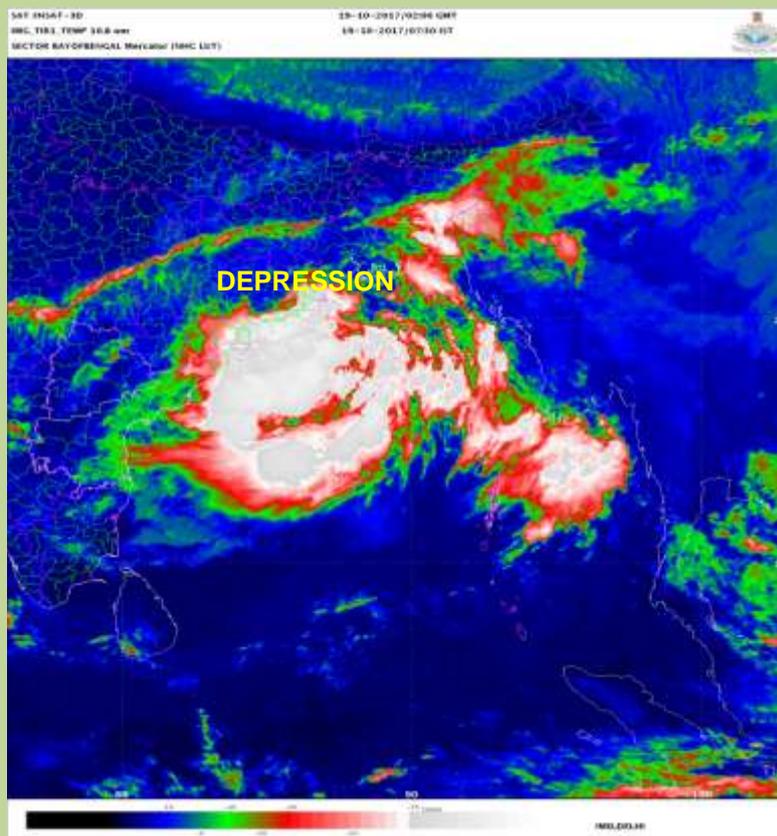




**GOVERNMENT OF INDIA  
MINISTRY OF EARTH SCIENCES  
INDIA METEOROLOGICAL DEPARTMENT**

**Depression over westcentral Bay of Bengal  
(19-22 October, 2017): A Report**



INSAT-3D enhanced coloured IR imagery based on 0200 UTC of 19<sup>th</sup> October

**Cyclone Warning Division  
India Meteorological Department  
New Delhi  
November 2017**

## **Depression over westcentral Bay of Bengal (19-22 November 2017)**

### **1. Introduction**

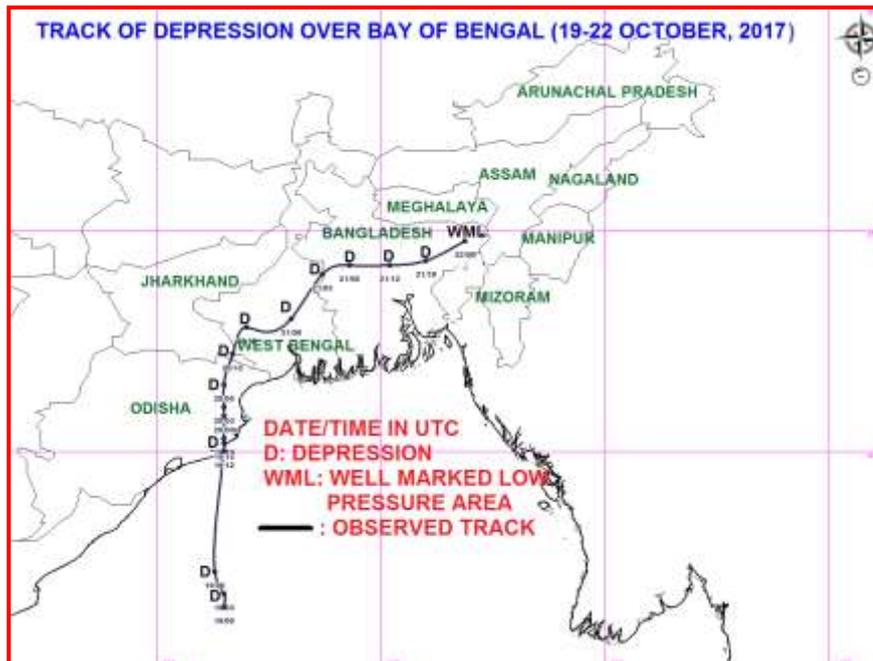
A low pressure area (LPA) formed over central Bay of Bengal (BoB) in the morning of 15<sup>th</sup> October. It lay as a well marked low pressure area (WML) over central and adjoining south BoB in the morning of 17<sup>th</sup>. It further concentrated into a depression in the early hours of 19<sup>th</sup> over westcentral BoB. Moving nearly northwards, it crossed Odisha coast close to Paradip in the late evening of 19<sup>th</sup>. The system started recurving and moved nearly eastwards for sometime from the night of 20<sup>th</sup>. It then moved northeastwards across Gangetic West Bengal and Bangladesh. It weakened into a well marked low pressure area over northeast Bangladesh and adjoining Meghalaya & South Assam in the early morning of 22<sup>nd</sup> October. The observed track of the system is presented in Fig.1.

The salient features of the system were as follows:

- (i) The system had a clockwise recurving track after landfall. It moved nearly northward before landfall
- (ii) The total life period of the system was 96 hours (4 days) 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 over Odisha, Gangetic West Bengal, Assam, Meghalaya, Nagaland, Manipur & Mizoram during 19<sup>th</sup> to 21<sup>st</sup> October.

IMD mobilised all its resources to track 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 Bay of Bengal (19-22 October 2017)**

### **2. Brief life history**

## 2.1. Genesis

Under the influence of an upper air cyclonic circulation over southwest BoB & neighbourhood and the east-west shear zone along latitude 12.0°N, a low pressure area (LPA) formed over central BoB in the morning of 15<sup>th</sup> October. The associated cyclonic circulation extended upto 5.8 km above mean sea level tilting southwestwards with height. It lay as a well marked low pressure area (WML) over central and adjoining south BoB in the morning of 17<sup>th</sup> with associated cyclonic circulation extending upto 5.8 km above mean sea level. It concentrated into a depression and lay centered over westcentral BoB at 0000 UTC of 19<sup>th</sup> near latitude 16.5° N and longitude 86.5 °E, about 470 km south of Chandbali and 370 km south-southeast of Puri.

Considering the environmental conditions, at 0000 UTC of 19<sup>th</sup>, the sea surface temperature over the region was 30-32°C. The ocean thermal energy was about 80-100 KJ/cm<sup>2</sup> over the area with increasing magnitude (more than 100 KJ/cm<sup>2</sup>) near north Andhra Pradesh-south Odisha coast. The vertical wind shear between upper and lower levels was moderate to high (15-25 knots) around the system centre. It was decreasing towards north and was around 10 knots near Odisha coast and increasing towards south. The vertical wind shear between middle and lower levels was low (5-10 knots). The low level relative vorticity was around 50-100 x 10<sup>-6</sup> s<sup>-1</sup> to the south of system centre. Low level convergence was about 20 x 10<sup>-5</sup> s<sup>-1</sup> to the north and 10 x 10<sup>-5</sup> s<sup>-1</sup> to the south of system centre. The upper level divergence was around 20 x 10<sup>-5</sup> s<sup>-1</sup> to the southwest of system centre. The upper tropospheric ridge at 200 hpa level ran along 20.0°N. The upper level winds were mainly westerly over the area. The analysis of the mean layer winds suggested that the system was being steered by the lower and middle tropospheric mean winds towards north-northwest with a speed of about 06 knots. The Madden Julian Oscillation (MJO) index lay in phase 5 with amplitude > 1. The lower vertical wind shear between middle and lower levels and movement of the system towards the region of low vertical wind shear, increased low level relative vorticity and favourable MJO Phase favoured the genesis of depression over westcentral Bay of Bengal at 0000 UTC of 19<sup>th</sup>.

## 2.2. Intensification and Movement:

Similar environmental conditions prevailed and the system maintained its intensity. The lower vertical wind shear between middle and lower levels helped in maintaining the intensity of the system. The system lay close to the upper and middle tropospheric ridge. As a result it moved nearly northward and made landfall over Odisha coast close to Paradip during 1400 to 1500 UTC of 19<sup>th</sup>.

It continued its northward movement for some time and then north-northeastwards movement till night of 20<sup>th</sup>. It then moved nearly north-eastwards and lay centered at 0300 UTC of 21<sup>st</sup> over Bangladesh and adjoining West Bengal near Latitude 24.0° N and longitude 88.7° E, about 35 km west-northwest of Ishurdi (Bangladesh) and 45 km east-southeast of Berhampore (West Bengal). It then moved nearly eastwards and weakened into a well marked low pressure area over northeast Bangladesh and adjoining Meghalaya & South Assam at 0000 UTC of 22<sup>nd</sup> October.

