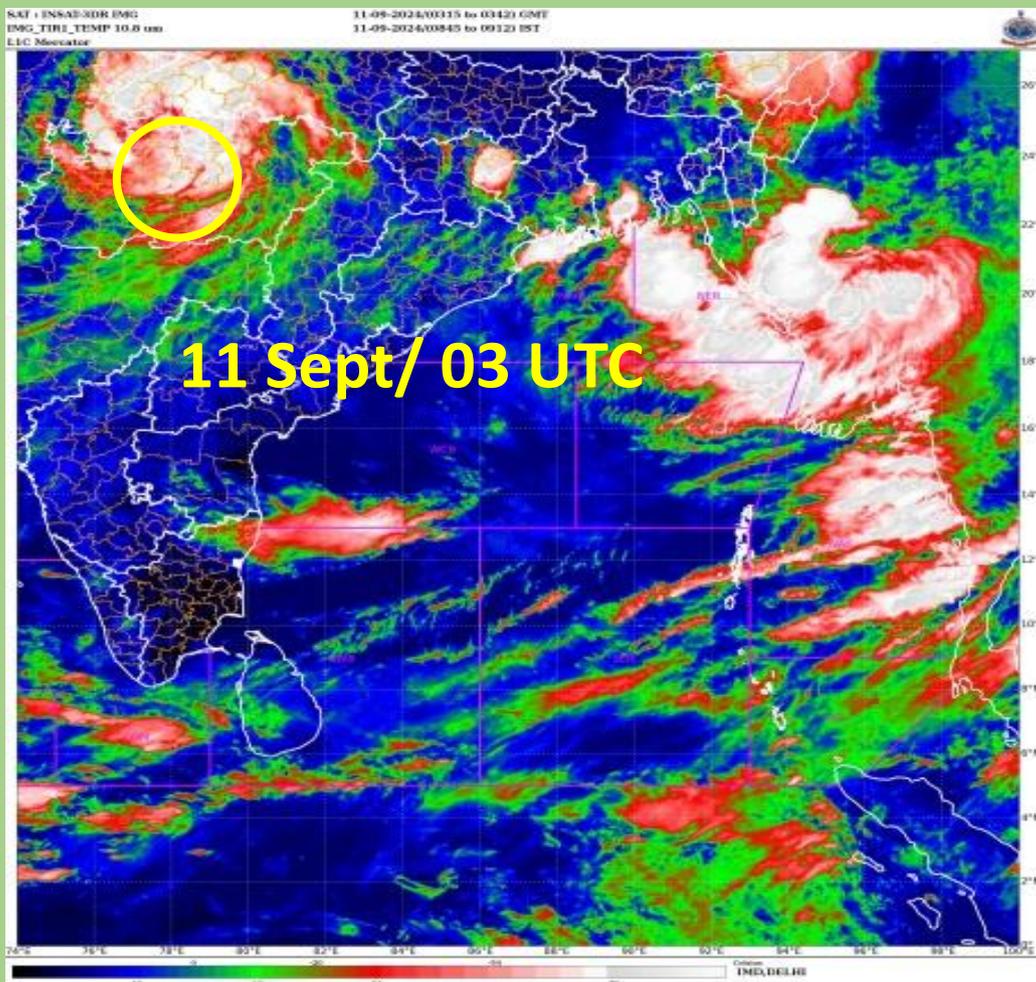




**GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
INDIA METEOROLOGICAL DEPARTMENT**

**Depression over Northeast Madhya Pradesh during 11th September -13th
September, 2024: A Report**

**INSAT-3D Satellite imagery of Depression over Northeast Madhya Pradesh
at 0300 UTC of 11th, 2024**



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

Depression over Northeast Madhya Pradesh during 11th-13th September 2024

Introduction

- The well-marked low-pressure area has formed over Northeast Madhya Pradesh and neighborhood in the evening (1730 hours IST/1200 UTC) of 10th September.
- It moved nearly north-northwestwards and intensified into a depression over Northeast Madhya Pradesh by the morning of 11th September (0830 hours IST/0300 UTC).
- It then moved north-northeastwards and lay centered over north Madhya Pradesh adjacent to northwest Uttar Pradesh as depression on 0530 IST/0000 UTC of 12th September.
- It continued to move north-northeastwards and weakened into a well-marked low (WML) pressure area over northwest Uttar Pradesh & neighborhood in the morning (0830 hours IST/0300 UTC) of the 13th September.

