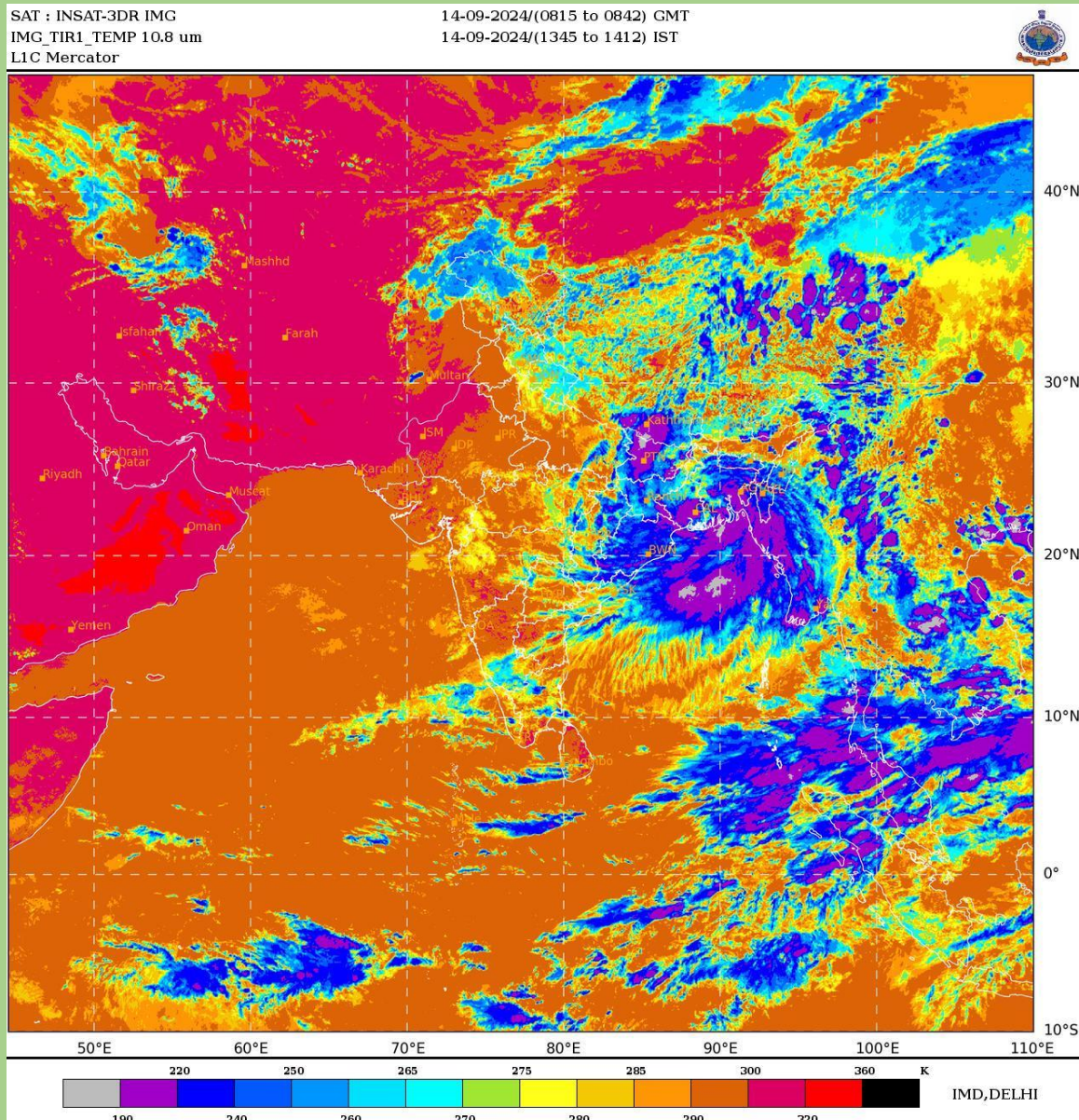




**GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
INDIA METEOROLOGICAL DEPARTMENT**

**Deep Depression over Northeast Bay of Bengal and adjoining Bangladesh
during 13th Sept – 18th Sept, 2024: A Report**



**INSAT-3D Satellite imagery of Deep Depression over Northeast Bay of Bengal and adjoining
Bangladesh at 0815 UTC of 14th September, 2024**

**Cyclone Warning Division
India Meteorological Department
New Delhi
September, 2024**

Deep Depression over Northeast Bay of Bengal and adjoining Bangladesh during 13th Sept – 18th Sept, 2024

- Under the influence of an upper air cyclonic circulation over southeast Bangladesh and neighbourhood, a low-pressure area formed over southeast Bangladesh and neighbourhood around mid-night (2330 hours IST / 1800 UTC) of 12th September, 2024.
- It moved west-northwestwards and lay as a well marked low pressure area over northeast Bay of Bengal (BoB) and adjoining southeast Bangladesh coast in the morning (0830 hours IST / 0300 UTC) of the 13th September, 2024.
- Continuing to move west-northwestwards, it concentrated into a Depression over northeast BoB close to Bangladesh coast in the same evening (1730 hours IST / 1200 UTC) of the 13th September, 2024.
- Continuing to move further west-northwestwards, it intensified into a Deep Depression over Bangladesh and adjoining Gangetic West Bengal in the early morning (0530 hours IST / 0000 UTC) of 14th September, 2024. Thereafter, it made a loop and moved across Gangetic West Bengal during 14th -15th and across Jharkhand on 16th September.
- Continuing to move further west-northwestwards, it weakened into a Depression over Jharkhand and adjoining north Chhattisgarh in the early morning (0530 hours IST / 0000 UTC) of 17th September, 2024.
- Continuing to move further west-northwestwards, it weakened into a Well-Marked Low-Pressure Area over northeast Madhya Pradesh and adjoining southwest Uttar Pradesh in the early morning (0530 hours IST / 0000 UTC) of 18th September 2024.

The observed track of the system is presented in **Fig.1** and the best track is given in **Table 1**.

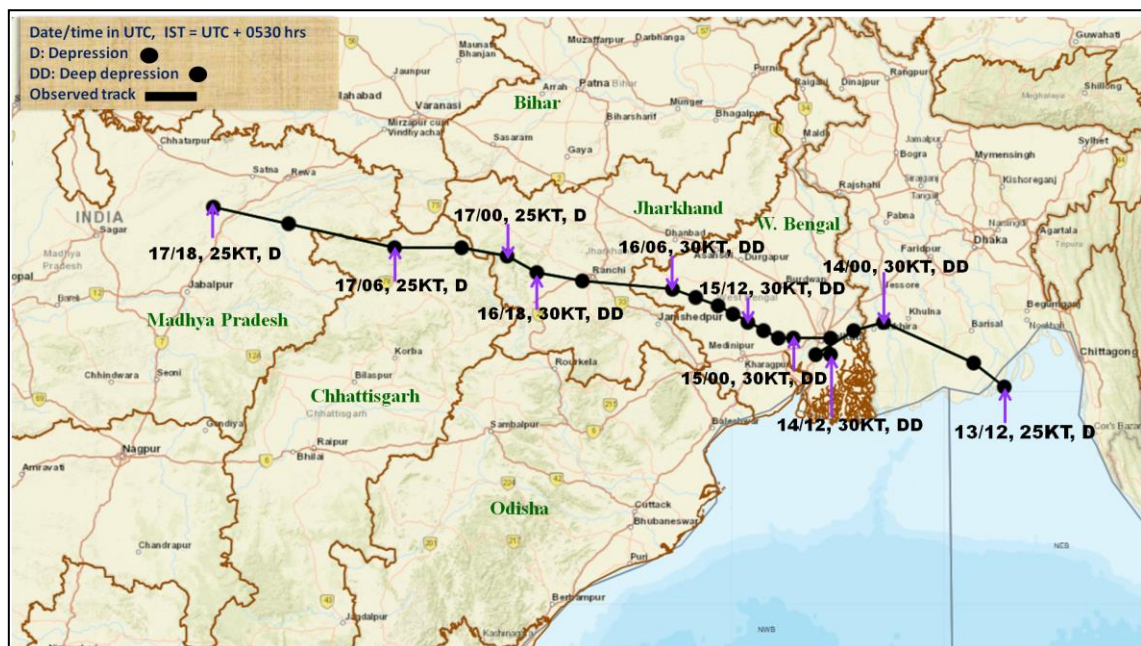


Fig. 1: Observed track of Deep Depression over Northeast BoB and adjoining Bangladesh during 13th – 18th September, 2024

Table1: Best track positions and other parameters of the Deep Depression over Northeast BoB and adjoining Bangladesh during 13th – 18th September, 2024

Date	Time (UTC)	Lat.	Long.	C.I No.	ECP	ΔP	MSW (kt)	Category
13.09.24	1200	22.0	90.8	1.5	992	3	25	D
	Crossed Bangladesh coast close to Patuakhali (Bangladesh) between 1700 to 1800 UTC of 13th September (2230 to 2330 hrs IST of 13th September) as a depression with wind speed of 45-55 gusting to 65 kmph							
	1800	22.3	90.4	-	992	3	25	D
14.09.24	0000	22.8	89.2	-	990	5	30	DD
	0300	22.7	88.8	-	990	5	30	DD
	0600	22.4	88.3	-	990	5	30	DD
	1200	22.4	88.5	-	989	5	30	DD
	1800	22.6	88.5	-	989	5	30	DD
15.09.24	0000	22.6	88.0	-	990	5	30	DD
	0300	22.6	87.8	-	991	5	30	DD
	0600	22.7	87.6	-	992	5	30	DD
	1200	22.8	87.4	-	992	5	30	DD
	1800	22.9	87.2	-	992	5	30	DD
16.09.24	0000	23.0	87.0	-	992	5	30	DD
	0300	23.1	86.7	-	992	5	30	DD
	0600	23.2	86.4	-	993	5	30	DD
	1200	23.3	85.2	-	993	5	30	DD
	1800	23.4	84.6	-	993	5	30	DD
17.09.24	0000	23.6	84.2	-	997	4	25	D
	0300	23.7	83.7	-	997	4	25	D
	0600	23.7	82.7	-	999	3	20	D
	1200	24.0	81.3	-	996	3	20	D
	1800	24.2	80.3	-	998	3	20	D
18.09.24	0000	Weakened into a well-marked low-pressure area over northeast Madhya Pradesh and adjoining southwest Uttar Pradesh						

KT: Knots (nautical mile per hour), 1 KT=1.85 kmph, D: Depression, DD: Deep Depression

1. Brief life history - Genesis Intensification and movement

1.1 Genesis

A low-pressure area formed over southeast Bangladesh and neighbourhood in the midnight (1800 UTC) of 12th September. At 1800 UTC of 12th September, the MJO index was in phase 5 with an amplitude of less than 1 and was likely to continue in same phase during next 2-3 days. Thus, MJO was favourable for enhancement of convective activity over the north BoB and adjoining areas for the next 2-3 days. The NCICS CFS model analysis field indicated prevalence of westerly wind anomaly (5-7 mps) and Equatorial Rossby waves during 12th-16th Sep over central India & central BoB with easterly wind anomaly (3-5 mps) over north BoB and northeastern parts of India. The low-level convergence was about $20 \times 10^{-6} \text{ s}^{-1}$ over northeast BoB & adjoining Myanmar. Upper-level divergence was about $20 \times 10^{-6} \text{ s}^{-1}$ over northeast BoB & adjoining Myanmar. The vertical wind shear (VWS) was low to moderate (5-15 kt) over coastal Bangladesh & neighbourhood. The relative vorticity at 850 hPa level was around $70\text{-}100 \times 10^{-6} \text{ s}^{-1}$ over northeast BoB & adjoining Myanmar with vertical extension upto 500 hPa level. Under these favorable conditions the upper air cyclonic circulation over southeast Bangladesh and neighbourhood lay as a low-pressure area over southeast Bangladesh and neighbourhood at 1800 UTC of 12th September, 2024.

