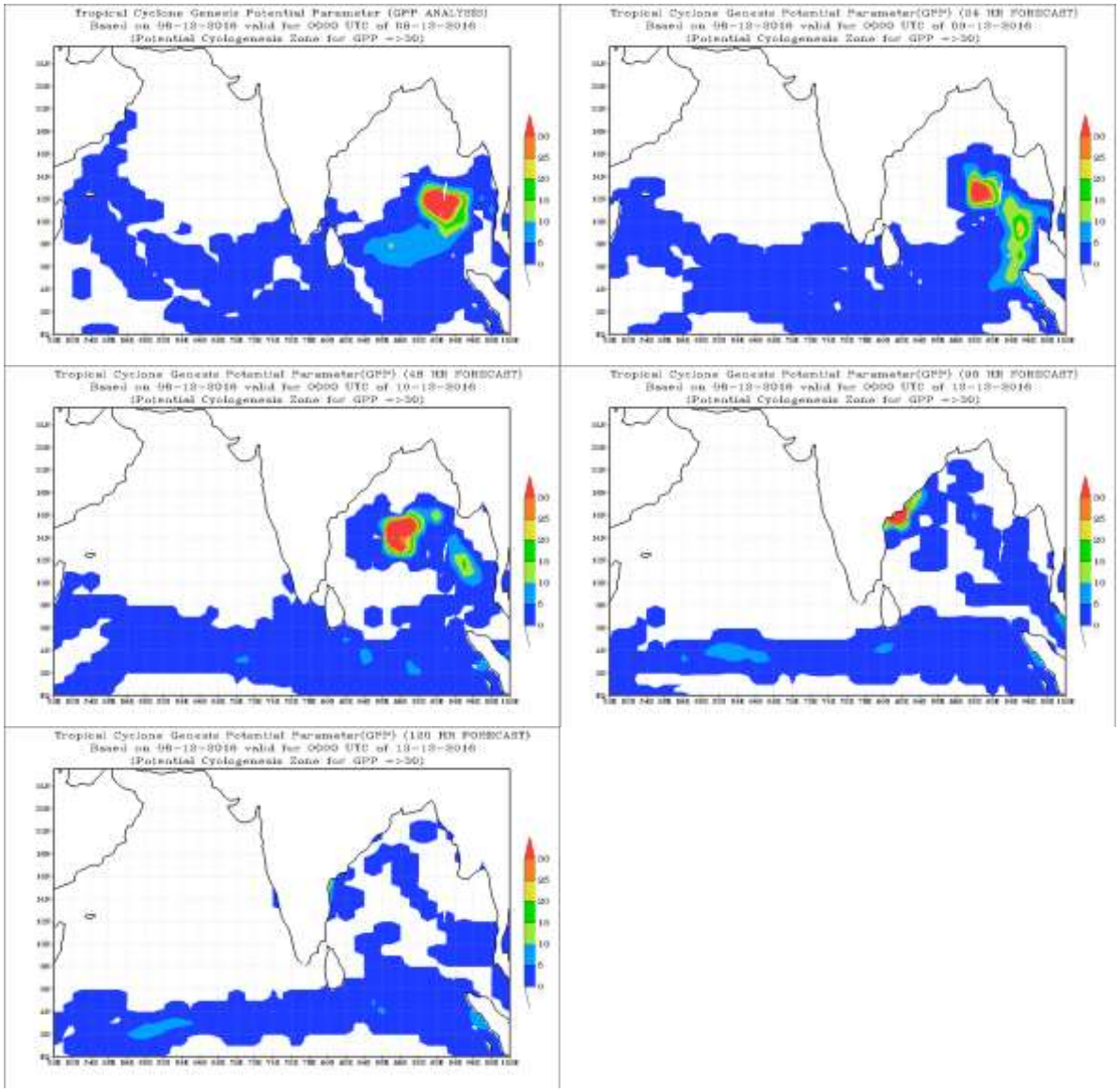
00Z /07.12.2016 : 6
No. of Ascents reaching 250hPa level =6
MISDA :2

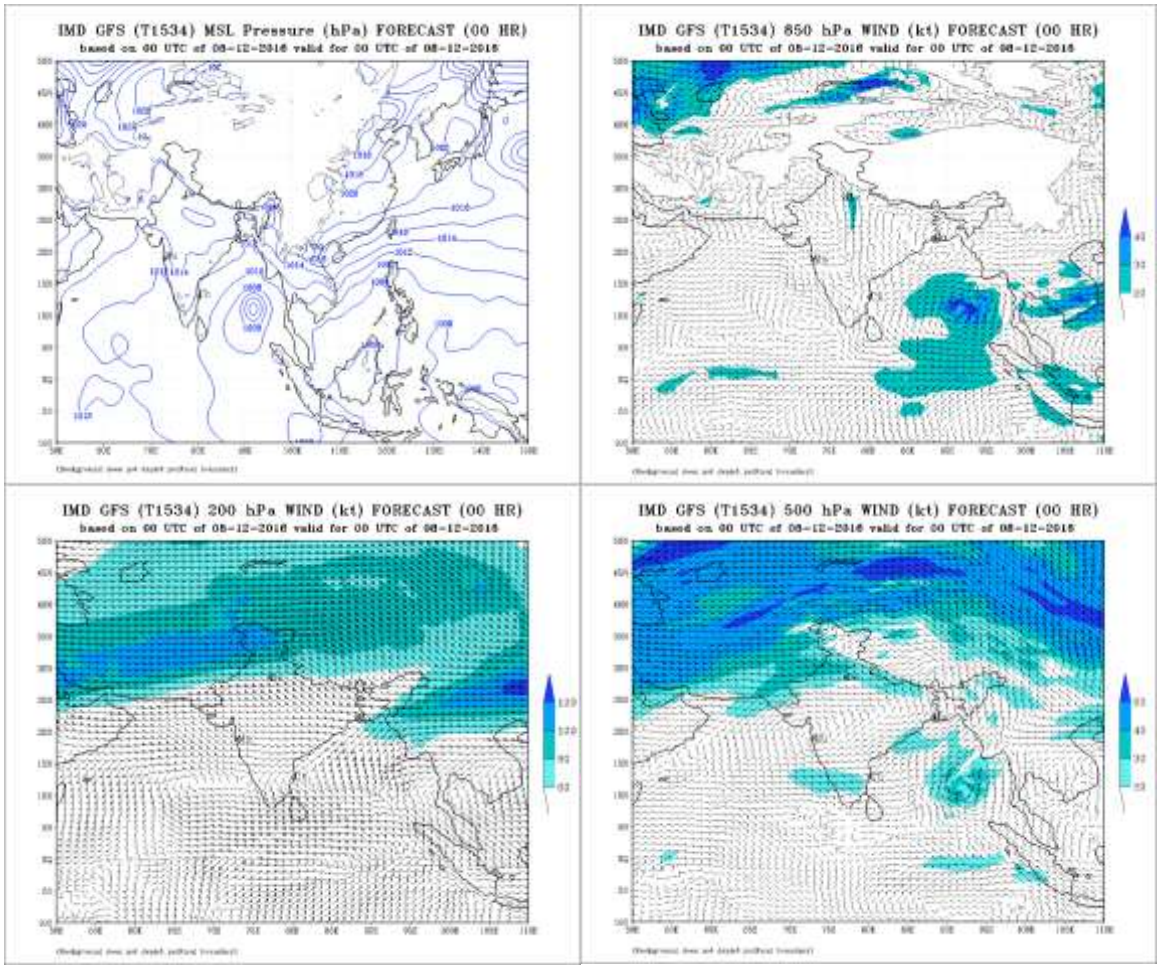
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No. of Ascents reaching 250 hPa level =2
MISDA : 6

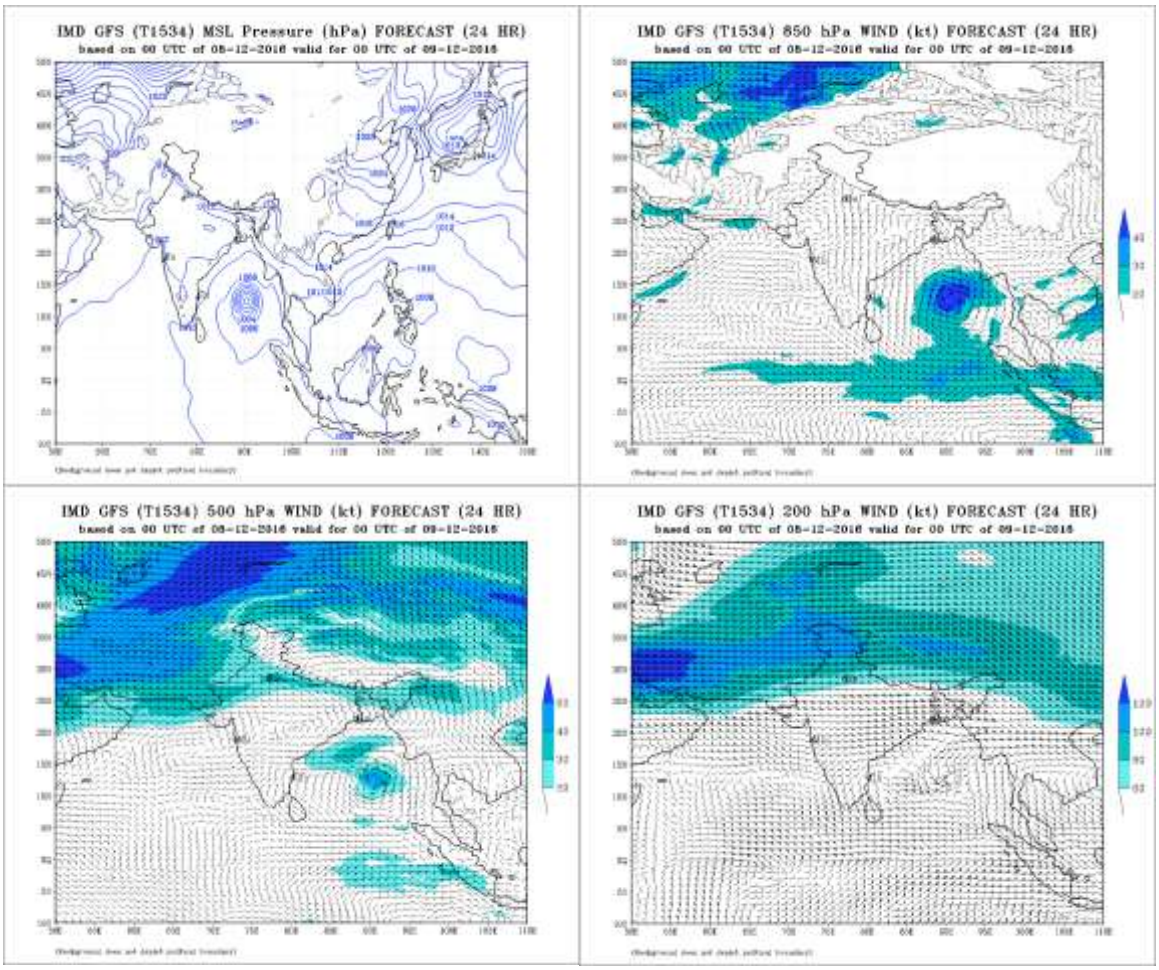
No. of PILOT Ascents:

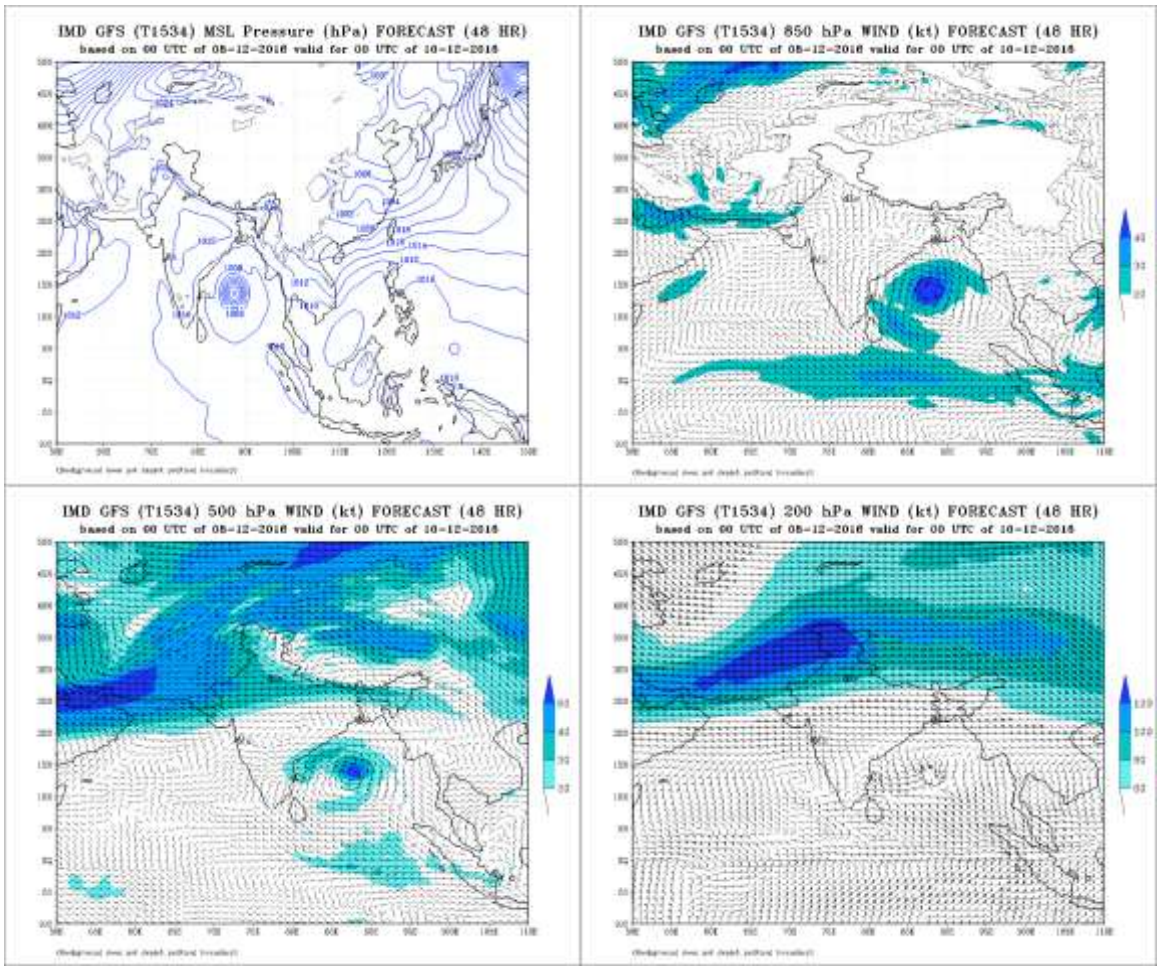
07.12.2016	
06Z	18Z
4	3

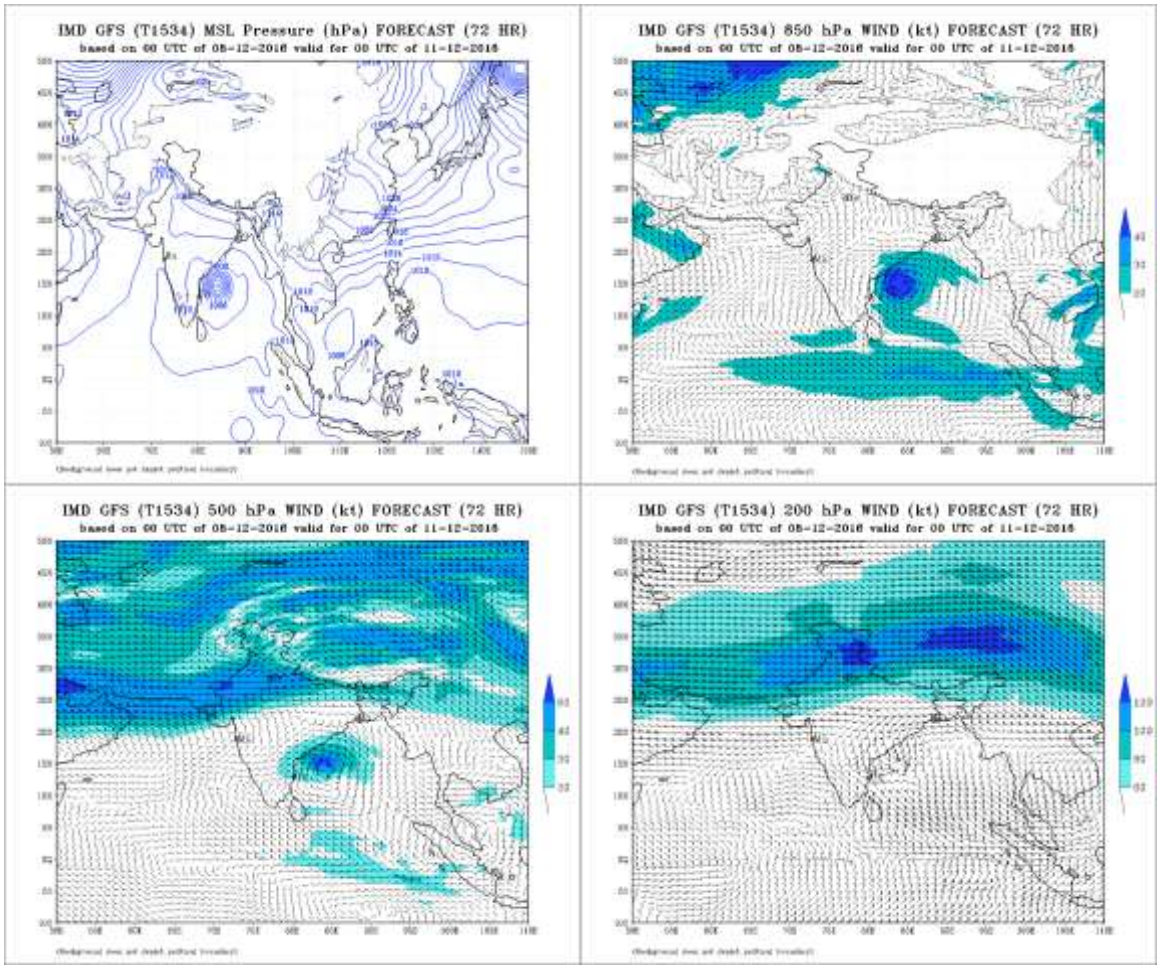
Annexure-II

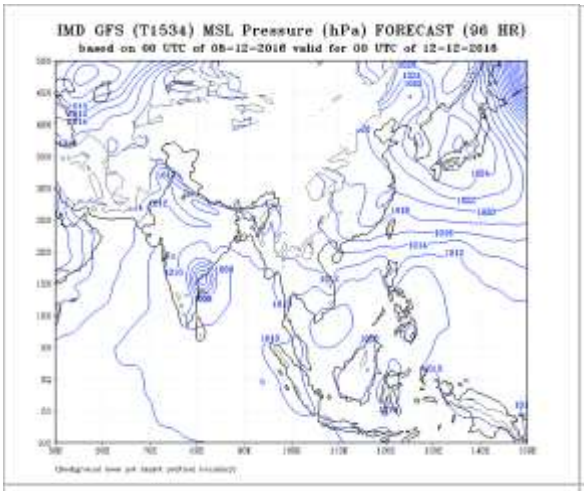

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 08-13-2016 valid for 0000 UTC of 08-13-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 08-13-2016 valid for 0000 UTC of 09-13-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 08-13-2016 valid for 0000 UTC of 10-13-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 08-13-2016 valid for 0000 UTC of 11-13-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 08-13-2016 valid for 0000 UTC of 13-13-2016
(Potential Cyclogenesis Zone for GPP =>30)

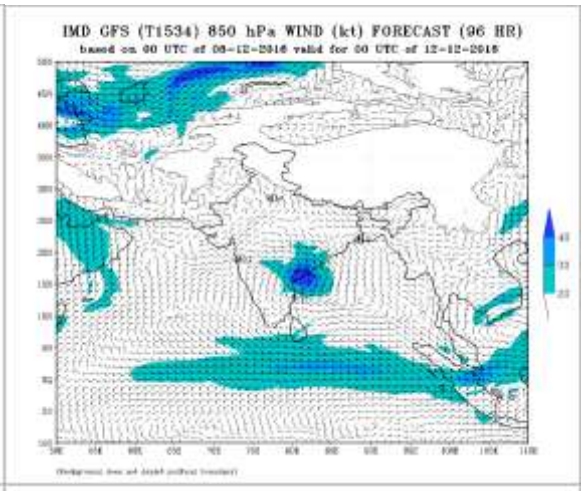

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 08-12-2016 valid for 00 UTC of 08-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 08-12-2016 valid for 00 UTC of 08-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
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IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 08-12-2016 valid for 00 UTC of 08-12-2016

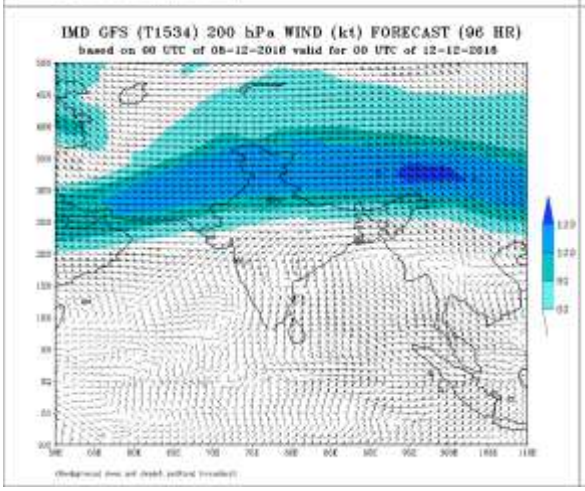

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based on 00 UTC of 08-12-2016 valid for 00 UTC of 09-12-2016

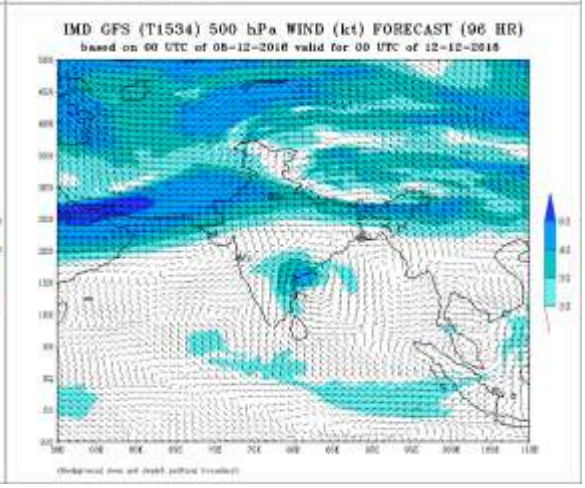

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IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 08-12-2018 valid for 00 UTC of 10-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
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IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 08-12-2018 valid for 00 UTC of 10-12-2018

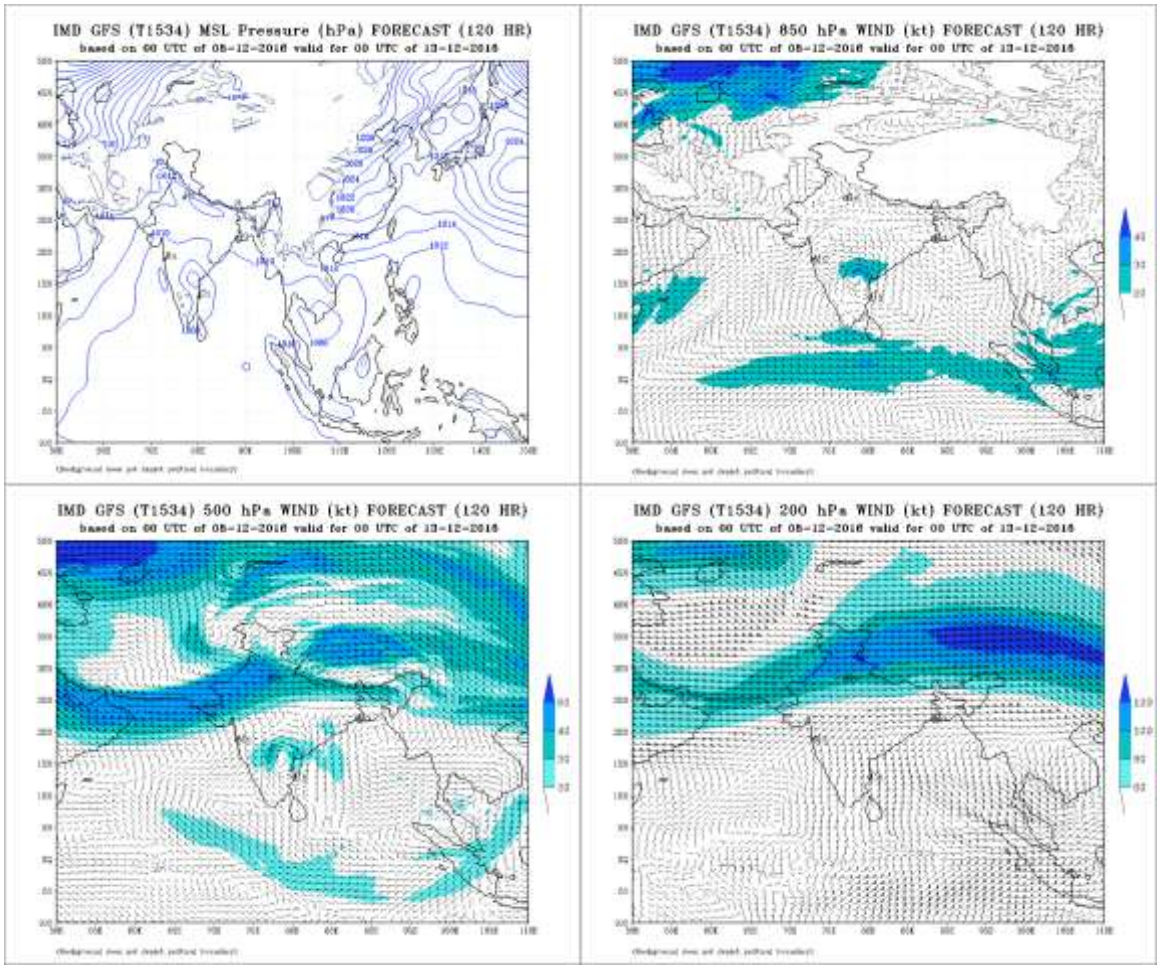

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 08-12-2018 valid for 00 UTC of 11-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
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IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 08-12-2016 valid for 00 UTC of 12-12-2016


IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
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based on 00 UTC of 08-12-2016 valid for 00 UTC of 12-12-2016


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
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IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 08-12-2018 valid for 00 UTC of 13-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
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based on 00 UTC of 08-12-2018 valid for 00 UTC of 13-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 08-12-2018 valid for 00 UTC of 13-12-2018

FDP (Cyclone) NOC Report Dated 09th December 2016

Synoptic features:

The Cyclonic Storm, (VARDAH) over southeast Bay of Bengal moved slowly northwards and lay over the same region, centred at 1730 hrs IST of yesterday, the 8th Dec. 2016 near Lat. 11.7º N / Long. 90.5º E, about 1020 kms east- southeast of Visakhapatnam, 1120 kms east-southeast of Machilipatnam and 240 kms west-southwest of Port Blair. It then moved north-northwestwards, slightly intensified further and lies centred over southeast Bay of Bengal, at 0830 hrs IST of today, the 9th Dec. 2016 near Lat. 12.1º N / Long. 90.4º E, about 990 kms southeast of Visakhapatnam, 1090 kms eastsoutheast of Machilipatnam and 250 kms west-northwest of Port Blair. The system is very likely to intensify further into a Severe Cyclonic Storm during next 12 hours. It is very likely to move initially northwestwards, then west-northwestwards and cross Andhra Pradesh coast between Nellore and Kakinada around afternoon/evening of 12th Dec. 2016. However, the system is likely to weaken slightly before landfall.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 28-29˚C around the system area. The SST decreases towards northwest and west central Bay of Bengal becoming 26-27˚C near north Andhra Pradesh, and Odisha coasts.

Tropical Cyclone Heat Potential (TCHP):

The ocean heat content is about 70-80 kJ/cm^2 over the system area and gradually decreases towards northwest, becoming less than 50 kJ/cm^2 near, Odisha, and adjoining north Andhra Pradesh coasts except for a small pocket of westcentral Bay off central Andhra Pradesh coast where it is 60-70 kJ/cm^2.

Relative Vorticity:

The low-level relative vorticity about 250 x10^{-6} s^{-1} to the south of the system centre.

Convergence:

The low level convergence is about 20 x10^{-6} s^{-1} and is to the west-northwest of the system centre.

Divergence:

The upper level divergence is around 20 x10^{-6} s^{-1} to the west-northwest of the system centre.

Wind Shear:

Wind shear of horizontal wind is high (20-25 kts) around the system centre.

Wind Shear Tendency:

The wind shear tendency is neutral over the system area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, the system intensity is T3.0. Convection shows central dense overcast (CDO) pattern. Minimum cloud top temperature (CTT) is minus 93 deg C. Associated broken low/medium clouds with embedded intense to very intense convection lie over southeast and adjoining eastcentral Bay of Bengal between 10.5 ^{0}N & 16.0^{0}N and longitude 86.0^0 E & 91.5^0 E.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 15^{0}N latitude over BoB.

M.J.O. Index:

MJO index lies in Phase 2 with amplitude less than 1. It would move to phase 3 during next 3 days with amplitude 1.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The cyclonic storm over SE Bay seen on the 00UTC analysis of 9th December is seen to be moving in a WNW with slight intensification 10th and 11th also. The CS is seen off the

coast of south Andhra Pradesh on 12th morning and crossed the coast to the south of Ongol by evening of 12th. On 13th the system is seen lying as a low over interior AP.

NCEP-GFS: The model analysis shows the CS, Vardah over the southeast BoB and adjoining east-central BoB east of Andaman & Nicobar Islands. In the models forecasts, the system moves west-northwestward to enter west-central BoB and becomes a SCS on 10 December 2016. The system continues to move in west-northwestward direction over west-central BoB towards Andhra Pradesh coast during 11 December 2016 and shows further intensification. Then, the system starts weakening and makes landfall over south coastal Andhra Pradesh coast near to the south of Ongole in the evening of 12 December 2016. Moving inland, the system dissipates quickly to become a low over south Andhra Pradesh coast and adjoining areas on 13 December 2016.

ECMWF: The model analysis indicates the CS, Vardah over east-central BoB. In the forecasts, the system with west-northwestward movement intensifies further to enter west-central BoB during 10 December 2016 and becomes a SCS. Then, the system continues to move in west-northwestward direction till 11 December over west-central BoB. Thereafter, the system moves westward and starts weakening during 12 December to approach south Andhra Pradesh coast. The system crosses south Andhra Pradesh coast near Ongol as CS in the evening of 12 December 2016. The system dissipates quickly after landfall.

WRF: The WRF model analysis shows the CS, Vardah over southeast BoB adjoining east-central BoB. In model forecasts, the system moves mostly west-northwestward direction with gradual intensification to become a SCS on 10 over west-central BoB and a VSCS on 11 December 2016 over west-central BoB. The system makes landfall as a SCS over south Andhra Pradesh coast south of Machilipatnam and north of Chennai in the morning of 12 December 2016.

HWRF: The model shows the CS over south-east and adjoining east-central BoB east of Andman Islands. The system moves west-northwestward direction with intensification till 12 UTC of 10 December. Thereafter, it continues to move in the same direction rather most westward direction and weakens a bit till early morning of 12 December 2016. The system moves southwestward towards south Andhra Pradesh coast and moving west makes landfall in between Ongole and Chennai in the night of 12 December 2016.

JMA: The forecast based on analysis of 00 UTC on 9th shows a cyclonic storm over SE Bay which moving in a WNW direction intensifies into a SCS on 10th over northern parts of SE Bay and over northern parts of SW Bay on 11th and approaches south Andhra coast as a CS, near Nellore by the morning of 12th December.

Meteo-France ARP Model: The forecast based on 00 UTC analysis of 9th December shows that the CS over SE Bay is seen to be moving in a NNW direction till 11th December without any significant intensification. On 12th morning it is seen close to Ongol on South AP coast.

NCMRWF-NCUM: The cyclonic storm in the analysis field on 00UTC of 9th December further intensifies with a NW movement on 10th and is seen as a SCS on 11th December. On 12th morning it is seen off the south AP coast as CS and crossed the coast in the evening of 12th to the south of Machilipatnam and is seen as a depression by 13th morning over the coastal region.

NCMRWF-UM-Regional Model: The forecast based on 00 UTC analysis of 9th shows the cyclonic storm over SE Bay moving slowly in a WNW direction intensifies into a SCS on 10th and continued to move the same way on 11th also towards south Andhra coast and neighbouring North Tamil Nadu coast. On 12th morning it weakened slightly close to the coast.

NCMRWF-NEPS Model:

The forecast based on the analysis for 00 UTC of 9th December shows a CS on over SE Bay which moving in a WNW direction intensify slightly on 11th over southern parts of WC Bay. Further moving in a WNW direction it weakened to a DD over western parts of WC Bay on 12th off the coast of

North Tamil Nadu and neighbouring South Andhra coast and crosses south coastal AP near Nellore in the evening of 12th December.

IITM-GEFS: N.A.

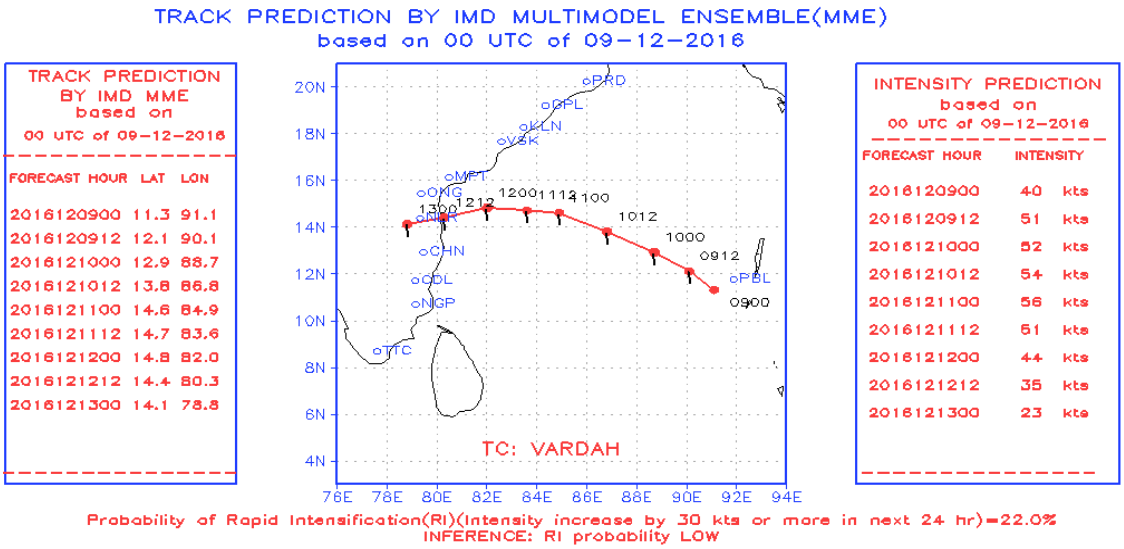
Dynamical statistical models

IMD Genesis Potential Parameter (GPP):

Analysis and forecasts of GPP based on 00 UTC of 09 December 2016 suggests a zone of significant GPP (> 30) over southeast BoB and adjoining east-central BoB. The organized significant GPP zone continually moves west-northwestward direction initially during 10 and 11 December and then moves westward during 12 December to cross Andhra Pradesh coast in the night of 12 December 2016

MME TRACK: MME track forecast for the cyclonic storm " VARDAH" over the southeast Bay of Bengal based on 0000 UTC of 9th December 2016 shows a northwestward movement of the system for the next 12 hours, thereafter a westnorthwestward movement till 0000 UTC of the 11th, then a westward movement till 0000 UTC of the 12th and after that the system is likely to move in a near west-southwestward direction making landfall close to Nellore around 1300 UTC of 12th December 2016.

SCIP INTENSITY: Intensity prediction by the SCIP model shows that the cyclonic storm " VARDAH"



over the southeast Bay of Bengal is likely to intensify into a Severe Cyclonic Storm by 1200 UTC of 9th December 2016, weaken gradually after 1200 UTC of the 11th and make landfall as a cyclonic storm.

RAPID INTENSIFICATION: Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 22.0% (Inference: RI probability LOW).

Summary and Conclusion:

Most of the models indicate that the cyclonic storm over SE Bay will further move in a WNW to NW direction and reach south coastal Andhra Pradesh. As per the majority of the models, the system is expected to cross south Andhra coast by evening of 12th December between Nellore and Machilipatnam. Most of the models indicate weakening of the system as it approaches the coast. However, there is still not much consensus about the landfall intensity.

The environmental parameters are favourable for further intensification of the system into a severe cyclonic storm and its northwestward/west-northwestward movement towards andhra pradesh coast during next 3 days. However, as the system approaches the coast, it will encounter cold and dry air over north and westcentral Bay off Andhra Pradesh, Odisha coasts. In addition, high vertical wind shear and lower SSTand ocean thermal energy near Andhra Pradesh coast will be unfavourable factors when the system reaches nearer to Andhra Pradesh coast. This may lead to weakening of the system to some extent before landfall.

IOP : IOP for Andhra Pradesh and north Tamil Nadu coasts during 10-12 December.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	08/12	**09/00**	**09/03**
India	43	30	45
Coastal stations			
WB	10	3	8
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	2	2
Myanmar	0	1	0
Thailand	3	3	3
Sri Lanka	8	9	10

AWS:

Region	Date/Time (UTC)		
	08/12	**09/00**	**09/03**
WB	4	2	4
Odisha	3	1	5
AP	7	3	7
Tamil Nadu	26	12	23
Puducherry	1	1	1
A & N	0	0	0

RS/RW (12Z) of 08/12/2016 : 17 /43

No. of Ascents reaching 250 hPa levels:12 , MISDA:- 8

RS/RW (00Z) of 09/12/2016 : 28/43

No. of Ascents reaching 250 hPa levels: 24, MISDA: 5

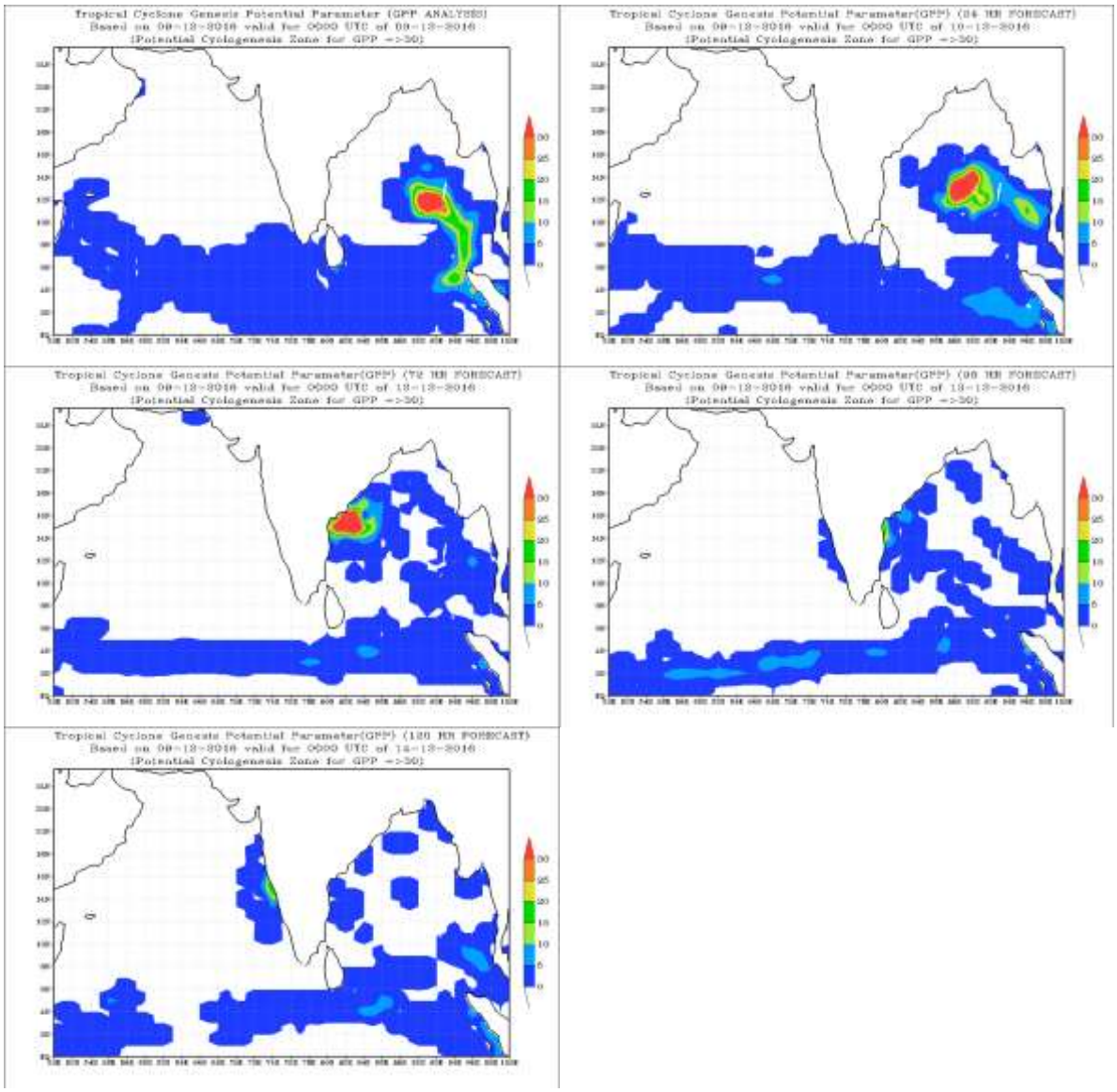
- **No. of PILOT Ascents**

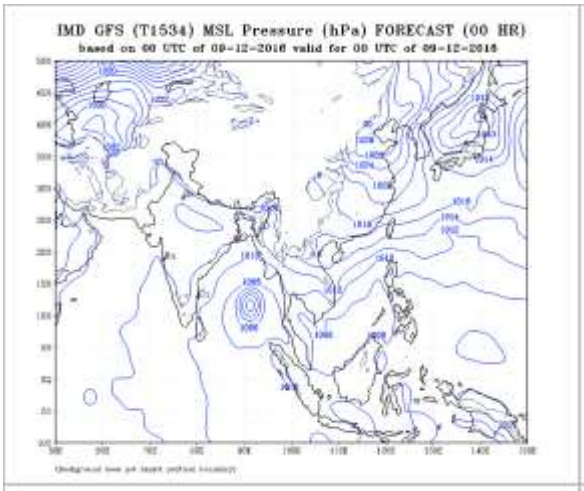
08 /12Z	09 /00Z
15	9

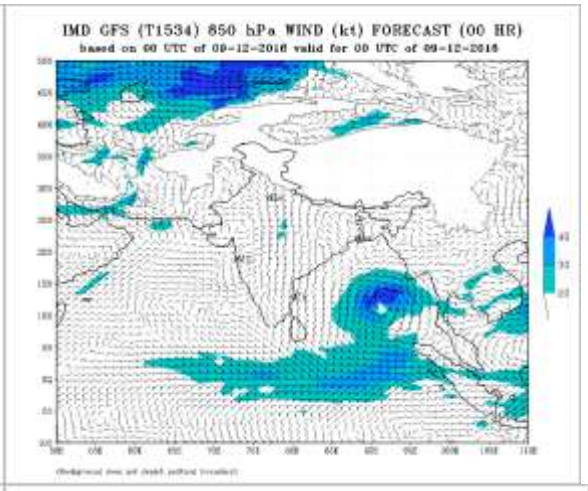
Buoy Data

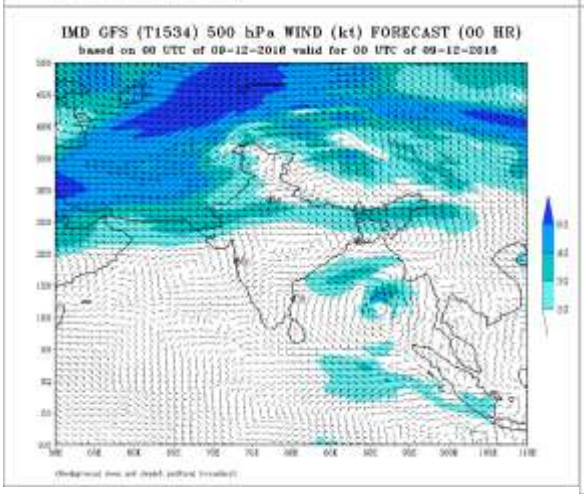
08/12Z	09 /00Z	09/03Z
11	12	4

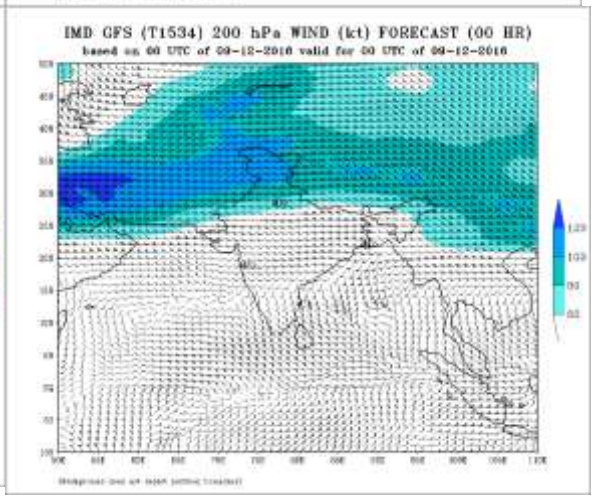
Annexure-II

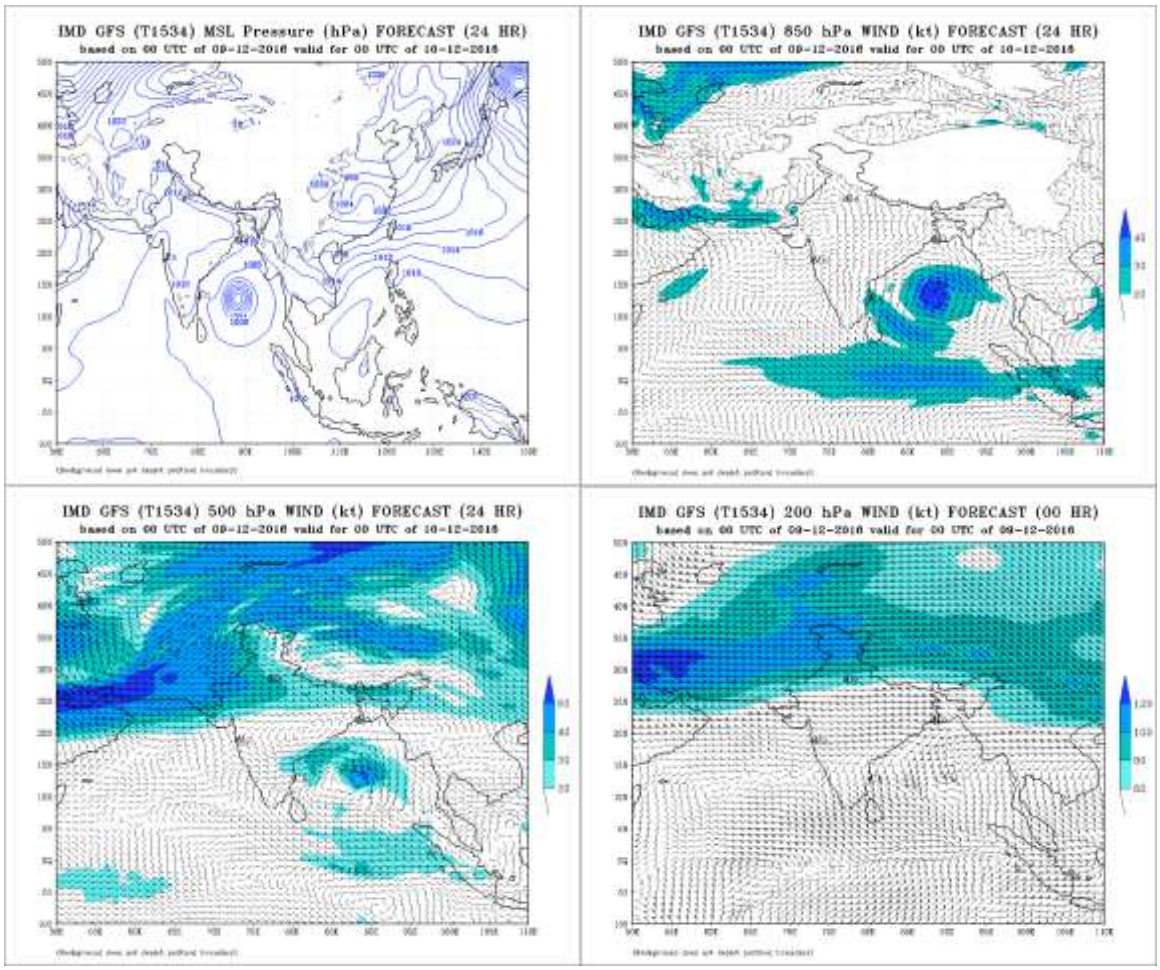

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 00-13-2016 valid for 0000 UTC of 00-13-2016
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Based on 00-13-2016 valid for 0000 UTC of 14-13-2016
(Potential Cyclogenesis Zone for GPP =>30)

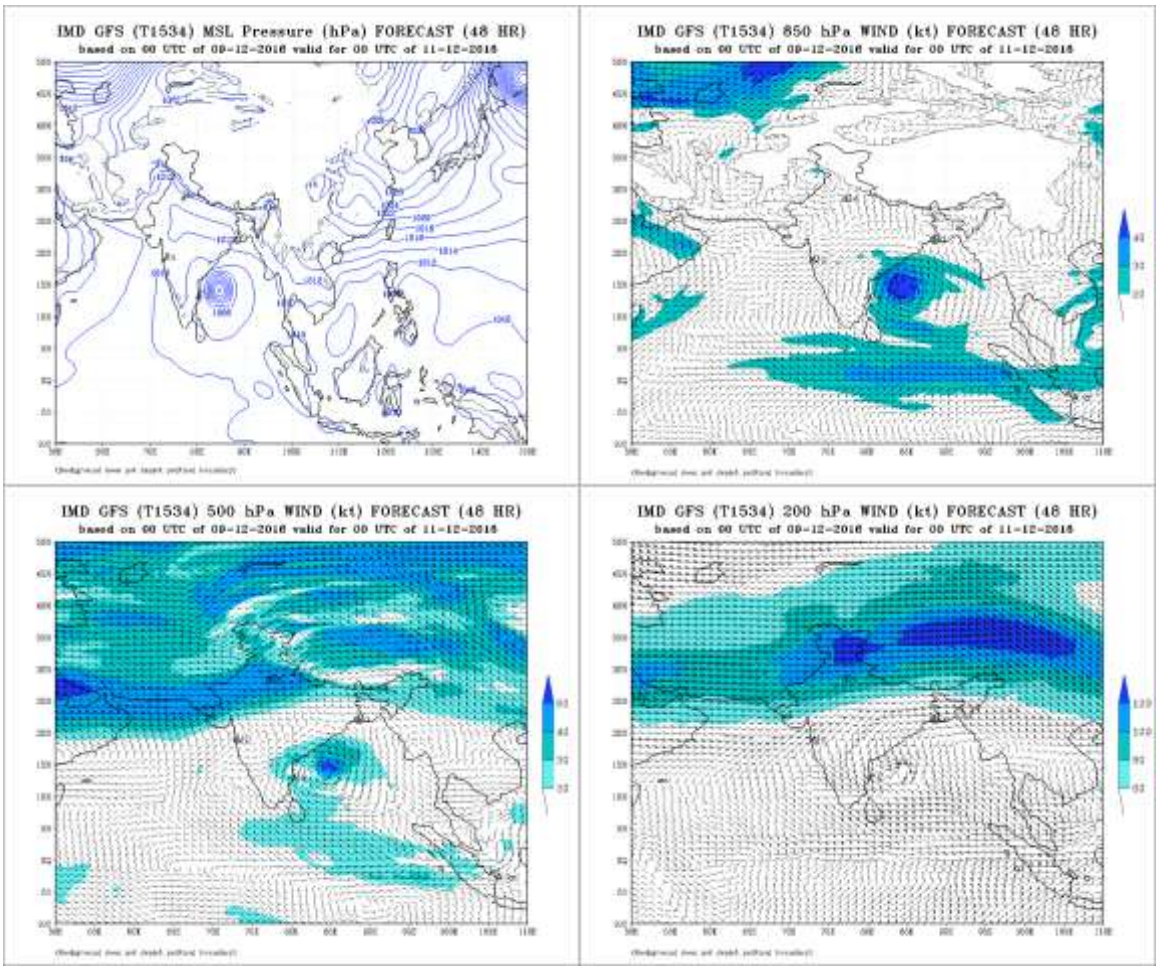

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 09-12-2016 valid for 00 UTC of 09-12-2016

