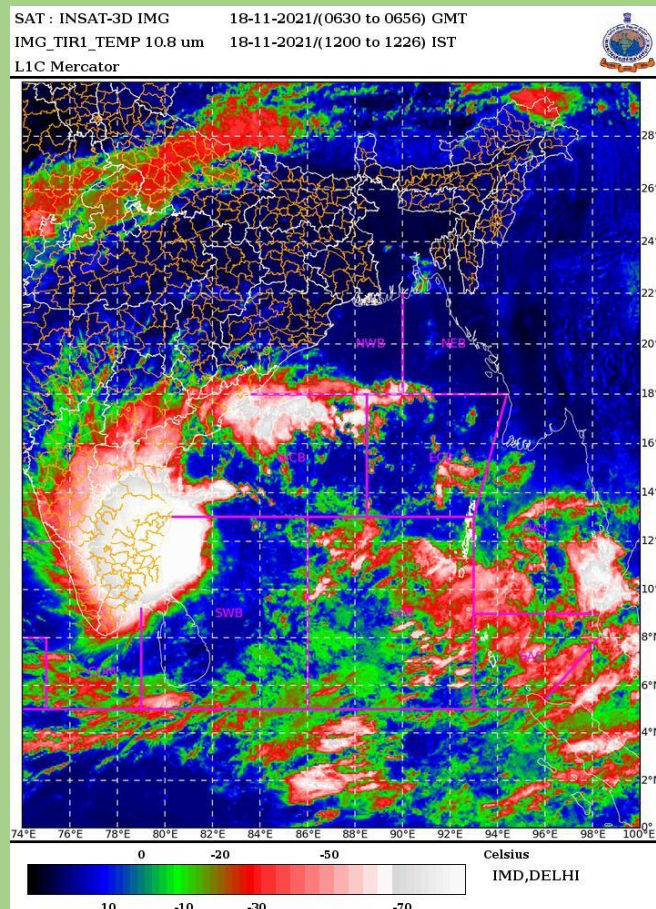




**GOVERNMENT OF INDIA  
MINISTRY OF EARTH SCIENCES  
INDIA METEOROLOGICAL DEPARTMENT**

**Depression over Bay of Bengal  
(18<sup>th</sup> –19<sup>th</sup> November 2021): A Report**



**INSAT-3D Satellite imagery at 0630 UTC of 18<sup>th</sup> November, 2021**

**Cyclone Warning Division  
India Meteorological Department  
New Delhi  
November, 2021**

## Depression over Bay of Bengal (18<sup>th</sup> – 19<sup>th</sup> November, 2021)

### 1. Introduction

- A Low Pressure Area (LPA) formed over south Andaman Sea & adjoining Thailand coast during the noon (0830 hrs IST/0300 UTC) of 13<sup>th</sup> November.
- It persisted as a low pressure area over south Bay of Bengal(BoB) for around 4 days.
- It moved westwards and lay as a well marked low pressure area (WML) over southwest & adjoining westcentral BoB off north Tamil Nadu and South Andhra Pradesh coasts in the morning (0530 hrs IST/0000 UTC) of 18<sup>th</sup> Nov.
- Under favourable environmental conditions, it concentrated into a depression over southwest BoB off North Tamil Nadu coast in the forenoon (0830 hrs IST/0300 UTC) of 18<sup>th</sup> Nov.
- It moved west-northwestwards and crossed north Tamil Nadu coast between Puducherry and Chennai near latitude 12.45°N and longitude 80.1°E during early hours of 19<sup>th</sup> Nov (0300-0400 hours IST of 19<sup>th</sup> / 2130-2230 UTC of 18<sup>th</sup>).
- It weakened into a well marked low pressure area over interior Tamil Nadu on 19<sup>th</sup> early morning (0530 hrs IST/0000 UTC) and gradually became less marked over same region on 20<sup>th</sup> November.
- The observed track of the system during 18<sup>th</sup> – 19<sup>th</sup> November is presented in Fig.1. Best Track parameters associated with the system are presented in Table1.

### 2. Salient features:

- The system developed during active phase of northeast monsoon season.
- It had a brief life period of about 27 hours against the average life period (1990-2013) of 48 hours of depression category in post-monsoon season over the BoB.
- It caused heavy to very heavy rainfall at few places with extremely heavy rainfall at isolated places over Tamil Nadu, Puducherry & Karaikal and Rayalseema on 18<sup>th</sup> November

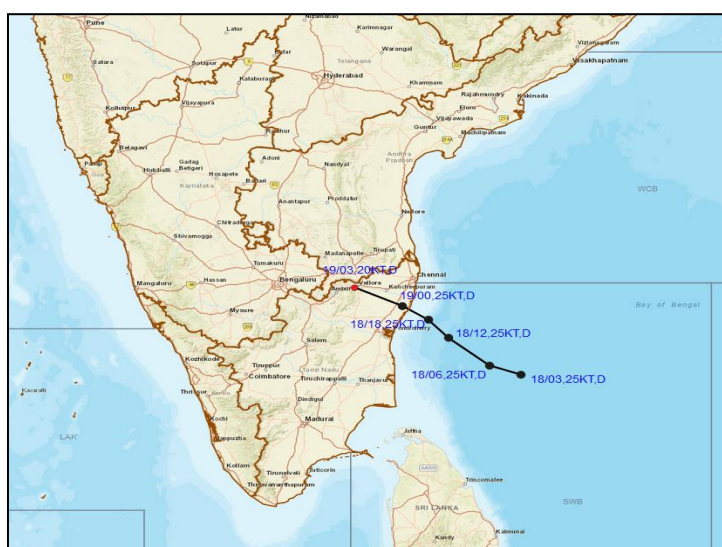


Fig.1: Observed track of depression over the Bay of Bengal during 18-19<sup>th</sup> November 2021

**Table 1: Best track positions and other parameters of the Depression over southwest Bay of Bengal during during 18-19<sup>th</sup> November 2021**

Date	Time (UTC)	Centre lat. <sup>0</sup> N/ long. <sup>0</sup> E		C.I. NO.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
18.112021	0300	11.0	82.3	1.5	1000	25	4	D
	0600	11.2	81.7	1.5	1000	25	4	D
	1200	11.8	80.9	1.5	1000	25	4	D
	1800	12.2	80.5	1.5	1000	25	4	D
19.11.2021		Crossed north Tamilnadu coast between Puducherry & Chennai near Lat. 12.45°N and Long., 80.1°E during 0300-0400 hour IST of 19th November, 2021						
	0000	12.5	80.0	1.5	1000	25	4	D
	0300	12.7	79.7	1.5	1002	20	3	D
	0600	Depression weakened into a Well Marked Low pressure Area over north Tamilnadu & neighborhood.						

### 3. Brief life history

#### Genesis, Intensification and movement

Under the influence of a cyclonic circulation over Gulf of Thailand and neighbourhood, an LPA formed over south Andaman Sea & adjoining Thailand coast at 0300 UTC of 13<sup>th</sup> November. It persisted as a low pressure area over south BoB for around 4 days.

