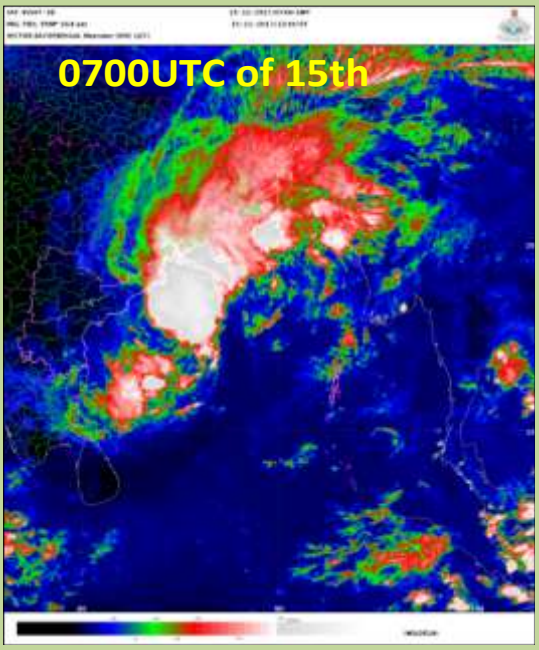
GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
INDIA METEOROLOGICAL DEPARTMENT

Depression over westcentral Bay of Bengal (15-17 November, 2017): A Report



INSAT-3D enhanced coloured IR imagery based on 0700 UTC of 15th November

Cyclone Warning Division

India Meteorological Department

New Delhi

November 2017

Depression over westcentral Bay of Bengal
(15-17 November 2017)

1. Introduction

A low pressure area (LPA) formed over southwest Bay of Bengal (BoB) and neighborhood in the morning of 10th November, 2017. It lay as a well marked low pressure area (WML) over southwest BoB and neighborhood in the morning of 13th. It further concentrated into a depression over westcentral BoB off Andhra Pradesh. Moving nearly north-northeastwards, it weakened into a WML over northwest Bay of Bengal off Odisha Coast. The observed track of the system is presented in Fig.1.

The salient features of the system were as follows:

(i) The system moved nearly north-northeastward and weakened over Sea.

(ii) The total life period of the system was 51 hours against the average life period of depression of 65 hours in post monsoon season over the BoB.

(iii) The system caused heavy to very heavy rainfall at isolated places over Odisha and coastal Andhra Pradesh on 15th and heavy rainfall at isolated places on 17th.

IMD mobilised all its resources to monitor the system and regular warnings w.r.t. track, intensity, landfall and associated adverse weather were issued to concerned central and state disaster management agencies, print & electronic media and general public. Regular advisories were also issued to WMO/ESCAP Panel member countries including Bangladesh.

The brief life history, associated weather and forecast performance of IMD/RSMC, New Delhi are presented below.

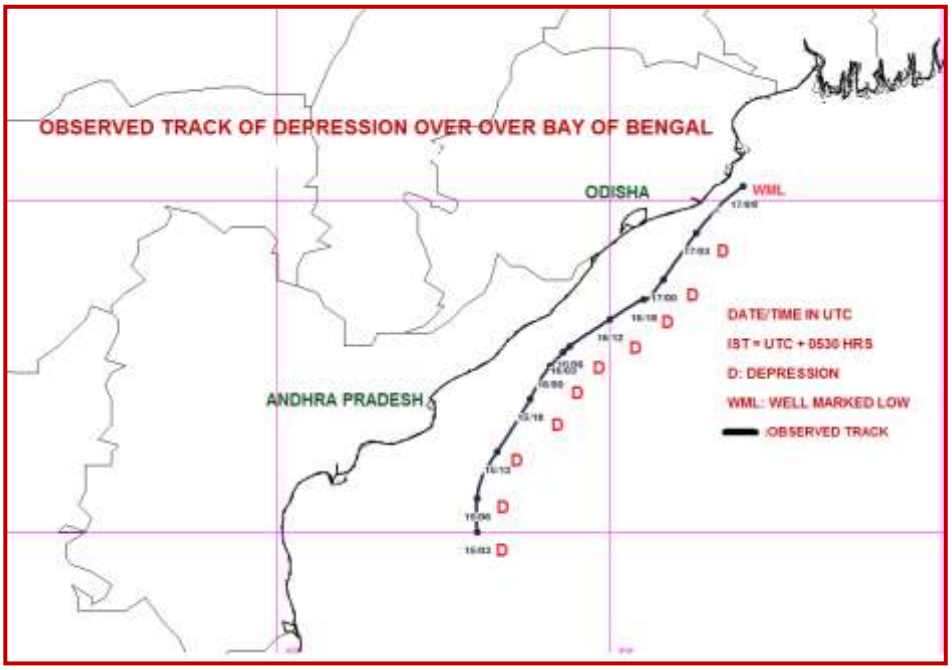


Fig.1: Observed track of Depression over westcentral Bay of Bengal (15-17 November, 2017)

2. Brief life history

2.1. Genesis

An LPA formed over southwest BoB and neighborhood at 0300 UTC of 10th November, 2017. It lay over southwest BoB and adjoining Sri Lanka coast at 0300 UTC of 12th. It lay as a WML over southwest BoB and neighborhood at 0300 UTC of 13th. It further lay over westcentral and adjoining southwest BoB at 0300 UTC of 14th. It concentrated into a depression over westcentral BoB off Andhra Pradesh coast and lay centred at 0300 UTC of 15th November near latitude 15.0^0 N and longitude 83.0^{0}E about 230 km southeast of Machilipatnam (Andhra Pradesh), 300 km south of Visakhapatnam and 510 km south-southwest of Gopalpur (Odisha) .

Considering the environmental conditions, at 0000 UTC of 15th, the sea surface temperature over the region was 28-29^{0}C. The ocean thermal energy was about 70-80 KJ/cm^2 over the area. The vertical wind shear between upper and lower levels was low to moderate (5-15 kt) around the system centre. It was increasing towards north and south. The vertical wind shear between middle and lower levels was low (5-10 knots). The low level relative vorticity was around 100 x 10^{-6} s^{-1} to the southwest of system centre. Low level convergence was about 20 x 10^{-5} s^{-1} to the north-northeast of system centre. The upper level divergence was around 30 x 10^{-5} s^{-1} near system centre. The upper tropospheric ridge at 200 hpa level ran along 17.0^{0}N over BoB and Andaman Sea. The analysis of the mean layer winds suggested that the system was being steered by the lower to upper tropospheric mean winds towards north with a speed of about 06 knots. The Madden Julian Oscillation (MJO) index lay in phase 5 with amplitude < 1. The increased vertical wind shear towards north & northeast and unfavourable MJO conditions suggested that the system would not intensify further.