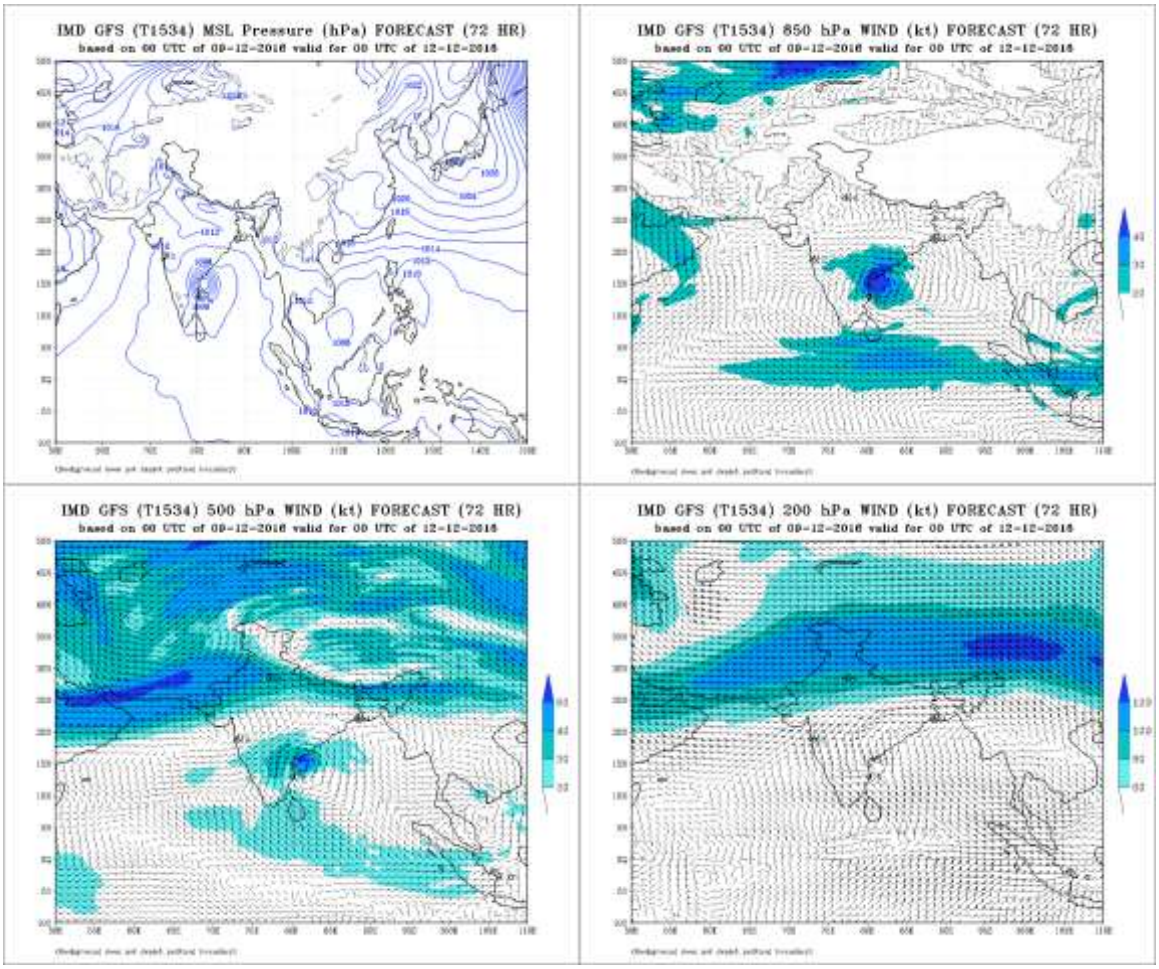

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 09-12-2016 valid for 00 UTC of 09-12-2016

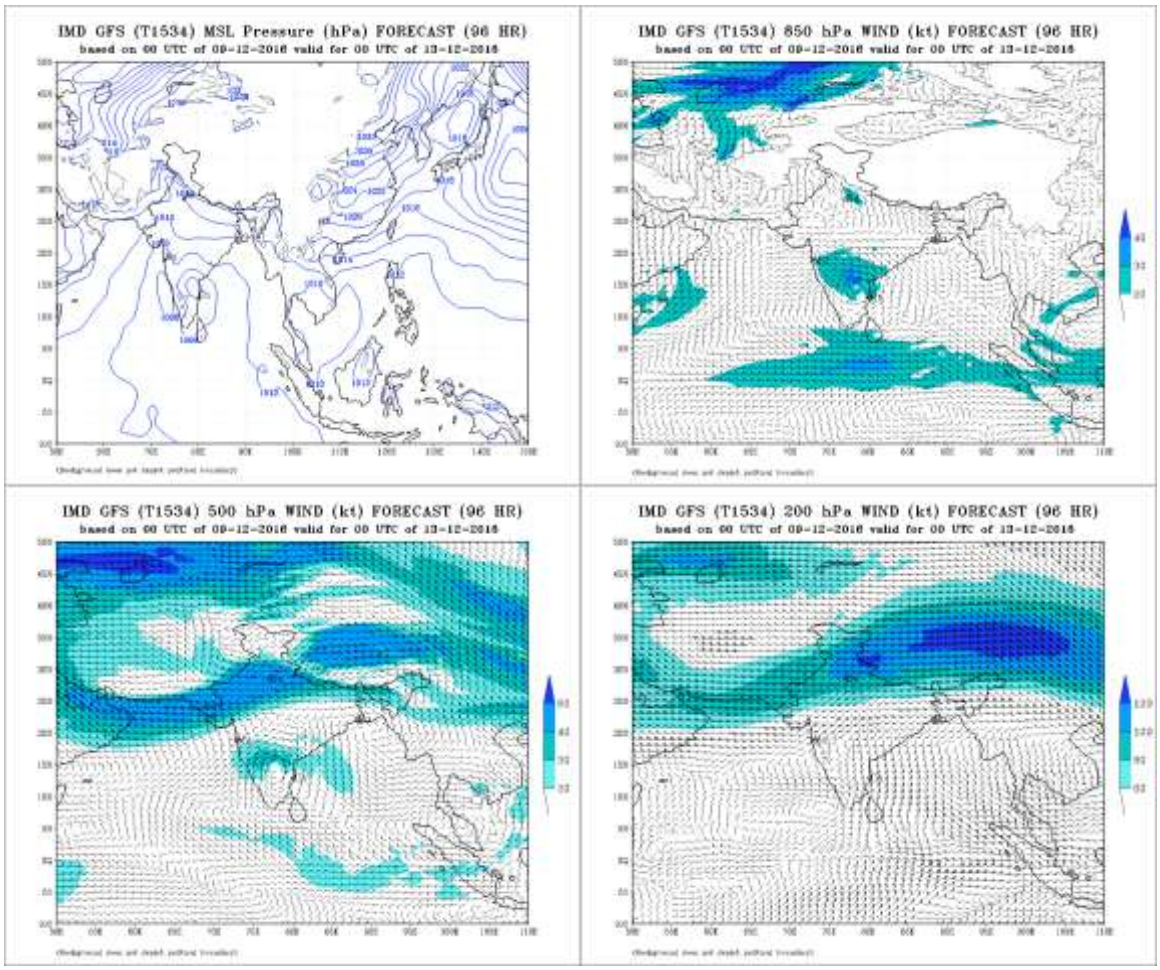

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 09-12-2016 valid for 00 UTC of 09-12-2016

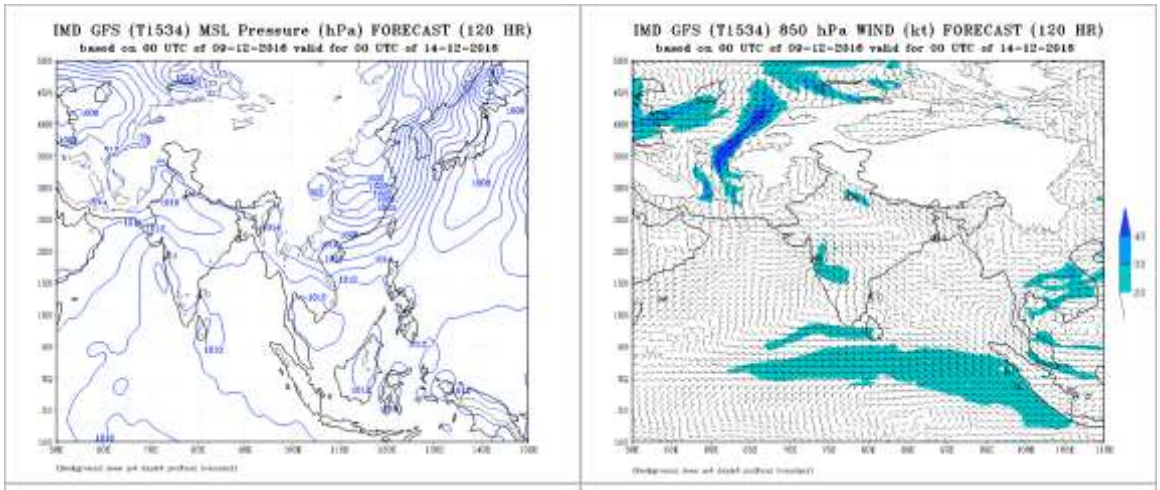

IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 09-12-2016 valid for 00 UTC of 09-12-2016

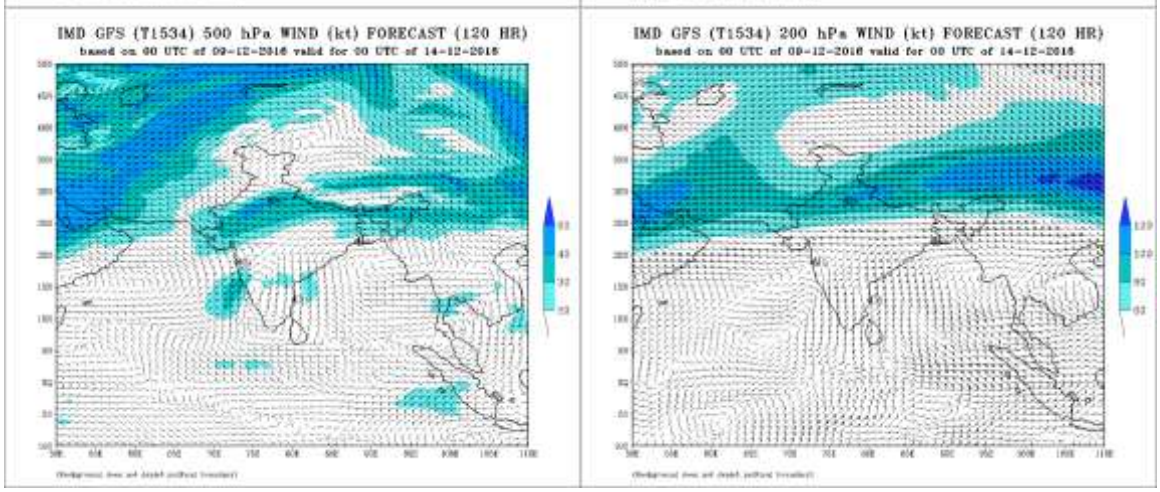

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IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
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IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 09-12-2016 valid for 00 UTC of 12-12-2016
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IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
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IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
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FDP (Cyclone) NOC Report Dated 10th December 2016

Synoptic features:

The Cyclonic Storm, (VARDAH) over southeast Bay of Bengal moved westnorthwestwards and lay centred at 1730 hrs IST of yesterday, the 9th Dec. 2016 over southeast Bay of Bengal near Lat. 12.2º N / Long. 90.0º E, about 950 kms south-southeast of Visakhapatnam, 1050 kms southeast of Machilipatnam and 300 kms west-northwest of Port Blair. It further moved west-northwestwards, intensified into a Severe Cyclonic Storm and lay centred at 2330 hrs IST of yesterday, the 9th Dec. 2016 over southeast Bay of Bengal near Lat. 12.3° N / Long. 89.6° E about 910 kms south-southeast of Visakhapatnam, 1000 kms southeast of Machilipatnam and 340 kms west-northwest of Port Blair. It continued to move west-northwestwards and lies centred at 0830 hrs IST of today, the 10th Dec. 2016 over southeast Bay of Bengal near Lat. 12.7° N / Long. 88.0° E, about 880 kms east-southeast of Nellore and 830 kms east-southeast of Machilipatnam. The system is very likely to move westnorthwestwards and further intensify during next 24 hours. It is very likely to maintain its peak intensity upto 11th Dec. evening. Thereafter, it is likely to weaken gradually while moving towards Andhra Pradesh coast. It is very likely to cross south Andhra Pradesh coast between Nellore and Machilipatnam around afternoon/evening of 12th Dec. 2016.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 28-29˚C around the system area. The SST decreases towards northwest and west central Bay of Bengal becoming 26-27˚C near north Andhra Pradesh, and Odisha coasts.

Tropical Cyclone Heat Potential (TCHP):

The ocean heat content is about 70-80 kJ/cm^2 over the system area and gradually decreases towards northwest, becoming less than 50 kJ/cm^2 near, Odisha, and adjoining north Andhra Pradesh coasts except for a small pocket of westcentral Bay off central Andhra Pradesh coast where it is 60-70 kJ/cm^2.

Relative Vorticity:

The low-level relative vorticity about 250 x10^{-6} s^{-1} to the south of the system centre and is extending upto mid-tropospheric levels.

Convergence:

The low level convergence is about 30 x10^{-6} s^{-1} around the system centre.

Divergence:

The upper level divergence is around 40 x10^{-6} s^{-1} to the west-southwest of the system centre.

Wind Shear:

Wind shear of horizontal wind is high (20-25 kts) around the system centre.

Wind Shear Tendency:

The wind shear tendency is neutral over the system area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, the system intensity is T3.5. Convection shows central dense overcast (CDO) pattern. Minimum cloud top temperature (CTT) is minus 93 deg C. Associated broken low/medium clouds with embedded intense to very intense convection lie over southeast and adjoining eastcentral Bay of Bengal between 11.4 ^{0}N & 14.5^{0}N and longitude 84.2^0 E & 88.5^0 E.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 17^{0}N latitude over BoB.

M.J.O. Index:

MJO index lies in Phase 2 with amplitude less than 1. It would move to phase 3 during next 3 days with decreasing amplitude.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The cyclonic storm over SE Bay seen on the 00UTC analysis of 10th December is seen to be moving in a WNW with intensification 11th also. The CS is seen off the coast of south Andhra Pradesh on 12th morning and crossed the coast as depression to the south of Nellore by evening of 12th. On 13th the system is seen lying as a low over interior AP.

NCEP-GFS: It show similar behavior as IMD GFS.

ECMWF: The model analysis indicates similar track intensity forcast like IMD GFS, except the fact that the it crosses the coast as a Deep Depression close to Nellore between 06 and 12 UTC of 12th.

WRF: The WRF model analysis shows the CS, crossing the coast to the north of Chennai and south of Nellore by 12th evening.

HWRF: The model shows the CS crossing south Andhra Pradesh coast close to Nellore by 12 UTC of 12th as SCS.

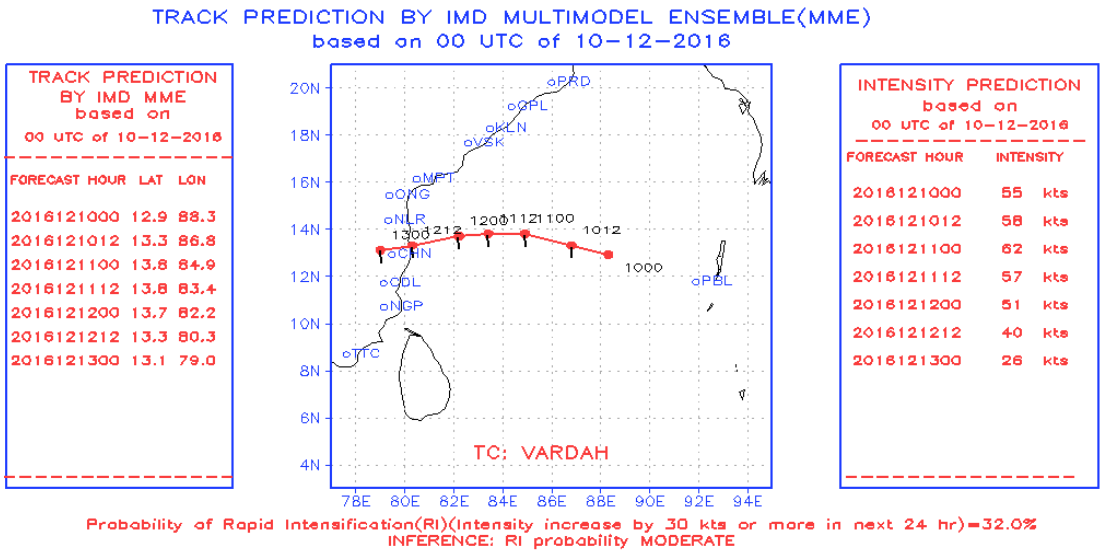
JMA: The forecast based on analysis of 00 UTC on 10th shows the cyclonic storm over SE Bay crossing south Andhra coast as a CS, between Nellore and Chennai by the morning of 12th December.

Meteo-France ARP Model: The forecast based on 00 UTC analysis of 10th December shows that the CS over SE Bay is seen to be moving westward and crossing the coast near 14 ^{0}N by afternoon of 12th December.

NCMRWF-NCUM: The NCUM track suggests the system would track northwestwards and move towards AP coast. The SCS is crossing the AP coast on 13th Dec2016 after around 6UTC between Nellore and Chennai.

IMD MME TRACK:

MME track forecast for the cyclonic storm " VARDAH" over the southeast Bay of Bengal based on 0000 UTC of 10th December 2016 shows a west-northwestward movement till 0000 UTC of the 11th and thereafter the system is likely to move in a westward direction for about 24 hours and then in a westsouthwestward direction. As per the MME track there has been a change in the landfall point prediction. The system is likely to make landfall between Nellore and Chennai, being closer to Chennai, around 1200 UTC of 12th December 2016.



SCIP INTENSITY:

Intensity prediction by the SCIP model shows that the severe cyclonic storm " VARDAH" over the southeast Bay of Bengal is likely to intensify further during the next 24 hours and weaken gradually after 1200 UTC of the 11th and make landfall as a cyclonic storm.

RAPID INTENSIFICATION:

RAPID INTENSIFICATION: Probability of Rapid Intensification (RI) (Intensity increase by 30 kts or more in next 24h) = 32.0% (Inference: RI probability MODERATE)

Summary and Conclusion:

The environmental parameters are favourable for further intensification of the system during next 06 hours and its west-northwestward movement towards south Andhra Pradesh coast during next 3 days. The latest total precipitable water imagery (TPW) indicates cold and dry air incursion over north and westcentral bay off Andhra Pradesh, Odisha coasts and also reaching upto the periphery of southeast sector of the system. In addition, high vertical wind shear and lower SST and ocean thermal energy near Andhra Pradesh coast will be unfavourable factors when the system reaches nearer to Andhra Pradesh coast. It may lead to gradual weakening of the system from 11th /1200 UTC onwards.

Most of the models are also indicating the same. Considering all the above, the system is expected to cross south Andhra coast by evening of 12th December between Nellore and Machilipatnam.

IOP : IOP for Andhra Pradesh and north Tamil Nadu coasts during 11-12 December.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	09/12	10/00	10/03
India	43	31	39
Coastal stations			
WB	10	3	8
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	2	3
Myanmar	0	0	1
Thailand	3	3	3
Sri Lanka	8	7	7

AWS:

Region	Date/Time (UTC)		
	09/12	10/00	10/03
WB	5	2	4
Odisha	7	2	4
AP	9	3	8
Tamil Nadu	25	11	8
Puducherry	1	1	0
A & N	0	0	0

RS/RW (12Z) of 09/12/2016 : 14 /43

No. of Ascents reaching 250 hPa levels:11 , MISDA:- 3

RS/RW (00Z) of 10/12/2016 : 26 /43

No. of Ascents reaching 250 hPa levels: 18, MISDA: 5

No. of PILOT Ascents

09 /12Z	10/00Z
20	7

Buoy Data

09/12Z	10/00Z	10/03Z
10	11	5

STATUS OF CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**09.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /09.12.2016 : 6

No. of Ascents reaching 250hPa level =5

MISDA :2

12Z /09.12.2016 : 2

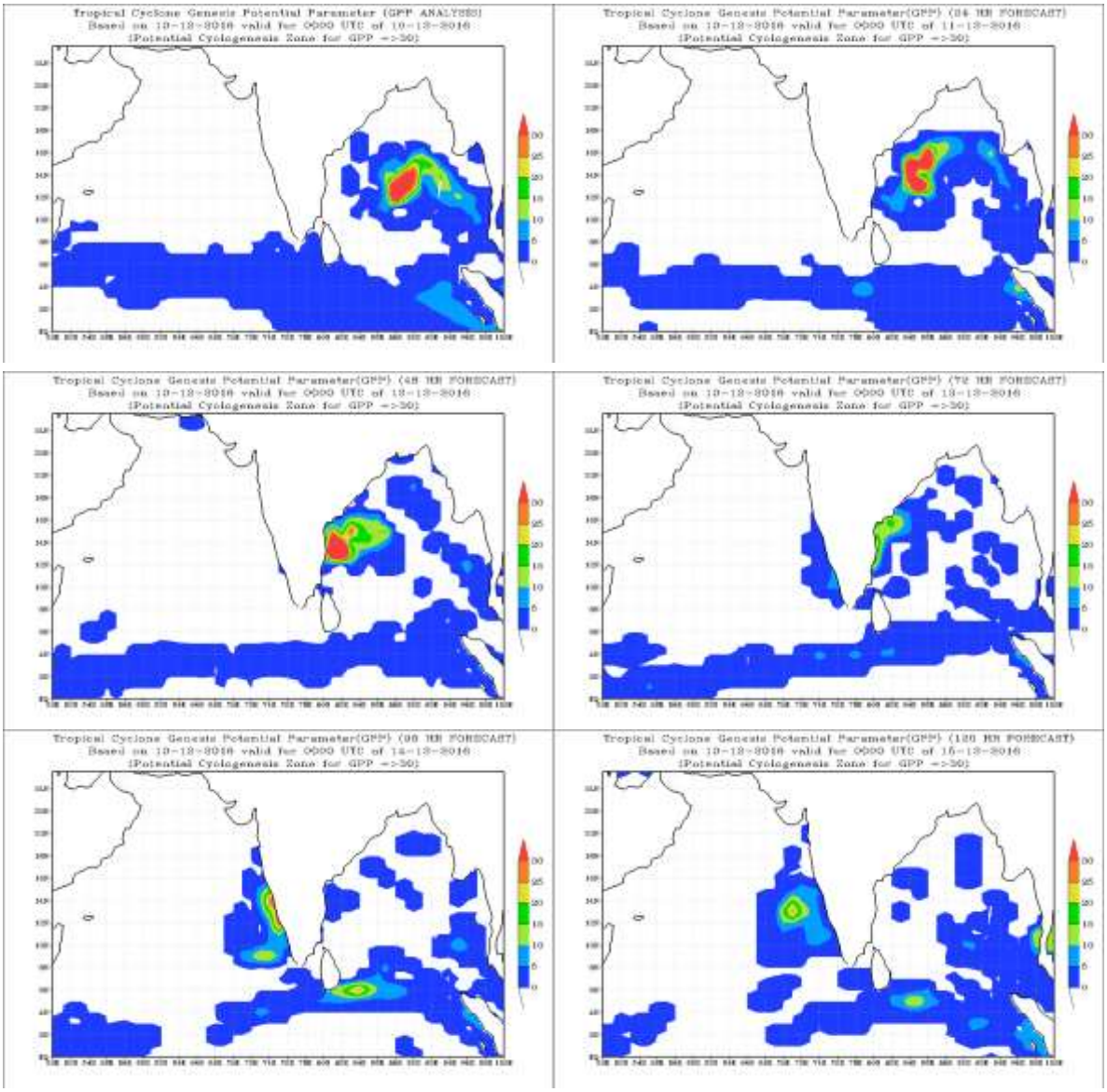
No. of Ascents reaching 250 hPa level =2

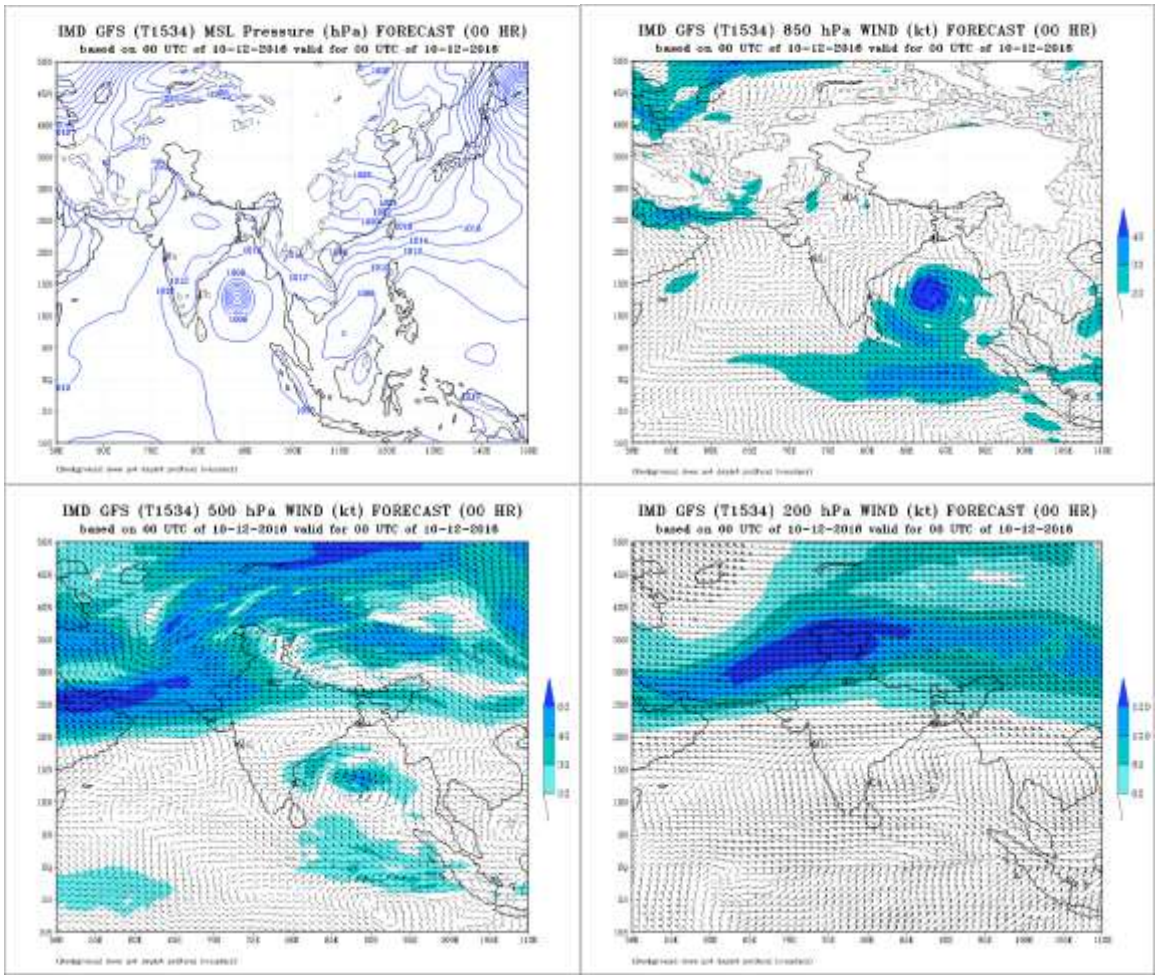
MISDA : 6

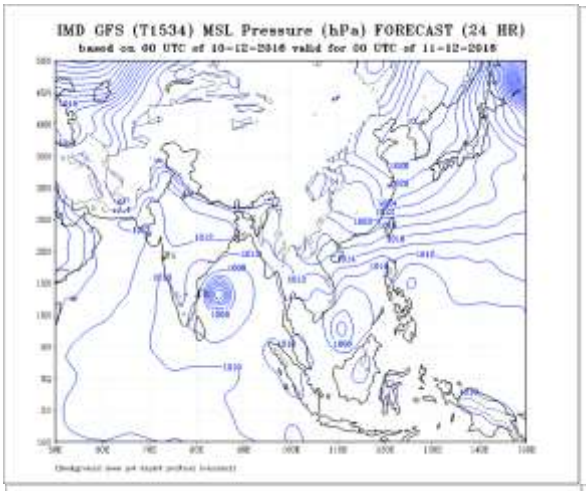
No. of PILOT Ascents:

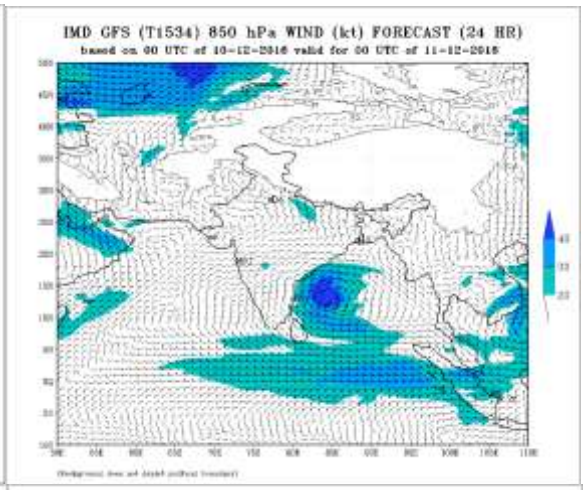
09.12.2016	
06Z	18Z
4	3

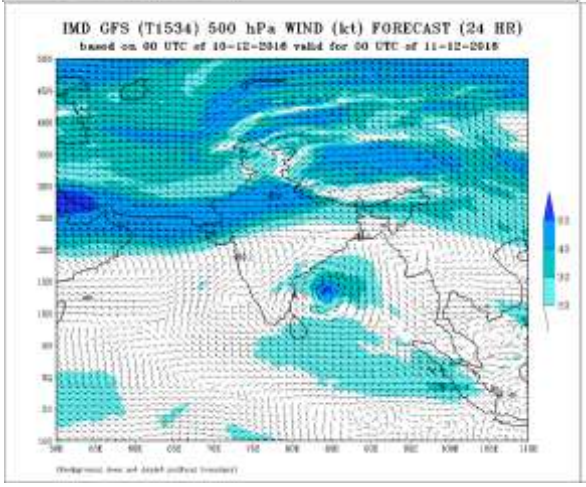
Annexure-II

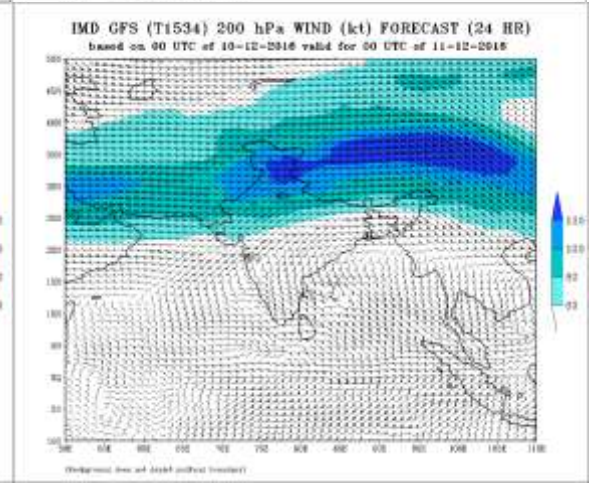

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 10-13-2016 valid for 0000 UTC of 10-13-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 10-13-2016 valid for 0000 UTC of 11-13-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 10-13-2016 valid for 0000 UTC of 12-13-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 10-13-2016 valid for 0000 UTC of 13-13-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 10-13-2016 valid for 0000 UTC of 14-13-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 10-13-2016 valid for 0000 UTC of 15-13-2016
(Potential Cyclogenesis Zone for GPP =>30)

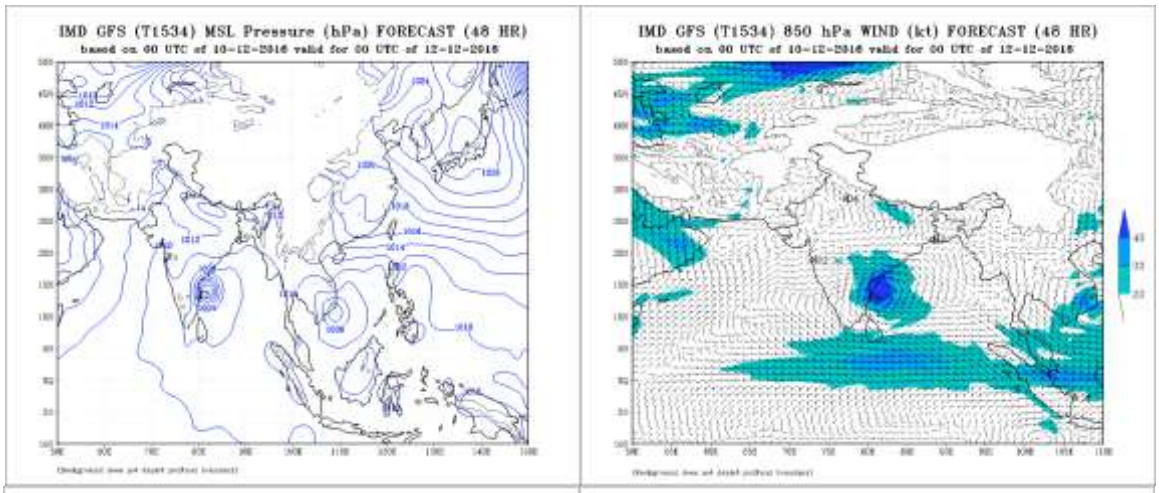

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 10-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 10-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 10-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 10-12-2016

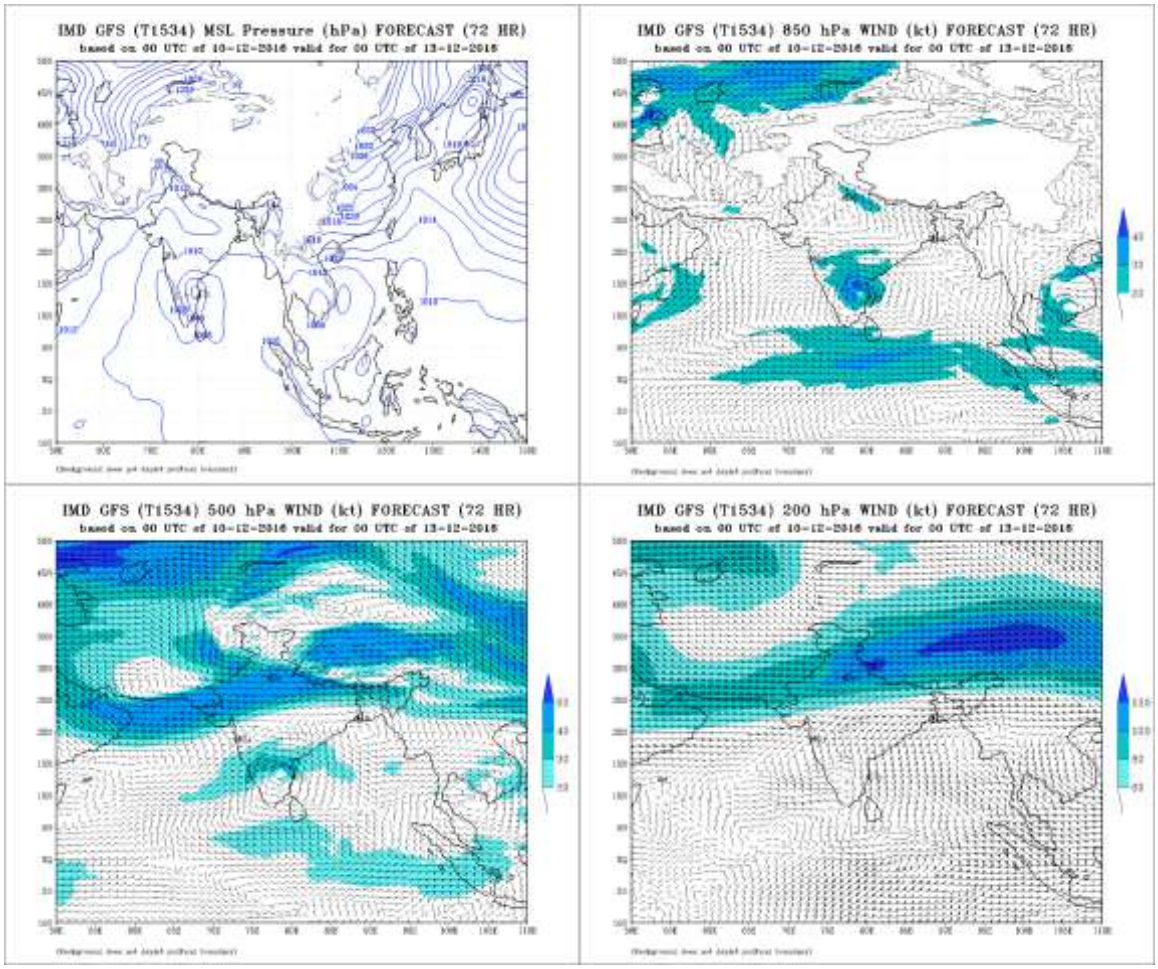

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 11-12-2018

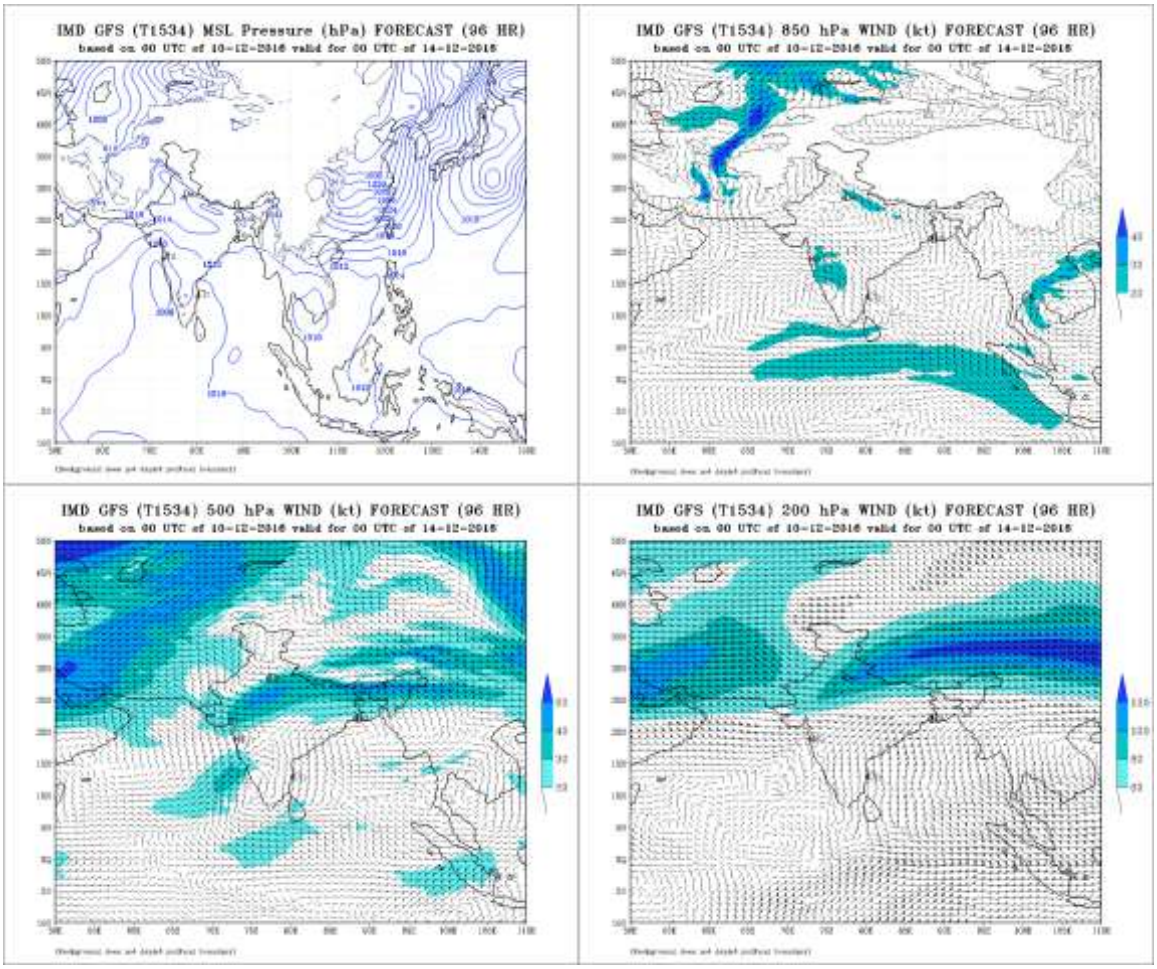

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 11-12-2018

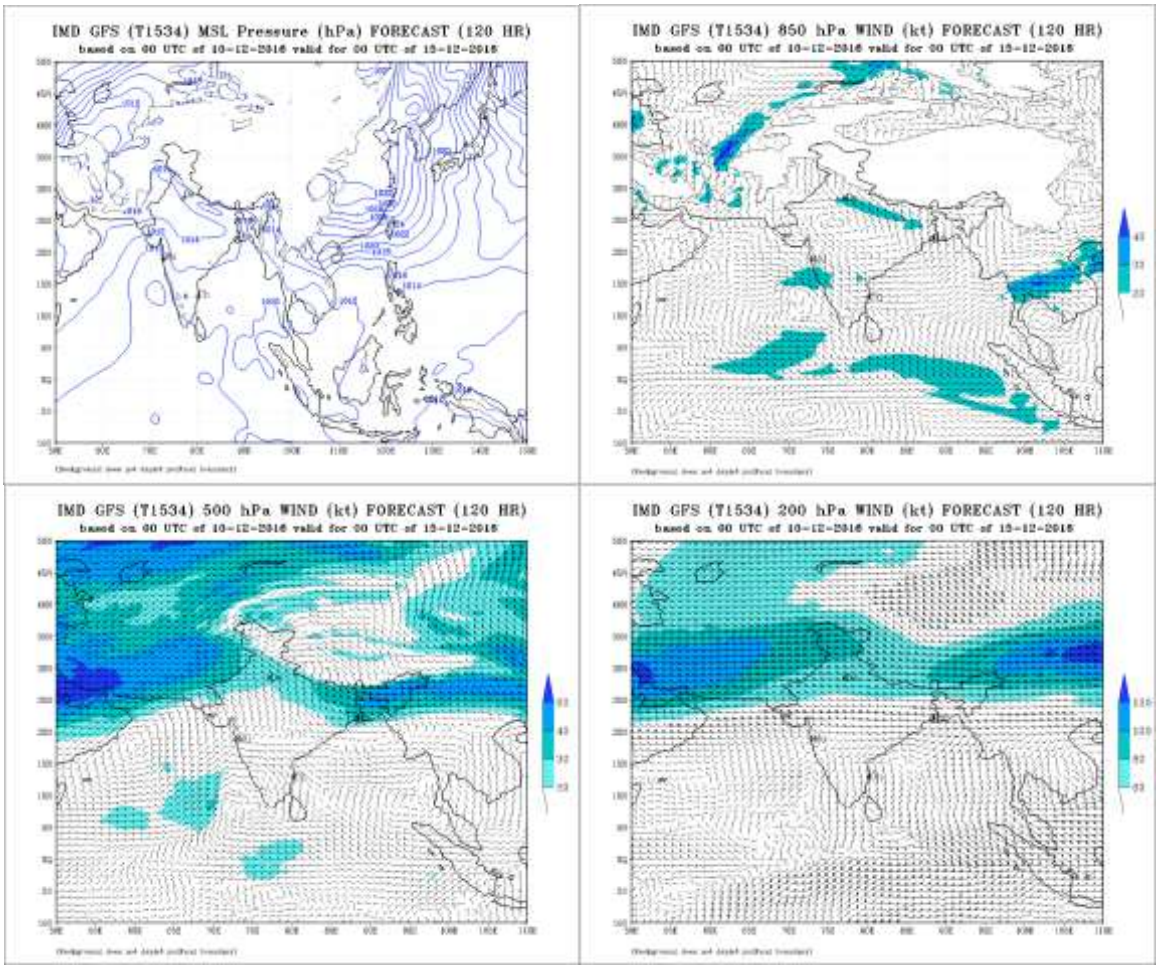

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 11-12-2018


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 11-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 12-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 12-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 12-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 12-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 13-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 13-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 13-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 10-12-2016 valid for 00 UTC of 13-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 14-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 14-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 14-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 14-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 15-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 15-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 15-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 10-12-2018 valid for 00 UTC of 15-12-2018

FDP (Cyclone) NOC Report Dated 11th December 2016

Synoptic features:

The Severe Cyclonic Storm (VARDAH) over southeast Bay of Bengal moved westnorthwestwards and further intensified into a Very Severe Cyclonic Storm and lay over west central and adjoining south Bay of Bengal, centred at 1730 hrs IST of yesterday, the 10th Dec. 2016 near Lat. 13.2ºN / Long 86.4ºE, about 710 kms east-southeast of Nellore, 650 kms eastsoutheast of Machilipatnam and 660 kms east of Chennai. It then moved nearly west wards (west-northwest wards upto mid-night, west wards upto early morning and west-southwest wards in the morning hours) and now lies over westcentral and adjoining southwest Bay of Bengal, centred at 0830 hrs IST of today, the 11th Dec. 2016 near Lat. 13.1°N / Long. 84.3°E, about 490 kms east-southeast of Nellore, 480 kms southeast of Machilipatnam and 440 kms east of Chennai. The system is very likely to move nearly west-southwestwards and weaken gradually from today evening onwards while moving towards north Tamilnadu and adjoining south Andhra Pradesh coasts. It is very likely to cross north Tamilnadu and south Andhra Pradesh coasts, close to Chennai as a Cyclonic Storm by 12th Dec. 2016 afternoon.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 28-29˚C around the system area. The SST decreases towards northwest and west central Bay of Bengal becoming 26-27˚C near north Andhra Pradesh, and Odisha coasts.

Tropical Cyclone Heat Potential (TCHP):

The ocean heat content is about 70-80 kJ/cm^2 over the system area and gradually decreases towards northwest, becoming less than 50 kJ/cm^2 near, Odisha, and adjoining north Andhra Pradesh coasts except for a small pocket of westcentral Bay off central Andhra Pradesh coast where it is 60-70 kJ/cm^2.

Relative Vorticity:

The low-level relative vorticity about 250 x10^{-6} s^{-1} to the southwest of the system centre and is extending upto mid-tropospheric levels.

Convergence:

The low level convergence is about 25-25 x10^{-6} s^{-1} to the southwest of the system centre.

Divergence:

The upper level divergence is around 40 x10^{-6} s^{-1} to the southwest of the system centre.

Wind Shear:

Wind shear of horizontal wind is high (20-25 kts) around the system centre.

Wind Shear Tendency:

The wind shear tendency is neutral over the system area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, the system intensity is T4.0. Convection shows central dense overcast (CDO) pattern. Minimum cloud top temperature (CTT) is minus 92 deg C. Associated broken low/medium clouds with embedded intense to very intense convection lie over southeast and adjoining eastcentral Bay of Bengal between 11.0 ^{0}N & 15.0^{0}N and longitude 82.0^0 E & 85.5^0 E.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 17^{0}N latitude over BoB.

M.J.O. Index:

MJO index lies in Phase 3 with amplitude less than 1. It would remain in phase 3 during next 3 days with decreasing amplitude.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The severe cyclonic storm over SE Bay seen on the 00UTC analysis of 11th December is seen to be moving in a W/WSW with intensification and is seen lying at 00 UTC of 12th off north Tamil Nadu and adjoining south AP coast. The system crossed the coast as weaker system north of Chennai by evening of 12th. On 13th the system is seen lying as a low over interior north TN and adjoining south AP.

NCEP-GFS: It shows similar behavior as IMD GFS. The system is seen crossing the coast close to Chennai at 12ooUTC on 12th December and is seen as a low over interior Tamil Nadu on 13th. Further moving westwards, it is seen as a low over EC Arabian Sea off Karnataka coast on 15th.

ECMWF: The model analysis indicates similar track intensity forecast like IMD GFS, except the fact that the system is seen crossing the coast as a Deep Depression/ CS north of Chennai between 12 and 18 UTC of 12th.

WRF: The WRF model analysis shows the SCS, crossing the coast to the north of Chennai and south of Nellore by 12th evening. The system emerges into Arabian Sea and is seen as a well marked low pressure area on 14th off the coast of Karnataka.

HWRF: The model shows the SCS crossing north Tamil Nadu coast north of Chennai by 12 UTC of 12th as SCS. Further it moves inland as a low in a WNW direction.

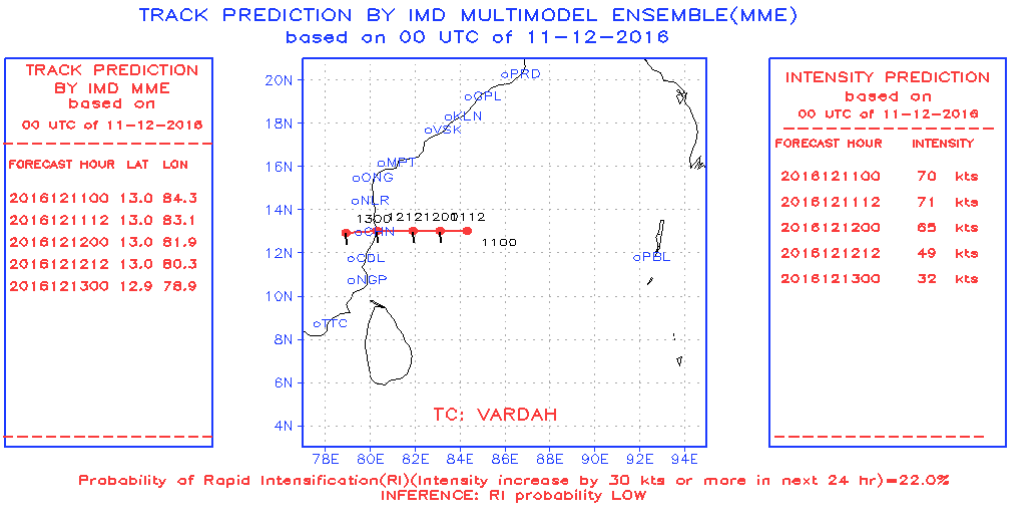
JMA: The forecast based on analysis of 00 UTC on 11th shows the cyclonic storm over SE Bay crossing south Andhra coast as a CS, between Nellore and Chennai by the morning of 12th December.