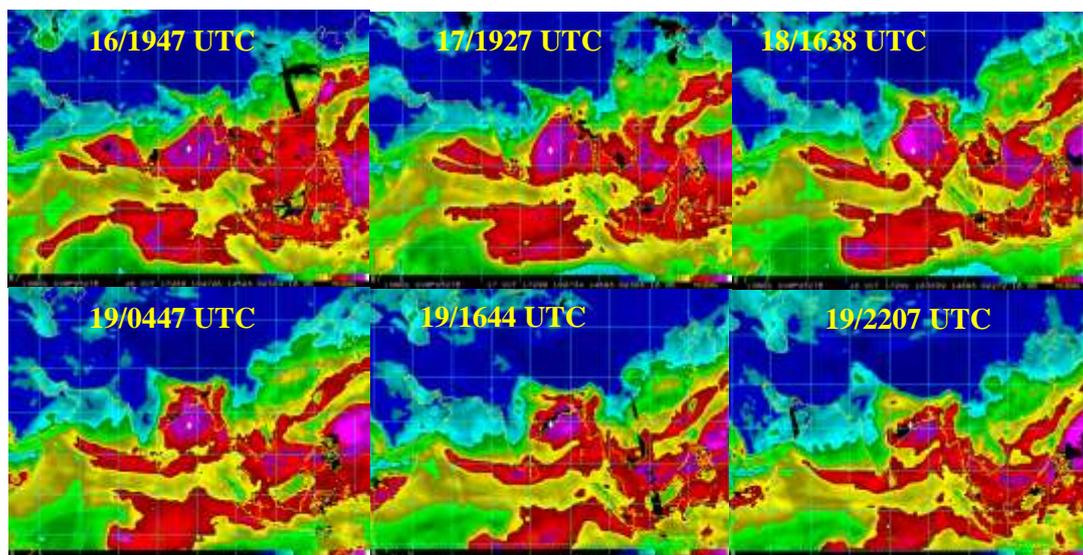
Under the influence of the trough in westerly to the west of the system and the anticyclonic circulation to the east, the depression recurved initially northeastwards and then eastwards towards Bangladesh.

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 Bay of Bengal during 19-22 October, 2017**

Date	Time (UTC)	Centre lat. <sup>o</sup> N/ long. <sup>o</sup> E	C.I. NO.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
19/10/2017	0000	16.5/86.5	1.5	999	25	3	D
	0300	16.8/86.5	1.5	998	25	4	D
	0600	17.3/86.3	1.5	998	25	4	D
	1200	20.0/86.5	1.5	998	25	4	D
	Crossed Odisha coast close to Paradip around 1400-1500 UTC of 19 <sup>th</sup> October						
20/10/2017	1800	20.3/86.5	-	998	25	4	D
	0000	20.8/86.5	-	998	25	4	D
	0300	21.0/86.5	-	998	25	4	D
	0600	21.5/86.5	-	998	25	4	D
	1200	22.2/86.7	-	998	25	4	D
21/10/2017	1800	22.8/87.0	-	998	25	4	D
	0000	23.0/88.0	-	997	25	4	D
	0300	24.0/88.7	-	997	25	4	D
	0600	24.2/89.3	-	997	25	4	D
	1200	24.2/90.2	-	997	20	4	D
22/10/2017	1800	24.3/91.0	-	998	20	3	D
	Weakened into a well marked low pressure area over northeast Bangladesh and adjoining Meghalaya & south Assam at 0000 UTC of 22nd October						

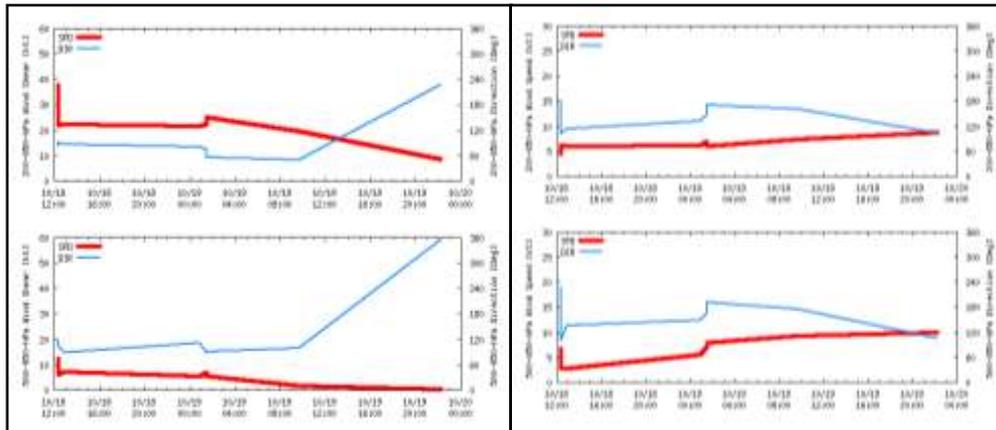
The total precipitable water (TPW) imageries (TPW) during 16-19 October are presented in Fig.2.



**Fig.2: Total precipitable water (TPW) imageries during 16-19 October**

These imageries indicate continuous warm and moist air advection from the southeast sector into the system. The intensity of the system as depression was maintained for about two days over the land due to (i) continuous warm and moist air advection into the

core of the system from the southeast sector and (ii) due to saturated soil moisture over the region in association with normal to excess rainfall in previous days of October 2017.

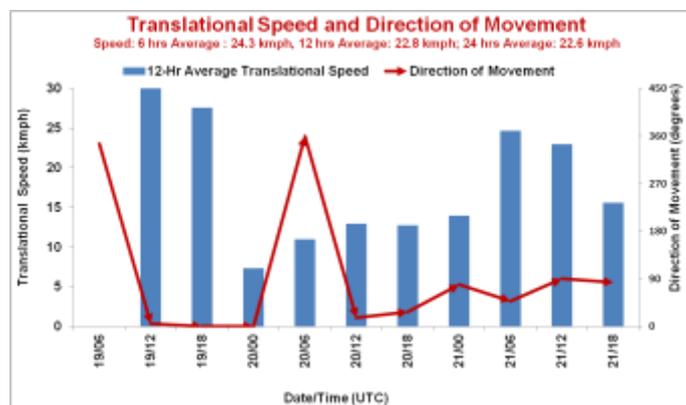


**Fig.3 Wind shear and mean wind in the middle and deep layer around the system during 18<sup>th</sup>-20<sup>th</sup> Oct 2017.**

The wind speed in middle and deep layer around the system centre is presented in Fig.3. The wind shear around the system between 200 & 850 hPa levels was about 20 kt prior to genesis. After genesis, it decreased gradually becoming low to moderate (10-15 kt). The wind shear around the system between 500 & 850 hPa levels was about 10 kt prior to genesis and less than 5 kt at the time of genesis. All these helped the system to maintain its intensity.

The mean wind speed between lower to upper levels was about 5 kt till genesis. It gradually increased becoming about 9 kt on 20<sup>th</sup> morning. The mean wind speed between lower and middle tropospheric levels was also less than 10 kt at the time of genesis and it gradually increased becoming about 10 kt on 20<sup>th</sup> morning. The average direction of the wind was 140° at the time and prior to genesis. It was 180° during 19/00 to 19/12 UTC, 140° during 19/12 to 19/18 UTC and 100° at 20/00 UTC.

The twelve hourly movement of the system is presented in Fig.4. The 12 hour average translational speed decreased gradually on 19<sup>th</sup> after landfall and become minimum in the early morning of 20<sup>th</sup>. It then increased gradually till noon of 21<sup>st</sup> and decreased thereafter.



**Fig.4: 12 hour average translational speed during 19<sup>th</sup> to 21<sup>st</sup> October**

#### 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 from SCATSAT and international geostationary and polar orbiting satellites were also considered for monitoring the system.

##### 4.1 INSAT-3D features

Typical INSAT-3D visible, IR and enhanced colored imageries are presented in Fig.5. At 0000 UTC of 19<sup>th</sup>, the intensity of the system was T 1.5. Associated broken low/medium clouds with embedded intense to very intense convection lay over central and adjoining northwest BoB between latitude 13.0<sup>o</sup>N & 20.0<sup>o</sup>N and west of longitude 90.0<sup>o</sup>E, Odisha, adjoining West Bengal and north Andhra Pradesh. Minimum cloud top temperature (CTT) was -93.0<sup>o</sup>C. During genesis, maximum convection was sheared to west-northwest sector of the depression.

