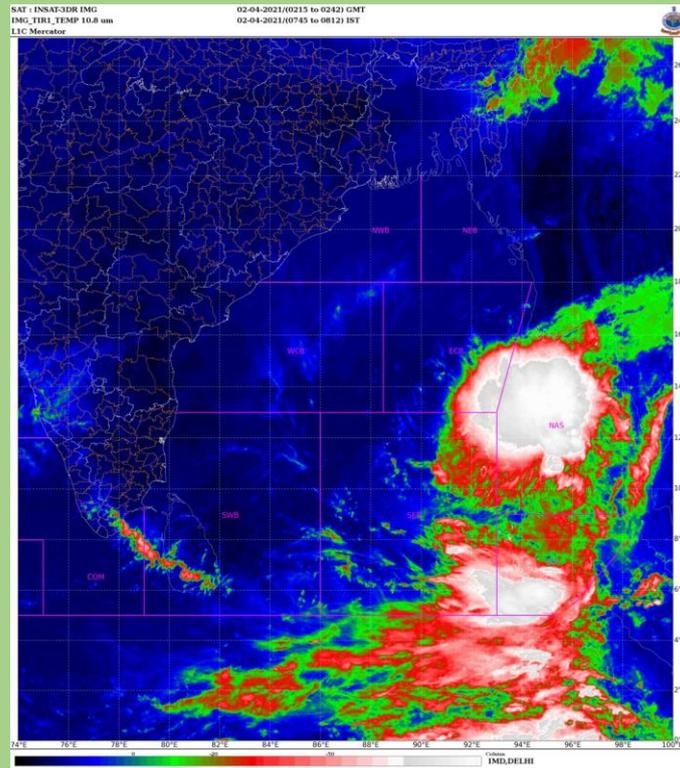




**GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
INDIA METEOROLOGICAL DEPARTMENT**

**Depression over Bay of Bengal
(10th – 11th November 2021): A Report**



**INSAT-3D Satellite imagery at 0215 UTC of 2nd April, 2021
for Depression over north southwest Bay of Bengal**

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

Depression over southwest Bay of Bengal (10th– 11th November, 2021)

1. Introduction

- A low pressure area formed over the southeast Bay of Bengal (BoB) and neighbourhood at 0300 UTC (0830 hrs IST) of 9th November, 2021.
- It lay as a well marked low pressure area (WML) over southeast and adjoining southwest BoB at 0000 UTC (0530 hrs IST) of 10th Nov.
- It moved west-northwestwards and concentrated into a depression over southwest BoB at 1200 UTC (1730 hrs IST) of 10th Nov.
- Moving further northwestwards, it crossed north Tamil Nadu & adjoining south Andhra Pradesh coasts close to Chennai, near latitude. 12.95°N and longitude 80.25°E during 1200 to 1300 UTC (1730 to 1830 hrs IST) with a maximum sustained wind speed of 45 – 55 kmph gusting to 65 kmph.
- It weakened into a WML over north Tamilnadu & neighborhood at 0000 UTC (0530 hrs IST) of 12th Nov.
- The observed track of the system is presented in Fig.1. The best track parameters of the system are presented in table1.

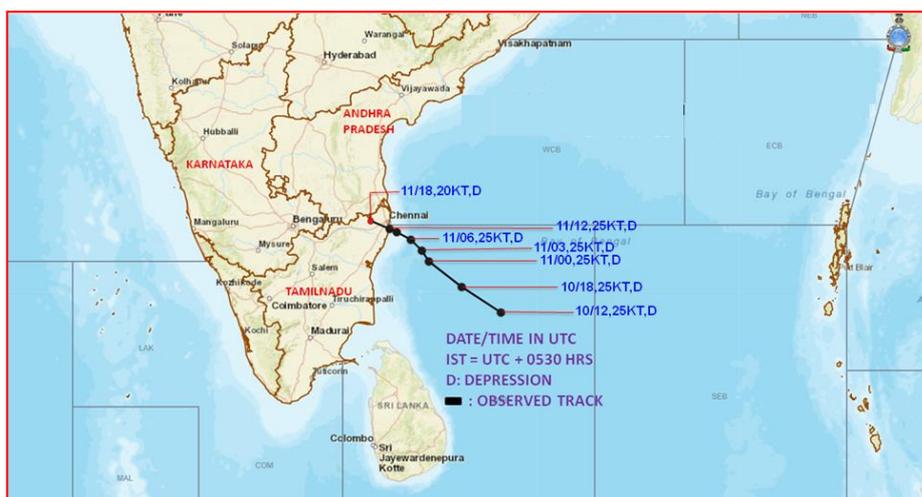


Fig.1: Observed track of depression over southwest BoB (10-12 November, 2021)

Table1: Best track positions and other parameters of the depression over southwest Bay of Bengal during 10 Nov- 12 Nov, 2021

Date	Time (UTC)	Centre lat. ^o N/ long. ^o E		C.I. NO.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
10.11.2021	1200	10.6	83.4	1.5	998	25	4	D
	1800	11.3	82.3	1.5	998	25	4	D
11.11.2021	0000	12.0	81.5	1.5	998	25	4	D
	0300	12.3	81.2	1.5	998	25	4	D

	0600	12.6	80.8	1.5	998	25	4	D
	1200	12.9	80.3	1.5	998	25	4	D
	Crossed north Tamil Nadu & adjoining south Andhra Pradesh coasts close to Chennai, near Lat. 12.95°N and Long. 80.25°E during 1730 and 1830 hrs IST with a maximum sustained wind speed of 45 – 55 kmph gusting to 65 kmph.							
	1800	13.1	79.8	1.5	1000	20	3	D
12.11.2021	0000	Depression weakened into a Well Marked Low pressure Area over north Tamilnadu & neighborhood						

Knots: kt, 1 kt = 1.85 kmph

2. Salient features

- It caused heavy to very rainfall at a few places with extremely heavy rainfall at isolated places over Tamil Nadu, Puducherry and Karaikal on 11th and heavy to very rainfall at a few places on 12th. It also caused heavy rainfall at a few places over Rayalseema on 12th.
- It had a total life period of 36 hours against the average life period (1990-2013) of 48 hours of depression category in post-monsoon season over the BoB.
- The system had track length of about 485 km

3. Genesis, Intensification and movement

Under the influence of the cyclonic circulation over southeast Bay of Bengal & neighbourhood, a low pressure area formed over the same region at 0300 UTC of 9th November. At 0300 UTC of 9th, the sea surface temperature (SST) was about 29-30°C over entire BoB. Tropical cyclone heat potential (TCHP) was about 100-120 KJ/cm² over parts of eastern equatorial Indian Ocean and adjoining southeast BoB & south Andaman Sea. In addition, a near equatorial convergence zone was present roughly along 5°N latitude over the region, providing the necessary cyclonic vorticity. An elongated zone of positive low level convergence ($10-40 \times 10^{-5} s^{-1}$) lay over equatorial Indian Ocean and adjoining southwest BoB. A large extended zone of positive upper level divergence about $05-20 \times 10^{-5} s^{-1}$ lay over the same region. Positive low level vorticity was about ($50 \times 10^{-6} s^{-1}$) to the southeast and also to the southwest of system area with vertical extension upto 500 hpa level. Under these favourable conditions a low pressure area formed over southeast BoB at 0300 UTC of 9th November. Similar favourable conditions prevailed and the system lay as a well marked low pressure area (WML) over southeast and adjoining southwest BoB at 0000 UTC of 10th Nov.

