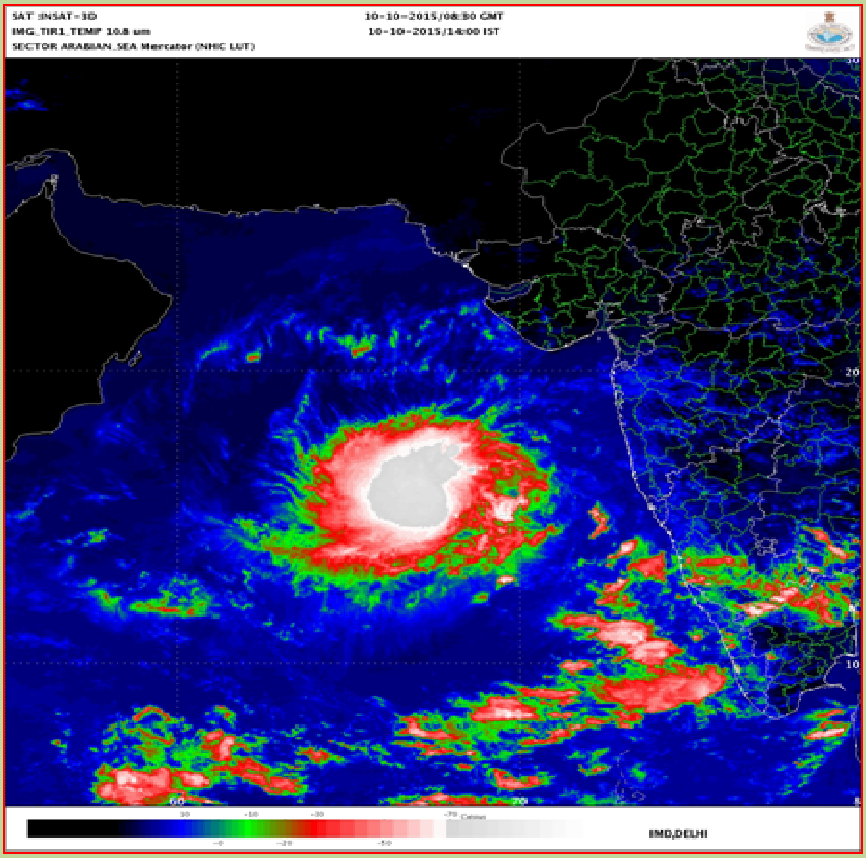
GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
EARTH SYSTEM SCIENCE ORGANISATION
INDIA METEOROLOGICAL DEPARTMENT

Deep Depression over the Arabian Sea (09-12 October 2015): A Report



INSAT-3D enhanced colored imagery based on 0830 UTC of 10th October

Cyclone Warning Division

India Meteorological Department

New Delhi

OCTOBER 2015

Deep Depression over the Arabian Sea (09-12 October 2015)

1. Introduction

A depression formed over the Arabian Sea (AS) on 9th October morning from a low level circulation embedded in the eastwest shear zone passing through eastcentral AS. It moved north-northwestwards and intensified into a deep depression (DD) on 10th morning. Continuing its north-northwestward movement, it maintained its intensity till 11th morning. It then weakened gradually and dissipated over the sea itself while moving initially northwards and then west-northwestwards.

The salient features of this system are as follows.

i. The DD weakened over the sea due to its slow movement and dry air intrusion from northwest.
ii. India Meteorological Department (IMD) predicted genesis of the system 72 hrs in advance.
iii. The movement of DD away from the Indian coasts was also predicted well in advance from the first bulletin itself on 9th Oct 2015 (0830 IST). Hence reducing cost towards cyclone preparedness measures including evacuation of coastal regions by Disaster Managers.
iv. No heavy rainfall warning was issued by IMD during the entire life period of the system.
v. The numerical weather prediction (NWP) and dynamical statistical models provided reasonable guidance with respect to its genesis, track and intensity, though there was some divergence in model guidance with respect to track and intensity.

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

2. Monitoring of DD

The DD was monitored & predicted continuously since its inception by IMD. The forecast of its genesis on 9th October, its track, intensity, dissipation over sea were predicted with sufficient lead time. Observed tarck of DD over AS during 9th -12th October is shown in fig.1.

At the genesis stage, the system was monitored mainly with satellite observations, supported by meteorological buoys and ships. Various national and international NWP models and dynamical-statistical models including IMD's and NCMRWF's global and meso-scale models were utilized to predict the genesis, track and intensity of the storm. 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.

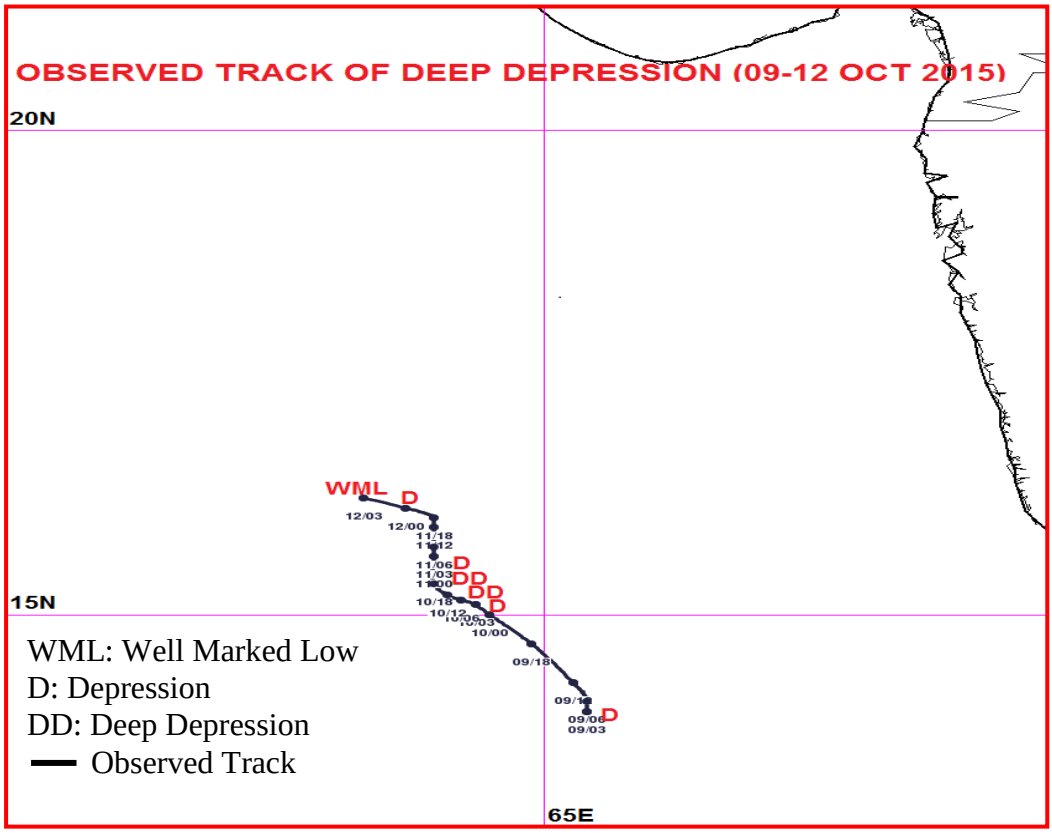


Fig.1 Observed track of DD over AS during 9th-12th October 2015

3. Brief life history

3.1. Genesis

In association with east-west shear zone extending from eastcentral AS to eastcentral Bay of Bengal (BoB) across south Peninsula, an upper air cyclonic circulation extending upto mid-tropospheric levels lay over eastcentral AS on 6th October. It persisted over the same region on 7th and lay as a low pressure area (LPA) over esatcentral and adjoining southeast AS in the early morning of 8th. It became well marked low (WML) over the same region in the forenoon of 8th. According to satellite imagery, the low level cyclonic circulation (LLCC) which was observed over southeast and adjoining eastcentral AS on 7th moved gradually northwards and intensified into a vortex (T1.0) over eastcentral AS near latitude 12.8^0N/longitude 71.3^0E at 0300 UTC of 8th. The convection over the area organised during past 24 hours. Lowest cloud top temperature (CTT) near the system centre was about -70^0C. The convection pattern was of shear type. The distance between the centre and cloud mass was about 1.5^0. The convective cloud mass was sheared to northwest of the system centre. Ascat observations suggested the associated maximum sustained surface winds of about 25 kts. Winds were higher in the eastern sector due to increased cross equatorial flow. The sea surface temperature was 29-30˚C, ocean thermal energy was about 60-80KJ/cm^2, low level convergence was (5-10)x10^{-5} s^{-1}, upper level divergence was about (20)x10^{-5} s^{-1}, the low level relative vorticity was about (100-150)x10^{-5} s^{-1}, vertical wind shear was low to moderate(10-20 knots) around the system centre. Low level vorticity and upper

level divergence increased during past 24 hours. The sub-tropical ridge in the upper tropospheric level lay along 17˚N. Under these conditions, the low pressure area moved slowly north-northwestwards and concentrated into a depression over eastcentral Arabian Sea and lay centred at 0000 UTC of 9th October near 14.0^0N/70.3^0E, about 410 km west- southwest of Goa and 630 km south-southwest of Mumbai. The intensity of the system as per the Dvorak's technique was T1.5. Intense to very intense convection lay over AS and adjoining Indian Ocean area between 11.0^0N & 16.5^0N and east of longitude 71.0^0E. Similar conditions prevailed leading to further intensification of the system to DD at 0600 UTC of 10th.

To summarise, the genesis of the DD can be attributed to the persistent well defined eastwest shear zone embedded in large scale monsoon circulatio and favourable environmental conditions like warmer SST, moderate wind shear, increased vorticity and upper air divergence.

3.2. Intensification

The depression moved north-northwestwards very slowly with a speed of about 6 kmphon 9th and it intensified into a DD at 1800 UTC of 9th and lay centered at latitude 14.7^0N/ longitude 69.9^0E over eastcentral AS, about 430 km west-southwest of Goa and 580 km south-southwest of Mumbai. It intensifed into DD mainly due to moderate wind shear (15-20 knots), warmer SST (29-31^0C), higher Ocean thermal energy (60-80 KJ/cm^2) and incursion of warm and moist air from south in association with the eastwest shear zone and cross equatorial flow.

As the system moved further northwards from 0300 to 1800 UTC of 11th, it experienced moderate to high southeasterly wind shear (15-25 knots) leading to further shearing of cloud mass to the northwest. In addition, the dry air intruded towards the system from northwest cutting off the supply of warm and moist air from southeast as observed through animation of total precipitable water (TPW) imageries (fig. 2a). SST was also low to the west of the system centre. As a result the system weakened into a depression at 0300 UTC of 11th and into a WML at 0300 UTC of 12th. According to satellite imageries the distance between the LLCC and the convection bounadry in the shear pattern increased gradually and the centre was poorly defined in IR imagery on 12th. The depth of convection reduced significantly from 10th to 11th being limited to mid-tropospheric level as observed in the CTT field. (fig 2b). It further decreased on 12th and weakened into a low pressure area in the morning of 13th becoming less marked on 14th.

It may also be mentioned here that another low pressure area formed over north BoB in the morning of 7th and became WML on 8th over northeast BoB. It moved northeastwards and lay over Myanmar and adjoining Bangladesh, Mizoram and Tripura on 9th morning. Though both the systems developed in association with same eastwest shear zone, their interaction if any, needs to be further investigated. The best track parameters of the systems are presented in Table 1.