Similar features prevailed and the low-pressure area over southeast Bangladesh moved west-northwestwards and lay as a well-marked low pressure area over northeast BoB and adjoining southeast Bangladesh coast on 13th September morning (0300 UTC).

At 1200 UTC 13th September 2024, the sea surface temperature (SST) was 28-30°C over the north BoB. Tropical cyclone heat potential (TCHP) was 80-100 KJ/cm² near the system centre. Low-level convergence was around $20 \times 10^{-6} \text{ s}^{-1}$, and upper-level divergence was around $20 \times 10^{-6} \text{ s}^{-1}$ over the north BoB. The VWS was low (5-10 knots) over the system area and along the forecast track. The relative vorticity at the 850 hPa was around $200 \times 10^{-6} \text{ s}^{-1}$ over the north BoB, extending upto the 200 hPa level. Under these favorable conditions the well-marked low pressure area over northeast BoB and adjoining southeast Bangladesh coast concentrated into a Depression over northeast BoB close to Bangladesh coast at 1200 UTC of the 13th September, 2024.

1.2 Intensification and movement

At 0000 UTC of 14th September, similar sea conditions prevailed. Low-level convergence increased and was around $20\text{-}30 \times 10^{-6} \text{ s}^{-1}$ over Gangetic West Bengal and northeast BoB. Upper-level divergence also increased and was around $20\text{-}30 \times 10^{-6} \text{ s}^{-1}$ over the north BoB and adjoining areas of West Bengal and Odisha. The VWS was low to moderate (10-15 knots) over the system area and increasing along the forecast track. The relative vorticity at the 850 hPa level was around $150 \times 10^{-6} \text{ s}^{-1}$ over the north BoB and neighborhood, extending up to the 200 hPa level. Under these favorable conditions, the depression over northeast BoB intensified into a Deep Depression over Bangladesh and adjoining Gangetic West Bengal at 0000 UTC of the 14th September 2024.

During 14th - 16th September, similar favourable environmental features (MJO, equatorial Rossby waves, moisture carrying southwesterly winds from Arabian Sea, favourable low level positive relative vorticity, low level convergence and upper-level divergence) continued and the system maintained its intensity of deep depression over land during 14th to 16th September, 2024.

At 0000 UTC 17 September 2024, MJO index entered into phase 6 (unfavorable). The NCICS-based forecast indicated the persistence of westerly winds (3-5 mps) over the central parts of India, along with easterly winds (3-5 mps) over northeastern parts of India. The equatorial Rossby wave had moved away. The low-level convergence decreased and was around $20 \times 10^{-6} \text{ s}^{-1}$ over the system area. Upper-level divergence also decreased and was around $30 \times 10^{-6} \text{ s}^{-1}$ over the system area. The VWS was moderate to high (15-20 knots) over the system area and along the forecast track. The relative vorticity at the 850 hPa level decreased and was around $120 \times 10^{-6} \text{ s}^{-1}$ to the south of the system center and extended up to the 500 hPa level ($40\text{-}50 \times 10^{-6} \text{ s}^{-1}$), indicating a decrease in the depth of convection. Thus, environmental features indicated gradual weakening of the system. Under these unfavorable conditions the deep depression over central parts Jharkhand weakened into a depression over west Jharkhand and adjoining north Chhattisgarh at 0000 UTC of the 17th September 2024. It weakened into a well-marked low-pressure area over northeast Madhya Pradesh and adjoining southwest Uttar Pradesh at 0530 IST(00 UTC) of 18th September 2024.

2. Monitoring

India Meteorological Department (IMD) maintained round the clock watch over the north Indian Ocean (NIO) and the system was monitored well in advance since 12th September. The system was monitored with the help of available satellite observations from INSAT 3D and 3DR, polar orbiting satellites, available ships & buoy observations in the region and coastal observations on the day of landfall. Various numerical weather prediction models run by Ministry of Earth Sciences (MoES) institutions, global models 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 models' guidance, decision making process and warning products generation.

2.1. Features observed through satellite

Satellite monitoring of the system was mainly done by using half hourly INSAT-3D and 3DR imageries. Satellite imageries of other international geostationary satellites, high resolution polar orbiting satellites and scatterometer imageries from ASCAT, OCEANSAT-3 were also considered for monitoring of the system. Typical INSAT-3D enhanced colored imageries, visible/ IR, brightness temperature and water vapour imageries are presented in **Fig.2(a) to 2(e)**. During the entire life cycle, the clouds were organized in shear pattern. The detailed features from the satellite pictures are discussed in this section.

At 1200 UTC 13th September 2024, the intensity of the system was characterized as T 1.5. The associated scattered to broken low and medium clouds had embedded intense to very intense convection over East Odisha, Gangetic West Bengal, Meghalaya, Bangladesh, North adjoining Central BoB, Arakan Coast and Myanmar

(minimum cloud top temperature (CTT) -80 to -93 °C). There was moderate to intense convection over Mizoram and Tripura (minimum CTT of -60 to -70 °C).

At 00 UTC of 14 September 2024, associated broken low and medium clouds with embedded intense to very intense convection was observed over Bihar, Jharkhand, West Bengal, Odisha, Tripura, Mizoram, Bangladesh, and north adjoining central BoB (minimum CTT -80 to -93°C).

At 1200 UTC 14th September 2024, associated broken low and medium clouds with embedded intense to very intense convection lay over Bihar, east Jharkhand, south Gangetic West Bengal, north Odisha, Tripura, Mizoram, Bangladesh, and north & adjoining central BoB (minimum CTT -80 to -93 °C). Moderate to intense convection lay over south Chhattisgarh, south Odisha, north Gangetic West Bengal, and sub-Himalayan West Bengal.

At 0300 UTC 15th September 2024, associated scattered to broken low and medium clouds with embedded intense to very intense convection was observed over southwest Bihar, north Chhattisgarh, Jharkhand, north Odisha, Gangetic West Bengal, Bangladesh, and north BoB (minimum was -80 to -93 °C). Moderate to intense convection was detected over southeast Uttar Pradesh, south Odisha, sub-Himalayan West Bengal, Meghalaya, Assam, Manipur, Mizoram, and Tripura (minimum CTT was -60 to -70 °C).

At 1200 UTC 15th September 2024, spiral band organization of clouds continued. Associated scattered to broken low and medium clouds with embedded intense to very intense convection lay over north Chhattisgarh, Jharkhand, north Odisha, Gangetic West Bengal, Bangladesh, Meghalaya, Tripura, Mizoram, and north BoB (minimum CTT was -70 to -90 °C). Moderate to intense convection lay over Bihar, west Assam, and Sub-Himalayan West Bengal (minimum CTT -60 to -70 °C).

At 0300 UTC 16th September 2024, a spiral band organization of clouds continued. Associated scattered to broken low and medium clouds with embedded intense to very intense convection lay over Jharkhand, north Odisha, Gangetic West Bengal, Bangladesh, and northwest BoB (minimum CTT -70 to -90 °C). Moderate to intense convection lay over east Madhya Pradesh, north Chhattisgarh, Bihar, Sub-Himalayan West Bengal, Meghalaya, and West Assam (minimum CTT -50 to -70 °C).

At 1200 UTC 16th September 2024, a spiral band organization of clouds continued. Associated scattered to broken low and medium clouds with embedded intense to very intense convection lay over east Uttar Pradesh, east Madhya Pradesh, Jharkhand, north Chhattisgarh, north Odisha, Gangetic West Bengal, and north Bangladesh (minimum CTT -70 to -90 °C). Moderate to intense convection lay over Bihar, Sub-Himalayan West Bengal, south Chhattisgarh, and south Odisha (minimum CTT -50 to -70 °C).

At 0000 UTC 17th September 2024, associated scattered to broken low and medium clouds with embedded intense to very intense convection lay over south Bihar, southeast Uttar Pradesh, northeast Madhya Pradesh, Jharkhand, north Chhattisgarh, north Odisha, Gangetic West Bengal, and north Bangladesh (minimum CTT -70 to -90 °C). Moderate to intense convection lay over Gangetic West Bengal (minimum CTT was -50 to -70 °C).

At 1200 UTC 17th September 2024, associated scattered to broken low and medium clouds with embedded intense to very intense convection lay over west Bihar, Uttar Pradesh, east Madhya Pradesh, south Jharkhand, north Chhattisgarh, and north Odisha (minimum CTT was -70 to -90 °C). Moderate to intense convection lay over east Gangetic West Bengal, Sub-Himalayan West Bengal, and Bangladesh (minimum CTT -50 to -70 °C).

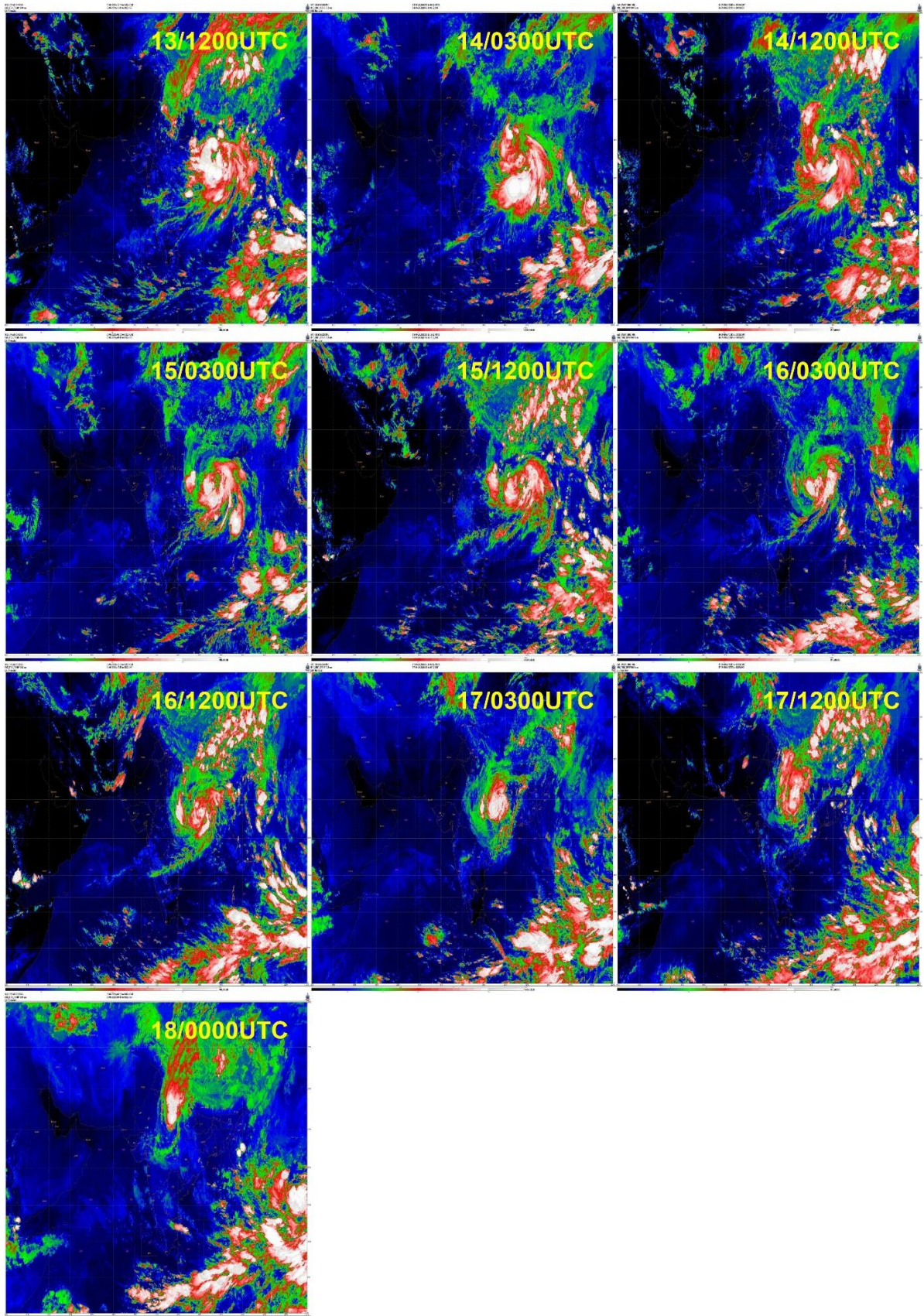


Fig.2(a): INSAT-3R NHC Curve imageries during life cycle of Deep Depression over Northeast BoB during 13th – 18th September, 2024