Under favourable environmental conditions, it concentrated into a WML over southwest BoB at 0000 UTC of 18<sup>th</sup> and into a depression over southwest BoB off North Tamil Nadu coast at 0300 UTC of 18<sup>th</sup> Nov. At 0300 UTC of 18<sup>th</sup> November, the sea surface temperature (SST) was about 29-31°C over southwest BoB. Tropical cyclone heat potential (TCHP) was about 80-100 KJ/cm<sup>2</sup> over southwest BoB. Madden Julian Oscillation Index was in phase 4 with amplitude close to 1. It was likely to continue in same phase during next 5 days. The positive low level vorticity increased in previous 24 hours and was around (100 x10<sup>-6</sup> s<sup>-1</sup>) over southwest BoB to the south of system centre with vertical extension upto 500 hpa level. Positive low level convergence also increased and was about 30 x10<sup>-5</sup> s<sup>-1</sup> to the northwest of system centre. Positive upper level divergence also increased significantly and was around 30x10<sup>-5</sup> s<sup>-1</sup> to the northwest of system centre. Vertical wind shear was low (10-15 kts) over system area and upto north Tamilnadu & adjoining south Andhra Pradesh coasts. The latest total precipitable water vapour imagery at that time indicated moist warm air inflow into the core of system. The upper tropospheric ridge lay near 19.5<sup>0</sup>N. Under these favourable conditions, the low pressure area over central parts of south BoB moved west-northwestwards and intensified into a well marked low pressure area over southwest BoB at 0000 UTC and into a depression at 0300 UTC of 18<sup>th</sup> November.

The system was steered west-northwestwards by the east-southeasterly winds in the southern periphery of the upper tropospheric ridge. However, the land interactions

inhibited further intensification of the system. Under these conditions, the depression over southwest BoB moved further west-northwestwards and maintained its intensity.

At 1200 UTC of 18th November, similar sea and MJO conditions prevailed. The positive low level vorticity was around  $100 \times 10^{-6} \text{ s}^{-1}$  over southwest BoB to the south of system centre with vertical extension upto 500 hpa level. Positive low level convergence reduced slightly and was about  $20 \times 10^{-5} \text{ s}^{-1}$  to the west of system centre. Positive upper level divergence also reduced and was around  $05-10 \times 10^{-5} \text{ s}^{-1}$  to the northwest of system centre. Vertical wind shear was low (15-20 kts) over system area and along forecast track. The upper tropospheric ridge lay near 19.50N. The system was continuously steered west-northwestwards by the east-southeasterly winds prevailing in the southern periphery of the upper tropospheric ridge.

At 1800 UTC of 18th November, similar sea and MJO conditions prevailed. The positive low level vorticity was around  $100 \times 10^{-6} \text{ s}^{-1}$  over southwest BoB to the south of system centre with vertical extension upto 500 hpa level. Positive low level convergence was about  $20 \times 10^{-5} \text{ s}^{-1}$  to the west of system centre. Positive upper level divergence was around  $15-20 \times 10^{-5} \text{ s}^{-1}$  to the northwest of system centre. Vertical wind shear was low to moderate (15-20 kts) over system area and along forecast track. The upper tropospheric ridge lay near 19.50N. The system moved northwestwards by the east-southeasterly winds prevailing in the southern periphery of the upper tropospheric ridge and crossed north Tamilnadu coast between Puducherry & Chennai near  $12.45^\circ\text{N}/80.1^\circ\text{E}$  during 0300-0400 hours IST of 19th (2130-2230 UTC of 18th).

At 0300 UTC of 19<sup>th</sup> November, positive low level vorticity was about  $100 \times 10^{-6} \text{ s}^{-1}$  over Tamilnadu to the south of system centre. Positive low level convergence was about  $10 \times 10^{-5} \text{ s}^{-1}$  to the northeast of system centre. Positive upper level divergence was  $20 \times 10^{-5} \text{ s}^{-1}$  to the northwest of system centre. Wind shear was low (05-10 kt) over system area and increased gradually becoming 15 kt to its northwest, along the forecast track. Upper tropospheric ridge ran along  $18^\circ\text{N}$ . Under these conditions, the system moved west-northwestwards and weakened marginally.

Similar unfavourable trends in the environmental features continued and because of land interactions, the system weakened into a WML over interior Tamil Nadu on at 0600 UTC of 19<sup>th</sup> and gradually became less marked over the same region on 20<sup>th</sup> November morning.

#### **4. Monitoring of depression over southwest Bay of Bengal**

India Meteorological Department (IMD) maintained round the clock watch over the north Indian Ocean and the system was monitored since 10<sup>th</sup> November (3 days prior to formation of LPA over south Andaman Sea and adjoining Thailand on 13<sup>th</sup> November and 8 days prior to formation of depression over southwest BoB on 18<sup>th</sup> November).

The depression was monitored with the help of available satellite observations from INSAT 3D & 3DR and polar orbiting satellites. Various numerical weather prediction models developed by Ministry of Earth Sciences (MoES) institutions and dynamical-statistical models were utilized to predict the genesis, track, landfall and intensity of the system. A digitized forecasting system of IMD was utilized for analysis and comparison of various model guidance, decision making process and warning product generation.

##### **4. 1. Features observed through satellite**

Satellite monitoring of the system was mainly done by using half hourly INSAT-3D and 3DR imageries. Satellite imageries of international geostationary satellites

Meteosat-8, high resolution polar orbiting satellites and scatterometer imageries from ASCAT were also considered for monitoring the system. Typical INSAT-3D visible/ IR imageries, enhanced colored imageries and ASCAT(Met-Op A) imageries are presented in Fig.2. As per INSAT-3D at 0300 UTC of 18th November, the intensity of the system was characterised as T 1.5. The cloud mass over southwest BoB and neighbourhood further organised. Intense convective cloud mass was sheared to the west of system centre. The western part of the convective cloud mass entered northeast Tamilnadu & a secondary cloud band was observed over Andhra Pradesh. Broken low and medium clouds with embedded intense to very intense convection lay over southwest and adjoining westcentral BoB between bet latitude 9.0N & 13.5N and west of longitude 82.5E, over Tamilnadu & adjoining south Andhra Pradesh & Palk Strait. Minimum cloud top temperature (CTT) was minus 93°C.