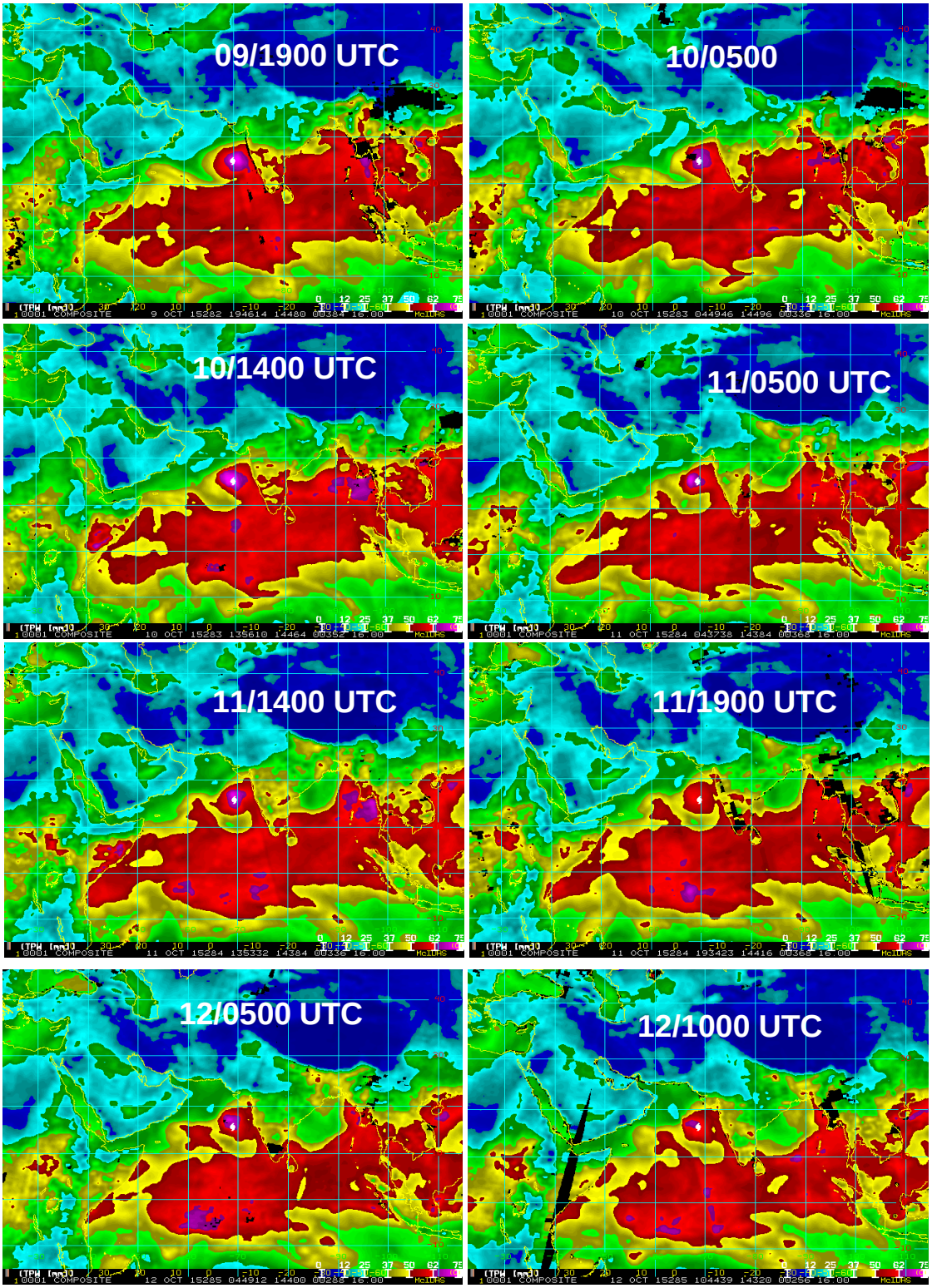


Fig. 2a Total precipitable water imageries based on 1900 UTC of 9th, 0500 & 1400 UTC of 10th, 0500, 1400 & 1900 UTC of 11th and 0500 & 1000 Utc of 12th October in association with DD over AS (09-12 October).

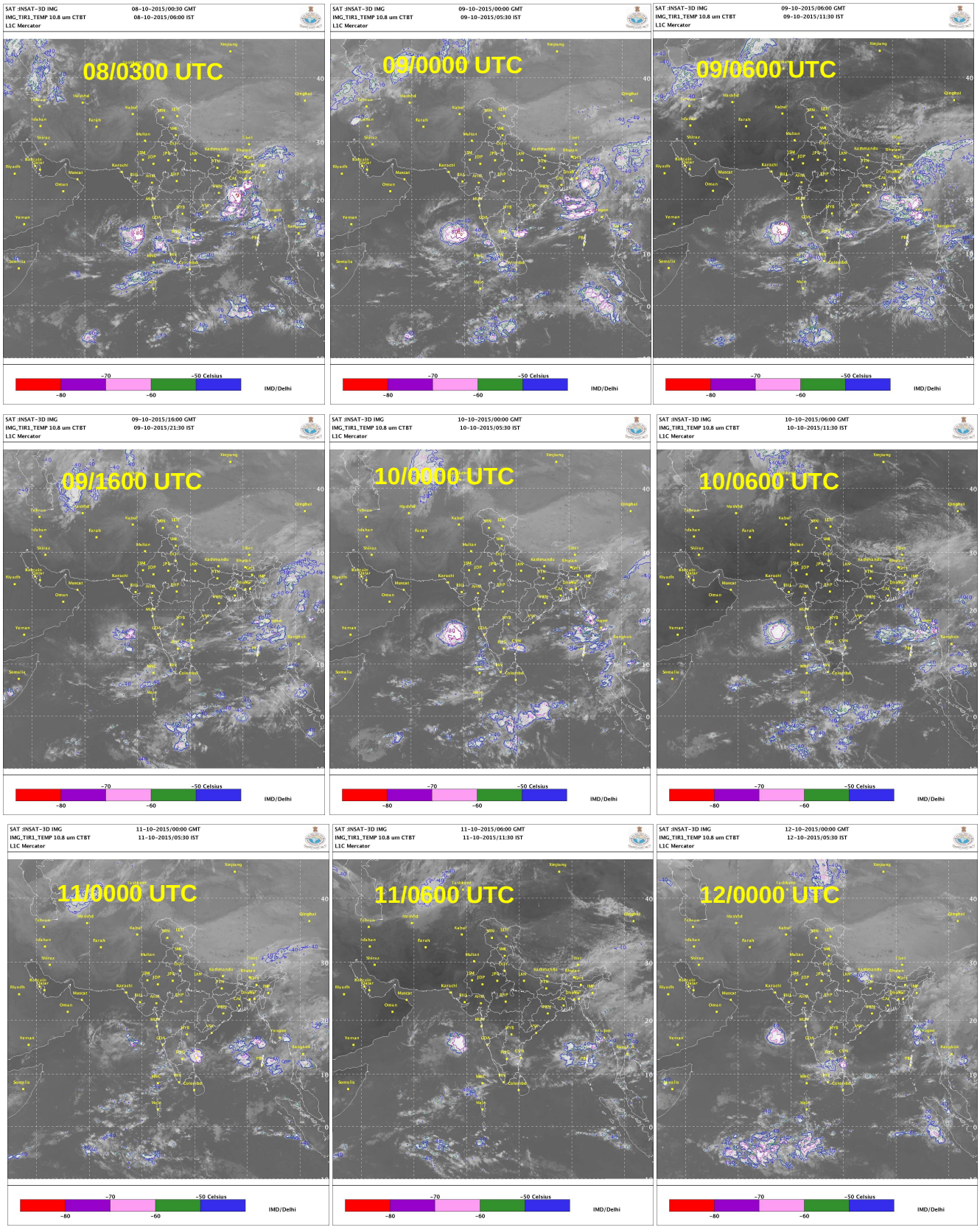


Fig.2b INSAT-3D cloud top brightness temperature imageries based on 0300 of 8th, 0000, 0600 & 1600 UTC of 9th, 0000 & 0600 UTC of 10th, 0000 & 0600 UTC of 11th and 0000 UTC of 12th October in association with DD over AS (09-12 October)

Table 1: Best track positions and other parameters of DD over the Arabian Sea during 09-12 October, 2015

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
09-10-2015	**0000**	14.0/70.3	1.5	1004	25	3	**D**
	0300	14.0/70.3	1.5	1004	25	4	D
	0600	14.1/70.3	1.5	1004	25	4	D
	1200	14.3/70.2	1.5	1002	25	4	D
	1800	14.7/69.9	2.0	1001	30	5	**DD**
10-10-2015	0000	15.0/69.6	2.0	1001	30	5	DD
	0300	15.1/69.5	2.0	1001	30	5	DD
	0600	15.1/69.4	2.0	1000	30	6	DD
	1200	15.2/69.3	2.0	1000	30	6	DD
	1800	15.3/69.2	2.0	1000	30	6	DD
11-10-2015	0000	15.5/69.2	2.0	1001	30	5	DD
	0300	15.6/69.2	1.5	1003	25	4	**D**
	0600	15.7/69.2	1.5	1003	25	4	D
	1200	15.9/69.2	1.5	1004	25	3	D
	1800	16.0/69.2	1.5	1004	25	3	D
12-10-2015	0000	16.1/69.0	1.5	1004	20	3	D
	0300	Well marked low pressure area over eastcentral Arabian Sea.					

3.3 Movement

The DD was basically steered north-northwestwards by the anticyclonic circulation lying to the east-northeast of the system centre in the middle and upper tropospheric levels. As the system lay close to the ridge and in the boundary of this anticyclonic circulation, the system moved north-northwestwards very slowly. The system underwent change in direction from 1800 UTC of 10th. The translational speed decreased about 12 hours prior to the change in direction of movement of the system. On an average the system moved with a translational speed of 3.8 kmph. On 11th night, the system started moving west-northwestwards under the influence of another anticyclonic circulation lying to the northwest of the system centre and the anticyclone to the east-northeast became less marked.

4. Features observed through satellite

4.1. Features observed through satellite:

Satellite monitoring of the system was mainly done by using half hourly Kalpana-1, INSAT-3D imageries. Satellite imageries of international geostationary satellites Meteosat-7 and MTSAT and microwave & high resolution images of polar orbiting satellites DMSP, NOAA series, TRMM, Metops were also considered. Typical satellite INSAT-3D imageries of DD during the life cycle of the system are shown in Fig. 3 (a, b & c). Intensity estimation using Dvorak's technique suggested that the system attained an intensity of T 1.5 on 0000 UTC 9th. Associated broken low and medium clouds with embedded intense to very intense convection lay over AS and adjoining Indian Ocean

between latitude 11.0^0 N to 16.5^0 N and longitude 65.0^0 E to 71.0^0 E. The lowest CTT was about -.86^{0}C. The cloud pattern was shear type. At 0600 UTC of 10th, the system attained intensity of T2.0 corresponding to DD. Associated low and medium clouds with intense to very intense convective clouds at many places lay over area between latitude 13.0^0 N to 18.6^0 N and longitude 65.0^0 E to 70.0^0 E. The lowest cloud top temparature was - 80^{0}C. The cloud pattern was curved band type. At 1800 UTC of 10th, the system started weakening. Enhanced IR imageries depicting the growth of the system to T 1.5, T 2.0 and its weakening to T 1.5 are presented in Fig.4. The system further weakened with intensity becoming T1.0 on 13th June 2015 corresponding to a well marked low pressure area.