Meteo-France ARP Model: The forecast based on 00 UTC analysis of 10th December shows that the CS over SE Bay is seen to be moving westward and crossing the coast near 14 ^{0}N by afternoon of 12th December.

NCMRWF-NCUM: The NCUM track shows the SCS would weaken into a CS and would cross the coast near Nellore on 13th Dec after 1200 UTC.

IMD MME TRACK:

MME track forecast for the cyclonic storm " VARDAH" over the southeast Bay of Bengal based on 0000 UTC of 11th December 2016 shows a westward movement till 0000 UTC of the 13th. As per the MME track there is a change in the landfall point prediction and the system is likely to make landfall closer to Chennai, around 1200 UTC of 12th December 2016.



Summary and Conclusion:

Most of the models are indicating that the system have a westward/ west-southwestward track and will cross the north Tamil Nadu-south Andhra Pradesh coast by evening of 12th December. All the models are indicating the weakening of the system before crossing of the coast, however, there is variation in the landfall intensity.

Latest total precipitable water imagery indicates the reduction in feeding of warm and moist air to the core of the system from southeast direction. The vertical wind shear of horizontal wind is high around the system centre and is same along the forecast track. The high vertical wind shear and lower SST and ocean thermal energy near Andhra Pradesh and Tamil Nadu coasts will be unfavourable factors when the system reaches nearer to these coasts. It may lead to weakening of the system from today, the 11th December evening/night onwards.

Considering all the above, it is very likely that the system will cross north Tamil Nadu and south Andhra Pradesh coasts, close to Chennai as a cyclonic storm by 12th December 2016 afternoon

IOP : IOP for Andhra Pradesh and north Tamil Nadu coasts to continue on 12th December.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time(UTC)		
	10/12	11/00	11/03
India	40	36	42
Coastal stations			
WB	9	5	9
Odisha	6	6	6
AP	8	12	10
TamilNadu	10	11	10
Puducherry	1	1	1
A& N	6	1	6
Bangladesh	0	2	3
Myanmar	0	0	1
Thailand	3	3	3
SriLanka	8	7	7

AWS:

Region	Date/Time(UTC)		
	10/12	11/00	11/03
WB	7	4	4
Odisha	9	2	5
AP	5	1	1
TamilNadu	25	11	8
Puducherry	1	1	0
A& N	0	0	0

RS/RW (12Z) of 10/12/2016 : 14 /43

No. of Ascents reaching 250 hPa levels:11 , MISDA:- 3

RS/RW (00Z) of 11/12/2016 : 26 /43

No. of Ascents reaching 250 hPa levels: 18, MISDA: 5

No. of PILOT Ascents

10/12Z	11/00Z
20	7

Buoy Data

10/12Z	11/00Z	11/03Z
10	11	5

STATUS OF CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**10.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

00Z /10.12.2016 : 6

No. of Ascents reaching 250hPa level =6

MISDA :2

12Z /10.12.2016 : 2

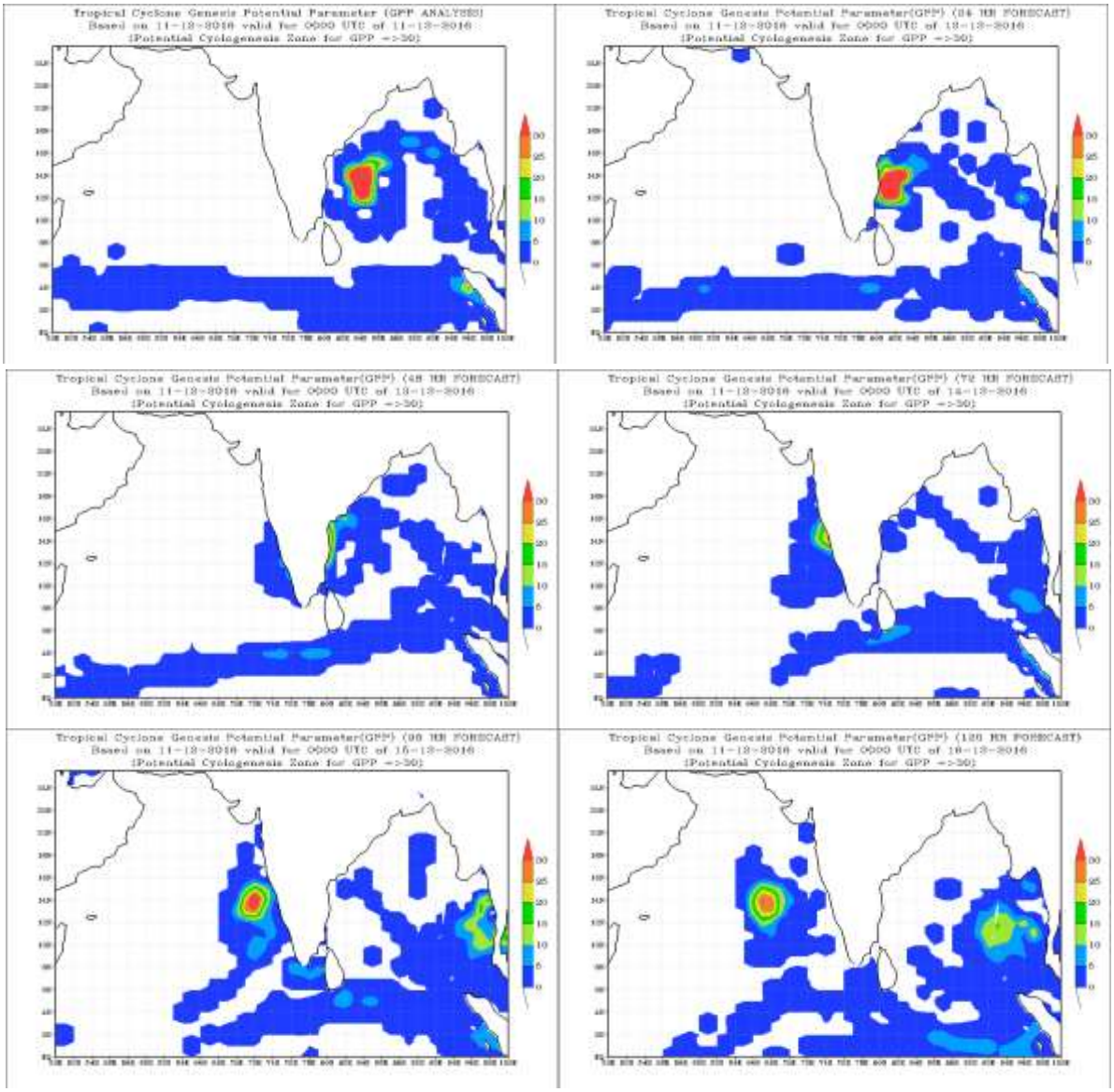
No. of Ascents reaching 250 hPa level =2

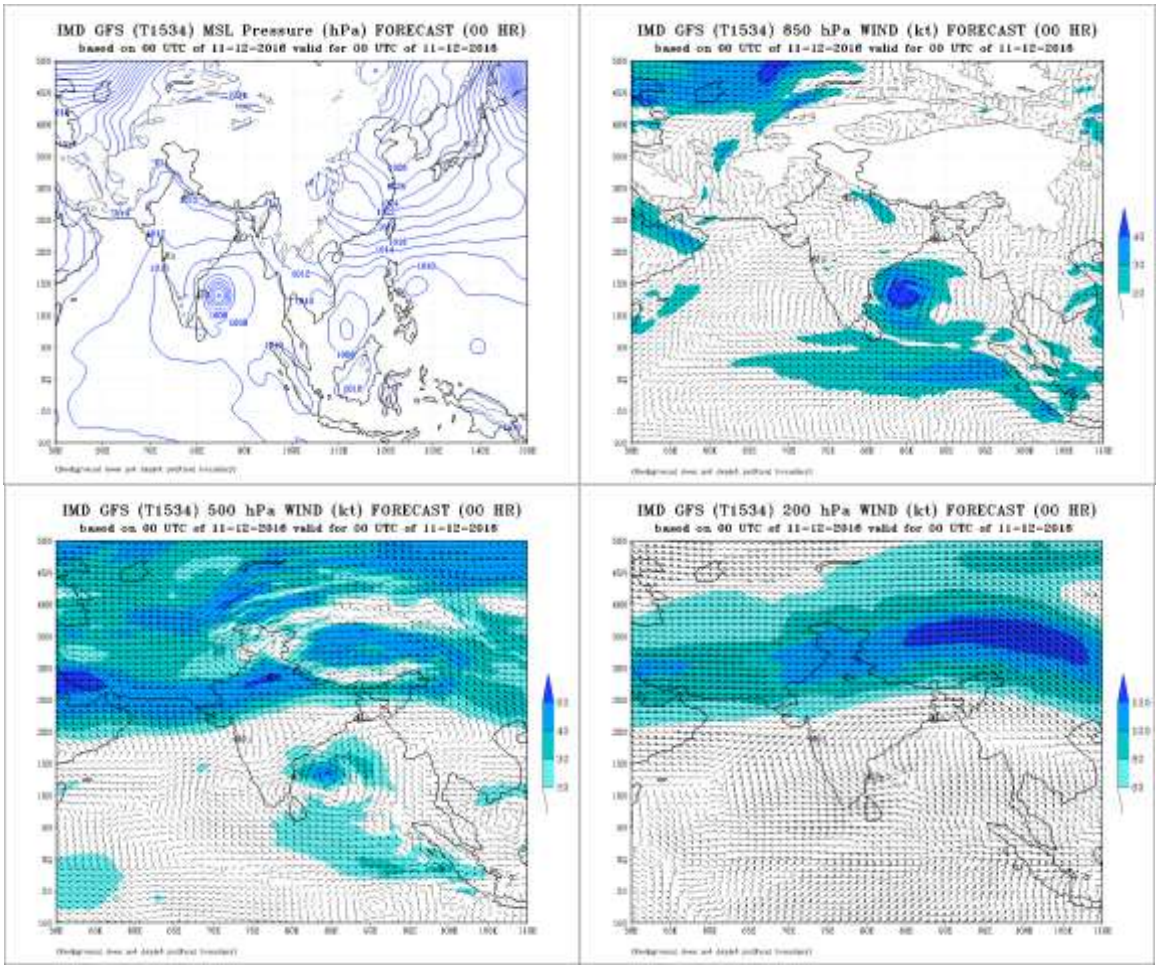
MISDA : 6

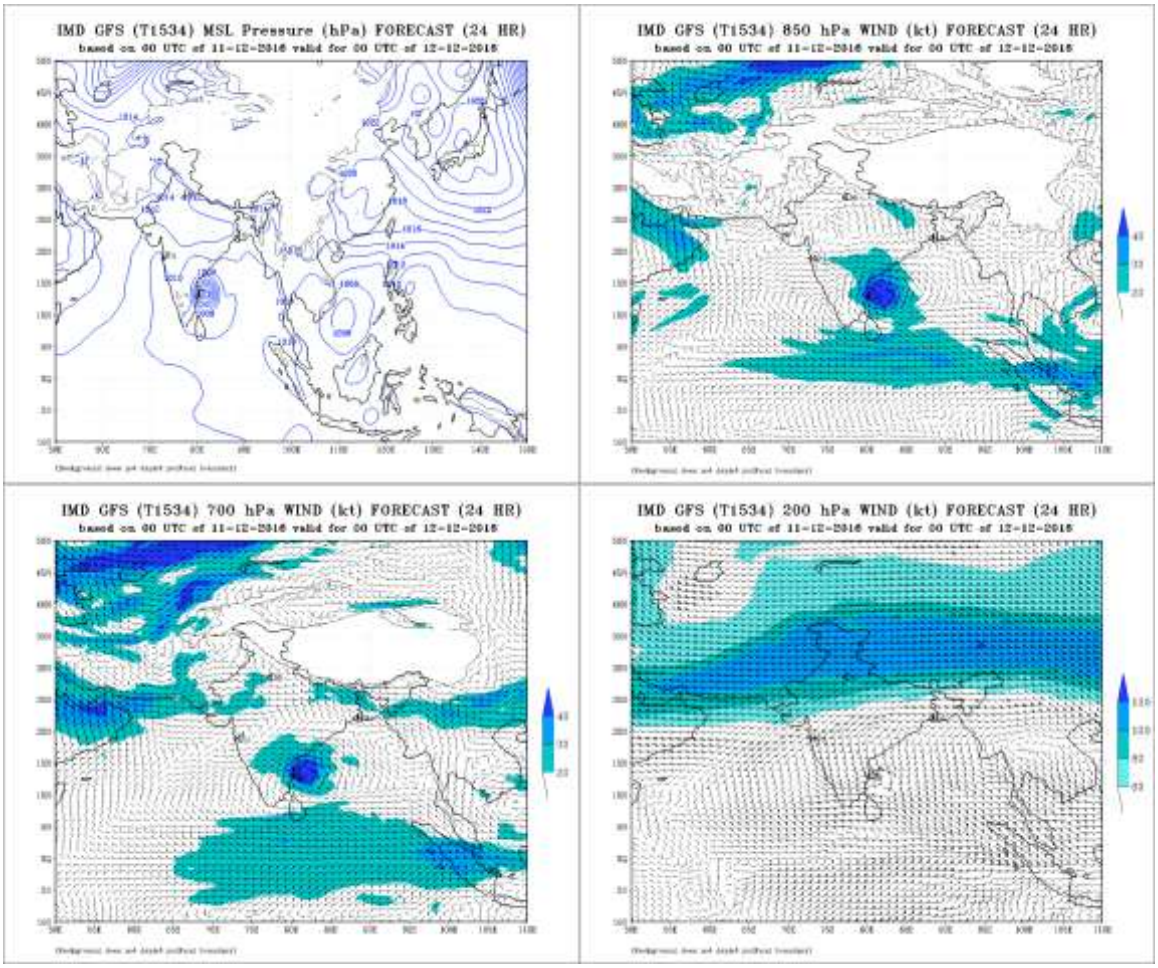
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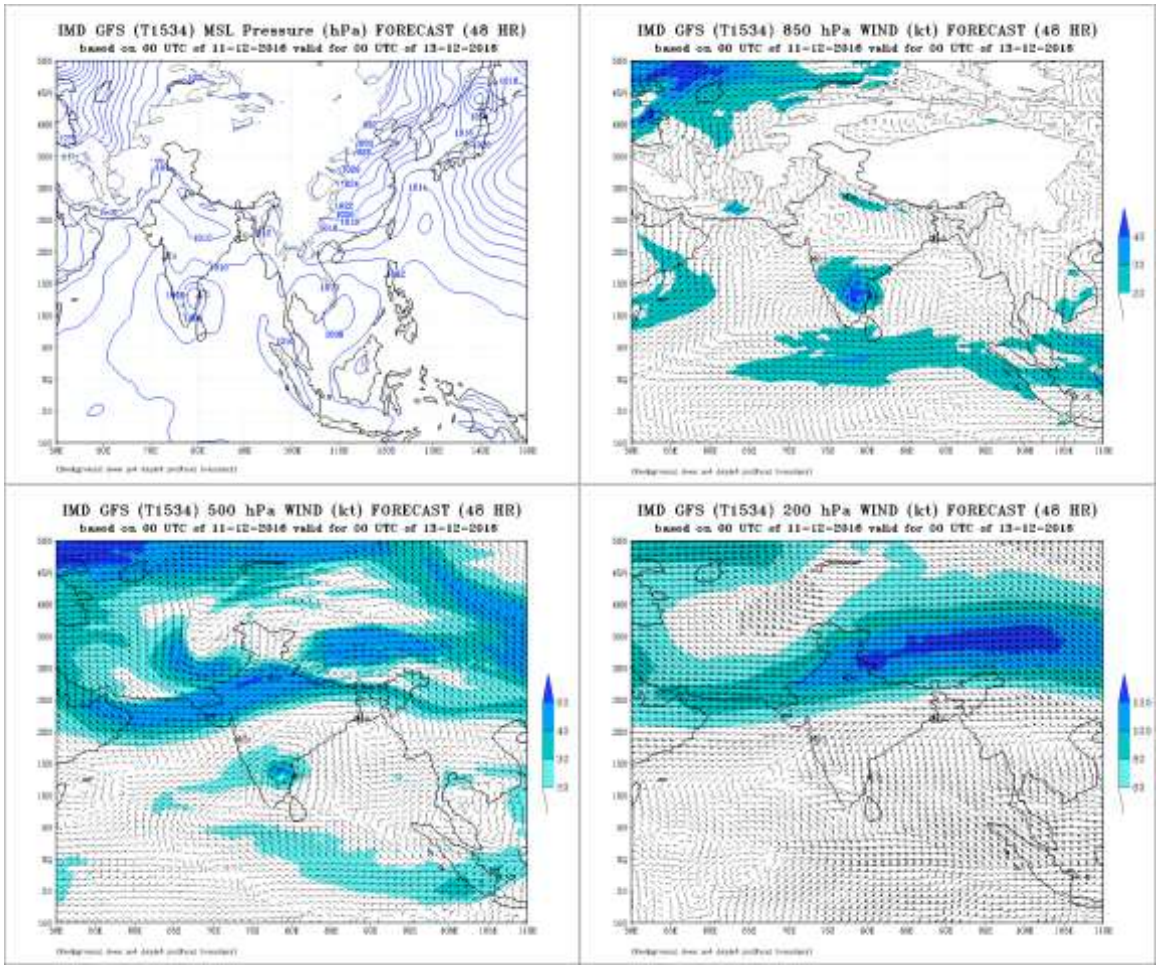
10.12.2016	
06Z	18Z
3	4

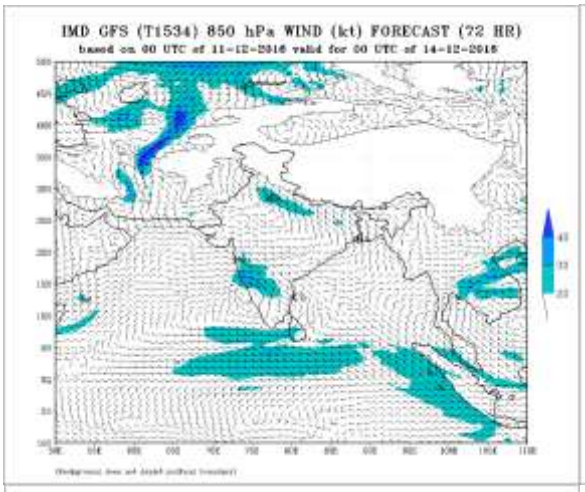
Annexure-II

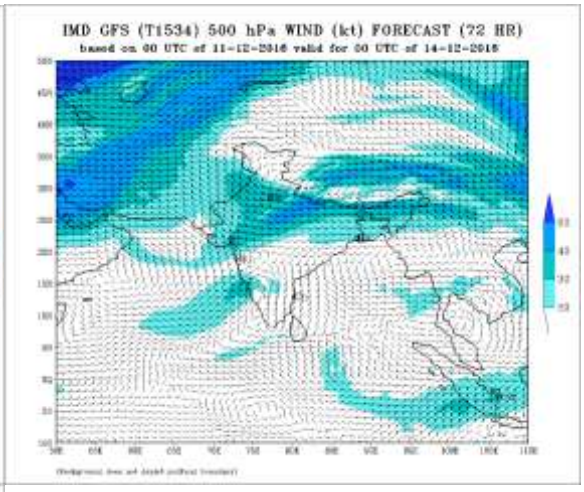

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 11-12-2016 valid for 0000 UTC of 11-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 11-12-2016 valid for 0000 UTC of 12-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 11-12-2016 valid for 0000 UTC of 13-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 11-12-2016 valid for 0000 UTC of 14-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 11-12-2016 valid for 0000 UTC of 15-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 11-12-2016 valid for 0000 UTC of 16-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

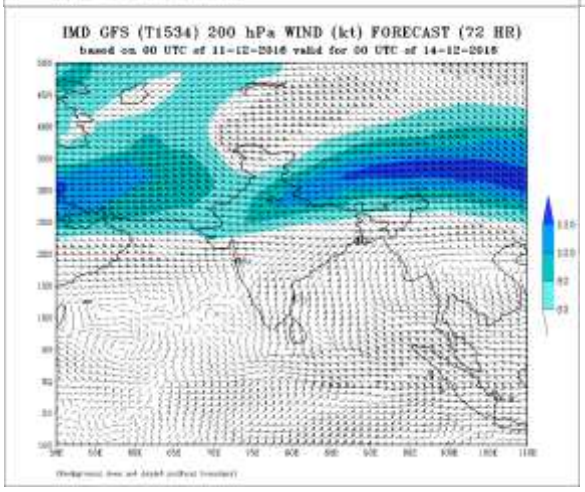

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 11-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 11-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 11-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 11-12-2016

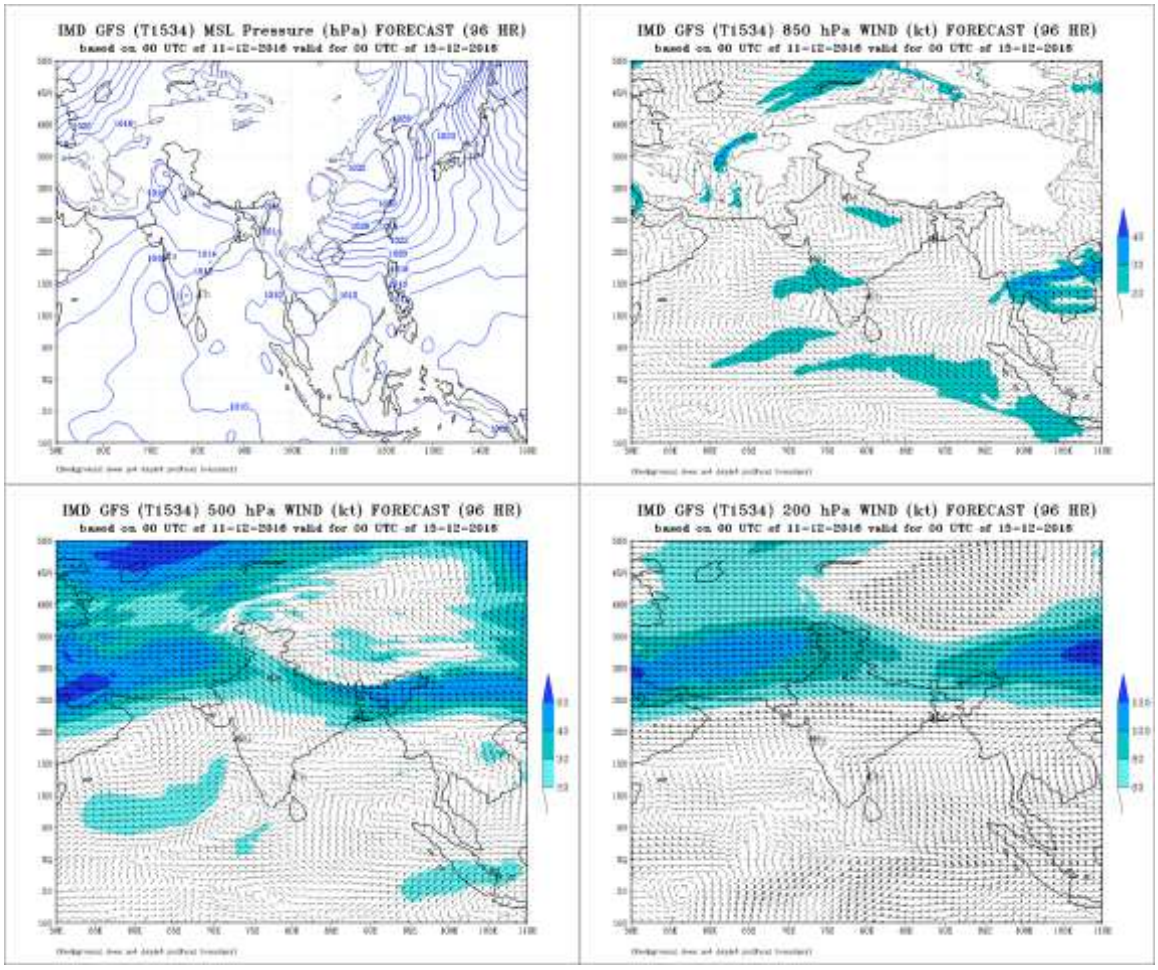

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 12-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 12-12-2016
IMD GFS (T1534) 700 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 12-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 12-12-2016

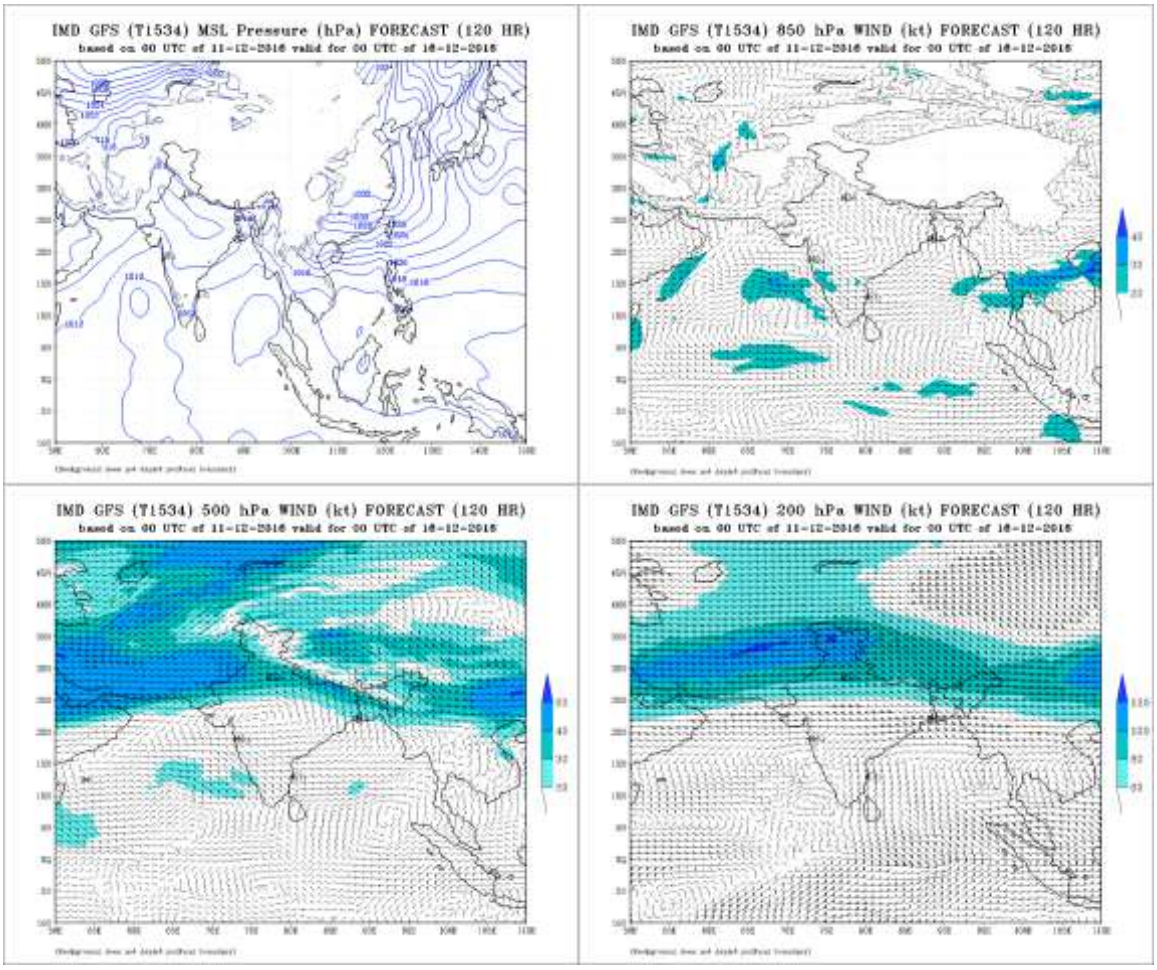

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 13-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 13-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 13-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 13-12-2016


IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 11-12-2018 valid for 00 UTC of 14-12-2018


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 11-12-2018 valid for 00 UTC of 14-12-2018


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 11-12-2018 valid for 00 UTC of 14-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 15-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 15-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 15-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 11-12-2016 valid for 00 UTC of 15-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 11-12-2018 valid for 00 UTC of 16-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 11-12-2018 valid for 00 UTC of 16-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 11-12-2018 valid for 00 UTC of 16-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 11-12-2018 valid for 00 UTC of 16-12-2018

FDP (Cyclone) NOC Report Dated 12th December 2016

Synoptic features:

The Very Severe Cyclonic Storm (VARDAH) over westcentral and adjoining southwest Bay of Bengal moved westwards and lay over the same region centred at 1730 hrs IST of yesterday, the 11th Dec. 2016 near Lat. 13.3 º N / Long. 83.0 º E, about 300 kms east of Chennai and 350 kms east -southeast of Nellore.It further moved westwards and lies over westcentral and adjoining southwest Bay of Bengal centred at 0830 hrs IST of today, the 12th Dec. 2016, near Lat. 13.2 º N / Long. 81.2 º E, about 105 kms east-northeast of Chennai. The system is very likely to continue to move nearly westwards and cross north Tamil Nadu and south Andhra Pradesh coasts, close to Chennai as a Severe Cyclonic Storm with a wind speed of 100 to 110 kmph gusting to 120 kmph by today, the 12th Dec. 2016 afternoon.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 28-29˚C around the system area. The SST decreases towards northwest and adjoining west central Bay of Bengal becoming 26-27˚C near north Andhra Pradesh.

Tropical Cyclone Heat Potential (TCHP):

The ocean heat content is about 70-80 kJ/cm^2 over the system area and gradually decreases towards northwest, becoming less than 50 kJ/cm^2 near Andhra Pradesh coast except for a small pocket of westcentral Bay off central Andhra Pradesh coast where it is 60-70 kJ/cm^2.

Relative Vorticity:

The low-level relative vorticity about 200-250 x10^{-6} s^{-1} to the south and southwest of the system centre.

Convergence:

The low level convergence is about 25-25 x10^{-6} s^{-1} to the south and southwest of the system centre.

Divergence:

The upper level divergence is around 30 x10^{-6} s^{-1} to the southwest of the system centre.

Wind Shear:

Wind shear of horizontal wind is high (20-25 kts) around the system centre and is same along the forecast track.

Wind Shear Tendency:

The wind shear tendency is neutral over the system area.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, the system intensity is T4.0. Convection shows central dense overcast (CDO) pattern. Minimum cloud top temperature (CTT) is minus 82 deg C. Associated broken low/medium clouds with embedded intense to very intense convection lie over southeast and adjoining eastcentral Bay of Bengal between 11.0 ^{0}N & 15.0^{0}N and to the west of longitude 82.0^0 E

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 17^{0}N latitude over BoB.

M.J.O. Index:

MJO index lies in Phase 4 with amplitude close1. It would move to phase during next 3 days with decreasing amplitude.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The severe cyclonic storm over SE Bay seen on the 00UTC analysis of 12th December is seen lying at 00 UTC of 12th off north Tamil Nadu and adjoining south AP coast. The

system is seen to cross the coast as weaker system north of Chennai by evening of 12th. On 13th the system is seen lying as a low over interior north TN and adjoining south AP. On 14th morning it is seen as a low off the coast of north Kerala and adjoining Karnataka coasts and is seen as a low without significant intensification in a west to west-southwestward direction and is seen over western parts of southwest Arabian Sea on 18th.

NCEP-GFS: It shows similar behavior as IMD GFS. The system is seen crossing the coast close to Chennai at 12UTC on 12th December and is seen as an extended low over interior Tamil Nadu on 13th. Further moving westwards, it is seen as a low over EC Arabian Sea off Karnataka and Kerala coasts on 14th. It is seen as a WML over Lakshadweep and adjoining SE Arabian Sea on 15th and on 16th over SE and adjoining EC Arabian Sea and as a low on 17th over SW Arabian Sea.

ECMWF: The model analysis indicates the system is seen crossing the coast close to Chennai Chennai between 12 and 18 UTC of 12th as SCS. On 13th it is seen as a low over north Tamil Nadu and adjoining Rayalaseema and becomes less marked on 14th. A low pressure area is seen over EC and adjoining SE Arabian Sea on 16th which intensifies to a DD on 17th over SW and adjoining SE Arabian Sea and further intensifies into CS with NW movement on 18th over southern parts of WC Arabian Sea.

WRF: The WRF model analysis shows the SCS, crossing the coast to the north of Chennai and south of Nellore by 12th evening. The system emerges into Arabian Sea and is seen as a well marked low pressure area on 14th off the coast of Karnataka and a depression on 15th over northern parts of SE Arabian Sea.

HWRF: The model shows the SCS crossing north Tamil Nadu coast north of Chennai by 12 UTC of 12th as SCS. Further it moves inland as a low in a WNW direction and emerges into Arabian Sea by 00UTC of 14th.

NCMRWF-NCUM: The NCUM forecast show VSCS would track towards Nellore and cross coast in the afternoon on 13th Dec 2016 and becomes a low over interior parts of south penionsula on 14th and becomes less marked on 15th

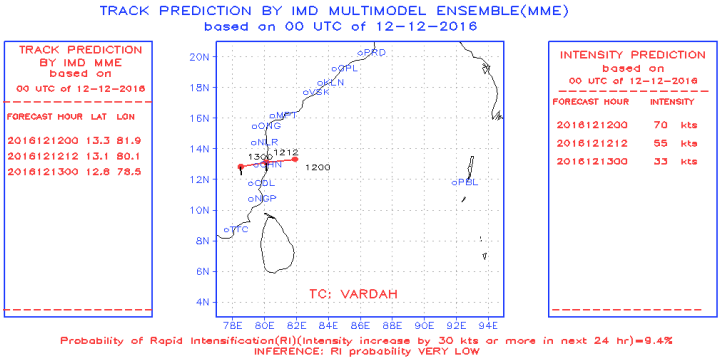
NCUM- Reg 4KM: The system is seen crossing coast as SCS by evening of 13th and became lessmarked by 15th.

NEPS: The model forecast shows that the system is seen weakening into a low on 15th and crosses coast as a low by 15th evening.

IMD GPP: The GPP analysis and forecast fields show that the significant zone of GPP over SW Bay off north Tamil Nadu and adjoining south Andhra coast crosses coast on 12th and emerges into Arabian sea off Karnataka coast on 15th and moves westward till 19th and it is seen close to Somali peninsula on 19th.

IMD MME TRACK:

MME track forecast for the cyclonic storm " VARDAH" over the southeast Bay of Bengal based on 0000 UTC of 12th December 2016 shows a west-southwestward movement till 0000 UTC of the 13th. As per the MME track the system will make landfall close to Chennai, around 1200 UTC of 12th December 2016.



Summary and Conclusion:

Most of the models are indicating that the system cross the north Tamil Nadu-south Andhra Pradesh coast by evening of 12th December except NCUM and its ensemble and regional models. All the models are indicating the weakening of the system before crossing of the coast.

The high vertical wind shear and lower SST and ocean thermal energy near Andhra Pradesh and Tamilnadu coasts will be unfavourable factors when the system reaches nearer to these coasts. It may lead to slight weakening of the system before landfall.

Considering all the above, it is very likely that the system will cross north Tamil Nadu and south Andhra Pradesh coasts, close to Chennai as a cyclonic storm by 12th December 2016 afternoon.

Majority of the models indicate emergence of the system into Arabian Sea on and reorganization into a WML to CS intensity. IMD GPP forecast also indicates a significant zone over Arabian Sea till 19th. Hence the emergence and re-intensification of the system over Arabian Sea needs to be monitored.

IOP : No IOP for the next 5 days.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	11/12	**12/00**	**12/03**
India	41	31	44
Coastal stations			
WB	8	3	7
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	2	2
Myanmar	0	1	0
Thailand	3	3	3
Sri Lanka	5	7	8

AWS:

Region	Date/Time (UTC)		
	11/12	**12/00**	**12/03**
WB	6	3	2
Odisha	5	3	4
AP	7	2	5
Tamil Nadu	25	11	18
Puducherry	1	1	1
A & N	0	0	0

RS/RW (12Z) of 11/12/2016 : 13 /43

No. of Ascents reaching 250 hPa levels:11 , MISDA:- 5

RS/RW (00Z) of 12/12/2016 : 23 /43

No. of Ascents reaching 250 hPa levels: 19, MISDA: 3

No. of PILOT Ascents

11 /12Z	12/00Z
18	6

Buoy Data

11/12Z	12/00Z	12/03Z
12	11	6

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**11.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

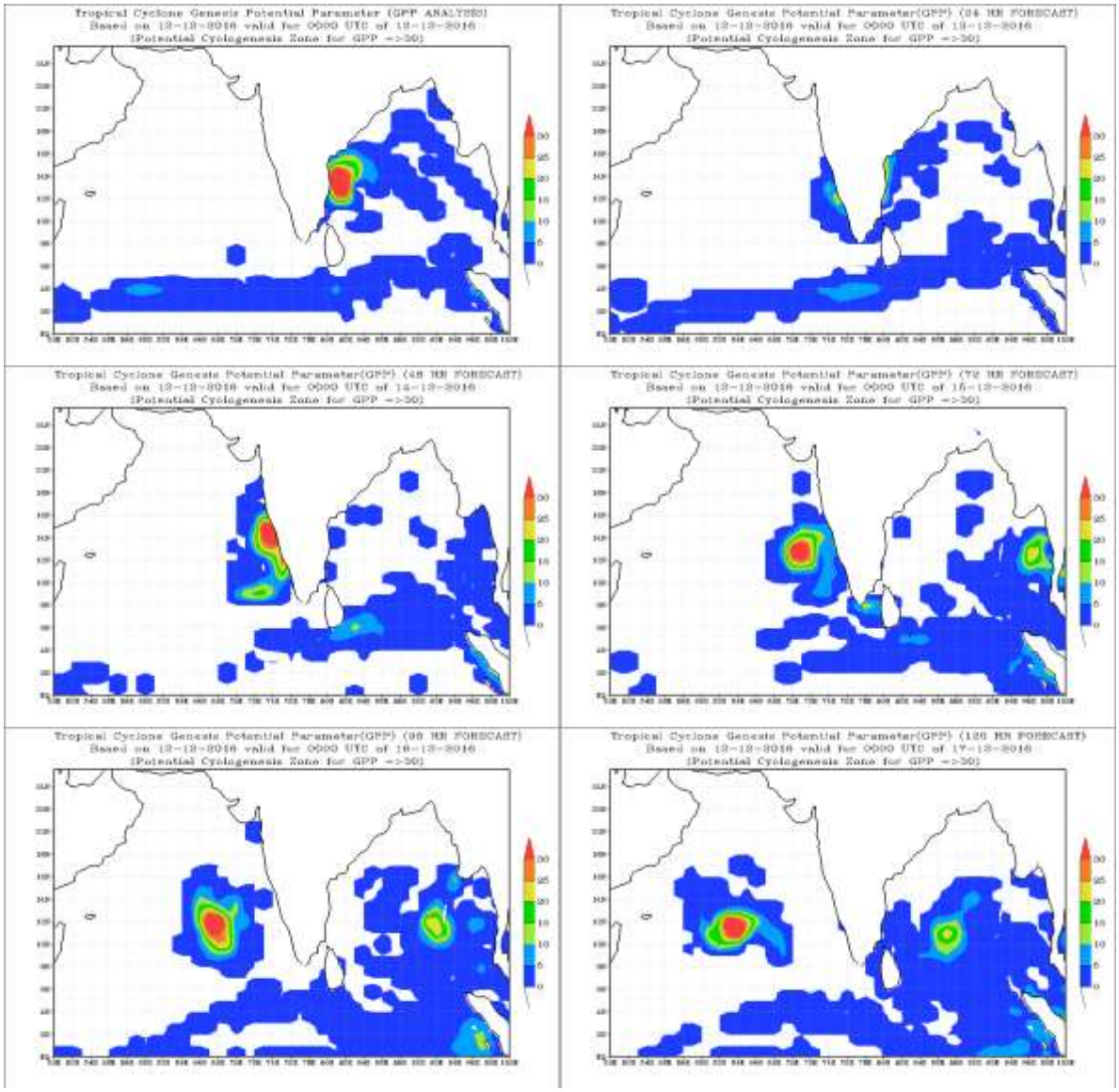
00Z /11.12.2016 : 5
No. of Ascents reaching 250hPa level =5
MISDA :3

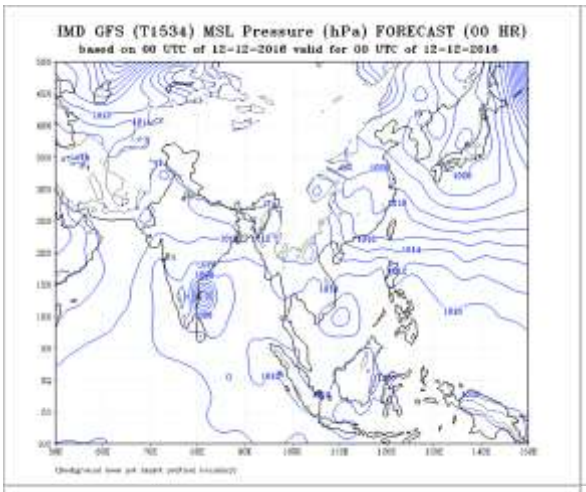
12Z /11.12.2016 : 1
No. of Ascents reaching 250 hPa level =1
MISDA : 7

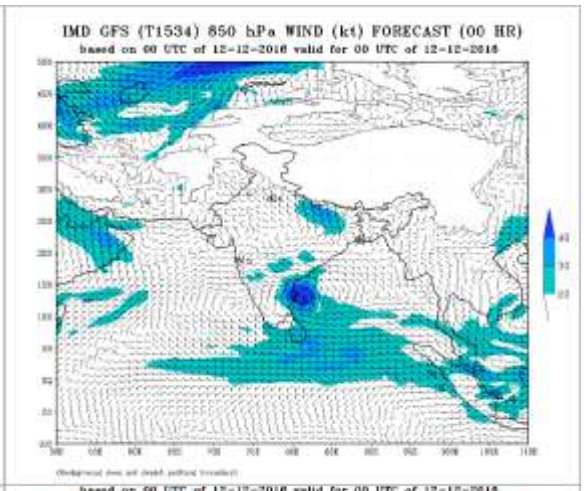
No. of PILOT Ascents:

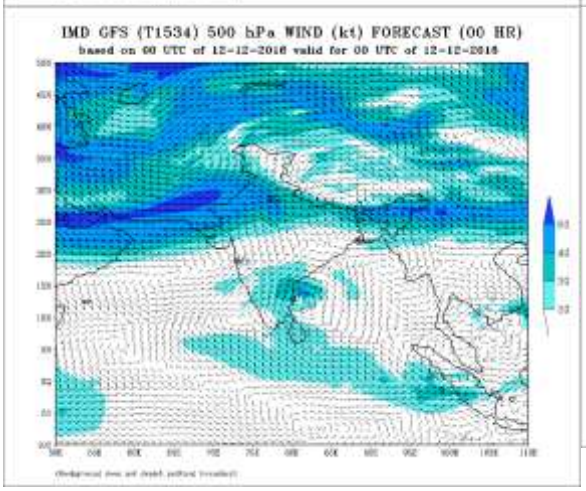
11.12.2016	
06Z	18Z
2	3

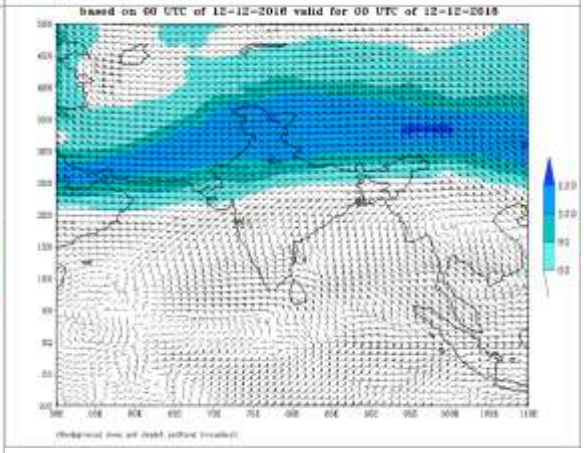
Annexure-II

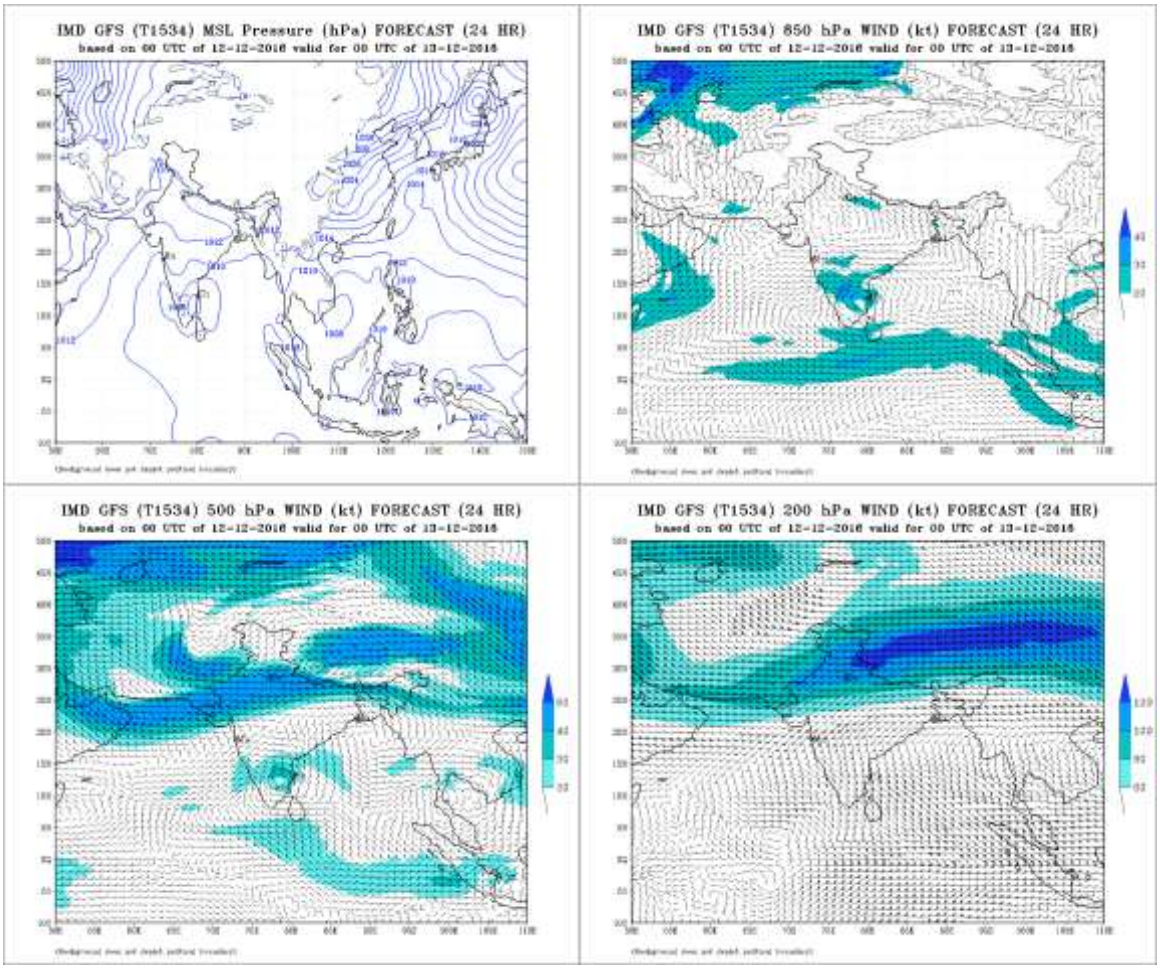

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(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 13-12-2016 valid for 0000 UTC of 17-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 13-12-2016 valid for 0000 UTC of 18-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