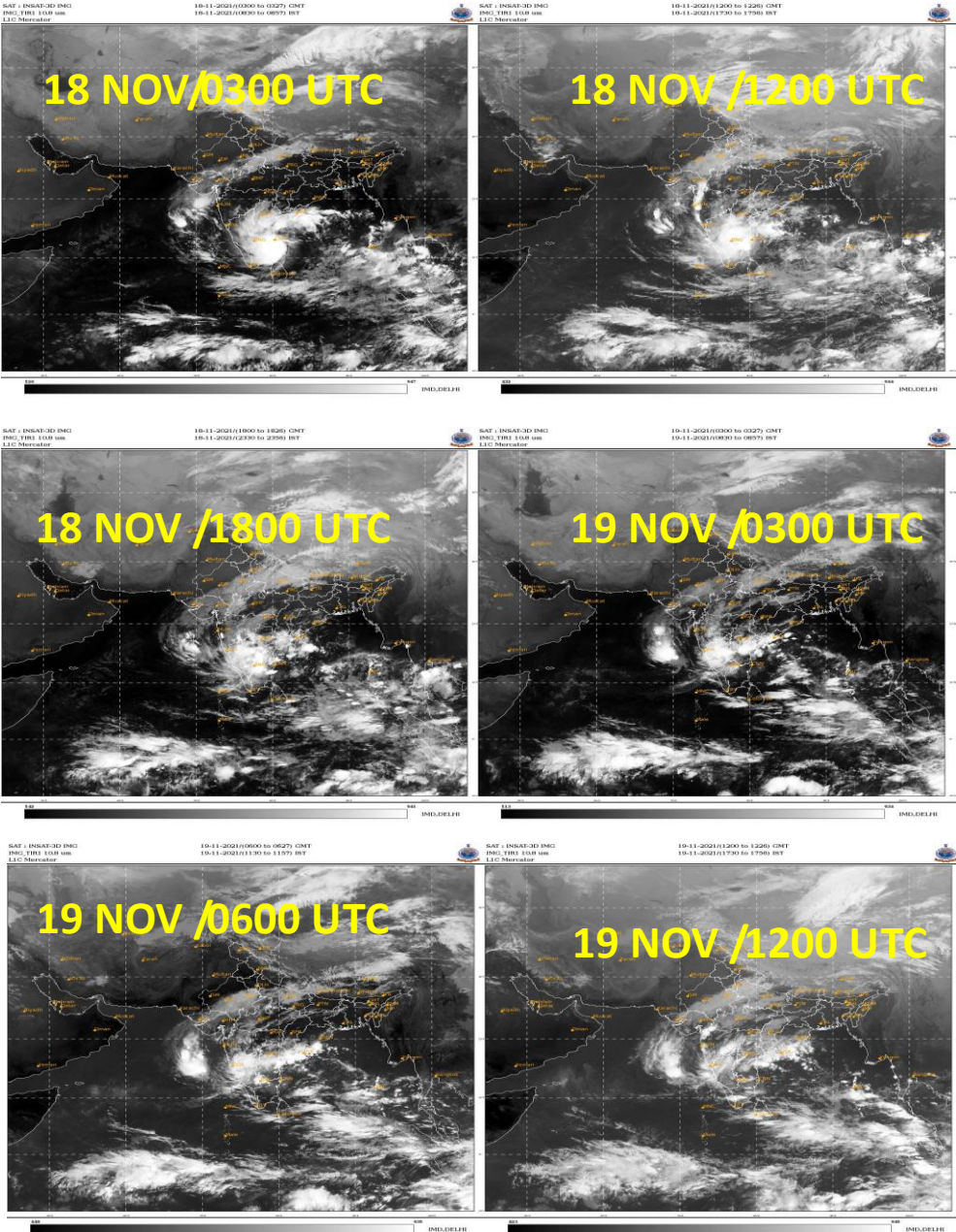
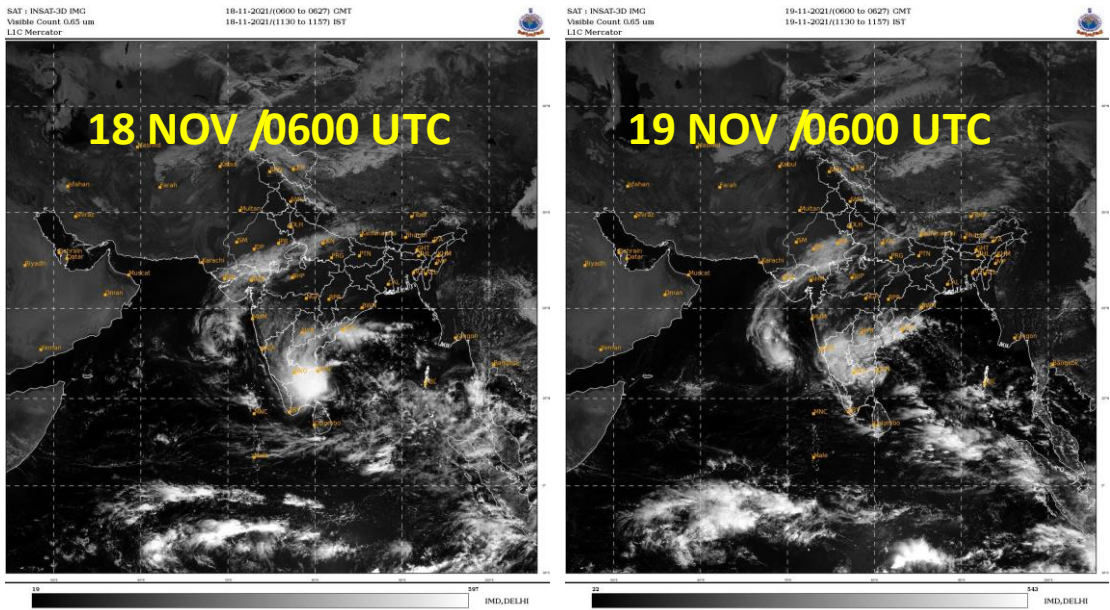
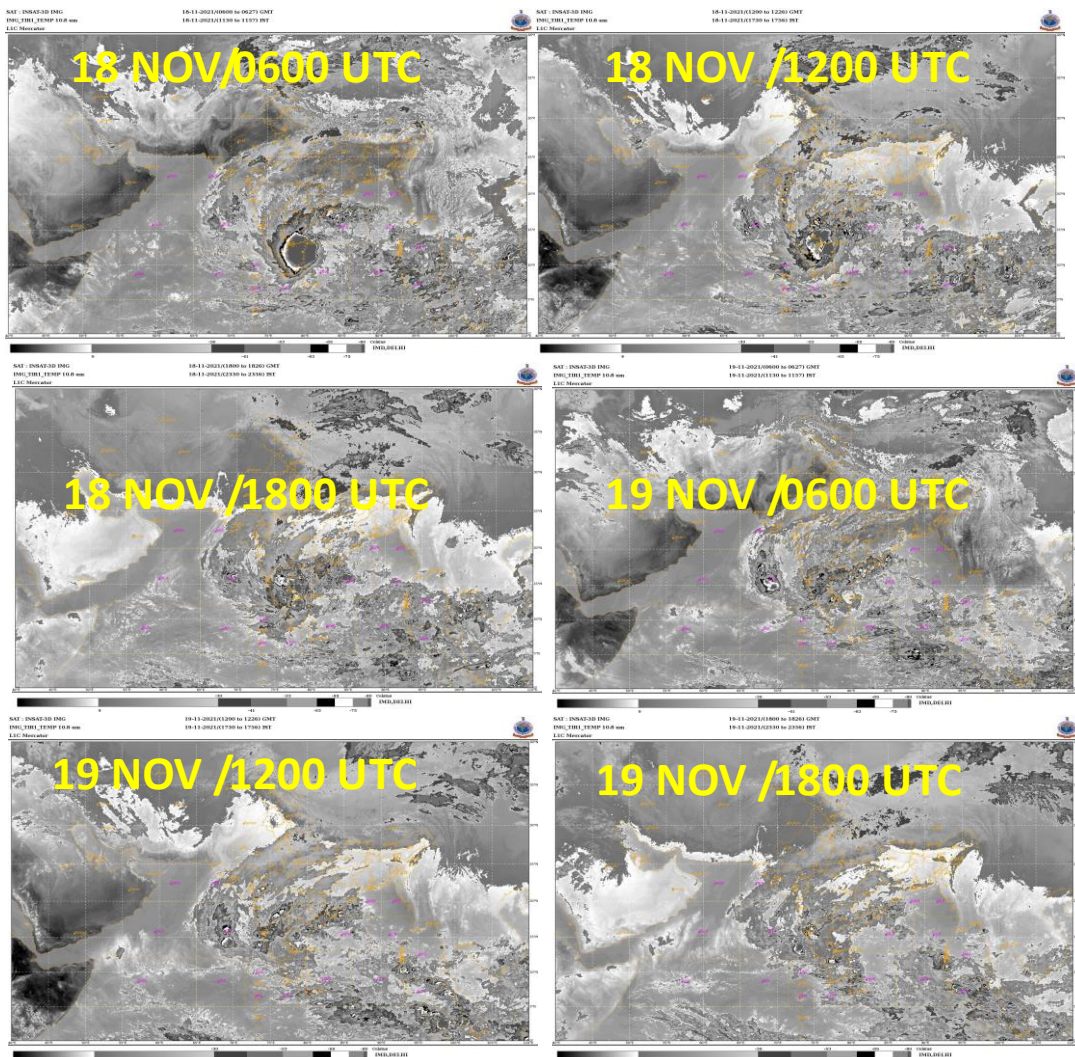