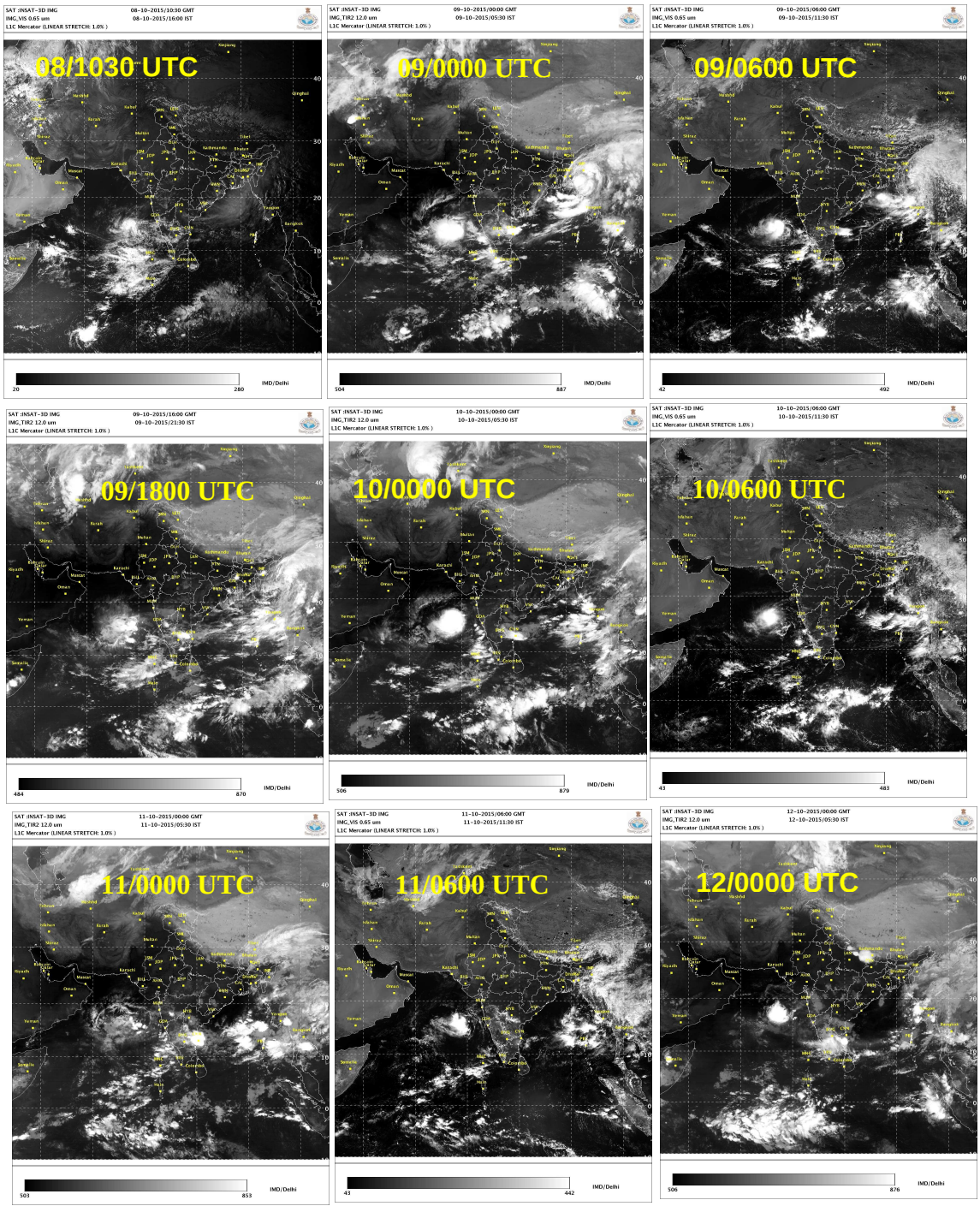


Fig.3a INSAT-3D VIS./IR imageries based on 1030 UTC of 8th, 0000, 0600 & 1800 UTC of 9th, 0000 & 0600 UTC of 10th, 0000 & 0600 UTC of 11th and 0000 UTC of 12th October in association with DD over AS (09-12 October)

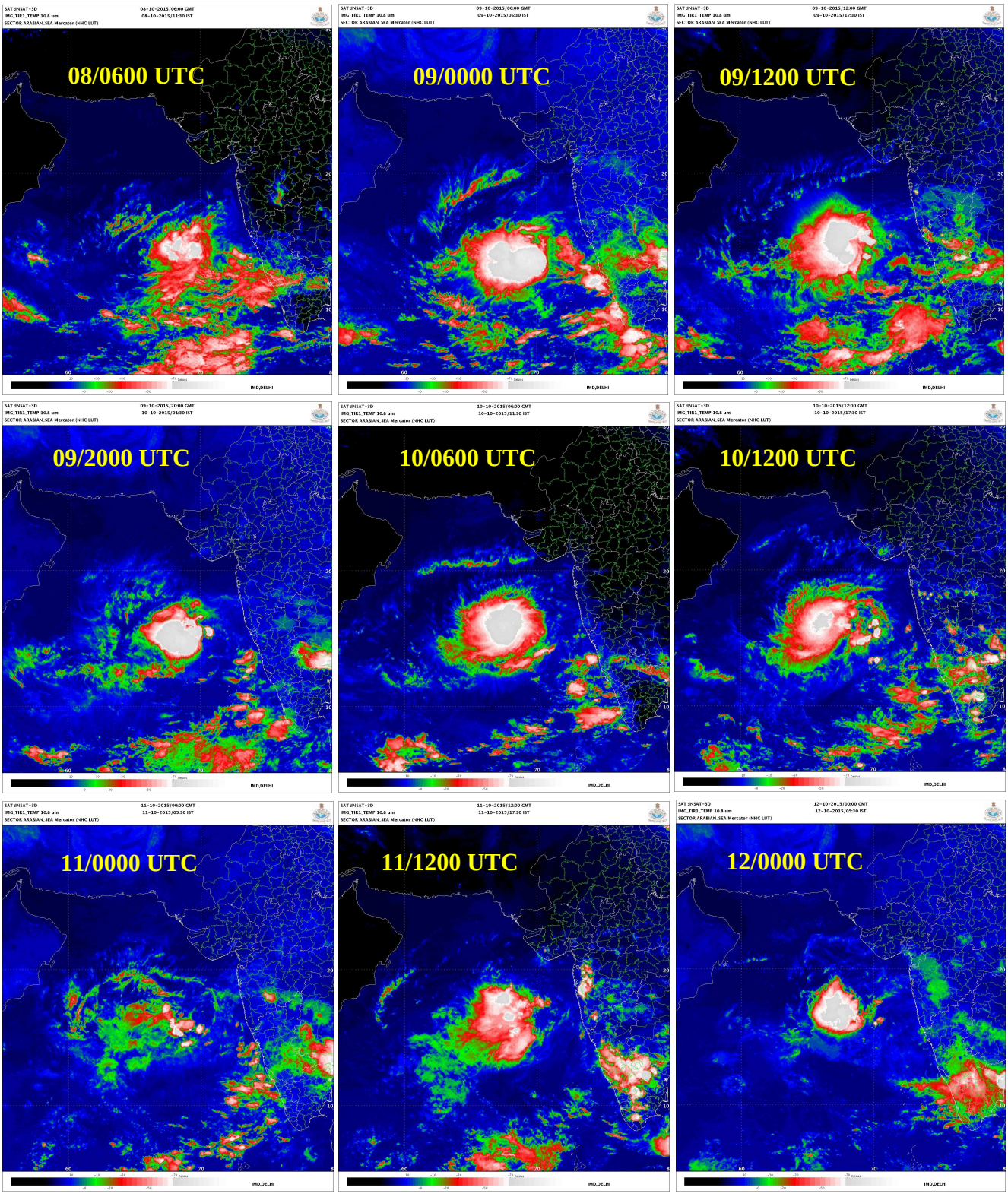


Fig.3b INSAT-3D enhanced colored imageries based on 06 UTC of 9th , 00, 12, 20 UTC of 10th , 06,12 UTC of 10th , 00, 12 UTC of 11th and 00 UTC of 12th October in association with DD (09-12 October) over AS.

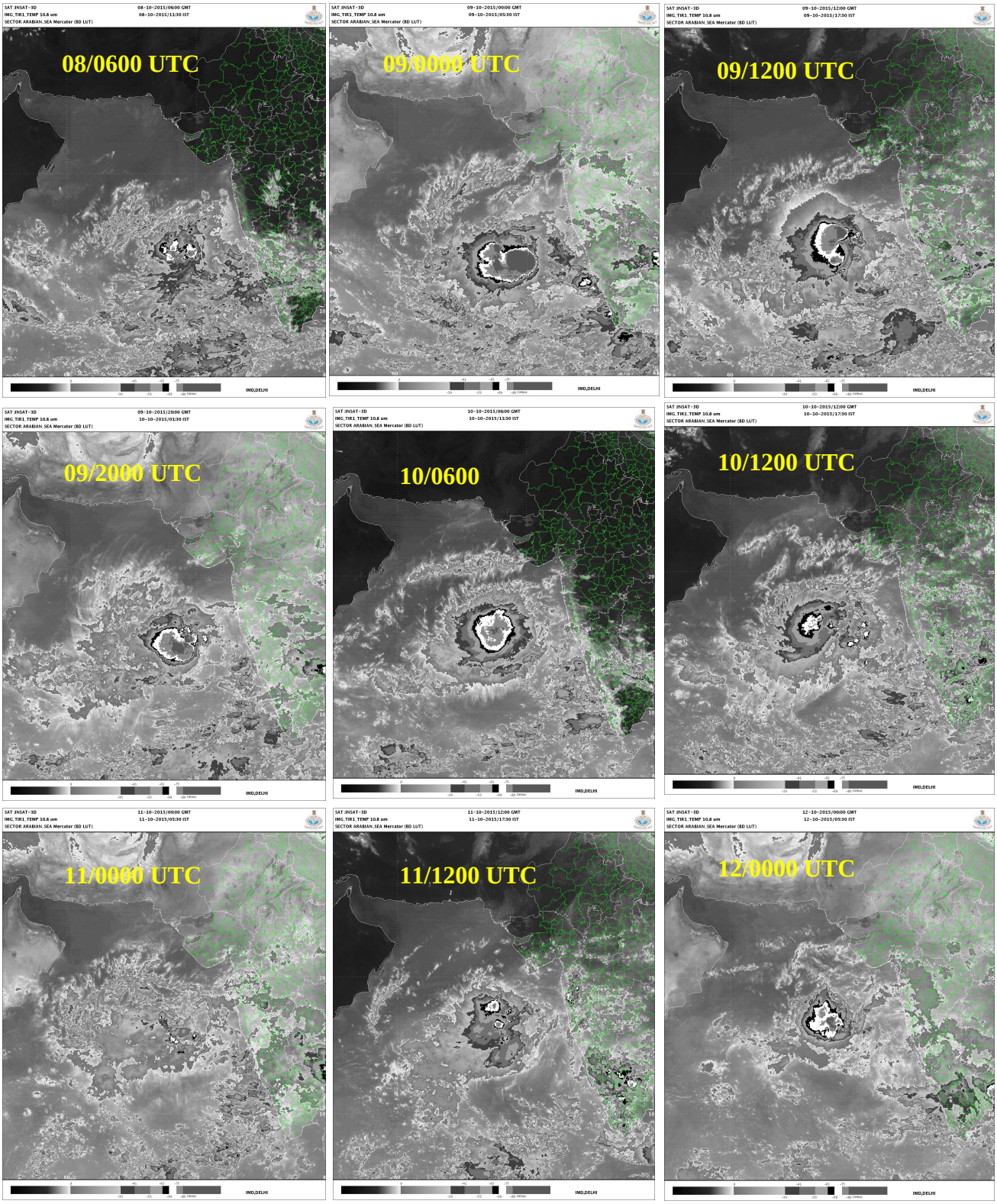


Fig.3c INSAT-3D IR enhanced imageries based on 06 UTC of 9th , 00, 12, 20 UTC of 10th , 06,12 UTC of 10th, 00, 12 UTC of 11th and 00 UTC of 12th October in association with DD (09-12 October) over AS.