At 1200 UTC of 10th Nov., the SST was about 29-30°C over southwest & adjoining westcentral BOB. TCHP was about 80-100 KJ/cm² over the system region. Various environmental features including the low level vorticity, low level convergence and upper level divergence further consolidated. Positive low level vorticity was about ($100 \times 10^{-6} s^{-1}$) around system area and was oriented northwestwards with vertical extension upto 500 hPa level. Positive low level convergence was around $30 \times 10^{-5} s^{-1}$ to the northwest of system centre. Positive upper level divergence was around $40 \times 10^{-5} s^{-1}$ to the northwest of system centre. Warm moist air incursion was seen into the core of system as per total precipitable water imagery. Wind shear was low to moderate (10-20 kts) over the system region and high (>30 kt) near Tamilnadu-Andhra Pradesh coasts. The upper tropospheric ridge lay along 19°N over BOB. The east-southeasterly winds prevailing in the upper tropospheric level steered the system west-northwestwards.

At 0300 UTC of 11th Nov., similar sea conditions prevailed at the system region. The positive low level vorticity was about ($150 \times 10^{-6} s^{-1}$) around the system centre and was oriented slightly to the west with vertical extension upto 500 hpa level. Positive low

level convergence was around $30 \times 10^{-5} \text{ s}^{-1}$ to the northwest of system centre. The positive upper level divergence increased and was around $40 \times 10^{-5} \text{ s}^{-1}$ to the east of system centre. Warm moist air incursion was seen into the core of system as per total precipitable water imagery. Wind shear was low to moderate (15-20 kts) over the system region and high (>25 kt) near Tamilnadu & Andhra Pradesh coasts. This high vertical wind shear near the coast was expected to off-set other favourable environmental conditions thereby depleting the chances of further intensification of the system. The upper tropospheric ridge lay along 17°N over BoB. east-southeasterly winds prevailing in the southern periphery of upper tropospheric level steered the system west-northwestwards. Under these conditions, the system maintained the intensity of depression, moved west-northwestwards and crossed north Tamil Nadu and adjoining south Andhra Pradesh coasts close to Chennai, near $12.95^\circ\text{N}/80.25^\circ\text{E}$ during 1200 and 1300 UTC (1730 and 1830 hrs IST) with a maximum sustained wind speed of 45 – 55 kmph gusting to 65 kmph.

Thereafter, due to land interactions and increased vertical wind shear, the system weakened into a WML over north Tamil Nadu and neighborhood at 0000 UTC of 12th November, 2021.

4. Monitoring of depression over southwest BoB

India Meteorological Department (IMD) maintained round the clock watch over the north Indian Ocean and the system was monitored since 4th November (5 days prior to formation of LPA over southeast BoB on 9th November and 6 days prior to formation of depression over southwest BoB on 10th November). First information about formation of depression over southwest during 10th-12th November was indicated in the extended range outlook issued by IMD on 4th November.

The cyclone was monitored with the help of available satellite observations from INSAT 3D and 3DR and various 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 cyclone. A digitized forecasting system of IMD was utilized for analysis and comparison of various models guidance, decision making process and warning product generation.

The features observed through satellite are discussed below:

At 1200UTC of 10th Nov, intensity of the system was characterized as T 1.5. The clouds associated with the system were organised in shear pattern with convective clouds sheared to the northwest of system centre. The centre of the system was clearly seen in F-18 microwave pass imagery at 1056 UTC. Scattered to broken low & medium clouds with embedded intense to very intense convection lay over southwest & adjoining westcentral BOB between latitude 9.5N & 17.5N , longitude 80.0E & 89.0E . Minimum cloud top temperature was minus 93°C .

At 0300 UTC of 11th Nov., similar features continued. The cloud mass moved further northwards. Broken low & medium clouds with embedded intense to very intense convection lay over southwest & adjoining westcentral BoB between latitude 11.5N & 18.0N and longitude 80.0E & 89.0E , over north Tamil Nadu, coastal Andhra Pradesh and neighbourhood. Minimum cloud top temperature is minus 93°C .

At 0000 UTC 12th, weak convective clouds lay over north Tamilnadu and neighbourhood. Typical INSAT 3D based cloud imageries are presented in Fig.2 a-d and ASCAT imageries are presented in Fig.3.