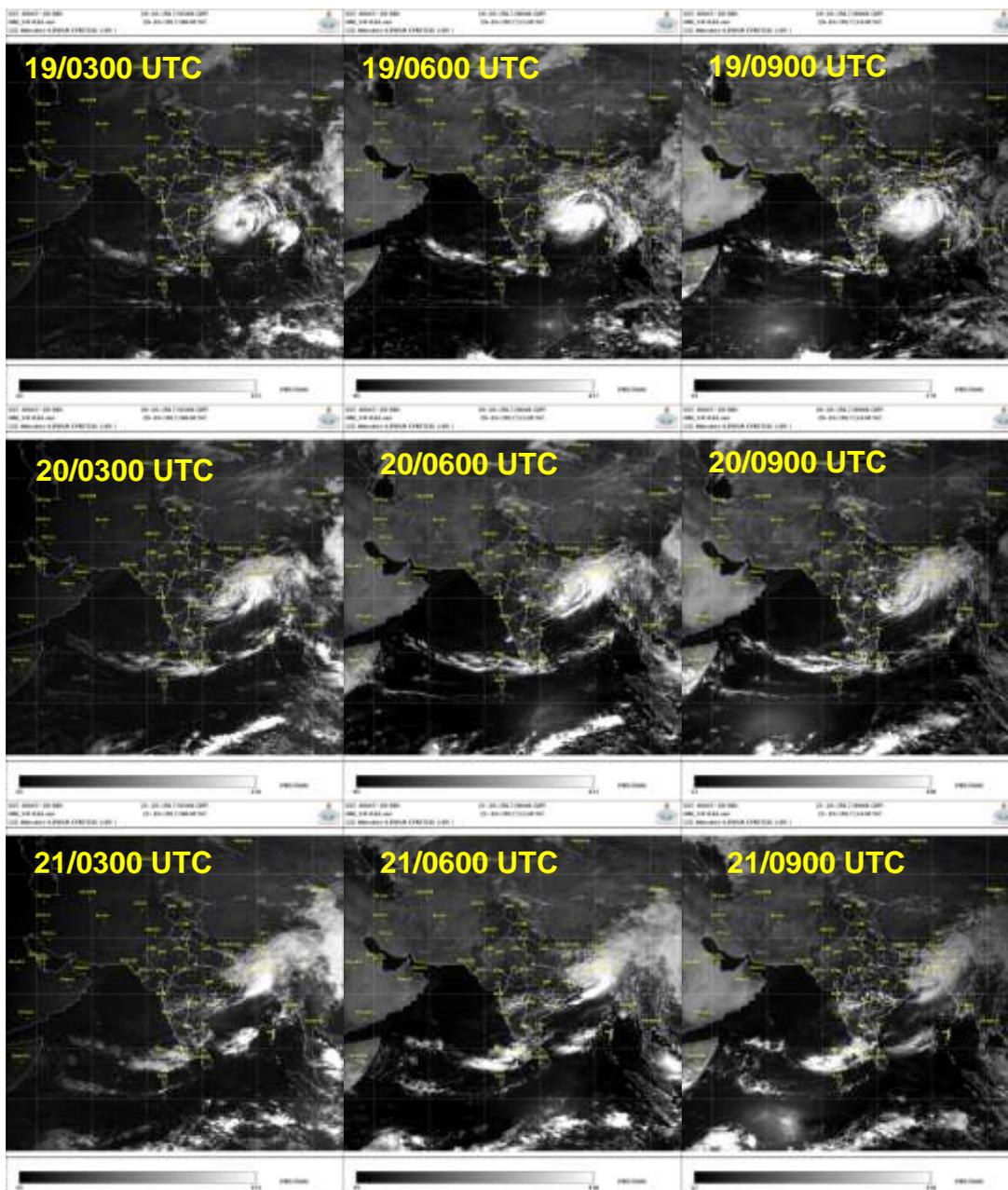
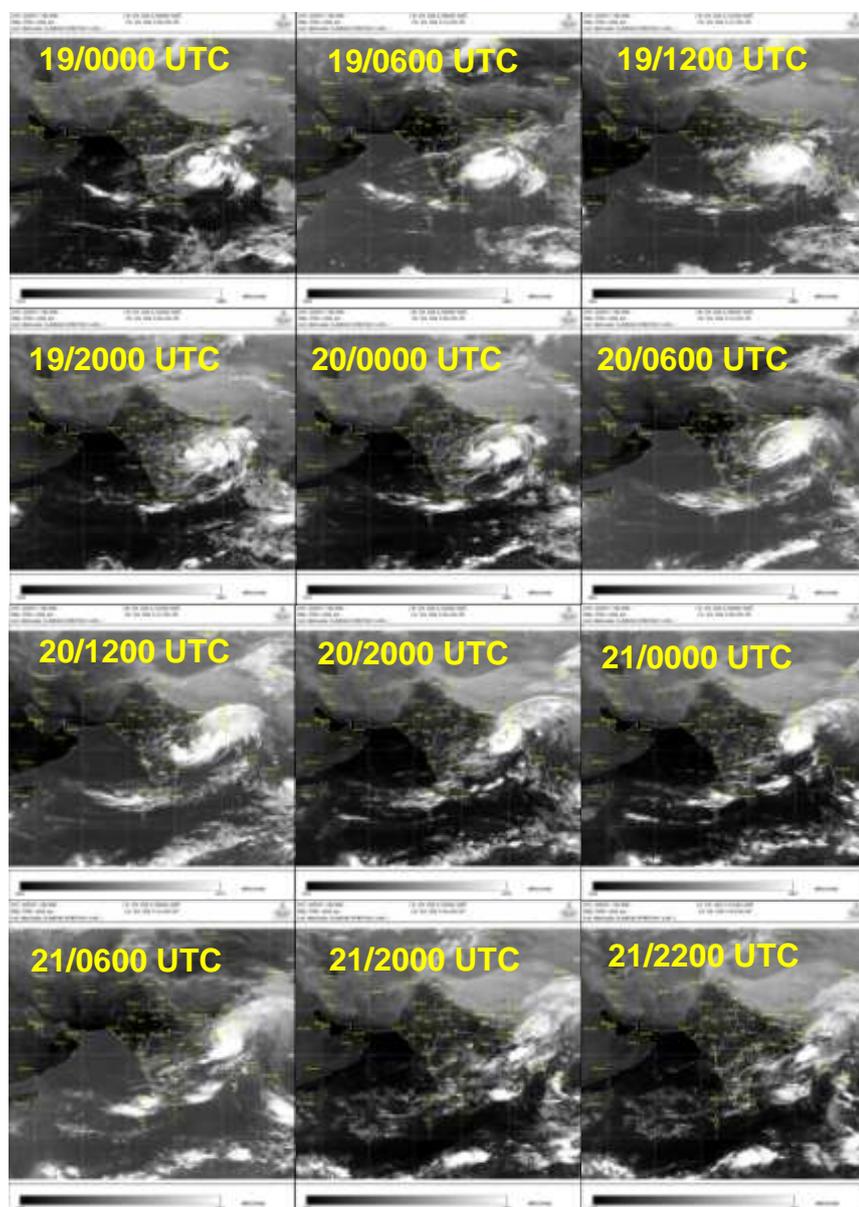
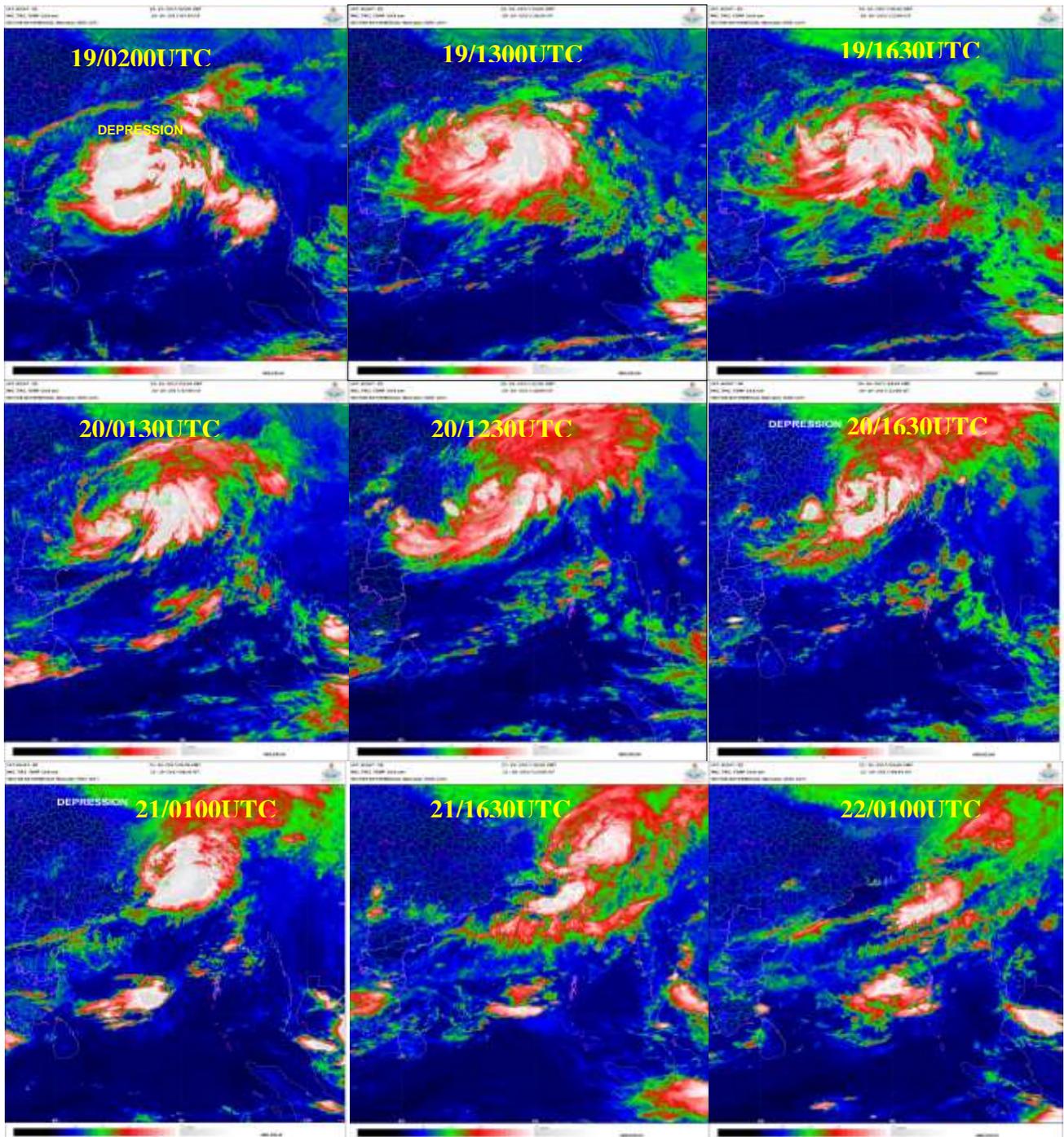