4.2 Dynamical Features

To analyse the dynamical features MSLP, 10m wind and winds at 850, 500 & 200 hPa levels based on 00 UTC of 8th to 12th October 2015 are presented in fig.4a-e based on IMD GFS analysis. The system extended upto 500 hPa level. As per IMD-GFS analysis, winds were higher in northeast and southeast sector on 8th, northeast and northwest sector on 9th, northeast and southern sector on 10th and around the system centre on 11th and 12th. Considering the MSLP, GFS analysis could pick up the initial conditions on 8th with two closed isobars and underestimated on 9th with 1 closed isobar. Further, it showed intensification on 10th with 2 closed isobars, weakening on 11th and again strengthening on 12th. Thus the model could not pick up the intensity of the system and exhibited oscillations in the intensification of the system. The upper tropospheric ridge of the anticyclonic circulation to the northeast of the system centre was captured by the model. However, the anticyclonic circulation to the northwest of the system centre on 12th leading to west-northwestward movement of the system could not be detected.

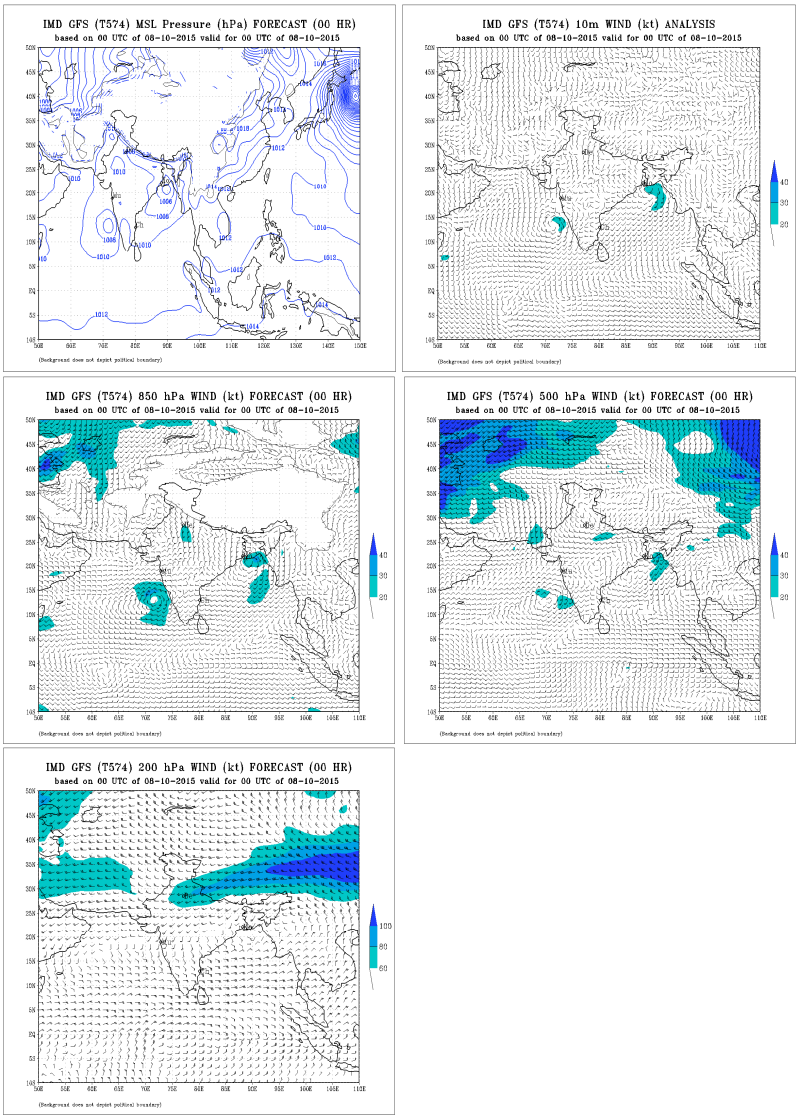
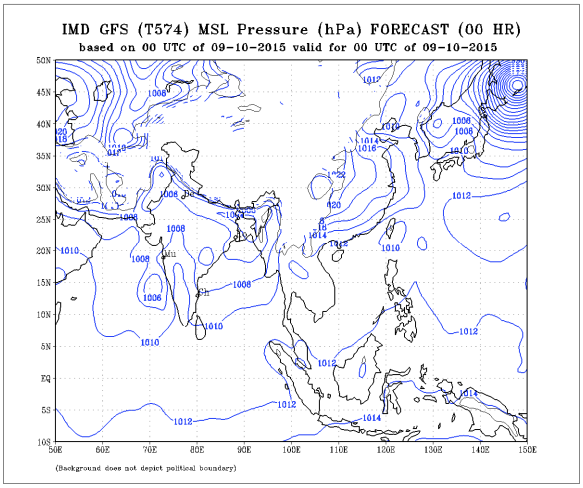
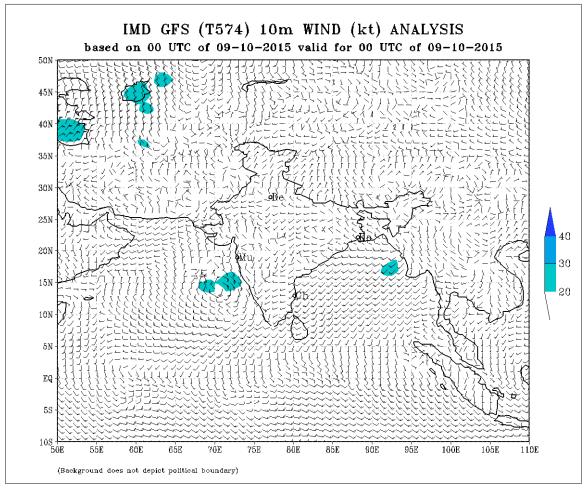
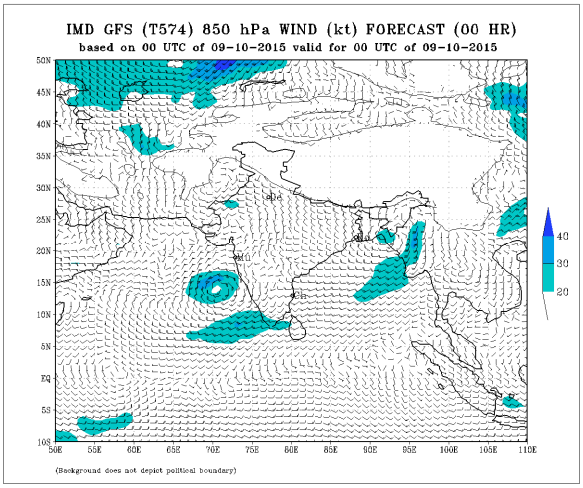
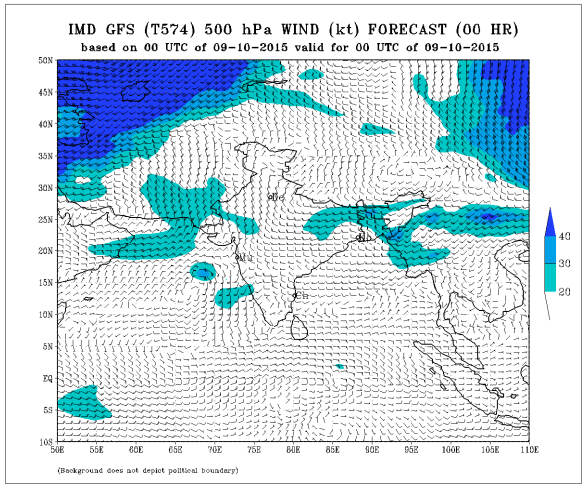


Fig.4a IMD-GFS MSLP, 10m wind, winds at 850, 500 and 200 hPa levels based on 00 UTC of 8th October 2015.









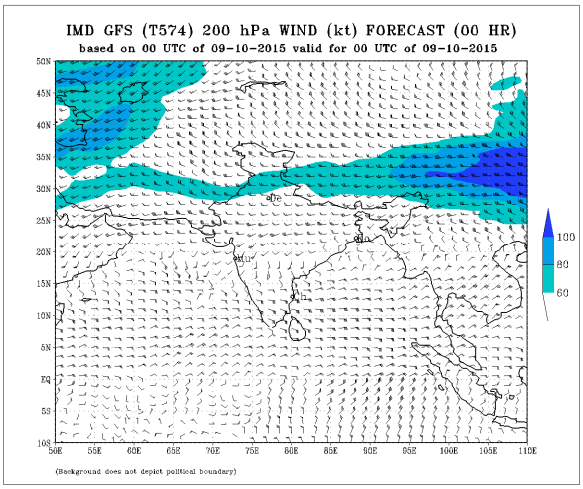
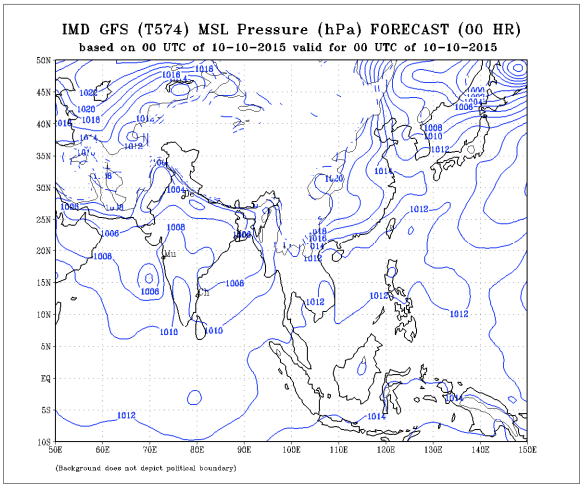
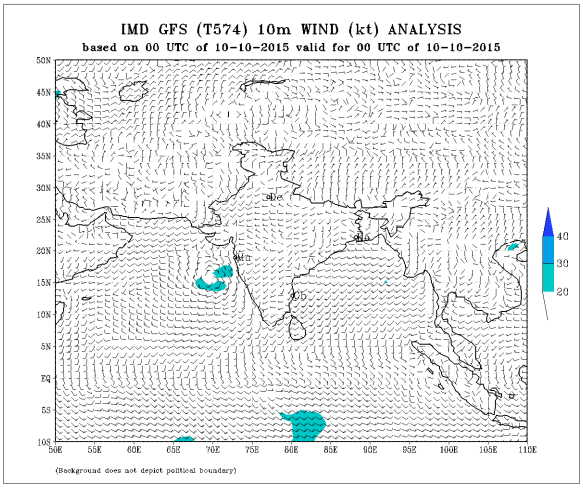
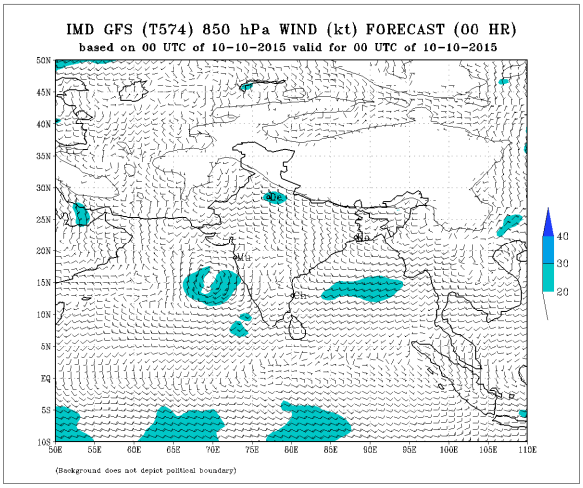
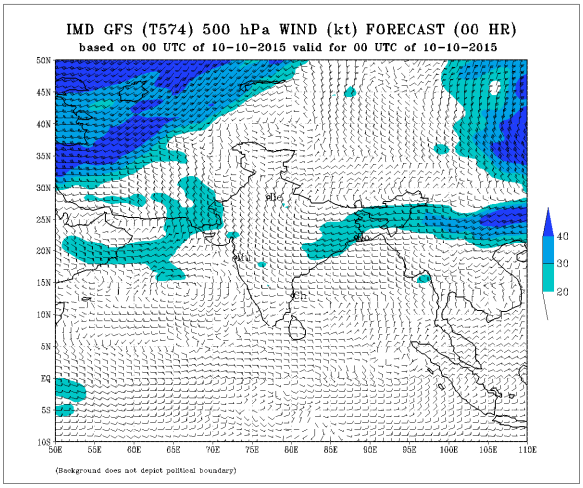