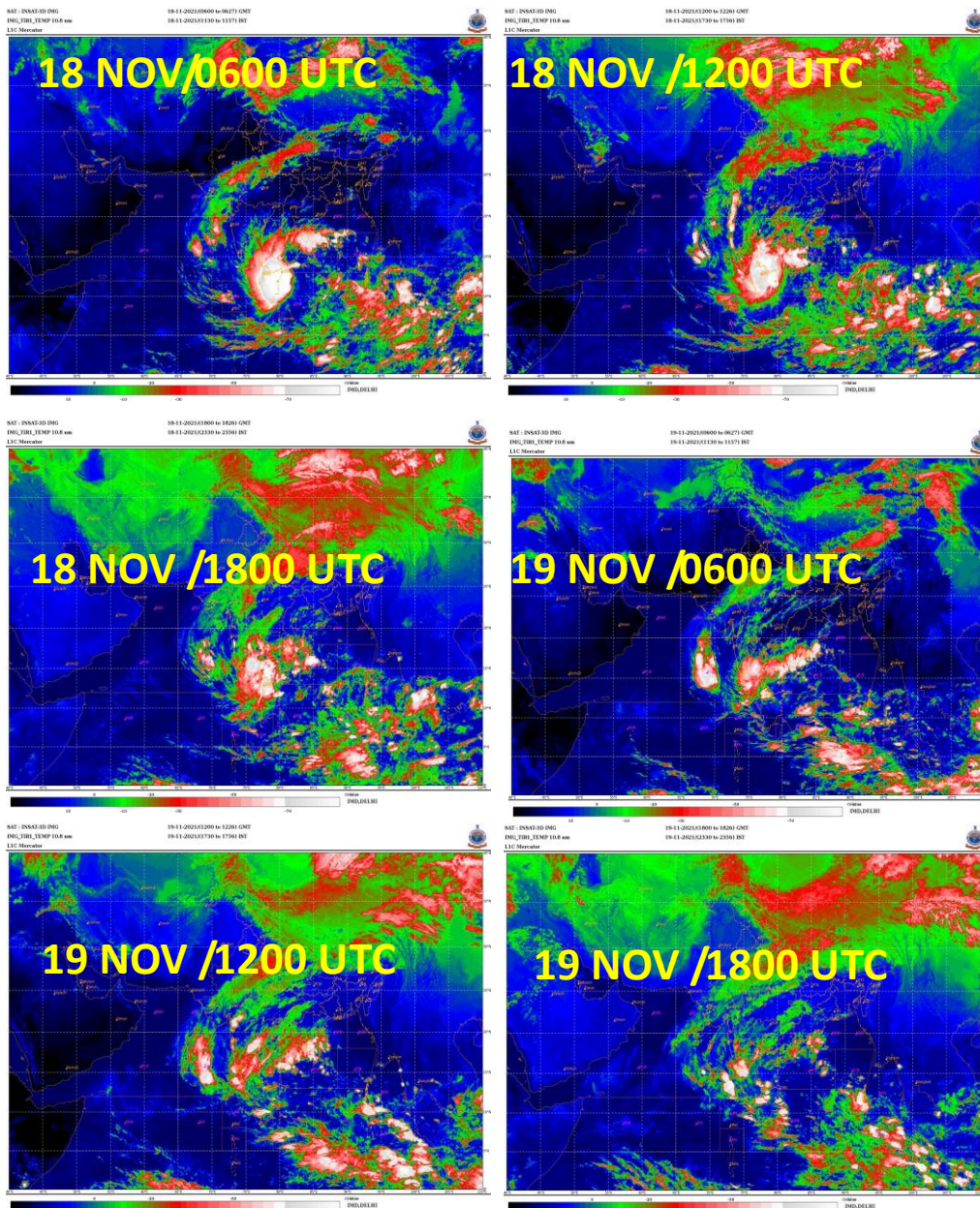
Fig. 2a: INSAT-3D IR imageries during life cycle of Depression during 18th-19th Nov, 2021