Fig. 5 (i): INSAT-3D visible imageries during Depression (19-22 October, 2017)

At 1200 UTC of 19<sup>th</sup>, intensity of the system was T 1.5. Associated broken low/medium clouds with embedded intense to very intense convection lay over central and adjoining northwest BoB between latitude 14.5N & 21.0N and west of longitude 91.0E. Minimum CTT was minus 93.0°C. Gradually as the system moved northwards, the convection shifted towards northwest sector. At the time of landfall, the maximum convection lay over the northern sector. Thereafter, with the northeastward movement of the system, the convection also shifted to the northeast sector of the depression. The convection was well organised with distinct spiral banding as can be seen from satellite and radar imageries. The spiral bands clearly depicted warm and moist air advection from the sea reaching upto northeast sector of depression even after landfall. The structure got disorganised gradually on 21<sup>st</sup> with shearing of convection far away from the system centre over Bangladesh on 21<sup>st</sup> October. As a result, the depression weakened into a well marked low on 22<sup>nd</sup> morning and dissipated rapidly on 23<sup>rd</sup> as the system moved away from the coast and interacted with the rugged terrain of northeast India and Bangladesh.



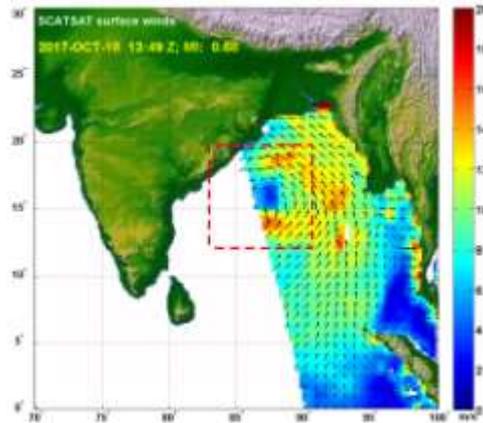
**Fig. 5(ii): INSAT-3D IR imageries during Depression (19-22 October, 2017)**



**Fig. 5(iii): INSAT-3D enhanced coloured imageries during Depression (19-22 October, 2017)**

#### **4.2: Features observed through SCATSAT imageries**

Typical imageries from, SCATSAT are presented in Fig.5 (iv). SCATSAT passes are available at [http://mosdac.gov.in/scorpio/SCATSAT\\_Data](http://mosdac.gov.in/scorpio/SCATSAT_Data). The observations based on 1349 UTC of 18<sup>th</sup> Oct. indicated cyclonic circulation over westcentral BoB. Stronger winds were seen in eastern sector. Winds of the order of 31 kt were seen in the eastern sector. SCATSAT gives 1 minute average wind. The equivalent 3 minute average wind is about 25 kt. Thus, the estimated intensity by SCATSAT matched best track estimates.

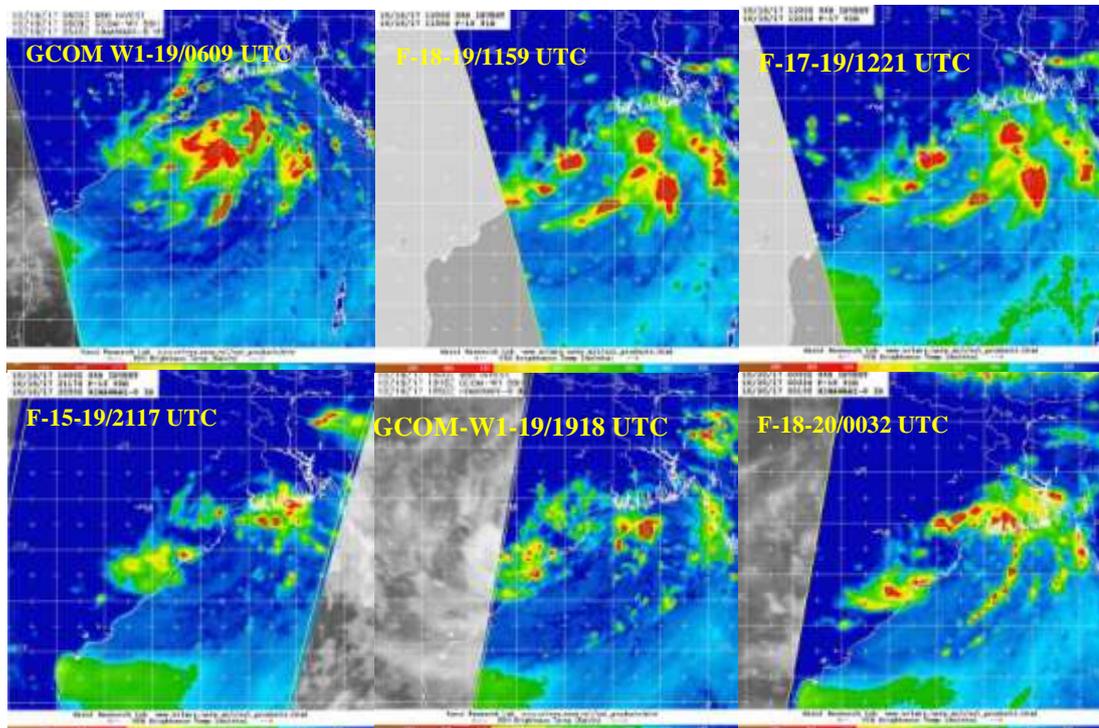


**Fig. 5 (iv): SCAT SAT imagery based on 1349 UTC of 18<sup>th</sup> October**

The matching index developed by SAC-ISRO for prediction of TC genesis based on the scatterometer observation of 1349 UTC of 18<sup>th</sup> October was above the threshold ( $>0.6$ ), indicating intensification of system into a cyclonic storm. However, the depression did not intensify into a cyclonic storm.

**4.3: Features observed through Microwave imageries:**

F-15, F-17, F-18 and GCOM-W1 microwave imageries of the system during 19<sup>th</sup> to 20<sup>th</sup> October 2017 are presented in **Fig.5 (v)**. 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. Area of intense convection was seen in the northeast sector around noon of 19<sup>th</sup> with a well defined spiral band extending from southwest sector to northeast sector. Around 1200 UTC, an intense convective cloud patch was seen over Odisha with spiral bands extending in northeast sector upto eastcentral BoB. At 00 UTC of 20<sup>th</sup>, well defined convective clouds were seen over Gangetic West Bengal, Bangladesh and northeast India.



**Fig. 5 (v): Microwave imageries during life cycle of depression over BoB (19-22 Oct. 2017)**

#### 4.4. Features observed through Radar:

Since genesis, the system was tracked by DWR Paradip. Hourly images from DWR Paradip were utilized for determining the location and movement of system since its genesis. Typical DWR Radar imageries are presented in Fig.6. Like the satellite imageries, the Radar imageries indicated clockwise shifting of convection from northwest sector to northern sector at the time of landfall and to the northeast sector of the depression thereafter.