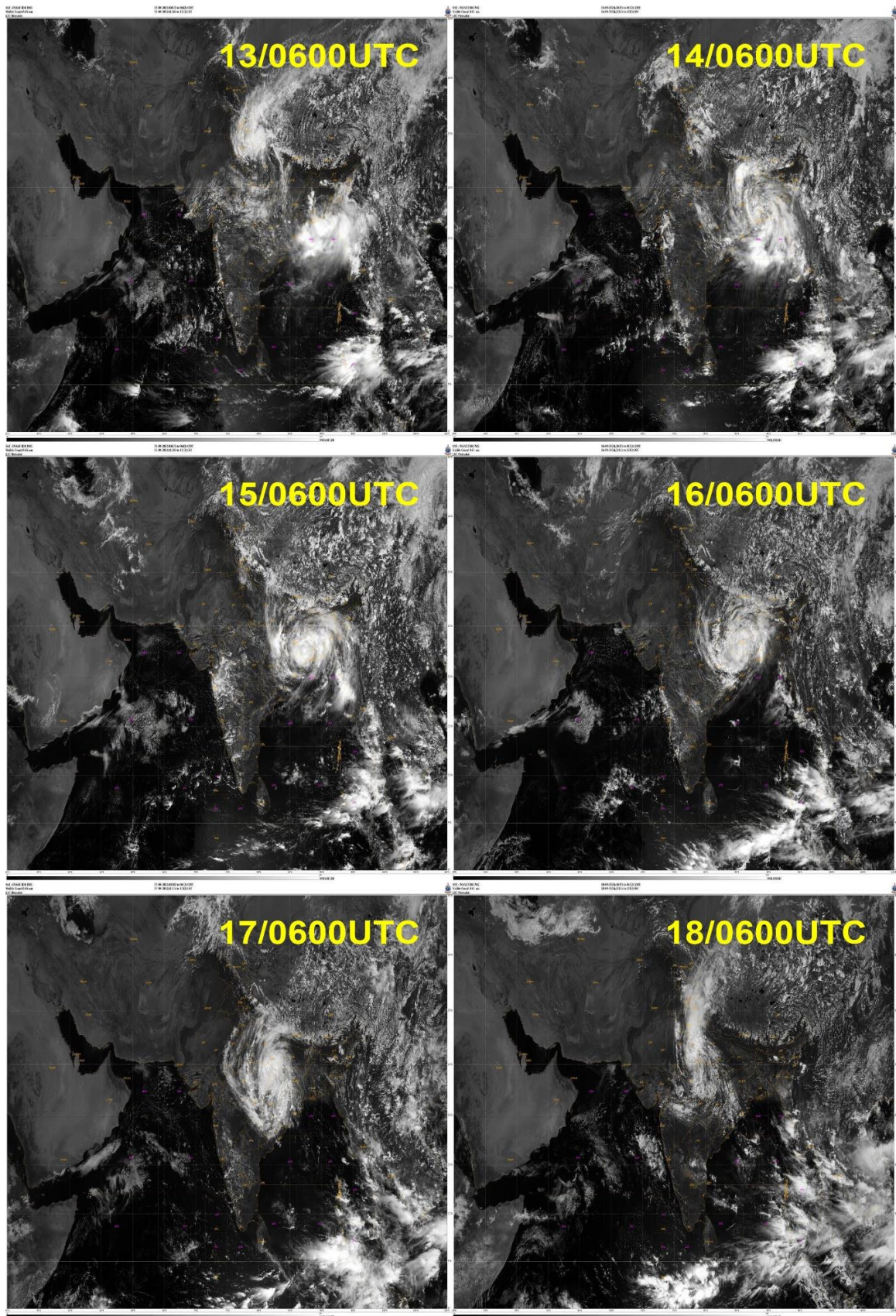


Fig.2 (b): INSAT-3R Visible imagerys during life cycle of Deep Depression over Northeast BoB during 13th – 18th September, 2024

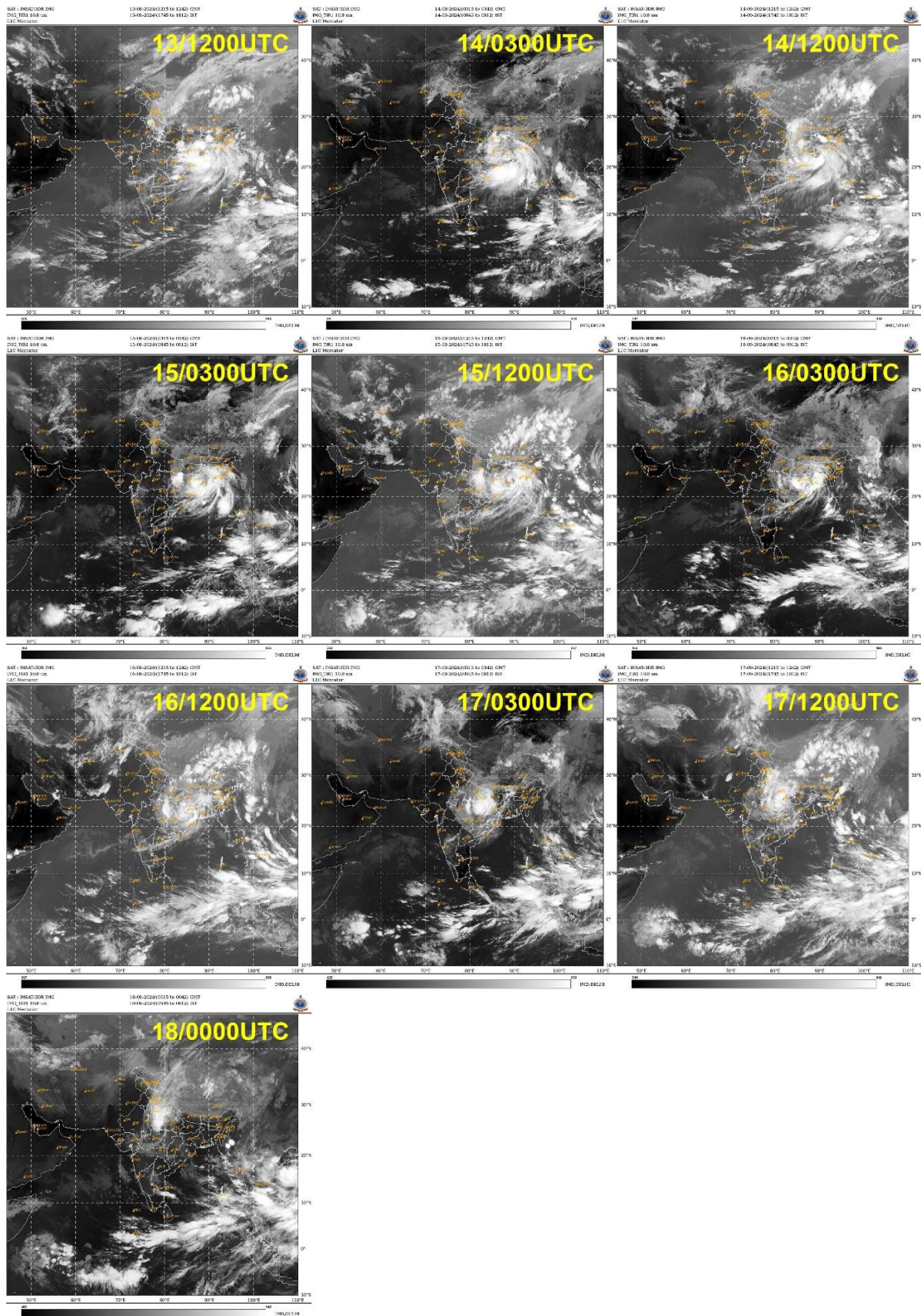


Fig.2(c): INSAT-3D IR imageries during life cycle of Deep Depression over Northeast BoB during 13th – 18th September, 2024