2.2. Intensification and Movement:

At 0000 UTC of 16th, the sea surface temperature over the region was 28-29^{0}C. However, it was about 26-27^{0}C over coastal Odisha. The ocean thermal energy was about 70-80 KJ/cm^2 over the area. It decreased to 50 KJ/cm^2 to the north of 20^{0}N. The vertical wind shear between upper and lower levels was low to moderate (10-15 kt) around the system centre and it was increasing towards north. The low level relative vorticity was around 100 x 10^{-6} s^{-1} to the southeast of system centre. Low level convergence was about 40 x 10^{-5} s^{-1} to the east of system centre. The upper level divergence was around 40 x 10^{-5} s^{-1} to the northeast of system centre. The upper tropospheric ridge at 200 hpa level ran along 17.0^{0}N over BoB and Andaman Sea. The analysis of the mean layer winds suggested that the system was being steered by the lower to upper tropospheric mean winds towards north with a speed of about 06 knots. The analysis of the mean layer winds suggested that the system was being steered by lower to upper level winds. The upper tropospheric ridge ran along 17^{0}N in association with an anticyclonic circulation over central BoB. A trough in westerly ran along 67 ^{0}E to the north of 18 ^{0}N. As a result, strong southerly/ southwesterly winds prevailed near the system. All these features favoured north-northeastward movement of the system. Further, the increased wind shear, lower sea surface temperatures and ocean thermal energy to the north suggested weakening of the system as it would move further northwards. Continuing north-northeastward movement, it weakened into a WML at 0600 UTC of 17th over northwest BoB off north Odisha- West Bengal coasts. The best track parameters of the system are presented in Table 1.

Table 1: Best track positions and other parameters of the Depression over the westcentral Bay of Bengal during 19-22 October, 2017

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
15/11/2017	0300	15.0/83.0	1.5	1004	25	4	D
	0600	15.5/83.0	1.5	1004	25	4	D
	1200	16.2/83.3	1.5	1001	25	4	D
	1800	17.0/83.8	1.5	1002	25	4	D
16/11/2017	0000	17.5/84.1	1.5	1004	25	4	D
	0300	17.7/84.3	1.5	1004	25	4	D
	0600	17.7/84.3	1.5	1004	25	4	D
	1200	18.1/85.0	1.5	1004	25	4	D
	1800	18.5/85.5	1.5	1004	25	4	D
17/11/2017	0000	18.8/85.8	1.5	1004	25	4	D
	0300	19.5/86.3	1.5	1006	25	4	D
	Weakened into a well marked low pressure area over northwest Bay of Bengal off north Odisha-West Bengal coasts at 0600 UTC						

3. 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 from SCATSAT and international geostationary satellites Meteosat-7 & MTSAT, microwave & high resolution images of polar orbiting satellites DMSP, NOAA series, TRMM, Metops were also considered for monitoring the system.

3.1 INSAT-3D features

Typical INSAT-3D visible, IR and enhanced colored imageries are presented in Fig.2. At 0300 UTC of 15th, intensity of the system was T 1.5. Broken low & medium clouds with embedded intense to very intense convection lay over westcentral and adjoining northwest BoB. At 1200 UTC of 15th, broken low & medium clouds with embedded intense to very intense convection lay over westcentral & adjoining eastcentral BoB and northwest BoB. As the system moved further north-northeastwards, at 0300 UTC of 16th, broken low & medium clouds with embedded moderate to intense convection lay over westcentral and adjoining eastcentral BoB and over northwest BoB. The cloud mass started disorganizing from the night of 16th and at 0300 UTC of 17th, broken low & medium clouds with embedded moderate to intense convection lay over westcentral and adjoining eastcentral BoB, northwest BoB and coastal Odisha. At 0600 UTC of 17th, the system weakened into a well marked low pressure area with broken low & medium clouds with embedded moderate to intense convection lay over north BoB and coastal Odisha, coastal West Bengal and coastal Bangladesh.