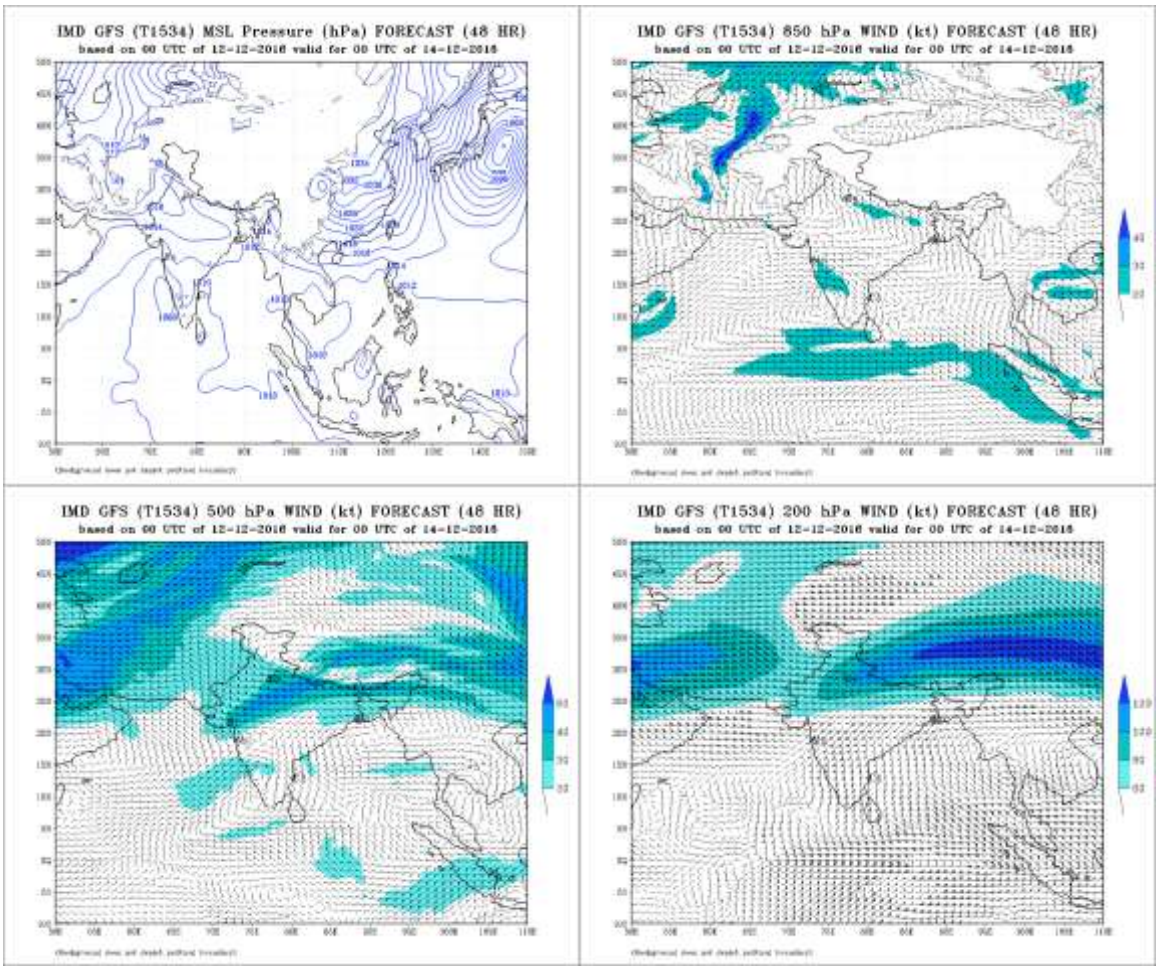

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
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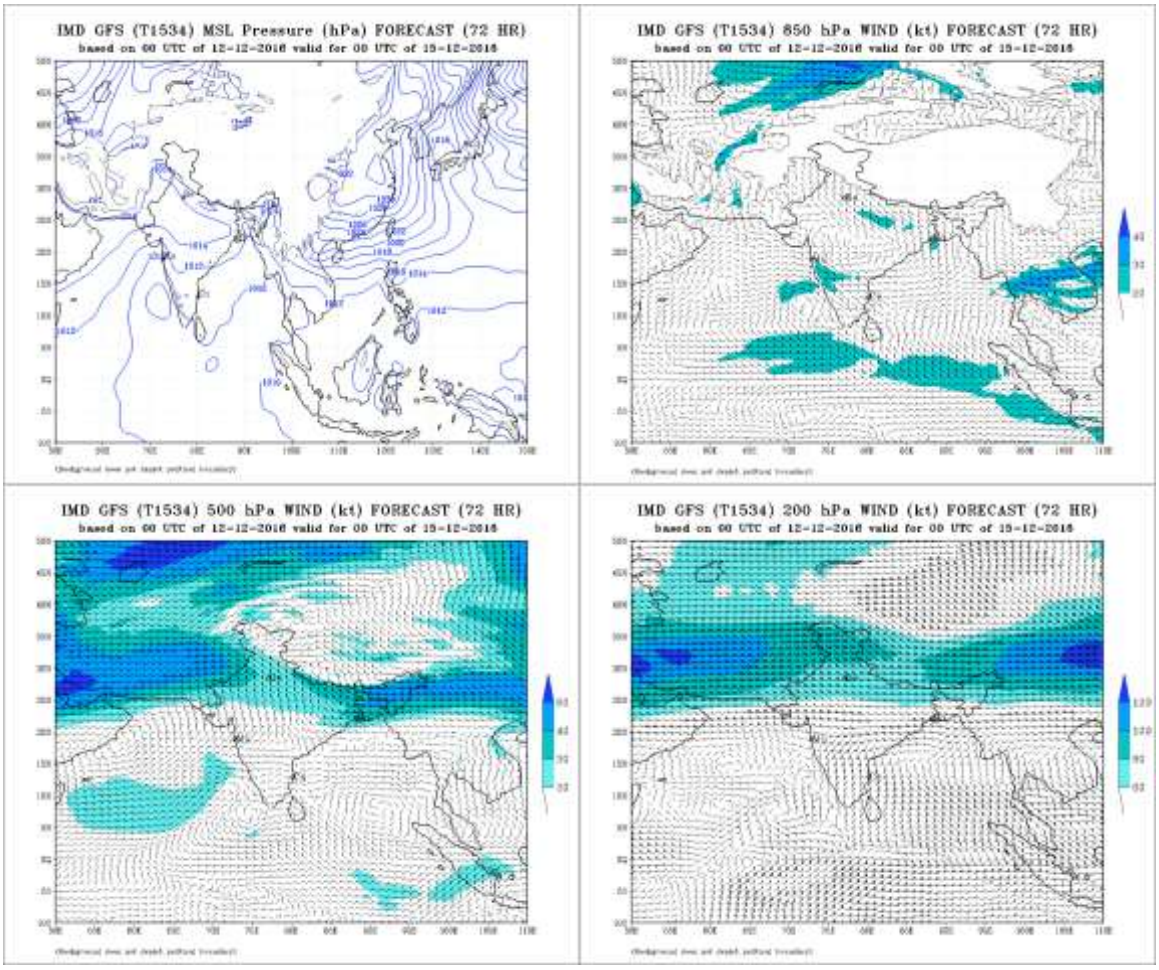

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 12-12-2016

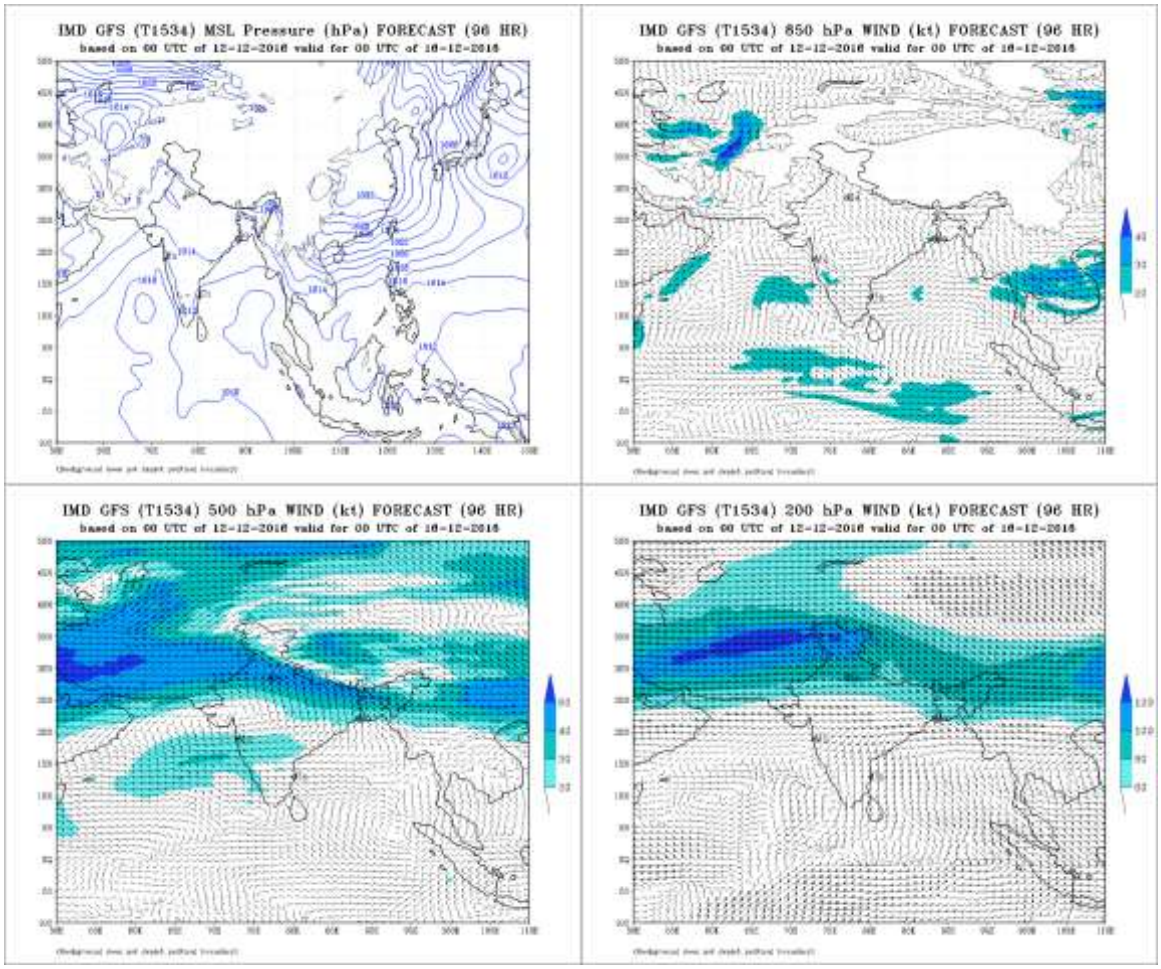

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 12-12-2016

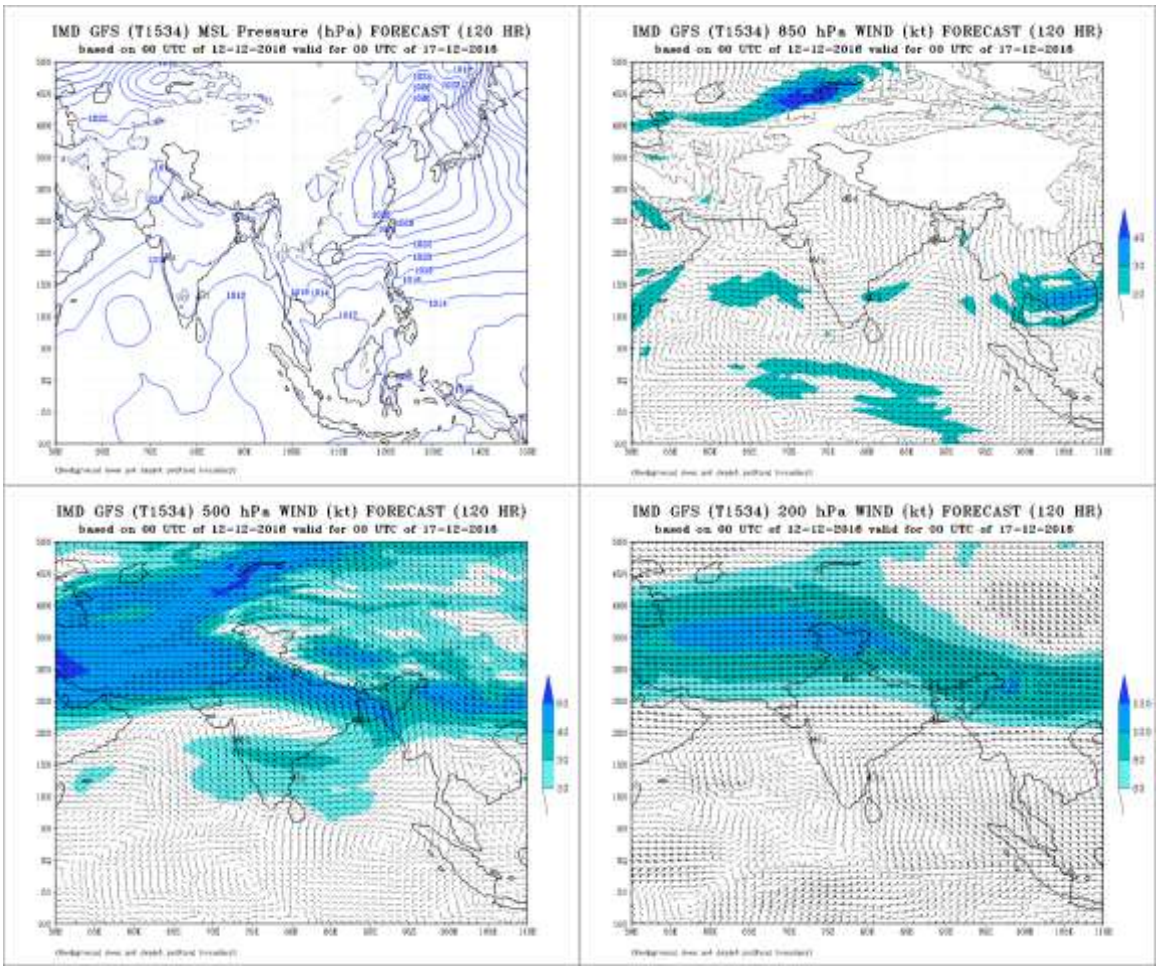

based on 00 UTC of 12-12-2016 valid for 00 UTC of 12-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 13-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 13-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 13-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 13-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 12-12-2018 valid for 00 UTC of 14-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 12-12-2018 valid for 00 UTC of 14-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 12-12-2018 valid for 00 UTC of 14-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 12-12-2018 valid for 00 UTC of 14-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 12-12-2018 valid for 00 UTC of 15-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 12-12-2018 valid for 00 UTC of 15-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 12-12-2018 valid for 00 UTC of 15-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 12-12-2018 valid for 00 UTC of 15-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 16-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 16-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 16-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 16-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 12-12-2016 valid for 00 UTC of 17-12-2016

FDP (Cyclone) NOC Report Dated 13th December 2016

Synoptic features:

The Very Severe Cyclonic Storm, VARDAH over west central & adjoining southwest Bay of Bengal moved nearly westwards, weakened into a Severe Cyclonic Storm at 1430 hrs IST of yesterday, the 12th Dec 2016, near Lat. 13.1º N / Long.80.3º E close to Chennai Coast. It further moved nearly westwards, crossed north Tamil Nadu Coast close to Chennai between 1500-1700 hrs IST of yesterday, the 12th Dec. 2016 as a Severe Cyclonic Storm and lay centred at 1730 hrs IST of yesterday, the 12th Dec. 2016 over north Tamil Nadu near Lat. 13.0ºN / Long. 79.9ºE, about 40 kms west of Chennai. It continued to move westwards and weakened into a Cyclonic Storm at 2030 hrs IST of yesterday, near Lat. 12.9ºN / Long. 79.5ºE, about 40 kms east of Vellore and 80 kms west-southwest of Chennai. It continued to move westwards, weakened into a Deep Depression and lay centred at 2330 hrs IST of yesterday, the 12th Dec. 2016 over north interior Tamil Nadu near Lat. 12.7º N / Long. 79.1º E, about 25 kms southeast of Vellore and 60 kms of east-northeast of Tiruppattur. It move westsouthwestwards, weakened into a Depression and lay centred at 0530 hrs IST of today, the 13th Dec. 2016 over north interior Tamil Nadu near Lat. 12.5º N / Long. 78.0º E, about 50 kms west of Tiruppattur. It further moved westwards, weakened into a Well marked low pressure area over north interior Tamil Nadu and adjoining south interior Karnataka at 0830 hrs IST of today, the 13th Dec. 2016. Associated cyclonic circulation extends upto 9.5 kms a. s. l.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 28-29˚C around the system area. The SST decreases towards northwest and adjoining west central Bay of Bengal becoming 26-27˚C near north Andhra Pradesh. It is around 28-30 over SE and adjoining C Arabian Sea.

Tropical Cyclone Heat Potential (TCHP):

The ocean heat content is about 70-80 kJ/cm^2 over the system area and gradually decreases towards northwest, becoming less than 50 kJ/cm^2 near Andhra Pradesh coast except for a small pocket of westcentral Bay off central Andhra Pradesh coast where it is 60-70 kJ/cm^2.

Relative Vorticity:

The low-level relative vorticity about 125 x10^{-6} s^{-1} seen over south peninsular region.

Convergence:

Low level convergence about 5-10 x10^{-6} s^{-1} is seen over south peninsula and adjoining EC Arabian Sea.

Divergence:

There are no significant zones of upper level divergence over Bay of Bengal as well as in Arabian Sea.

Wind Shear:

Low to moderate wind shear of horizontal wind is seen over central Bay of Bengal which is seen continuing over central Arabian Sea as well.

Wind Shear Tendency:

Decreasing wind shear tendency is seen over southern parts of BoB as well over Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low/medium clouds with embedded isolated weak to moderate convection is seen over westcentral Bay of Bengal off AP- Tamil Nadu coasts and over Andaman Sea.

Arabian Sea

Scattered low/medium clouds with embedded weak to moderate convection is seen over southeast Arabian Sea off Karnataka-Kerala coasts and also over Comorin Area.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 18^0N latitude over BoB.

M.J.O. Index:

MJO index lies in Phase 4 with amplitude close1. It would move to phase during next 3 days with decreasing amplitude.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The analysis of 00UTC on 13th December is indicates the presence of a low pressure area over interior north TN and adjoining south AP., which is seen moving in westerly direction and on 14th morning it is seen as a low off the coast of north Kerala and adjoining Karnataka coasts and over Lakshadweep and adjoining EC Arabian Sea on 15th and became less marked on 16th .

NCEP-GFS: It shows similar behavior as IMD GFS. The low becomes well marked on 15th over Lakshadweep and adjoining EC Arabian Sea on 15th and further weakened to a low on 16th and continued its westward travel.

ECMWF: The model analysis on 13th indicates a low over north Tamil Nadu and adjoining south Karnataka which and becomes less marked on 14th. A low pressure area is seen over EC and adjoining SE Arabian Sea on 15th which intensifies to a D on 17th over SW and adjoining SE Arabian Sea and further intensifies into CS over SW Arabian Sea on 18th.

WRF: The WRF model analysis on 13th a well marked low pressure area over South Karnataka and adjoining Tamil Nadu, which on 14th is seen as a low off the coast of Karnataka and over SE Arabian Sea and adjoining Lakshadweep area on 15th.

IITM GEFS: The forecast based on 13th December analysis shows a low pressure area off the coasts of Karnataka and adjoining Kerala on 14th which moves in a WSW direction till 16th and becomes less marked thereafter.

IMD GPP: The GPP analysis and forecast fields show a significant zone of GPP over Arabian Sea off Karnataka coast on 14th which moves west-southwestward till 19th and it is seen close to Somali peninsula on 19th.

Summary and Conclusion:

Most of the models are indicating that the remnant of system which crossed the north Tamil Nadu-south Andhra Pradesh on 12th December to move across the south peninsula as a low/ well marked low and emerge into Arabian Sea on 14th as a low. Majority models are showing the low to take a west-southwestward movement over Arabian Sea till16th without significant intensification, except ECMWF model, which shows the system to intensify into a cyclonic storm on 18th over SW Arabian Sea. IMD GPP forecast also indicates a significant zone (>30) over Arabian Sea which moves till 19th in a west-southwestward direction.

Hence the emergence and re-intensification of the system over Arabian Sea needs to be monitored.

IOP : No IOP for the next 5 days.

Annexure-I

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**12.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**19**	**20**	**20**

No. of RS/RW Ascents

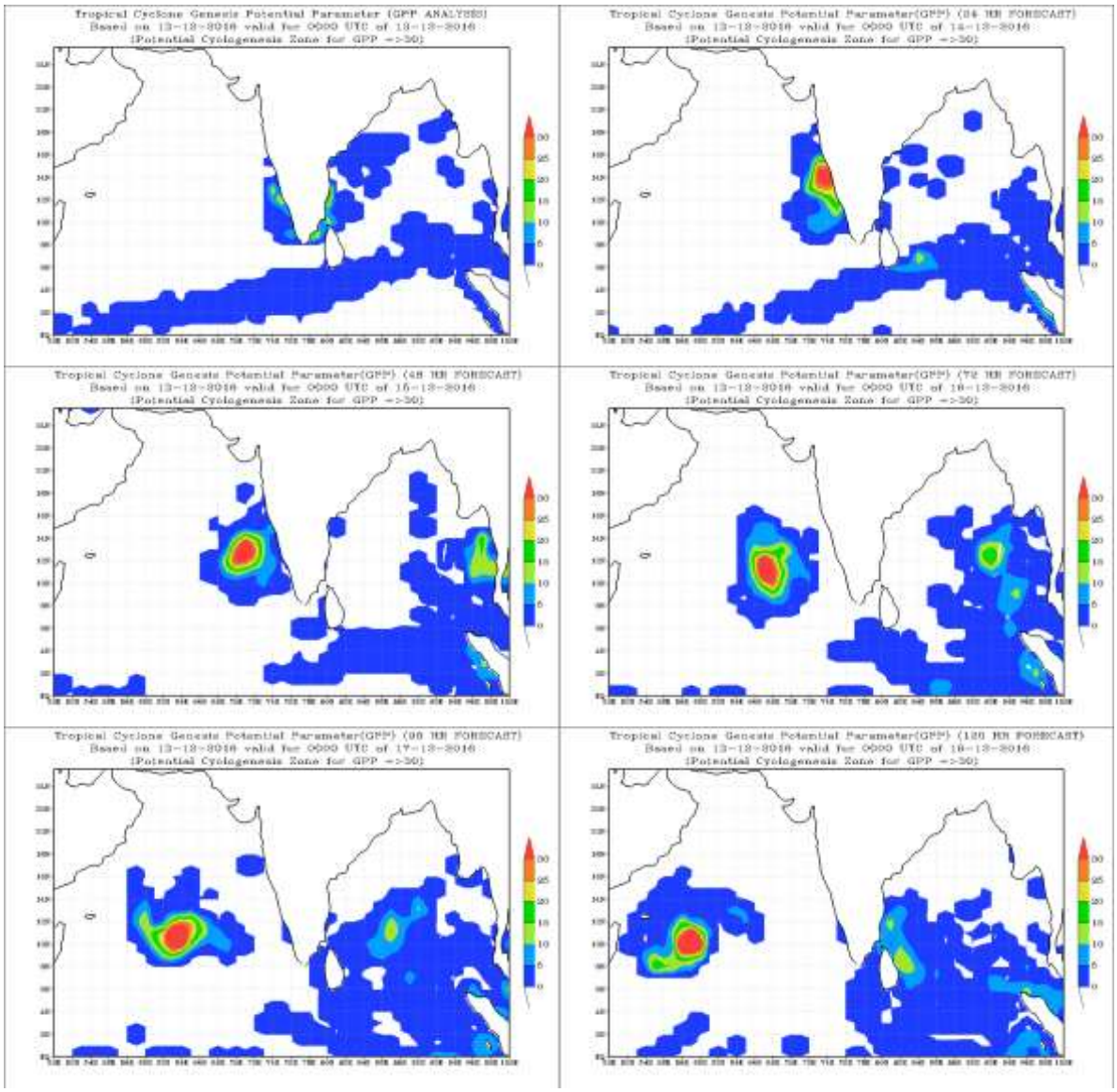
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MISDA :2

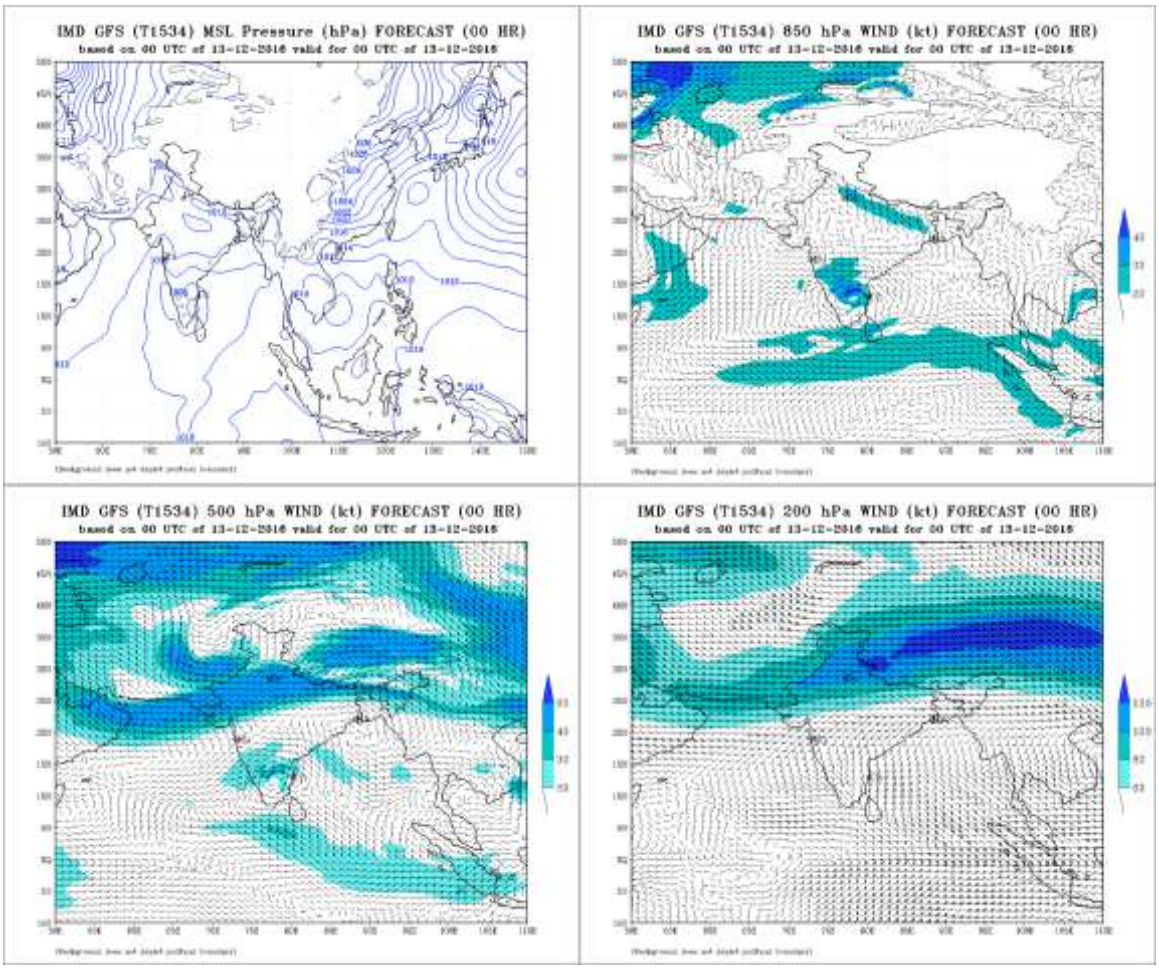
12Z /12.12.2016 : 2
No. of Ascents reaching 250 hPa level =2
MISDA : 6

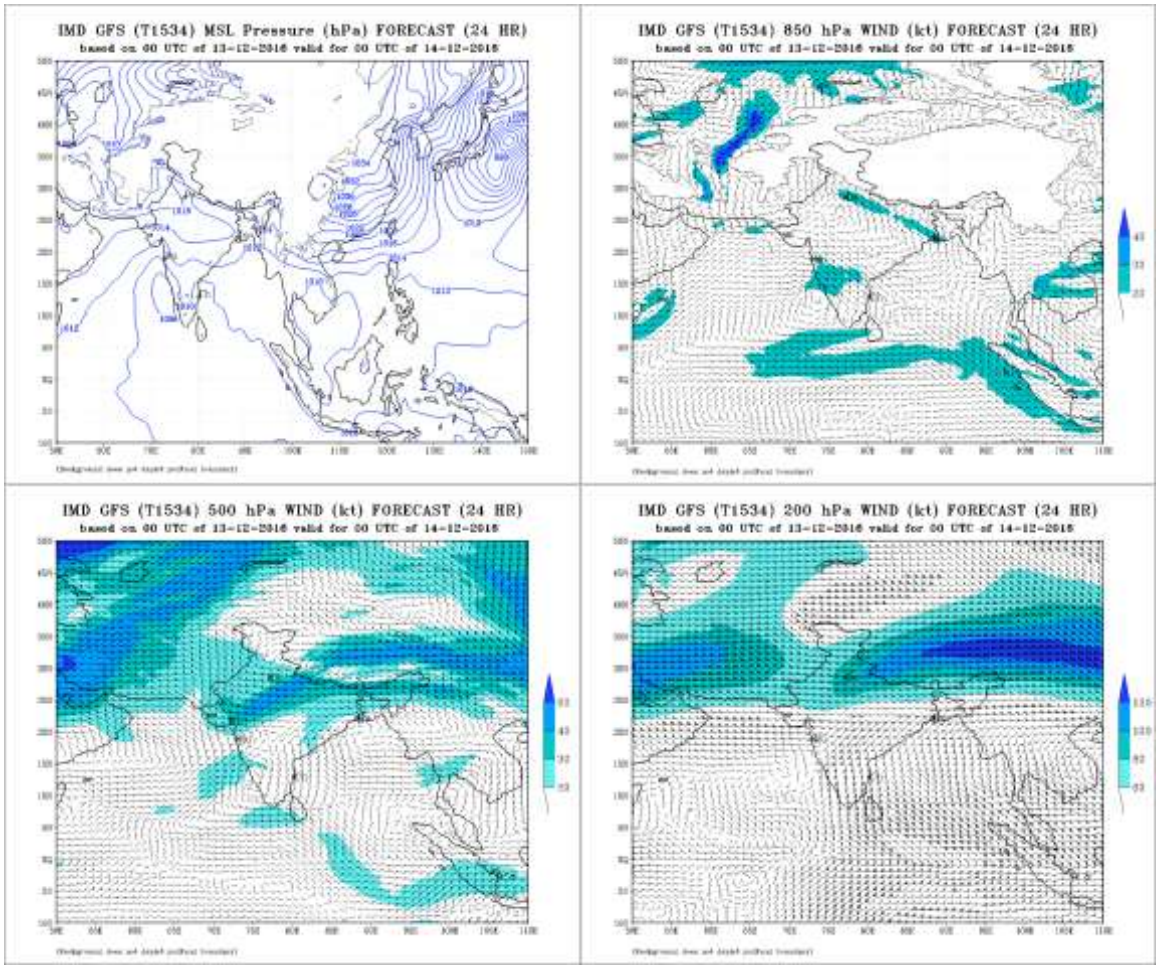
No. of PILOT Ascents:

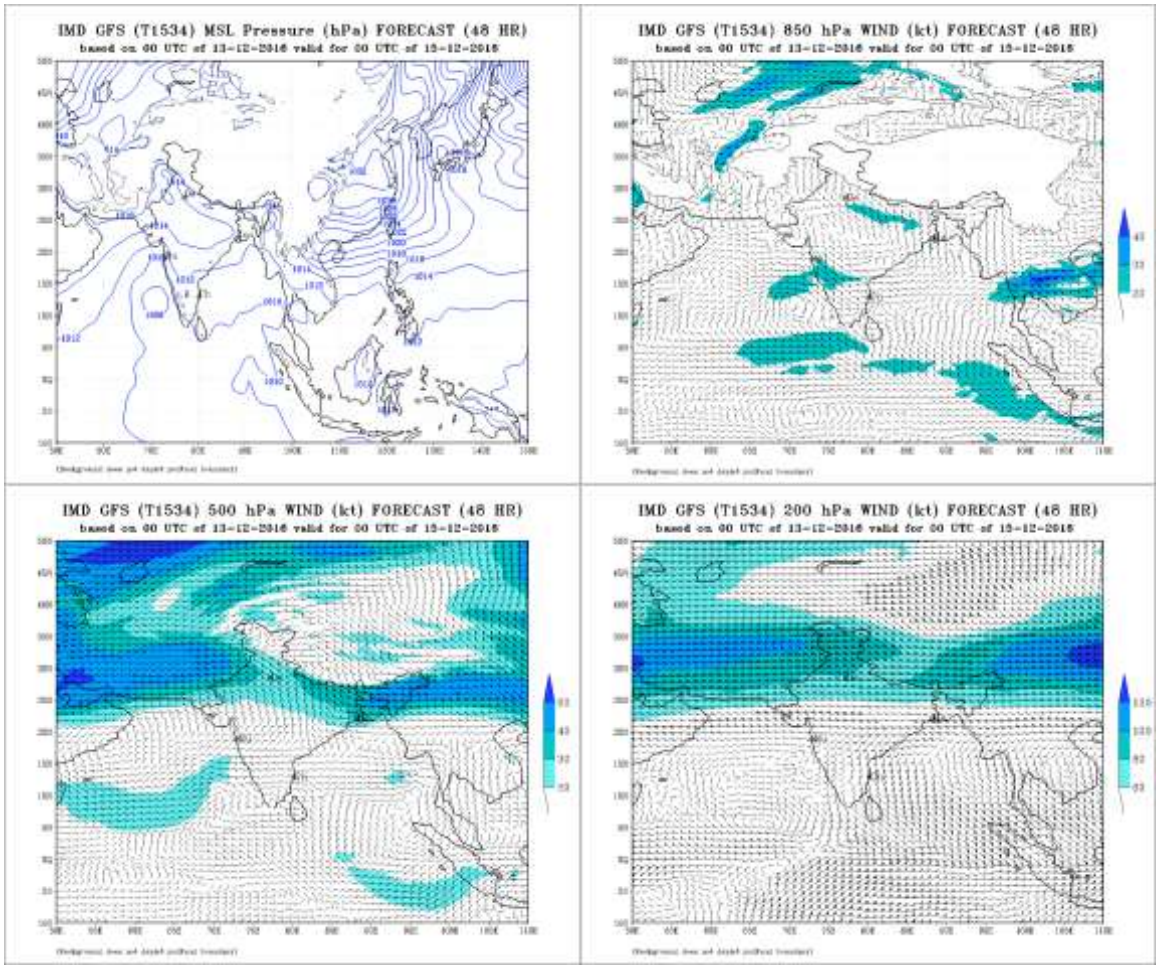
12.12.2016	
06Z	18Z
3	1

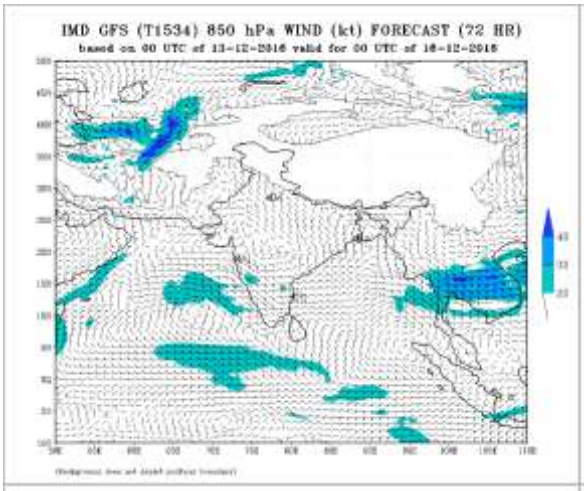
Annexure-II

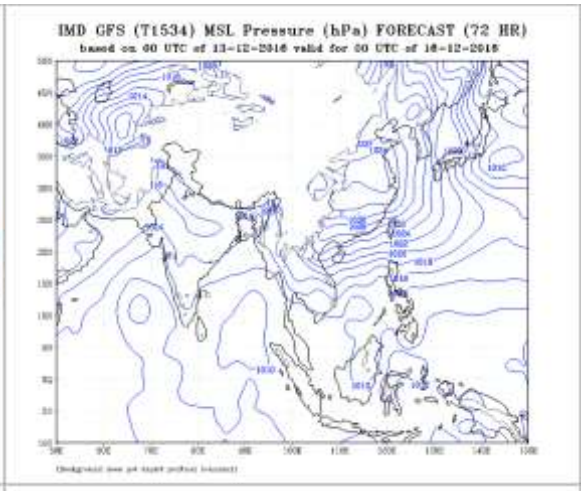

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 13-10-2016 valid for 0000 UTC of 13-10-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 13-10-2016 valid for 0000 UTC of 14-10-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 13-10-2016 valid for 0000 UTC of 15-10-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 13-10-2016 valid for 0000 UTC of 16-10-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 13-10-2016 valid for 0000 UTC of 17-10-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 13-10-2016 valid for 0000 UTC of 18-10-2016
(Potential Cyclogenesis Zone for GPP =>50)

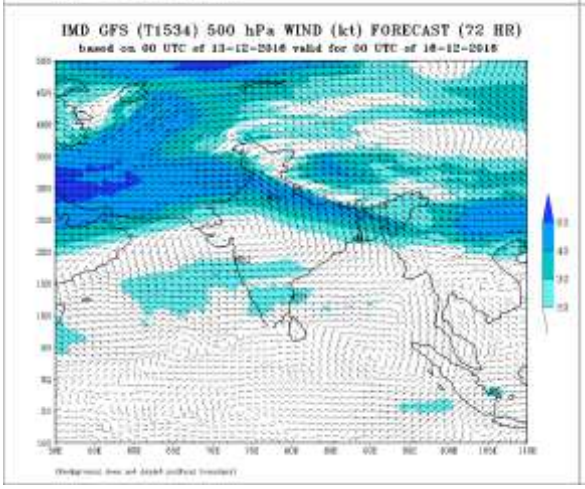

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 13-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 13-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 13-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 13-12-2018

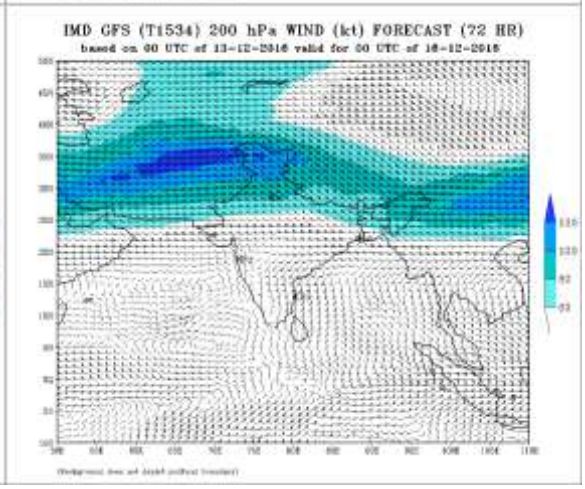

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 14-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 14-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 14-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 14-12-2018

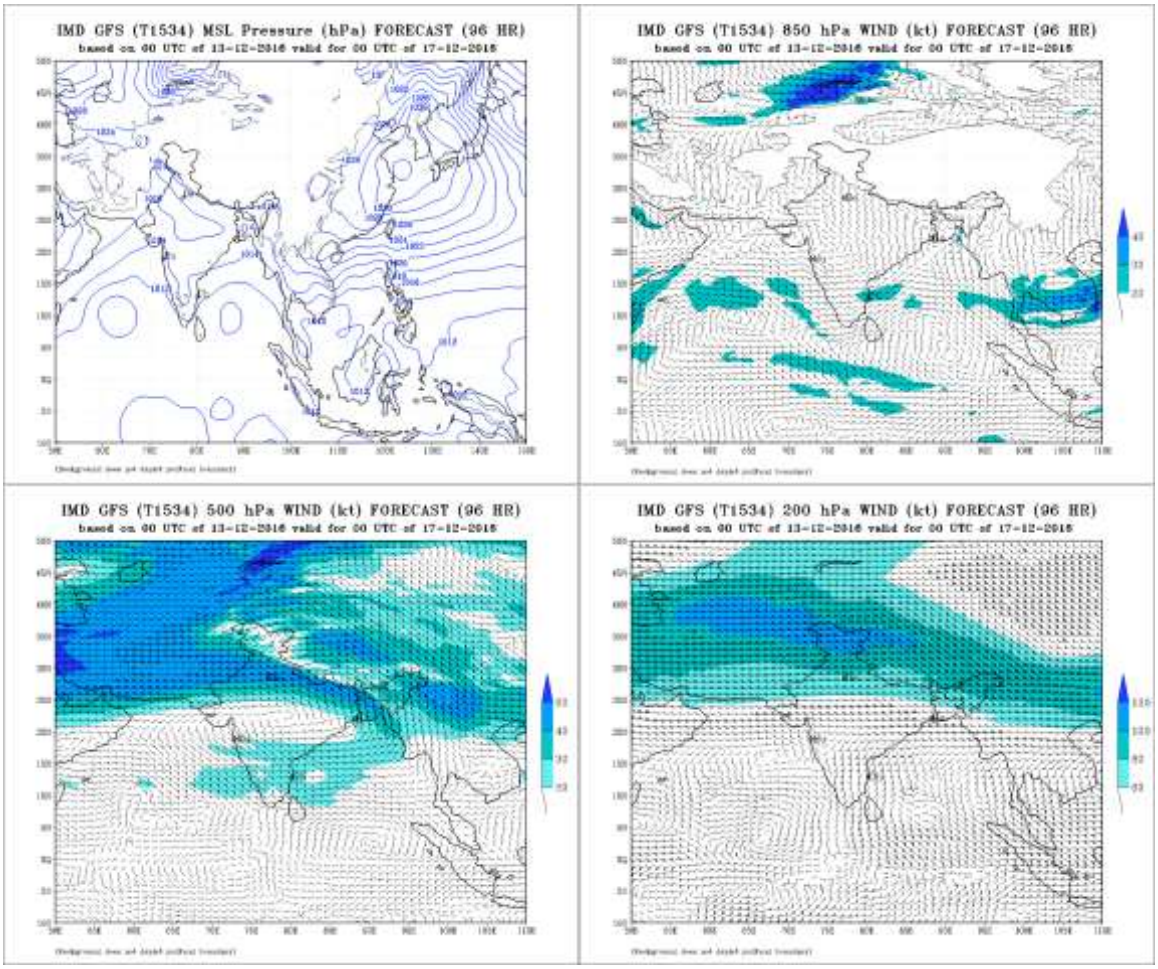

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 15-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 15-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 15-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 15-12-2016

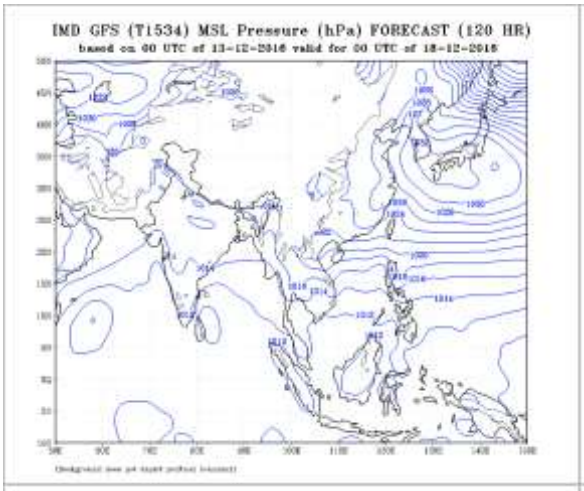

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 16-12-2016

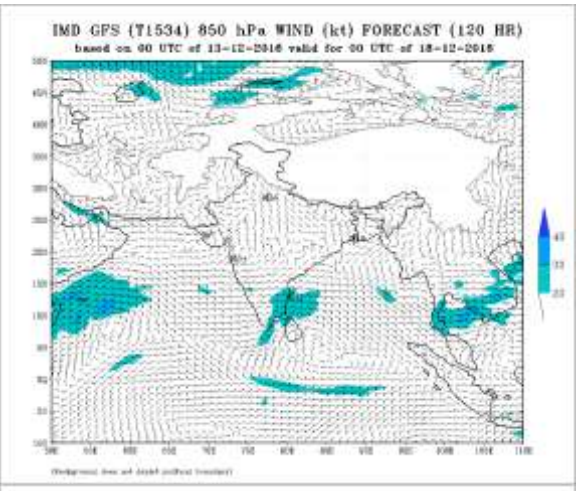

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 16-12-2016

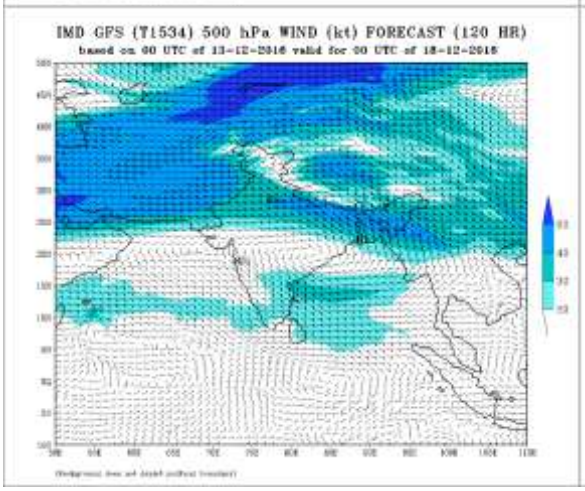

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 16-12-2016

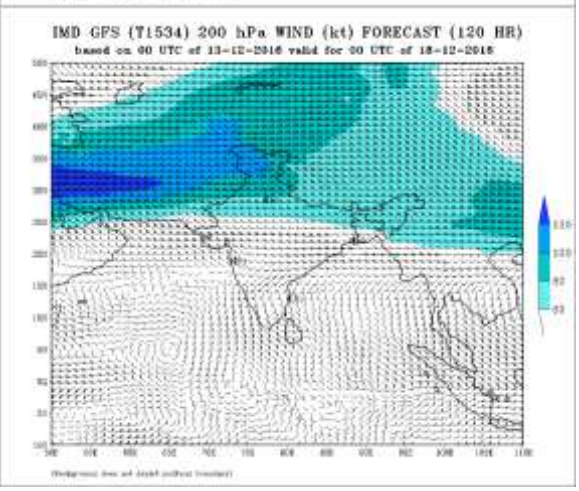

IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 16-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 13-12-2016 valid for 00 UTC of 17-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 18-12-2018


IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 18-12-2018


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 18-12-2018


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 13-12-2018 valid for 00 UTC of 18-12-2018

FDP (Cyclone) NOC Report Dated 14th December 2016

Synoptic features:

The low pressure area over southeast Arabian Sea and adjoining south Karnataka and Kerala now lies over southeast Arabian sea & adjoining Coastal Karnataka and Kerala. The associated upper air cyclonic circulation now extends upto 7.6 km above mean sea level.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 27-29˚C over most parts of Bay of Bengal. It is around 28-30 over SE and adjoining EC Arabian Sea. It decreases to north.

Tropical Cyclone Heat Potential (TCHP):

The ocean heat content is about 70-100 kJ/cm^2 over a small pocket of eastcentral and adjoining southeast Bay. Rest area it is less than this value. In Arabian Sea, TCHP is less than less than 50 kJ/cm^2 to the north of 14^0 N latitude. It increases southwards.

Relative Vorticity:

The low-level relative vorticity about 80 $x10^{-6}$ s^{-1} seen over Lakshadweep area.

Convergence:

Low level convergence about 5-10 $x10^{-6}$ s^{-1} is seen over coastal Karnataka and adjoining EC Arabian Sea.

Divergence:

There are no zones of positive upper level divergence over Bay of Bengal as well as in Arabian Sea.

Wind Shear:

Low to moderate wind shear of horizontal wind is seen over central Bay of Bengal which is seen continuing through south peninsula to south Arabian Sea.

Wind Shear Tendency:

Decreasing wind shear tendency is seen over most parts of Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low/medium clouds with embedded weak to moderate convection is seen over south Bay of Bengal and over Andaman Sea.

Arabian Sea

Scattered low/medium clouds with embedded moderate to intense convection is seen over southeast Arabian Sea and adjoining coastal Karnataka and north Kerala in association with the low level circulation (LLC) over the area.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 18^0N latitude over BoB.

M.J.O. Index:

MJO index lies in Phase 4 with amplitude close1. It would remain with a very low amplitude during the next three days.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The analysis of 00UTC on 14th December indicates the presence of a low pressure area off the coast of north Kerala and adjoining Karnataka coasts and over Lakshadweep and adjoining EC Arabian Sea. The system remains as a low on 15th and on 16th. It is seen as WML on 17th and 18th over central parts of Arabian Sea, and weakens thereafter over western parts of southwest Arabian Sea with a west-southwestward movement.

NCEP-GFS: It shows similar behavior as IMD GFS. The low becomes well marked on 15th over Lakshadweep and adjoining EC Arabian Sea on 15th and on 16th with its westward travel and

weakened to a low on 17th and the low is seen over SW Arabian Sea on 18th and became less marked on 17th.

ECMWF: The forecast based on model analysis on 14th indicates a low over EC and adjoining SE Arabian Sea on 15th concentrates in to a depression on 17th over SW and adjoining WC Arabian Sea and further intensifies into CS over northern parts of SW Arabian Sea on 18th. The system moves in a west-southwestward direction and is seen close to Somali coast and on 20th over Gulf of Aden.

WRF: The WRF model analysis on 14th a low pressure area is seen off the coast of Karnataka and over SE Arabian Sea and adjoining Lakshadweep area which becomes less marked on 15th.

NCUM: The analysis on 14th indicates a low over Lakshadweep area which moving in a west-southwestward direction and concentrates into a depression on 17th over northern parts of southwest Arabian Sea, and off Somali coast on 19th and became less marked on 20th.

IITM GEFS: The forecast based on 14th December analysis shows a low pressure area off the coasts of Karnataka and adjoining Kerala on 15th which moves in a WSW direction till 17th and becomes less marked thereafter.

IMD GPP: The GPP forecast fields show a significant zone of GPP over Arabian Sea off Karnataka coast on 14th which moves west-southwestward and becomes less significant by 16th. However on 17th GPP zone reappeared and became prominent with WSW movement on 18th and is seen close to Somali peninsula on 19th. It becomes less marked on 20th.

Summary and Conclusion:

Most of the models are indicating that the low over Lakshadweep area and adjoining SE Arabian Sea on 14th to take a west-southwestward movement over Arabian Sea. ECMWF and NCUM models are indicating the system to concentrate into a depression on 17th. ECMWF further shows that the system will intensify into a cyclonic storm on 18th over SW Arabian Sea. IMD GPP forecast also indicates a significant zone (>30) over Arabian Sea which moves till 19th in a west-southwestward direction.