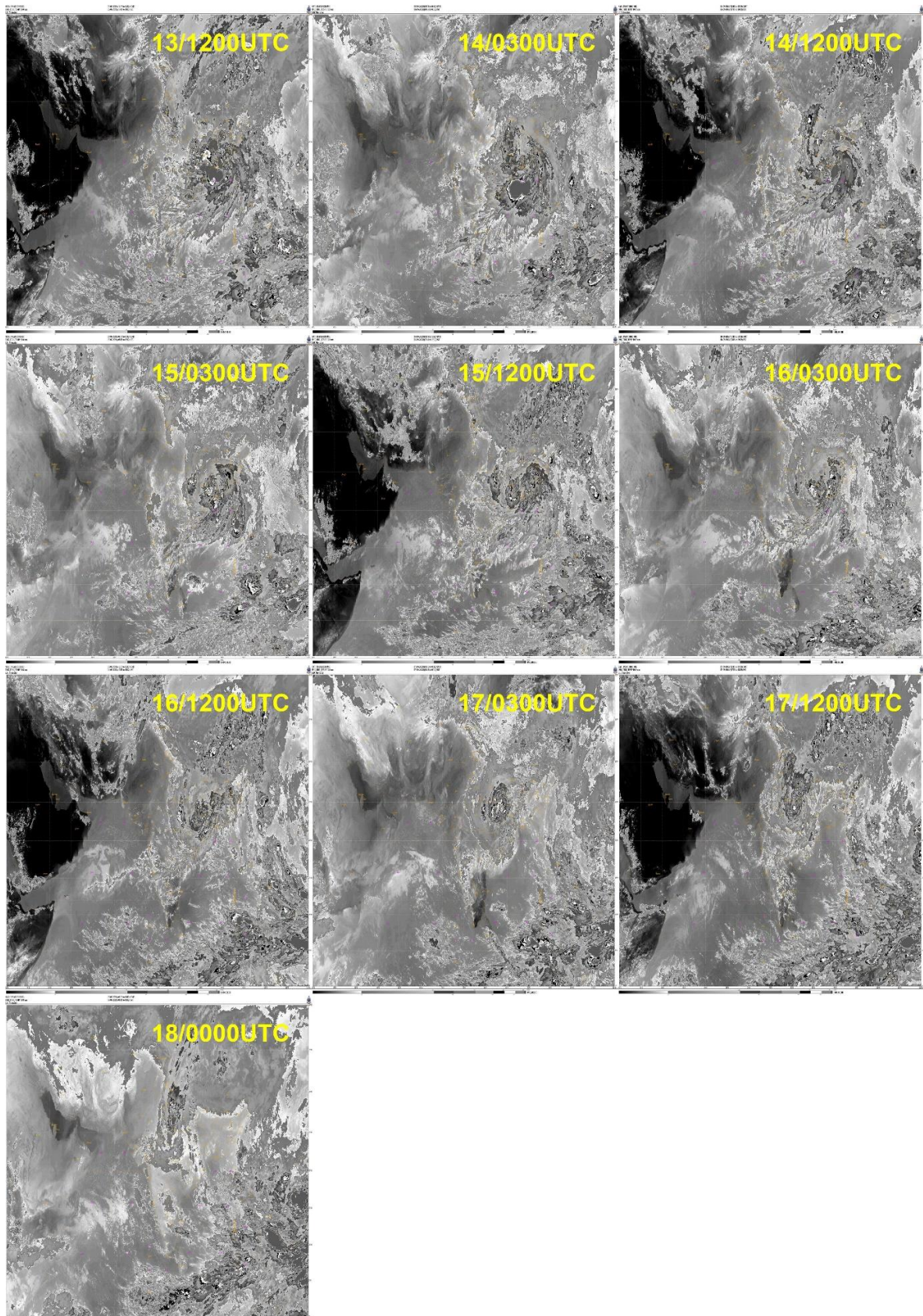


Fig.2 (d): INSAT-3D enhanced IR imageries during life cycle of Deep Depression over Northeast BoB during 13th – 18th September, 2024

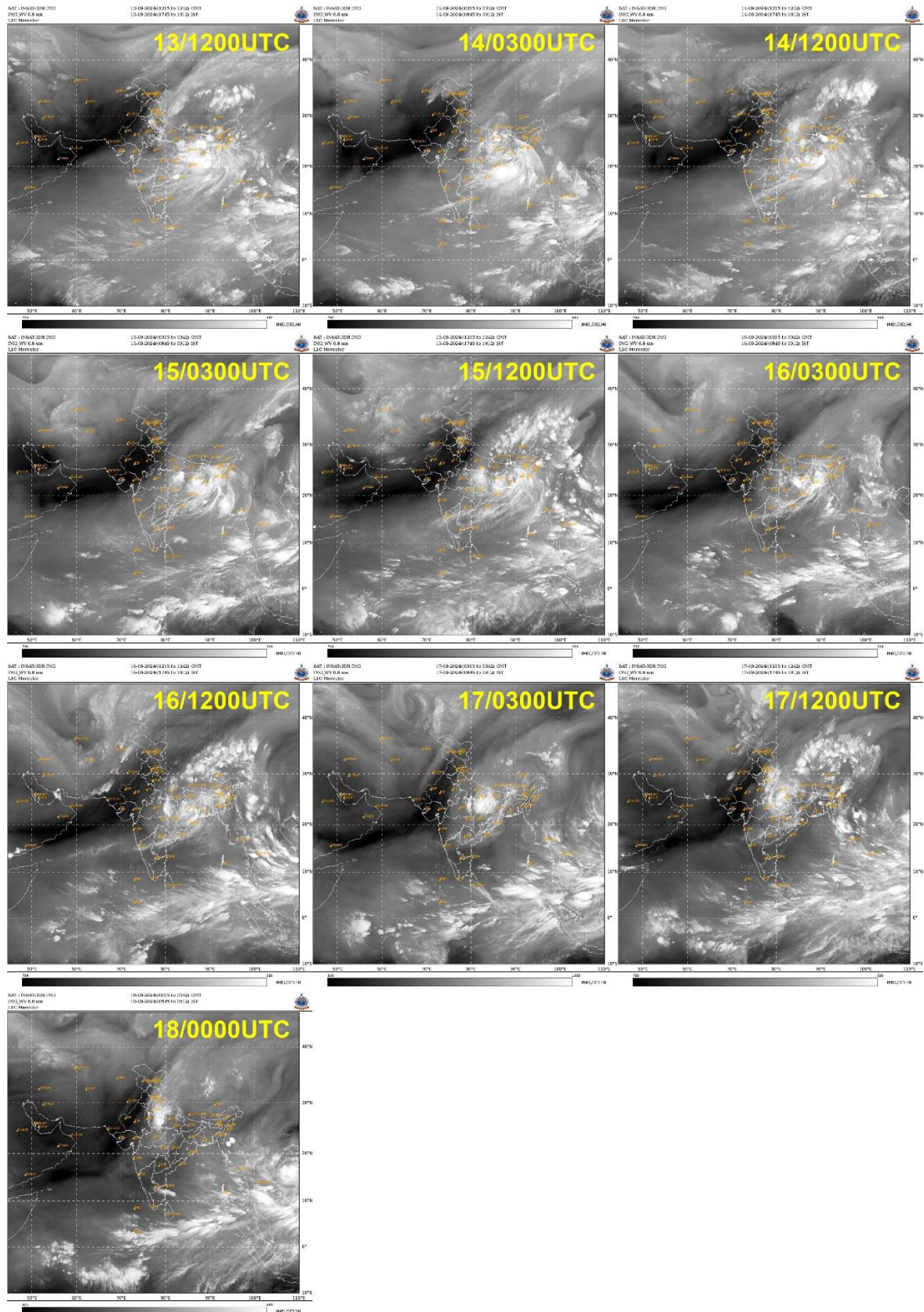


Fig.2 (e): INSAT-3D Water Vapour imageries during life cycle of Deep Depression over Northeast BoB during 13th – 18th September, 2024

3. Dynamical Features

IMD GFS (T1534) analysis field of mean sea level pressure (MSLP), winds at 10 m, 850, 500 and 200 hPa levels at 0000 UTC during 13th to 18th September, 2024 are presented in **Fig. 3(a) to 3(f)** respectively.

At 0000 UTC of 13th September, the model indicated an upper air cyclonic circulation over northwest BoB and adjoining southeast Bangladesh. However, at that time, it lay as a low-pressure area over southeast Bangladesh and neighbourhood. Thus, the model underestimated the intensity of the system. However, location was correctly captured.

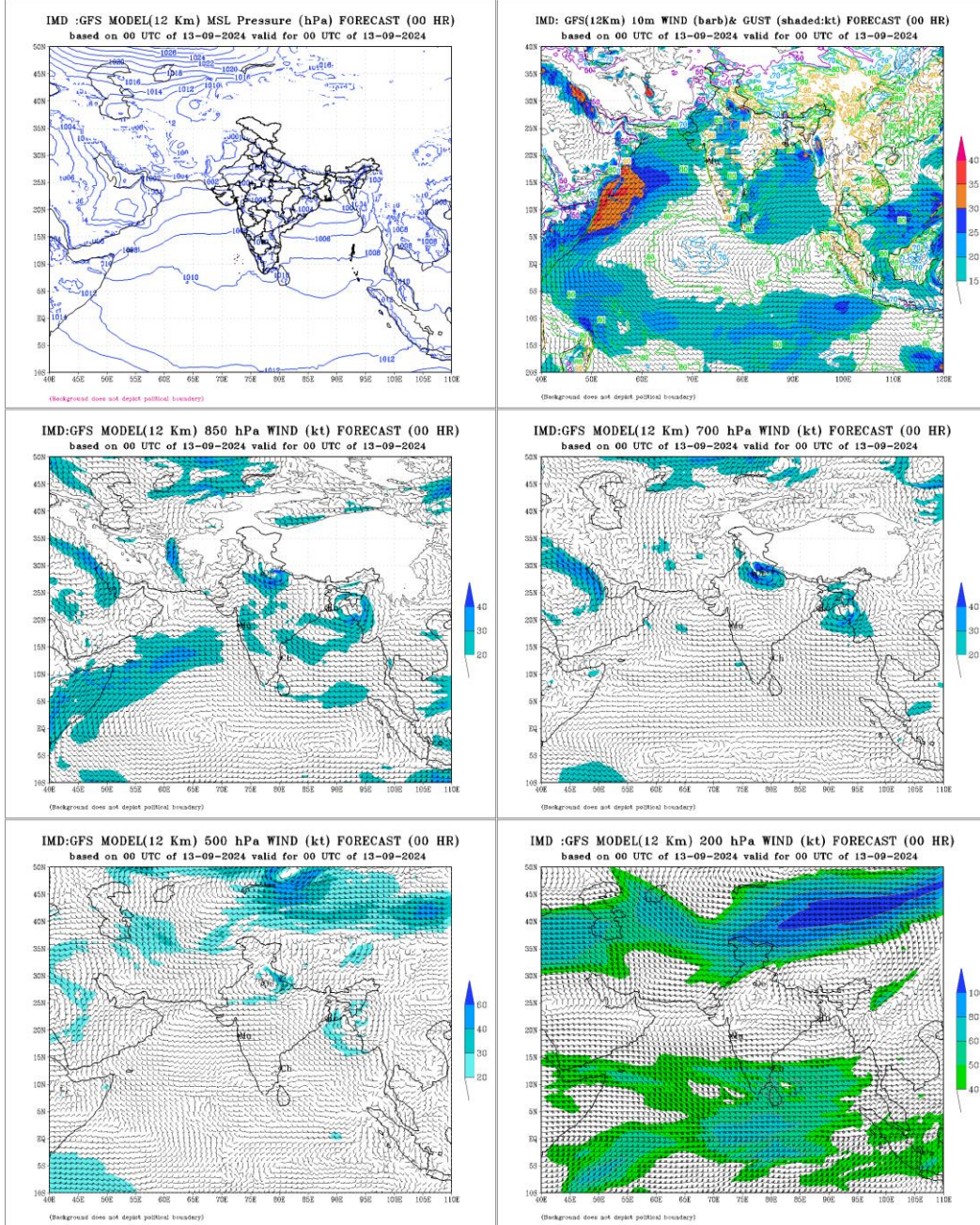


Fig. 3(a): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 700, 500 and 200 hPa levels based on 0000 UTC of 13th September 2024

At 0000 UTC of 14th September, the model indicated a deep depression over southwest Bangladesh and neighbourhood near 22.5N/89.0E. At that time, it lay as a deep depression over southeast Bangladesh and neighbourhood near 22.8⁰ N/89.2⁰E. Thus, the model captured the location and intensity of the system correctly.