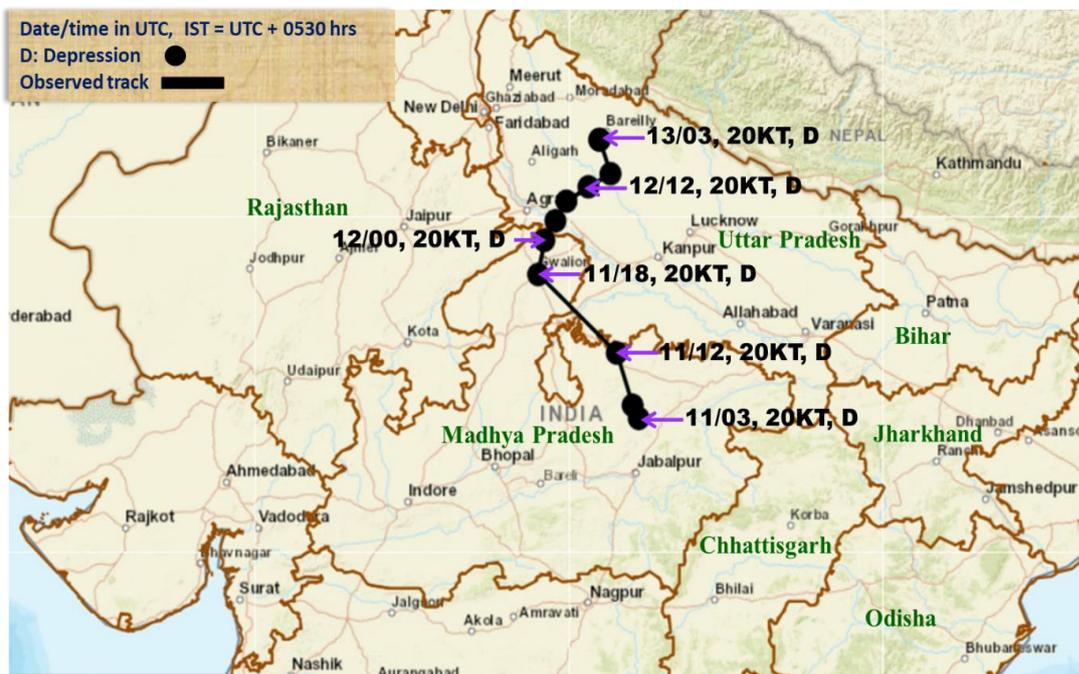


Fig. 1: Observed track of Depression over Northeast Madhya Pradesh.

Table 1: Best track positions and other parameters of the Depression over Northeast Madhya Pradesh during 11th Sept – 13th Sept, 2024.

| Date | Time (UTC) | Lat. | Long. | ECP | ΔP | MSW (kt) | Category |
|----------|------------|---------------------------------------------------------------------------------------------|-------|-----|------------|----------|----------|
| 11.09.24 | 0300 | 24.0 | 80.0 | 995 | 3 | 20 | D |
| | 0600 | 24.2 | 79.9 | 995 | 3 | 20 | D |
| | 1200 | 25.0 | 79.6 | 994 | 4 | 20 | D |
| | 1800 | 26.2 | 78.2 | 994 | 4 | 20 | D |
| 12.09.24 | 0000 | 26.7 | 78.3 | 993 | 4 | 20 | D |
| | 0300 | 27.0 | 78.5 | 993 | 4 | 20 | D |
| | 0600 | 27.3 | 78.7 | 993 | 4 | 20 | D |
| | 1200 | 27.5 | 79.1 | 993 | 4 | 20 | D |
| | 1800 | 27.7 | 79.5 | 993 | 3 | 20 | D |
| 13.09.24 | 0000 | 28.2 | 79.3 | 994 | 3 | 20 | D |
| | 0300 | Weakened into a well-marked low-pressure area over northwest Uttar Pradesh & neighbourhood. | | | | | |