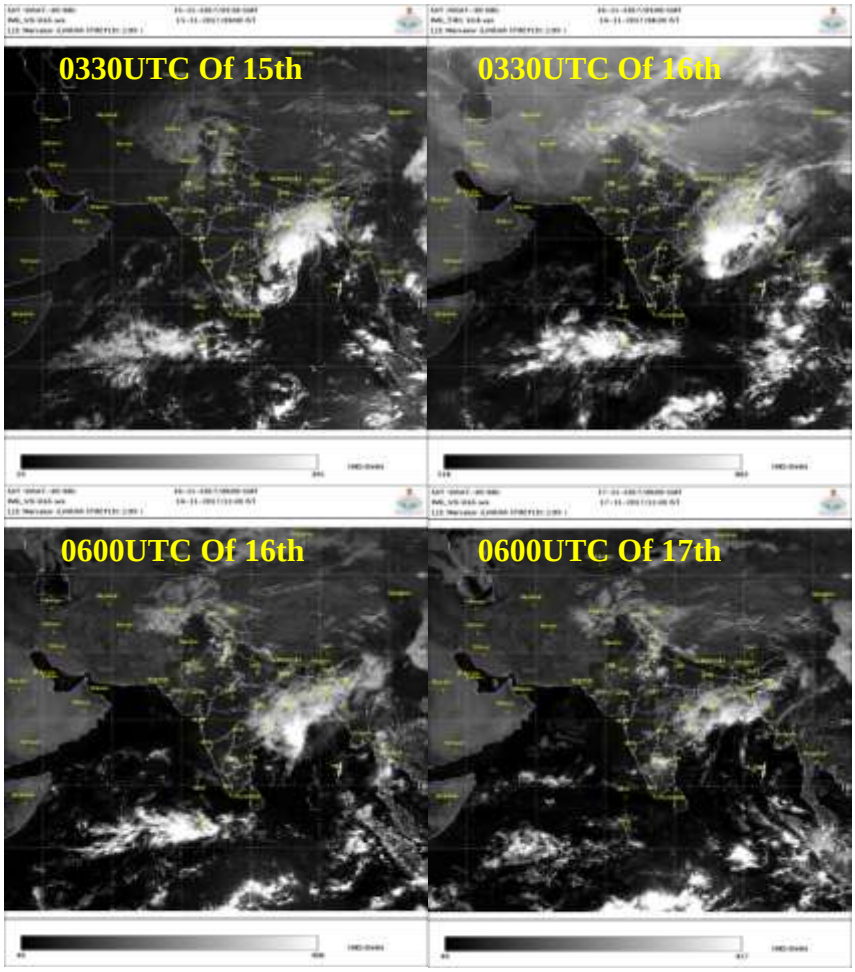


Fig. 2(i): INSAT-3D Visible imageries of Depression (15-17 November, 2017)

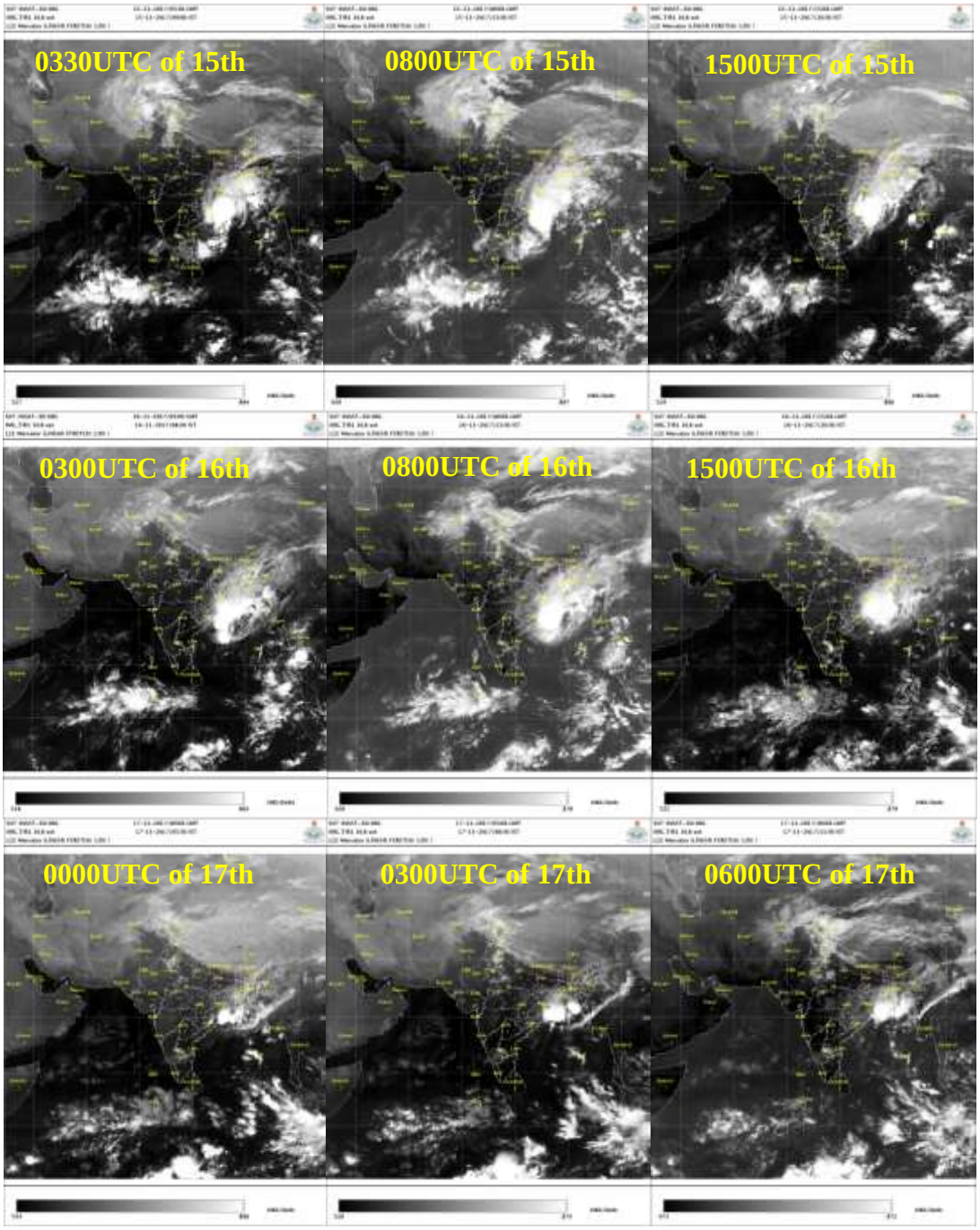


Fig. 2(ii): INSAT-3D IR imageries of Depression (15-17 November, 2017)