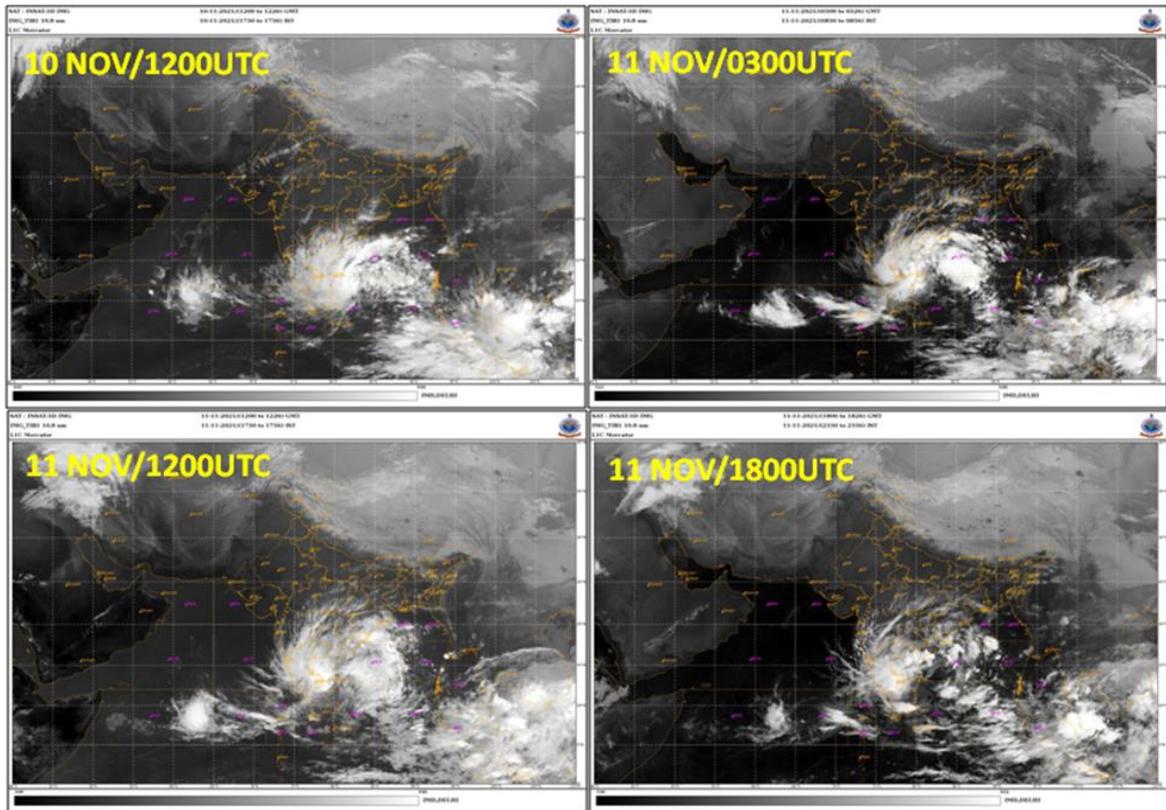


Fig.2 a. INSAT-3D IR imageries during 10-11 November, 2021

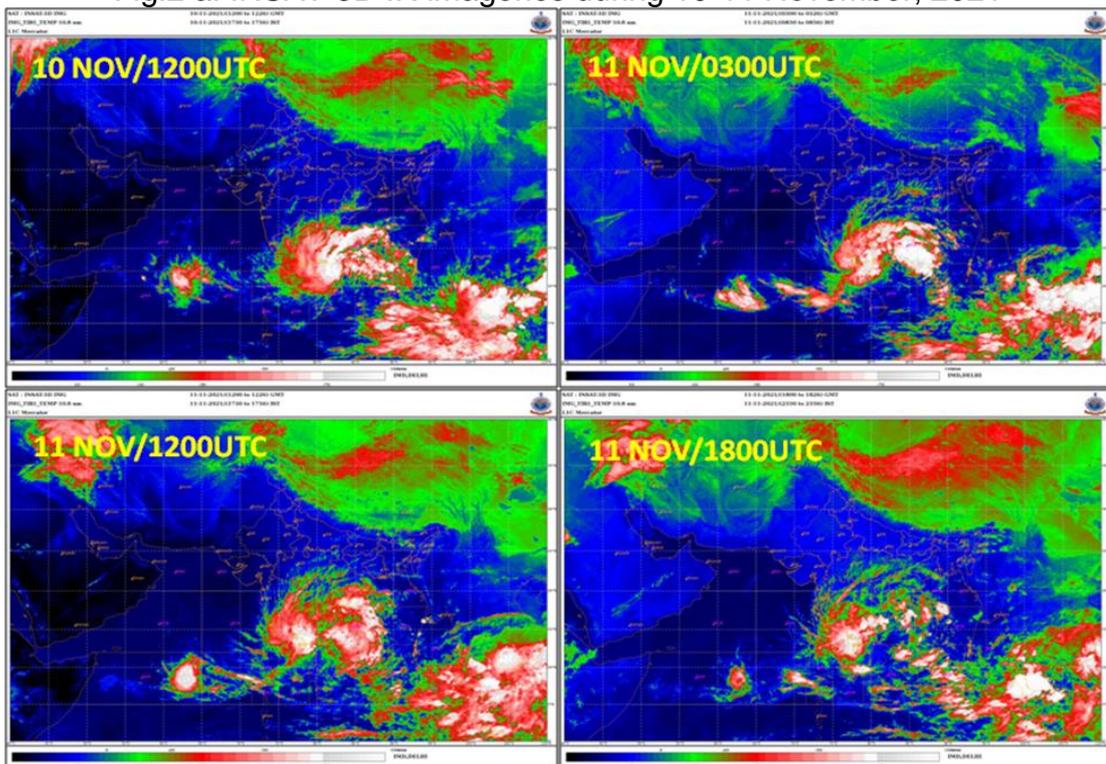


Fig.2 b.INSAT-3D IR NHC imageries during 10-11 November, 2021

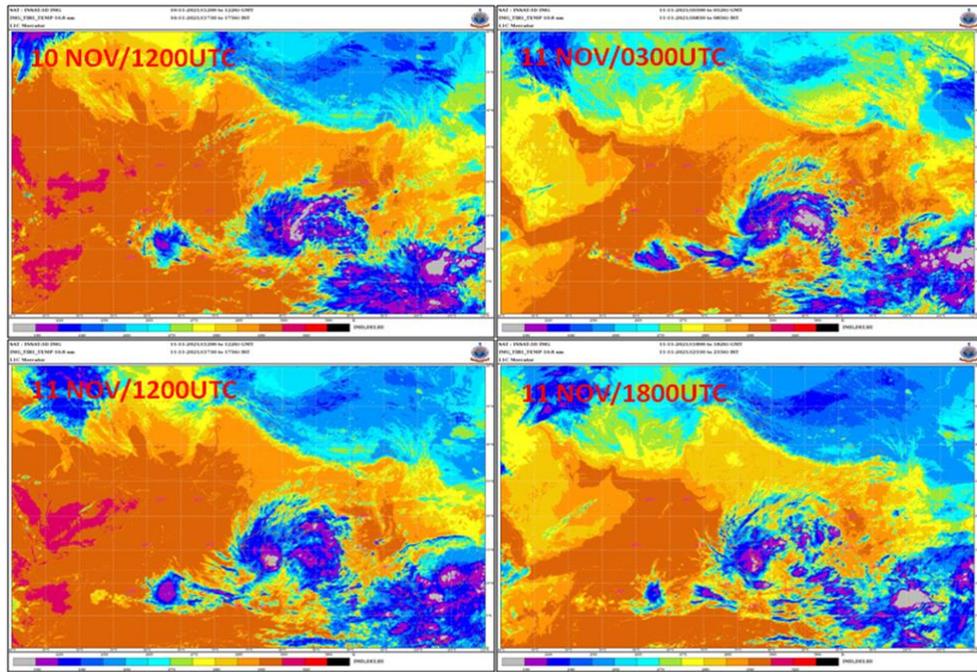


Fig.2 c.INSAT-3D IR1TEMP imageries during 10-11 November, 2021

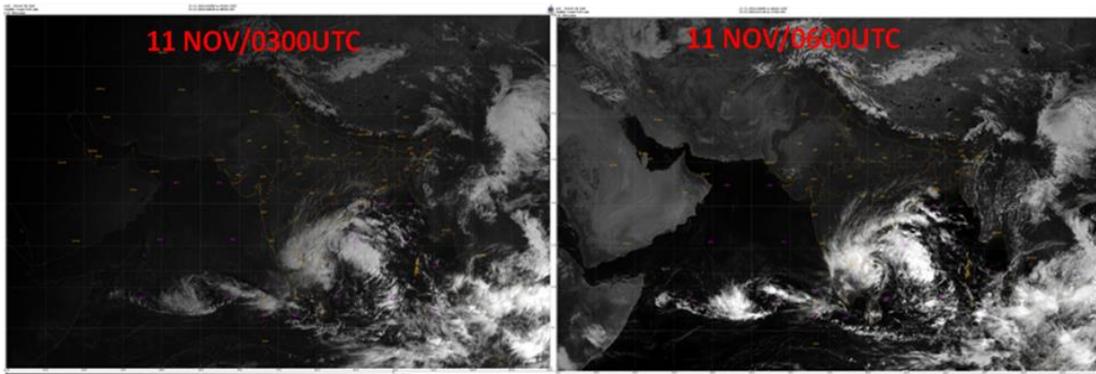


Fig.2d.INSAT-3D Vis imageries during life cycle of Depression (10-11 November, 2021)

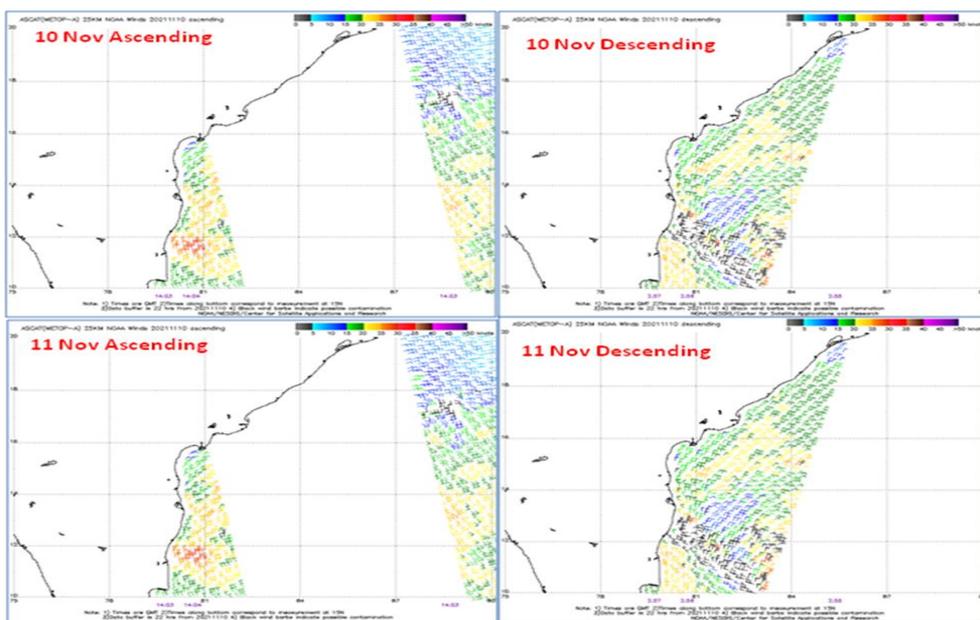


Fig. 3: ASCAT imageries during 10-11 November, 2021

Typical maximum reflectivity imageries from Doppler Weather Radar, Chennai are presented in Fig. 4.