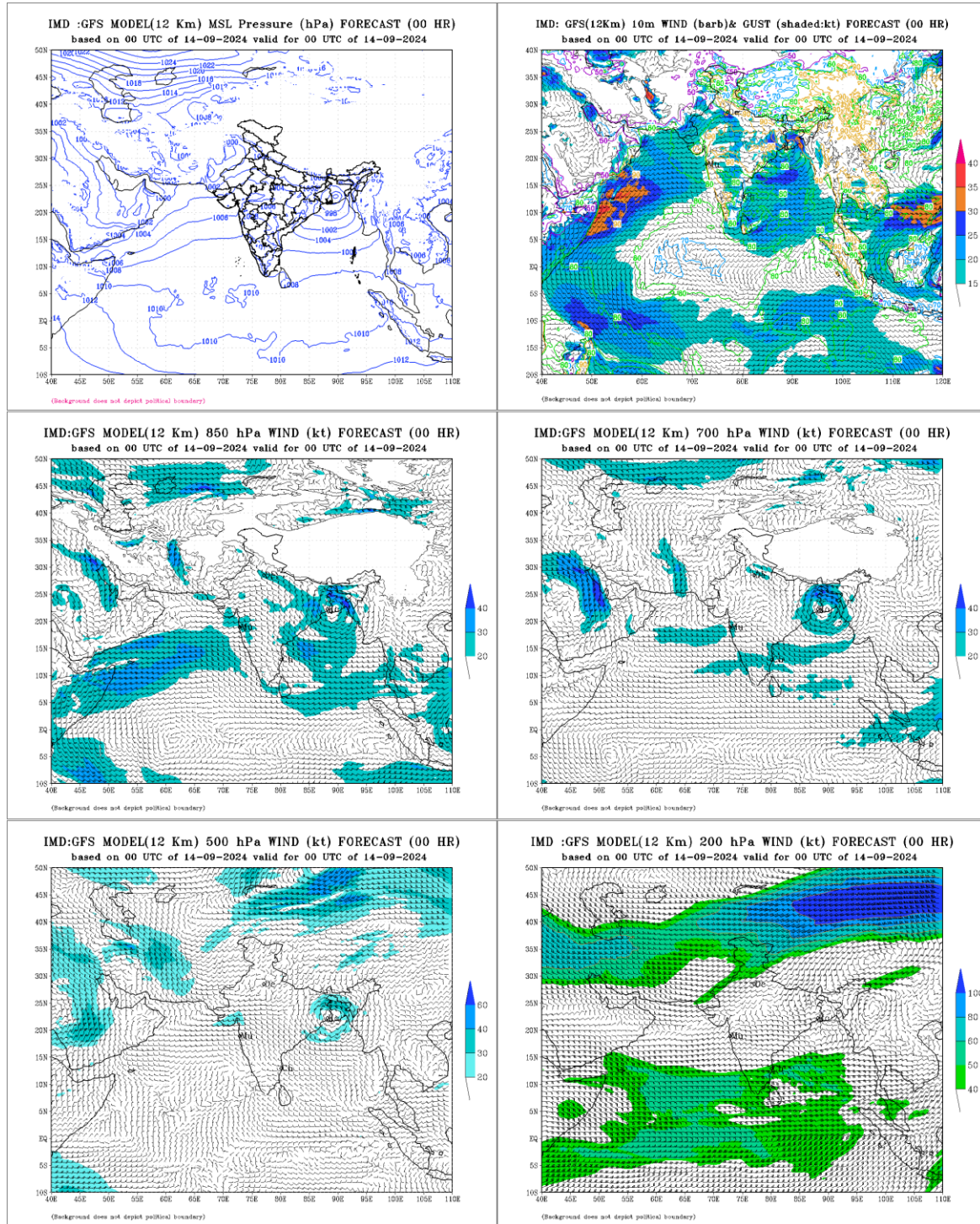


Fig. 3(b): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 700, 500 and 200 hPa levels based on 0000 UTC of 14th September 2024

At 0000 UTC of 15th September, the model indicated slight intensification of the system over Gangetic West Bengal and neighbourhood near 23.0°N/88.0°E. At that time, it lay as a deep depression over Southeast Bangladesh and adjoining Gangetic West Bengal near 22.6°N/88.0°E. Thus, the model slightly overestimated the intensity of the system and could't capture movement correctly. Vertically, the system extended upto 500 hPa level with no significant tilting.

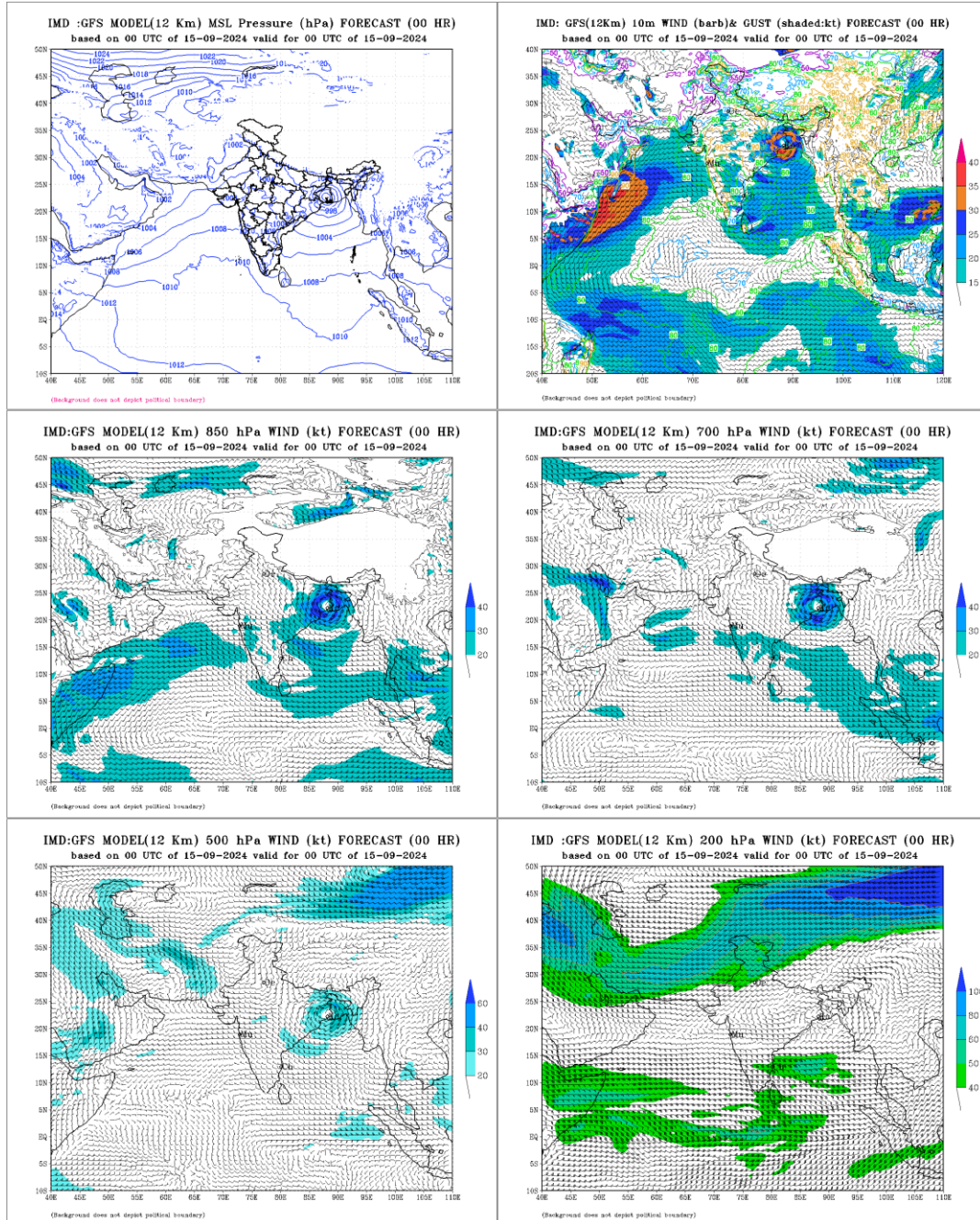


Fig. 3(c): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 700, 500 and 200 hPa levels based on 0000 UTC of 15th September 2024

At 0000 UTC of 16th September, the model indicated slight intensification of the system over Gangetic West Bengal and neighbourhood near 23.0°N/88.0°E. At that time, it lay as a deep depression over Southeast Bangladesh and adjoining Gangetic West Bengal near 22.6°N/88.0°E. Vertically, the system extended upto 500 hPa level with no significant tilting. Thus, the model slightly overestimated the intensity of the system and could not capture movement correctly.

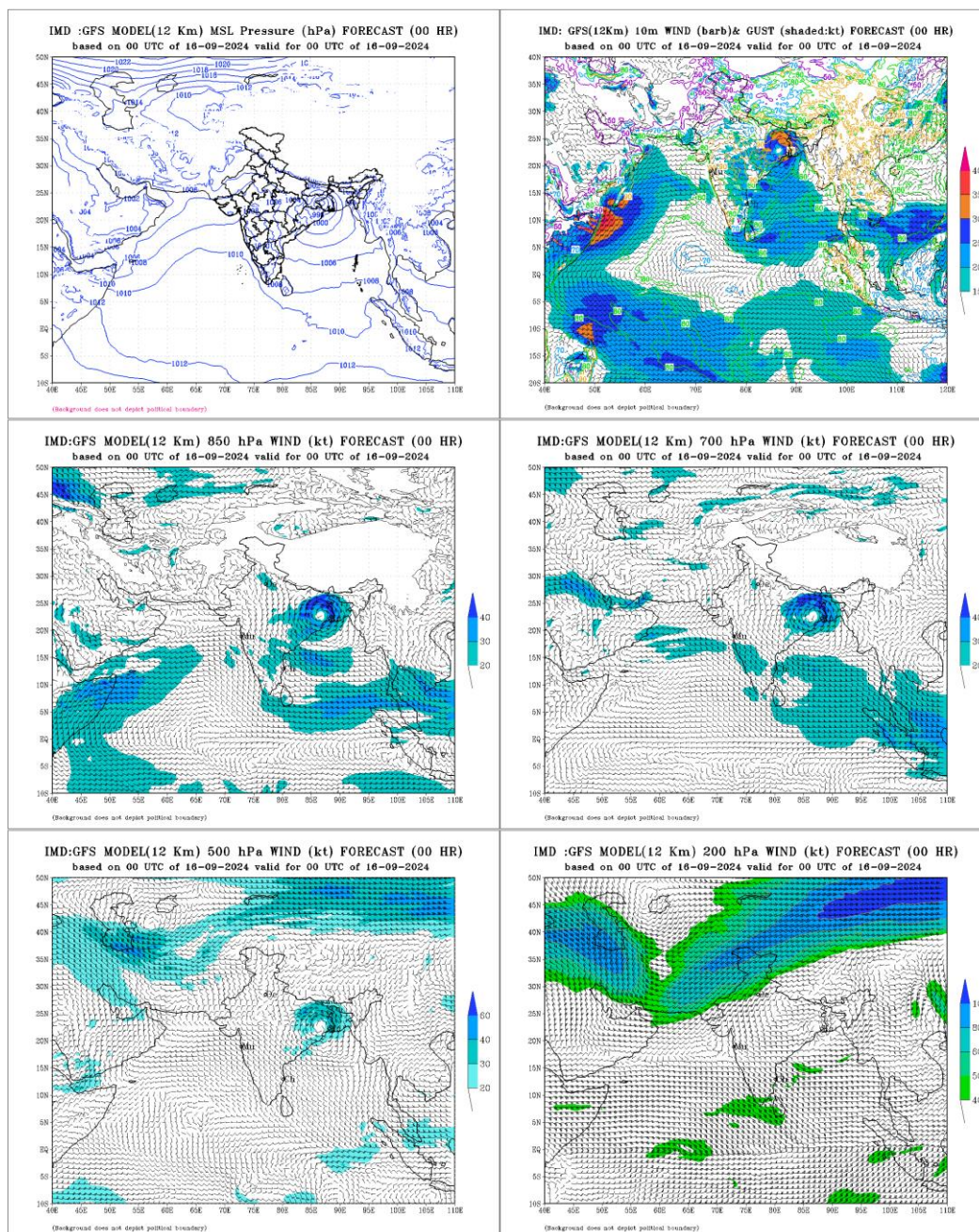


Fig. 3(d): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 700, 500 and 200 hPa levels based on 0000 UTC of 16th September 2024

At 0000 UTC of 17th September, the model indicated weakening of the system into a depression Jharkhand and adjoining north Chhattisgarh & southeast Uttar Pradesh near 24.0N/83.8E. At that time, it lay as a depression over Jharkhand and adjoining north Chhattisgarh near 23.6°N/84.2°E. Vertically, the system extended upto 500 hPa level with no significant tilting. Thus, the model could correctly capture the weakening and movement of the system.