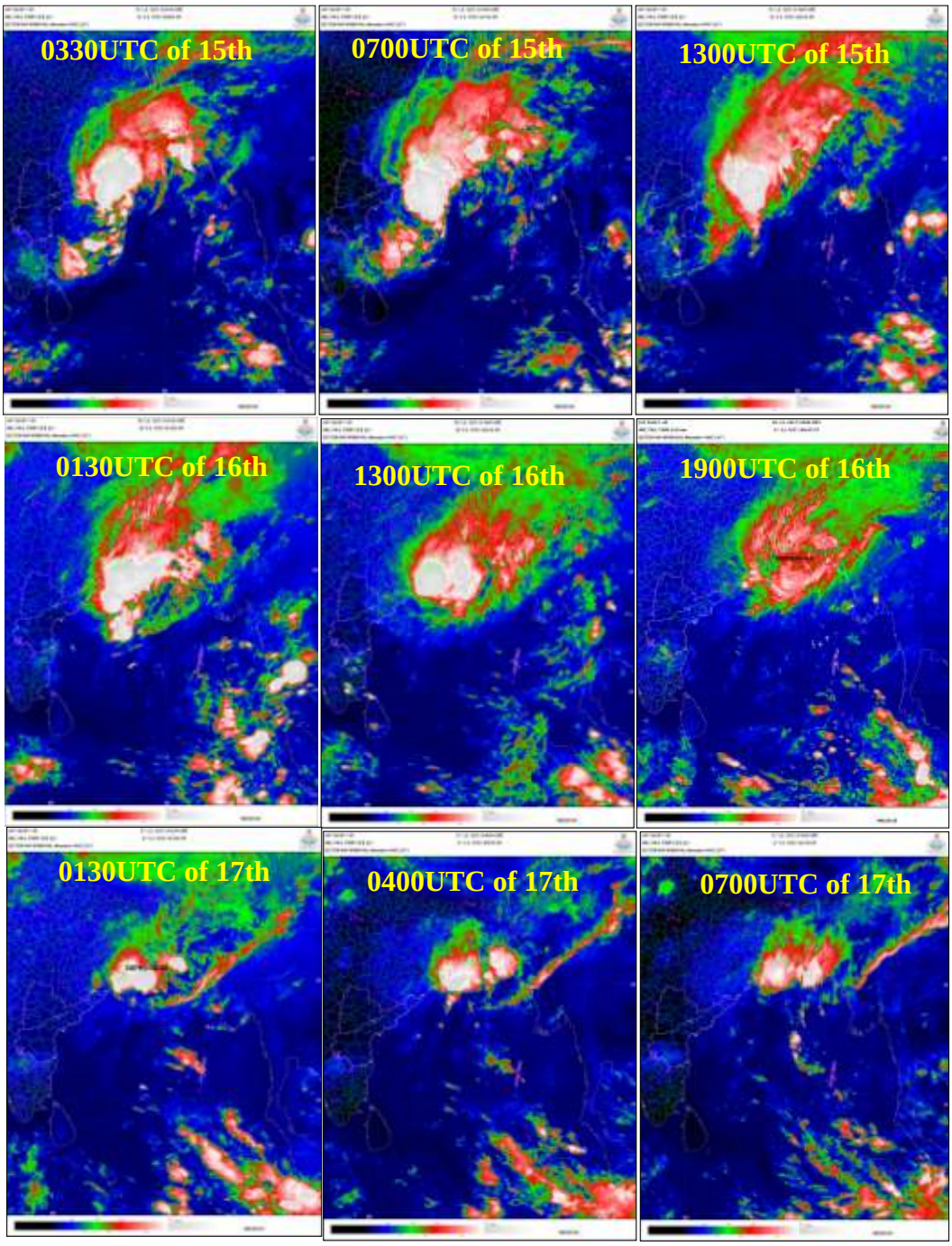


Fig. 2(iii): INSAT-3D enhanced coloured imageries of Depression (15-17 November, 2017)

3.3. Features observed through Radar:

Throughout its life cycle, the system was tracked by DWR Paradip, Visakhapatnam and Kolkata. These imageries were utilized for determining the location and movement of system. Typical DWR imageries are presented in Fig.3.

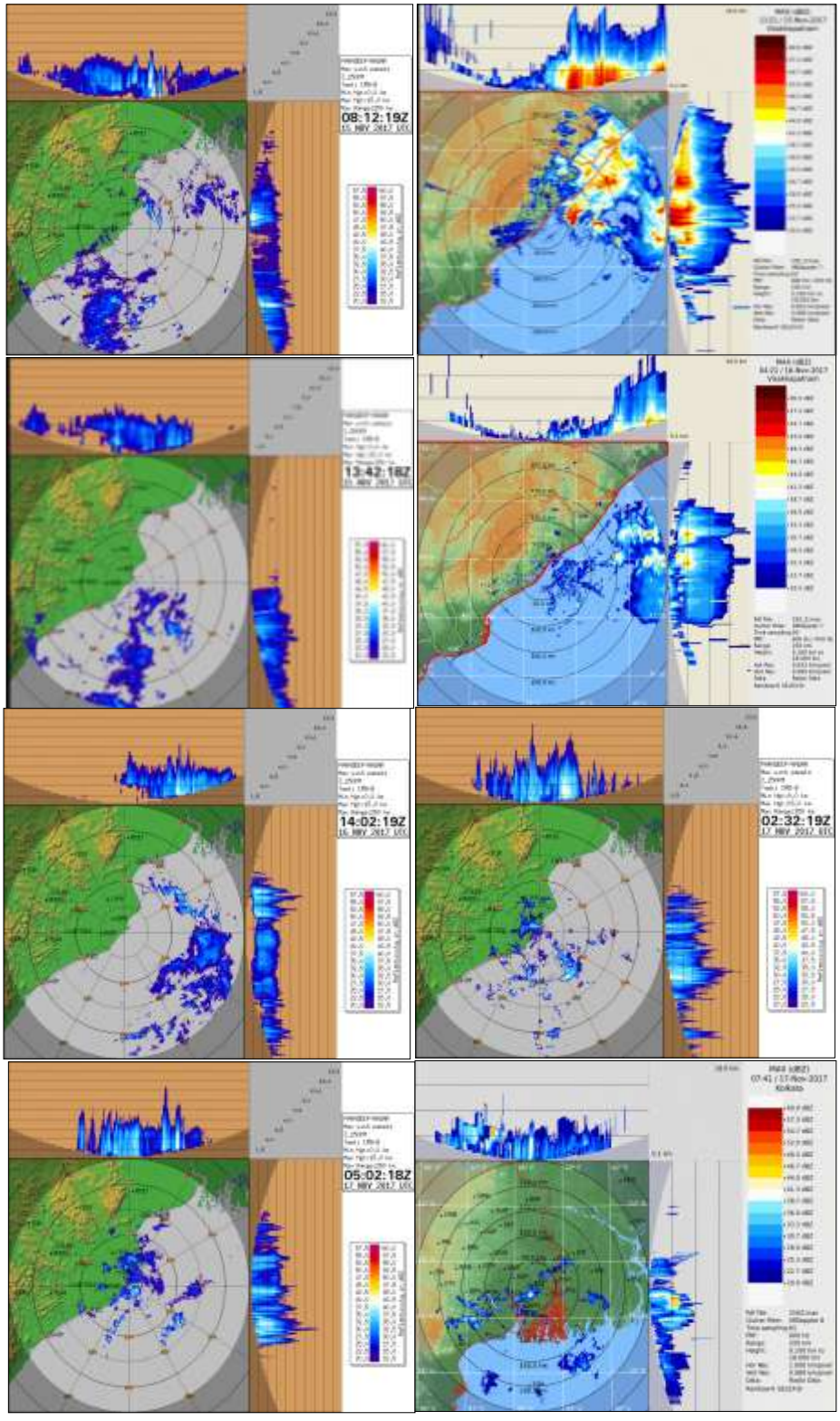


Fig. 3: Typical DWR imageries during Depression (15-17 November, 2017)