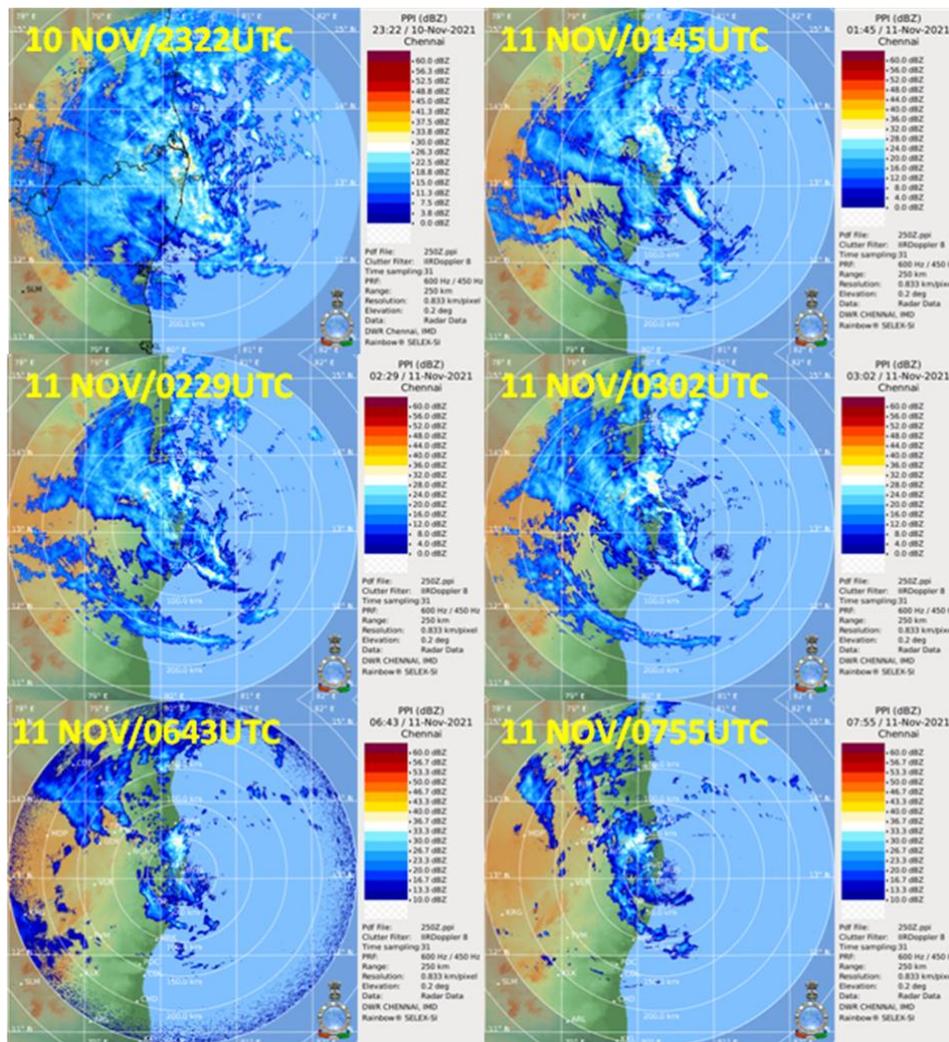


Fig.4: Typical Max Z Radar imageries of DWR Chennai during 10-11 November, 2021. The total precipitable water imagery during 10th-11th November indicating warm moist to the northeast of system centre are presented in Fig.5.

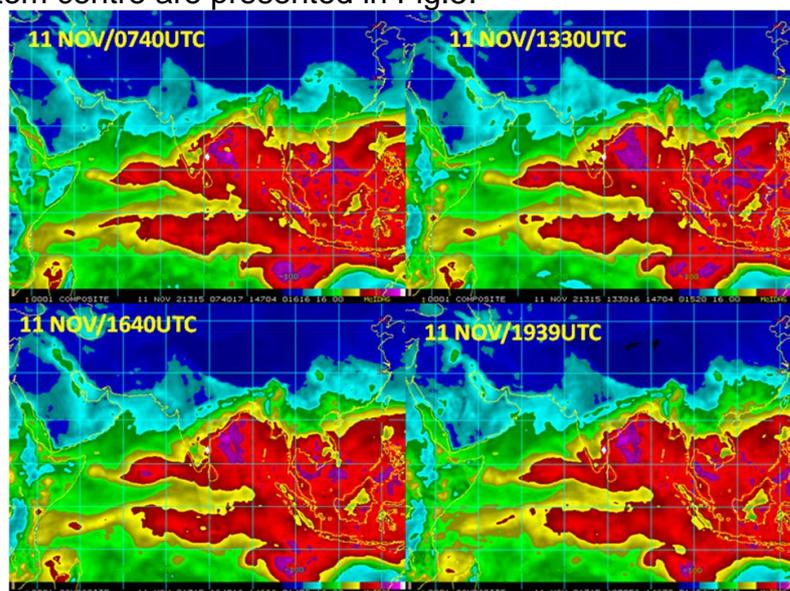


Fig.5. Total Precipitable Water Imagery during 10-11 November, 2021

6. Dynamical features

IMD GFS analysis fields of mean sea level pressure (MSLP), 10m wind, winds at 850, 500 & 200 hPa levels are presented in Fig. 6. The 10m wind analysis based on 0000 UTC of 10th November indicated a well marked low pressure area over southwest BoB with vertical extension upto 500 hPa level. At upper level, the ridge was seen near 16^oN. East-southeasterly winds were prevailing over the system area indicating west-northwestwards movement of the system. At 0000 UTC of 10th IMD GFS correctly picked intensity, location and movement of the system.