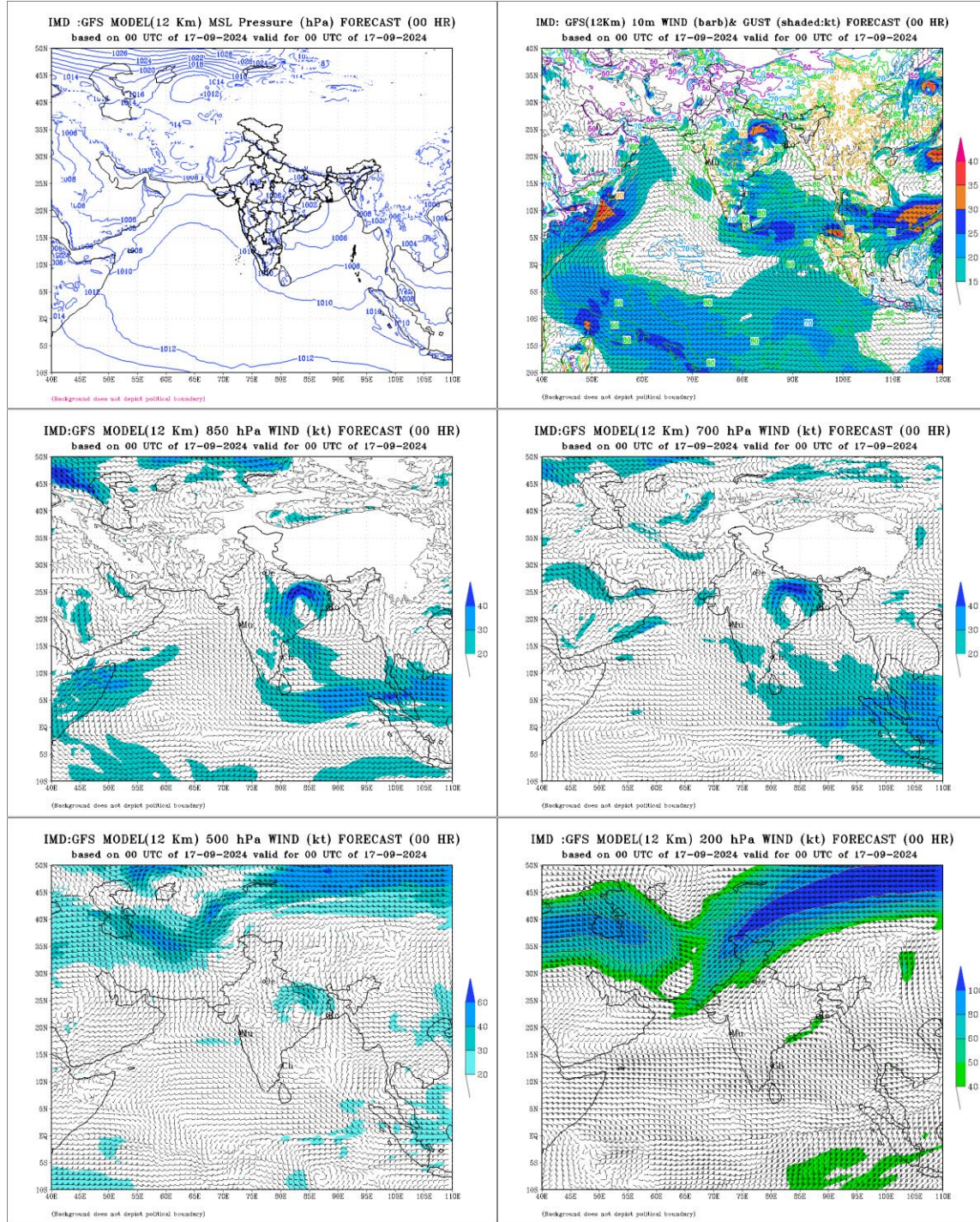


Fig. 3(e): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 700, 500 and 200 hPa levels based on 0000 UTC of 17th September 2024

At 0000 UTC of 18th September, the model indicated slight weakening of the system over northeast Madhya Pradesh and adjoining southwest Uttar Pradesh near 24.5°N/79.0°E. At that time, it lay as a depression over Jharkhand and adjoining north Chhattisgarh near 23.6°N/84.2°E. Vertically, the system extended upto 700 hPa level with no significant tilting. Thus, the model could correctly capture the weakening and movement of the system

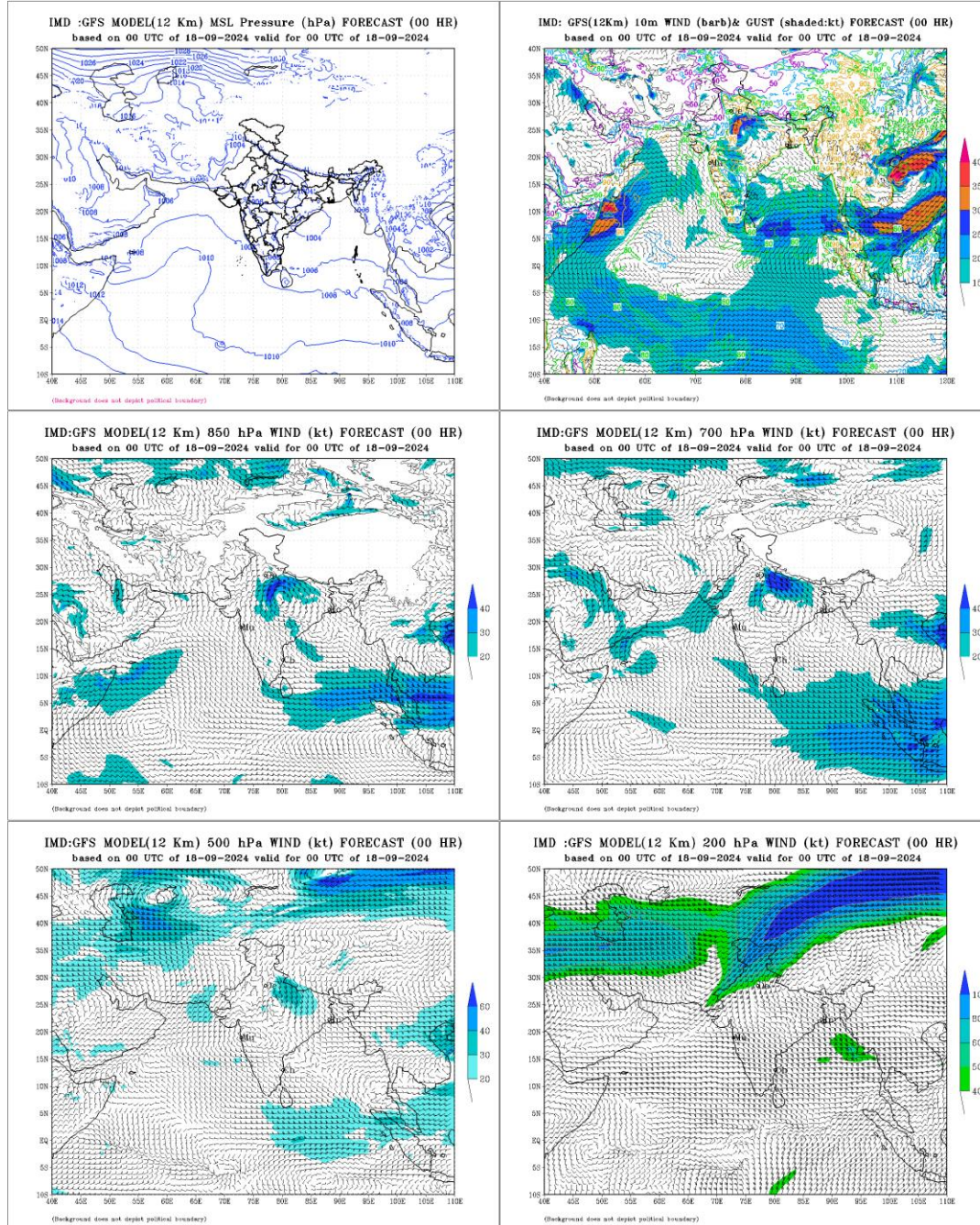


Fig. 3(f): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 700, 500 and 200 hPa levels based on 0000 UTC of 18th September 2024

Overall, IMD GFS could correctly capture the genesis, intensification and movement of the system.

4. Realized Weather

Rainfall associated with the deep depression based on IMD-NCMRWF satellite gauge merged data are depicted in **Fig 4**.

- It is seen that light to moderate rainfall occurred at many places over Gangetic West Bengal and Uttarakhand on 12th September.
- Light to moderate rainfall occurred at many places with heavy to very heavy rainfall at isolated places over Gangetic West Bengal, Uttarakhand, Odisha and heavy rainfall at isolated places over Bihar, West Uttar Pradesh, Himachal Pradesh, Delhi, Jharkhand, Chhattisgarh, Sub-Himalayan West Bengal, East Uttar Pradesh on 13th September.
- Light to moderate rainfall occurred at many places with heavy to very heavy rainfall isolated places over Gangetic West Bengal, Jharkhand and heavy rainfall at isolated places over Odisha, Himalayan West Bengal and West Uttar Pradesh on 14th September.
- Light to moderate rainfall occurred at many places with heavy to very heavy rainfall isolated places over Jharkhand, Gangetic West Bengal, Chhattisgarh, Odisha and heavy rainfall at isolated places over Madhya Pradesh, East Uttar Pradesh, Bihar and Sub-Himalayan West Bengal on 15th September.
- Light to moderate rainfall occurred at many places with heavy to very heavy rainfall isolated places over Chhattisgarh and East Madhya Pradesh.