Fig.4b IMD-GFS MSLP, 10m wind, winds at 850, 500 and 200 hPa levels based on 00 UTC of 9th October 2015.









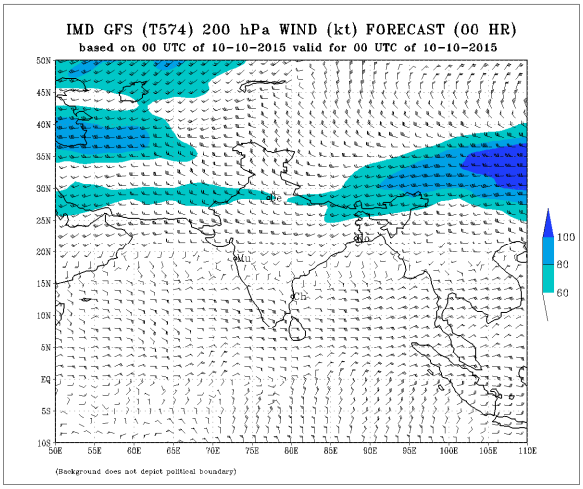


Fig.4c IMD-GFS MSLP, 10m wind, winds at 850, 500 and 200 hPa levels based on 00 UTC of 10th October 2015.

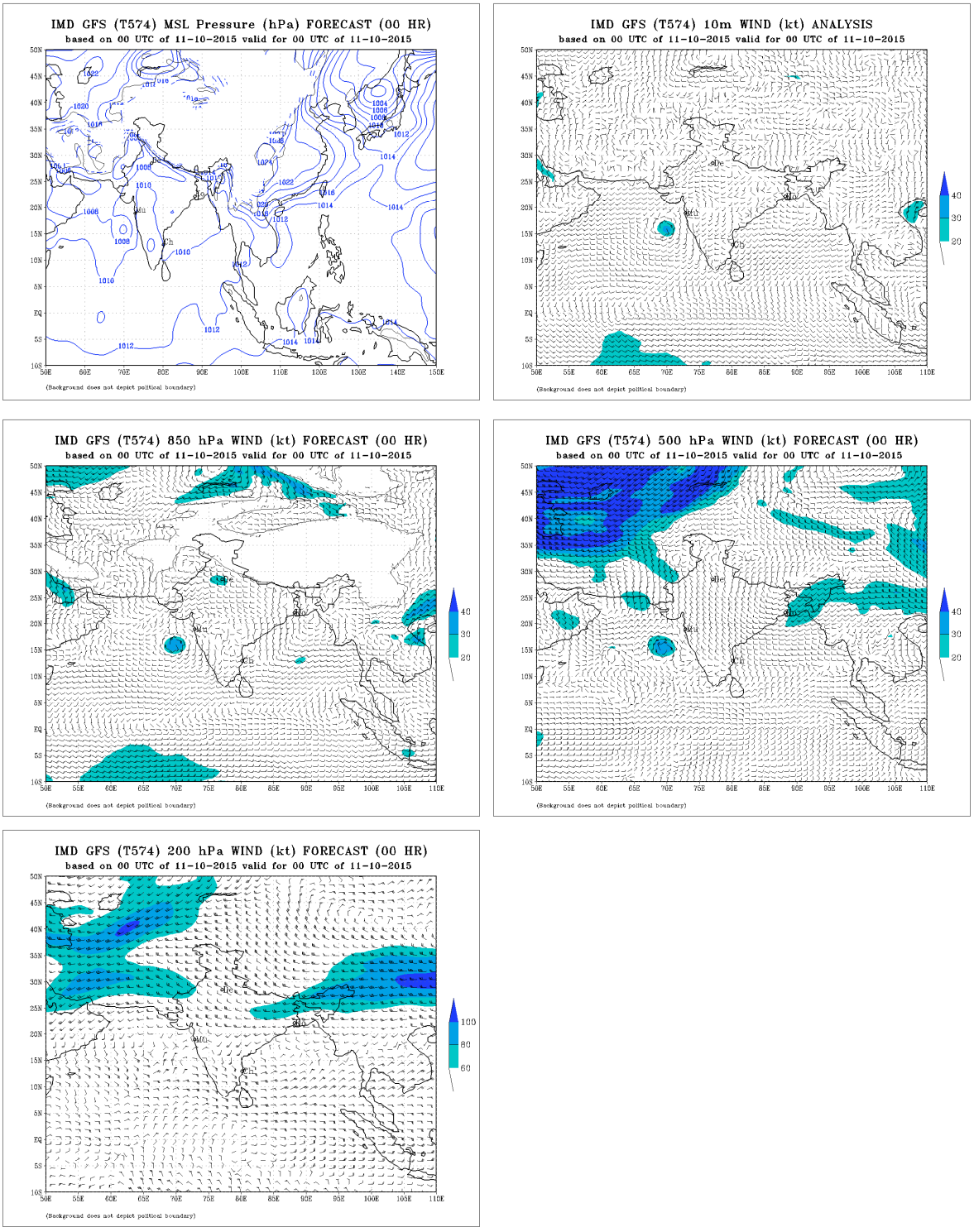


Fig.4d IMD-GFS MSLP, 10m wind, winds at 850, 500 and 200 hPa levels based on 00 UTC of 11th October 2015.

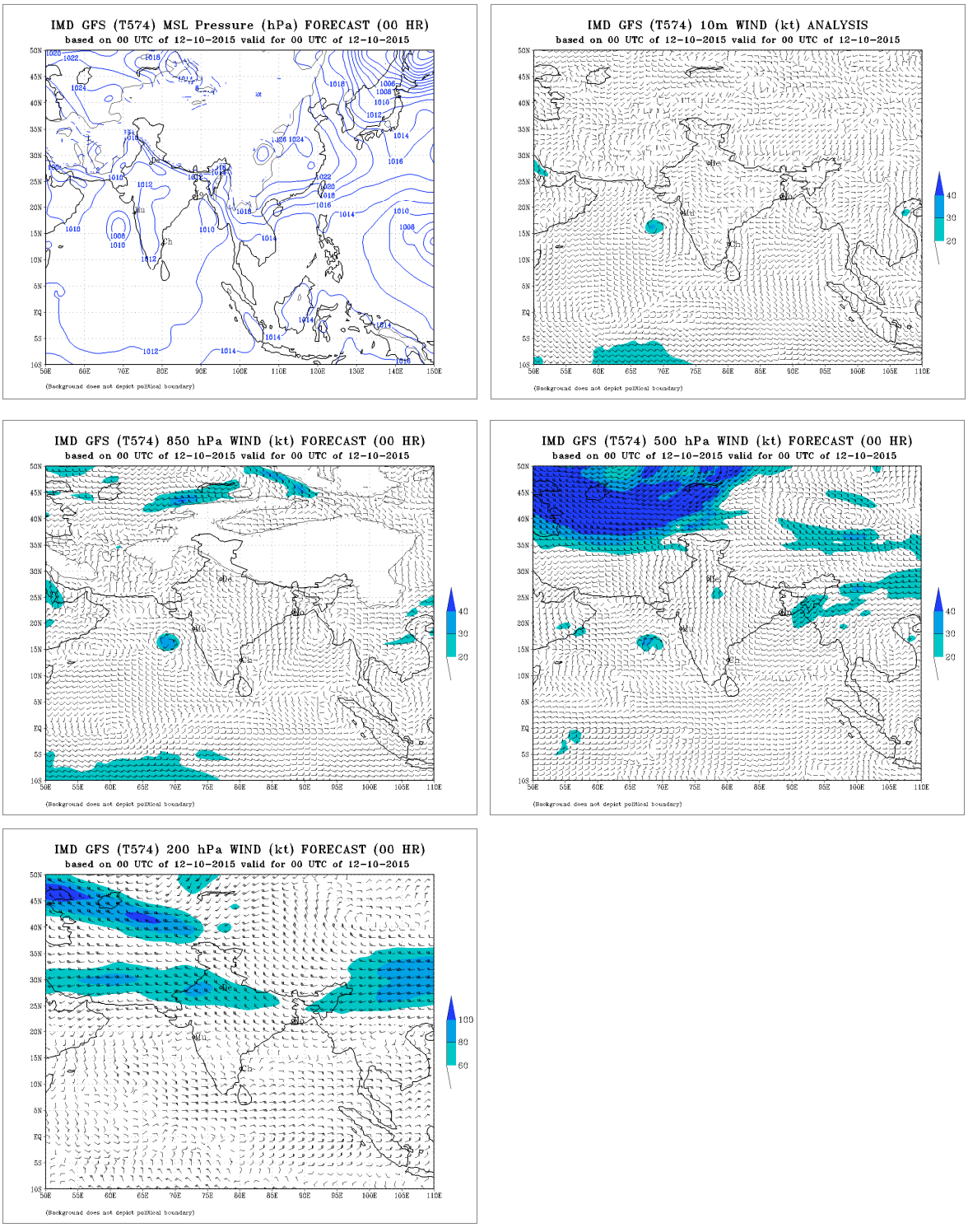


Fig.4e IMD-GFS MSLP, 10m wind, winds at 850, 500 and 200 hPa levels based on 00 UTC of 12th October 2015.