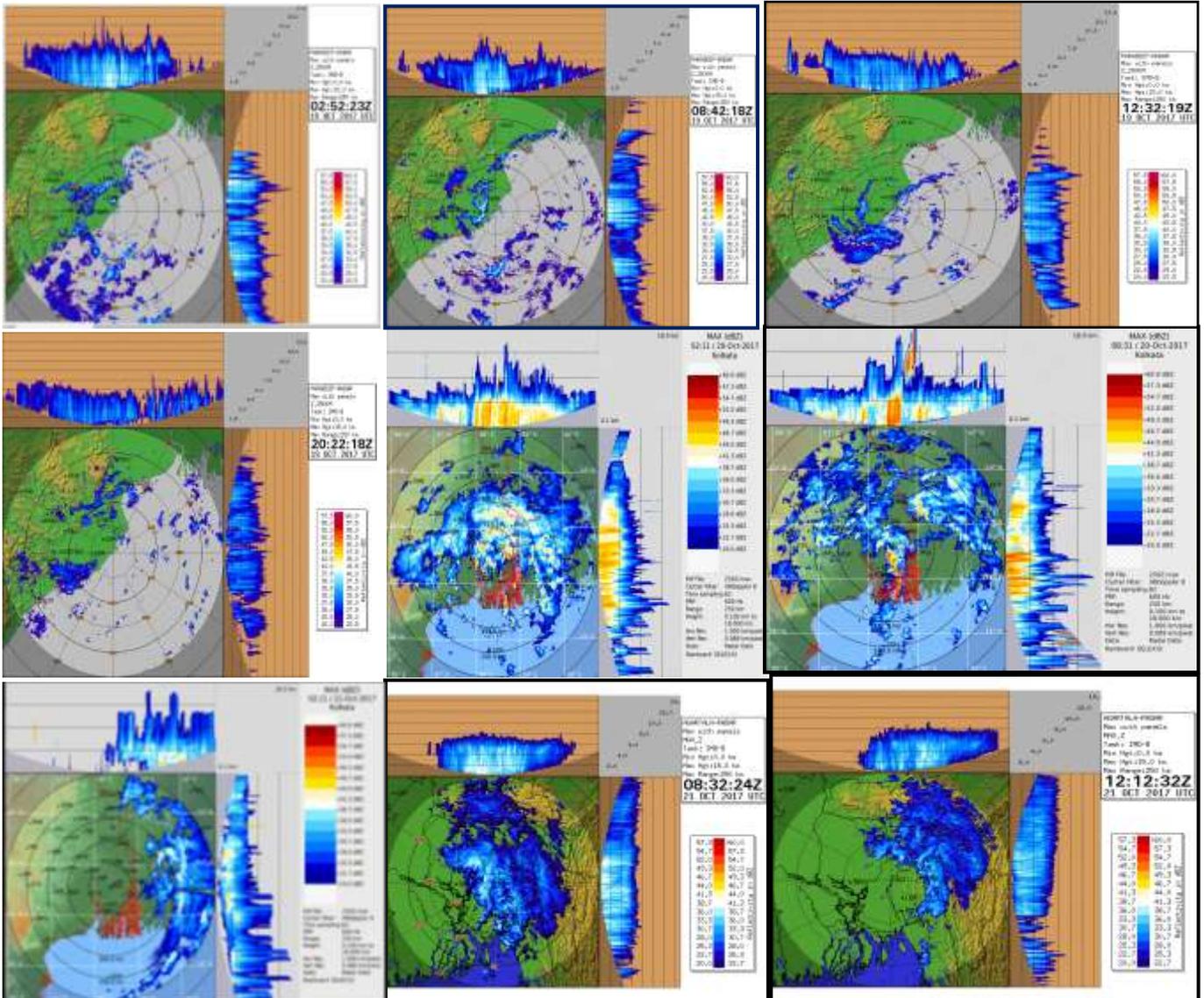


Fig. 6: DWR Paradip Radar imageries during Depression (19-22 October, 2017)

#### 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.7. IMD GFS (T1534) could simulate the genesis of the system on 19<sup>th</sup> October and intensification of system on 20<sup>th</sup> & 21<sup>st</sup>. It also simulated stronger surface wind in the eastern sector of the depression throughout the life period. It also simulated the steering flow for the system.

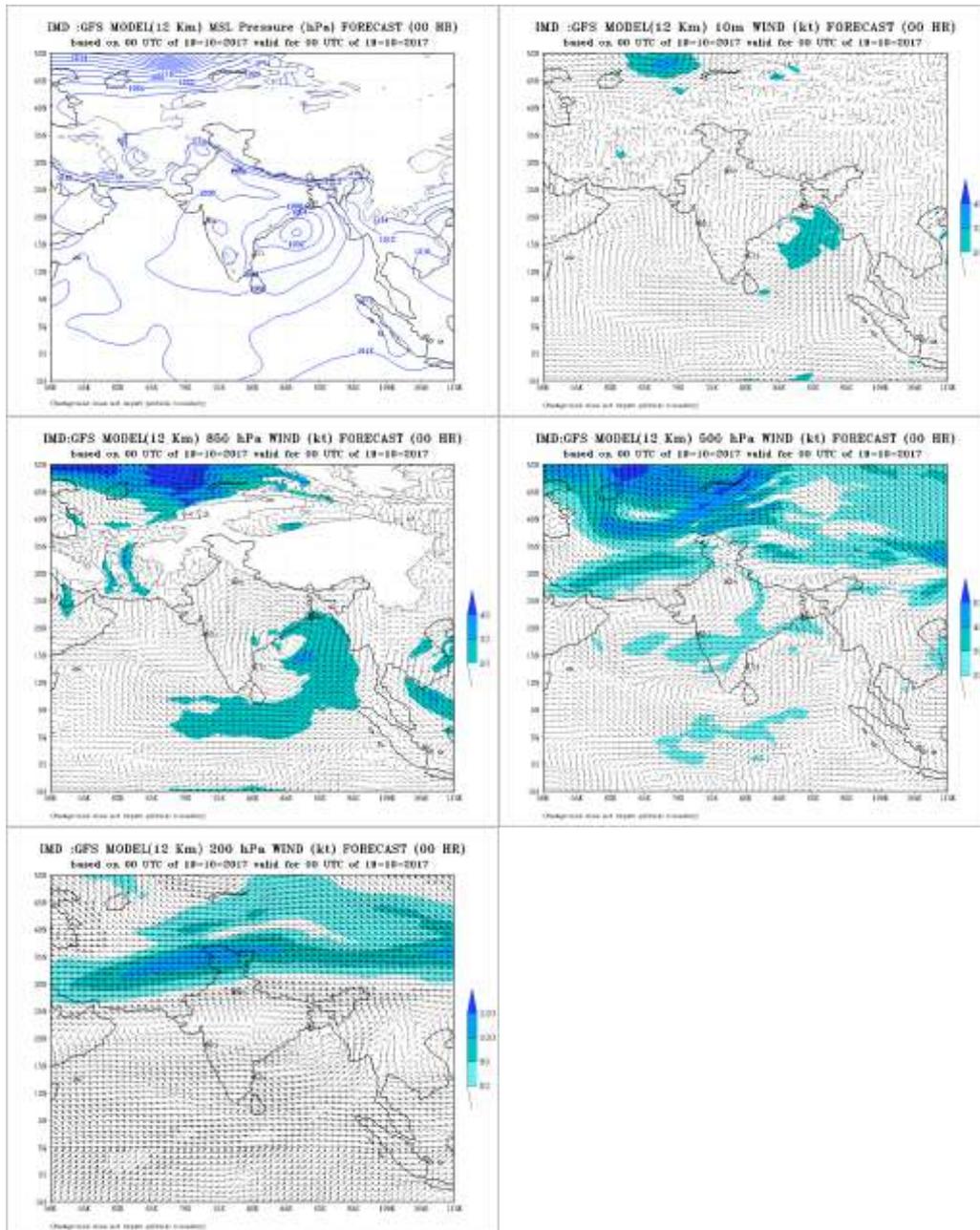
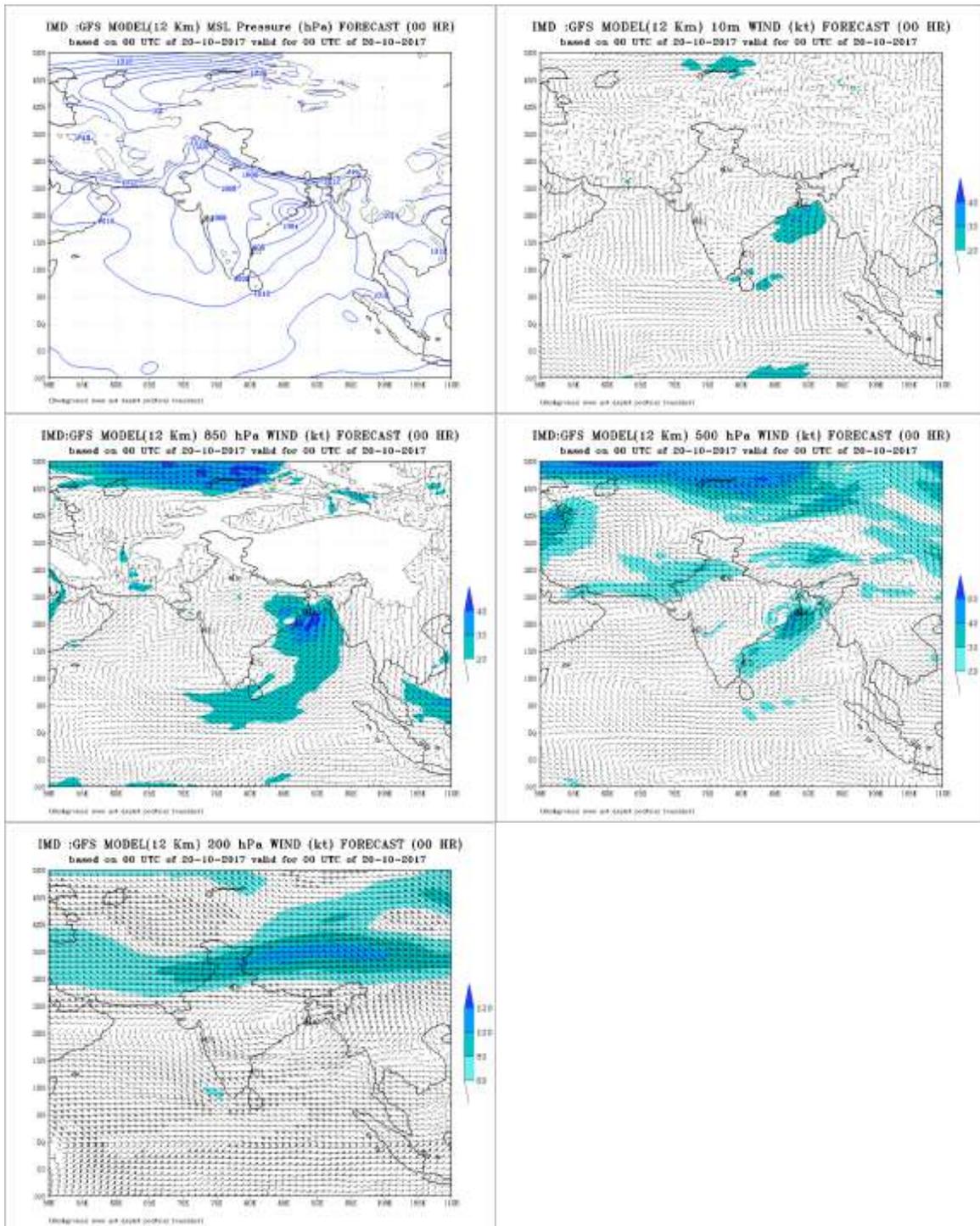
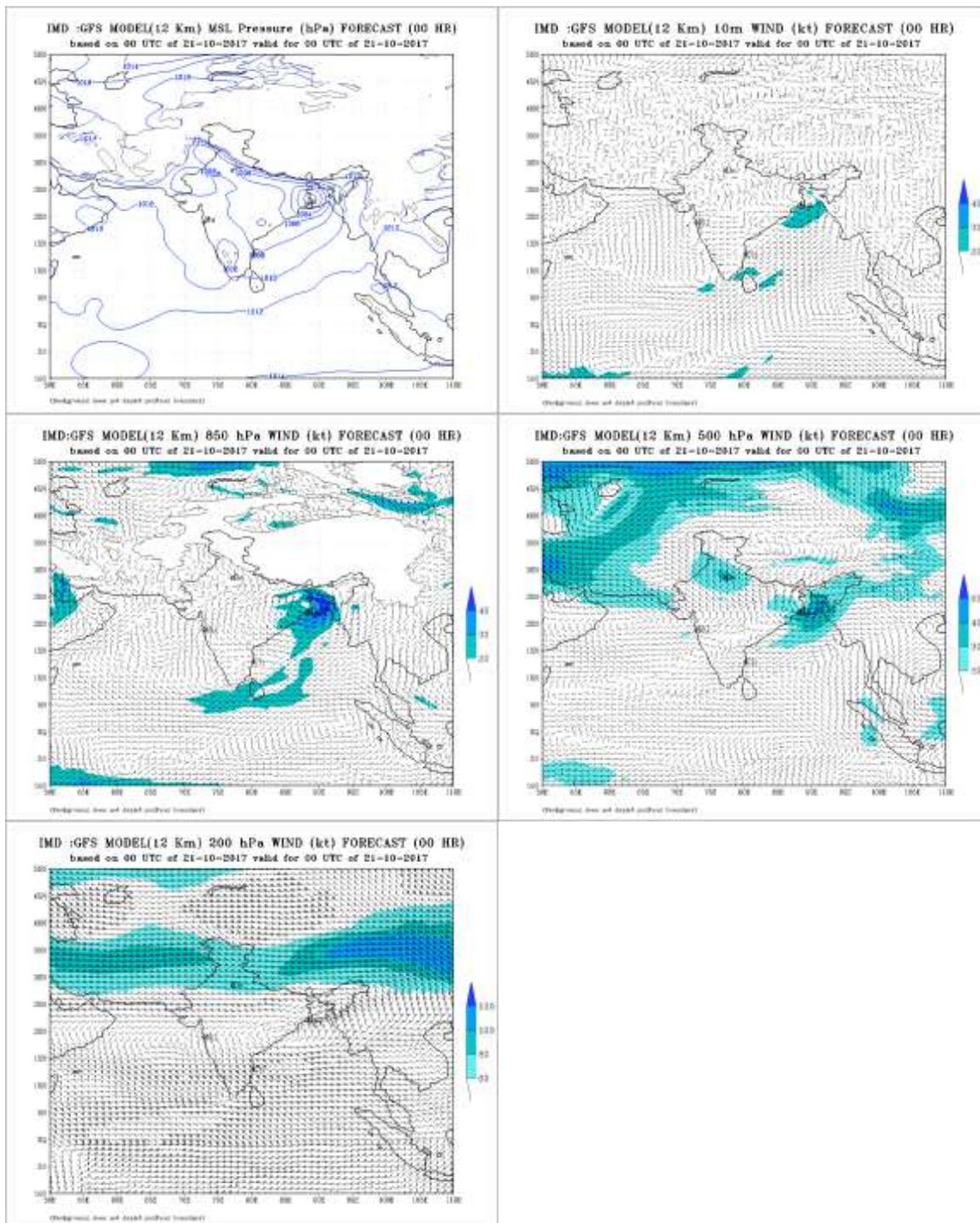