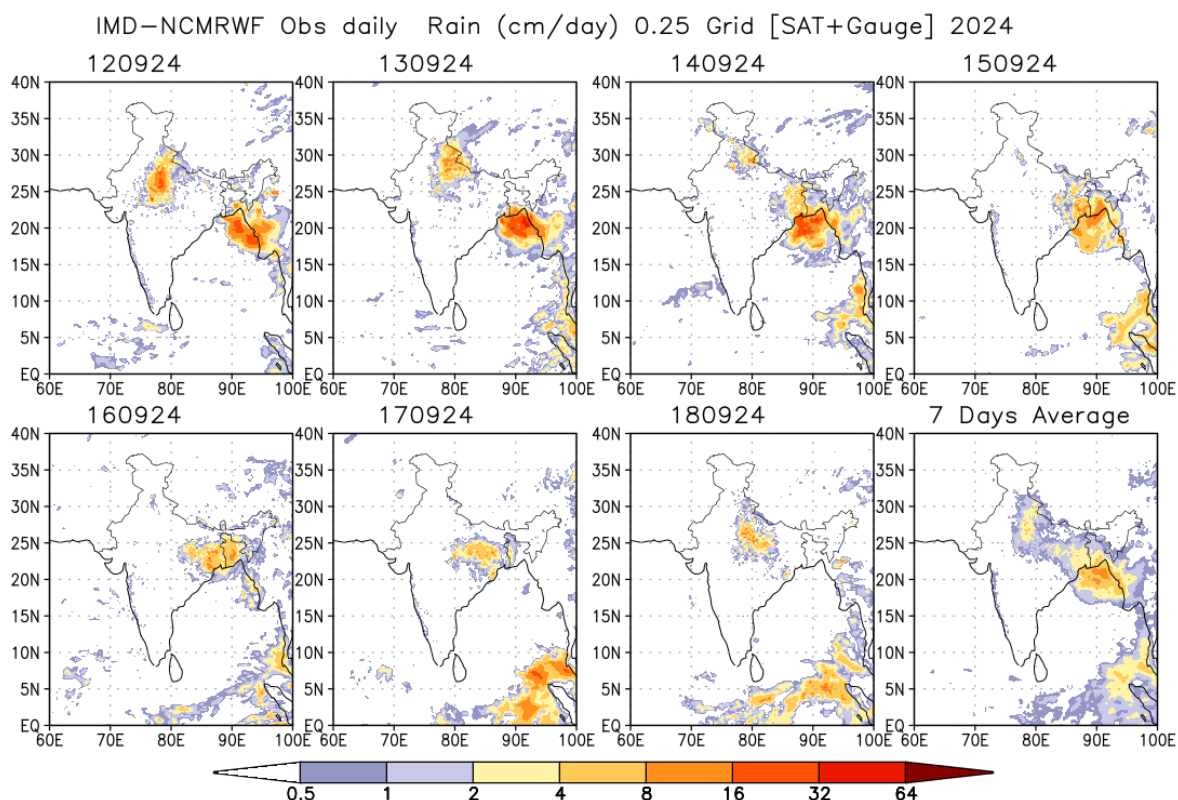


Fig. 4: NCMRWF-IMD satellite gauge merged data plots of realized 24 hours accumulated rainfall ending at 0830 IST of date from 13th to 18th September, 2024.

4.1 Rainfall forecast verification

The forecast for heavy to extremely heavy rainfall episodes in association with the system are verified with the 24 hours accumulated rainfall realized at various stations. The details of the day-wise verification are given in **Table-2**.

Table 2: Rainfall forecast verification

Date/Base Time of observation	24-hour Heavy rainfall warning ending at 0300 UTC of next day	Realized 24-hour heavy rainfall (≥ 7 cm) ending at 0300 UTC of date
13.09.2024 / 0830	<p>Uttarakhand: Heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places on 13th and heavy rainfall at isolated places on 14th September.</p> <p>Himachal Pradesh: Heavy rainfall at isolated places on 13th September.</p> <p>Uttar Pradesh: Heavy to very heavy rainfall at isolated places on 13th and heavy rainfall at isolated places on 14th September.</p>	<p>13th September:</p> <p>Gangetic West Bengal: Contai 18, Durgachack 17, Digha 12, Bagati & Sagar Island 11 each, Durgapur 10, Diamond Harbour, Panagarh & Suri 9 each, Jangipur, Dum Dum, Alipore, Salar & Suri 8 each and Basirhat, Kalyani, Berhampore, Hetampur, Tilpara Barrage, Saltlake, Sri Niketan & Gheropara 7 each.</p> <p>Uttarakhand: Champawat 18, Haldwani 16, Nainital 15, Lohaghat 11, Pantnagar & Pithoragarh 9 each, Ghansali 8 and Banbasa & Bhagwanpur 7 each;</p> <p>Odisha: Kusumi 14, Bhograi 10 and Jaleswar 7,</p> <p>Bihar: Beldaur & Khaira 9 each, Lakhisarai, Nabinagar, Halsi & Jamui 8 each and Gogri, Bausi & Begusarai 7 each;</p> <p>West Uttar Pradesh: Kasba Tanda 9, Bijnor 8 and Suar 7;</p> <p>Himachal Pradesh: Kataula 8 and Palampur 7;</p> <p>Delhi: Palam 8 and Aya Nagar & Lodi Road 7 each;</p> <p>Jharkhand: Giridih Bengbad & Bengabad 8 each and Sujani & Pakuria 7 each;</p> <p>Chhattisgarh: Surajpur 7;</p> <p>Sub-Himalayan West Bengal: Malda 7;</p> <p>East Uttar Pradesh:</p>
14.09.2024 / 0830	<p>Gangetic West Bengal (including Kolkata): Heavy to very heavy rainfall at few places over Gangetic West Bengal and extremely heavy rainfall at isolated places over south Gangetic West Bengal on 14th; heavy rainfall at isolated places on 15th September. Sub-Himalayan West Bengal: Heavy rainfall at isolated places on 14th September. Odisha: Heavy to very heavy rainfall at a few places over Odisha and extremely heavy rainfall at isolated places over north Odisha on 14th and heavy to very heavy rainfall at isolated places on 15th and heavy rainfall at isolated places over Odisha 16th September. Jharkhand: Heavy to very heavy rainfall at isolated</p>	

	<p>places and extremely heavy rainfall over south Jharkhand on 14th & 15th and heavy rainfall at isolated places over Odisha 16th September.</p> <p>Bihar: Heavy rainfall at isolated places very likely on 14th & 15th and heavy rainfall at isolated places over Odisha 16th September.</p> <p>Chhattisgarh: Heavy to very heavy rainfall at a few places on 14th & 15th and extremely very heavy rainfall over north Chhattisgarh on 15th September and heavy rainfall at isolated places on 16th September.</p> <p>East Madhya Pradesh: Heavy to very heavy rainfall at isolated places on 15th; heavy to very heavy rainfall at a few places with Extremely very heavy rainfall at isolated places over northeast Madhya Pradesh Chhattisgarh on 16th September and heavy to very heavy rainfall at isolated places on 17th September.</p> <p>East Uttar Pradesh: Heavy rainfall at isolated places on 16th & 17th September.</p> <p>West Madhya Pradesh: Heavy rainfall at isolated places on 17th & 18th September.</p> <p>Mizoram & Tripura: Heavy rainfall during 14th -16th September.</p> <p>Assam & Meghalaya: Isolated heavy rainfall on 14th September.</p>	<p>Katarniaghat 7;</p> <p>14th September:</p> <p>Gangetic West Bengal: Jhargram 19, Contai 15, Amtala 14, Kharidwar, Bankura, Lalgah & Kansabati 13 each, Kalyani, Tusuma & Digha 12 each, Asansol, Phulberia, D.P.Ghat, Asansol, Bagati & Bankura 11 each, Kharagpur 10, Panagarh, Barrackpur, Harinkhola, Narayanpur, Debagram, Mohanpur, Midnapore & Durgachack 9 each, Basirhat, Midnapore, Burnpur, Sri Niketan, Purihansa, Durgapur & Hetampur 8 each and Suri, Salar, Luchipur, Burdwan, Labpur, Kakdwip, Rajnagar & Gheropara 7 each;</p> <p>Jharkhand: Meral 15, Garhwa 14, Burmu, Daltonganj & Chakulia 11 each, Potka, Dhalbhumgarh, Garu, Palamu, Latehar & Balumat 9 each, Panchet 8 and Boram, Panchet, Rajdhanwar, Nandadih, Maithon, Gurabandha, Chandwa, Hendigir, Messenjoy & Saryu 7 each;</p> <p>Odisha: Bhograi 13, Rajghat 12, Suliapada 11, Udala & Jaleswar 10 each, Tensa9, Rasagovindapur, Betanati, Chandua Kuliana, Kaptipada, Jamsolaghat & Bangiriposi 8 each and Sarasakan, Bijatala, G B Nagar 7 each;</p> <p>West Uttar Pradesh: Saharanpur 10;</p> <p>Chhattisgarh: Kusmi 7;</p> <p>Sub-Himalayan West Bengal: Darjeeling 7.</p> <p>15th September:</p> <p>Jharkhand: Tandwa 16, Lawalong 15, Simaria & Maithon 14 each, Maithon 13,</p>
15.09.2024 / 0830	<p>Gangetic West Bengal (including Kolkata): Heavy to very heavy rainfall at few places over Gangetic West Bengal and extremely heavy rainfall at isolated places over south Gangetic West Bengal on 15th; heavy rainfall at isolated places on 16th September.</p>	