4. Dynamical features

IMD GFS (T1534) analysis and forecast of mean sea level pressure (MSLP), winds at 10 m, 850, 500 and 200 hPa levels are presented in Fig.4. IMD GFS (T1534) could well simulate the genesis of the system on 15th November, it's north-northeastward movement and dissipation on 17th. It could also capture broad scale features like trough in westerlies along 62^0E to the north of 20^0N.

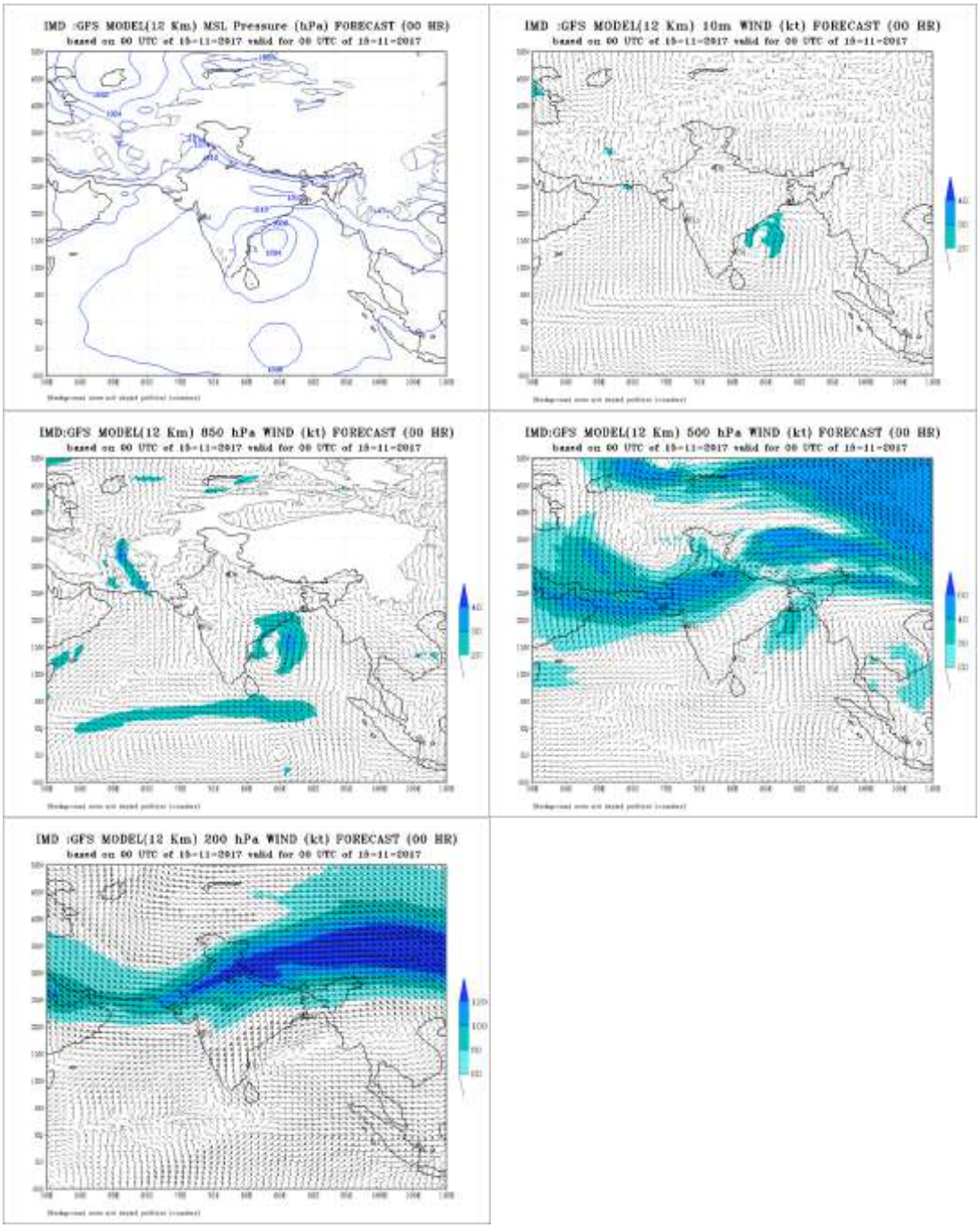


Fig. 4 (i): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 15th November 2017