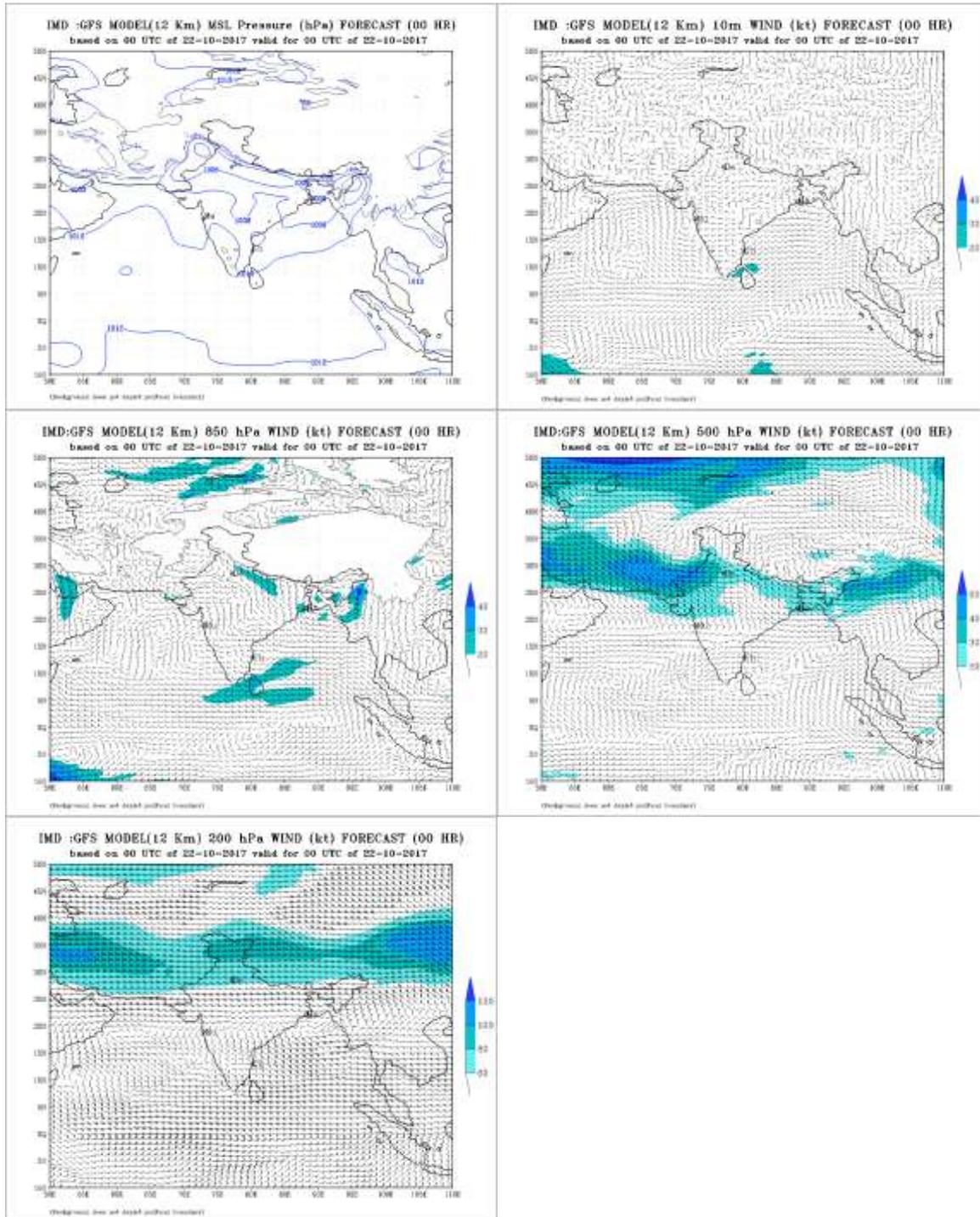
Fig.7 (i): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 19<sup>th</sup> October