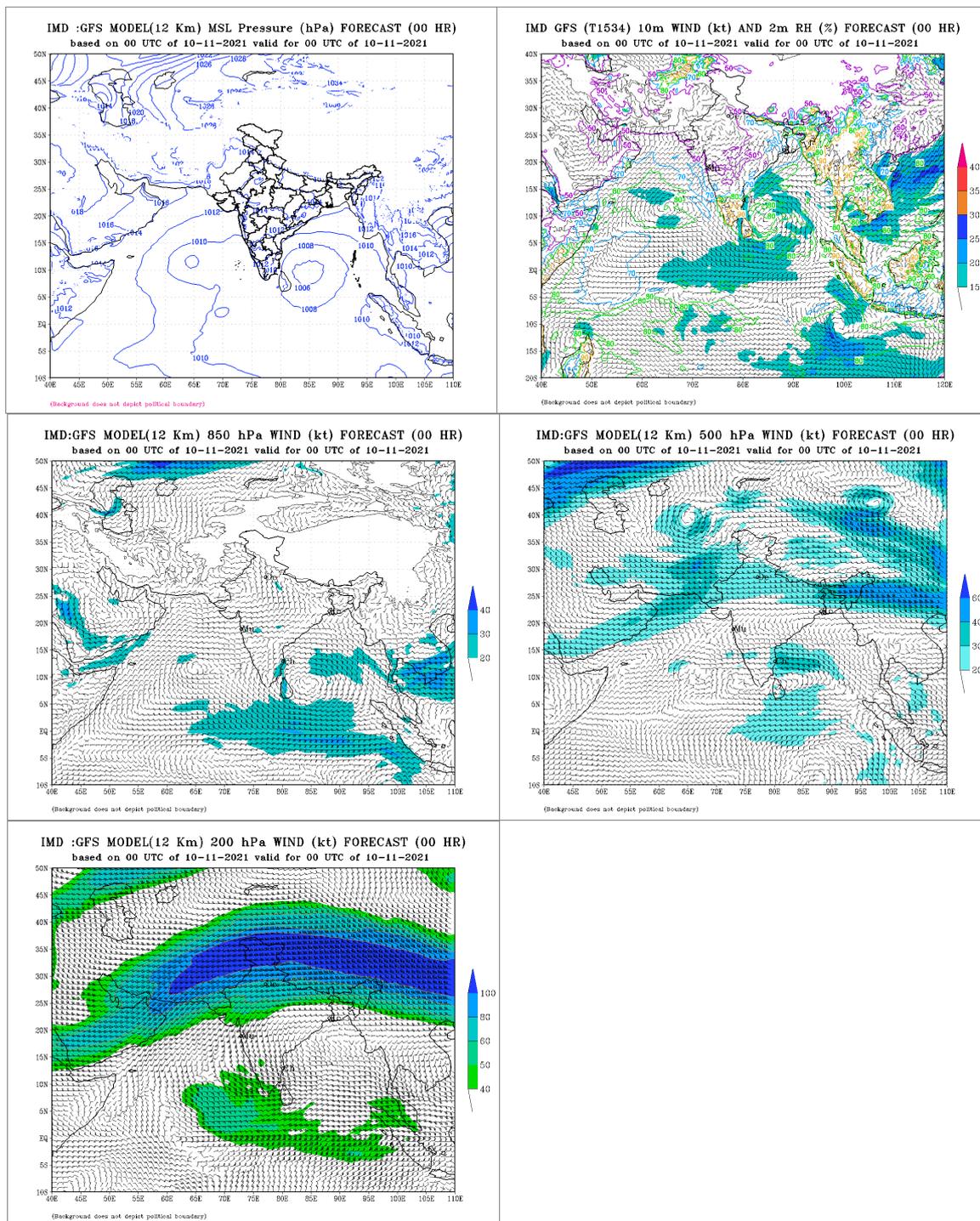


Fig.6 (a) IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 11th November 2021

The 10m wind analysis based on 0000 UTC of 11th November indicated a deep depression over southwest BoB with vertical extension upto 500 hPa level. At upper level, the ridge was seen near 16⁰N. East-southeasterly winds were prevailing over the system area indicating west-northwestwards movement of the system. Though broad scale features were correctly picked, but at 0000 UTC of 11th IMD GFS slightly over-estimated the intensity of the system.

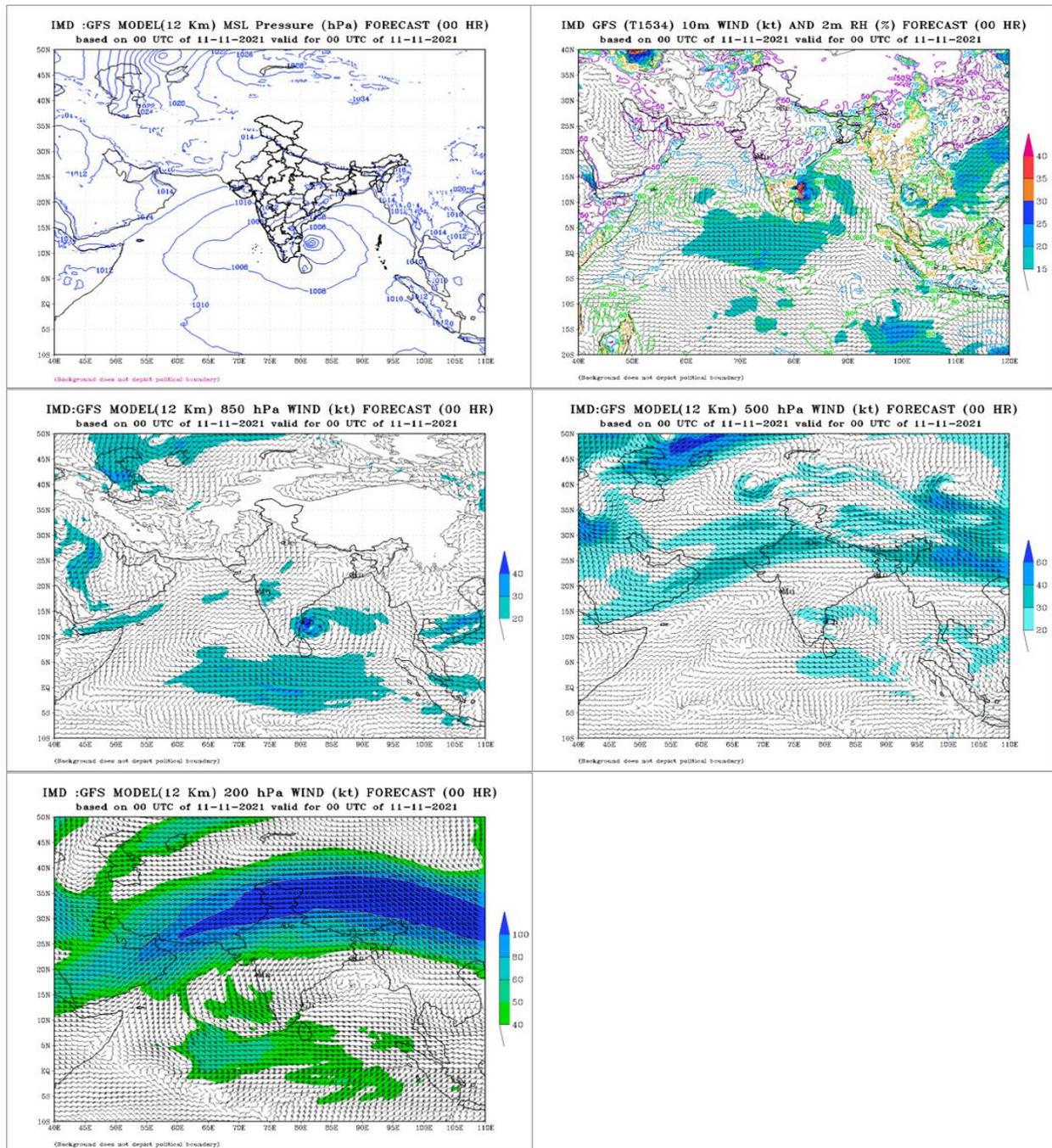


Fig.6 (b): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 11th November 2021

Thus, overall IMD GFS correctly picked genesis, location and movement and of the system.

7. Realized Weather:

7.1. Realised rainfall

Rainfall associated with the depression based on IMD-NCMRWF GPM merged gauge rainfall data is depicted in **Fig 7**. It indicates that active northeast monsoon and the system caused heavy to very heavy rainfall on 9th & 12th and heavy to very rainfall at a few places with extremely heavy rainfall on 10th & 11th over Tamil Nadu, Puducherry and Karaikal. It also caused heavy to very heavy rainfall at a few places over Rayalseema and coastal Andhra Pradesh on 11th & 12th November.