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

1. Brief life history - Genesis Intensification and movement

1.1 Genesis, movement and intensification

The well-marked low-pressure area formed over Northeast Madhya Pradesh and neighbourhood in the evening (1730 hours IST/1200 UTC) of 10th September, moved nearly north-northwestwards and intensified into a depression over Northeast Madhya Pradesh by the morning of 11th September (0830 hours IST/0300 UTC). By 1130 hours IST/0600 UTC on the same day, the depression was centered near latitude 24.2°N and longitude 79.9°E, about 60 km northeast of Damoh (Madhya Pradesh), 90 km south of Khajuraho (Madhya Pradesh), 100 km west-southwest of Satna (Madhya Pradesh), and 190 km southeast of Jhansi (Uttar Pradesh).

On 11th September, the Madden-Julian Oscillation (MJO) index was observed to be in Phase 5, with an amplitude of less than 1. This phase of the MJO supported an enhancement of convective activity over East and Central India. Additionally, guidance from the NCICS indicated the presence of strong westerly winds (5-7 m/s) along with Rossby waves over central India. Strong easterly winds (5-7 m/s) were also observed over the northern parts of India. The environmental conditions during this period were favorable, with low-level convergence around $10 \times 10^{-6} \text{s}^{-1}$, and upper-level divergence at approximately $20 \times 10^{-6} \text{s}^{-1}$ over the system area. Wind shear was moderate (15-20 kt) in the vicinity of the system, with

stronger shear (>20 kt) to the north. Vorticity at the 850 hPa level was about $150 \times 10^{-6} \text{s}^{-1}$, extending vertically up to the 500 hPa level. The mid-level shear was cyclonic over the system area, indicating a moderately favorable environment for intensification.

By the morning of 12th September, the depression over Northeast Madhya Pradesh moved north-northwestwards and lay centered over Southwest Uttar Pradesh near latitude 27.0°N and longitude 78.5°E , about 50 km east-southeast of Agra (Uttar Pradesh), and 90 km north-northeast of Gwalior (Madhya Pradesh). The system remained in a favorable environment, with low-level convergence around $20 \times 10^{-6} \text{s}^{-1}$ and upper-level divergence at about $20 \times 10^{-6} \text{s}^{-1}$. Wind shear over the system area was moderate (10-15 kt), with higher shear (>20 kt) to the north. Vorticity at the 850 hPa level was around $200 \times 10^{-6} \text{s}^{-1}$, extending up to 500 hPa.

By 13th September, the Madden-Julian Oscillation (MJO) index remained in Phase 5, with an amplitude greater than 1. The system had been in this phase for several days, but the support from the MJO for convective activity was gradually diminishing. The MJO was expected to move into Phase 6 during the following week, which would further reduce the support for the system.

On the morning of 13th September, the low-level convergence remained about $20 \times 10^{-6} \text{s}^{-1}$ around the system area, while upper-level divergence was still around $20 \times 10^{-6} \text{s}^{-1}$. Wind shear was low to moderate (5-15 kt) over the system area, but high wind shear (>20 kt) persisted to the north of the system. Vorticity at the 850 hPa level was approximately $100 \times 10^{-6} \text{s}^{-1}$, with vertical extension up to the 700 hPa level. The system was gradually experiencing the influence of high vertical wind shear, as the westerly wind trough in the upper troposphere began to move eastward.

Given these unfavorable environmental conditions, the depression over Southwest Uttar Pradesh began to weaken. By the morning of 13th September, it had weakened into a Well-Marked Low-Pressure Area over northwest Uttar Pradesh and its surroundings. With the environmental conditions no longer conducive to sustaining its intensity, the system weakened and dissipated.

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 10th October since it has been evolved from a previous system. 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. Typical INSAT-3D enhanced colored imageries, visible/ IR and brightness temperature imageries are presented in Fig. 2 (a) to 2 (d). During the entire life cycle, the clouds were organized in shear pattern. The detailed features from the satellite pictures are discussed in this section.

As per the INSAT-3DR imagery at 0300 UTC on 11th September, the system was associated with scattered to broken low and medium clouds, with embedded intense to very intense convection. These clouds were observed over Uttar Pradesh, eastern Rajasthan, and Madhya Pradesh, with a minimum cloud top temperature of -93°C . Moderate to intense convection was also seen over Vidarbha and Chhattisgarh.