5. Bulletins issued by IMD

5.1 Bulletins issued by Cyclone Warning Division, New Delhi

IMD continuously monitored, predicted and issued bulletins containing track & intensity forecast. The above structured track and intensity forecasts were issued from the stage of deep depression onwards. The cone of uncertainty in the track forecast was also given for all cyclones. The radius of maximum wind and radius of≥28 knots and ≥34 knots wind in four quadrants was also issued for every six hours. The graphical display of the observed and forecast track with cone of uncertainty and the wind forecast for different quadrants were uploaded in the RSMC, New Delhi website (http://rsmcnewdelhi.imd.gov.in/) regularly. The prognostics and diagnostics of the systems were described in the RSMC bulletins and tropical cyclone advisory bulletins. The TCAC bulletin was also sent to Asian Disaster Risk Reduction (ADRR) centre of WMO at Honkong. Tropical cyclone vitals were prepared every six hourly from deep depression stage onwards and provided to various NWP modeling groups in India for bogusing purpose. Bulletins issued by Cyclone Warning services of IMD in association with the system are given in Table 2 (a-c)

Table-2a: Bulletins issued by Cyclone Warning Division, New Delhi

Bulletins issued by Cyclone Warning Division, New Delhi in association with Deep Depression Over Arabian Sea (9th to 11th October, 2015			
S.No.	Bulletin	No. of Bulletins	Issued to
1	National Bulletin	17	1. RSMC website 2. FAX and email to Control Room NDM, Cabinet Secretariat, Minister of Sc. & Tech, Secretary MoES, DST, HQ Integrated Defence Staff, DG Doordarshan, All India Radio, DG-NDRF, Dir. Indian Railways, Indian Navy, IAF, Chief Secretary- Kerala, Karnataka, Goa, Maharashtra, Gujarat, Daman & Diu and Dadra Nagar Haveli. 3. Email's to Modelling Groups- IIT-Delhi & Bhubaneswar, NCMRWF and INCOIS.
2	RSMC Bulletin	11	1. RSMC website 2. All WMO/ESCAP Panel member countries through GTS and E-mail. 3. Indian Navy, IAF coast guard by e-mail
3	Tropical Cyclone Advisory Centre Bulletin (Text & Graphics)	4	1. Met Watch offices in Asia Pacific regions through GTS to issue Significant Meteorological information (SIGMET) for International Civil Aviation as per ICAO guidelines 2. WMO's Aviation Disaster Risk Reduction

			Centre (ADRR), Honkong through ftp 3. RSMC website (both TCAC text & graphic bulletins)
4	TC vitals	4	Modelling group-NCMRWF, IIT, INCOIS, IMD NWP through ftp and email for creation of synthetic vortex in NWP Models
5	Quadrant Wind radii	4	Modelling group- NCMRWF, IIT, INCOIS, IMD NWP through email
6	SMS	5 times (No. -250) 5 times (No. -6334)	1. Disaster management officers at central & State Level (Kerala, Karnataka,Maharastra, Goa, Gujarat, Daman & Diu, Dadra Nagar Haveli) 2. General public of Kerala, Karnataka, Goa . Maharashtra, Gujarat, Daman & Diu, Dadra Nagar Haveli.

Table-2b: Bulletins issued by RWFC, Mumbai and ACWC Chennai.

S. No	Type of Bulletin	No. of Bulletins issued			
		ACWC Mumbai	ACWC Chennai	CWC Ahmedabad	MC Goa
1	Sea Area Bulletins	10	3	-	-
2	Coastal Weather Bulletins	10	-	14	-
3	Fishermen warning issued	12	15	6	4
4	Port Warnings	12	39	4	4
5	Heavy Rainfall Warning	06	-	-	2
6	Information & Warnings issued to State Government and other Agencies	02	-	12	15
7	SMS	103	-	-	86

6. Performance of operational NWP models

6.1. Prediction of cyclogenesis (Genesis Potential Parameter (GPP))

a. Grid point analysis and forecast of GPP

Grid point analysis and forecast of GPP is used to identify potential zone of cyclogenesis (T3.0). Figure 5(a-d) shows the predicted zone of cyclogenesis. Grid point analysis and forecasts of GPP shows that it over-predicted the genesis, as maximum intensity was deep depression.

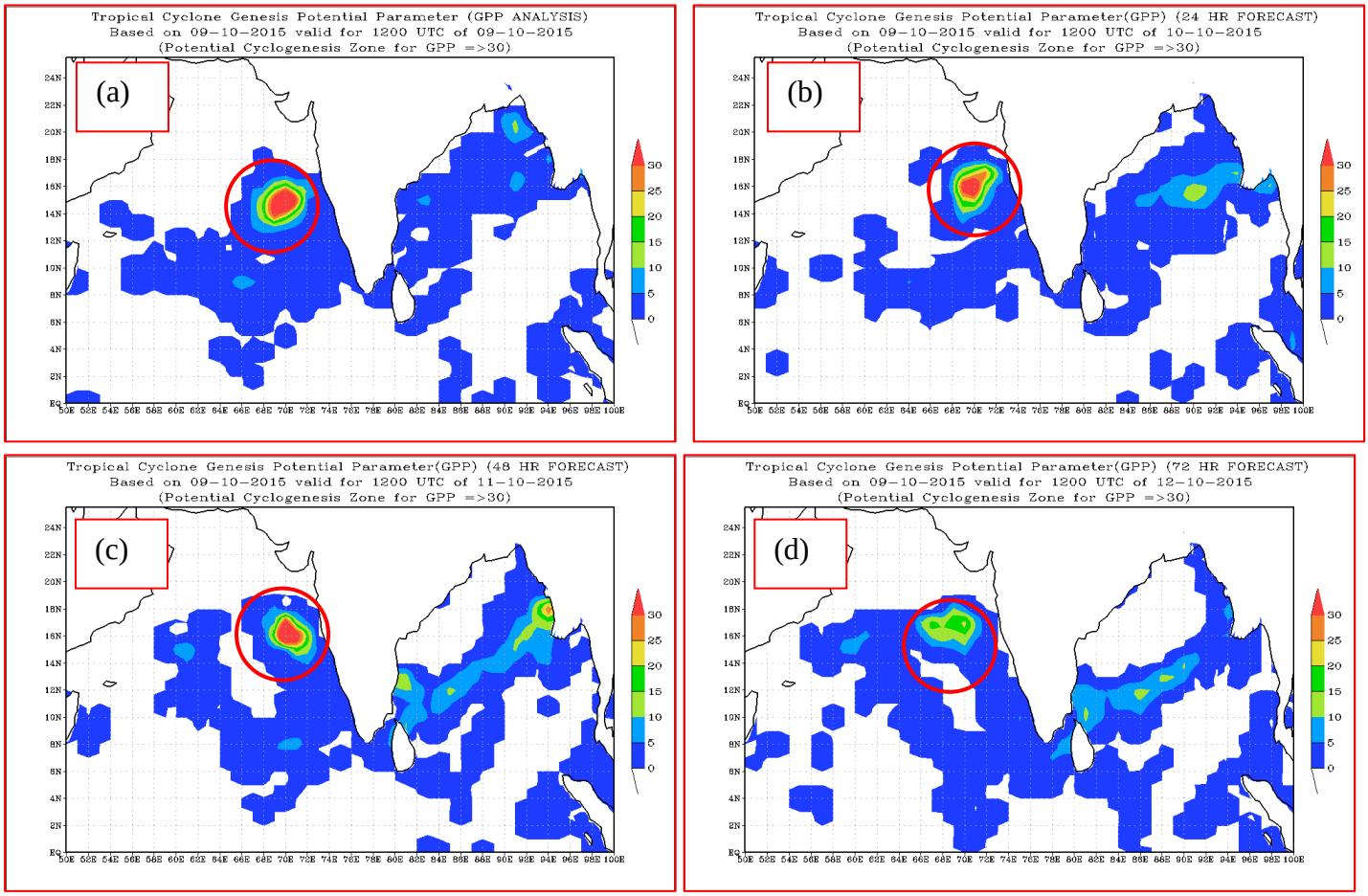


Figure 5(a-d): Predicted zone of cyclogenesis.

***b. Area average analysis of* GPP:**

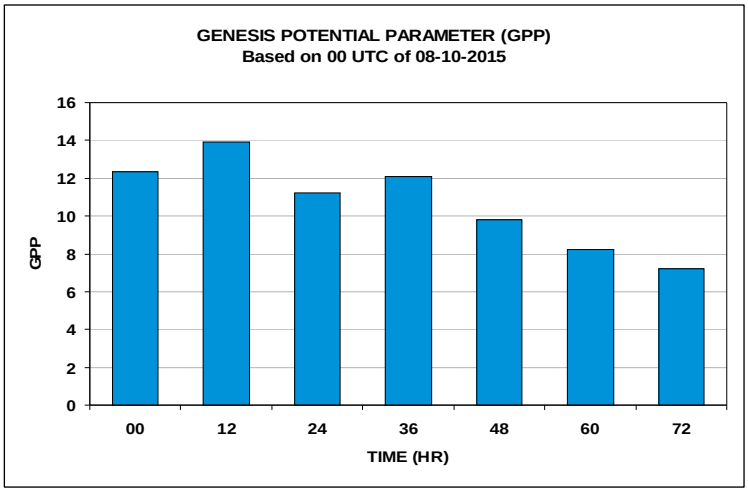


Fig. 6 Area average analysis and forecasts of GPP based on 0000 UTC of 08.10.2015

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

of development. Conditions for: (i) Developed system: Threshold value of GPP ≥ 8.0 and (ii) Non-developed system: Threshold value of GPP < 8.0. It is seen that the analysis and forecasts of GPP (Fig.6) over-predicted the genesis (T.No. 1.0).

6.2.1. Track prediction by numerical weather prediction (NWP) and Intensity forecast by statistical cyclone intensity prediction (SCIP) model:

The track prediction by multi-model ensemble (MME) and Intensity forecast by SCIP model based on 00 UTC of 9th to 11th is presented in fig.7. Track prediction by various models is presented in fig. 8 a-c. Track prediction by HWRF model based on 00 & 12 UTC of 9th to 11th October 2015 are presented in fig 9.