**Fig.7 (ii): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 20<sup>th</sup> October**



**Fig.7 (iii): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 21<sup>st</sup> October**



**Fig.7 (iv): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 22<sup>nd</sup> October**

## 5. Realized Weather:

### 5.1 Rainfall:

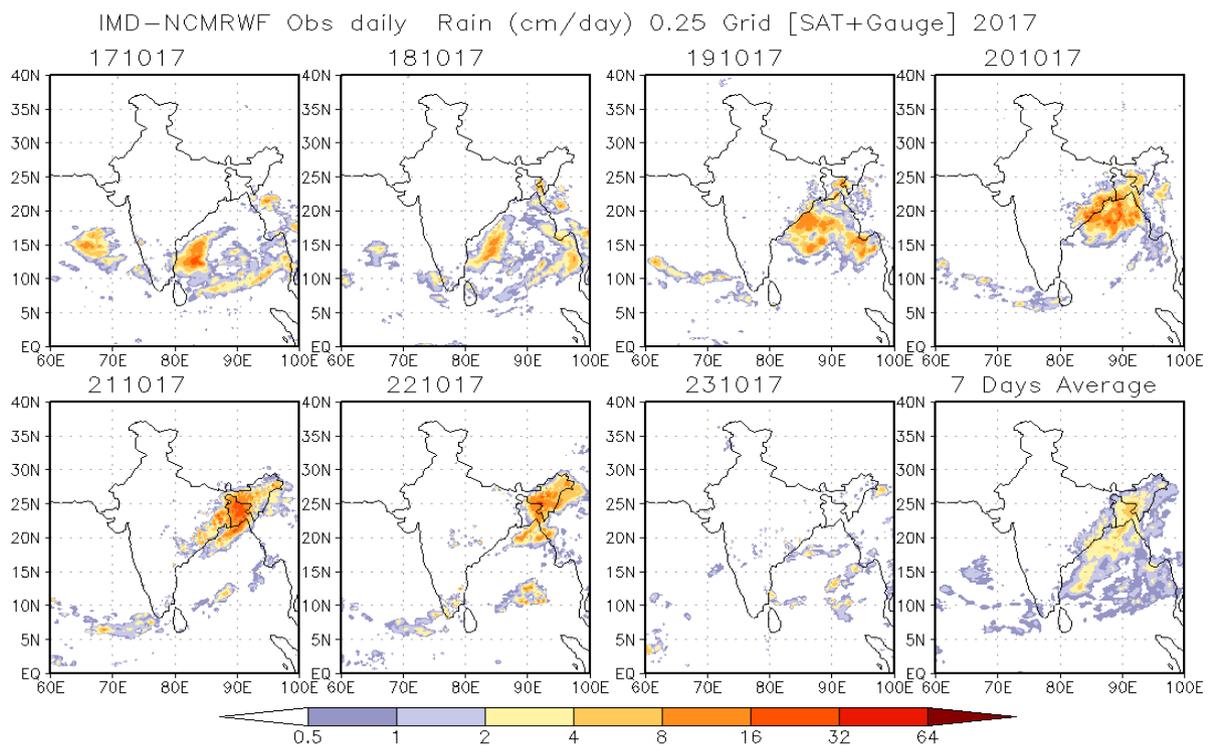
#### Realised weather:

Under its influence, isolated heavy rainfall occurred over Odisha on 18<sup>th</sup>. It caused isolated heavy rainfall over Gangetic West Bengal and scattered heavy with isolated very heavy rainfall over Odisha on 19<sup>th</sup>. On 20<sup>th</sup>, Assam & Meghalaya experienced isolated heavy to very

heavy rainfall, Gangetic West Bengal experienced scattered heavy and isolated very heavy to extremely heavy rainfall. The system caused, isolated heavy to very heavy rainfall with extremely heavy falls at one or two places over Assam & Meghalaya and widespread heavy to very heavy rainfall over Nagaland, Manipur, Mizoram & Tripura on 21<sup>st</sup> October.

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.8. It can be seen that the system caused heavy to very heavy rainfall (8-16 cm) mainly over eastcentral and some parts of westcentral BoB on 18th. On 19th, the heavy to very heavy rainfall was seen over coastal Odisha, West Bengal and southwest Bangladesh. On 20th, entire Bangladesh received heavy to very heavy rainfall with rainfall belt extending northeastwards over Nagaland, Manipur, Mizoram and Tripura. On 21st heavy to very heavy rainfall was observed over eastern parts of Bangladesh, Assam, Nagaland and Manipur.



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

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

**19<sup>th</sup> October:**

**Tripura:** Kamalpur-7

**Odisha:** Derabis -8, Balikuda, Pattamundai, Nimpara, Tirtol-7 each

**20<sup>th</sup> October**

**Mizoram:** Serchip (Hydro)-8

**Gangetic West Bengal:** Contai-10, Kalaikunda ( IAF)-8, Canning-7

**Odisha:** Balimundali-22, Tikarpara-21, Jaipur-20, Tirtol-20, Gop-19, Tangi-18, Remuna, Pipili, Brahmagiri-17 each, Chandikhol, Puri-16 each, Jajpur, Balasore, Soro-15 each, Banpur, Ranpur, Nilgiri, Kakatpur, Nawana-14 each, Bolagarh, Nimpara-13 each, Krishnaprasad, Alipingal, Satyabadi, Chandbali, Bonth, Chandanpur, Bari-12 each, NH5 Gobindpur, Daitari, Rajkanika, Binjharpur, Udala, Nuagada, Balikuda, Jagatsinghpur, Kantapada-11 each, Mohana, Hindol-10 each, Kujanga, Betanati, Astaranga, Dhamnagar, Rajghat, Anandpur, Balipatna, Niali, Karanjia, Kaptipada, Phulbani, Chhatrapur, Sukinda, R.Udaigiri, Banki, Bhadrak, Bhograi-9 each, Jenapur, Marsaghai, Bhubaneswar Aero, Mundali, Mahanga, Danagadi, Lanjigarh, Daringibadi, Berhampur, Mahendragarh, Odagaon, Jaleswar, Nayagarh, Kotagarh, Akhuapada, Samakhunta, Baliguda-8 each, Ambadola, Athgarh, Bhuban, Baripada, Garadapur, Harichandanpur, Keonjhar, Purushottampur, Khandapara, Jamsolaghat, Muniguda, Tihidi, Bangiriposi, Gopalpur, Naraj-7 each.

### **21<sup>st</sup> October**

**Arunachal Pradesh:** Namsai-18, Miao-11

**Assam & Meghalaya:** Manash Nh Xing-14, Kokrajhar-13, Aie Nh Xing-9, Williamnagar 8, Panbari 8, Beky Rly.Bridge-7 each

**Nagaland, Manipur, Mizoram & Tripura:** Sonamura-11

**Sub-Himalayan West Bengal & Sikkim:** Cooch Behar-7

**Gangetic West Bengal:** Bankura-28, Bankura-21, Kalaikunda-20, Narayanpur-18, Phulberia, Kansabati Dam-12 each, Suri-11, Tusuma, Panagarh, D.P.Ghat, Sri Niketan-10 each, Gheropara, Tilpara Barrage, Hetampur, Salar-9 each, Midnapore, Bagati, Amtala, Midnapore-8 each, Debagram, Purulia, Burdwan-7 each.

**Odisha:** Nawana-12, Basudevpur-10, Birmaharajpur-9, Banki, Barmul, Mohana, Rairangpur, Ullunda-7 each

**Jharkhand:** Ghatsila 7

### **22<sup>nd</sup> October:**

**Assam & Meghalaya:** Cherrapunji (Ramakrishna Maath)-31, Cherrapunji-28, Halflong-14, Margherita-13, Karimganj-13, Williamnagar-11, A P Ghat, Silchar-8 each, B P Ghat, Lakhipur, Bokajan-7 each

**Nagaland, Manipur, Mizoram & Tripura:** Amarpur-18, Belonia-17, Kamalpur-15, Sabroom, Dharmanagar/ Panisagar-13 each, Chhamonu, Agartala Aero-11 each, Kailashahar Aero, Khowai, Sonamura-10 each, Arundhutinagar, Udaipur-9 each, Imphal T-Aero 8

## **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 system were described in the RSMC bulletins.
- 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.
- 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 Odisha, West Bengal, Assam,

Arunachal Pradesh, Meghalaya, Manipur, Nagaland, Mizoram and Tripura. 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.

- Regular updates were uploaded on facebook and tweeter regularly during the life period of the system.
- Press and electronic media were given daily updates since inception of system through press release, e-mail, website and SMS.
- The three/six hourly bulletins were issued by the cyclone warning division at New Delhi and cyclone warning centres of IMD at Kolkata, 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	17	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: Odisha, West Bengal, Assam, Arunachal Pradesh, Meghalaya, Manipur, Nagaland, Mizoram and Tripura
2	RSMC Bulletin	4	1. IMD's website 2. WMO/ESCAP member countries through GTS and E-mail 3. Indian Navy, IAF by E-mail
3	Press Release	3	Disaster Managers, Media persons by email and uploaded on website
4	Facebook/ Tweeter	14 times each	Cyclone Warnings were uploaded on Social networking sites like Face book and Tweeter since inception to weakening of system (every time when there was change in intensity).
5	SMS	77,442	SMS through (i) IMD network for disaster managers at national level and concerned states-145 (ii) Department of Electronics and Information Technology-77,297

**Table 3: Statistics of Bulletins issued by Area Cyclone Warning Centres (ACWC) Kolkata/ACWC Chennai/ Cyclone Warning Centres (CWC) Bhubaneswar**

S.No.	Type of Bulletin	No of Bulletins issued		
		ACWC Kolkata	ACWC Chennai	CWC Bhubaneswar
1.	Sea Area Bulletins	08	NA	NA
2.	Coastal Weather Bulletins	West	2	15