According to the INSAT-3DR imagery at 0300 UTC on 12th September, the convective clouds were sheared towards the northeast under the influence of an approaching westerly trough in the middle and upper tropospheric levels. The associated scattered to broken low and medium clouds, with embedded intense to very intense convection, were observed over eastern Rajasthan, western Madhya Pradesh, western Uttar Pradesh, and Uttarakhand, with minimum cloud top temperatures ranging from -80°C to -93°C . Moderate to intense convection was also visible over Himachal Pradesh, Haryana, Delhi, eastern Uttar Pradesh, and eastern Madhya Pradesh, with minimum cloud top temperatures between -50°C and -70°C .

As per the INSAT-3DR imagery at 0300 UTC on 13th September, scattered to broken low and medium clouds with embedded intense to very intense convection were observed over Uttarakhand and western Uttar Pradesh, with minimum cloud top temperatures of -75°C . Moderate to intense convection was seen over eastern Himachal Pradesh, eastern Rajasthan, and northwest Madhya Pradesh, with minimum cloud top temperatures ranging from -50°C to -60°C . Weak to moderate convection was also present over eastern Ladakh, western Himachal Pradesh, eastern Punjab, Haryana, Delhi, and eastern Uttar Pradesh.

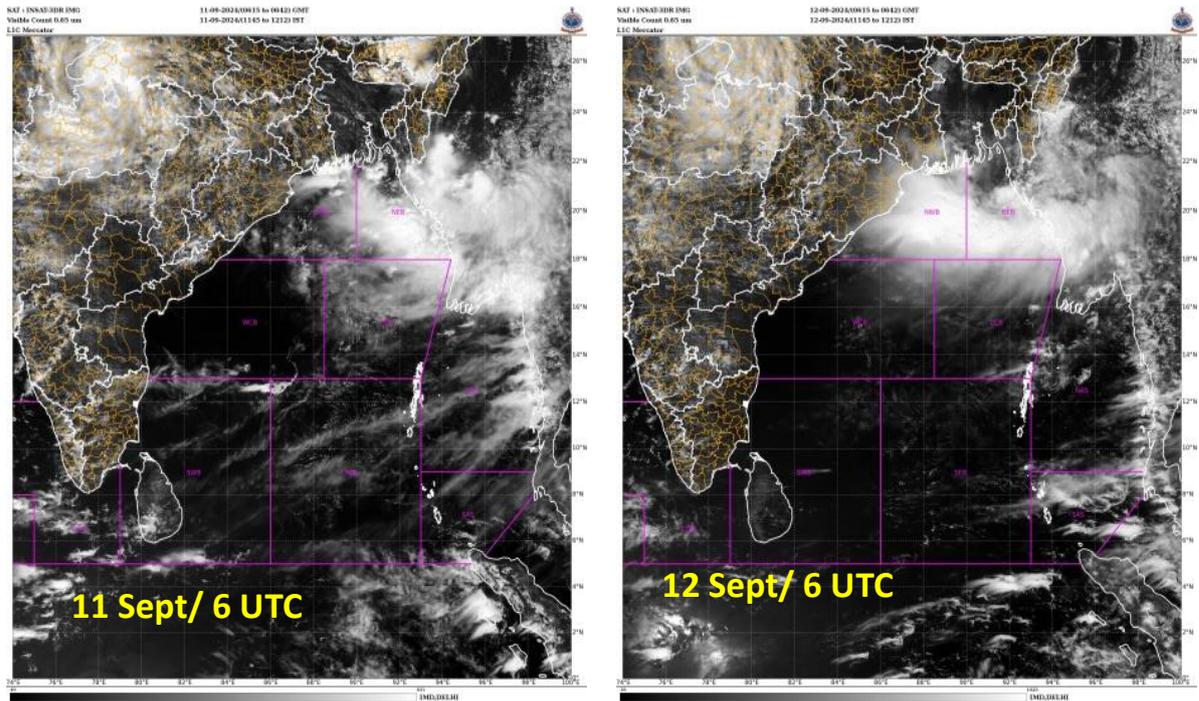


Fig. 2 (a): INSAT-3D Visible imageries during life cycle of Depression over Northeast Madhya Pradesh during 11th September -13th September, 2024