**Fig. 2 b: INSAT-3D VIS imageries during 18-19 Nov, 2021**



**Fig. 2 c: INSAT-3D BD curve imageries during 18-19 November, 2021**

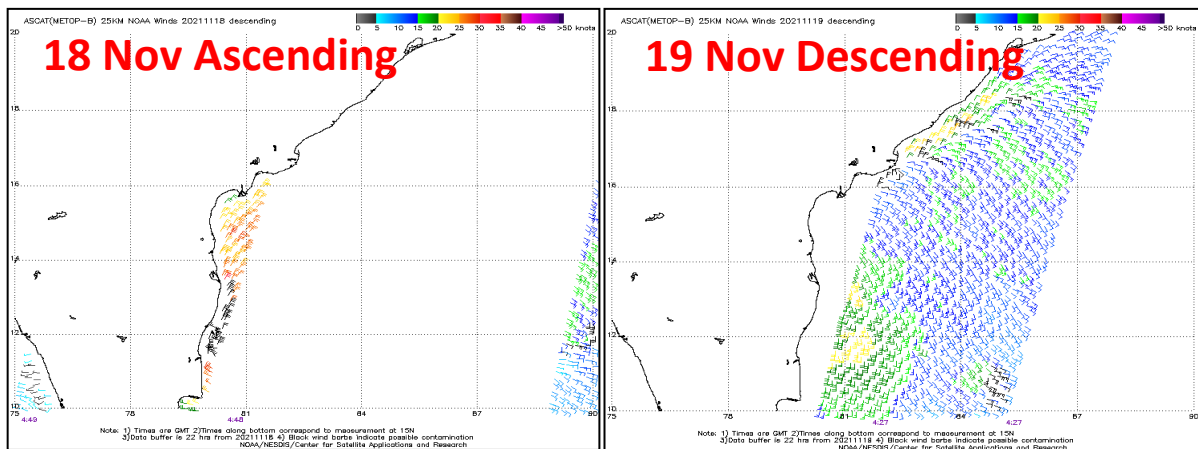


**Fig.2d: INSAT-3D enhanced colored imageries during 18-19 November, 2021**

At 1200 UTC of 18<sup>th</sup> November, the intensity of the system was characterised as T 1.5. The clouds were organised in shear pattern. Intense convective cloud mass was sheared to the west of system centre. Due to land interaction the convective cloud mass over Tamilnadu got disorganised. The cloud mass was spread across north Tamilnadu, south Andhra Pradesh and south interior Karnataka. Broken low and medium clouds with embedded intense to very intense convection lay over southwest and adjoining westcentral BoB between bet latitude 11.0N & 15.0N and west of longitude 80.5E and also over Tamilnadu & adjoining south Andhra Pradesh & south interior Karnataka. Minimum CTT was minus 93<sup>o</sup>C. Microwave imagery at 1055 UT of 18<sup>th</sup> indicated exposed low level circulation to the east of the cloud mass.

The system moved northwestwards and was over land during 2130-2230 UTC of 18<sup>th</sup>. Thereafter, due to land interactions the system started disorganizing.

At 0300 UTC of 19<sup>th</sup> November, broken low and medium clouds with embedded moderate to intense convection lay over northwest Tamilnadu, Rayalseema, adjoining south coastal Andhra Pradesh and south interior Karnataka. Minimum CTT was minus 70<sup>o</sup>C.