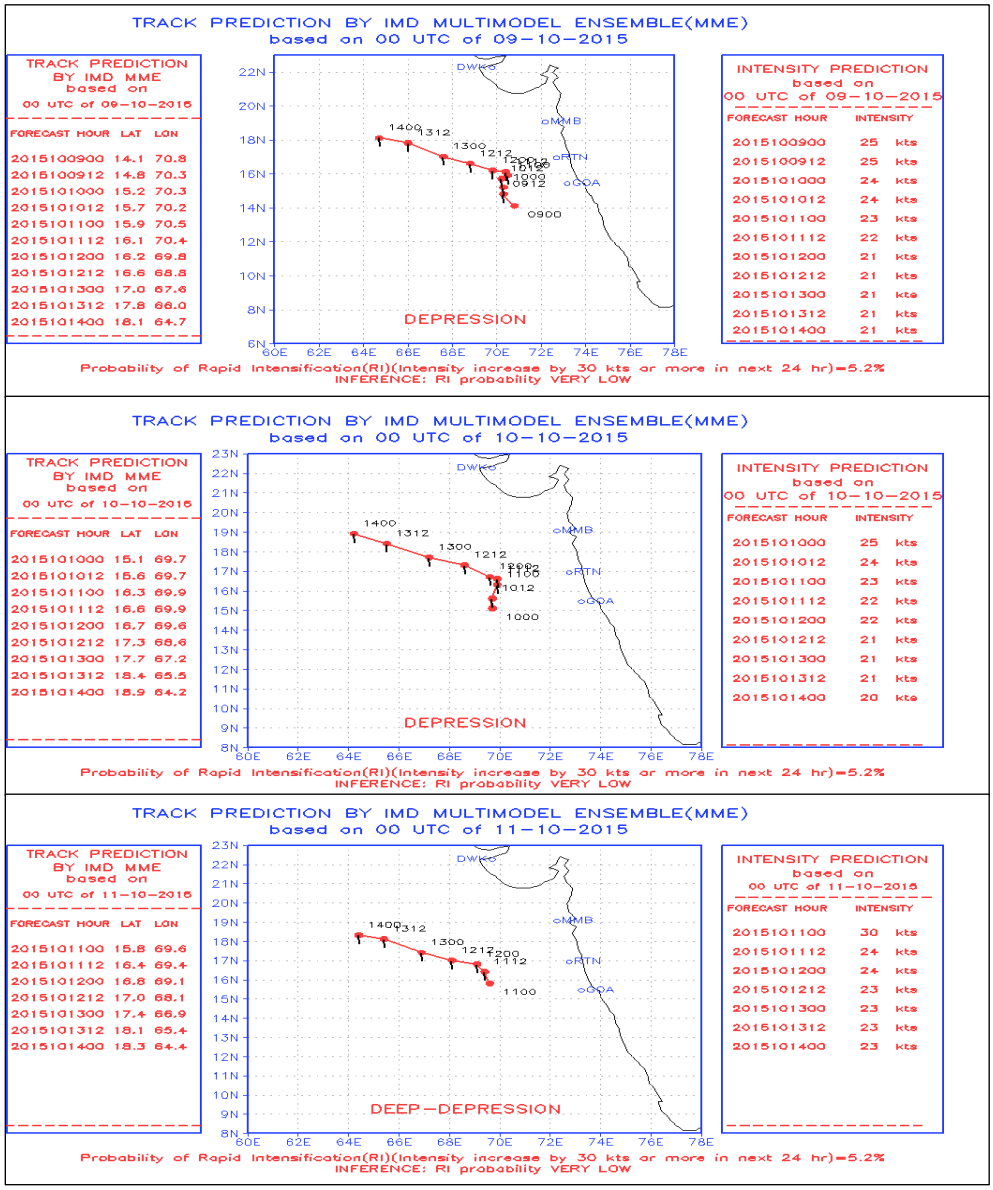


Fig. 7: Track prediction by MME and intensity forecast by SCIP model

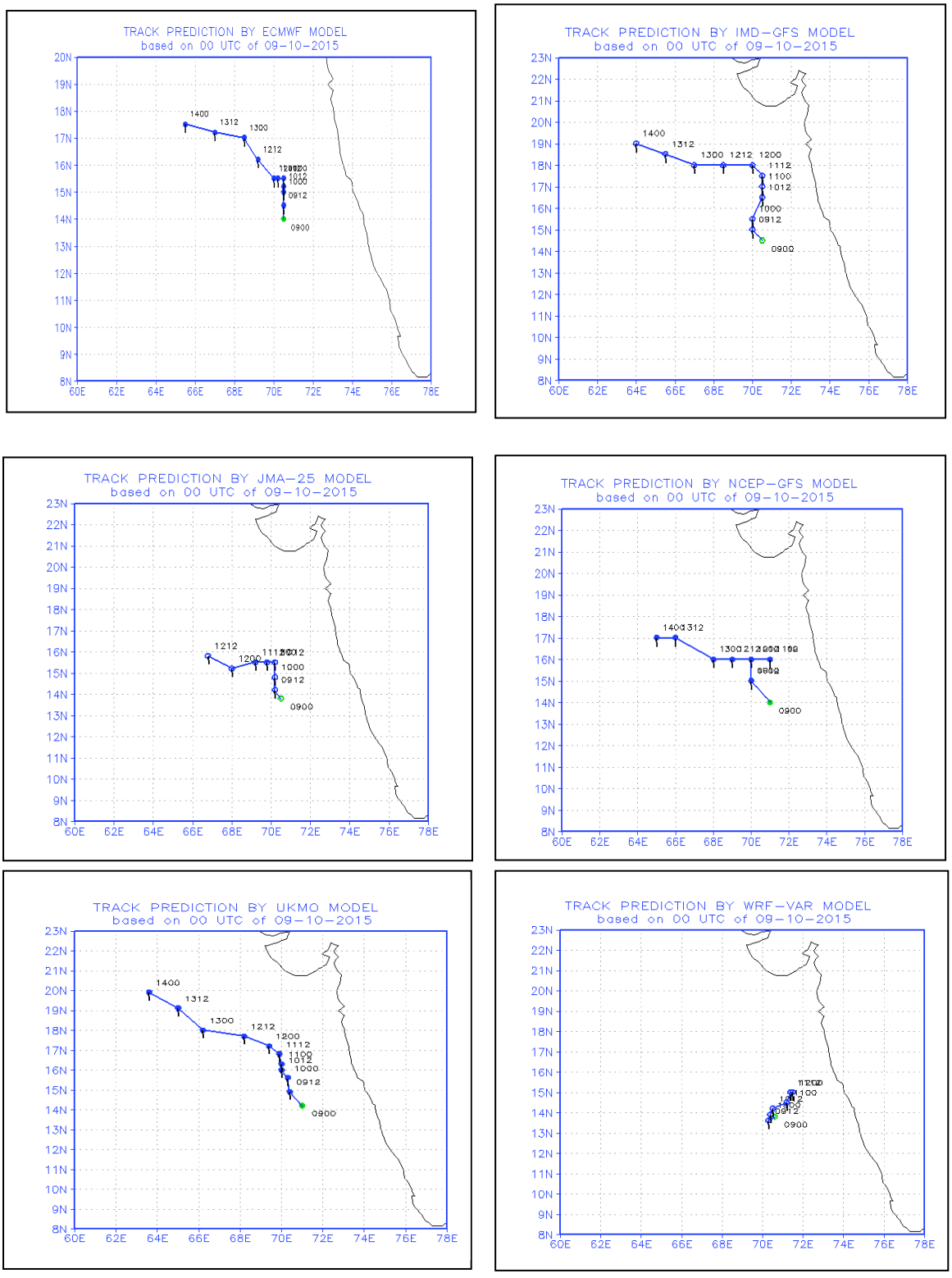


Fig.8(a). Track prediction by NWP models based on 0000 UTC of 09.10.2015

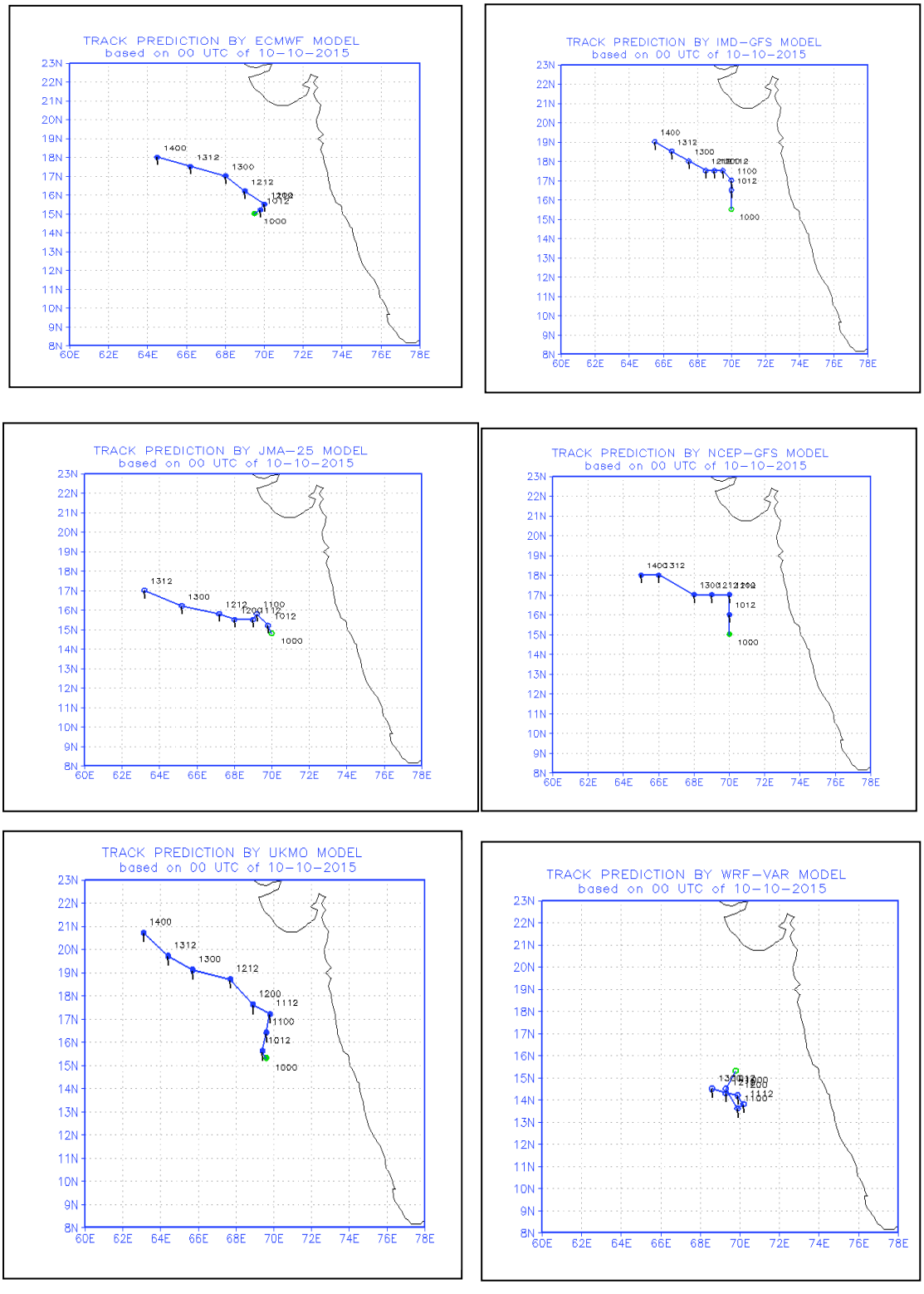


Fig.8(b). Track prediction by NWP models based on 0000 UTC of 10.10.2015

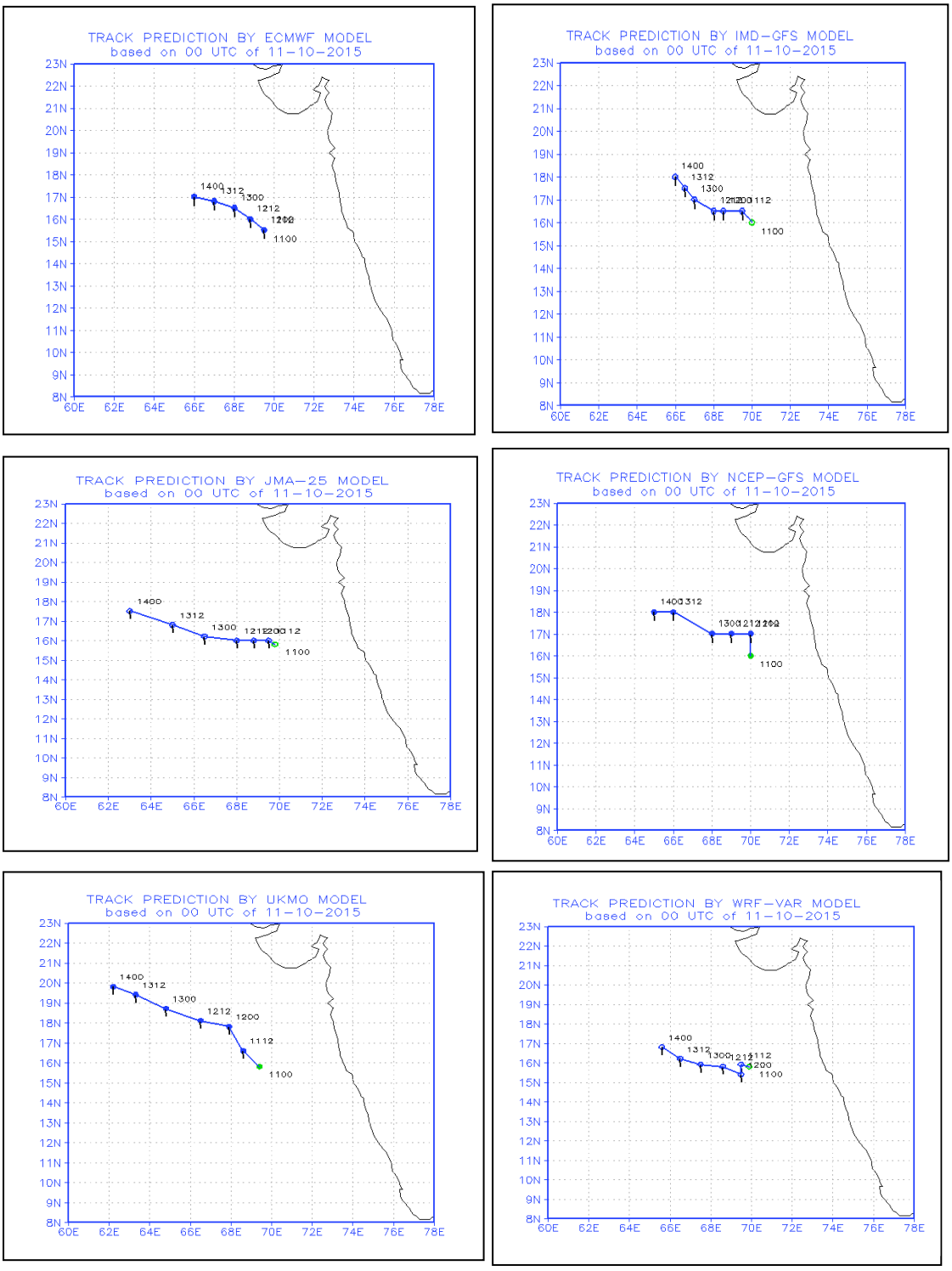


Fig. 8(c): Track prediction by NWP models based on 0000 UTC of 11.10.2015

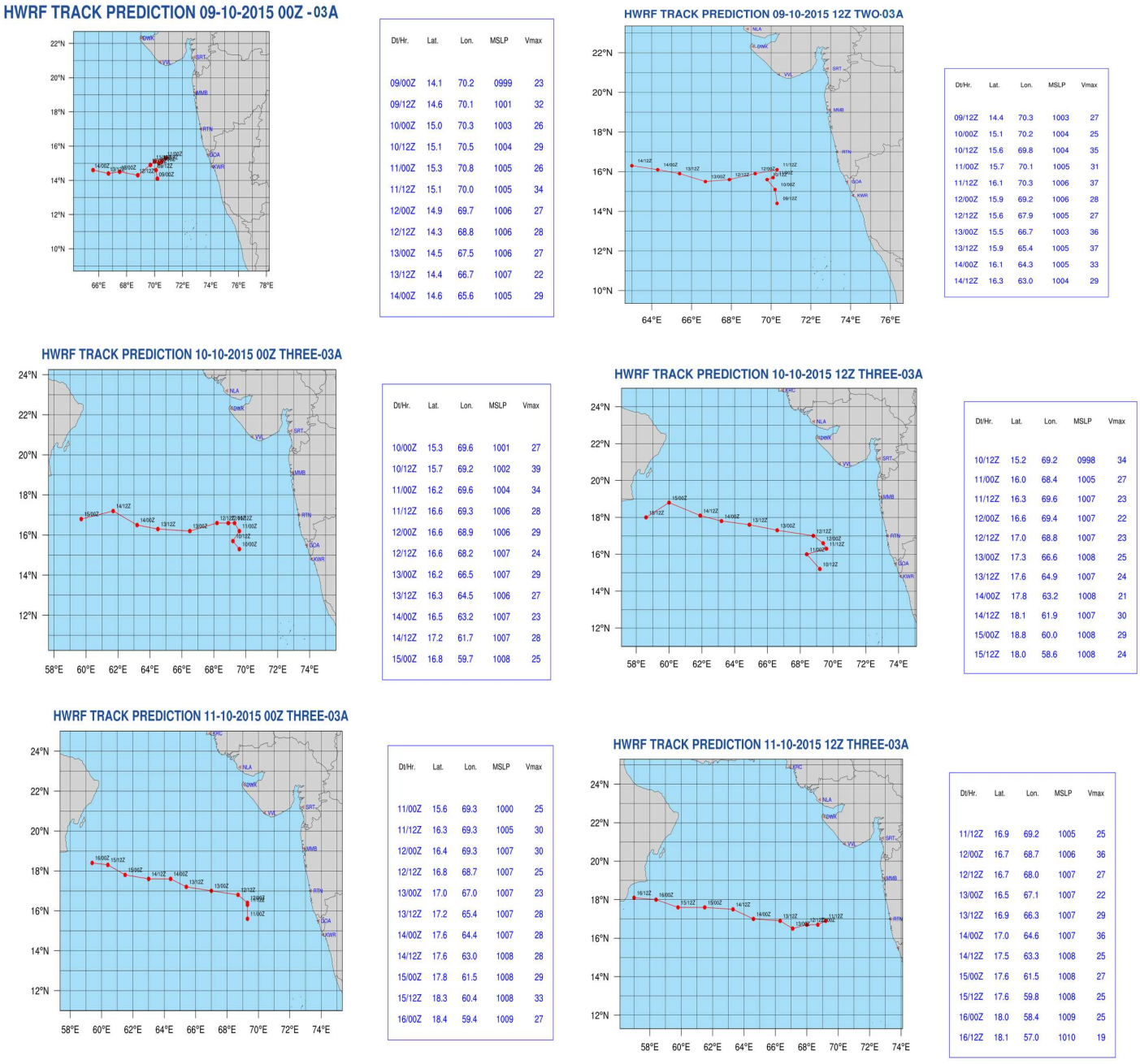


Fig.9. Track and intensity prediction by HWRF model based on 00 & 12 UTC of 9th to 11th October 2015

6.3 Accuracy of track forecasts by various NWP models

Track forecast errors from IMD-GFS, IMD-WRF, JMA, UKMO, ECMWF, IMD-MME, IMD-HWRF, NCMRWF-GFS, GEFS & Unified Model (NCUM) are presented in table 3. It is seen that track forecast errors for IMD-GFS and NCEP GFS were large as compared to other models for various lead periods. Track forecast errors by JMA were the least. The ECMWF, HWRF and IMD-MME also showed better forecast for various lead periods.

Table-3: Average track forecast errors (Direct Position Error) in km

Lead time →	12 hr	24 hr	36 hr	48 hr	60 hr	72 hr
IMD-GFS	106(3)	109(3)	187(2)	186(2)	225(1)	236(1)
IMD-WRF	63(3)	156(3)	214(2)	237(2)	256(1)	294(1)
JMA	33(3)	42(3)	76(2)	95(2)	44(1)	146(1)
NCEP	115(3)	125(9)	133(2)	173(2)	193(1)	107(1)
UKMO	72(3)	144(3)	137(2)	145(2)	125(1)	129(1)
ECMWF	49(3)	89(3)	113(2)	133(2)	116(1)	126(1)
IMD-MME	59(3)	91(3)	110(2)	119(2)	130(1)	86(1)
IMD-HWRF	73(8)	77(6)	99(5)	123(2)	124(1)	-
NCMRWF-NGFS	-	113(3)	-	160(2)	-	108(1)
NCMRWF-NCUM	-	138(3)	-	146(2)	-	183(1)
NCMRWF-NGEFS	-	150(3)	-	74(2)	-	155(1)

Table-4 Intensity forecast error of SCIP and HWRF models.

Lead time →	12 hr	24 hr	36 hr	48 hr	60 hr	72 hr
IMD-SCIP (AAE)	2.3(3)	5.1(3)	4.5(2)	4.5(2)	3.0(1)	1.0(1)
IMD-SCIP (RMSE)	3.5(3)	5.6(3)	4.7(2)	5.1(2)	3.0(1)	1.0(1)
IMD-HWRF (AAE)	5(8)	2(6)	2(5)	8(2)	9(1)	

The intensity forecast errors from SCIP model varied between 4.5 to 5.0 kts for 24 to 48 hours lead period. HWRF error based on absolute error varied from 2 to 9 knots for various lead period. The analysis of SCIP model forecast indicates that, it could not predict the intensification of the system to deep depression stage. The HWRF though predicted intensification, the predicted intensity fluctuated showing intensification and weakening without any consistent trend.

7. Operational Forecast Performance

Following are the salient features of the bulletins issued by IMD.

(i) **6th October:** Forecast of cyclogenesis over Arabian Sea on 9th October.

(ii) **7th October:** Forecast of cyclogenesis over Arabian Sea on 9th October.