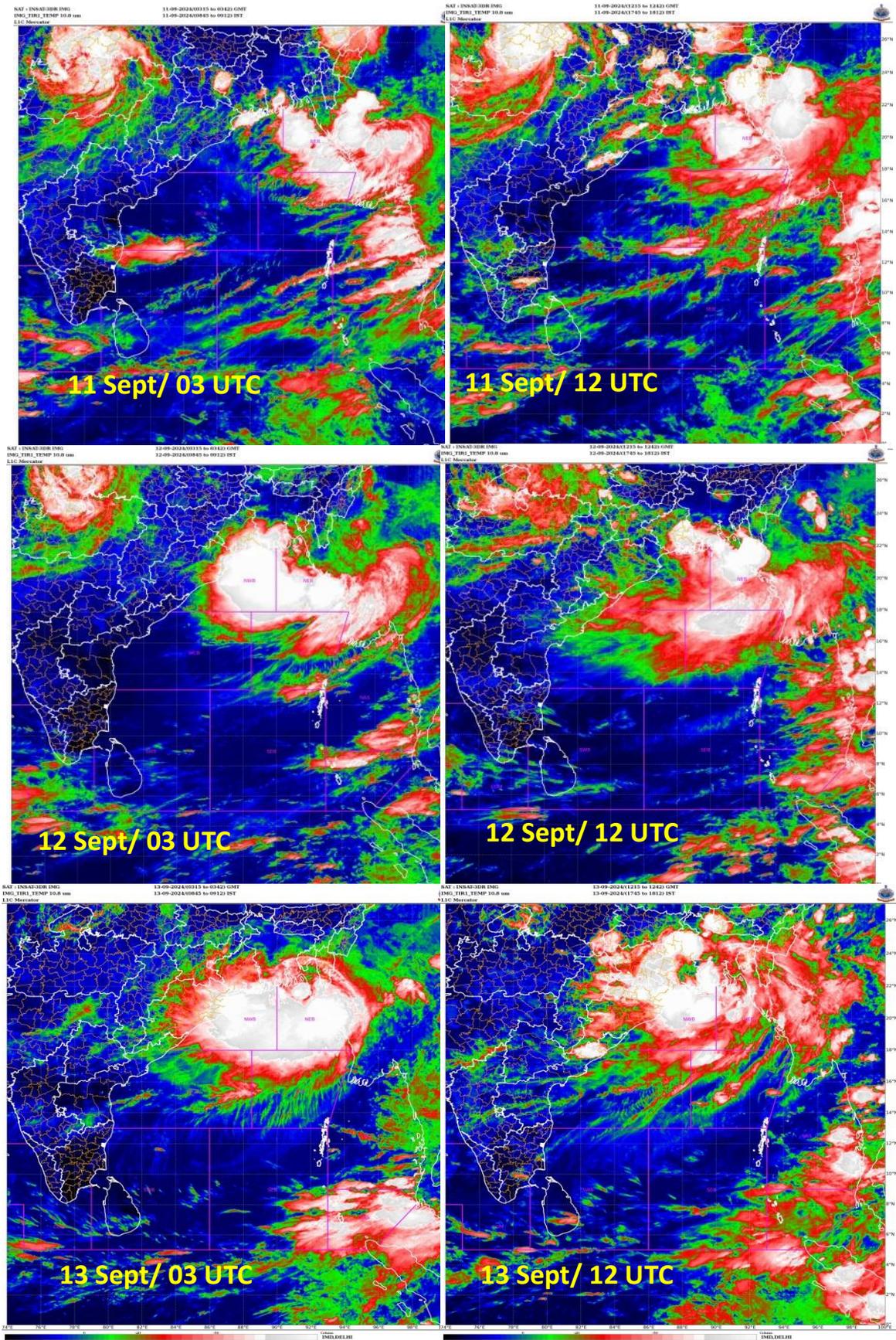


Fig. 2(b): INSAT-3D enhanced colored imageries during life cycle of Depression over Northeast Madhya Pradesh during 11th September - 13th September, 2024