	<p>Sub-Himalayan West Bengal: Heavy rainfall at isolated places on 15th September.</p> <p>Odisha: Heavy to very heavy rainfall at a few places over Odisha and extremely heavy rainfall at isolated places over north Odisha on 15th and heavy to very heavy rainfall at isolated places on 16th September.</p> <p>Jharkhand: Heavy rainfall at isolated places and extremely heavy rainfall over south Jharkhand on 15th and heavy to very heavy rainfall at isolated places over Jharkhand 16th September.</p> <p>Bihar: Heavy to very heavy rainfall at isolated places very likely on 15th & 16th and heavy rainfall at isolated places over Bihar 17th September.</p> <p>Chhattisgarh: Heavy to very heavy rainfall at a few places on 15th & 16 th September and heavy rainfall at isolated places on 17th September.</p> <p>East Madhya Pradesh: Heavy rainfall at isolated places on 15th, heavy to very heavy rainfall at isolated places 16th & 17th September.</p> <p>West Madhya Pradesh: Heavy rainfall at isolated places on 17th & 18th September.</p> <p>East Uttar Pradesh: Light to moderate rainfall at most places with heavy rainfall at isolated places on 16th & 17th September.</p> <p>Mizoram & Tripura: Isolated heavy rainfall during 15th -16th September.</p> <p>Assam & Meghalaya: Isolated heavy rainfall on 15th September.</p>	<p>Gurabandha & Gobindpur 12 each, Sindri, Putki, Chandrapura , Chandankiary , Panchet , Panchet, Ghatsila , Latehar Balumat, Musabani 11each, Potka , Chakulia , Karmatand , Jamshedpur Aero , Dhalbhumgarh , Parsabad 10each, Jamtara , Putki, Bariyatu , Jamshedpur , Koderma, Bau Kanke 9each, Hazaribagh, Majhgaon , Shilaichak , Dumri 8 each, Rajdhanwar , Chandil , Chandwa , Maheshpur , Messenjoy , Jamtara, Tonto , Nimdih , Nawadih , Dhurki , Bagodari , Phusro , Balumath , Chaibasa , Garhwa , Kharsema , Tenughat 7each; Gangetic West Bengal: Asansol , Asansol , Suri 15each, Suri , Kharidwar 13each, Burnpur 12, Purihansa , Luchipur 11each, Bankura , Harinkhola , Gheropara 10each, Sri Niketan , Tusuma , Rajnagar , Phulberia 9each, Purulia , Bankura , Mankar , Simula , Tantloi , Amtala , Lalgah , Rampurhat , Panagarh 8each, Narayanpur , Labpur , Nalhati , Durgapur , Tilpara Barrage , Hetampur , Amfu Kharagpur , Kalaikunda 7each; Chhattisgarh: Ramchandrapur 15, Kusmi 13, Samari 12, Wandrafnagar 11, Ramanujganj , Rajpur , Raghunath Nagar , Chando 8each, Pratappur 7;</p> <p>Odisha: Udala 14, G B Nagar , Nawana , Balimundali 12each, Raruana , Betanati , Karanjia , Bahalda 11each, Kaptipada , Balasore , Joshipur , Jaipur 10each, Sarasakana , Tiring , Nh5 Gobindpur , Kusumi , Bijatala 9each, Nilgiri , Joda , Jaleswar , Remuna , Jamsolaghat , Rasagovindapur</p>
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<p>16.09.2024 / 0830</p>	<p>Jharkhand: Heavy to very heavy rainfall at a few places & isolated extremely heavy rainfall over south Jharkhand & isolated heavy to very heavy rainfall over North Jharkhand on 16th September. Heavy to very heavy rainfall at isolated places over Jharkhand on 17th September. Gangetic West Bengal: Heavy rainfall at isolated places over Gangetic West Bengal on 16th September.</p> <p>Odisha: Heavy to very heavy rainfall at isolated places over North Odisha on 16th September and heavy rainfall at isolated places over Northwest Odisha on 17th September.</p> <p>Bihar: Heavy rainfall at isolated places is very likely over South Bihar on 16th and 17th September.</p> <p>Chhattisgarh: Heavy to very heavy rainfall at isolated places over North Chhattisgarh during 16th to 17th September.</p> <p>Madhya Pradesh: Heavy to very heavy rainfall at isolated places is likely over Northeast Madhya Pradesh on 16th & 17th September and heavy rainfall at isolated places on 18th September. Heavy rainfall at isolated places over Northwest Madhya Pradesh during 17th to 18th September.</p> <p>Uttar Pradesh: Heavy to very rainfall at isolated places over Southeast Uttar Pradesh during 16th and 17th September. Heavy to very rainfall at isolated places over West Uttar Pradesh on 17th and heavy rainfall at isolated places on 18th September.</p>	<p>, Baripada , Rajghat , Bhograi , Rairangpur & Muruda 8 each and Bangiriposi, Suliapada, Samakhunta & Chandua Kuliana, Sukruli 7 each;</p> <p>East Madhya Pradesh: Chitrangi 11 and Mauganj 8;</p> <p>East Uttar Pradesh: Churk 10, Chopan 8 and Robertsganj & Dudhi 7each;</p> <p>Bihar: Sanjhauli & Chakai 8 each and Rajauli 7;</p> <p>Sub-Himalayan West Bengal: Rongo & Lava 8 each and Jhallong 7.</p> <p>16th September:</p> <p>Chhattisgarh: Kusmi 15, Ramchandrapur 14, Samari & Biarpur 12 each, Ramanujganj 11, Odagi, Sonhat & Chando 9 each, Pondi Bachra & Balrampur 8 each and Rajpur, Bhaiyathan, Manora & Pasaan 7 each;</p> <p>East Madhya Pradesh: Churhat 14, Panagar 12, Bilhari, Jabalpur & Bargi 10 each, Mada 9 and Bijadandi, Sarai, Nowrozabad & Chitrangi 7 each.</p> <p>17th September:</p> <p>East Uttar Pradesh: Attarra 16, Kanpur & Mau 12 each, Beberu, Manikpur, Rajapur & Karwi 11 each, Kanpur, Banda & Lalganj 10 each, Tirwa & Koraon 9 each, Chhibramau 8 and Karchhana, Ghorawal, Kannauj, Prayagraj, Mirzapur, Prayagraj Sadar & Bhognipur 7 each;</p> <p>West Uttar Pradesh: Rath 22, Hamirpur 13, Etawah & Chakkar Nagar 12 each, Shikohabad 8 and Orai & Bharthana 7 each;</p>
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17.09.2024 / 0830	<p>Jharkhand: Heavy rainfall at isolated places over Jharkhand on 17th September.</p> <p>Bihar: Heavy rainfall at isolated places is very likely over South Bihar on 17 th September.</p> <p>Uttar Pradesh: Heavy to very rainfall at isolated places over Southeast Uttar Pradesh on 17th September. Heavy rainfall at isolated places over Southwest Uttar Pradesh on 17th and 18th September.</p> <p>Madhya Pradesh: Heavy to very heavy rainfall at isolated places is likely over North Madhya Pradesh on 17th September and heavy rainfall at isolated places on 18th September over Northwest Madhya Pradesh.</p> <p>Chhattisgarh: Heavy rainfall at isolated places over North Chhattisgarh on 17th September.</p> <p>East Rajasthan: Heavy rainfall at isolated places on 17th September.</p>	<p>East Madhya Pradesh: Hanumana 13, Chitrangi, Rewa & Gaurihar 10 each, Mauganj, Sarai & Ajaigarh 9 each, Mangawan, Nowgong & Churhat 8 each and Devendranagar, Naigarhi, Sidhi, Nagode, Birsingpur, Raipurkarchuliyan, Sihawal, Gudh, Jawa, Shahgarh and Unchehra 7each;</p> <p>Jharkhand: Lohardaga & Kharsema 8 each;</p> <p>West Madhya Pradesh: Roan 15, Lahar 12, Mihona, Gohad & Mau 11 each, Gwalior, Ambah, Bhandar & Dabra 9 each, Bhind, Porsa & Datia 8 each and Ater, Ghatigaon, Gormi & Seodha 7 each;</p> <p>Odisha: Dhenkanal & Dhenkanal 13 each, Bhuban 12 and Banki & Korei 10 each.</p>
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5. Damage due to the system

- As a result of heavy rainfall and discharge of water from Damodar Valley Corporation severe flooding occurred in southern West Bengal, claiming three lives and affecting over 2.5 lakh residents.
 - Six districts were significantly impacted, including Birbhum, Bankura, Howrah, Hooghly, North and South 24 Parganas, East and West Medinipur, and Paschim Bardhaman.
 - Worst affected Area: Ghatal in West Medinipur and Uday Narayanpur in Howrah. The release of water from the dams and reservoirs worsened the situation in Ghatal. The Dwarakeswar River breached as well causing floods in Hooghly. This led people to leave their homes in search of a safe and secure shelter.
 - The flooding also caused a lot of damage to the crops as they got washed away. Panskura railway station and it's adjoining bus stand in East Medinipur district sank after flood completely becoming inaccessible to commuters.
- (Situation Report 1 Floods in West Bengal Date: 20th September 2024 (Friday) Time: 12:00 PM (IST) Source: Sphere India)

6. Operational Forecast Performance

- First information about formation of a low-pressure area over North BoB with moderate probability was given in the Extended Range Outlook issued on 12th September, 2024.
- It indicated a low-pressure area likely to form over coastal Bangladesh and adjoining north BoB during next 24 hours. Thereafter, it was likely to move slowly west-northwestwards and concentrate into a depression over coastal West Bengal and adjoining northwest BoB during subsequent 48 hours.
- The daily tropical weather outlook issued at 0530 hours IST / 0000 UTC of 13th September, indicated that a low-pressure area formed over southeast Bangladesh and neighbourhood around 1800 UTC of 12th September and lay over the same region at 0000 UTC of today, the 13th September, 2024. It was likely to move slowly west-northwestwards and intensify into a depression over coastal West Bengal and adjoining northwest BoB during next 48 hours.
- In the first bulletin with formation of depression issued on 13th September at 1730 hours IST / 1200 UTC, it was indicated that the depression would continue to move west-northwestwards, it would cross Bangladesh coast near Patuakhali in the same night. Thereafter, it was likely to continue to move west-northwestwards across coastal Bangladesh and Gangetic West Bengal during subsequent 48 hours.
- Thus, the track, initial movement intensification/weakening of the system were well predicted by IMD/RSMC New Delhi.

7. Bulletins issued by IMD

- Track, intensity and landfall forecast: IMD continuously monitored, predicted and issued bulletins containing track & intensity forecast from the stage of depression till the system weakened into a low-pressure area. The forecast of these parameters were issued from the 12th September onwards along with the cone of uncertainty every six hourly for 00, +12, +24, +36 and +48 hours lead period.
- Adverse weather warning bulletins: The adverse weather warnings for heavy rain were issued every six hourly and updates were provided to central, state and district level disaster management agencies including MHA NDRF, NDMA for all Odisha, West Bengal, Jharkhand, Uttar Pradesh, Chhattisgarh, Madhya Pradesh, and Bihar. The bulletins also contained the suggested action for disaster managers and general public in particular for fishermen. These bulletins were also issued to Defense including Indian Navy & Indian Air Force, NDRF, Indian Coast Guard, ports, Shipping, Fishery, Railways, Surface Transport & Aviation Authorities.
- Warning graphics: The graphical display of the observed and forecast track with cone of uncertainty was 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 were also presented in graphics along with color codes in the website.
- Warning and advisory for marine community: The bulletins under Global Maritime Distress Safety System (GMDSS) were issued by the Marine Weather Services Division at New Delhi three times daily. Similarly, bulletins for maritime interest were issued by Area Cyclone Warning centre of IMD at

- Kolkata & Chennai and Cyclone Warning Centres at Visakhapatnam and Bhubaneswar for ports, fishermen, coastal and high sea shipping community.
- Fishermen Warning: Regular warnings for fishermen for deep sea of BoB and the states of Orissa, West Bengal and Andhra Pradesh were issued since 12th September onwards.
 - Warning and advisory through social media: Daily updates (every six hourly or whenever there was any significant change in intensity/track) were uploaded on Facebook and tweeter regularly during the life period of the system from 9th morning onwards, updates were posted on Facebook and tweeter.
 - Diagnostic and prognostic features of Depression: The prognostics and diagnostics of the system were described in the RSMC bulletins.

Statistics of bulletins issued by RSMC New Delhi in association with this system are given in **Table 3**.

Table 3: Bulletins issued by Cyclone Warning Division, IMD, New Delhi

SN	Bulletins	No. of Bulletins	Issued to
1	National Bulletin	23	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 Defense Staff, DG Doordarshan, All India Radio, DG-NDRF, Director Indian Railways, Indian Navy, IAF, Chief Secretary: West Bengal, Odisha, Andhra Pradesh, Chhattisgarh, Jharkhand, Madhya Pradesh, Uttar Pradesh
2	RSMC Bulletin	23	1. IMD's website 2. All WMO/ESCAP member countries including Bangladesh through GTS and E-mail. 3. Indian Navy, IAF by E-mail
3	GMDSS Bulletins	2	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)
4	Warnings through SMS	Frequently	SMS to (i) disaster managers at national level and concerned states (every time when there was change in track, intensity and landfall characteristics) by IMD Headquarters, (ii) to General Public registered through RSMC website by IMD Headquarters and RMC Kolkata office (iii) to fishermen through INCOIS network.
5	Warnings through social media	Daily	Cyclone Warnings were uploaded on social networking sites (Facebook and Twitter) since inception to weakening of system (every six hourly).

Statistics of bulletins issued by Area Cyclone Warning Centre Kolkata and Cyclone Warning Centre Bhubaneswar for marine community is presented in Table 4:

Table 4: Bulletins issued by Area Cyclone Warning Centre (ACWC) Kolkata and Cyclone Warning Centre (CWC)Bhubaneswar during its life period over sea

SN	Bulletins	ACWC Kolkata	CWC Bhubaneswar
1	Sea Area Bulletin for Bay of Bengal	1	-
2	Coastal Weather Bulletin for respective coastal area	10	12
3	Port Warnings for respective ports under jurisdiction	8	6
4	Fishermen Warnings for Bay of Bengal	6	16

8. Acknowledgement

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