Hence the intensification of the low pressure area over Arabian Sea needs to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Low	Low

IOP : No IOP for the next 5 days.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time(UTC)		
	13/12	14/00	141/03
India	39	36	43
Coastal stations			
WB	8	5	9
Odisha	6	6	6
AP	8	12	12
TamilNadu	10	11	9
Puducherry	1	1	1
A& N	6	1	6
Bangladesh	0	2	3
Myanmar	0	0	1
Thailand	3	3	3
SriLanka	8	7	7

AWS:

Region	Date/Time(UTC)		
	13/12	14/00	14/03
WB	7	4	4
Odisha	9	2	5
AP	5	1	1
TamilNadu	25	11	8
Puducherry	1	1	0
A& N	0	0	0

RS/RW (12Z) of 13/12/2016 : 35 /43

No. of Ascents reaching 250 hPa levels:13 , MISDA:- 22

RS/RW (00Z) of 14/12/2016 : 32 /43

No. of Ascents reaching 250 hPa levels: 31, MISDA: 1

- **No. of PILOT Ascents**

13/12Z	14/00Z
2	1

Buoy Data

13/12Z	14/00Z	14/03Z
10	11	5

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**13.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**19**	**19**	**20**

No. of RS/RW Ascents

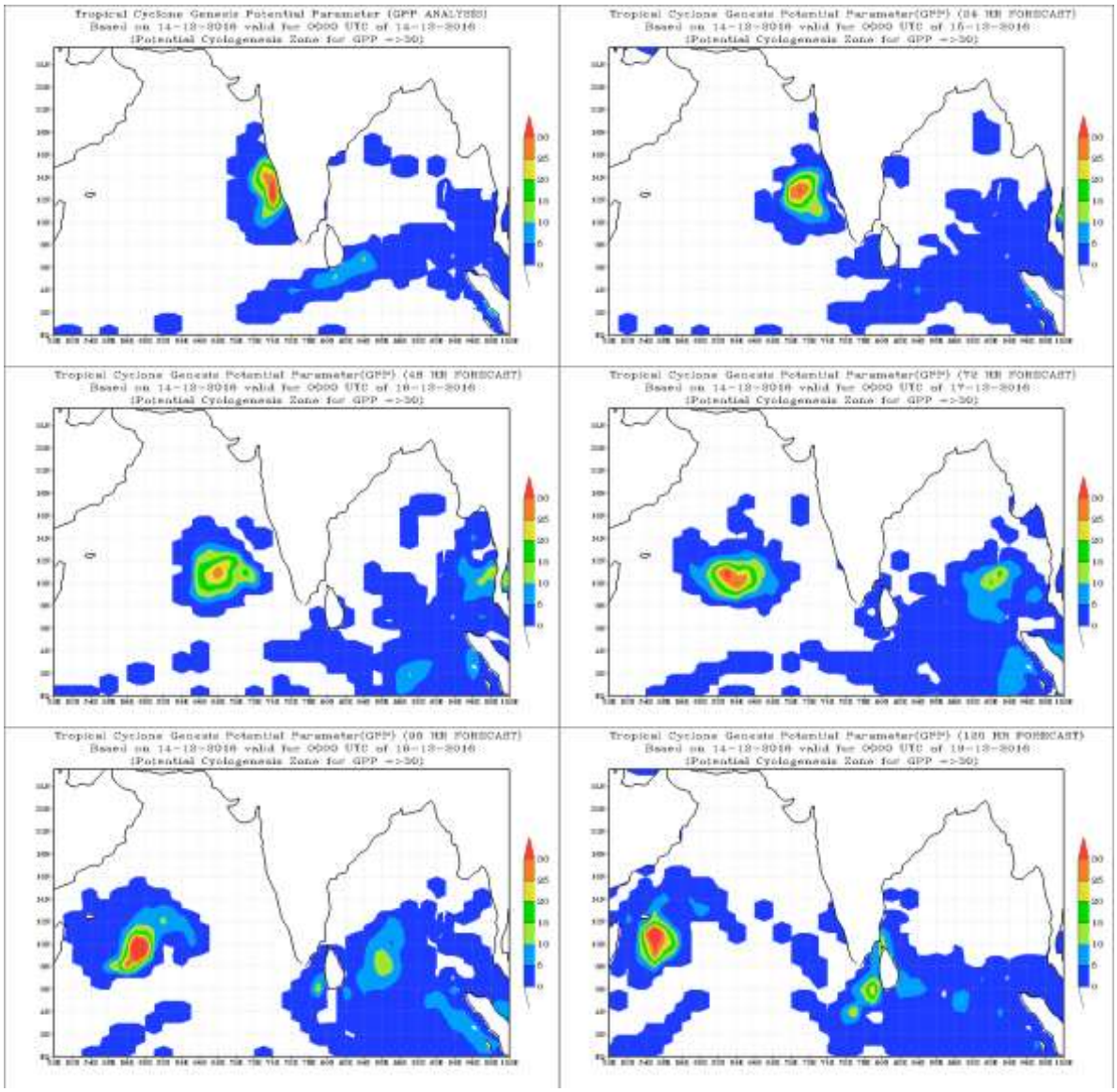
00Z /13.12.2016 : 6
No. of Ascents reaching 250hPa level =6
MISDA :2

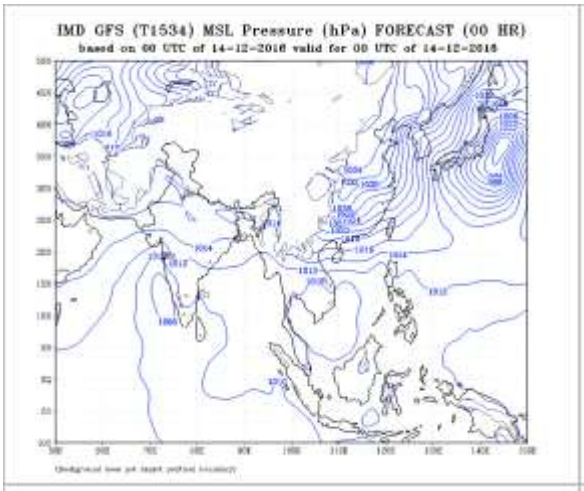
12Z /13.12.2016 : 2
No. of Ascents reaching 250 hPa level =2
MISDA : 6

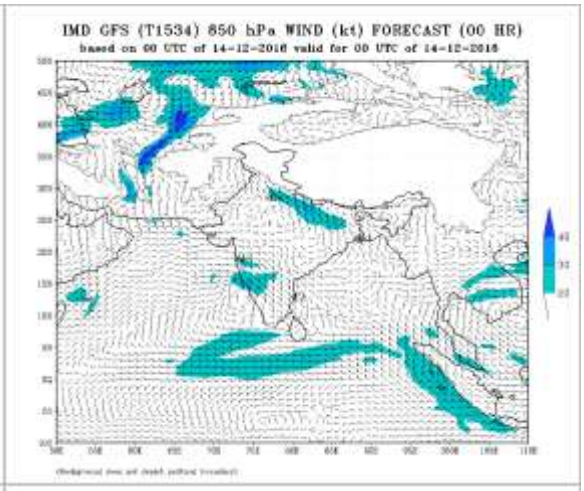
No. of PILOT Ascents:

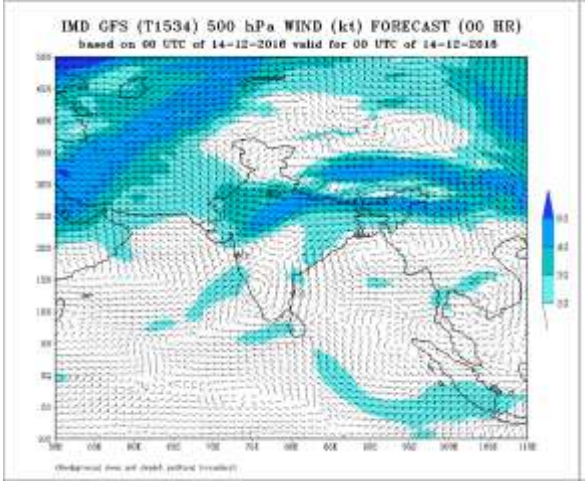
13.12.2016	
06Z	18Z
3	4

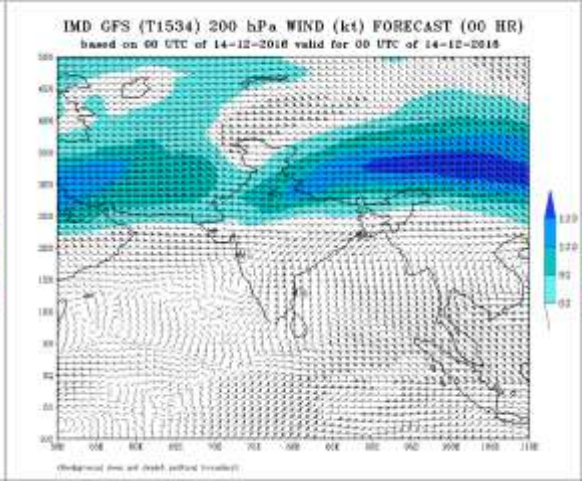
Annexure-II

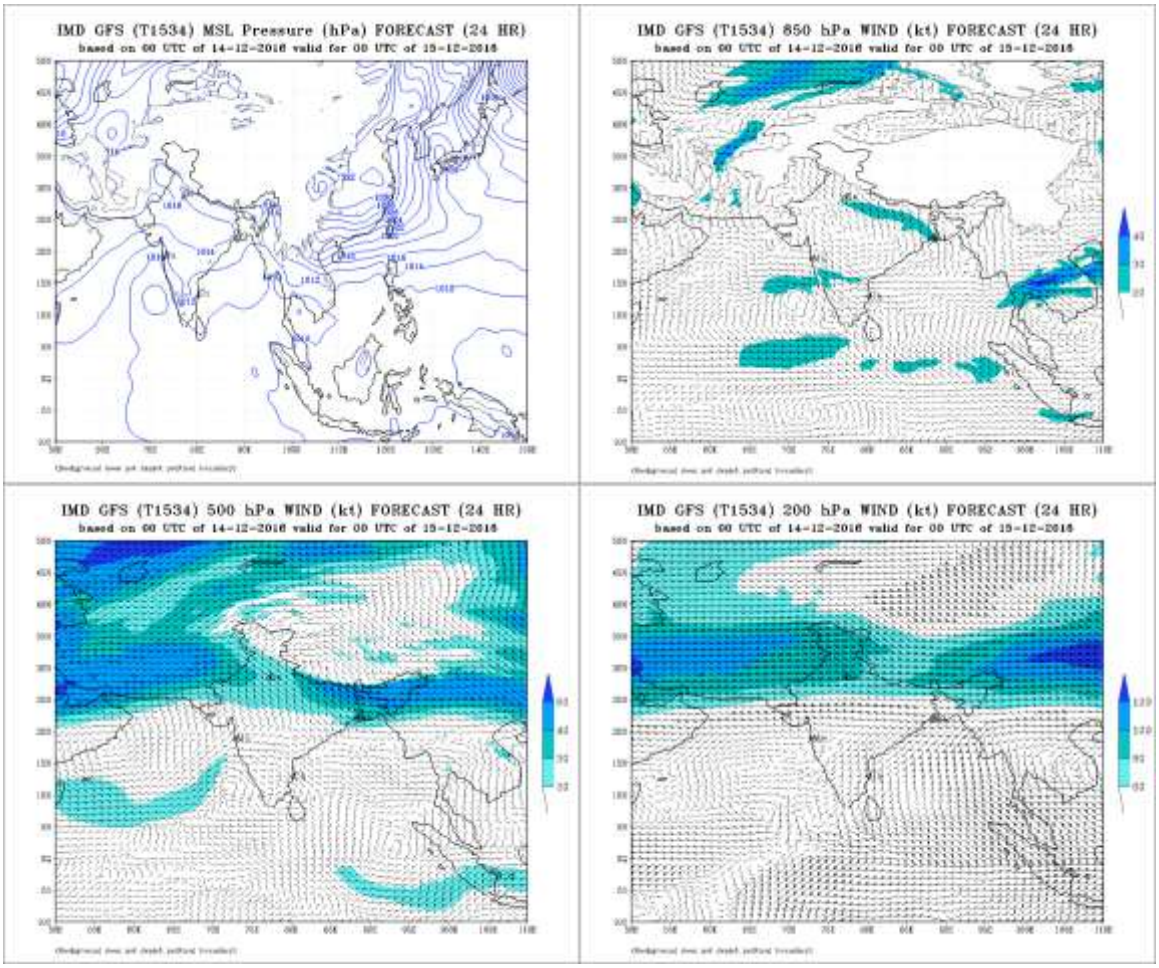

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 14-10-2016 valid for 0000 UTC of 14-10-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 14-10-2016 valid for 0000 UTC of 15-10-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 14-10-2016 valid for 0000 UTC of 16-10-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 14-10-2016 valid for 0000 UTC of 17-10-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 14-10-2016 valid for 0000 UTC of 18-10-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 14-10-2016 valid for 0000 UTC of 19-10-2016
(Potential Cyclogenesis Zone for GPP =>30)

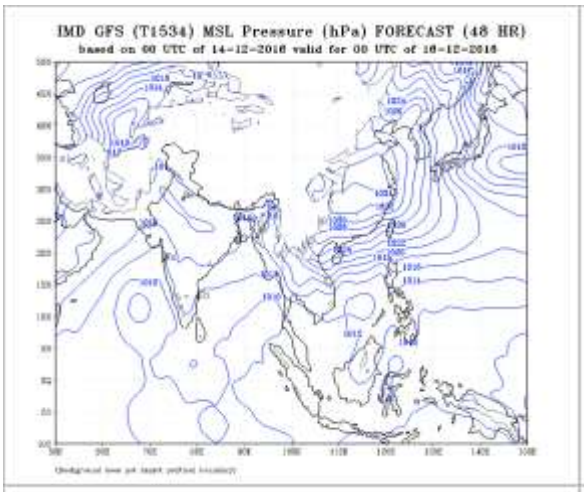

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 14-12-2016 valid for 00 UTC of 14-12-2016

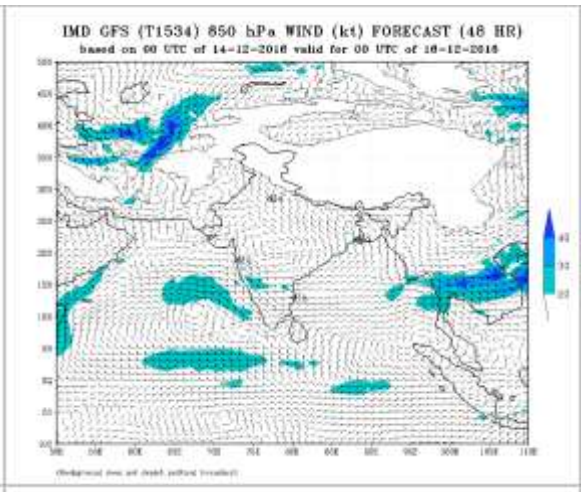

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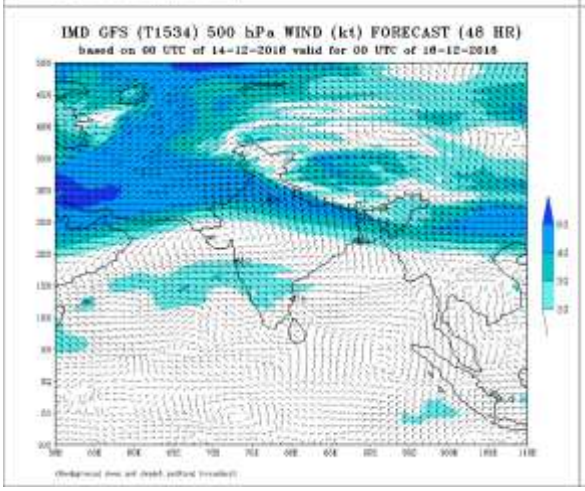

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 14-12-2016 valid for 00 UTC of 14-12-2016

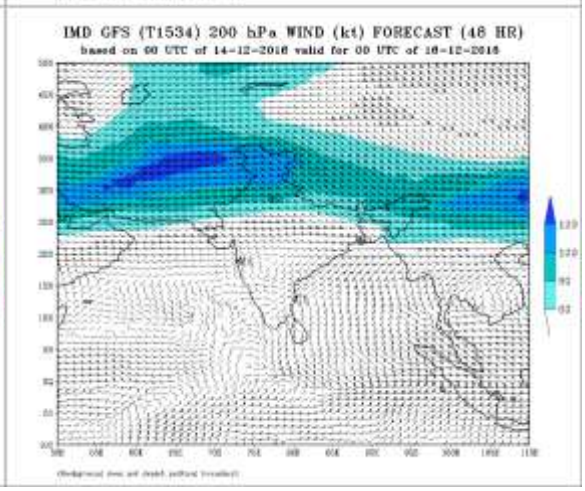

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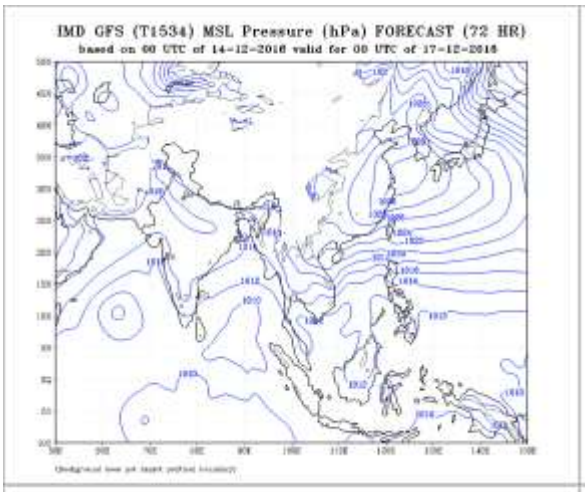

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 15-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 15-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 15-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 15-12-2018

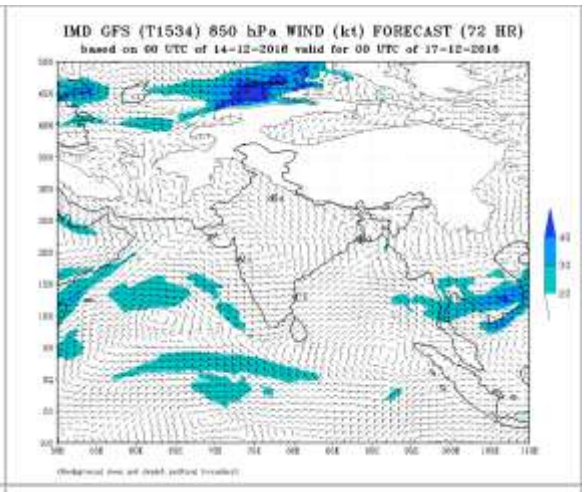

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 16-12-2018

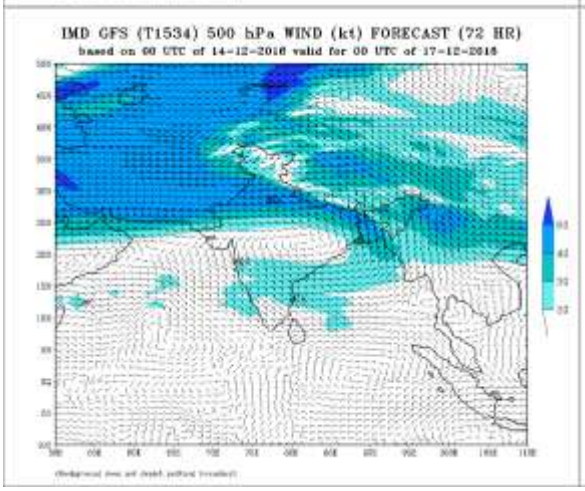

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 16-12-2018

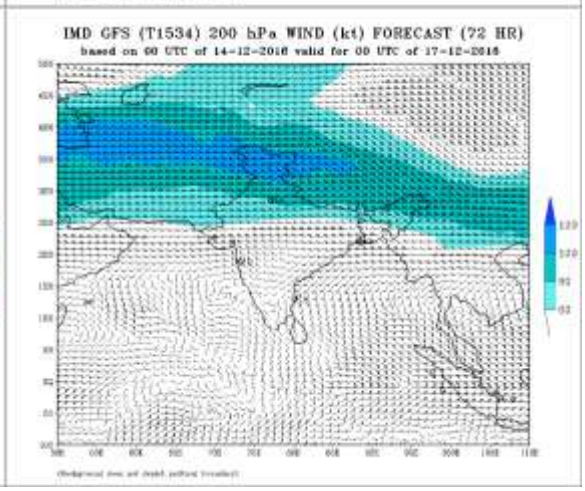

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 16-12-2018

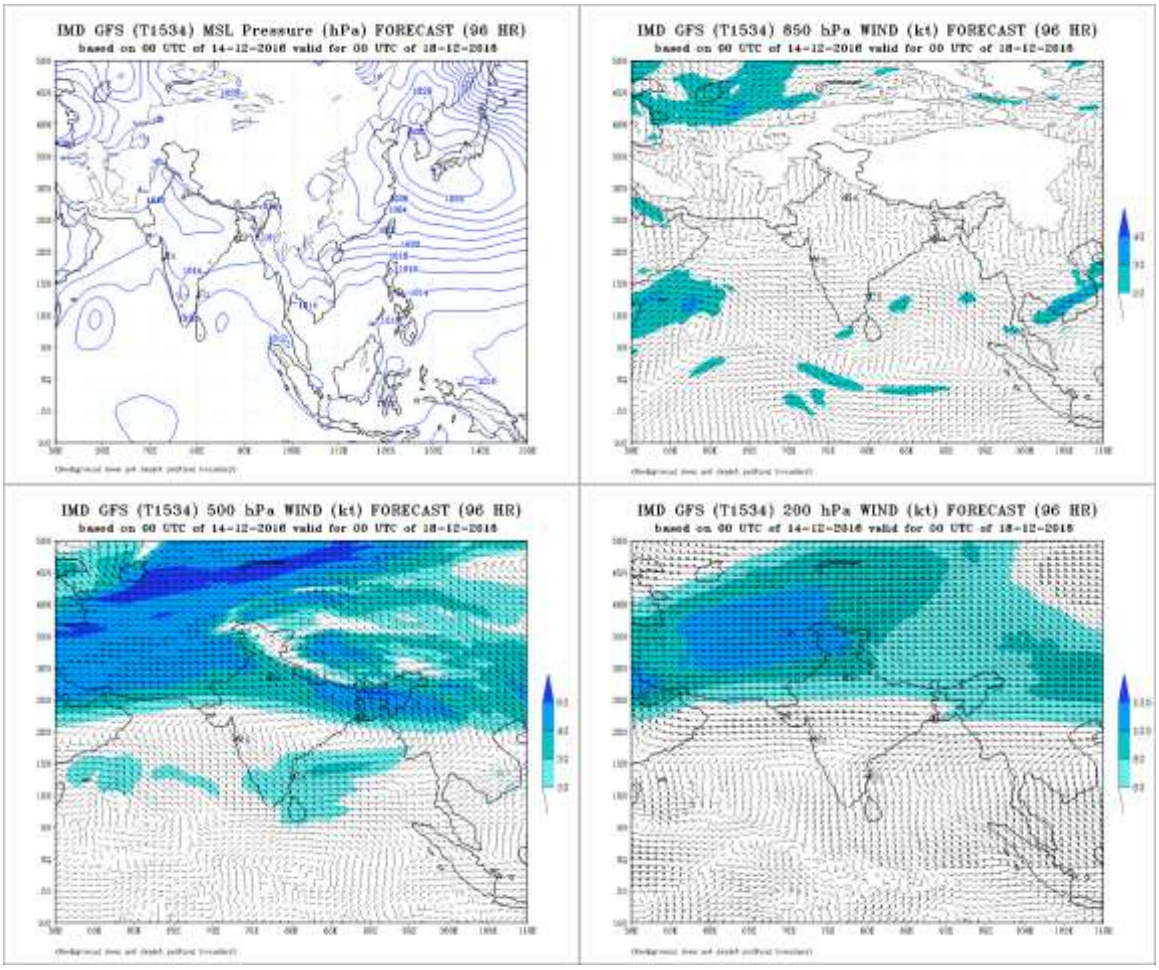

IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 16-12-2018

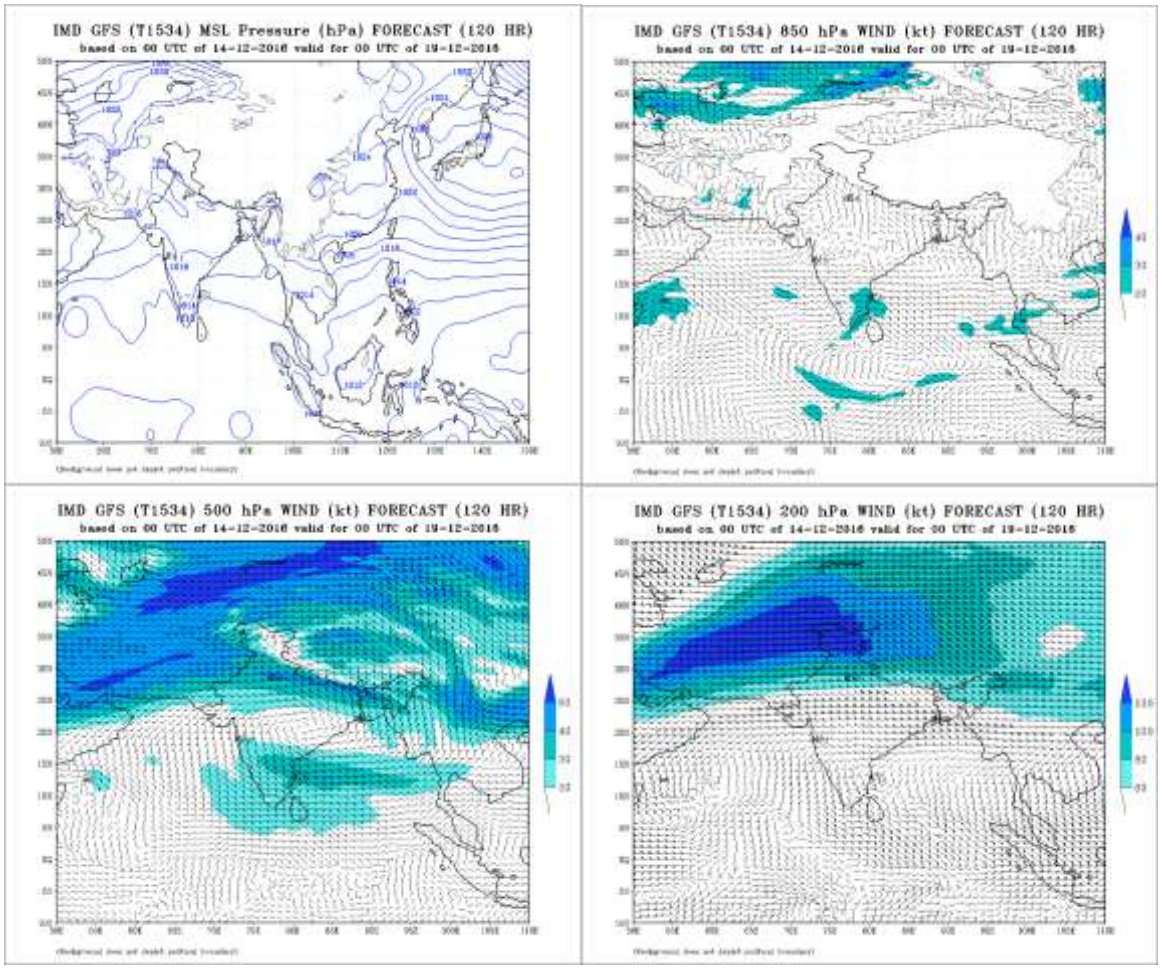

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 14-12-2016 valid for 00 UTC of 17-12-2016


IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 14-12-2016 valid for 00 UTC of 17-12-2016


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 14-12-2016 valid for 00 UTC of 17-12-2016


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 14-12-2016 valid for 00 UTC of 17-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 18-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 18-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 18-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 14-12-2018 valid for 00 UTC of 18-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 14-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 14-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 14-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 14-12-2016 valid for 00 UTC of 19-12-2016

FDP (Cyclone) NOC Report Dated 15th December 2016

Synoptic features:

The low pressure area over southeast Arabian Sea and adjoining areas of coastal Karnataka and Kerala persisted there yesterday evening. It now lies over Lakshadweep area and adjoining southeast Arabian Sea. Associated cyclonic circulation extends upto mid tropospheric levels. It is likely to move westwards and become more marked over southeast Arabian Sea during next 72 hrs. A cyclonic circulation extending upto 4.5 kms a. s. l. lies over Gulf of Siam and neighbourhood.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 27-29˚C over most parts of Bay of Bengal. It is around 28-30 over SE and adjoining EC Arabian Sea. It decreases to north.

Tropical Cyclone Heat Potential (TCHP):

The ocean heat content is about 70-100 kJ/cm^2 over a small pocket of eastcentral and adjoining southeast Bay. Rest area it is less than this value. In Arabian Sea, TCHP is less than less than 50 kJ/cm^2 to the north of 14^0 N latitude. It increases southwards.

Relative Vorticity:

The low-level relative vorticity about 70 $x10^{-6}$ s^{-1} seen over Lakshadweep area. An area with low-level relative vorticity about 40 $x10^{-6}$ s^{-1} seen over Malay Peninsula and adjoining Gulf of Thailand

Convergence:

Low level convergence about 10 $x10^{-6}$ s^{-1} is seen over coastal Karnataka and adjoining EC Arabian Sea and Lakshadweep area. Another area of positive convergence around 5 $x10^{-6}$ s^{-1} is seen over Malay Peninsula and adjoining Gulf of Thailand.

Divergence:

There is an area of positive upper level divergence 10 $x10^{-6}$ s^{-1} over Gulf of Thailand and adjoining Malay Peninsula. Over Lakshadweep area and adjoining SE Arabian Sea an area of positive divergence with value 10 $x10^{-6}$ s^{-1} is seen.

Wind Shear:

Low to moderate wind shear of horizontal wind is seen over Andaman Sea, central Bay of Bengal which is seen continuing through south peninsula to south Arabian Sea.

Wind Shear Tendency:

Decreasing wind shear tendency is seen over most parts of south BoB and Andaman Sea. Decreasing tendency is seen also over north and Central Arabian Sea. However, a small area of increasing tendency is seen over southern parts of EC Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low/medium clouds with embedded moderate to intense convection is seen over Tennaserim coast and over Andaman Sea.

Arabian Sea

Scattered low/medium clouds with embedded isolated moderate to intense convection is seen over Lakshadweep area and neighbourhood in association with the low level circulation (LLC) over the area.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 18^0N latitude over BoB.

M.J.O. Index:

MJO index lies in Phase 4 with amplitude close to1. It would remain with a very low amplitude during the next three days.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The analysis of 00UTC on 15th December indicates the low pressure area over Lakshadweep and adjoining EC Arabian Sea. The system is seen as WML on 16th and it weakens to a low on 17th and continues to move in a WSW direction till 19th and is seen near Somali coast.

NCEP-GFS: The analysis on 15th shows a well marked low over Lakshadweep and adjoining EC Arabian Sea on 15th and is seen on 16th over central parts of Arabian Sea. With its west-southwestward travel it weakens to a low on 17th and the low is seen over SW Arabian Sea off Somali coast on 19th.

ECMWF: The forecast based on model analysis on 15th indicates the low over EC and adjoining SE Arabian Sea becomes a well marked low on 16th and concentrates in to a depression on 17th over SW and adjoining WC Arabian Sea. The system moves in a west-southwestward direction and is seen close to Somali coast on 19th and becomes less marked over Somali coast on 20th.

WRF: The WRF model analysis on 15th indicates a low pressure area over SE Arabian Sea and adjoining Lakshadweep area which moves westwards and is seen over northern parts of SE ArSea on 16th.

Meteo-France ARP Model: The forecast based on 15th 00UTC analysis shows that the low in the analysis field is seen as a well marked low from 16th to 18th.

NCUM: The analysis on 15th indicates a low over Lakshadweep area which moving in a west-southwestward direction concentrates into a depression on 17th over southwest Arabian Sea, and a CS on 18th off Somali coast and weakened into a D on 19th over Somali coast and became less marked on 20th.

NCMRWF- NEPS: The forecast fields show the low over EC Arabian Sea and adjoining Lakshdweep area on analysis field moves in a WSW direction till 18th and becomes less marked thereafter.

IITM GEFS: The forecast based on 15th December analysis shows a well marked low pressure area over SE Arabian Sea and adjoining Lakshdweep area on 16th which becomes a low on 17th and moves in a WSW direction till 19th and becomes less marked thereafter.

IMD GPP: The GPP forecast fields shows no significant zone of GPP over Arabian Sea till 16th. On 17th a significant zone is appears over central parts of Arabian Sea, which moves west-southwestward and becomes less weak by 19th and less marked on 20th.

Summary and Conclusion:

Most of the models are indicating that the low over Lakshadweep area and adjoining SE Arabian Sea on 14th to take a west-southwestward movement over Arabian Sea. ECMWF and NCUM models are indicating the system to concentrate into a depression on 17th. NCUM further shows that the system to intensify into a cyclonic storm on 18th over SW Arabian Sea. IMD GPP forecast indicates a significant zone (>30) over Arabian Sea on 17th which becomes weak on 18th and moves till 19th in a west-southwestward direction.

The intensification of the low pressure area over Arabian Sea needs to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	NIL	Nil

IOP : No IOP for the next 5 days.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	14/12	**15/00**	**15/03**
India	42	31	46
Coastal stations			
WB	9	3	9
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	2	3
Myanmar	0	1	1
Thailand	2	3	3
Sri Lanka	5	7	8

AWS:

Region	Date/Time (UTC)		
	14/12	**15/00**	**15/03**
WB	5	1	1
Odisha	4	1	4
AP	9	3	5
Tamil Nadu	24	8	20
Puducherry	1	1	1
A & N	0	0	0

RS/RW (12Z) of 14/12/2016 : 13/ 43

No. of Ascents reaching 250 hPa levels: 12 , MISDA:- 3

RS/RW (00Z) of 15/12/2016 : 29 /43

No. of Ascents reaching 250 hPa levels: 27 ,MISDA: 2

- **No. of PILOT Ascents**

14 /12Z	15/00Z
26	12

Buoy Data

14/12Z	15/00Z	15/03Z
2	2	1

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**14.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

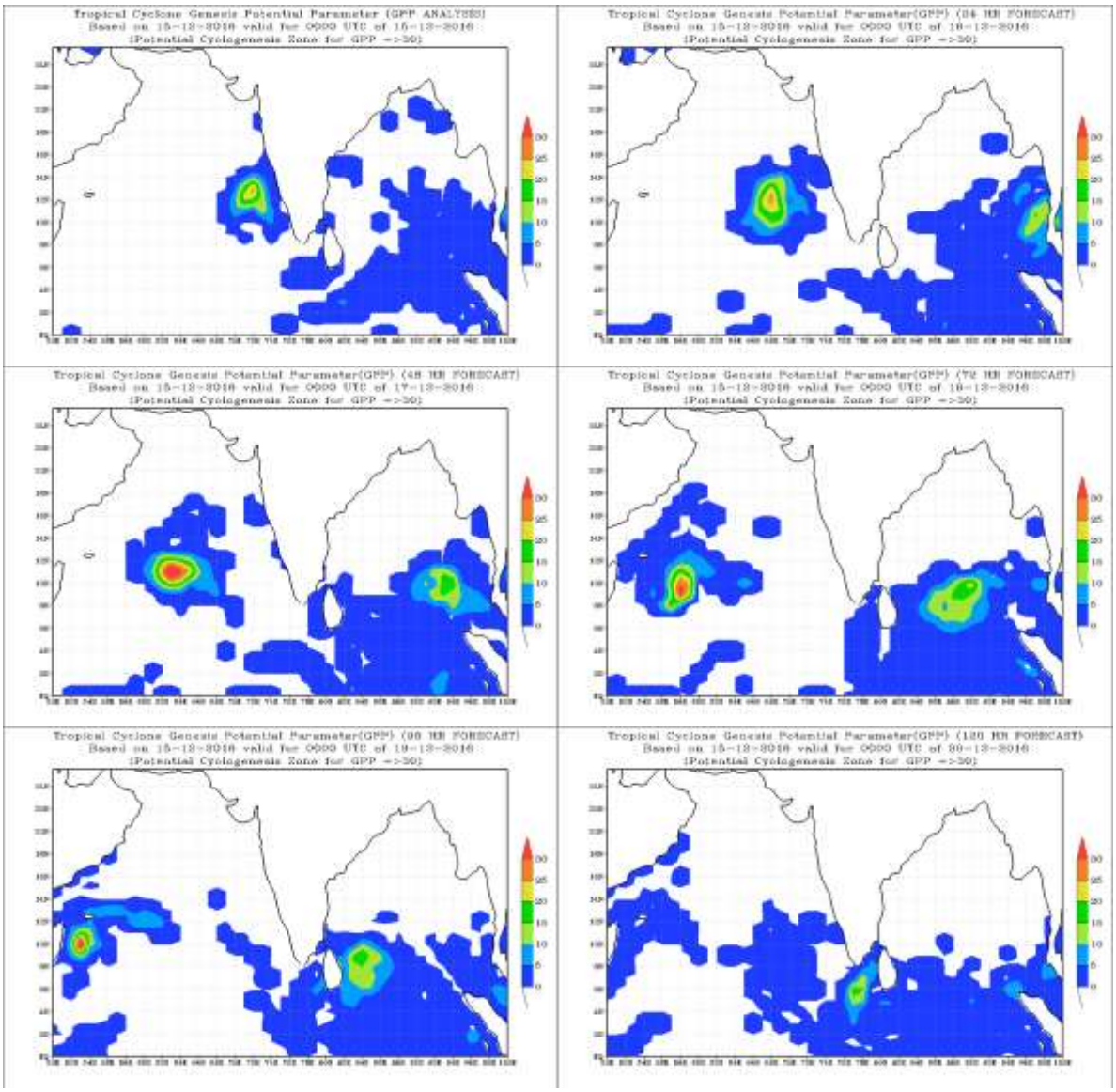
00Z /14.12.2016 : 7
No. of Ascents reaching 250hPa level =7
MISDA :1

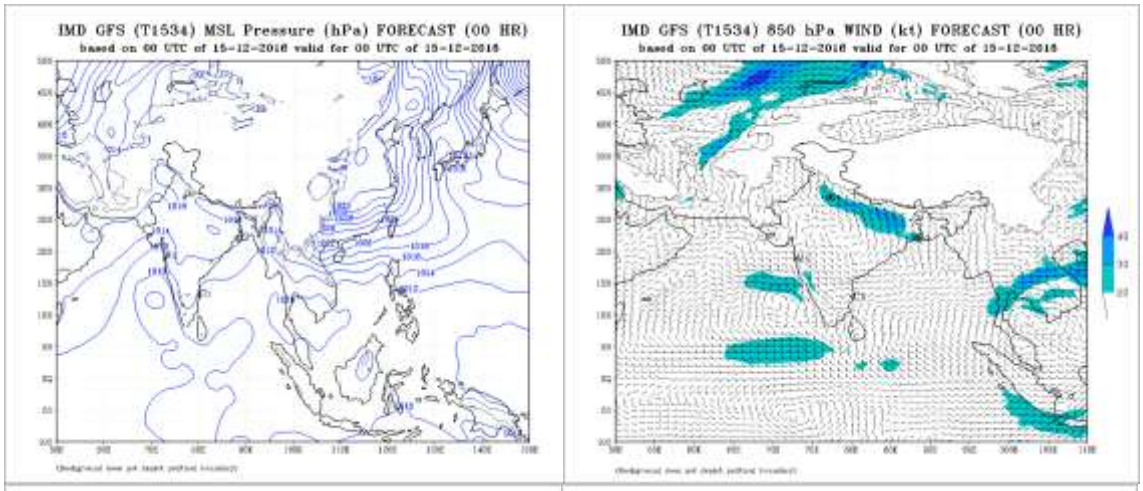
12Z /14.12.2016 : 1
No. of Ascents reaching 250 hPa level =1
MISDA : 7

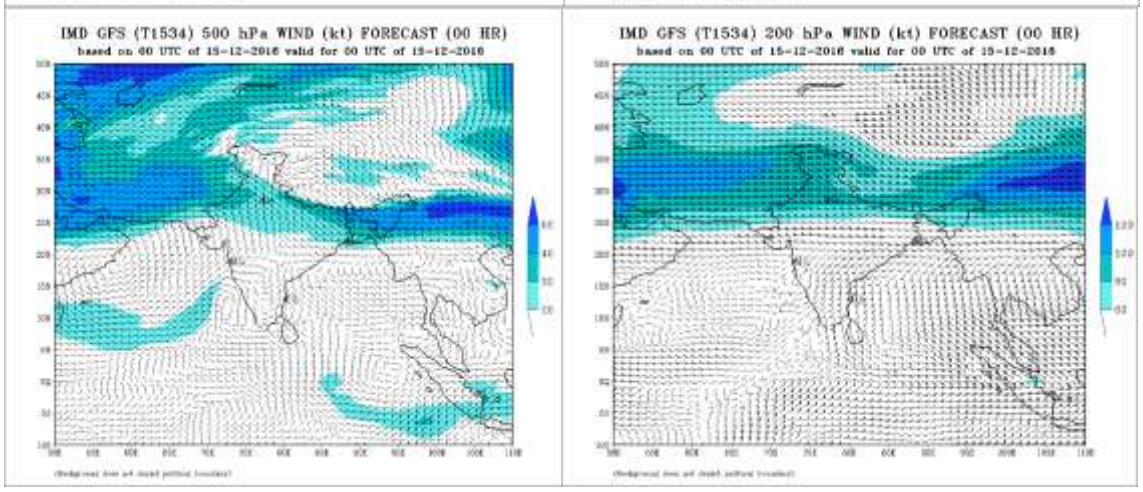
No. of PILOT Ascents:

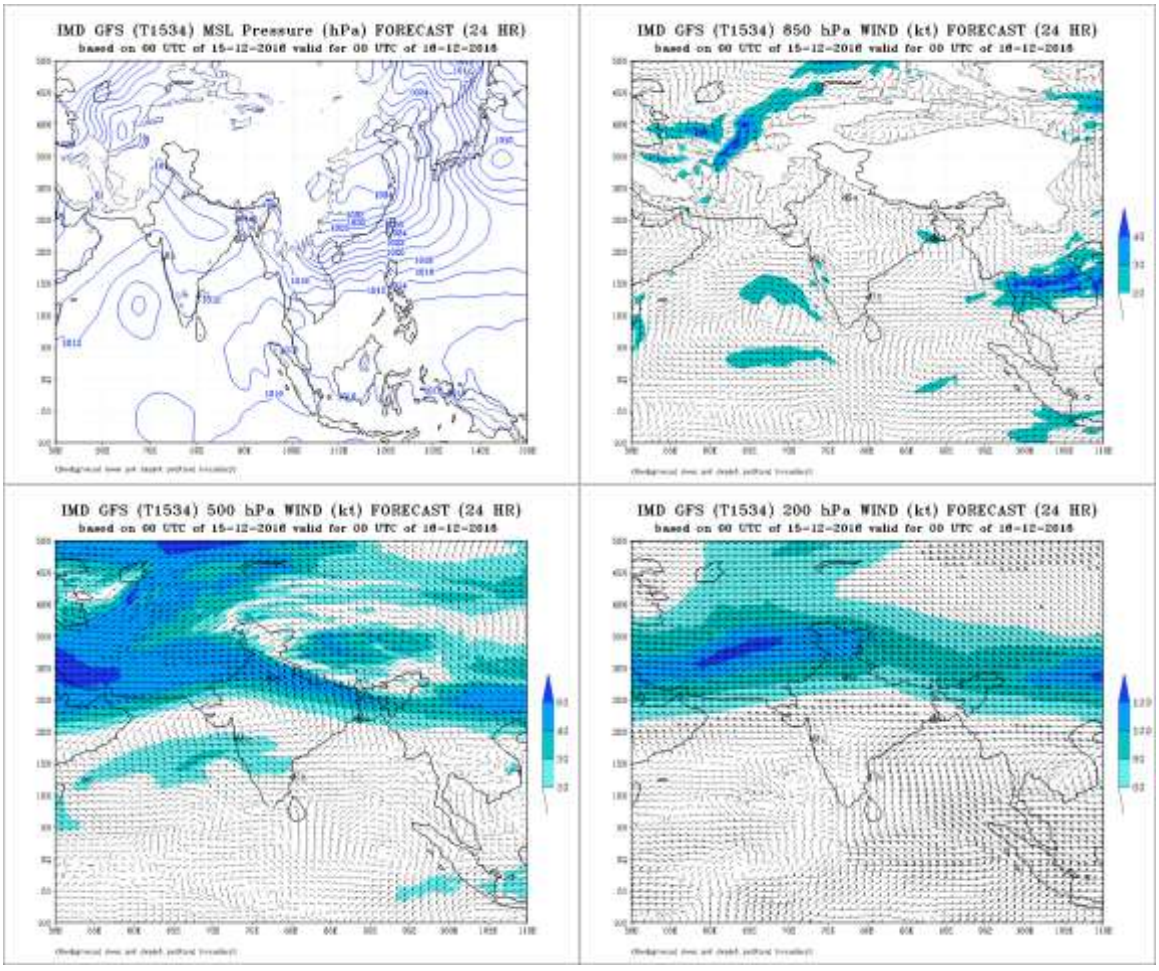
14.12.2016	
06Z	18Z
3	3

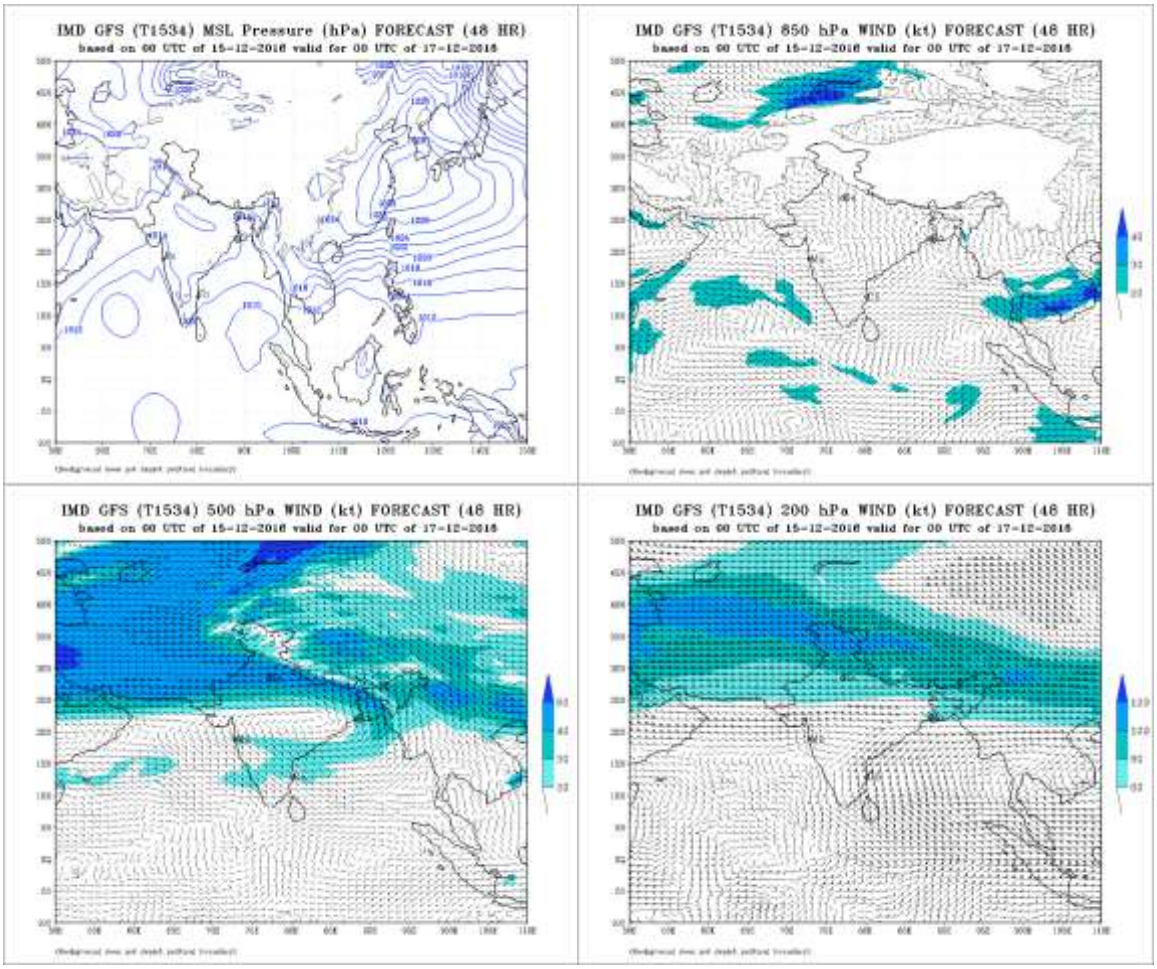
Annexure-II

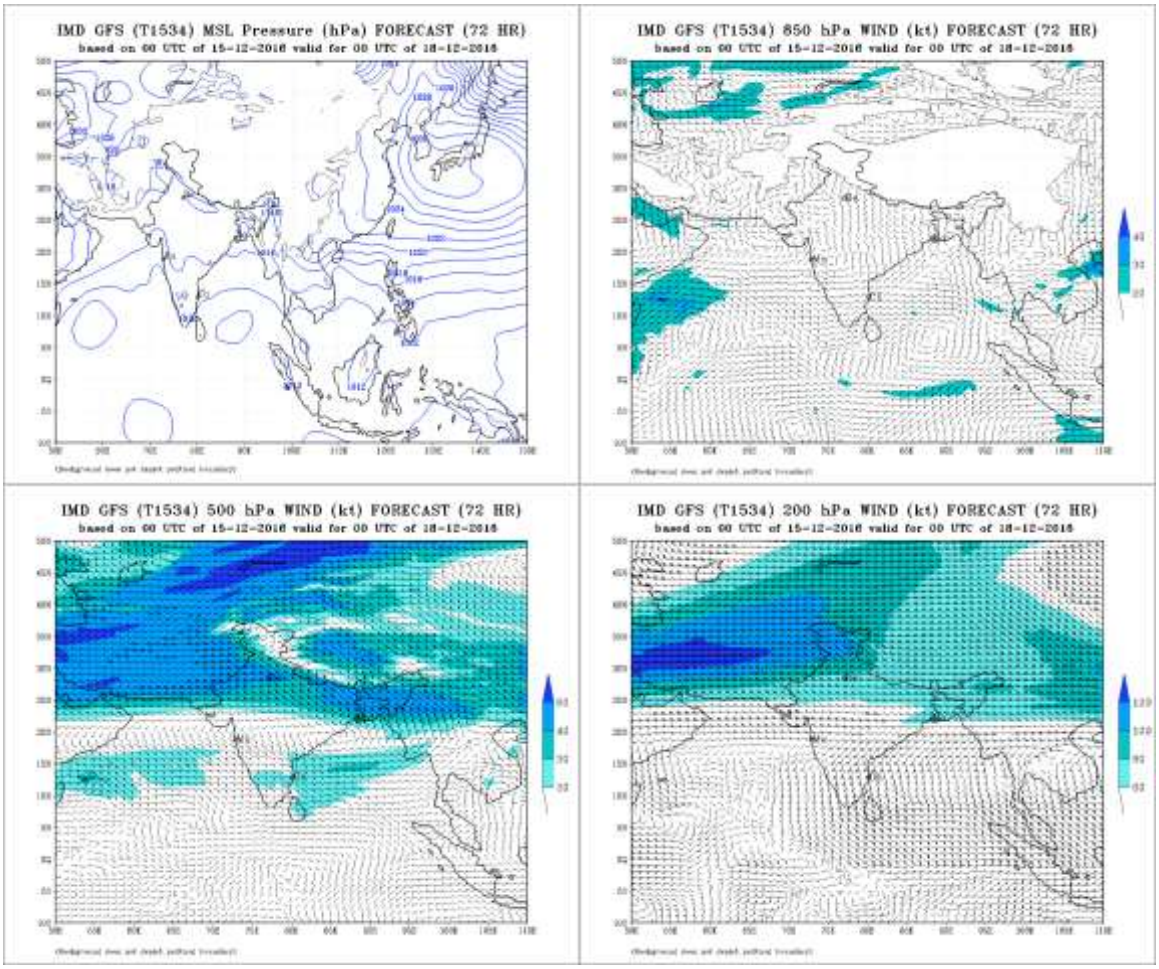

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 15-12-2016 valid for 0000 UTC of 15-12-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 15-12-2016 valid for 0000 UTC of 16-12-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 15-12-2016 valid for 0000 UTC of 17-12-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 15-12-2016 valid for 0000 UTC of 18-12-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 15-12-2016 valid for 0000 UTC of 19-12-2016
(Potential Cyclogenesis Zone for GPP =>50)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 15-12-2016 valid for 0000 UTC of 20-12-2016
(Potential Cyclogenesis Zone for GPP =>50)

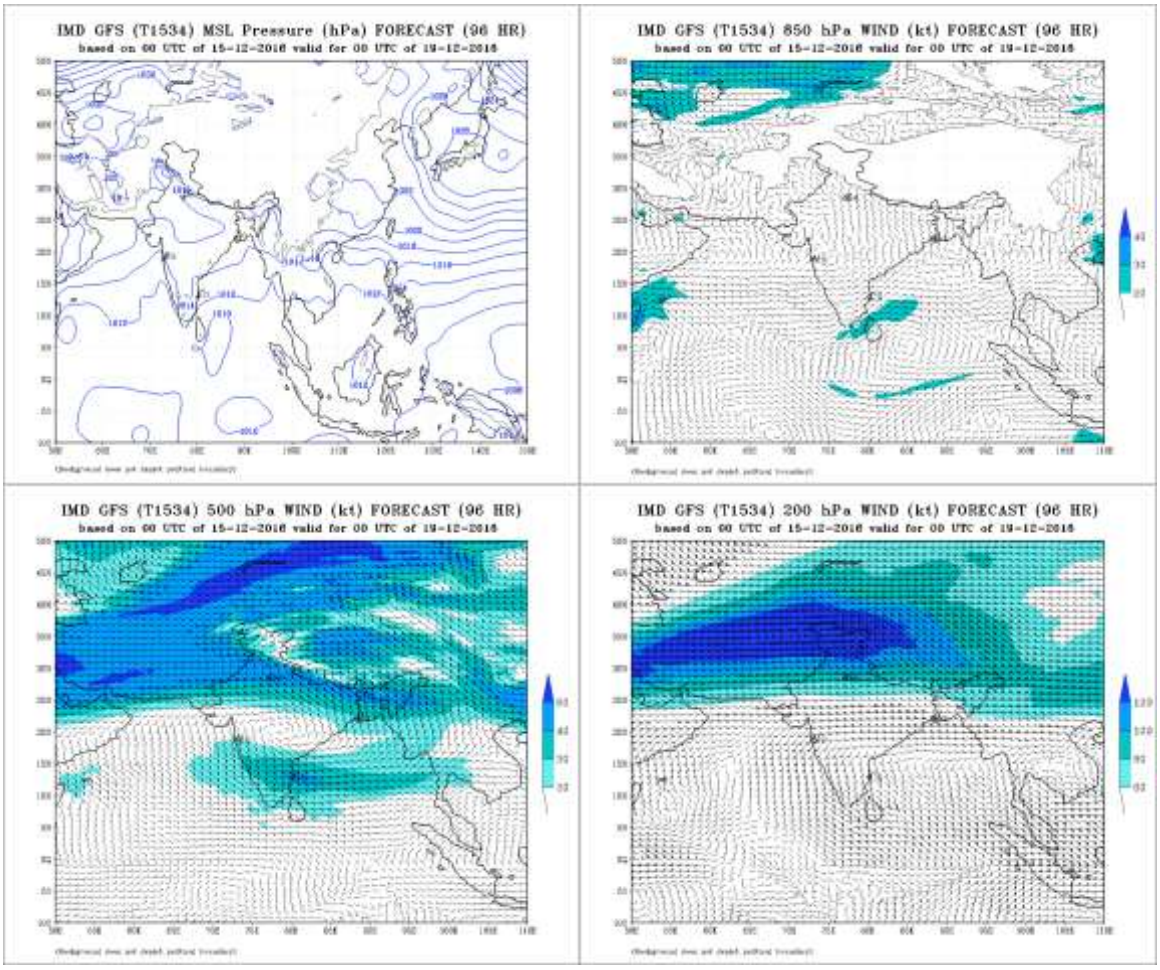

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 15-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 15-12-2016

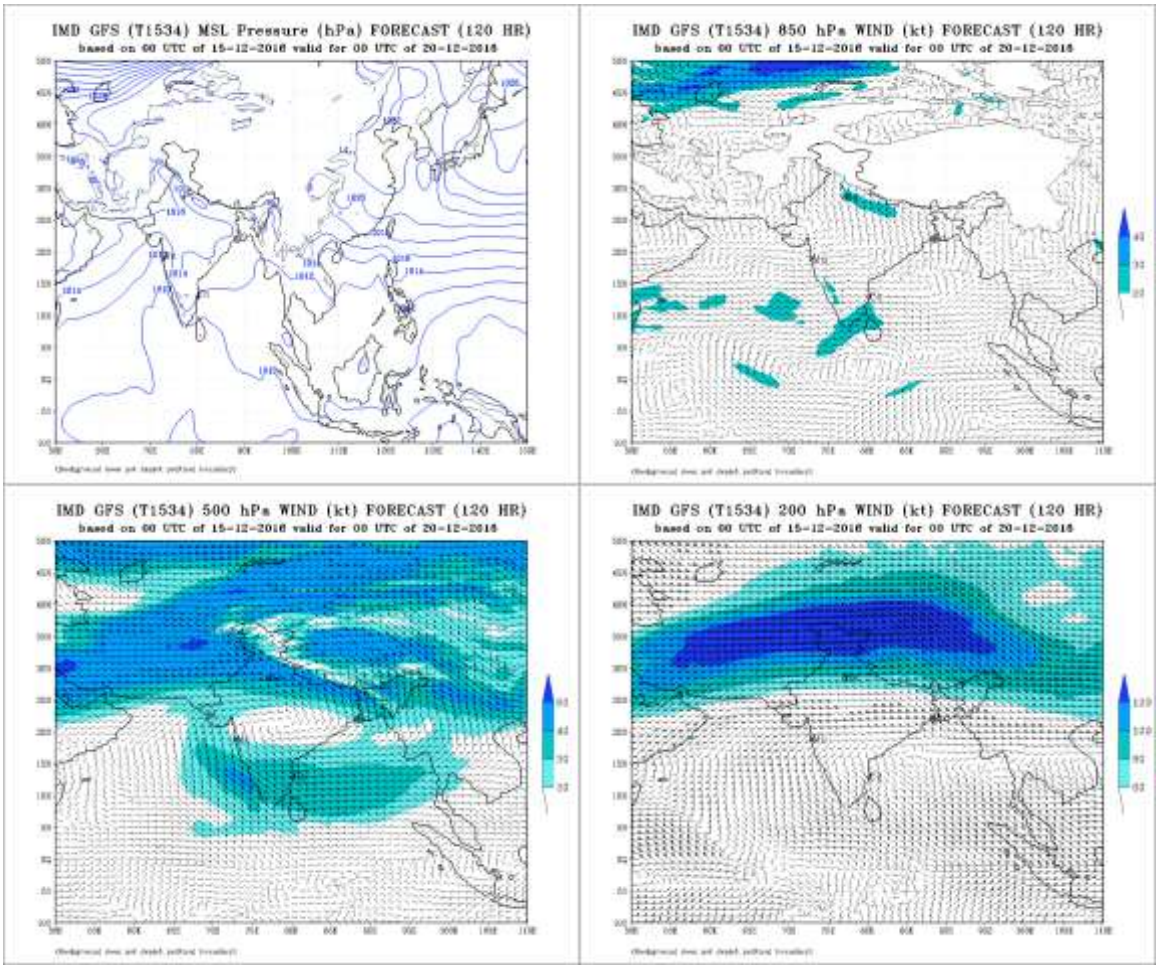

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 15-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 15-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 16-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 16-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 16-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 16-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 17-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 18-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 18-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 18-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 18-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 19-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 20-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 20-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 20-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 15-12-2016 valid for 00 UTC of 20-12-2016

FDP (Cyclone) NOC Report Dated 16th December 2016

Synoptic features:

The low pressure area over Lakshadweep area and adjoining southeast Arabian Sea now lies over southeast Arabian Sea and neighbourhood. Associated cyclonic circulation extends upto mid tropospheric levels. It is likely to move westwards and become more marked over the same region during next 48 hrs. A trough of low at mean sea level lies over Tennaserim coast and adjoining south Andaman Sea. The cyclonic circulation over Gulf of Siam and neighbourhood extending upto 4.5 kms a. s. l. now lies aloft this system.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 27-29˚C over most parts of Bay of Bengal. It is around 28-30 over SE and adjoining EC Arabian Sea. It decreases to the north.