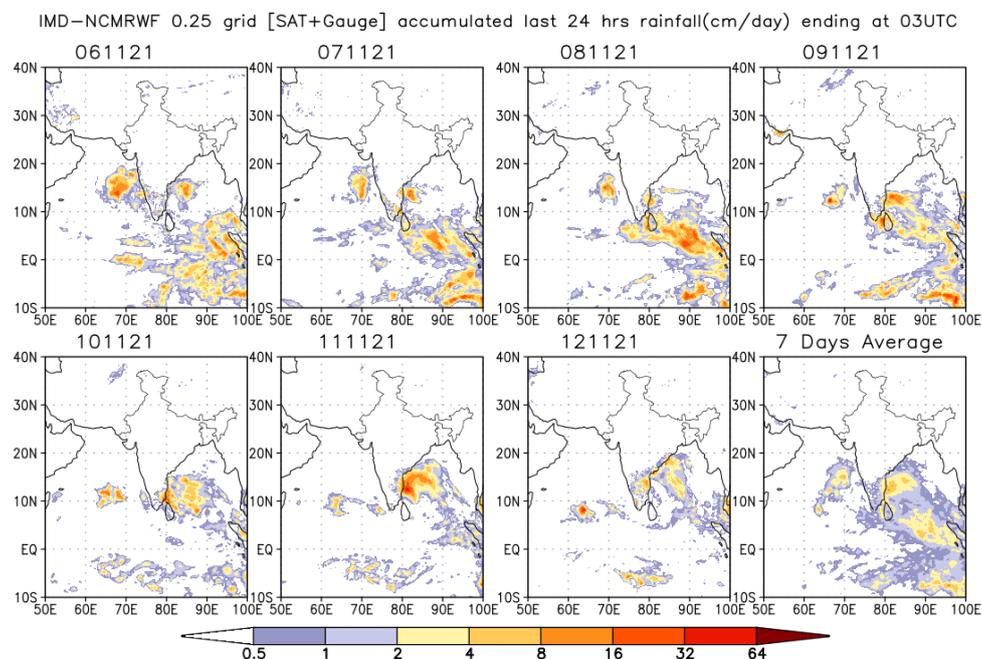


Fig.6: IMD-NCMRWF GPM merged gauge 24 hr cumulative rainfall (cm) ending at 0830 IST of date during 6th Nov. – 12th Nov. and 7 days average rainfall (cm/day)

The 24 hours cumulative rainfall (≥ 7 cm) ending at 0300 UTC (0830 hours IST) of date during 09th – 12th November 2021 is presented below:

9 November 2021

Tamilnadu, Puducherry & Karaikal: Chengalpattu-12; Kanyakumari, Toothukudi and Villupuram-9 each; Puducherry and Tenkasi-8 each; Kanchipuram-7.

Kerala & Mahe: Kottayam-10; Kollam-9; Malappuram-8

10 November 2021

Tamilnadu, Puducherry & Karaikal: Nagapattinam- Thirupoondi-31, Nagapattinam-29, Bedaranyam-25, Thalanayar-24;

Karaikal: Karaikal-29,

Tiruvarur- Thiruthuraipoondi-22, Mannargudi-14, Nannilam, Muthupettai-13 each, Valangaiman-12, Pandavaiyaru, Needamangalam, Kudavasal, Vettikadu, Lower Anaicut-11 each, **Thanjavur-** Peravurani-20, Echanviduthi-17, Thanjavur-16, Madukkur-15 each, Adiramapatnam-13, Manjalaru, Kumbakonam, Ayyampettai-12, Vallam-10, Budalur, Tiruvaiyaru -9 each, **Mayiladuthirai-**16.

Pudukkotai: Karambakudi-18, Manamelkudi, Avudayarkoil-10 each, Mimisal-8;

Mayiladuthurai: Tarangambadi-16, Mayiladuthurai-14, Sirkali-13, Manalmedu-12, Kollidam-11; **Puducherry:** M.o Pondicherry-9,

Namakkal: Rasipuram-8,

Ariyalur: Jayamkondam-10.

11 November 2021

Tamilnadu, Puducherry & Karaikal:

Chengalpattu: Tambaram-23, Mahabalipuram-17, Kelabakkam, Satyabama & Thirupporur-12 each, Thirukalukundram-11, Chengalpattu-10, Maduranthagam-9;

Tiruvallur: Cholavaram-22, Ennore-21, Gummidipoonai & Red Hills-18 each, Ambathur & Thomaraipakkam-15 each, Chembarabakkam-14, Ponneri-13, Poonamallee-12, Tiruvallur & Uthukottai-10 each, Koratur & Pondi-9 each;

Chennai: Peerambur-17, Nungambakkam-16, MGR Nagar-15, Meenambakkam, Taramani, Anna University & Chennai-14 each;

Kancheepuram: Kattukuppam-11, Sriperumbudur-10; Villupuram: Marakkanam-10,

Coastal Andhra Pradesh:

Nellore: Sullurpeta-18, Tada-14,

Rayalseema:

Chittoor: Satyavedu-11, Tirupati-8, Puttur-7,

Kerala & Mahe: Kollam:Aryankavu-18,

12 November 2021

Rayalseema:

YSR: Kodur-17; Rajampet-13; Pullampeta-11; Royachoti and Penagaluru-10 each; Sambepalle-9 each; Utukuru, Cuddapah-8 each; Vempalle, Chinnamandem, Atlur, Kadiri-7 each;

Chittoor: Puttur, Nagari-12 each; Satyavedu, Kalakada, Tirupathi-9 each; Thottambedu, Pakala-8 each; Srikalahasthi-7;

Tamilnadu, Puducherry & Karaikal: Kanyakumari: Suralacode-15; Perunchani Dam-13; Boothapandy-11; Mylaudi-10; Kottaram and Nagarcoil-7;

Tiruvallur: Tiruttani-12; Pallipattu-11; Cholavaram-10; Gummidipoondi-9; Uthukottai-8;

Ranipet: Wallajah-11; Arakonam and Kalavai-7;

Tiruvannamalai: Vembakkam-8;

Chennai: DGP Office-8; MGR Nagar-7;

Kanchipuram-7;

Salem: Yercaud-7;

Vellore: Katpadi-7;

Kerala: Idukki-14; Thodupuzha, Thiruvananthapuram-11 each; Ernakulam-7;

Coastal Andhra Pradesh: Nellore: Tada-11; Kavali-10; Atmapur-8; Vinjamur, Rapur, Kandukur, Venkatgiri-7 each.

7.2. Realised Wind

Realised estimated maximum sustained surface wind was 45-55 kmph gusting to 65 kmph prevailed over north coastal Tamil Nadu close to Chennai at the time of landfall. The following are the pertinent hourly observations from various stations of Chennai and Puducherry.

Station	Time (UTC) / MSLP (hPa), wind direction (Speed knots)					
	0900	1000	1100	1200	1300	1400
Chennai (MBK)	995.6 NNW	995.7 NW(20)	996.3 NE(20)	997.8 NE	1000.4 NE	1003.3 NE
Chennai (NBK)	996.0 NE	996.5 ENE (10)	997.0 ENE(15)	998.9 ESE	1000.5 ESE	1003.5 NW(light)
PDC	999.8 WSW(5)	999.9 WSW(5)	1000.2 SW(5)	1000.9 SW(5)	1001.9 SSW(5)	1002.9 SSW(5)

The Pressure Minima occurred all along the coast at 0900 UTC and started rising gradually.