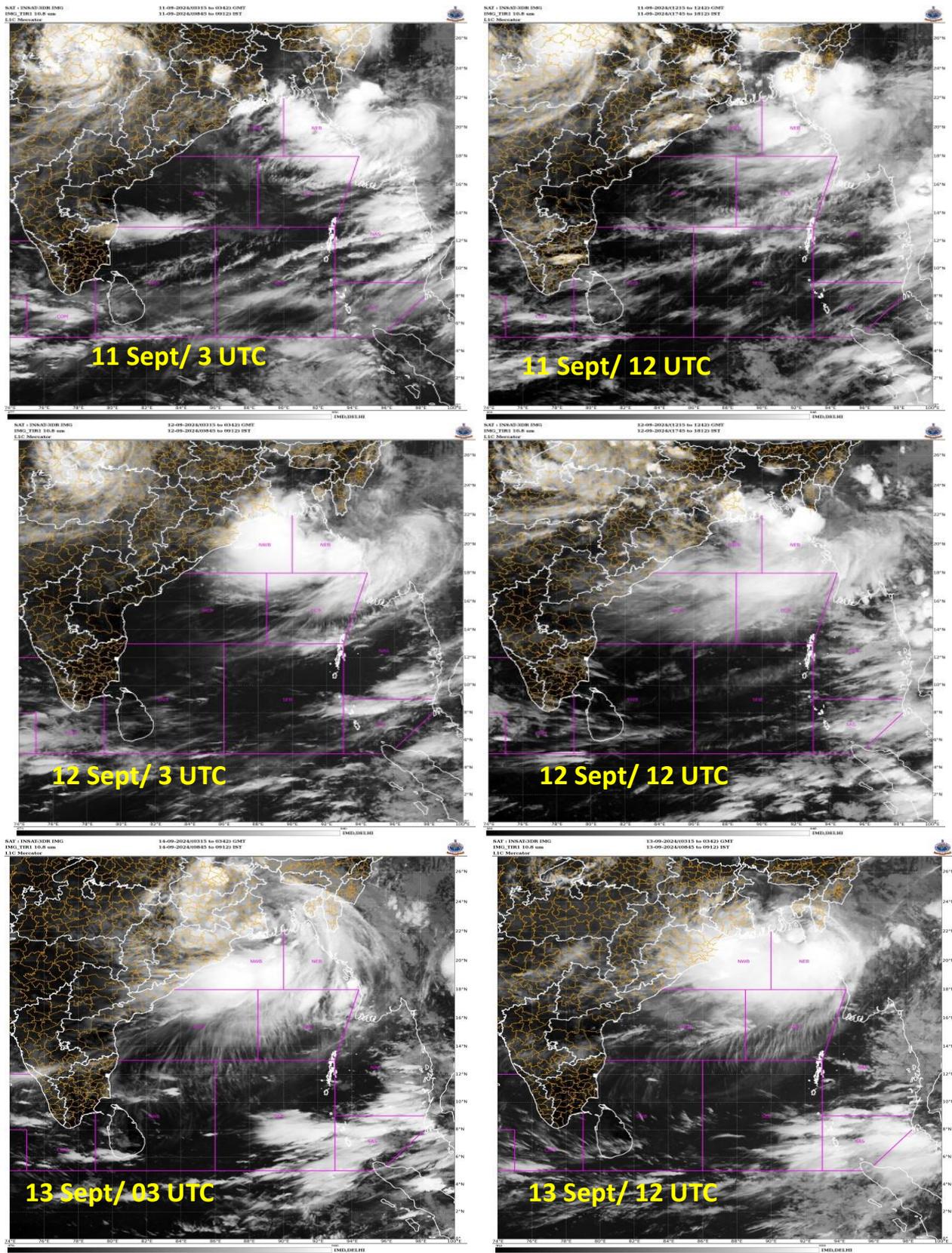


Fig. 2(c): INSAT-3D IR imageries during life cycle of Depression over Northeast Madhya Pradesh during 11th September -13th September, 2024