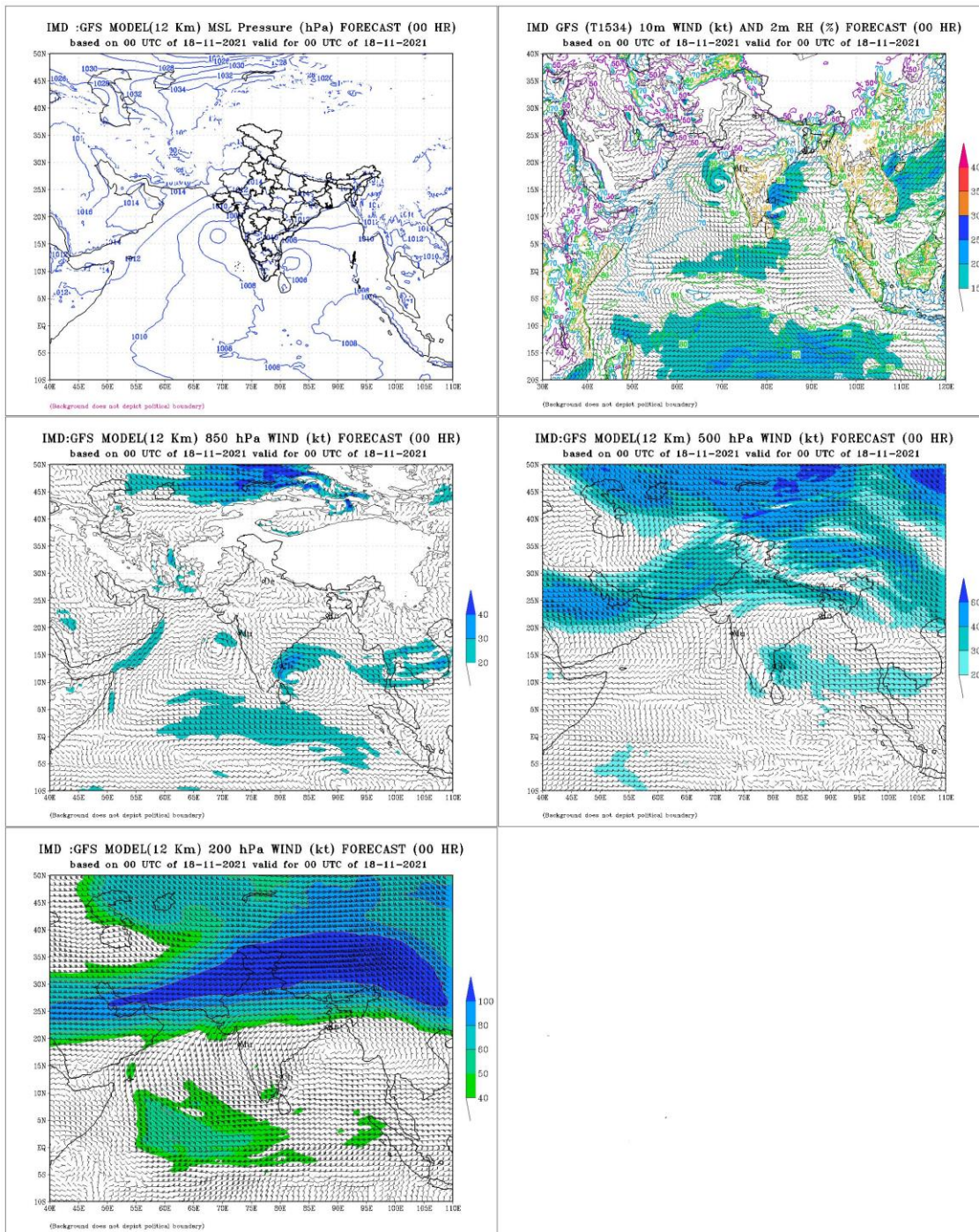


**Fig. 2e: ASCAT imageries on 18<sup>th</sup> -19<sup>th</sup> November 2021**

## 5. Dynamical features

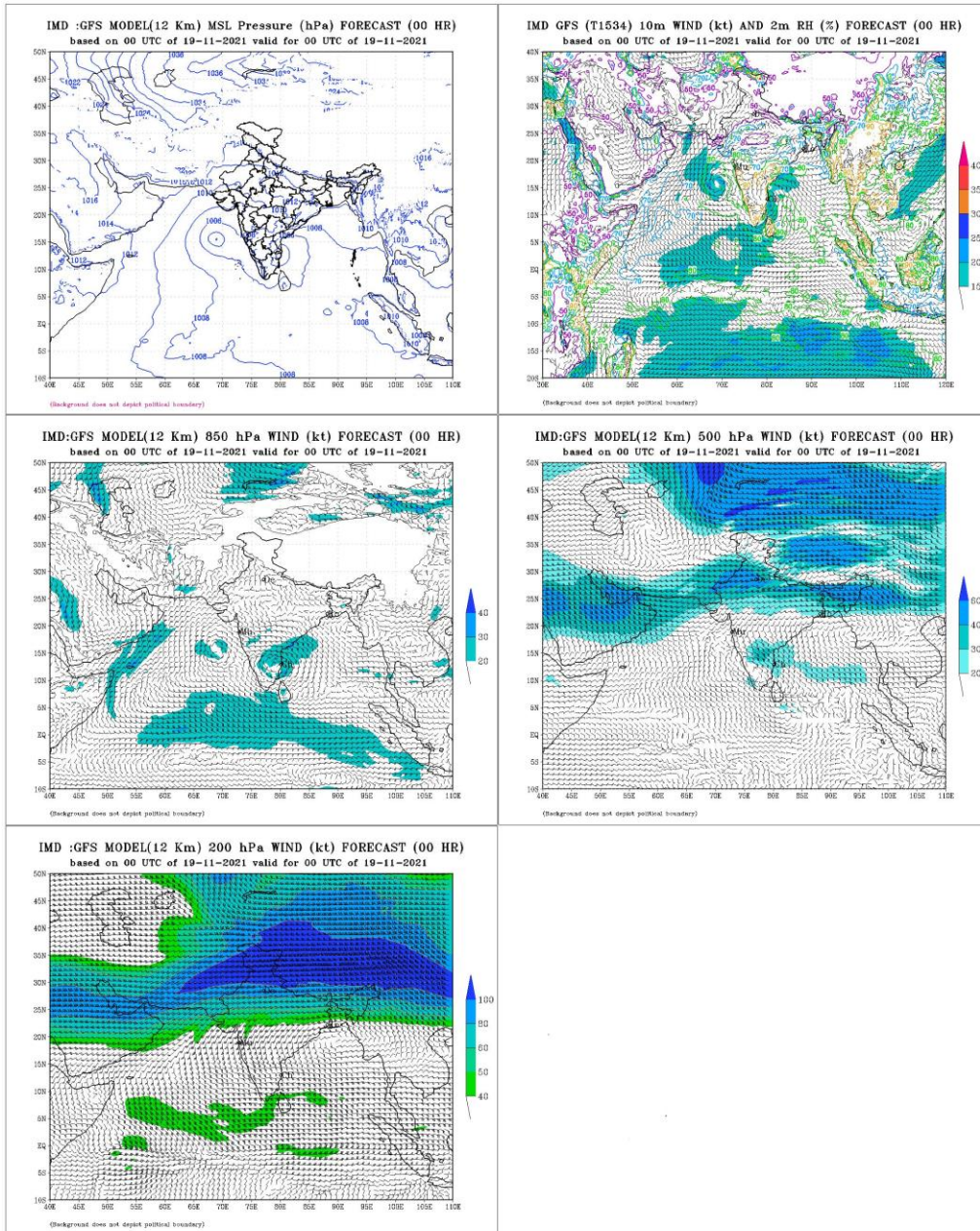
IMD GFS analysis fields of mean sea level pressure (MSLP), 10m wind, winds at 850, 500 & 200 hPa levels at 0000 UTC of 18<sup>th</sup> and 19<sup>th</sup> November are presented in Fig. 3 (a-b). The analysis fields based on 0000 UTC of 18<sup>th</sup> November indicated a depression over southwest BoB with vertical extension upto 500 hPa level. At upper level, the ridge was captured near 19<sup>o</sup>N (Fig. 3a).





**Fig.3 (a): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 18<sup>th</sup> November 2021**

The analysis fields based on 0000 UTC of 19<sup>th</sup> November indicated that the depression was centred over north Tamil Nadu and adjoining south Andhra Pradesh coasts close to Chennai. At upper level, the ridge was captured near 19<sup>0</sup>N (Fig. 3b).



**Fig.3 (b): 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> November 2021**

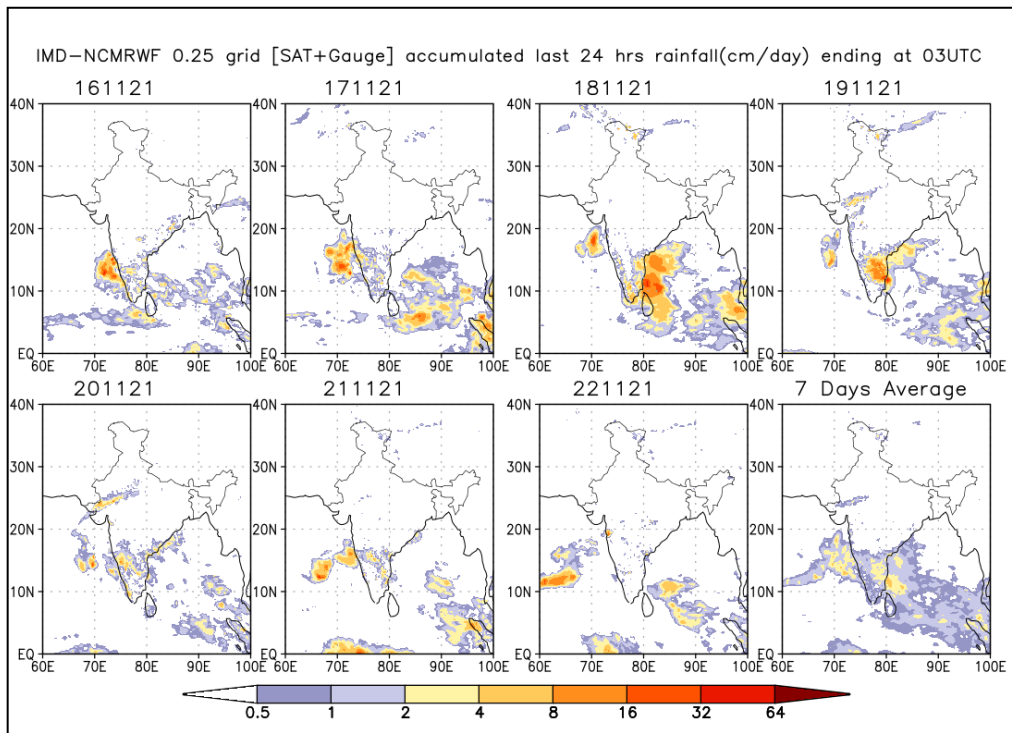
Thus, IMD GFS could capture the broad scale features, location, intensity and movement of system correctly throughout the life period of the system.

## 6. Realized Weather:

### 6.1. Realised rainfall

Rainfall associated with the depression over BoB based on IMD-NCMRWF GPM merged gauge rainfall data is depicted in **Fig 4**. It indicates heavy to very heavy rainfall at a few places over north Tamil Nadu & south Andhra Pradesh and at isolated places over Rayalseema and north interior Karnataka on 18<sup>th</sup> November. On 19<sup>th</sup>, heavy to very heavy rainfall at a few places over north interior Tamil Nadu, south

Andhra Pradesh, Rayalseema and north interior Karnataka with extremely heavy rainfall at isolated places over north interior Tamil Nadu and Rayalseema.