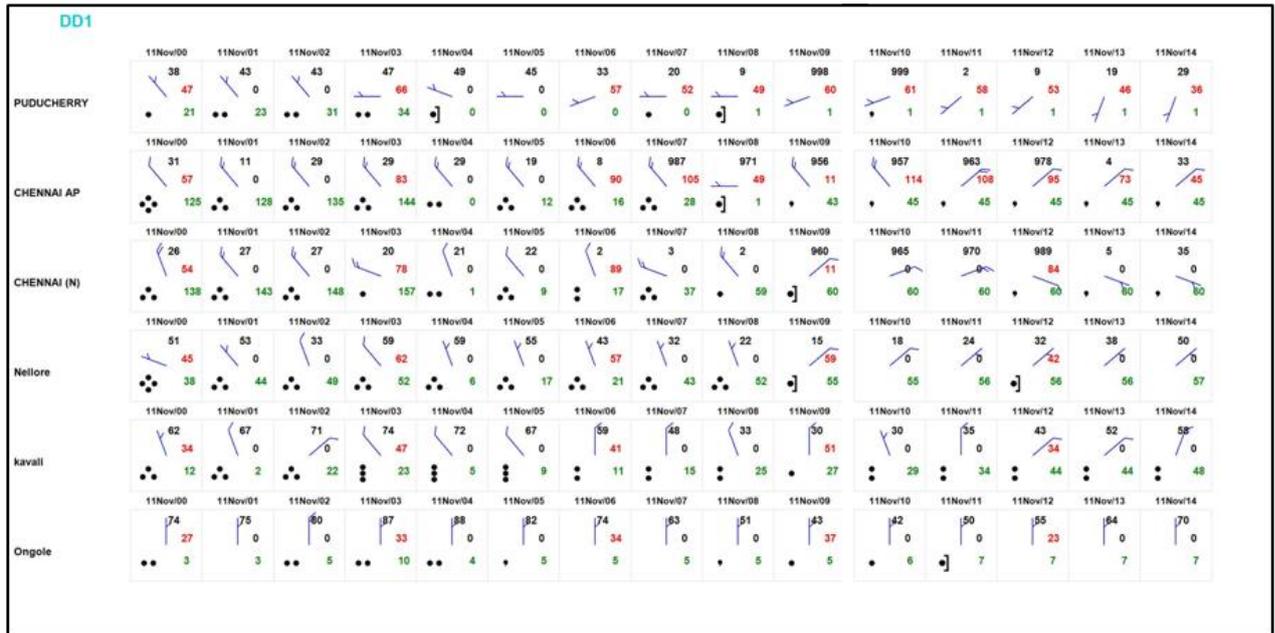


Fig.7: Hourly plot of observations from 0000 UTC to 1400 UTC of 11th November

8. Operational Forecast Performance

8.1. Genesis, Track and Intensity Forecast

- The first information about likely development of a low pressure area over southeast BoB and likely west-northwestwards movement with marginal intensification during 9th – 12th November 2021 was indicated in the extended range outlook issued on 04th Nov 2021 (about **5 days prior to formation of low pressure area over southeast BoB and 6 days prior to formation of depression** over southwest BoB).
- Subsequent tropical weather outlook issued on 5th Nov. indicated that a low pressure area would form over southeast BoB and neighborhood around 9th November.
- The advisories were further upgraded and the tropical weather outlook issued on 6th Nov., indicated likely formation of low pressure area over southeast BoB around 9th November. It was also indicated that the system would become more marked & move west-northwestwards towards north Tamilnadu coast during 9th-11th Nov.
- The daily prognosis & diagnostic report issued on 6th November indicated that the system would move west-northwestwards during 10th – 11th November with intensification into a Depression or higher intensity over southwest BoB close to Sri Lanka – Tamil Nadu coasts around 11th.
- The system was continuously monitored since 4th November and regular updates were issued thereafter in the daily tropical weather outlook issued at 0600 UTC and daily detailed prognostic and diagnostic report issued at 1200 UTC.
- On 10th November, it was indicated that the well marked low pressure area over southeast and adjoining southwest BoB would concentrate into a depression over southwest BoB during next 12 hours, move west–northwestwards and cross north

Tamilnadu & adjoining south Andhra Pradesh coast by the evening of 11th Nov., 2021.

- Regular structured bulletins commenced with the formation of depression over southwest BoB at 1200 UTC of 10th. In the subsequent bulletin issued at 1140 hours IST of 11th Nov., it was indicated that the system would cross north Tamilnadu & adjoining south Andhra Pradesh coast close to Chennai during evening of 11th.
- The bulletin issued at 2000 hrs IST of 11th Nov., informed that the system crossed north Tamil Nadu & adjoining south Andhra Pradesh coasts close to Chennai, near Lat. 12.95°N and Long. 80.25°E during 1730 and 1830 hrs IST with a maximum sustained wind speed of 45 – 55 kmph gusting to 65 kmph.

8.2. Adverse weather forecast verification

The verifications of adverse weather like heavy rainfall and squally 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 Forecast

Date/ Base Time of observation	24 hr Heavy rainfall warning issued at 0300 UTC of day (National Bulletin)	Realised 24-hour heavy rainfall ending at 0300 UTC
09.11.2021 /0300UTC	<p>9th Nov.: Heavy to very heavy rainfall falls & extremely heavy falls at isolated places very likely over south coastal Tamil Nadu.</p> <p>10th Nov.: Heavy to very heavy rainfall at a few places & extremely heavy falls at isolated places very likely over coastal Tamil Nadu and heavy to very heavy rainfall at isolated places over south coastal Andhra Pradesh.</p> <p>11th Nov.: Heavy to very heavy rainfall & extremely heavy falls at isolated places very likely over coastal Tamil Nadu south coastal Andhra Pradesh.</p> <p>12th Nov. Heavy rainfall at isolated places very likely over Tamil Nadu.</p>	<p>9 November 2021 Tamilnadu, Puducherry & Karaikal: Chengalpattu-12; Kanyakumari, Toothukudi and Villupuram-9 each; Puducherry and Tenkasi-8 each; Kanchipuram-7. Kerala & Mahe: Kottayam-10; Kollam-9; Malappuram-8</p> <p>10 November 2021 Tamilnadu, Puducherry & Karaikal: Nagapattinam- Thirupoondi-31, Nagapattinam-29, Bedaranyam-25, Thalanyar-24; Karaikal: Karaikal-29, Tiruvarur- Thiruthurai-22, Mannargudi-14, Nannilam, Muthupettai-13 each, Valangaiman-12, Pandavaiyaru, Needamangalam, Kudavasal, Vettikadu, Lower Anaicut-11 each, Thanjavur- Peravurani-20, Echanviduthi-17, Thanjavur-16, Madukkur-15 each, Adiramapatnam-13, Manjalaru, Kumbakonam, Ayyampettai-12, Vallam-10, Budalur, Tiruvaiyaru -9 each, Mayiladuthurai-16. Pudukkotai: Karambakudi-18, Manamelkudi, Avudayarkoil-10 each, Mimisal-8; Mayiladuthurai: Tarangambadi-16, Mayiladuthurai-14, Sirkali-13, Manalmedu-12, Kollidam-11; Puducherry: M.o Pondicherry-9, Namakkal: Rasipuram-8, Ariyalur: Jayamkondam-10.</p>
10.11.2021 /0300UTC	<p>10th Nov.: Heavy to very heavy rainfall at a few places & extremely heavy falls at isolated places very likely over north</p>	