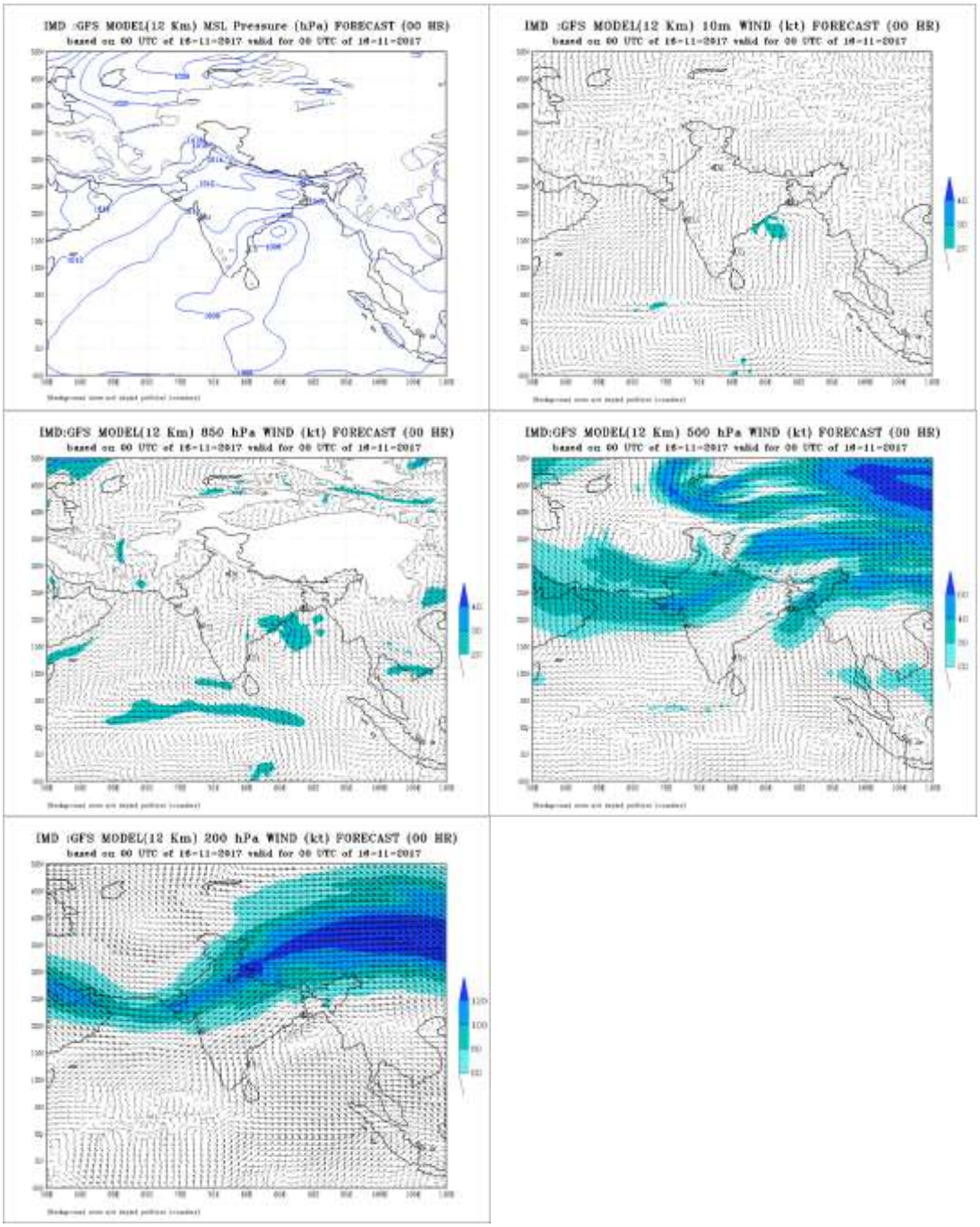


Fig. 4 (ii): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 16th November 2017

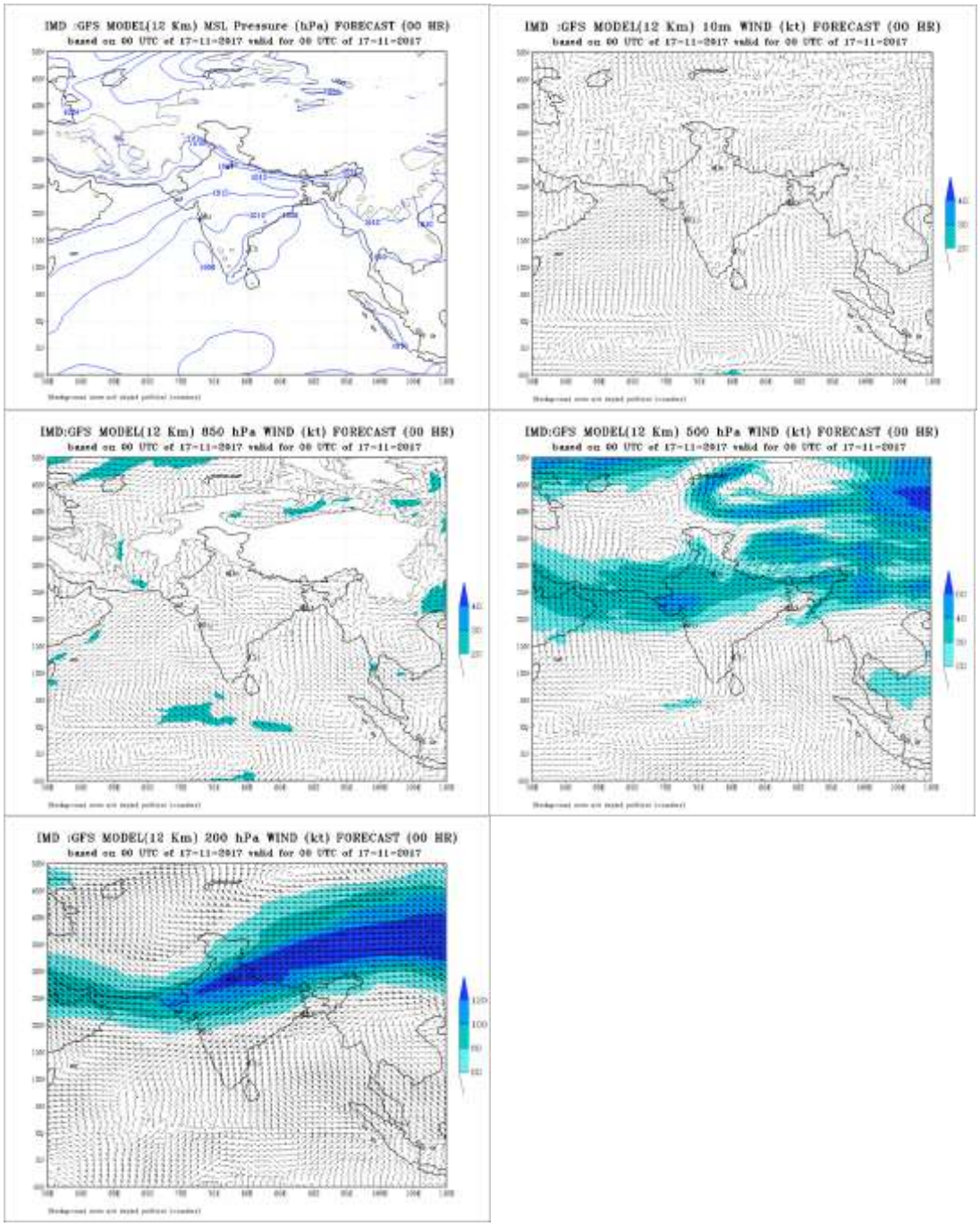


Fig. 4 (iii): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 17th November 2017

5. Realized Weather:

5.1 Rainfall:

Realised weather:

Under its influence, isolated heavy rainfall occurred over Odisha and isolated heavy to very rainfall over Andhra Pradesh occurred on 15th. On 17th, heavy rainfall occurred at isolated places over Odisha and Andhra Pradesh.