Tropical Cyclone Heat Potential (TCHP):

The ocean heat content is about 70-100 kJ/cm^2 over a small pocket of eastcentral and adjoining southeast Bay. Rest area it is less than this value. In Arabian Sea, TCHP is less than less than 50 kJ/cm^2 to the north of 14^0 N latitude. It increases southwards.

Relative Vorticity:

The low-level relative vorticity about 70 x10^{-6} s^{-1} seen over central parts of south Arabian Sea. An area with low-level relative vorticity about 40 x10^{-6} s^{-1} seen over Malay Peninsula and adjoining Gulf of Thailand.

Convergence:

Low level convergence about 10 x10^{-6} s^{-1} is seen over EC Arabian Sea and adjoining Lakshadweep area. Another area of positive convergence around 5 x10^{-6} s^{-1} is seen over Malay Peninsula and adjoining Gulf of Thailand and Andaman Sea.

Divergence:

There is an area of positive upper level divergence 20 x10^{-6} s^{-1} over Gulf of Thailand and adjoining Malay Peninsula. Over Lakshadweep area and adjoining SE Arabian Sea an area of positive divergence with value 10 x10^{-6} s^{-1} is seen.

Wind Shear:

Low to moderate wind shear of horizontal wind is seen over Andaman Sea, and neighbouring Malay Peninsula and Gulf of Thailand. The wind shear is low to moderate over entire south and central Arabian Sea. It is high over north Arabian Sea.

Wind Shear Tendency:

Decreasing wind shear tendency is seen over Andaman Sea. Decreasing tendency is seen also over small isolated pockets over northeast and east central Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low/medium clouds with embedded intense to very intense convection is seen over SE Bay. Scattered low/medium clouds with embedded isolated weak to moderate convection are seen over Andaman Sea.

Arabian Sea

Scattered low/medium clouds with embedded intense to very intense convection is seen over SE Arabian Sea between lat 8.5^0 N to 15.0^0 N and long 63.5^0 E to 67.0^0 E in association with the low level circulation (LLC) over the area.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 15^{0}N latitude over BoB.

M.J.O. Index:

MJO index lies in Phase 6 with very low amplitude. It would move to phase 5 with low amplitude during the next three days.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The forecast based on analysis of 00UTC on 16th December indicates the low pressure area over Lakshadweep and adjoining EC Arabian Sea becomes a WML on 16th which weakens to a low on 17th and continues to move in a WSW direction till 19th and is seen near Somali coast. It becomes less marked on 20th. Another low is seen on analysis field over Andaman Sea and adjoining SE Bay, which moving in a westward direction is seen near Sri Lanka coast on 18th. The low becomes unimportant on 19th.

NCEP-GFS: The analysis on 16th and forecast fields show a low over EC Arabian Sea which moving in a westward direction becomes well marked low on 18th. It becomes a low again on 19th and becomes less marked on 20th.

ECMWF: The analysis on 16th and forecast fields show a well marked low over EC Arabian Sea is seen moving in a westward direction. It is seen off Somali coast on 19th and becomes less marked on 20th. Another low is seen over south Bay and adjoining Andaman Sea on 17th, which with its westward travel is seen near Sri Lanka on 19th and becomes less marked on 20th.

WRF: The WRF model analysis on 16th indicates a low pressure area over northern parts of SE Arabian Sea which moves westwards.

Meteo-France ARP Model: The forecast based on 16th 00UTC analysis shows that the low in the analysis field is seen moving in a westward direction and is seen off Somali coast on 19th. Another low is over South Andaman Sea, which also moves in a west direction and lies over central parts of SE Bay on 19th.

NCUM: The analysis on 16th indicates a low over SE Arabian Sea which moving in a west-southwestward direction becomes more marked on 17th over southwest Arabian Sea, and becomes less marked on 18th.

NCMRWF- NEPS: The forecast based on 16th analysis show a low over SE Bay of Bengal on 18th direction which is seen over SW Bay close to Sri Lanka on 19th and becomes less marked on 20th.

IITM GEFS: The forecast based on 16th December analysis shows a low pressure area over SE Arabian Sea on 16th which moves in a WSW direction till 19th and seen off the coast of Somali on 19th and becomes less marked thereafter.

IMD GPP: The GPP forecast fields shows a significant zone of GPP over Arabian Sea on 16th analysis, which moved westwards and is seen over SW Arabian Sea, off Somalia coast on 19th and becomes less marked on 20th.

Summary and Conclusion:

Most of the models are indicating that the low over SE Arabian Sea to take a west/ west-southwestward movement over Arabian Sea without much intensification, except for ECMWF and NCUM models, which are indicating the system to develop upto a well marked low pressure area. IMD GPP forecast indicates a significant zone (>30) over Arabian Sea in the analysis field to move in a west-southwestward direction. On 19th the zone is seen off Somali coast and becomes less marked on 20th.

Hence, the intensification of the low pressure area over southeast Arabian Sea needs to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	NIL	Nil

IOP : No IOP for the next 5 days.

Annexure-I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	15/12	16/00	16/03
India	42	31	41
Coastal stations			
WB	9	3	9
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	1
Bangladesh	0	2	3
Myanmar	0	0	1
Thailand	2	3	3
Sri Lanka	5	9	9

AWS:

Region	Date/Time (UTC)		
	15/12	16/00	16/03
WB	2	1	3
Odisha	5	2	3
AP	7	6	6
Tamil Nadu	22	7	17
Puducherry	1	1	1
A & N	0	0	0

RS/RW (12Z) of 15/12/2016 : 11/ 43

No. of Ascents reaching 250 hPa levels: 11 , MISDA:- 4

RS/RW (00Z) of 15/12/2016 : 28 /43

No. of Ascents reaching 250 hPa levels: 24 ,MISDA: 3

- **No. of PILOT Ascents**

15 /12Z	16/00Z
17	11

Buoy Data

15/12Z	16/00Z	16/03Z
11	12	13

STATUS OF RMC, CHENNAI REGION OBSERVATION

No. of Synop data

Date→	**15.12.2016**							
UTC→	**00**	**03**	**06**	**09**	**12**	**15**	**18**	**21**
Chennai Region (Coasts of AP & TN)	**20**	**22**	**20**	**20**	**22**	**20**	**20**	**20**

No. of RS/RW Ascents

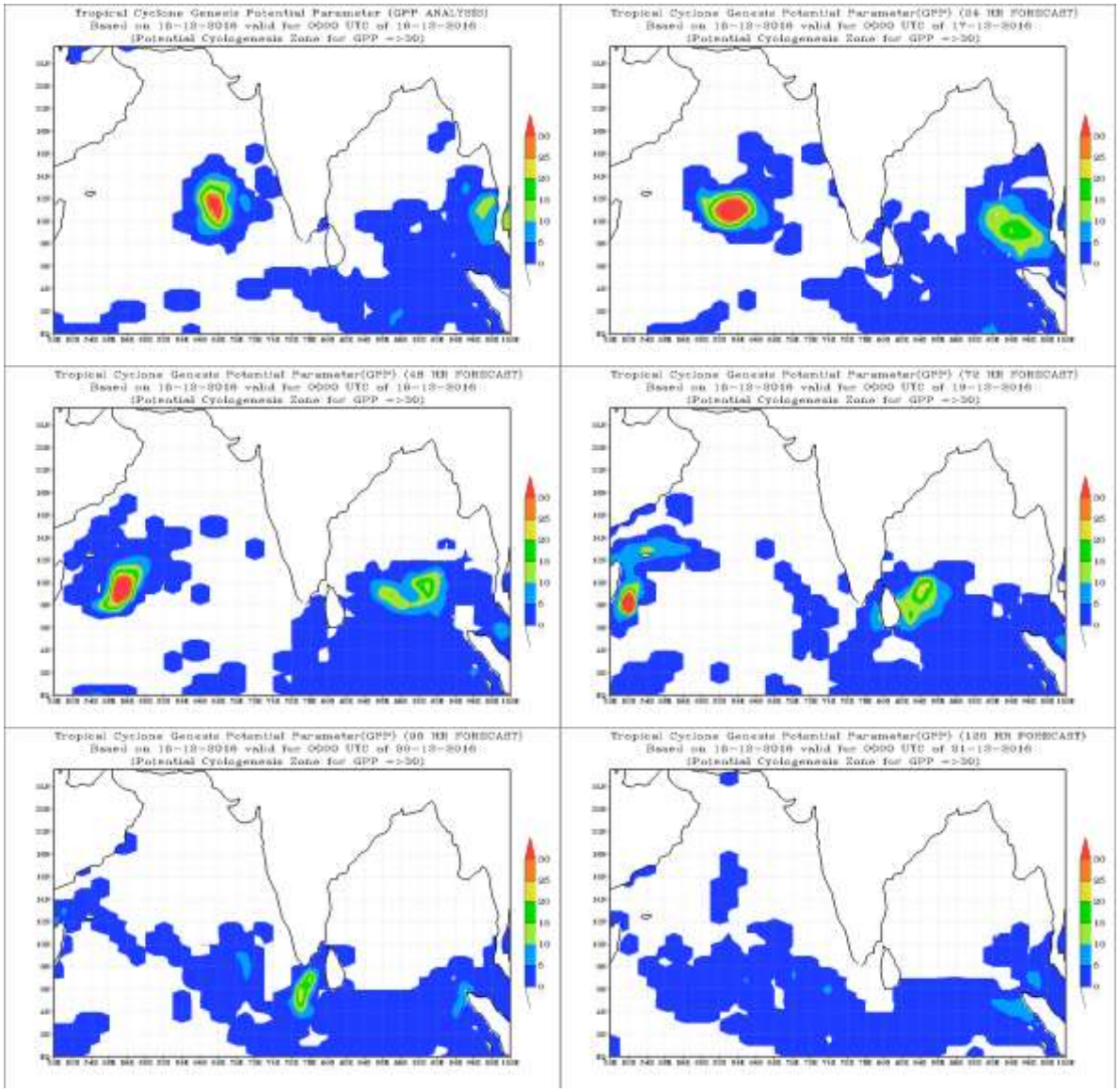
00Z /15.12.2016 : 6
No. of Ascents reaching 250hPa level =6
MISDA :2

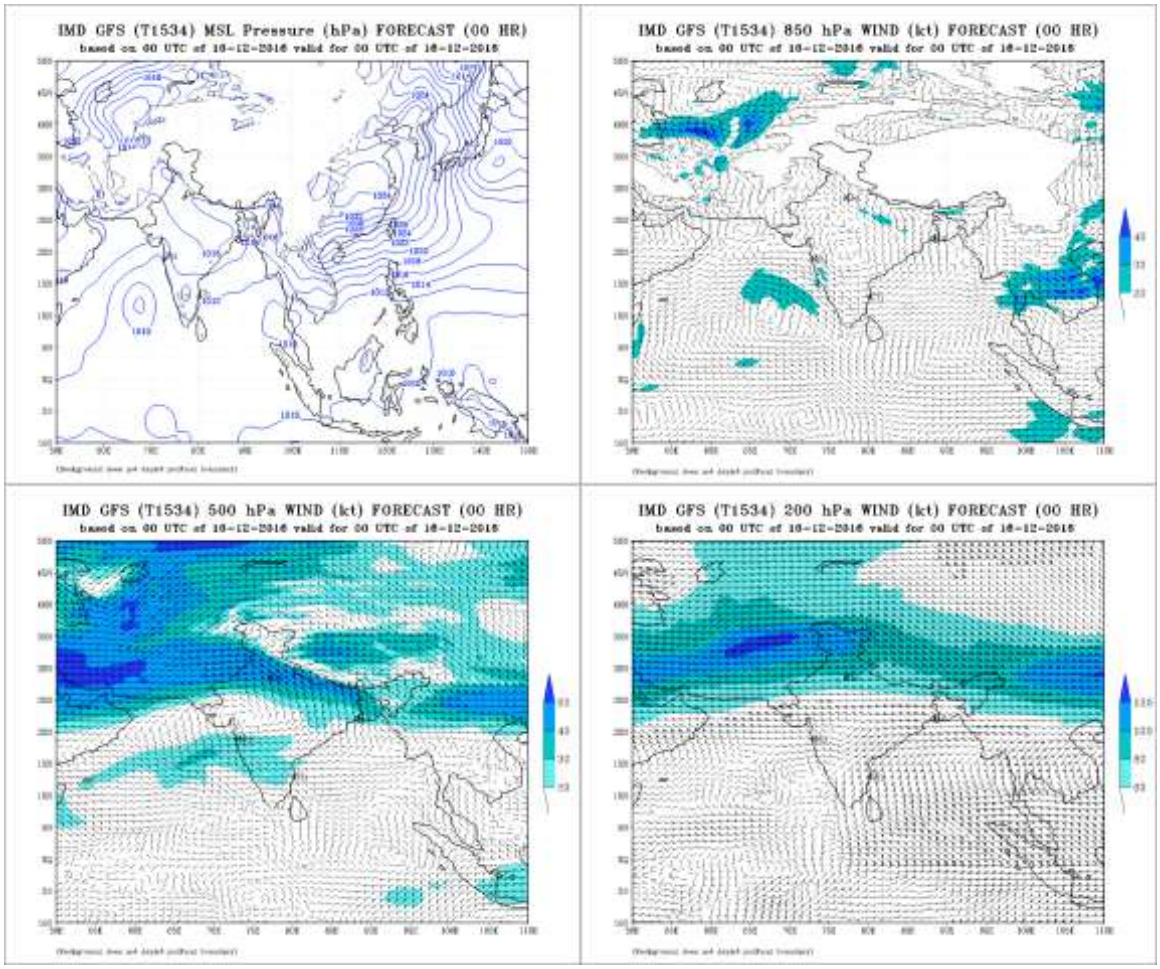
12Z /15.12.2016 : 2
No. of Ascents reaching 250 hPa level =2
MISDA : 6

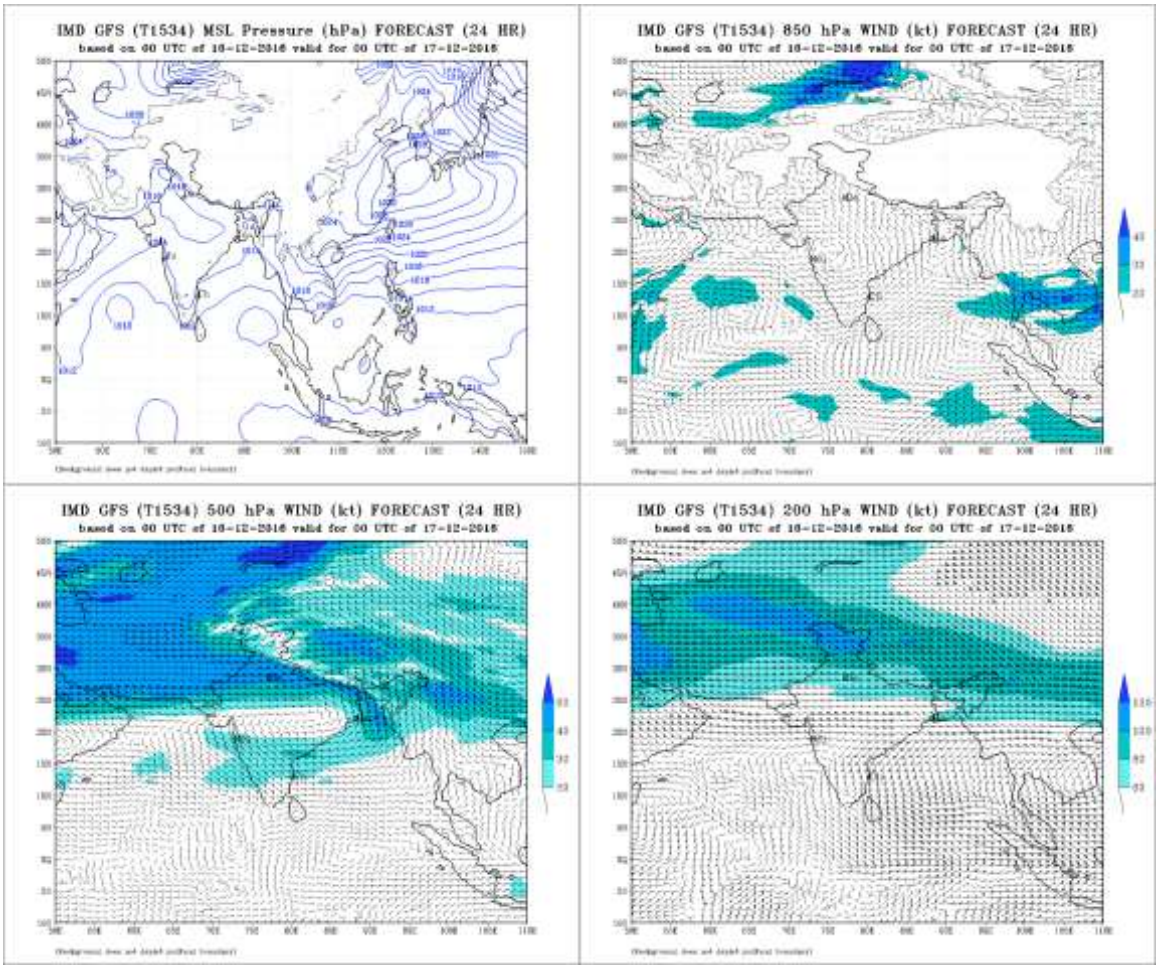
No. of PILOT Ascents:

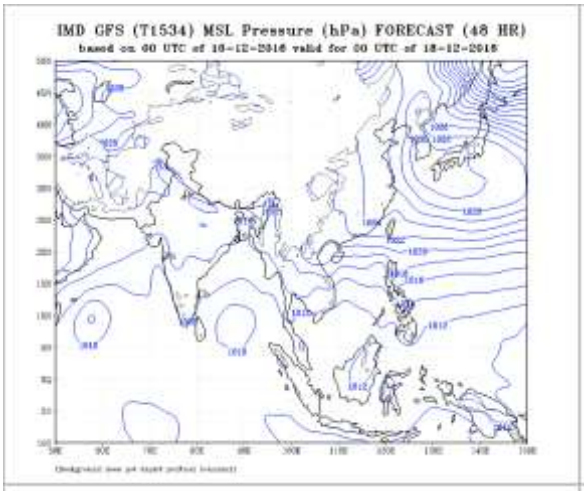
15.12.2016	
06Z	18Z
5	4

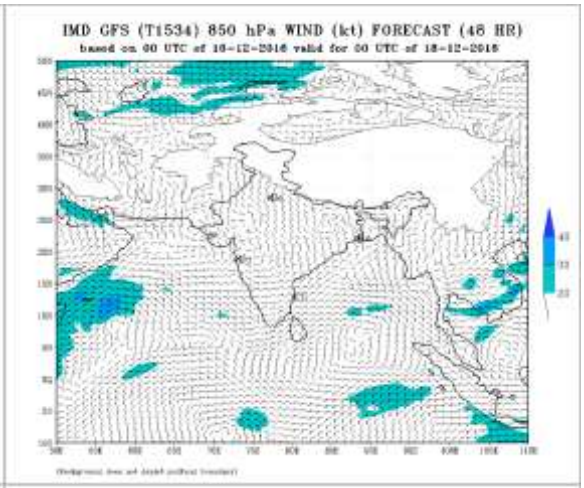
Annexure-II

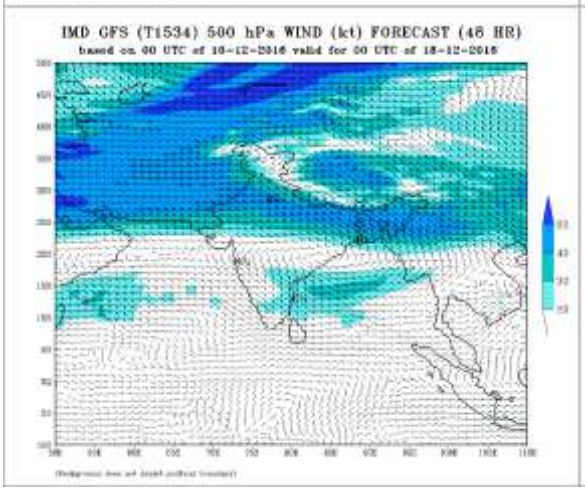

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 16-12-2016 valid for 0000 UTC of 16-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 16-12-2016 valid for 0000 UTC of 17-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 16-12-2016 valid for 0000 UTC of 18-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 16-12-2016 valid for 0000 UTC of 19-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 16-12-2016 valid for 0000 UTC of 20-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 16-12-2016 valid for 0000 UTC of 21-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

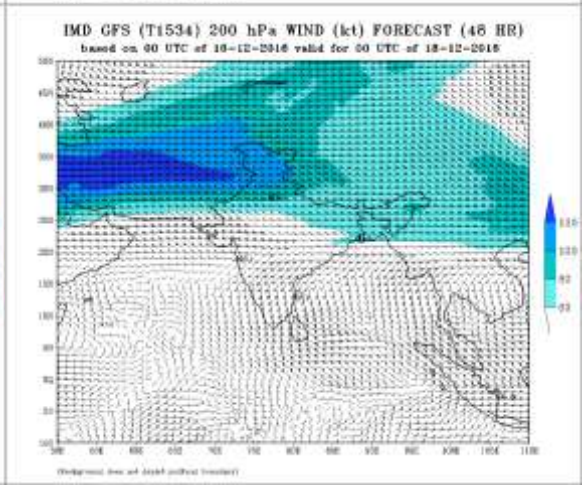

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 16-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 16-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 16-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 16-12-2016

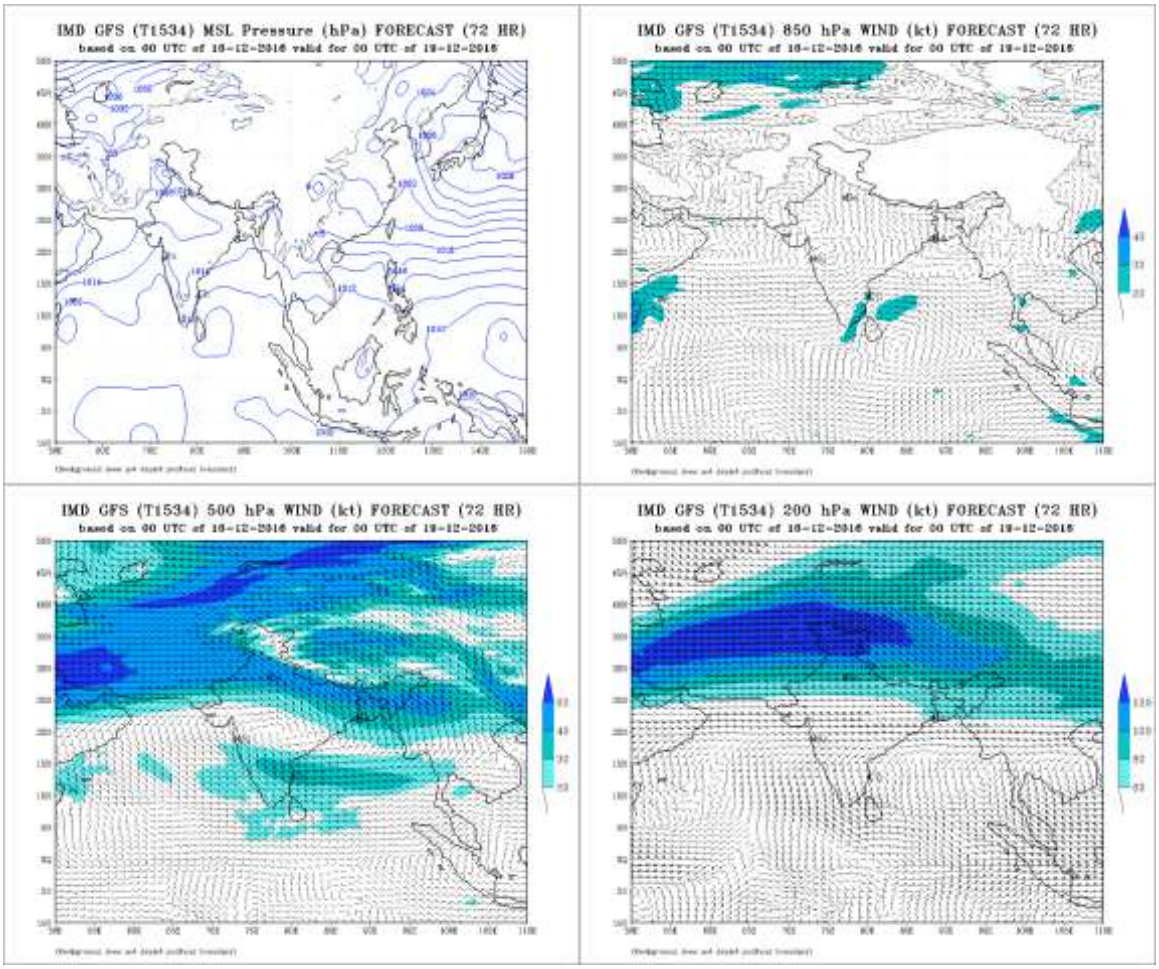

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 17-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 17-12-2016

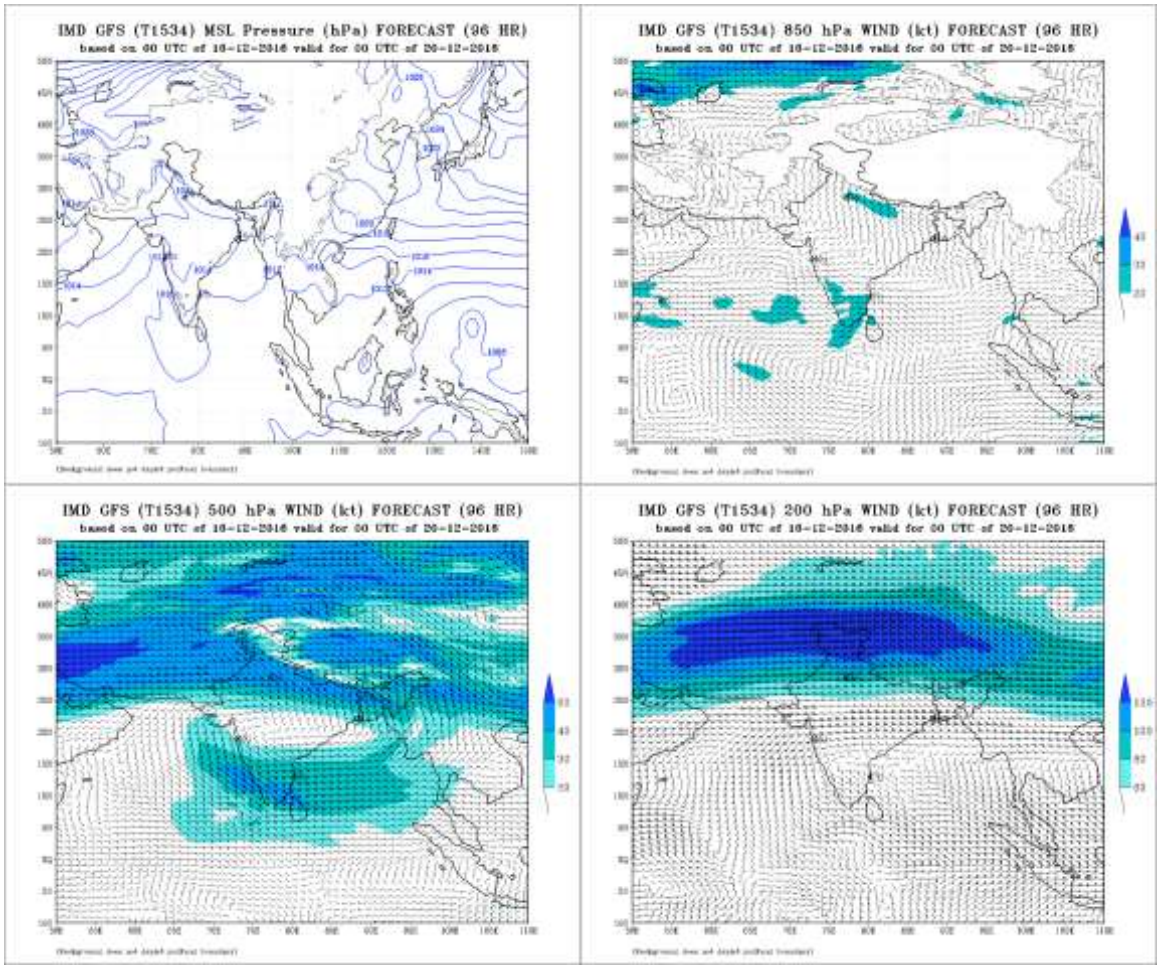

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 18-12-2016

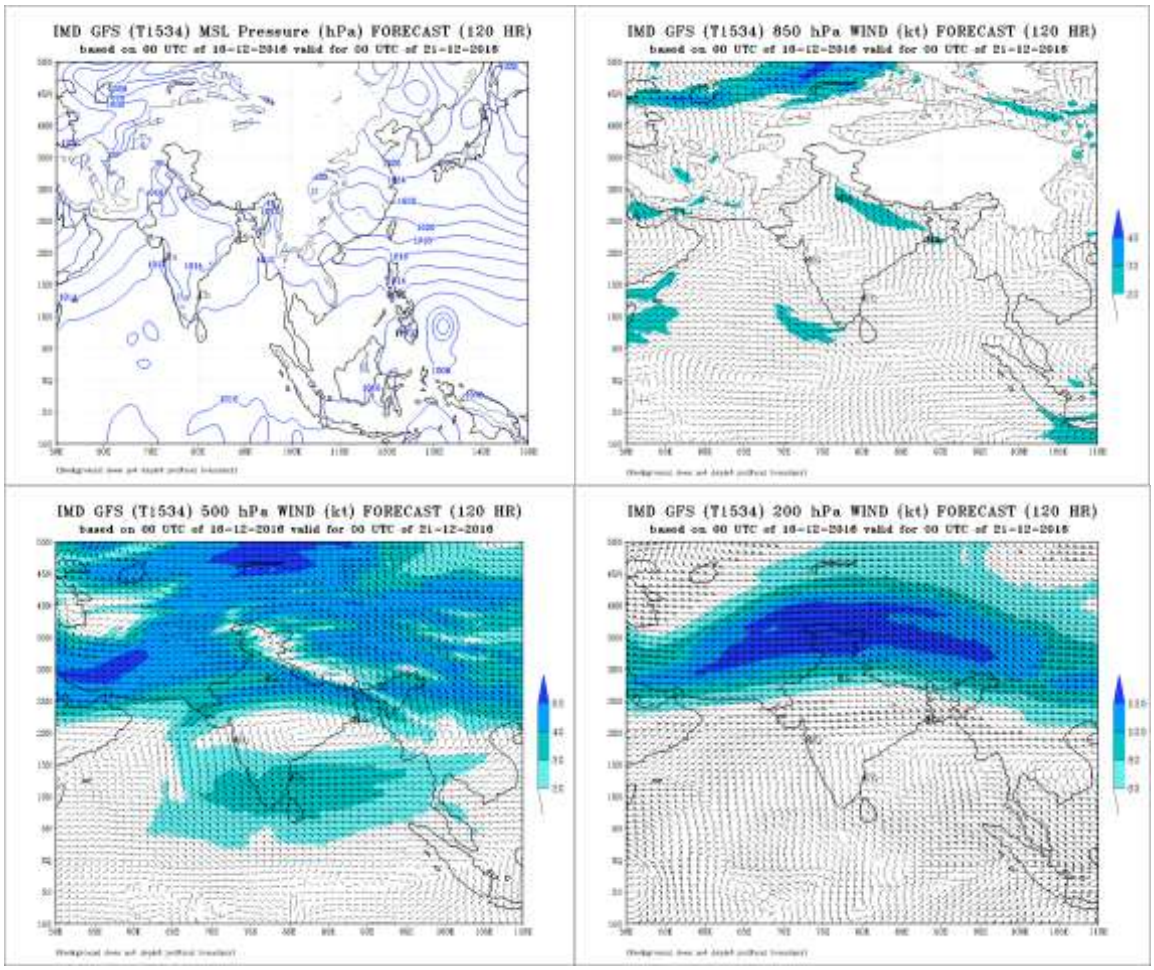

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 18-12-2016


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 18-12-2016


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 18-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 19-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 20-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 20-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 20-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 20-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 21-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 21-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 21-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 16-12-2016 valid for 00 UTC of 21-12-2016

FDP (Cyclone) NOC Report Dated 17th December 2016

Synoptic features:

The low pressure area over southeast Arabian Sea and neighbourhood moved westwards and became well marked over central parts of south Arabian Sea in the early morning hours. Further moving westwards, it concentrated into a Depression and lay centred at 0830 hrs IST of today, the 17th Dec. 2016 over southwest Arabian Sea, near Lat. 11.0°N / Long. 62.5°E, about 1110 kms west of Amini Divi, 950 kms east-southeast of Socotra (Yemen) and 1250 kms east-southeast of Bereeda (Somalia). The system is very likely to move nearly westwards and is likely to intensify into a deep depression during next 24 hrs.

The trough of low at mean sea level over Tenasserim coast and adjoining south Andaman Sea now lies over south Andaman Sea and neighbourhood with the cyclonic circulation aloft extending upto mid tropospheric levels.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is about 26-28˚C around the system area. It decreases to the west and southwest of the system.

Relative Vorticity:

The low-level relative vorticity about 70-80 $x10^{-6}$ s^{-1} seen over system centre in Arabian Sea.

An area with low-level relative vorticity about 40 $x10^{-6}$ s^{-1} seen over Malay Peninsula and adjoining Gulf of Thailand.

Convergence:

Low level convergence about 5-10 $x10^{-6}$ s^{-1} is seen around the system centre. Another area of positive convergence around 5 $x10^{-6}$ s^{-1} is seen over Malay Peninsula and adjoining Gulf of Thailand and Andaman Sea.

Divergence:

There is an area of positive upper level divergence 20 $x10^{-6}$ s^{-1} over Gulf of Thailand and adjoining Malay Peninsula.

Over the system area positive divergence with value 10 $x10^{-6}$ s^{-1} is seen.

Wind Shear:

Low to moderate wind shear of horizontal wind is seen over Andaman Sea, and neighbouring Malay Peninsula and Gulf of Thailand. The wind shear is low to moderate over the system centre and also over entire south and central Arabian Sea. It is high over north Arabian Sea.

Wind Shear Tendency:

Decreasing wind shear tendency is seen over Andaman Sea.

There is neutral tendency over the system area. Decreasing tendency is seen over small isolated pockets over northeast and east central Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low/ medium clouds with embedded intense to very intense convection is seen over Andaman and Nicobar islands. Scattered low/medium clouds with embedded isolated moderate to intense convection are seen over SE and adjoining EC Bay and central Andaman Sea.

Arabian Sea

According to satellite imagery vortex is seen over Arabian Sea centred near 10.6^0 N/61.2^0 E with intensity T1.5. Associated scattered low/ medium clouds with embedded moderate to intense convection are seen over SE Arabian Sea between latitude 9.0^0 N to 14.0^0 N and long 57.5^0 E to 63.7^0 E.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 15^0N latitude over BoB. The ridge over Arabian Sea lies along 16^0N

M.J.O. Index:

MJO index lies in Phase 5 with very low amplitude. It would continue in phase 5 with low amplitude during the next three days.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The forecast based on analysis of 00UTC on 17th December indicates the depression area over EC Arabian Sea moves in a WSW direction till 18th and is seen near north Somali coast on 19th as a low. It becomes less marked on 20th. Another low is seen on analysis field over south Andaman Sea and adjoining SE Bay, which moving in a westward direction is seen near Sri Lanka coast on 19th. The low becomes unimportant on 20th.

NCEP-GFS: The analysis on 17th and forecast fields show a depression over EC Arabian Sea which moving in a west-southwestward direction becomes low on 18th. It is seen off Somali coast on 19th and becomes less marked on 20th.

ECMWF: The analysis on 17th and forecast fields show a depression over EC Arabian Sea on 18th which is seen moving in a west-southwestward direction. It is seen off north Somali coast on 19th as a low and becomes less marked on 20th

Meteo-France ARP Model: The forecast based on 17th 00UTC analysis shows that the well marked low in the analysis field is seen moving in a south-westward direction and is seen off north Somali coast on 19th. It becomes less marked on 20th. Another low is over South Andaman Sea and adjoining SE Bay which moves in a west direction and lies over Sri Lanka on 20th.

JMA: The analysis field on 17th shows a low over northern parts of SW Arabian Sea, which moves west-southwestwards till 18th and becomes less marked on 19th over the sea. Another low is seen in the analysis field over south Andaman Sea which becomes less marked on 18th.

NCUM: The analysis on 17th indicates the low pressure system over SE Arabian Sea which moving in a west-southwestward direction becomes weaker on 18th and becomes less marked on 19th over northern parts of Somali coast.

NCMRWF- NEPS: The analysis on 17th show a depression over SE Arabian Sea which moving a west-southwestward direction is seen as a low on 19th northern parts of Somali coast, which becomes less marked on 20th.

IITM GEFS: The forecast based on 17th December analysis shows a low pressure area over northern parts of SW Arabian Sea and adjoining SE Arabian Sea on 18th which moving in a WSW direction is seen off the coast of north Somali on 19th and becomes less marked thereafter. Another low is seen over SE Bay on 18th which moving in a westward direction becomes unimportant on 20th over Comorin area.

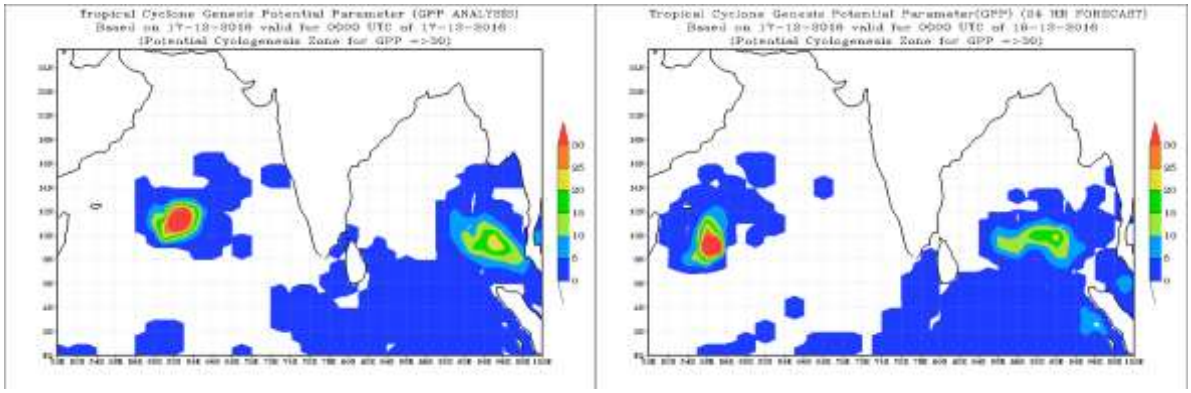
IMD GPP: The GPP forecast fields shows a significant zone of GPP over northern parts of SE and adjoining SE Arabian Sea on 17th analysis, which moving in a westward direction is seen over SW Arabian Sea, off northern Somali coast on 19th and becomes less marked on 20th.

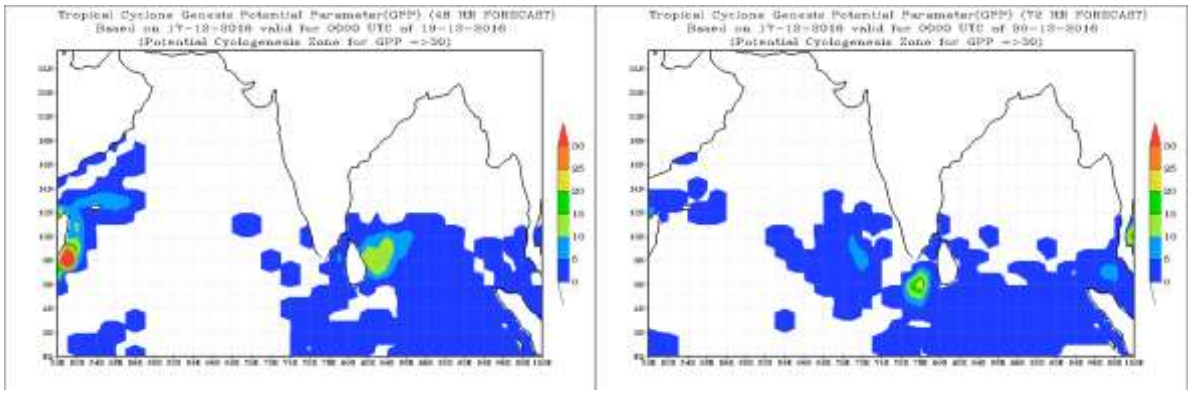
Summary and Conclusion:

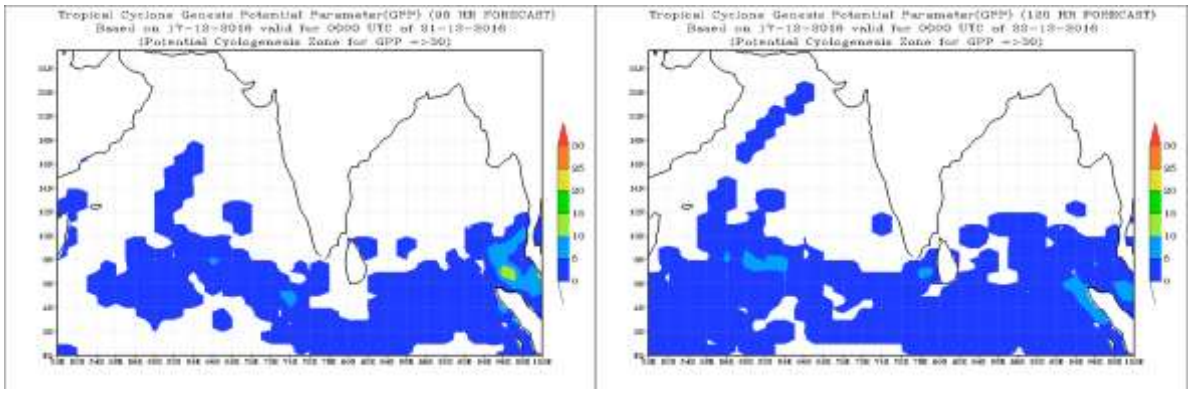
Most of the models are indicating that the depression over SE Arabian Sea to take a west-southwestward movement towards north Somali coast by 19th December without significant intensification over Arabian Sea. IMD GPP forecast indicates a significant zone (>30) over Arabian Sea in the analysis field which moves in a west-southwestward direction. On 19th the zone is seen off Somali coast and becomes less marked on 20th.