**Fig.4: IMD-NCMRWF GPM merged gauge rainfall plots during 16<sup>th</sup> -22<sup>nd</sup> November 2021**

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

**Rainfall Dated 18.11.2021**

**Tamilnadu:** Tiruppur district: Dharmapuram-13, Palladam-8, Tiruppur, Avinasi-7 each, **Thanjavur district:** Thanjavur-12, Ayyampettai-10, Budalur-8, Thanjai Papanasam, Tiruvaiyaru-7 each, **Tenkasi district:** Sankarankoil-11, **Perambalur district:** Chettikulam-11, **Coimbatore district:** Sulur-10, Valparai-8, Chinnakalur-7, **Dindigul:** Odanchatram-9, Palani-7; **Erode district** Bhavanisagar-9; **Tiruvarur district:** Needamangalam, Valangaiman-9 each; **Tirunelveli district:** Palayamkottai-9, Ambasamudram-7, **Toothukudi district:** Srivaikuntam, Surangudi, Kayathar-9 each, Kayalpattinam-8, **Virudhunagar district:** Sattur-8, Virudhunagar-7, **Nilgiris district:** Avalanche-8; **Cuddalore district:** Tozhudur-7;

**Rayalaseema:** **YSR District:** Atlur-10, Penagaluru-9, Rajampet, Cuddapah Vallur, Utukuru-7 each, **Chittoor district:** Tirupati-9, Srikalahasti, Thottambedu-7 each, Theni: gudalur, Veerapandi-7 each;

**Coastal Andhra Pradesh:** **Nellore district:** Atmakur-8, Vinjamur-7;

**North Interior Karnataka:** **Haveri district:** Hirekerur-10.

## **Rainfall Dated 19.11.2021**

**Tamilnadu, Puducherry & Karaikal:** Puducherry district -Puducherry-19, Dharmapuri district: Dharmapuri-18, Harur and Palacode-12, Kanchipuram district -Uthiramerur-14, Cuddalore district -Cuddalore-14, Krishnagiri district -Uthangiri-14, Penikondapuram- 11, Barur-10, Chengalpattu district -Cheyyur-10, Ranipet district -Wallajah-12, Tirupattur district -Alangayam-13;

**Royalaseema:** Anantapuramu district -Nambulipulikunta-24, YSR district - Sambalpur, Royachoti and Vemapalle-18 each, Pulivendla-17, Lakkireddipalle-16;

**Coastal Andhra Pradesh & Yanam:** Prakasham district -Kandukur-11, Nellore district -Venkatagiri-10, Sullupreta-8, Udaigiri, Vinjamur, Rapur and Atmakun-7 each;

**East Godavari district** -Amlapuram-9, **Krishna district** -Avanigada-7;

**South Interior Karnataka:** Bengaluru district: Hoskte-10, Electronic City-12; Chikaballapura district: Chintamani-12; Kolar district: Bangapet-18, Malur-17, Kolar PWD-15; Tumkuru district: Gubbi-15.

### **6.2. Realised Wind**

Realised estimated maximum sustained surface wind was 40-50 kmph gusting to 60 kmph over north Tamil Nadu in the early hours of 19<sup>th</sup> November at the time of landfall.

### **7. Damage due to the system**

As per media reports, 9 persons including four kids, died in house collapse in Vellore's Pernambut (Source: Indian Express dated 19<sup>th</sup> November)

## **8. Operational Forecast Performance**

### **8.1. Genesis, Track and Intensity Forecast**

- First information about likely formation of a low pressure area over Andaman Sea around 14<sup>th</sup> November was indicated in the daily detailed prognostic & diagnostic report issued on 8<sup>th</sup> November under Forecast Demonstration Project (about 5 days prior to formation of low pressure area on 13<sup>th</sup> and 10 days prior to formation of depression on 18<sup>th</sup> November).
- Subsequently, in the Tropical Weather Outlook bulletin issued at 1130 hrs IST/0600 UTC of 10<sup>th</sup> November, the information was further updated and it was indicated that a low pressure area would form over south Andaman Sea around 13<sup>th</sup> November. It was also indicated that the system would move west-northwestwards and intensify further.
- Actually, low pressure area formed over Andaman Sea on 13<sup>th</sup> November. It moved gradually west-northwestwards and intensified into a depression over southwest BoB on 18th November.
- In the first National Bulletin issued at 1145 hrs IST of 18th November, it was indicated that the system would move west– northwestwards and cross north Tamilnadu & adjoining south Andhra Pradesh coasts around Chennai by the early morning of 19th November, 2021 and the system crossed coast between Puducherry and Chennai during 0300-0400 IST of 19th November.

## 8.2. Adverse weather warning verification

The verifications of adverse weather like heavy rainfall and gale wind forecast issued by IMD are presented in Tables 2-3. It is found that the adverse weather was predicted accurately and well in advance

**Table 2: Verification of Heavy Rainfall Warning**

Date/ Base Time of observation	24 hr Heavy rainfall warning ending at 0300 UTC of next day	Realised 24-hour heavy rainfall ending at 0300 UTC of 3 <sup>rd</sup> April
18.11.2021 /0300UTC	Heavy to very heavy rainfall at a few places and extremely heavy falls at isolated places very likely over Tamil Nadu, Puducherry & Karaikal, heavy to very heavy rainfall and extremely heavy falls at isolated places over adjoining districts of Rayalaseema and heavy to very heavy rainfall at isolated places over south coastal Andhra Pradesh & south interior Karnataka.	<b>Tamilnadu: Tiruppur:</b> Dharmapuram-13, Palladam-8, Tiruppur, Avinasi-7 each, <b>Thanjavur:</b> Thanjavur-12, Ayyampettai-10, Budalur-8, Thanjai Papanasam, Tiruvaiyaru-7 each, <b>Tenkasi:</b> Sankarankoil-11, <b>Perambalur:</b> Chettikulam-11, <b>Coimbatore:</b> Sulur-10, Valparai-8, Chinnakalur-7, <b>Dindigul:</b> Odanchatram-9, Palani-7; <b>Erode:</b> Bhavanisagar-9; <b>Tiruvarur:</b> Needamangalam, Valangaiman-9 each; <b>Tirunelveli:</b> Palayamkottai-9, Ambasamudram-7, <b>Toothukudi:</b> Srivaikuntam, Surangudi, Kayathar-9 each, Kayalpattinam-8, <b>Virudhunagar:</b> Sattur-8, Virudhunagar-7, <b>Nilgiris:</b> Avalanche-8; <b>Cuddalore:</b> Tozhudur-7; <b>Rayalaseema: YSR District:</b> Atlur-10, Penagaluru-9, Rajampet, Cuddapah Vallur, Utukuru-7 each, <b>Chittoor:</b> Tirupati-9, Srikalahasti, Thottambedu-7 each, Theni: gudalur, Veerapandi-7 each; <b>Coastal Andhra Pradesh: Nellore:</b> Atmakur-8, Vinjamur-7; <b>North Interior Karnataka: Haveri:</b> Hirekerur-10. <b>Rayalaseema: Anantapuramu-Nambulipulikunta-</b> 24, <b>YSR-Sambalpur,</b> Royachoti and Vemapalle-18 each, Pulivendla-17, Lakkireddipalle-16; <b>Tamilnadu, Puducherry &amp; Karaikal: Puducherry-Puducherry-</b> 19, <b>Dharmapuri:</b> Dharmapuri-18, Harur and Palacode-12, <b>Kanchipuram-Uthiramerur-</b> 14, <b>Cuddalore-Cuddalore-</b> 14, <b>Krishnagiri-Uthangiri-</b> 14, Penikondapuram- 11, Barur-10, <b>Chengalpattu-Cheyyur-</b> 10, <b>Ranipet-Wallajah-</b> 12, <b>Tirupattur-Alangayam-</b> 13; <b>Coastal Andhra Pradesh &amp; Yanam: Prakasham-Kandukur-</b> 11, <b>Nellore-Venkatagiri-</b> 10, Sullupreta-8, Udaigiri, Vinjamur, Rapur and Atmakun-7 each; <b>East Godavari-Amlapuram-</b> 9, <b>Krishna-Avanigada-</b> 7; <b>Gujarat Region: Mehsana-Dharoi colony-</b> 8, <b>Narmada-Tilakwada-</b> 7, <b>Sabarkanya-Ildar and Vadali-</b> 7 each. <b>South Interior Karnataka: Bengaluru:</b> Hoskte-10, Electronic City-12; <b>Chikaballapura:</b> Chintamani-12; <b>Kolar:</b> Bangapet-18, Malur-17, Kolar PWD-15; <b>Tumkuru:</b> Gubbi-15.
19.11.2021/ 0300 UTC	Heavy to very heavy rainfall at isolated places very likely over Rayalaseema and south interior Karnataka and heavy rainfall at isolated places over north interior Tamil Nadu south, coastal Andhra Pradesh, Telangana, Coastal and north interior Karnataka and Kerala.	