The rainfall is categorized as: heavy rain: 64.5 – 115.5 mm, very heavy rain: 115.6 – 200.4 mm, extremely heavy rain: 200.5 mm or more.

The daily rainfall distribution based on merged gridded rainfall data of IMD/NCMRWF during depression period is shown in Fig.5. It can be seen that the system caused heavy to very heavy rainfall (16-32 cm) rainfall over eastcentral BoB and 2-4 cm rainfall over coastal Odisha, Gangetic West Bengal and Bangladesh. On 17th, the heavy to very rainfall was seen over eastcentral BoB.

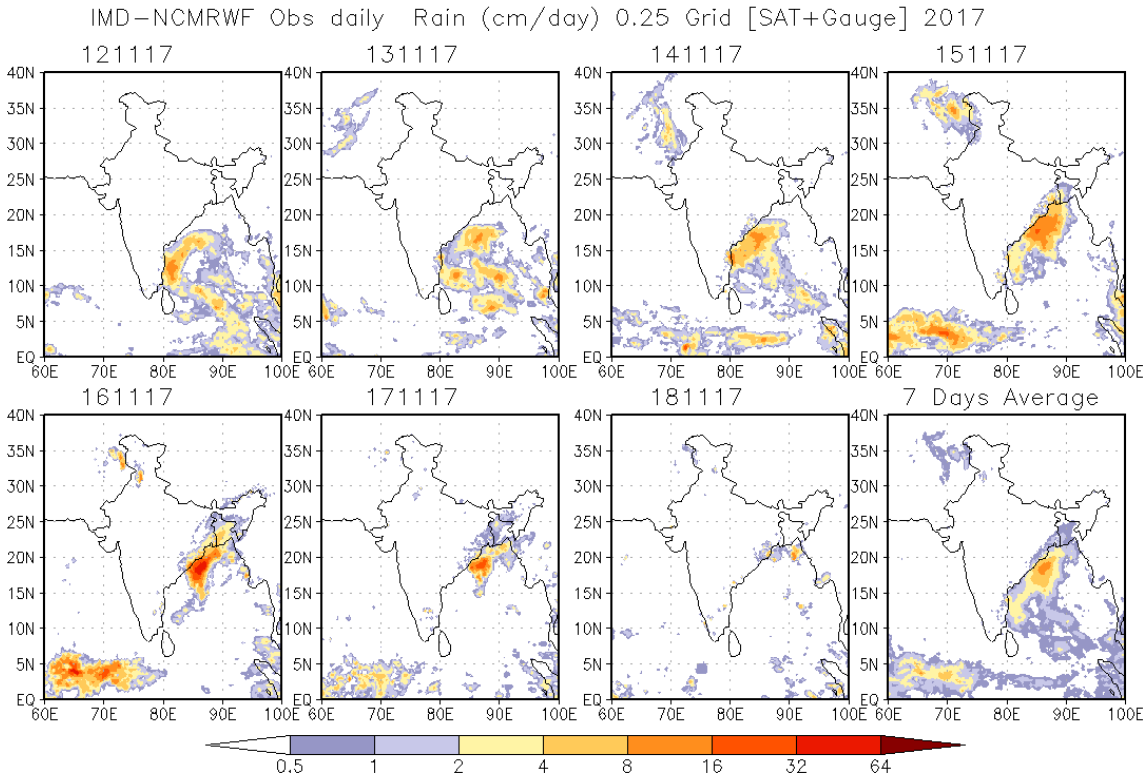


Fig.8: Daily rainfall distribution ending at 0300 UTC (0830 IST) of date based on merged grided rainfall data of IMD/NCMRWF during 17-23 October 2017.

Realized 24 hrs accumulated rainfall (≥7cm) ending at 0830 hrs IST of date during the life cycle of the system is presented below:

15 November 2017

Puducherry: Thanjavur-7

16 November 2017

Odisha: GOP & Astaranga – 9 each and Puri, Paradeep, Digapahandi, Paralakhemundi, Mahendragarh, Tirtol, Balikuda, Kujanga & Nischintakoili -7 each

Coastal Andhra Pradesh: Sompeta-18, Ichchapuram-17, Mandasa-14, Palasa & Kalingapatnam-11, Tekkali-9 and Pathapatnam-7

18 November 2017
Odisha: Tirtol - 8 and Rajkanika & Binjharpur -7 each
Coastal Andhra Pradesh: Vijayawada A.P.-9

5. Bulletins issued by IMD

5.1 Bulletins issued by Cyclone Warning Division, New Delhi

- IMD continuously monitored, predicted and issued bulletins containing track and intensity of the system till weakened into a low pressure area.
- The prognostics and diagnostics of the systems were described in the RSMC bulletins.
- Warnings bulletins for adverse weather like heavy rain were issued with every three hourly update during life cycle of system to the central, state and district level disaster management agencies including MHA, NDRF, NDMA, Chief Secretaries Andhra Pradesh, Odisha and West Bengal. These bulletins were also issued to Railways, surface transport, Defence including Indian Navy & Indian Air Force, Ministry of Agriculture, Ministry of Information and Broadcasting etc.
- The graphical display of the observed track was disseminated by email and uploaded in the RSMC, New Delhi website (http://rsmcnewdelhi.imd.gov.in/) regularly.
- Regular updates were uploaded on facebook and tweeter regularly during the life period of the system.
- Electronic media were given daily updates since inception of system through e-mail, website and SMS.
- The six hourly bulletins were issued by the cyclone warning division at New Delhi and cyclone warning centres of IMD at Chennai, Visakhapatnam and Bhubaneswar to ports, fishermen, coastal and high sea shipping community

Bulletins issued by Cyclone Warning services of IMD in association with the system are given in Table 2.