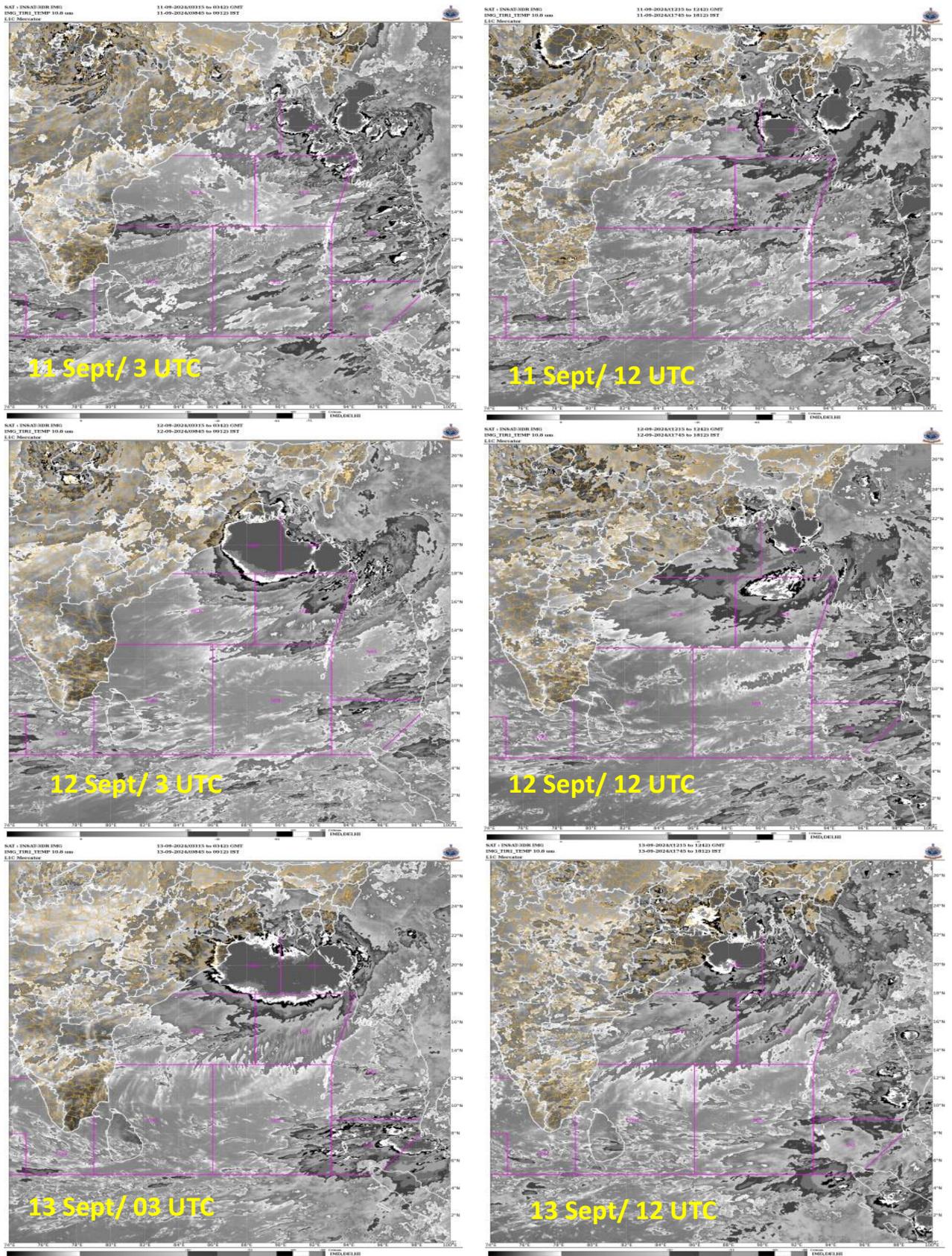


Fig. 2 (d): INSAT-3D enhanced infrared imageries during life cycle of Depression over Northeast Madhya Pradesh during 11th September -13th September, 2024

3. Dynamical Features

IMD GFS (T1534) daily analyses at 0000 UTC of mean sea level pressure (MSLP), winds at 10 m, 850, 500 and 200 hPa levels from 11th Sept to 13th Sept are presented in **Fig. 3(a) to 3(c)** respectively.

At 0000 UTC of 11th September, the MSLP analysis field indicated a depression centered at 23.5.0°N/79.0°E. Actually, the system was located near at 24.0°N/80°E at 0000 UTC based on the best track, indicating its northeast ward movement. GFS, analysis accurately indicated the systems location and intensity.