(iii) **8th October**: Forecast of cyclogenesis over Arabian Sea on 9th October with **HIGH confidence**.

(iv) **9th October (morning):** Depression formed at 0830 hrs IST of 9th over eastcentral AS. Forecast of intensification into DD during next 24 hours.

(v) **10th October (morning):** DD formed over eastcentral AS at 2330 hrs IST of 9th. Forecast of its intensification to marginal cyclonic storm during next 24 hours was issued at 1130 hours IST of 10th. It would move northwestwards and weaken gradually from 12th.

(vi) **11th October (morning):** DD would weaken due to dry air intrusion from northwest and slow movement of the system. It would move north-westnorthwards during

next 24 hours and west-northwestwards thereafter. The system weakened into a depression at 0830 hours IST of 11th.

(vii) 12th October (morning): The system would move west-northwestwards and weaken into a well marked low during next 12 hours. The system weakened into a well marked low at 0830 hours IST of 12th.

7.1. Operational track forecast error and skill

The operational average track forecast errors and skills (compared to CLIPER forecasts) are shown in Table 6. The track forecast errors for 12, 24 and 36 hours lead period have been 46.1, 115 and 172 km respectively. The skill in track forecast error varied between 33 to 49% for various lead periods. Forecast has been verified upto 36 hours lead period due to short life of the system.

Table-6: Track Forecast Error (km) and skill for DD (09-12 October 2015)

Lead Period (hrs)	N	Track forecast		
		Official Error (km)	Cliper Error (km)	Skill (%)
12	6	46.1	89.8	48.7
24	4	115 0	173.3	33.6
36	2	172.0	291.0	40.9

N: Number of six hourly forecasts verified.

7.2. 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 7.

Table-7: Intensity forecast errors (kts) and skill (%) for DD (09-12 October 2015)

Lead period (hrs)	Operational intensity error (kts)	
	AE	RMSE
12	4.8	6.3
24	12.7	13.6
36	18.0	18.2

The intensity forecast error based on AE from 12 to 36 hours lead period varied from 05 to 18 kts. The intensity forecast error has been slightly higher for 24 and 36 hours lead period mainly because it was a weak system and it rapidly dissipated over the sea. Further, the maximum intensity of the system was predicted as a marginal cyclonic storm (40 knots), though it intensified upto DD (30 knots) only.

8. Summary and conclusion

The deep depression over the Arabian Sea exhibited weakening due to dry air intrusion from the northwest. Though its genesis, intensification/weakening and track could be predicted well, there is still scope to improve the forecast of intensification/weakening of the system over Arabian Sea.

9. Acknowledgements

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