	<p>coastal Tamil Nadu, north interior Tamil Nadu and south coastal Andhra Pradesh and heavy to very heavy rainfall at isolated places over Rayalaseema.</p> <p>11th Nov.: Heavy to very heavy rainfall at a few places & extremely heavy falls at isolated places very likely over north coastal Tamil Nadu, north interior Tamil Nadu, south coastal Andhra Pradesh and Rayalaseema.</p>	<p>11 November 2021 Tamilnadu, Puducherry & Karaikal: Chengalpattu: Tambaram-23, Mahabalipuram-17, Kelabakkam, Satyabama & Thirupporur-12 each, Thirukalukundram-11, Chengalpattu-10, Maduranthagam-9; Tiruvallur: Cholavaram-22, Ennore-21, Gummidipoonai & Red Hills-18 each, Ambathur & Thomaraipakkam-15 each, Chembarabakkam-14, Ponneri-13, Poonamallee-12, Tiruvallur & Uthukottai-10 each, Koratur & Pondi-9 each; Chennai: Peerambur-17, Nungambakkam-16, MGR Nagar-15, Meenambakkam, Taramani, Anna University & Chennai-14 each; Kancheepuram: Kattukuppam-11, Sriperumbudur-10; Villupuram: Marakkanam-10, Coastal Andhra Pradesh: Nellore: Sullurpeta-18, Tada-14, Rayalseema: Chittoor: Satyavedu-11, Tirupati-8, Puttur-7, Kerala & Mahe: Kollam:Aryankavu-18, 12 November 2021 Rayalseema: YSR: Kodur-17; Rajampet-13; Pullampeta-11; Royachoti and Penagaluru-10 each; Sambepalle-9 each; Utukuru, Cuddapah-8 each; Vempalle, Chinnamandem, Atlur, Kadiri-7 each; Chittoor: Puttur, Nagari-12 each; Satyavedu, Kalakada, Tirupathi-9 each; Thottambedu, Pakala-8 each; Srialahasthi-7; Tamilnadu, Puducherry & Karaikal: Kanyakumari: Suralacode-15; Perunchani Dam-13; Boothapandy-11; Mylaudi-10; Kottaram and Nagarcoil-7; Tiruvallur: Tiruttani-12; Pallipattu-11; Cholavaram-10; Gummidipoondi-9; Uthukottai-8; Ranipet: Wallajah-11; Arakonam and Kalavai-7; Tiruvannamalai: Vembakkam-8; Chennai: DGP Office-8; MGR Nagar-7; Kanchipuram-7; Salem: Yercaud-7; Vellore: Katpadi-7; Kerala: Idukki-14; Thodupuzha, Thiruvananthapuram-11 each; Ernakulam-7; Coastal Andhra Pradesh: Nellore: Tada-11; Kavali-10; Atmapur-8; Vinjamur, Rapur, Kandukur, Venkatgiri-7 each.</p>
11.11.2021 /0300UTC	<p>11th Nov.: Heavy to very heavy rainfall at a few places & extremely heavy falls at isolated places very likely over north coastal Tamil Nadu, Puducherry, north interior Tamil Nadu, south coastal Andhra Pradesh and Rayalaseema and heavy to very heavy rainfall at isolated places over south interior Karnataka, Kerala and heavy rainfall at isolated places over north coastal Andhra Pradesh.</p> <p>12th Nov.: Heavy rainfall at isolated places very likely over Tamil Nadu, Puducherry, coastal Andhra Pradesh, Rayalaseema south interior Karnataka & Kerala.</p>	
12.11.2021 /0300UTC	<p>12th Nov.: Heavy rainfall at isolated places very likely over Tamil Nadu, Puducherry, coastal Andhra Pradesh, Rayalaseema, and south interior Karnataka & Kerala.</p>	

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.

- **Adverse weather warning bulletins:** The tropical cyclone forecasts alongwith expected adverse weather like heavy rain wind and strong wind was issued with every six hourly update to central, state and district level disaster management agencies including MHA NDRF, NDMA for all concerned states along the east coast of India including Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Andaman & Nicobar Islands, Kerala and Karnataka. The bulletins also contained the suggested action for disaster managers and general public in particular for fishermen. These bulletins were also issued to Defence including Indian Navy & Indian Air Force.
- **Warning graphics:** The graphical display of the observed and forecast track with cone of uncertainty and the wind forecast for different quadrants 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 gale/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, and Cyclone warning centres at Bhubaneswar, Visakhapatnam and Thiruvananthapuram to ports, fishermen, coastal and high sea shipping community.
- **Fishermen Warning:** Regular warnings for fishermen for deep sea of south BoB and Andaman & Nicobar Islands were issued since 6th November, 2021.
- **Diagnostic and prognostic features of Depression:** The prognostics and diagnostics of the systems were described in the RSMC bulletins and tropical cyclone advisory bulletins.

Statistics of bulletins issued by RSMC New Delhi and Cyclone Warning Centre Visakhapatnam and MC Bengaluru in association with the depression over southwest BoB are given in **Table 4 & 5**.

Table 4: Bulletins issued by RSMC New Delhi

S.N	Bulletin type	No. of Bulletins	Issued to
1	Special Message on formation of low pressure area	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 and Andaman & Nicobar Islands, Kerala and Karnataka.

2	National Bulletin	9	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, Andaman & Nicobar Islands, Kerala and Karnataka.
3	RSMC Bulletin	13	1. IMD's website 2. WMO/ESCAP member countries through GTS and E-mail.
4	GMDSS Bulletins	13	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	Around 6.7 lakhs	SMS to disaster managers at national level and concerned states (every time when there was change in track, intensity and landfall characteristics) (i) 499 to General Public by IMD Headquarters (ii) 2,140 to disaster managers by IMD Headquarters (iii) 4,78,474 SMS to farmers of Andhra Pradesh (iv) 1,89,752 whatsapp messages to farmers of Tamil Nadu, Andhra Pradesh, Karnataka and Kerala
6	Warnings through Social Media	Daily	Cyclone Warnings were 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

Table 5: Statistics of bulletins issued by CWC Visakhapatnam in association with depression over southwest BOB during 10th Nov to 12th Nov 2021

Sr No.	Type of Bulletin	CWC Visakhapatnam
1.	Sea Area Bulletins	–
2.	Coastal Weather Bulletins	8
3.	Fishermen Warnings issued	12
4.	Port Warnings	4
5.	Heavy Rainfall Warning	5
6.	Gale Wind Warning	–
7.	Storm Surge Warning	–
8.	Information & Warning issued to State Government and other Agencies	16
9.	SMS	–
10.	No. of Press Release	5

11.	No. of impact based warnings for a) District b) City	Districts: 43 City: 171
12.	No. of whatsapp messages	59
13.	No. of updates on facebook	17
14.	No. of updates on tweeter	17
15.	No. of Forecast / Warning video released	4

10. Damage due to the system

About 14 persons lost their lives in Tamil Nadu due to heavy rains in association with this system. (Source Business Standard, dated 11 Nov. 2021)



(a) A woman wades through a waterlogged street following heavy rain at KM Garden in Purasaiwakkam, in Chennai (Source Indian Express, 11th Nov.) and (b) Heavy water logging in several parts of Tamil Nadu; schools, colleges shut in capital city (Source Times of India, 12th Nov.)

11. Summary:

A low pressure area formed over the southeast Bay of Bengal (BoB) on 9th November, 2021. It moved west-northwestwards and concentrated into a depression over southwest BoB on 10th Nov. Moving further northwestwards, it crossed north Tamil Nadu & adjoining south Andhra Pradesh coasts close to Chennai, near latitude. 12.95°N and longitude 80.25°E during 1200 to 1300 UTC (1730 to 1830 hrs IST) with a maximum sustained wind speed of 45 – 55 kmph gusting to 65 kmph. It weakened into a WML over north Tamilnadu & neighborhood at 0000 UTC (0530 hrs IST) of 12th Nov. The system caused heavy to very rainfall at few places with extremely heavy rainfall at isolated places over Tamil Nadu, Puducherry and Karaikal on 11th and heavy to very rainfall at few places on 12th. It also caused heavy rainfall at few places over Rayalseema on 12th November. The system was monitored since 4th November (6 days prior to formation of depression over southwest BoB). 13 National bulletins, 13 RSMC bulletins, 2 Press Release and about 6.7 lakhs SMS & whatsapp messages were sent in association with this system to share information with disaster managers and sensitize masses.

12. 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) Bhubaneswar, Visakhapatnam, Thiruvananthapuram, MC Bengaluru and coastal stations. The contribution from Numerical Weather Prediction Division, Satellite and Radar Division, Surface & Upper air instruments Divisions, New Delhi, Information System and Services Division and Agromet Advisory Division at IMD is also duly acknowledged.