**Table 3: Verification of squally wind warning**

Date/Base Time of observation	Squally wind warning based on at 0300 UTC of date	Realised 24-hour Squally wind
18.11.2021 /0300UTC	Squally wind speed reaching 45-55 kmph gusting to 65 kmph likely to prevail over southwest & adjoining west-central Bay of Bengal and along & off Tamil Nadu, Puducherry and India Meteorological Department (Ministry of Earth Sciences) adjoining south Andhra Pradesh coasts during next 24 hours and decrease gradually thereafter.	Realised estimated maximum sustained surface wind was 40-50 kmph gusting to 60 kmph over north Tamil Nadu, southwest BoB.
19.11.2021/ 0300 UTC	Squally wind speed reaching 40-50 kmph gusting to 60 kmph likely to prevail over southwest & adjoining west-central Bay of Bengal, Gulf of Mannar, Comorin Area and along & off Tamil Nadu, Puducherry and adjoining south Andhra Pradesh coasts during next 06 hours and decrease gradually thereafter	

## 9. Warning Services

### Bulletins issued by Cyclone Warning Division, New Delhi

- **Track & intensity forecast:** IMD continuously monitored, predicted and issued bulletins containing track & intensity forecast for +12, +24 and +36 lead period till the system weakened into a low pressure area. The above forecasts were issued from the stage of depression onwards along with the cone of uncertainty in the track forecast every six hourly during the Depression period.
- **Adverse weather warning bulletins:** The forecasts alongwith expected adverse weather like heavy rain and squally wind was issued with every six hourly update to central, state and district level disaster management agencies including MHA NDRF, NDMA, Coast Guard, all concerned states along the east coast of India including Tamil Nadu, Andhra Pradesh, Puducherry, Rayalseema, Kerala, Karnataka and Andaman & Nicobar Islands and to press and electronic media. The bulletins also contained the suggested action for disaster managers and general public in particular for fishermen. These bulletins were also issued to Ministry of Defence including Indian Navy & Indian Air Force and CDS.
- **Warning graphics:** The graphical display of the observed and forecast track with cone of uncertainty were disseminated by email and uploaded in the RSMC, New Delhi website (<http://rsmcnewdelhi.imd.gov.in/>) regularly. The adverse weather warnings related to heavy rain and squally wind were also presented in graphics alongwith colour codes in the website.
- **Warning and advisory through social media:** Daily updates (every six hourly or whenever there was any significant change in intensity/track) were uploaded on face book and tweeter regularly during the life period of the system.
- **Warning and advisory for marine community:** The six hourly Global Maritime Distress Safety System (GMDSS) bulletins were issued by the Marine Weather Services division at New Delhi and bulletins for maritime interest were issued by Area cyclone warning centres of IMD at Chennai, Kolkata and Cyclone warning

centres at Visakhapatnam, Bhubaneswar and Thiruvananthapuram to ports, fishermen, coastal and high sea shipping community.

- **Fishermen Warning:** Regular warnings for fishermen were issued since 13<sup>th</sup> Nov.
- **Diagnostic and prognostic features of Depression:** The prognostics and diagnostics of the systems were described in the RSMC bulletins.

**Table 4: Bulletins issued by RSMC New Delhi**

S.N	Bulletin type	No. of Bulletins	Issued to
1	Special Message on formation of LPA	4	1. IMD's website, RSMC New Delhi website 2. FAX and e-mail to Control Room Ministry of Home Affairs & National Disaster Management Authority, Cabinet Secretariat, Minister of Science & Technology, Headquarter Integrated Defence Staff, Director General Doordarshan, All India Radio, National Disaster Response Force, Chief Secretary, Government of Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Rayalseema, and Andaman & Nicobar Islands, IAF, Indian Navy, coast guard, press and electronic media.
2	National Bulletin	8	-Do-
3	RSMC Bulletin	7	1. IMD's website 2. WMO/ESCAP member countries through GTS and E-mail.
4	GMDSS Bulletins	8	1. IMD website, RSMC New Delhi website 2. Transmitted through WMO Information System (WIS) to Joint WMO/IOC Technical Commission for Ocean and Marine Meteorology (JCOMM)
5	Warnings through SMS	Frequently	SMS to disaster managers at national level and concerned states (every time when there was change in track, intensity, landfall characteristics and associated adverse weather) through IMD's network, to farmers through Kisaan Portal and to fishermen through INCOIS.
6	Warnings through Social Media	Daily	Uploaded on Social networking sites (Face book and Tweeter) since inception to weakening of system (every six hourly).
7	Press Release	2	Disaster Managers, Media persons by email and uploaded on website

## 10. Acknowledgement:

India Meteorological Department (IMD) and RSMC New Delhi duly acknowledge the contribution from all the stake holders and disaster management agencies who contributed to the successful monitoring, prediction and early warning service of system. We acknowledge the contribution of all sister organisations of Ministry of Earth Sciences including National Centre for Medium Range Weather Forecasting Centre (NCMRWF), Indian National Centre for Ocean Information Services (INCOIS), National Institute of Ocean Technology (NIOT), Indian Institute of Tropical Meteorology (IITM) Pune, research institutes including IIT Bhubaneswar, IIT Delhi and Space Application Centre, Indian Space Research Organisation (SAC-ISRO) for their valuable support. The support from various Divisions/Sections of IMD including Area Cyclone Warning Centre (ACWC) Chennai, Kolkata, Cyclone Warning Centre (CWC) Visakhapatnam, Bhubaneswar & Thiruvananthapuram, Numerical Weather Prediction Division, Satellite and Radar Division, Surface & Upper air instruments Divisions and Information System and Services Division at IMD is also duly acknowledged.