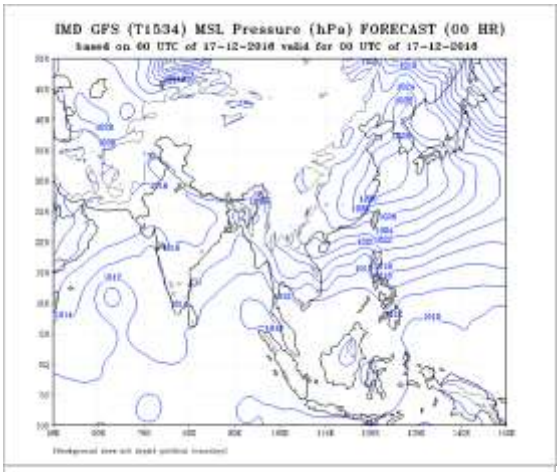
The environmental parameters are favourable for slight intensification of the system for the next 24 hours. Thereafter it will start showing weakening trend as the system approaches the coast, it will encounter cold sea waters. **IOP : No IOP for the next 5 days.**

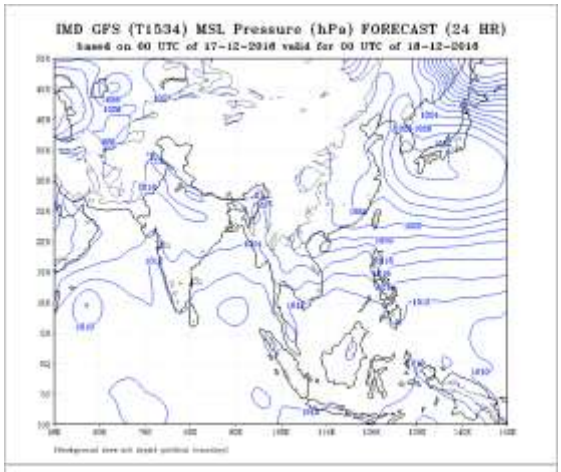
Annexure

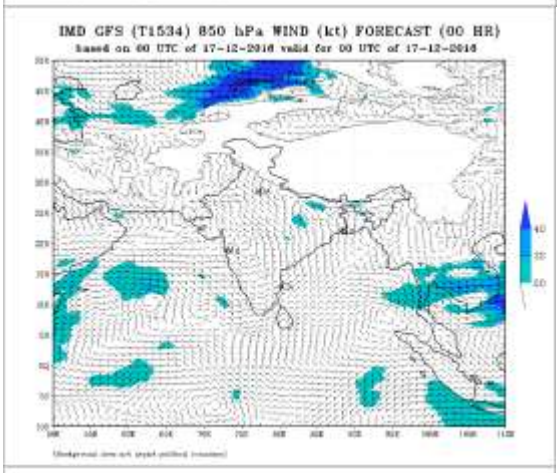

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 17-12-2016 valid for 0000 UTC of 17-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 17-12-2016 valid for 0000 UTC of 18-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

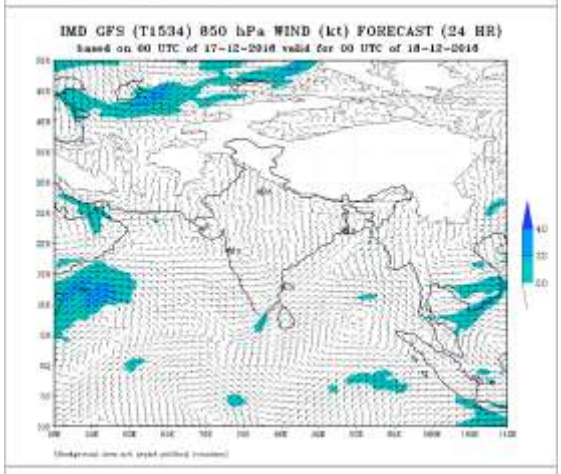

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 17-12-2016 valid for 0000 UTC of 19-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 17-12-2016 valid for 0000 UTC of 20-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

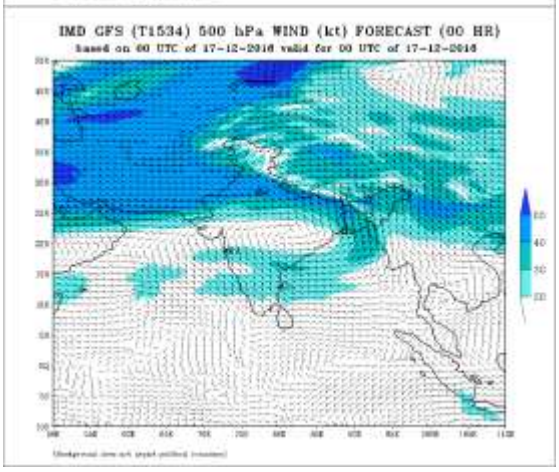

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 17-12-2016 valid for 0000 UTC of 21-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 17-12-2016 valid for 0000 UTC of 22-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

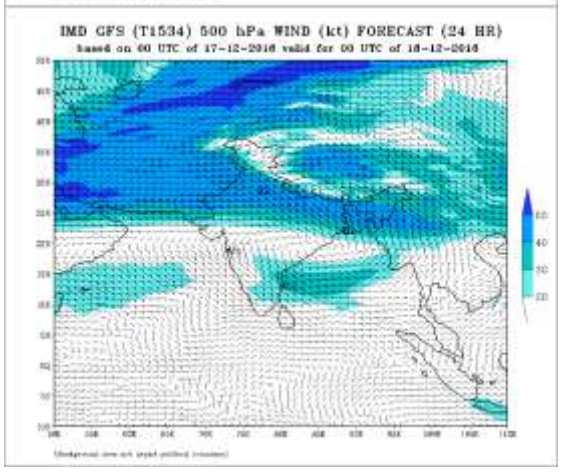

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 17-12-2016

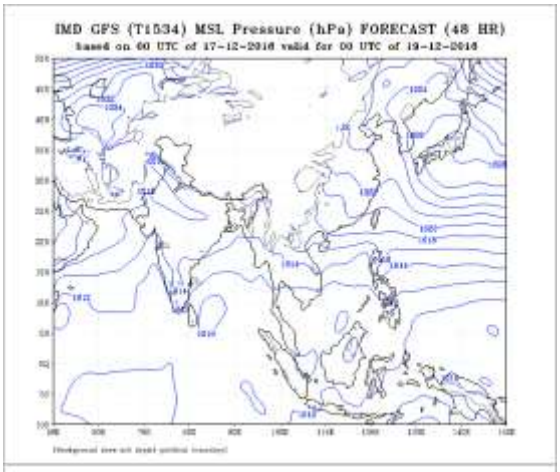

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 18-12-2016

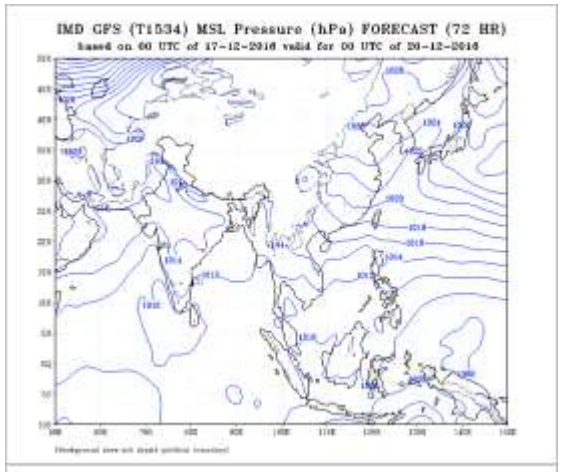

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
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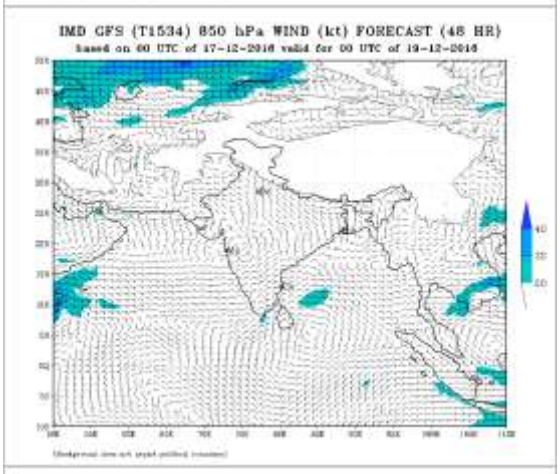

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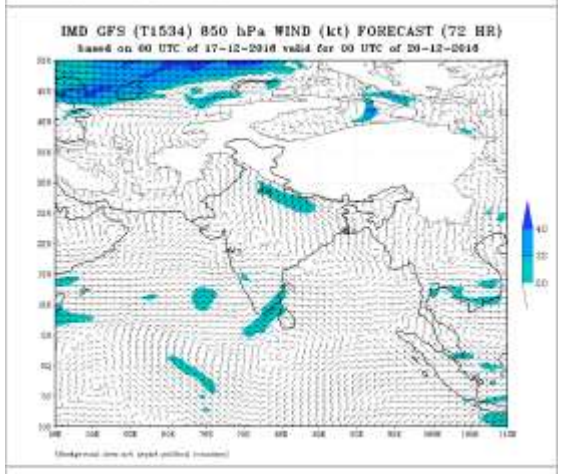

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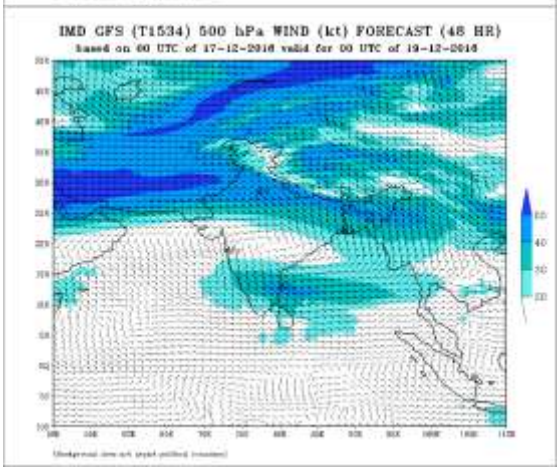

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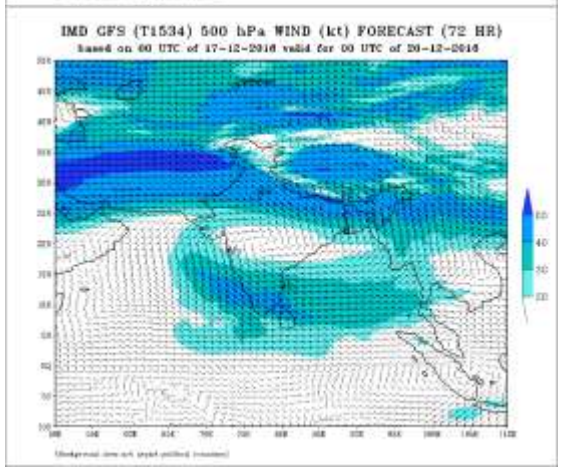

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 19-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 20-12-2016

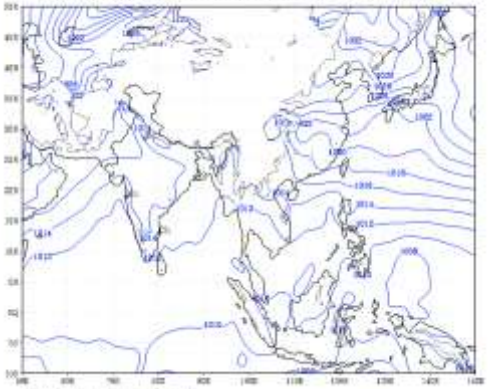

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 19-12-2016


IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 20-12-2016

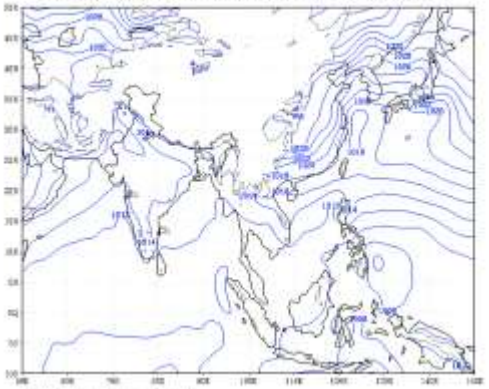

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 19-12-2016


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 20-12-2016

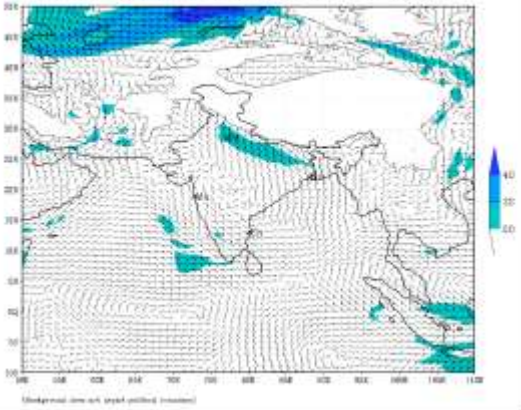
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 21-12-2016



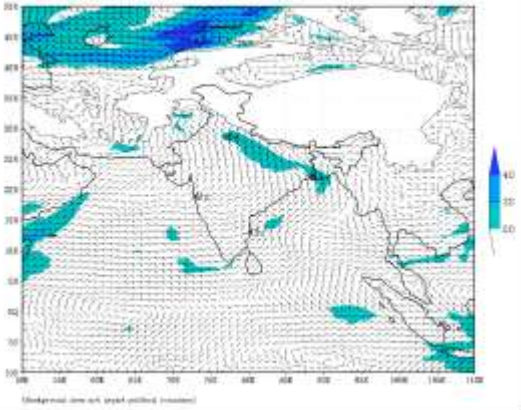
IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 22-12-2016



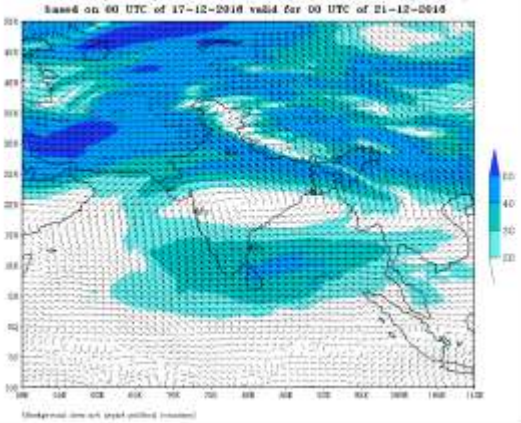
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 21-12-2016



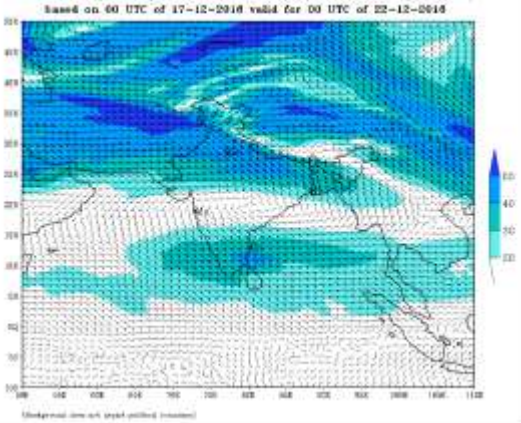
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 22-12-2016



IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 21-12-2016



IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 17-12-2016 valid for 00 UTC of 22-12-2016



FDP (Cyclone) NOC Report Dated 18th December 2016

Synoptic features:

The Depression over southwest Arabian sea moved west-southwestwards and lay centred at 0830 hours IST of today, the 18th December 2016 near latitude 9.4°N and longitude 56.8°E, about 1750 km west-southwest of Amini Divi, 480 km southeast of Socotra (Yemen) and 680 km east-southeast of Bereeda (Somalia). The system is very likely to continue to move west-southwestwards, weaken into a low pressure area and reach north Somali coast in next 24 hours. The trough of low pressure area at mean sea level over south Andaman Sea & neighbourhood now lies over southeast Bay of Bengal and neighbourhood and the associated upper air cyclonic circulation extends upto mid tropospheric levels.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is below 27˚C to the north of 15˚N over Arabian Sea. It increases to the south.

Relative Vorticity:

The low-level relative vorticity about 115 $x10^{-6}$ s^{-1} seen over the centre of the system in Arabian Sea.
An area with low-level relative vorticity about 20 $x10^{-6}$ s^{-1} seen over south Bay and another area over extreme north Bay.

Convergence:

Low level convergence about 5 $x10^{-6}$ s^{-1} is seen at the system centre. Another area of positive convergence around 5-10 $x10^{-6}$ s^{-1} is seen over south Andaman Sea.

Divergence:

There is are no areas of positive upper level divergence over Bay.
Over the system area positive divergence with value 5 $x10^{-6}$ s^{-1} is seen.

Wind Shear:

Low to moderate wind shear of horizontal wind is seen over central Bay. It increases to north and to the south.
The wind shear is moderate over the system centre. It is high over extreme south and north Arabian Sea and also near Somali Coast.

Wind Shear Tendency:

Decreasing wind shear tendency is seen over WC and adjoining south Bay of Bengal.
There is neutral tendency over the system area in Arabian Sea. Decreasing tendency is seen over north and central Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low/ medium clouds with embedded moderate to intense convection is seen over Andaman and Nicobar islands. Scattered low/medium clouds with embedded isolated moderate to intense convection are seen over south Bay and south Andaman Sea.

Arabian Sea

According to satellite imagery vortex is seen over Arabian Sea centred near 9.3^0 N/54.6^0 E with intensity T1.0. Associated scattered low/ medium clouds with embedded moderate to intense convection seen over SW Arabian Sea between latitude 7.5^0 N to 12.0^0 N and long 54.0^0 E to 57.0^0 E.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 16^0N latitude over BoB. The ridge over Arabian Sea lies along 16^0N

M.J.O. Index:

MJO index lies in Phase 5 with very low amplitude. It would continue in phase 5 with low amplitude during the next three days.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The forecast based on analysis of 00UTC on 18th December indicates the depression area over SW Arabian Sea moves in a WSW direction and is seen off north Somali coast on 19th as a low. It becomes less marked on 20th.

IMD WRF: The depression over SW Arabian Sea seen in the analysis is seen as a low on 19th near northern parts of Somali coast. It becomes less marked on 20th.

NCEP-GFS: The analysis on 18th and forecast fields show the depression over SW Arabian Sea on the analysis field moving in a west-southwestward direction becomes low and is seen off Somali coast on 19th and becomes less marked on 20th.

ECMWF: The analysis on 18th and forecast fields show the depression over SW Arabian Sea on 18th is seen moving in a west-southwestward direction. It is seen off north Somali coast on 19th and becomes unimportant on 20th

NCUM: The analysis on 18th indicates the depression over SW Arabian Sea which moving in a west-southwestward direction becomes a low on 19th off the coast of north Somali and becomes less marked on 20th th.

NCMRWF- NEPS: The analysis on 18th show a low over SE Arabian Sea and another low over SW Bay of Bengal. Both the systems are seen to become less marked on 19th.

IITM GEFS: The forecast for 19th based on 18th December analysis shows a low pressure area over northern parts of SW Arabian Sea, off the coast of north Somali on 19th which becomes less marked thereafter. No other low pressure is seen to develop for the rest of the forecast period.

IMD GPP: The significant zone of GPP over SW Arabian Sea on 18th analysis is seen moving in a westward direction and is seen off northern Somali coast on 19th which becomes less marked on 20th. No other significant GPP zone is seen forming in the rest of the forecast period.

Summary and Conclusion:

Majority of the models are indicating that the depression over SW Arabian Sea to take a west-southwestward movement and reach north Somali coast by 19th December as a weaker system. IMD GPP forecast indicates a significant zone (>30) over Arabian Sea in the analysis field which moves in a westward direction and on 19th the zone is seen off Somali coast and becomes less marked on 20th.

The environmental parameters are indicative of weakening of the system as the system approaches the coast it will encounter cold sea waters and high wind shear.

Considering all the above, it is expected that the depression over SW Arabian Sea to weaken and move in a west-southwestward direction and reach north Somali coast as a low by 19th December.

IOP : No IOP for the next 5 days.

Annexure I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	17/12	18/00	18/03
India	42	31	45
Coastal stations			
WB	9	3	8
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	2	3
Myanmar	0	1	1
Thailand	3	3	3
Sri Lanka	6	8	9

AWS:

Region	Date/Time (UTC)		
	17/12	18/00	18/03
WB	2	4	3
Odisha	3	2	5
AP	7	2	8
Tamil Nadu	23	6	20
Puducherry	1	1	1
A & N	0	0	0

RS/RW (12Z) of 17/12/2016 : 14/ 43

No. of Ascents reaching 250 hPa levels: 12 , MISDA:- 3

RS/RW (00Z) of 18/12/2016 : 27 /43

No. of Ascents reaching 250 hPa levels: 23 ,MISDA: 4

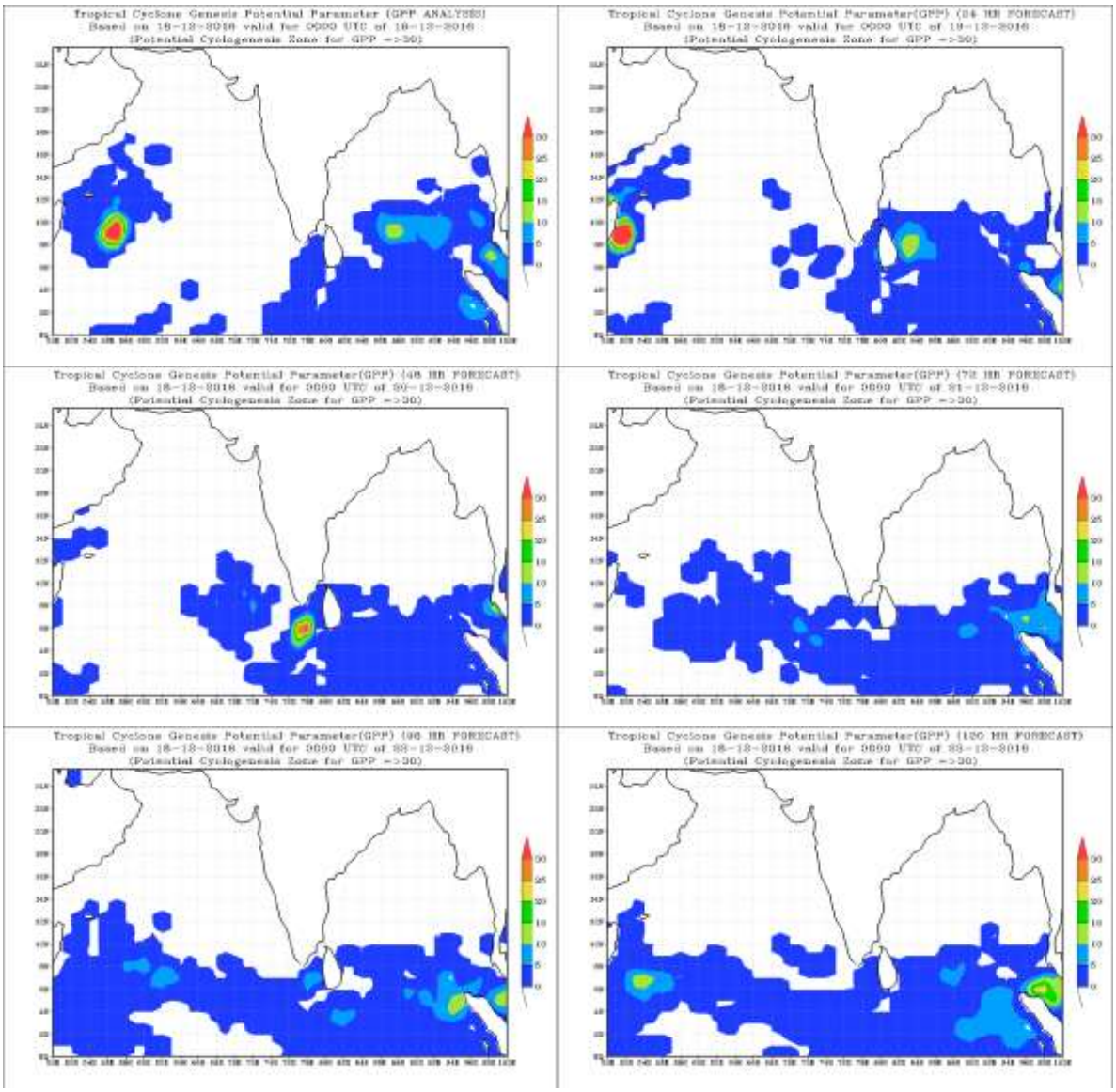
- **No. of PILOT Ascents**

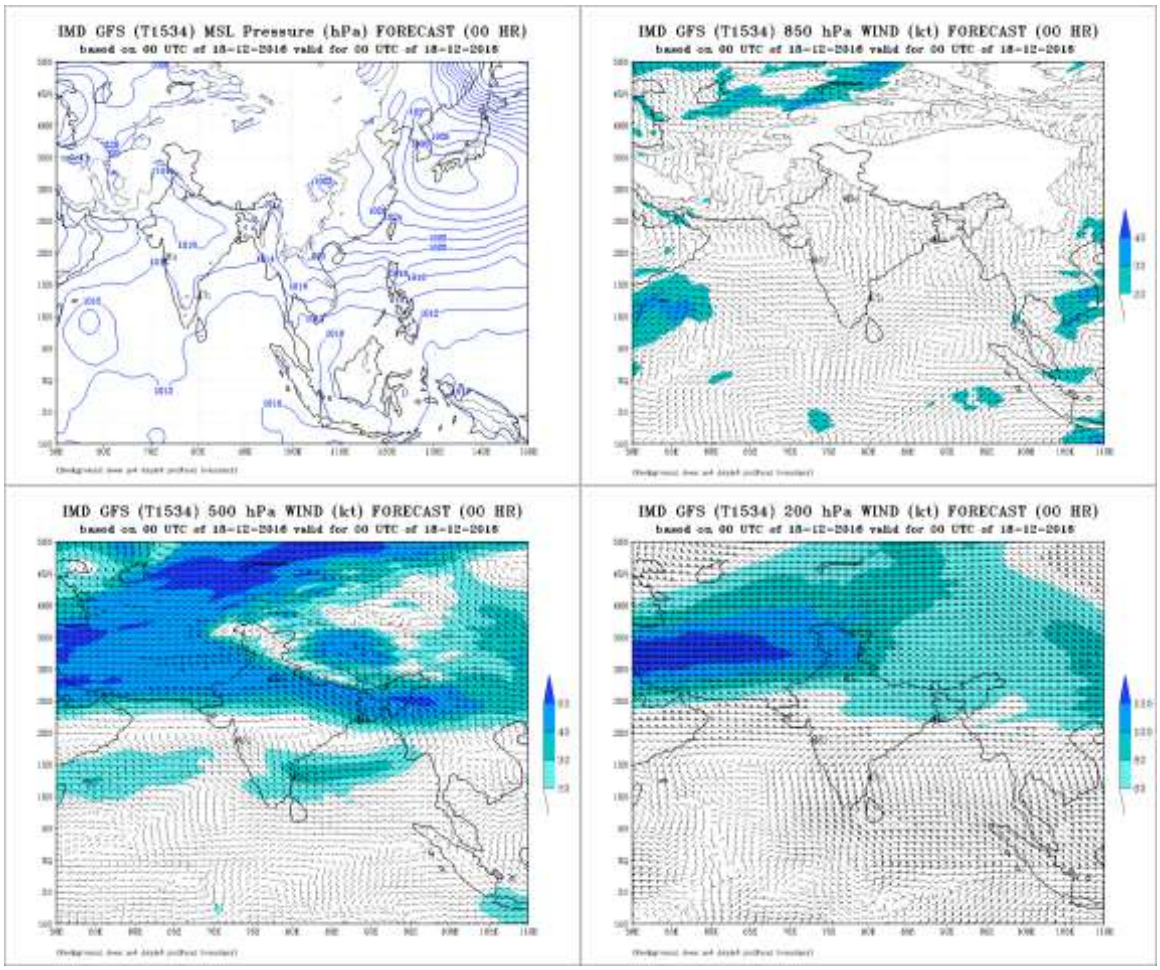
17 /12Z	18/00Z
18	12

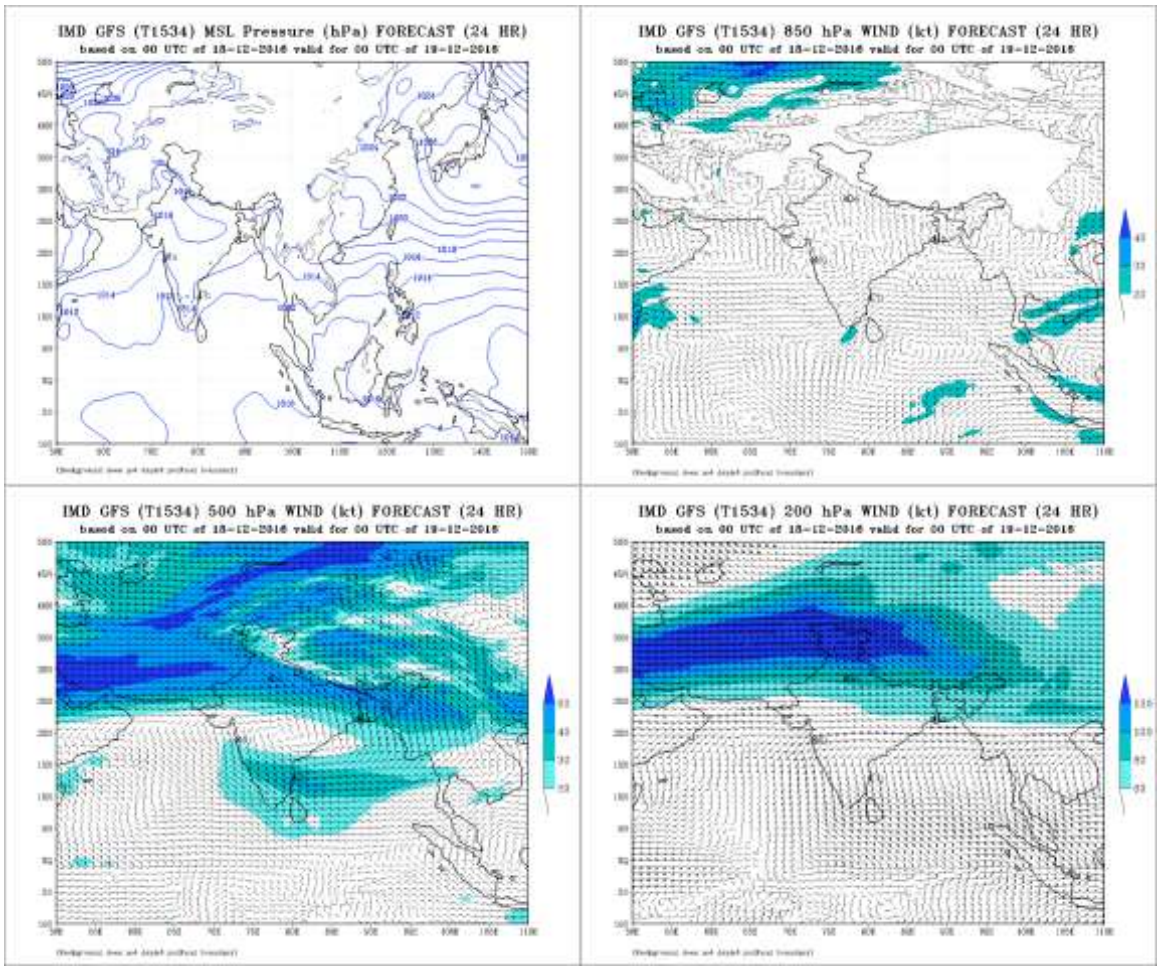
Buoy Data

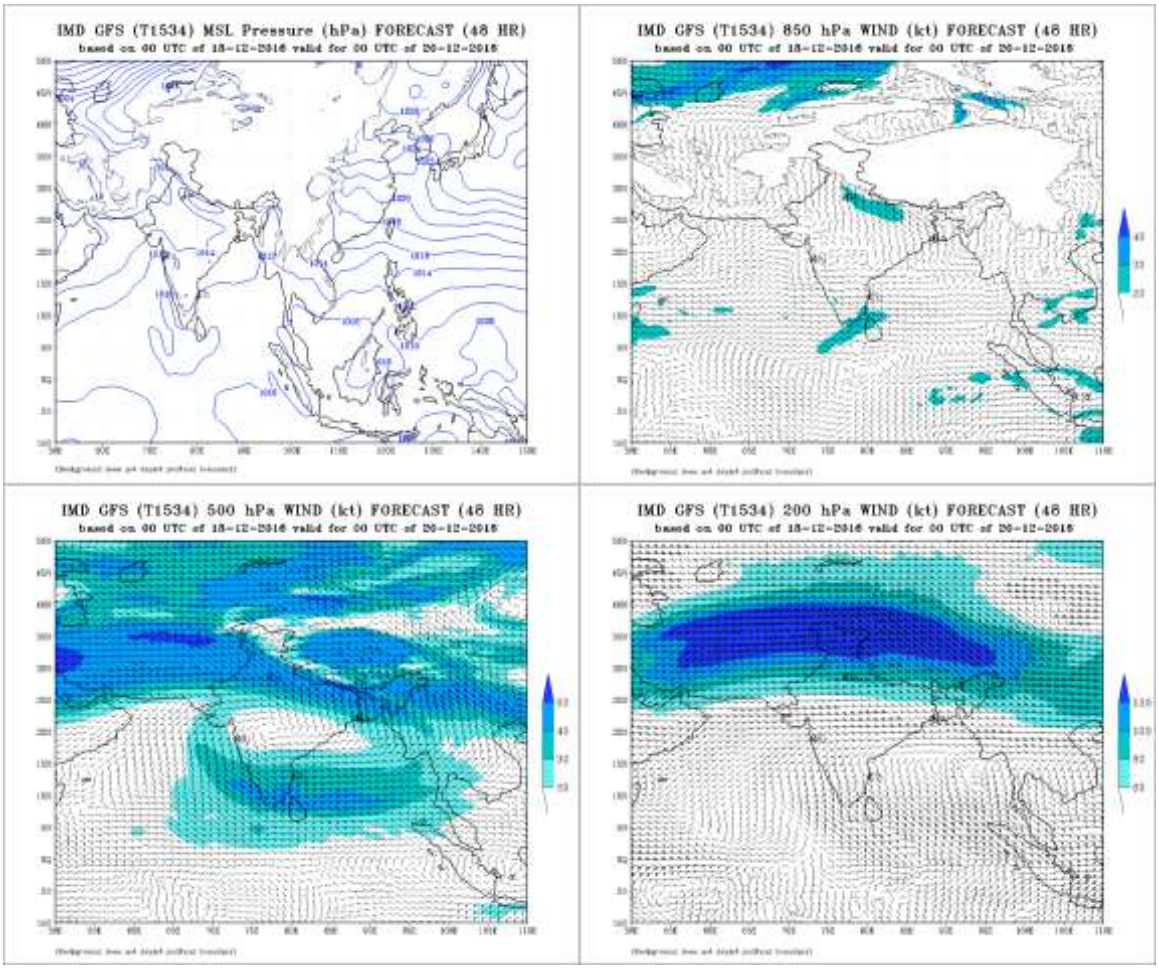
17/12Z	18/00Z	18/03Z
12	10	12

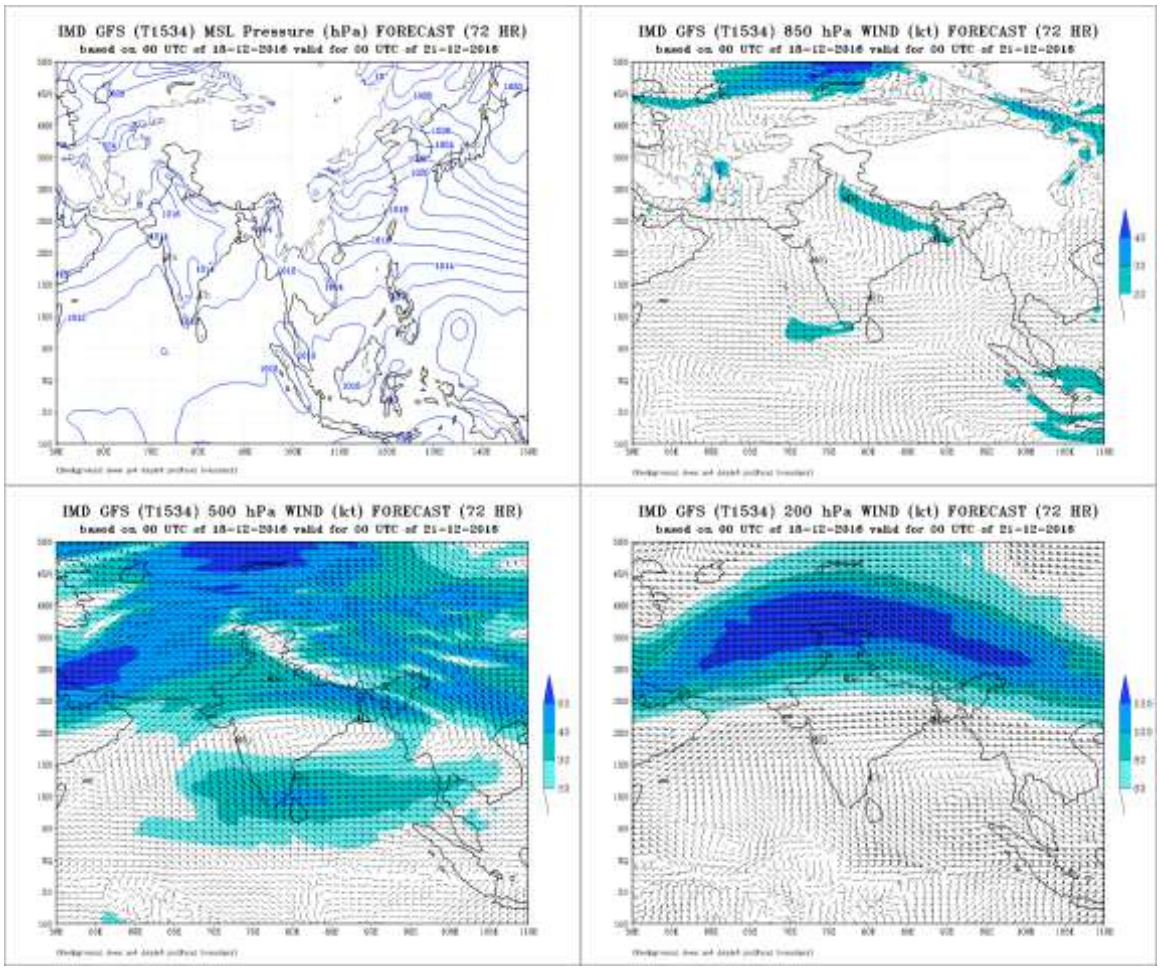
Annexure II

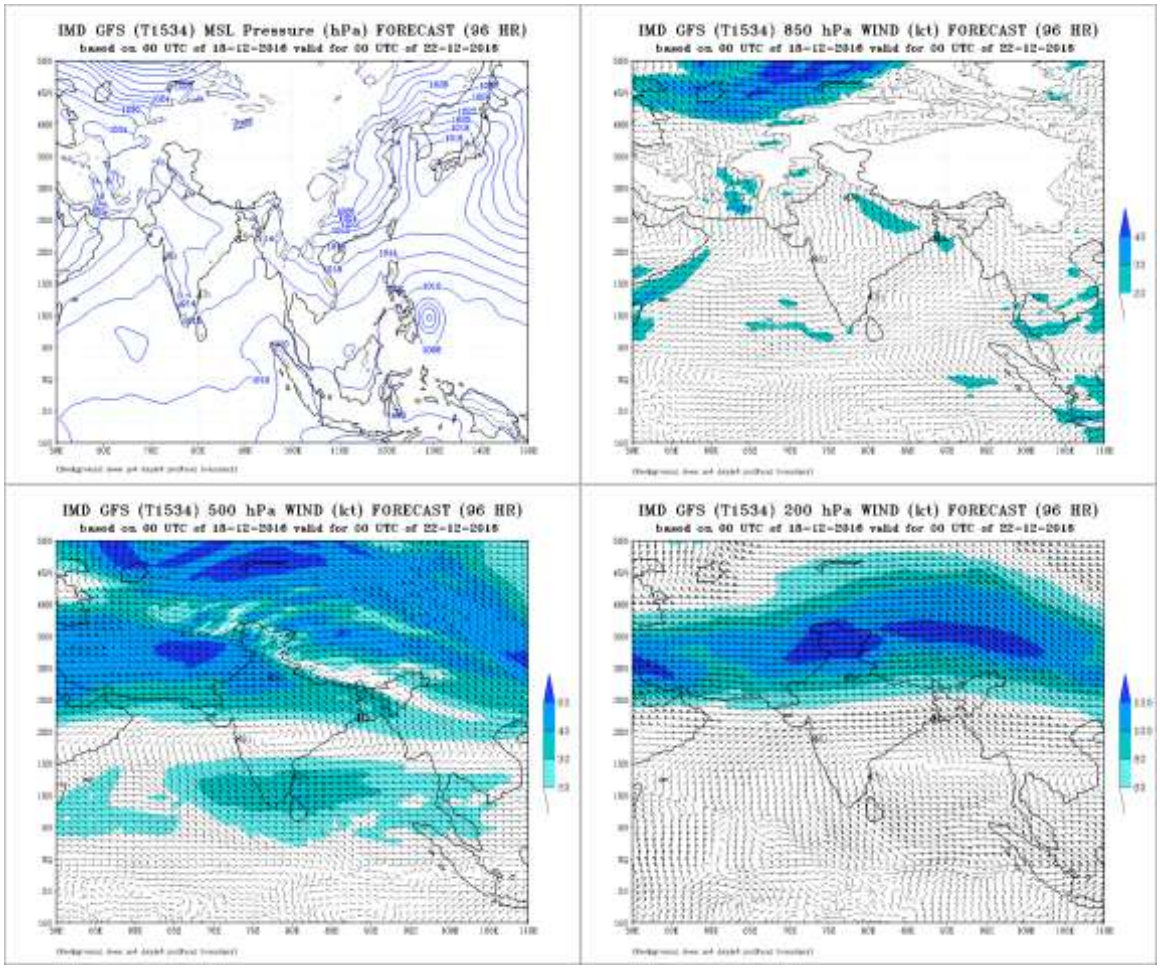

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 18-12-2018 valid for 0000 UTC of 18-12-2018
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 18-12-2018 valid for 0000 UTC of 19-12-2018
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 18-12-2018 valid for 0000 UTC of 20-12-2018
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 18-12-2018 valid for 0000 UTC of 21-12-2018
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 18-12-2018 valid for 0000 UTC of 22-12-2018
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 18-12-2018 valid for 0000 UTC of 23-12-2018
(Potential Cyclogenesis Zone for GPP =>30)

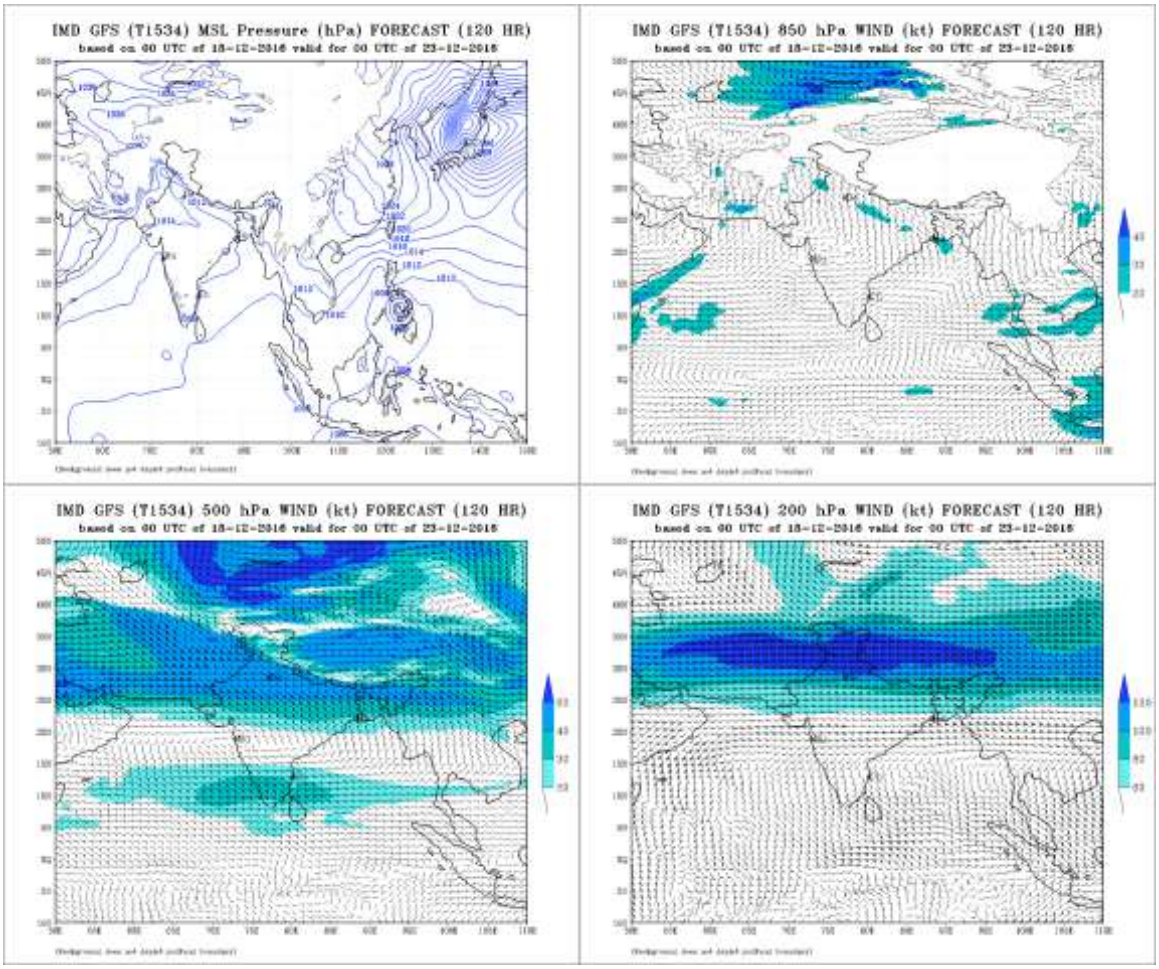

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 18-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 18-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 18-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 18-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 19-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 19-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 19-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 19-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 18-12-2016 valid for 00 UTC of 20-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 18-12-2016 valid for 00 UTC of 20-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 18-12-2016 valid for 00 UTC of 20-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 18-12-2016 valid for 00 UTC of 20-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 21-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 21-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 21-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 21-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 22-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 22-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 22-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 18-12-2018 valid for 00 UTC of 22-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 18-12-2016 valid for 00 UTC of 23-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 18-12-2016 valid for 00 UTC of 23-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 18-12-2016 valid for 00 UTC of 23-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 18-12-2016 valid for 00 UTC of 23-12-2016

FDP (Cyclone) NOC Report Dated 19th December 2016

Synoptic features:

The Depression over southwest Arabian Sea further moved west-southwestwards and weakened into a well marked low pressure area over southwest Arabian Sea in the forenoon of yesterday, th 18th of December 2016, and persisted there in the evening. It further moved westwards and weakened further today morning. The trough of low at mean sea level over southeast Bay of Bengal and neighbourhood now lies over southwest Bay of Bengal and neighbourhood with the cyclonic circulation aloft extending upto 2.1 kms a. s. l.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is below 27˚C to the north of 15˚N over Arabian Sea as well as in Bay of Bngal. It increases to the south.

Relative Vorticity:

The low-level relative vorticity about 5o $x10^{-6}$ s^{-1} seen over SW Arabian Sea near north Somali coast. An area with low-level relative vorticity about 20 $x10^{-6}$ s^{-1} seen over southwest Bay near Sri Lanka.

Convergence:

Low level convergence about 5 $x10^{-6}$ s^{-1} is seen over small pockets near Sumatra and south Andaman Sea and near Sri Lanka. Another area of positive convergence around 5-10 $x10^{-6}$ s^{-1} is seen over north Somali Coast.

Divergence:

There is an area of positive upper level divergence near Sumatra over south Andaman Sea and adjoining equatorial oceans.

An area of positive divergence with value 5-10 $x10^{-6}$ s^{-1} is seen over north Somali coast and neighbouring SW Arabian Sea.

Wind Shear:

Low to moderate wind shear is seen over south and central Bay. It is high over north Bay.

The wind shear is low to moderate over south and central Arabian Sea. It is high over north Arabian Sea and also near Somali Coast.

Wind Shear Tendency:

Decreasing wind shear tendency is seen over WC and adjoining south Bay of Bengal.

There is increasing tendency central parts of Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low/medium clouds with embedded isolated moderate to intense convection are seen over southwest Bay and south Andaman Sea. Scattered low/ medium clouds with embedded weak convection is seen over Nicobar islands.

Arabian Sea

Scattered low/ medium clouds with embedded moderate to intense convection seen over northeast Somalia, adjoining Gulf of Aden and adjoining SW Arabian Sea in association with the low level circulation over the area.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 16^0N latitude over BoB. The ridge over Arabian Sea lies along 14^0N

M.J.O. Index:

MJO index lies in Phase 5 with amplitude less than 1. It would continue in phase 5 with low amplitude during the next three days.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The forecast based on analysis of 00UTC on 19th December gives no indication of formation of low pressure systems over Indian Seas for the next 10 days.

IMD WRF: The forecast based on analysis of 00UTC on 19th December gives no indication of formation of low pressure systems over Indian Seas for the next 3 days.

NCEP-GFS: Similar inference as that of IMD GFS.

ECMWF: The forecast fields also do not show indication of formation of low pressure systems over Indian Seas for the next 3 days.

NCUM: No indication of any significant low pressure systems for the coming 10 days.

NCMRWF- NEPS: Inference is same as that of NCUM.

IITM GEFS: No indication of any significant low pressure systems for the coming 10 days.

IMD GPP: A small area of significant value of GPP is seen over SW Arabian Sea near north Somali coast in the analysis field on 19th which becomes less marked on 20th. No other significant GPP zone is seen forming in the rest of the forecast period.

Summary and Conclusion:

Majority of the models are indicating that no significant low pressure systems will form over Indian seas in the next few days.

No low pressure area is expected to form over the north Indian Ocean during next five days.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : No IOP for the next 5 days.