		Bengal(WB)- 08 Andaman & Nicobar (A&N) Islands – 08.		
3.	Fishermen Warnings issued	WB -25 A & N Islands –14	Nil	29
4.	Port Warnings	WB – 06	2	10
5.	Heavy Rainfall Warning	14	Nil	03
8.	Information & Warning issued to State Government and other Agencies	8	Nil	16
9	SMS	14 times	Nil	1000

NA.: Not Applicable

## 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 15<sup>th</sup>-16<sup>th</sup> October was issued on 11<sup>th</sup> October (0300 UTC). LPA developed over southwest BoB in the morning of 15<sup>th</sup> October (0300 UTC) (**96 hours in advance**).
- (ii) First information of development of depression over BoB around 17<sup>th</sup> October was issued on 13<sup>th</sup> October night (1800 UTC). The same was updated in 17<sup>th</sup> October morning for development of depression during next 24 hours and further updated on 18<sup>th</sup> mainly for development of depression during next 24 hours. The depression formed over westcentral BoB in the early hours of 19<sup>th</sup> (0000 UTC).
- (iii) **Landfall Track forecast:** In the first bulletin issued at 0900 hrs IST of 19<sup>th</sup>, it was predicted that the system would move north-northwestwards and cross coast between Puri and Chandbali around midnight of 19<sup>th</sup>. And the system crossed Odisha coast near Paradip between Puri and Chandbali between 1930-2030 hours IST.
- (iv) **Track forecast:** In the bulletin issued at 2300 IST of 19<sup>th</sup>, it was predicted that the depression would move north-northeastwards and weaken gradually into a Well Marked Low Pressure Area in the early morning of 22<sup>nd</sup>.
- (v) **Intensity Forecast:** In the first bulletin issued at 0900 hrs IST of 19<sup>th</sup>, it was predicted that the wind speed of 45-55 kmph gusting to 65 kmph would prevail along and off Odisha coast and adjoining north Andhra Pradesh and West Bengal coast. And wind speed of 50 kmph was observed at Paradip around 2030 hrs IST of 19<sup>th</sup>.
- (vi) **Heavy rainfall:** The verification of heavy rainfall warnings issued by IMD for depression during 19-22 October 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 (19-22 October, 2017)**

Date/Time of issue	Heavy rainfall warning	Realised heavy rainfall (7cm or more) ending at 0830 hrs IST of date
0830 IST of 19 <sup>th</sup> October 2017	(i) Heavy to very heavy rainfall at a few places over coastal Odisha, isolated heavy rainfall over interior	<b>19<sup>th</sup> October:</b> <b>Nagaland, Manipur, Mizoram &amp; Tripura:</b> Kamalpur-7 <b>Odisha:</b> Derabis-8, Balikuda, Pattamundai, Nimpara, Tirtol-7 each

	<p>Odisha during next 48 hours and isolated heavy rainfall over adjoining districts (Srikakulam &amp; Vijayanagram) of north Coastal Andhra Pradesh during next 24 hours.</p> <p>(ii) Heavy to very heavy rainfall at isolated places over coastal districts of West Bengal during next 24 hours and over West Bengal during subsequent 24 hours.</p> <p>(iii) Heavy rainfall over Mizoram &amp; Tripura on 19<sup>th</sup> and 20<sup>th</sup>, over east Jharkhand &amp; east Bihar on 20<sup>th</sup>.</p> <p>(iv) Heavy to very heavy rainfall at isolated places over Assam &amp; Meghalaya on 20<sup>th</sup> October.</p>	<p><b>20<sup>th</sup> October</b>  <b>Nagaland, Manipur, Mizoram &amp; Tripura:</b> Serchip (Hydro)-8  <b>Gangetic West Bengal:</b> Contai-10, Kalaikunda-8, Canning-7  <b>Odisha:</b> Balimundali-22, Tikarpara-21, Jaipur-20, Tirtol-20, Gop-19, Tangi-18, Remuna, Pipili, Brahmagiri-17 each, Chandikhol, Puri-16 each, Jajpur, Balasore, Soro-15 each, Banpur, Ranpur, Nilgiri, Kakatpur, Nawana-14 each, Bolagarh, Nimpara-13 each, Krishnaprasad, Alipingal, Satyabadi, Chandbali, Bonth, Chandanpur, Bari-12 each, NH5 Gobindpur, Daitari, Rajkanika, Binjharpur, Udala, Nuagada, Balikuda, Jagatsinghpur, Kantapada-11 each, Mohana, Hindol-10 each, Kujanga, Betanati, Astaranga, Dhamnagar, Rajghat, Anandpur, Balipatna, Niali, Karanjia, Kaptipada, Phulbani, Chhatrapur, Sukinda, R.Udaigiri, Banki, Bhadrak, Bhograi-9 each, Jenapur, Marsaghai, Bhubaneswar Aero, Mundali, Mahanga, Danagadi, Lanjigarh, Daringibadi, Berhampur, Mahendragarh, Odagaon, Jaleswar, Nayagarh, Kotagarh, Akhuapada, Samakhunta, Baliguda-8 each, Ambadola, Athgarh, Bhuban, Baripada, Garadapur, Harichandanpur, Keonjargarh, Purushottampur, Khandapara, Jamsolaghat, Muniguda, Tihidi, Bangiriposi, Gopalpur, Naraj-7 each.</p>
<p>0830 IST of 20<sup>th</sup> October 2017</p>	<p>(i) Heavy to very heavy and extremely heavy rainfall at isolated places over Assam &amp; Meghalaya and Sub-Himalayan West Bengal during next 48 hours.</p> <p>(ii) Heavy to very heavy rainfall at a few places over Gangetic West Bengal during next 24 hours and heavy rainfall at isolated places during subsequent 24 hours.</p> <p>(iii) Heavy to very heavy rainfall at isolated places over Odisha and Nagaland, Manipur, Mizoram &amp; Tripura during next 24 hours and isolated</p>	<p><b>21<sup>st</sup> October</b>  <b>Arunachal Pradesh:</b> Namsai-18, Miao-11  <b>Assam &amp; Meghalaya:</b> Manash Nh Xing-14, Kokrajhar-13, Aie Nh Xing-9, Williamnagar 8, Panbari 8, Beky Rly.Bridge-7 each  <b>Nagaland, Manipur, Mizoram &amp; Tripura:</b> Sonamura-11  <b>Sub-Himalayan West Bengal &amp; Sikkim:</b> Cooch Behar-7  <b>Gangetic West Bengal:</b> Bankura-28, Bankura-21, Kalaikunda-20, Narayanpur-18, Phulberia, Kansabati Dam-12 each, Suri -11, Tusuma, Panagarh, D.P.Ghat, Sri Niketan-10 each, Gheropara, Tilpara Barrage, Hetampur, Salar-9 each, Midnapore, Bagati, Amtala, Midnapore-8 each, Debagram, Purulia, Burdwan-7 each.  <b>Odisha:</b> Nawana-12, Basudevpur-10,</p>

	<p>heavy rainfall over east Jharkhand and East Bihar during next 24 hours.</p> <p>(iv) Heavy rainfall over Arunachal Pradesh, and Nagaland, Mizoram, Manipur &amp; Tripura during the subsequent 24 hrs.</p>	<p>Birmaharajpur-9, Banki, Barmul, Mohana, Rairangpur, Ullunda-7 each</p> <p><b>Jharkhand:</b> Ghatsila 7</p> <p><b>22<sup>nd</sup> October:</b></p> <p><b>Assam &amp; Meghalaya:</b> Cherrapunji(Ramakrishna Math)-31, Cherrapunji-28, Haflong-14, Margherita-13, Karimganj-13, Williamnagar-11, A P Ghat, Silchar-8 each, B P Ghat, Lakhipur, Bokajan-7 each</p> <p><b>Nagaland, Manipur, Mizoram &amp; Tripura:</b> Amarpur-18, Belonia-17, Kamalpur-15, Sabroom, Dharmanagar/ Panisagar-13 each, Chhamonu, Agartala-11 each, Kailashahar, Khowai, Sonamura-10 each, Arundhutinagar, Udaipur-9 each, Imphal-8</p>
0830 IST of 21 <sup>st</sup> October 2017	<p>(i) Heavy to very heavy rain at isolated places and isolated extremely heavy rainfall over Assam &amp; Meghalaya during next 24 hours.</p> <p>(ii) Isolated heavy rainfall over Sub- Himalayan West Bengal during next 12 hours.</p> <p>(iii) Heavy to very heavy rainfall at isolated places over Arunachal Pradesh, Nagaland, Manipur, Mizoram &amp; Tripura during next 24 hours.</p>	

## 7. Summary and Conclusion:

A low pressure area (LPA) formed over central Bay of Bengal (BoB) in the morning of 15<sup>th</sup> October. It further concentrated into a depression in the early morning of 19<sup>th</sup> over westcentral BoB. Moving nearly northwards, it crossed Odisha coast close to Paradip in the late evening of 19<sup>th</sup>. The system started recurving and moved nearly north-eastwards for sometime from the night of 20<sup>th</sup> across Gangetic West Bengal and Bangladesh. It weakened into a well marked low pressure area over northeast Bangladesh and adjoining Meghalaya & South Assam in the early morning of 22<sup>nd</sup> October.

## 8. Acknowledgements:

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