Table 2: Bulletins issued by Cyclone Warning Division, India Meteorological Department

S.No.	Bulletin	No. of Bulletins	Issued to
1	National Bulletin	12	1. IMD's website 2. FAX and e-mail to Control Room NDM, Ministry of Home affairs, Control Room NDMA, Cabinet Secretariat, Minister of Sc. & Tech, Secretary MoES, DST, HQ Integrated Defence Staff, DG Doordarshan, All India Radio, DG-NDRF, Director Indian Railways, Indian Navy, IAF, Chief Secretary: Andhra Pradesh, Odisha and West Bengal.
2	RSMC Bulletin	6	1. IMD's website 2. WMO/ESCAP member countries through GTS and E-mail 3. Indian Navy, IAF by E-mail
3	Facebook/ Tweet	3	Cyclone Warnings were uploaded on Social networking sites like Face book and Tweeter since inception till weakening of system
4	SMS	Once	SMS through (i) IMD network for disaster managers at national

		daily	level and concerned states-145 (ii) Department of Electronics and Information Technology-

Table 3: Statistics of Bulletins issued by ACWC Kolkata/ACWC Chennai/CWC Bhubaneswar

S.No.	Type of Bulletin	Statistics of Bulletins	
		ACWC Kolkata	ACWC Chennai
1.	Sea Area Bulletins	08.	Nil
2.	Coastal Weather Bulletins	WB Coast- 06. Andaman & Nicobar ISDS coast – 06.	4
3.	Fishermen Warnings issued	For WB Coast fishermen -12 For A & N coast fishermen – NIL.	Nil
4.	Port Warnings	For Ports in WB – 07. For Ports in Andaman & Nicobar – 07.	3
5.	Heavy Rainfall Warning	For GWB : 3. For A & N ISDS : NIL.	Nil
6.	Gale Wind Warning	Nil	Nil
7.	Storm surge warning	NIL	Nil
8.	Information & Warning issued to State Government and other Agencies	West Bengal Govt –5	Nil
9	SMS/ Whatsapp (message in group)		Nil

6. Operational Forecast Performance:

Genesis Forecast: The genesis of the system was well predicted by IMD.

(i) First information of development of low pressure area over eastcentral BoB and neighbourhood around 15th-16th October was released on 11th October (0300 UTC. LPA developed over southwest BoB in the morning of 15th October (0300 UTC) (**96 hours in advance**).

(ii) First information of development of depression over BoB around 17th October was released on 13th October night (1800 UTC). The same was updated in 18th October morning for development of depression during next 24 hours. And depression formed over westcentral BoB in the early hours of 19th (0000 UTC) (**24 hours in advance**).

IMD issued warning bulletins to the concerned central and state disaster management authorities & press and media. The verification of heavy rainfall warnings issued by IMD for depression during 15-17 November is presented in Table 4. It can be found that the occurrence of heavy rainfall in association with the system could be predicted well in advance.

Table 4: Verification of heavy rainfall warning issued by IMD for Depression over westcentral Bay of Bengal (15-17 November, 2017)

Date/Time of issue	Heavy rainfall warning	Realised heavy rainfall (7cm or more) ending at 0830 hrs IST of date
0830 IST of 15th November 2017	• Heavy to very heavy rainfall at isolated places very likely over coastal Odisha and rainfall at a few places over interior Odisha during next 48 hours. • Heavy rainfall at isolated places very likely over coastal areas of West Bengal and rainfall at a few places over remaining parts of Gangetic West Bengal during next 48 hours. • Heavy rainfall at isolated places very likely over north coastal Andhra Pradesh during next 24 hours.	**15 November 2017** Puducherry: Thanjavur-7 **16 November 2017** Odisha: GOP & Astaranga – 9 each and Pur Paradeep, Digapahandi, Paralakhemund Mahendragarh, Tirtol, Balikuda, Kujanga Nischintakoili -7 each Coastal Andhra Pradesh: Sompeta-18 Ichchapuram-17, Mandasa-14, Palasa Kalingapatnam-11, Tekkali-9 and Pathapatnam-7 **18 November 2017** Odisha: Tirtol - 8 and Rajkanika & Binjharpur - each Coastal Andhra Pradesh: Vijayawada A.P.-9
0830 IST of 16th November 2017	• Heavy to very heavy rainfall at isolated places very likely over coastal Odisha and coastal West Bengal during next 24 hours and decrease thereafter with occurrence of isolated heavy rainfall over coastal West Bengal during subsequent 24 hours. • Heavy rainfall at isolated places very likely over Vijayanagaram and Srikakulam districts of Andhra Pradesh during next 12 hours.	
0830 IST of 17th November 2017	• Rainfall at most places with heavy rainfall at isolated places very likely over north coastal Odisha during next 12 hours and coastal West Bengal during next 24 hours.	

7. Summary and Conclusion:

A low pressure area (LPA) formed over southwest Bay of Bengal (BoB) and neighborhood in the morning of 10th November, 2017. It lay as a well marked low pressure area (WML) over southwest BoB and neighborhood in the morning of 13th. It further concentrated into a depression over westcentral BoB off Andhra Pradesh in the morning of 15th. Moving nearly north-northeastwards, it weakened into a WML over northwest Bay of Bengal off Odisha Coast around noon of 17th.

8. Acknowledgements:

India Meteorological Department (IMD) duly thanks contribution from all the stake holders who contributed to the successful monitoring, prediction and warning service of the depression by IMD. We acknowledge the contribution of National Centre for Medium Range Weather Forecasting Centre (NCMRWF), NOIDA, Indian National Centre for Ocean Information Services (INCOIS), Hyderabad, National Institute of Ocean Technology (NIOT), Chennai and Space Application Centre and Indian Space Research Organisation (SAC-ISRO), Ahmedabad for their valuable support. The support from various Divisions/Sections of IMD including Area Cyclone Warning Centre (ACWC) Chennai & Kolkata, Cyclone Warning Centre (CWC) Bhubaneswar, DWR Paradip, Visakhapatnam & Kolkata, Agricultural Meteorology Division, Pune, Numerical Weather Prediction Division, Satellite Division and Information System and Services Division at IMD, New Delhi is also acknowledged.