Annexure- I

Status of observational system:

Synoptic observation:

Region	Date/Time (UTC)		
	18/12	19/00	19/03
India	41	31	46
Coastal stations			
WB	8	3	9
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	0	3	2
Myanmar	0	0	1
Thailand	3	3	3
Sri Lanka	6	8	8

AWS:

Region	Date/Time (UTC)		
	18/12	19/00	19/03
WB	3	4	4
Odisha	4	2	5
AP	7	3	5
Tamil Nadu	23	7	18
Puducherry	1	1	1
A & N	0	0	0

RS/RW (12Z) of 18/12/2016 : 13/ 43

No. of Ascents reaching 250 hPa levels: 11 , MISDA:- 2

RS/RW (00Z) of 19/12/2016 : 28 /43

No. of Ascents reaching 250 hPa levels: 26 ,MISDA: 3

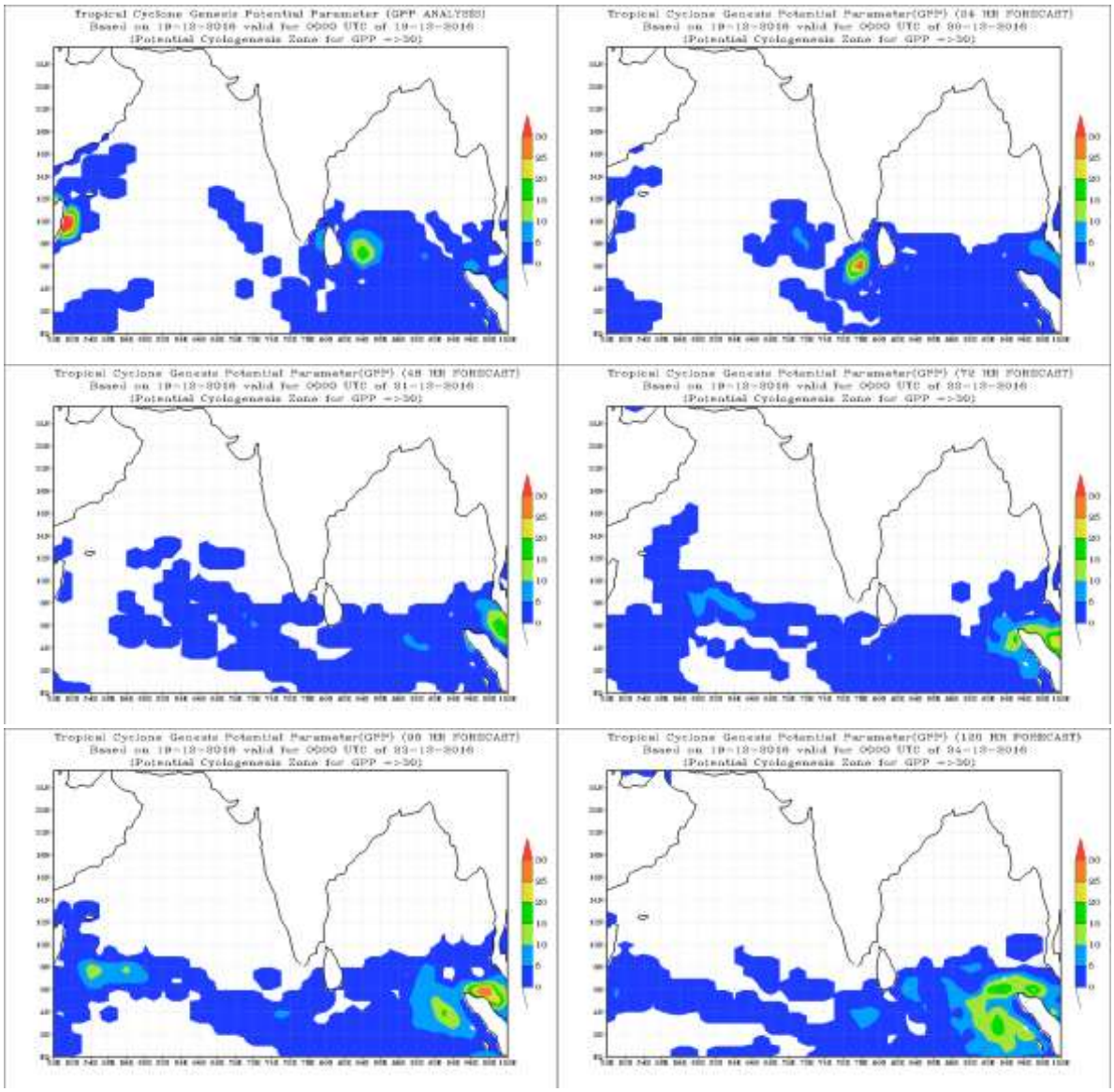
No. of PILOT Ascents

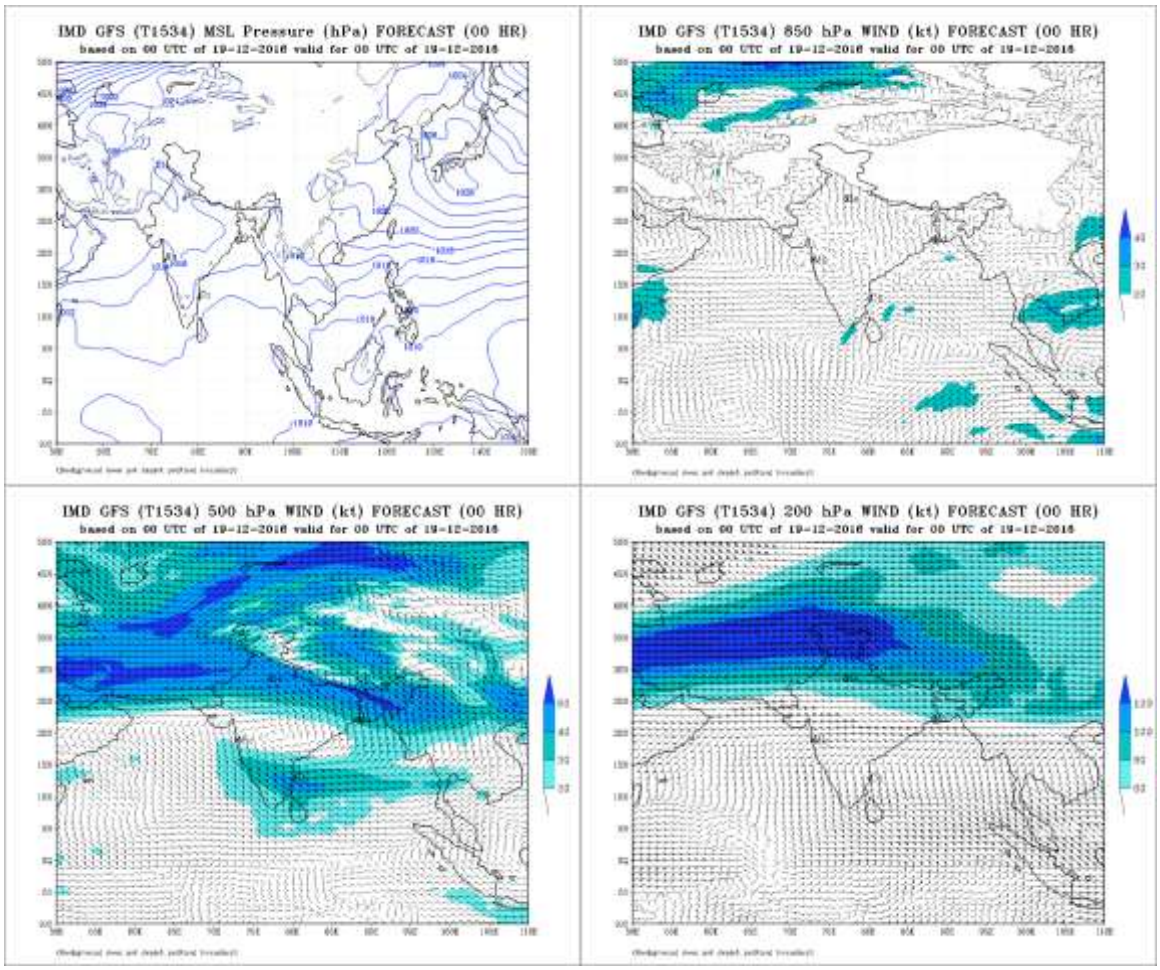
18 /12Z	19/00Z
17	11

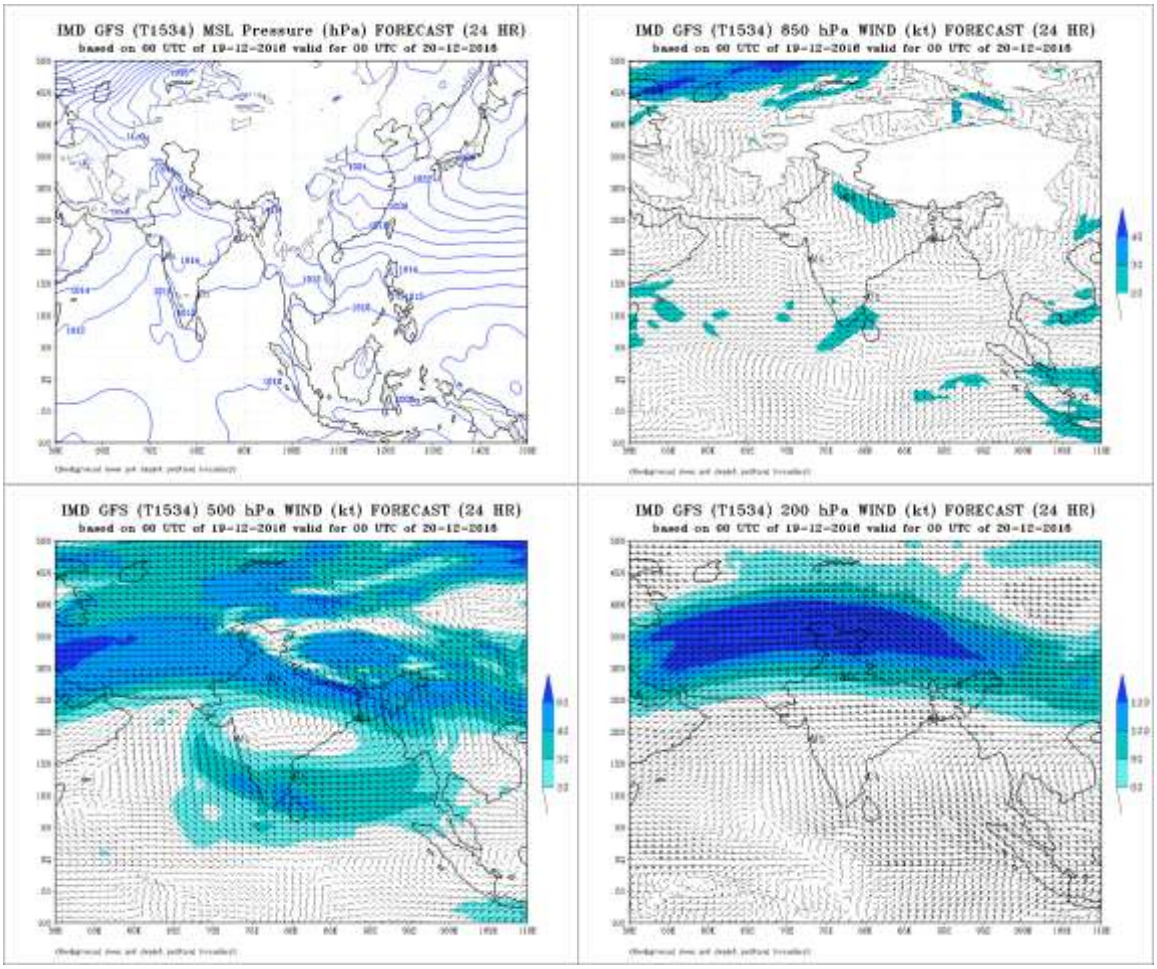
Buoy Data

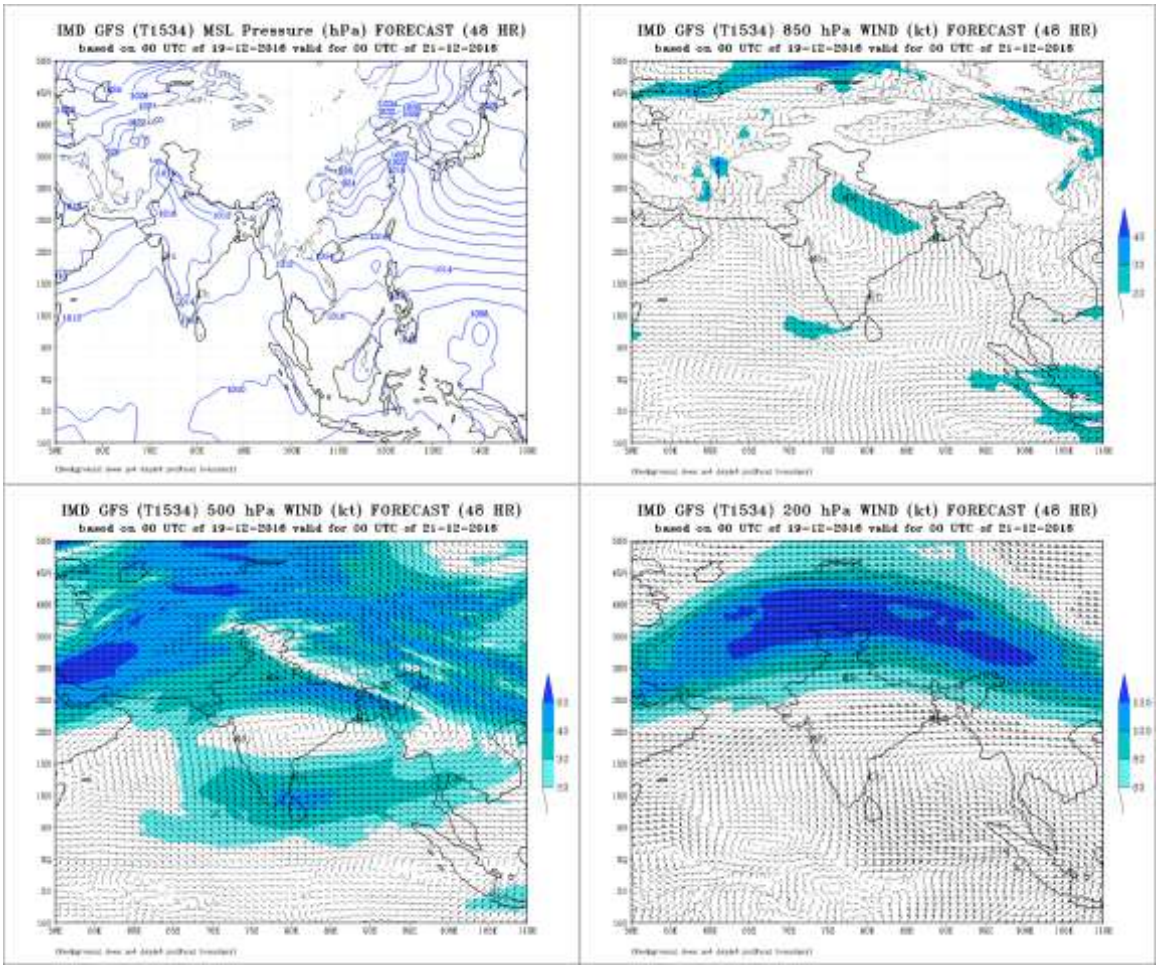
18/12Z	19/00Z	19/03Z
11	11	11

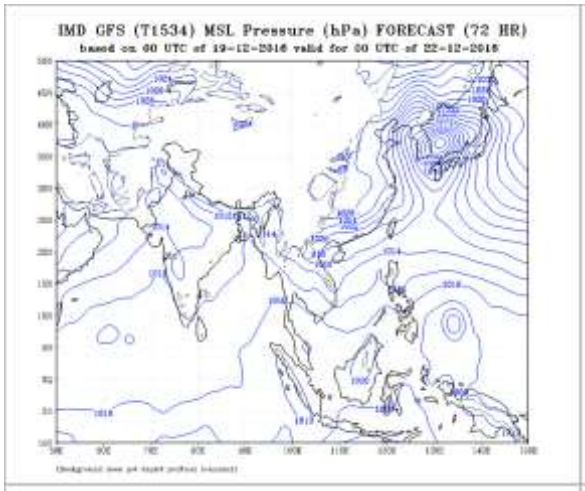
Annexure- II

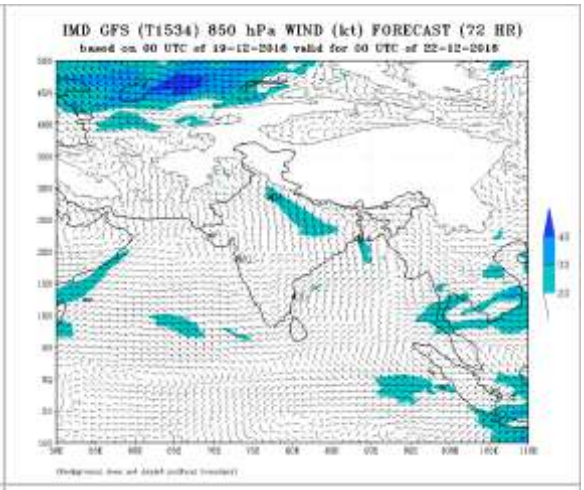

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 18-12-2016 valid for 0000 UTC of 18-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 18-12-2016 valid for 0000 UTC of 20-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 18-12-2016 valid for 0000 UTC of 21-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 18-12-2016 valid for 0000 UTC of 22-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 18-12-2016 valid for 0000 UTC of 23-12-2016
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 18-12-2016 valid for 0000 UTC of 24-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

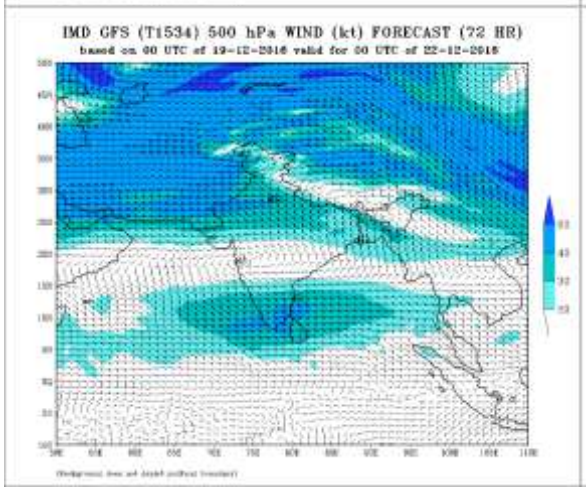

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 19-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 19-12-2016

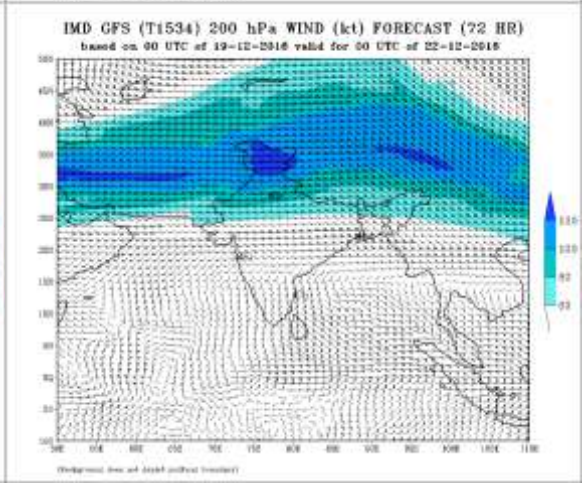

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 20-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 20-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 20-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 20-12-2018

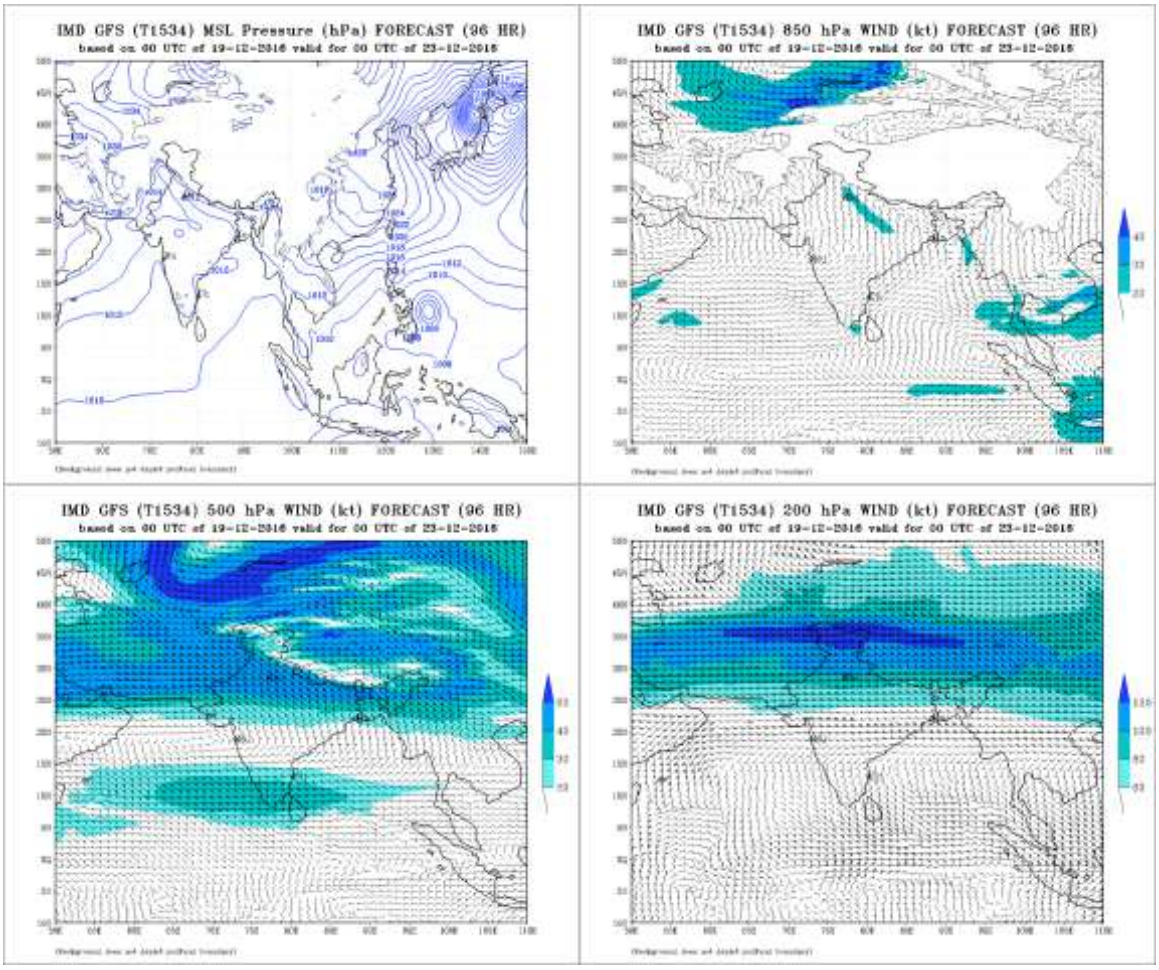

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 21-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 21-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 21-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 21-12-2018

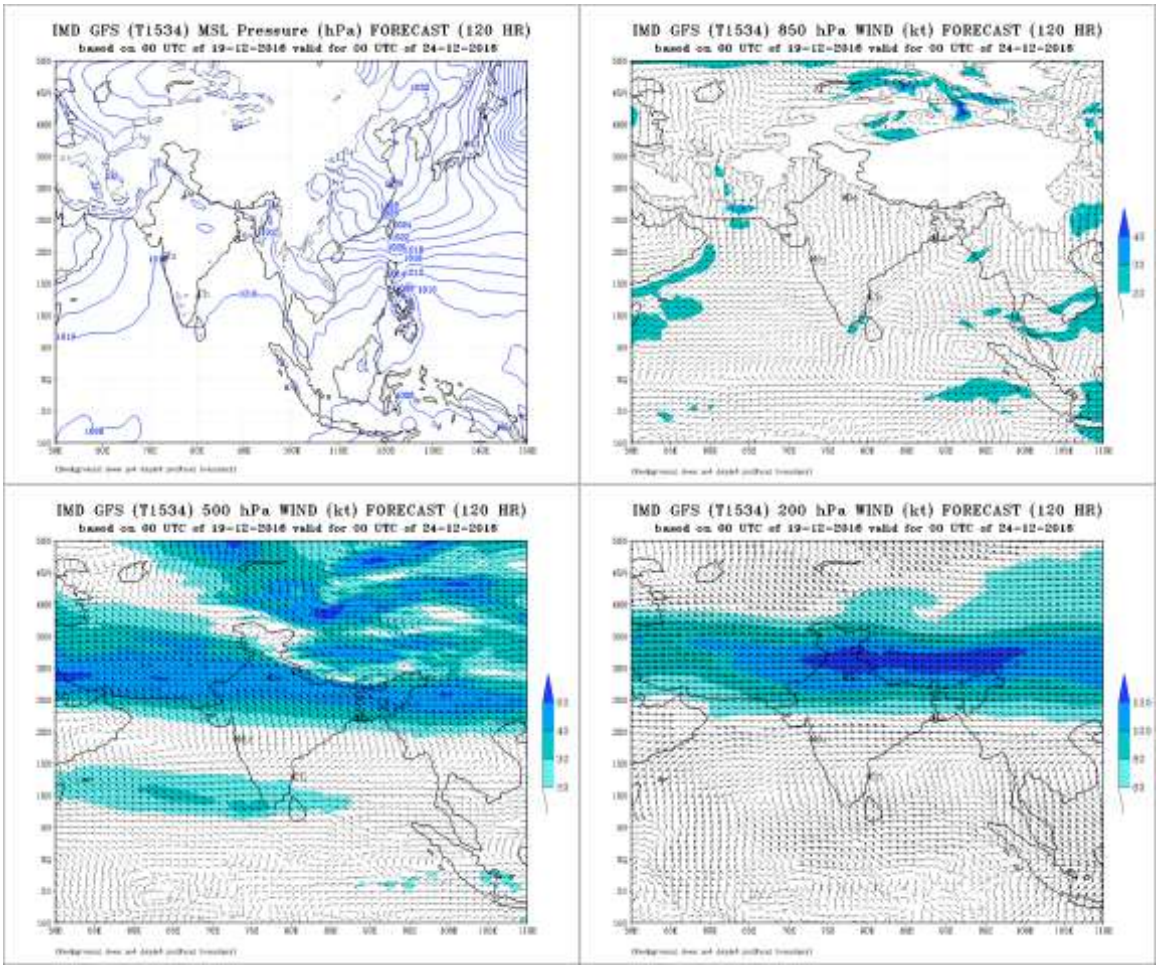

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 22-12-2016


IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 22-12-2016


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 22-12-2016


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 22-12-2016


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 23-12-2018
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 23-12-2018
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 23-12-2018
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 19-12-2018 valid for 00 UTC of 23-12-2018


IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 24-12-2016
IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 24-12-2016
IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 24-12-2016
IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 19-12-2016 valid for 00 UTC of 24-12-2016

FDP (Cyclone) NOC Report Dated 20th December 2016

Synoptic features:

The trough of low at mean sea level over southwest Bay of Bengal and neighbourhood lay as trough in low level easterlies extending from equatorial Indian Ocean to south Tamil Nadu coast across Gulf of Mannar.

Dynamical and thermodynamical features

Surface Temperature (SST):

The sea surface temperature (SST) is below 27˚C to the north of 15˚N over Arabian Sea as well as in Bay of Bngal. It increases to the south.

Relative Vorticity:

A zone of positive low-level relative vorticity of about 20-30 $x10^{-6}$ s^{-1} is seen over southeast Arabian Sea off Comorin region. Another zone of positive low-level relative vorticity of 20-30 $x10^{-6}$ s^{-1} is seen over eastcentral BOB off Myanmar coast.

Convergence:

Low level convergence of about 10-15 $x10^{-6}$ s^{-1} is seen over small pockets near Sumatra and south Andaman Sea and near Sri Lanka. Another area of positive convergence around 5-10 $x10^{-6}$ s^{-1} is seen over southeast AS off Comorin region.

Divergence:

There is an area of positive upper level divergence of about 10-20 $x10^{-6}$ s^{-1} near Sumatra over south Andaman Sea and adjoining equatorial oceans.

An area of positive divergence with value 5-10 $x10^{-6}$ s^{-1} is seen over southeast AS off Comorin region.

Wind Shear:

Low to moderate wind shear is seen over south and central Bay. It is high over north Bay.

The wind shear is low to moderate over southeast and eastcentral Arabian Sea. It is high over north Arabian Sea and also near Somali Coast.

Wind Shear Tendency:

Increasing wind shear tendency is seen over southeast and eastcentral Bay of Bengal.

There is decreasing tendency (5-10 knots) over southeast and adjoining eastcentral Arabian Sea.

Satellite observations based on 0900 UTC INSAT imagery:

Bay of Bengal & Andaman Sea:

According to satellite imagery, scattered low/medium clouds with embedded moderate to intense convection is seen over south Andaman Sea.

Arabian Sea

Scattered low/ medium clouds with embedded moderate to intense convection are seen over southeast Arabian Sea north of latitude 6.0^0N.

Large scale features

Upper tropospheric Ridge: Ridge at 200 hPa lies at 116^0N latitude over BoB

M.J.O. Index:

MJO index lies in Phase 5 with amplitude less than 1. It would continue in phase 5 with low amplitude during the next three days.

Storms and Depression over South China Sea/ South Indian Ocean: Nil.

NWP Input for FDP Cyclone based on 0000 UTC

IMD-GFS T1534: The forecast based on analysis of 00UTC on 20th December gives indication of formation of low pressure area over SE Bay on 24th and lies as a feeble low on central part of south Bay on 25th and becomes less marked on 26th.

IMD WRF: The forecast based on analysis of 00UTC on 20th December gives no indication of formation of low pressure systems over Indian Seas for the next 3 days.
NCEP-GFS: Similar inference as that of IMD GFS.
ECMWF: The forecast fields based on 00 UTC of 20th December show no indication of formation of low pressure systems over Indian Seas for the next 5 days.
NCUM: The forecast fields based on 00 UTC of 20th December show development of a circulation on 24th, moving northwestwards till 27th and becoming less marked thereafter.
NCMRWF- NEPS:. The forecast fields based on 00 UTC of 20th December show development of a depression over southwest BOB on 24th with intensification into a cyclonic storm on 25th. Initially it moves west-northwestwards to SW Bay off north TN coast on 26th and lies over SW Bay off north Sri Lanka coast on 27th and crosses northeast Sri Lanka coast on 27th and becoming lowover Sri Lanka on 28th, WML over Comorin area on 29th and cyclonic storm over the same area on 30th.
IITM GEFS: No indication of any significant low pressure systems for the coming 10 days.
IMD GPP: No significant GPP zone is seen for next 7 days.

Summary and Conclusion:

A few models are indicating formation of a low pressure area over SE Bay on 24th and its gradual west-northwestward movement No model suggests formation of depression except NEPS. Thus the formation of low on 24th needs to be monitored.

Probability of cyclogenesis (formation of depression) over Bay of Bengal and Andaman Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

Probability of cyclogenesis (formation of depression) over the Arabian Sea during next 120 hours

Lead period	Day-1 24 hours	Day 2 24-48 hours	Day-3 48-72 hours	Day-4 72-96 hours	Day-5 96-120 hours
Probability	Nil	Nil	Nil	Nil	Nil

IOP : No IOP for the next 5 days.

Annexure- I

Status of observational system:

Dated: 20.12.2016

Synoptic observation:

Region	Date/Time (UTC)		
	19/12	**20/00**	**20/03**
India	42	31	45
Coastal stations			
WB	9	3	8
Odisha	6	5	6
AP	10	12	12
Tamil Nadu	10	9	12
Puducherry	1	1	1
A & N	6	1	6
Bangladesh	5	7	8
Myanmar	0	2	3
Thailand	3	3	3
Sri Lanka	5	7	8

AWS:

Region	Date/Time (UTC)		
	19/12	**20/00**	**20/03**
WB	3	2	1
Odisha	4	2	4
AP	7	5	5
Tamil Nadu	23	7	22
Puducherry	1	1	1
A & N	0	0	0

RS/RW (12Z) of 19/12/2016 : 13/ 43

No. of Ascents reaching 250 hPa levels: 12 , MISDA:- 1

RS/RW (00Z) of 20/12/2016 : 29 /43

No. of Ascents reaching 250 hPa levels: 27 ,MISDA: 2

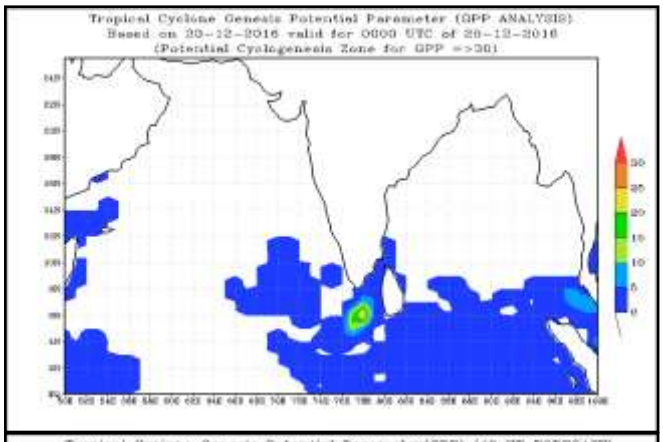
- **No. of PILOT Ascents**

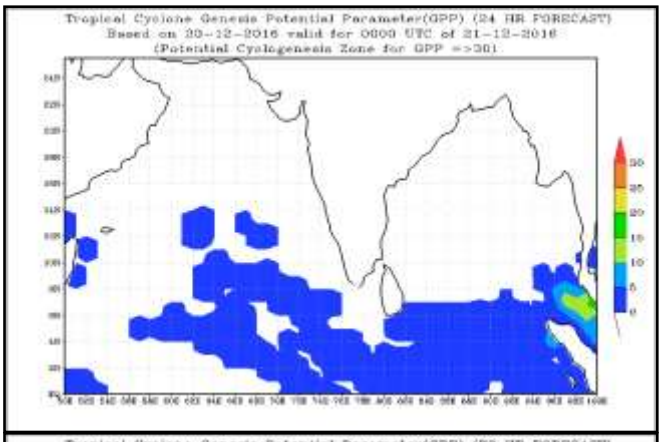
19 /12Z	**20/00Z**
21	12

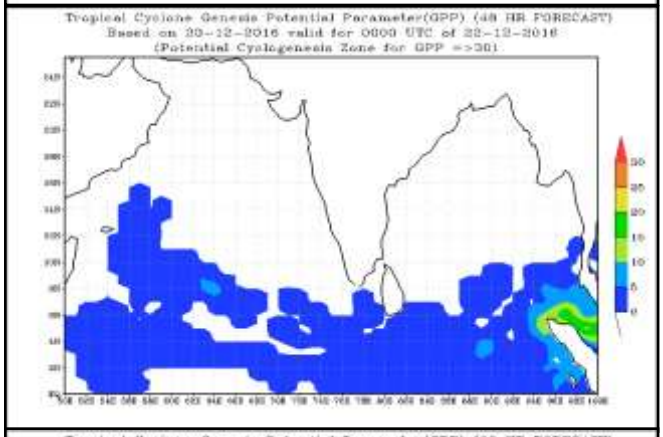
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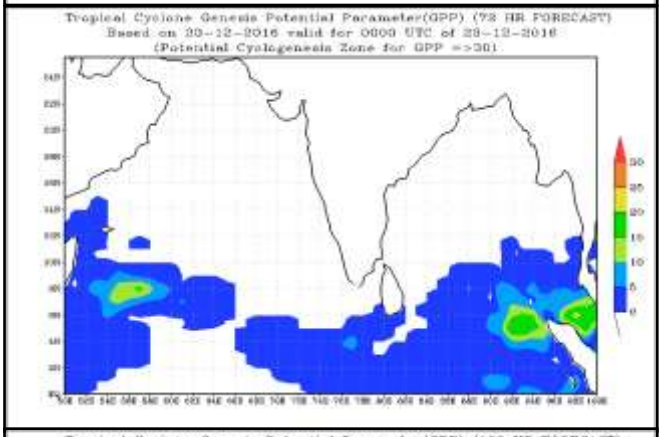
19/12Z	**20/00Z**	**20/03Z**
11	11	10

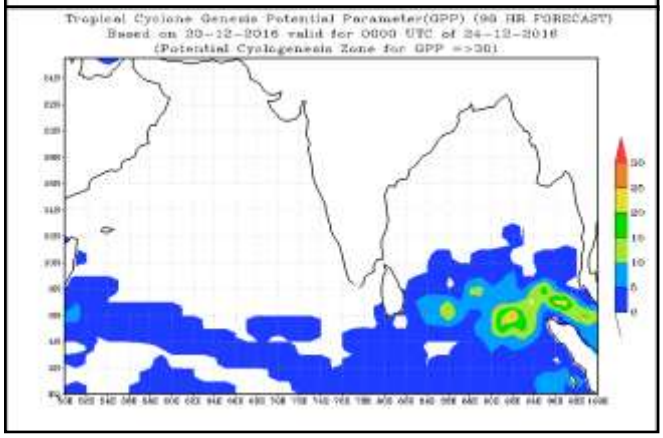
Annexure- II

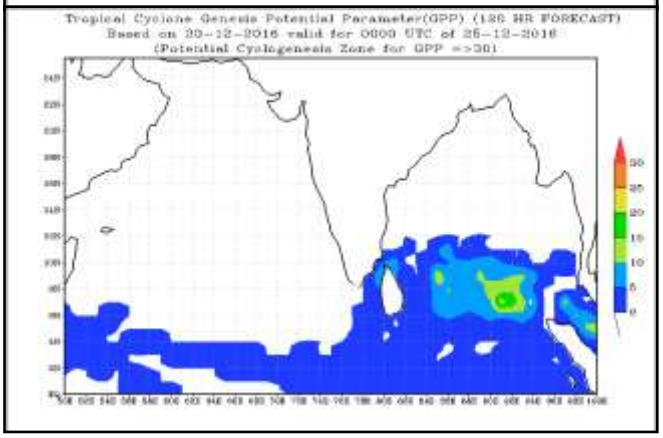

Tropical Cyclone Genesis Potential Parameter (GPP ANALYSIS)
Based on 20-12-2016 valid for 0000 UTC of 20-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

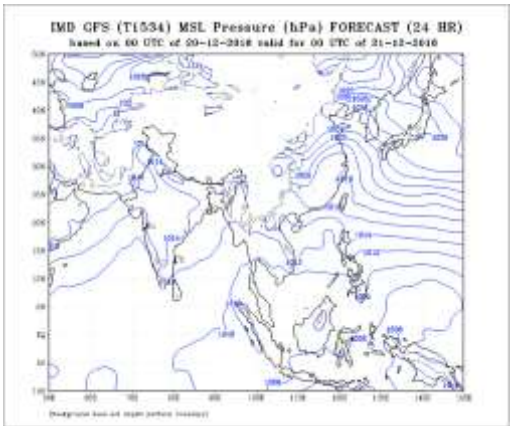

Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 20-12-2016 valid for 0000 UTC of 21-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

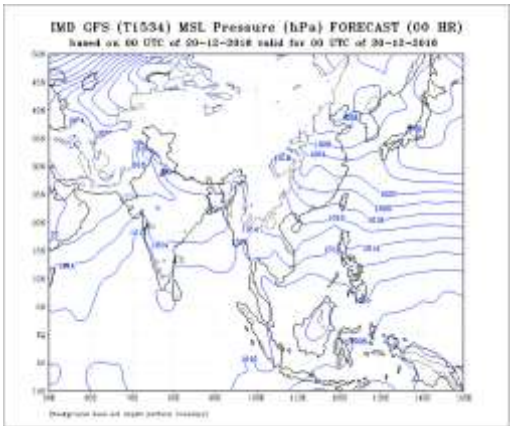

Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 20-12-2016 valid for 0000 UTC of 22-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

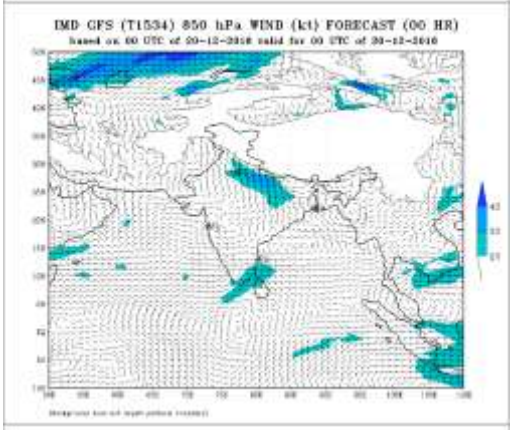

Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 20-12-2016 valid for 0000 UTC of 23-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

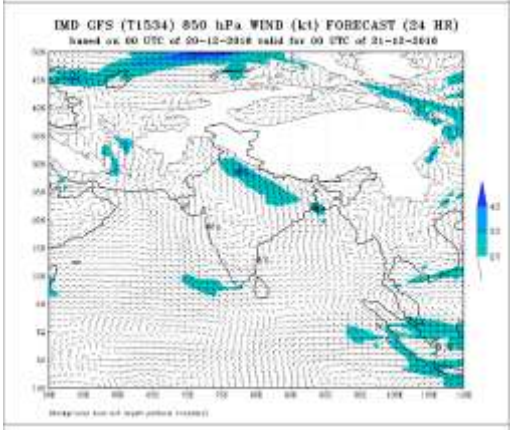

Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 20-12-2016 valid for 0000 UTC of 24-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

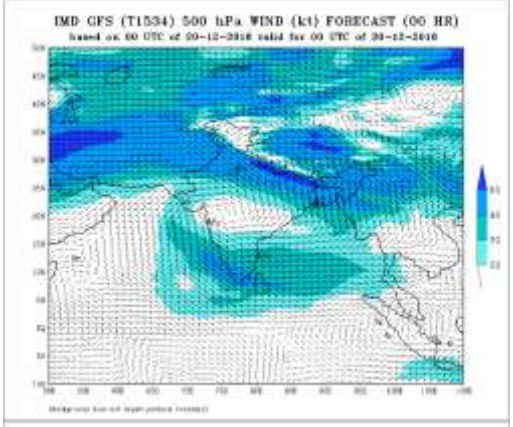

Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
Based on 20-12-2016 valid for 0000 UTC of 25-12-2016
(Potential Cyclogenesis Zone for GPP =>30)

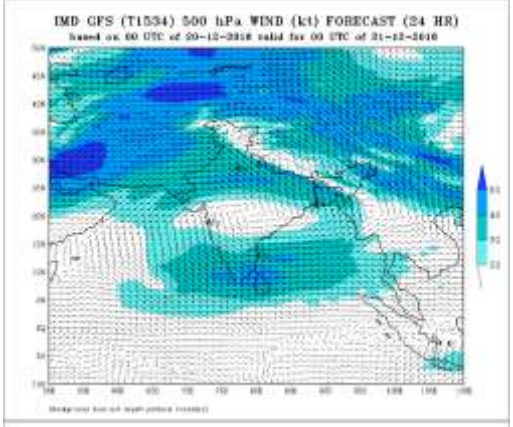

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (24 HR)
based on 00 UTC of 20-12-2016 valid for 00 UTC of 21-12-2016

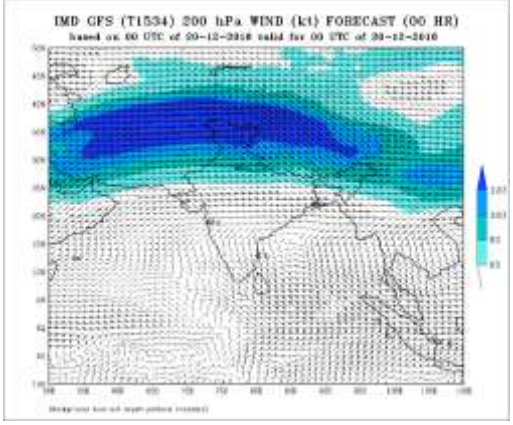

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 20-12-2016 valid for 00 UTC of 20-12-2016

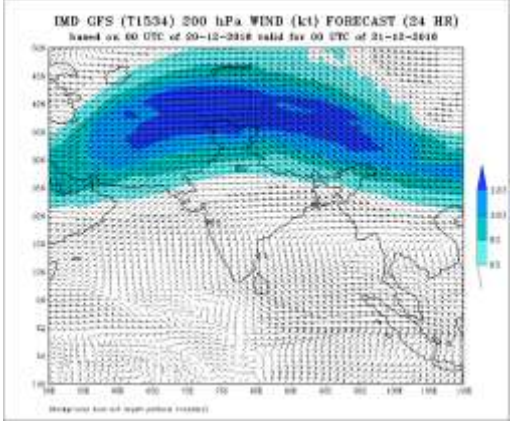

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 20-12-2016 valid for 00 UTC of 20-12-2016

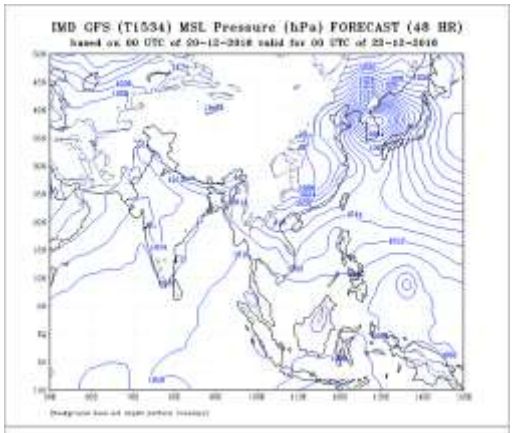

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (24 HR)
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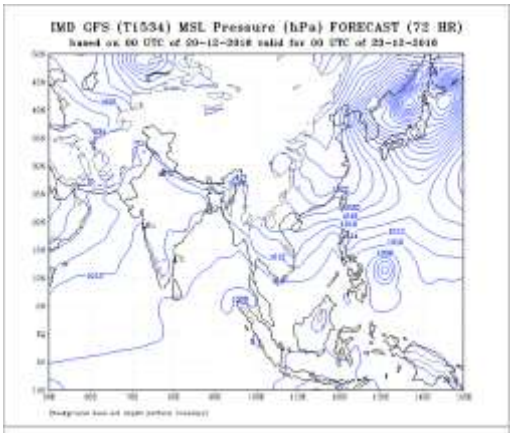

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (00 HR)
based on 00 UTC of 20-12-2016 valid for 00 UTC of 20-12-2016

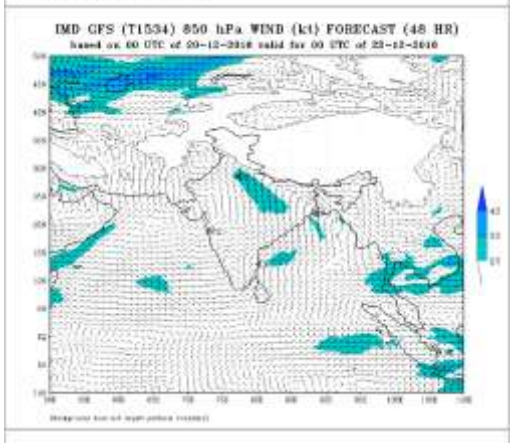

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (24 HR)
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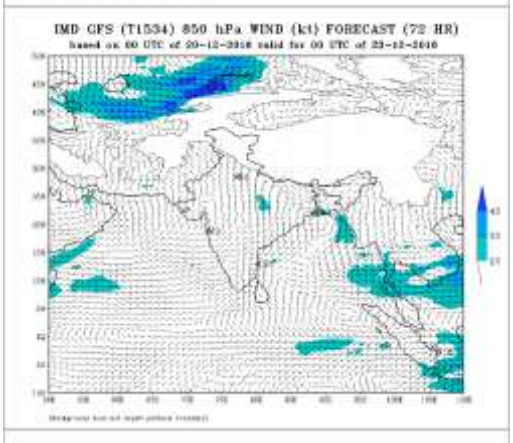

IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (00 HR)
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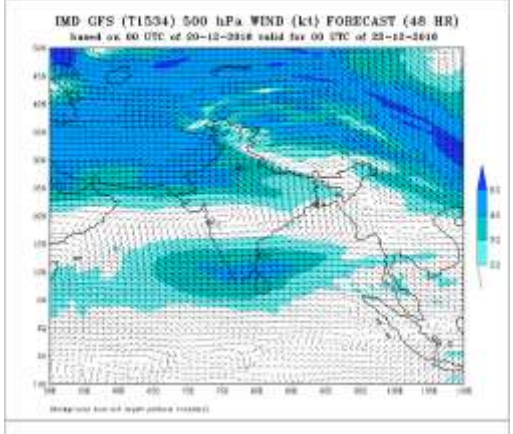

IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (24 HR)
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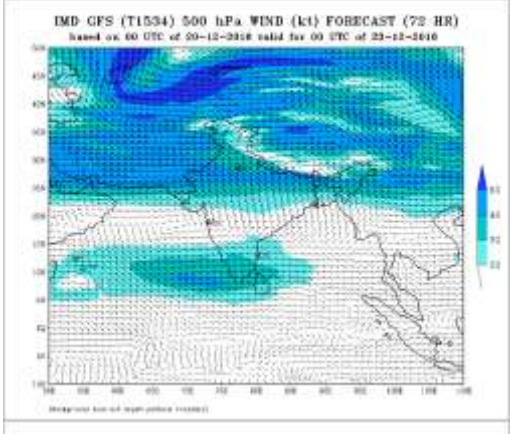

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (48 HR)

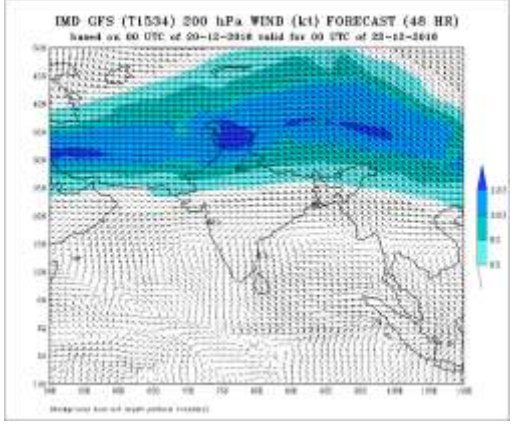

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (72 HR)

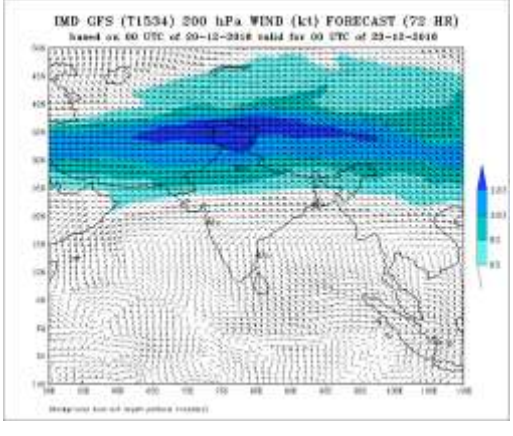

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (48 HR)

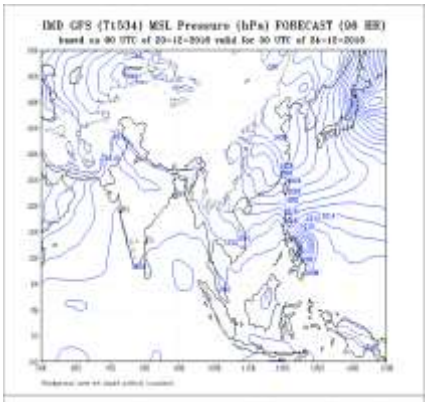

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (72 HR)

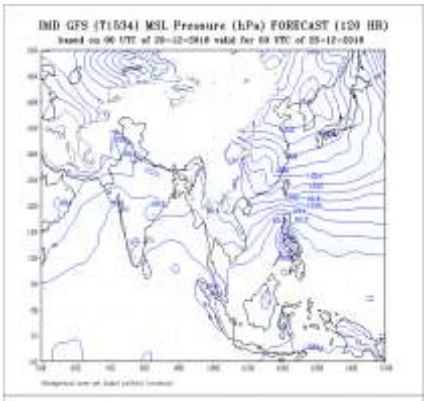

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (48 HR)

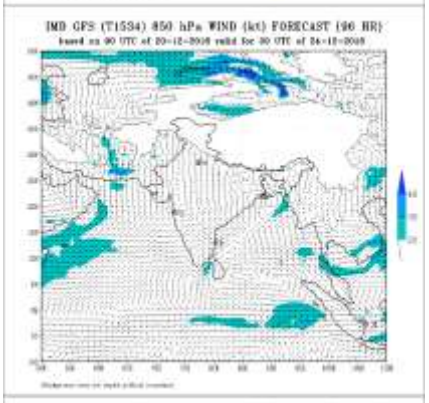

IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (72 HR)

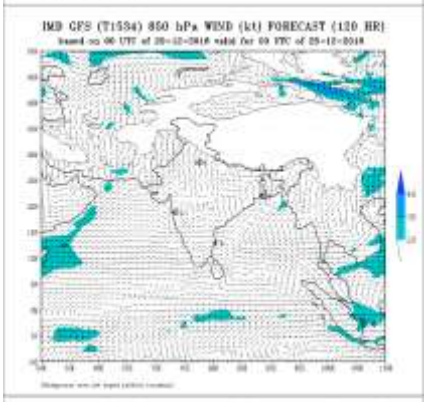

IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (48 HR)

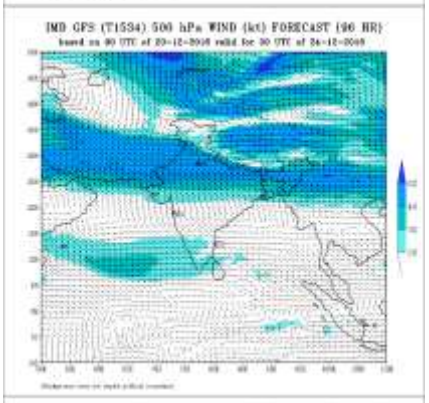

IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (72 HR)

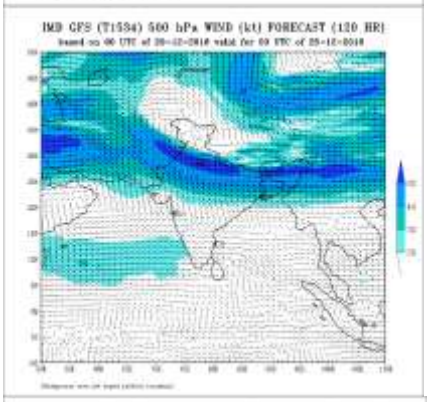

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (96 HR)

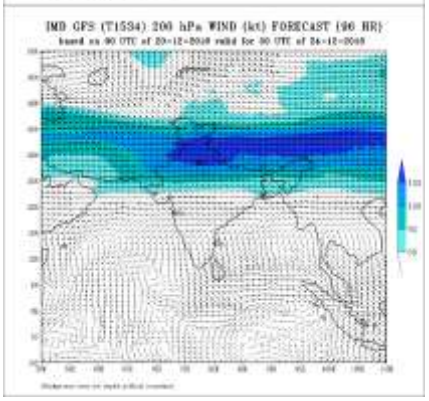

IMD GFS (T1534) MSL Pressure (hPa) FORECAST (120 HR)

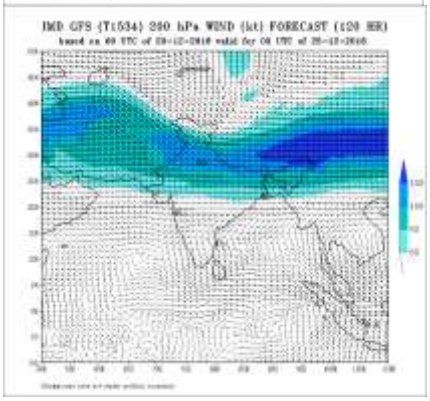

IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (96 HR)


IMD GFS (T1534) 850 hPa WIND (kt) FORECAST (120 HR)


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (96 HR)


IMD GFS (T1534) 500 hPa WIND (kt) FORECAST (120 HR)


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (96 HR)


IMD GFS (T1534) 200 hPa WIND (kt) FORECAST (120 HR)