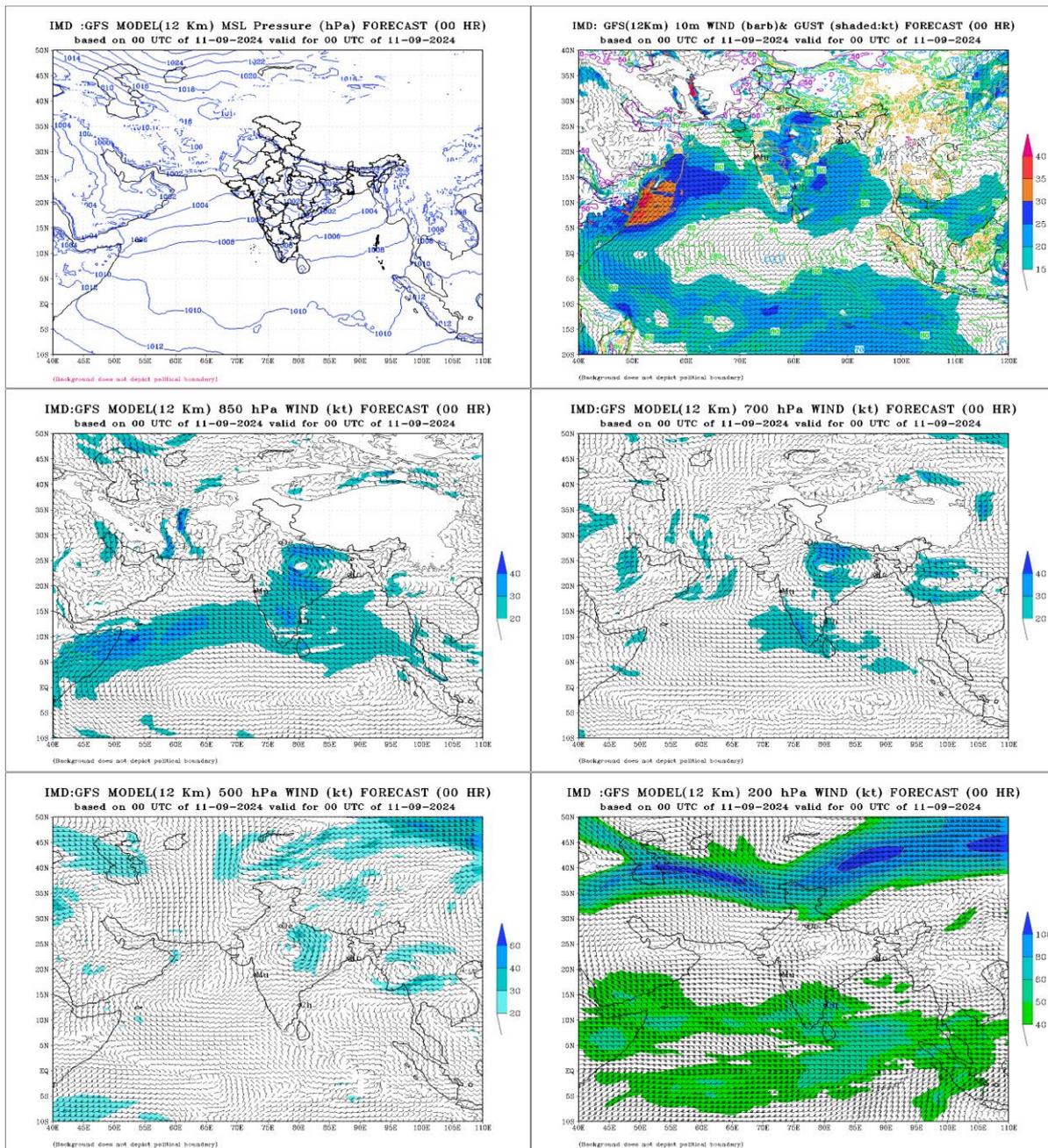


Fig. 3(a): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 11th September 2024

At 0000 UTC of 12th September, the MSLP analysis field indicated a depression centered at 26.5°N/78.5°E. Actually, the system was located near at 26.7°N/78.3°E at 0000 UTC of 12th September based on the best track. Hence, GFS analysis accurately indicated the systems location and intensity.

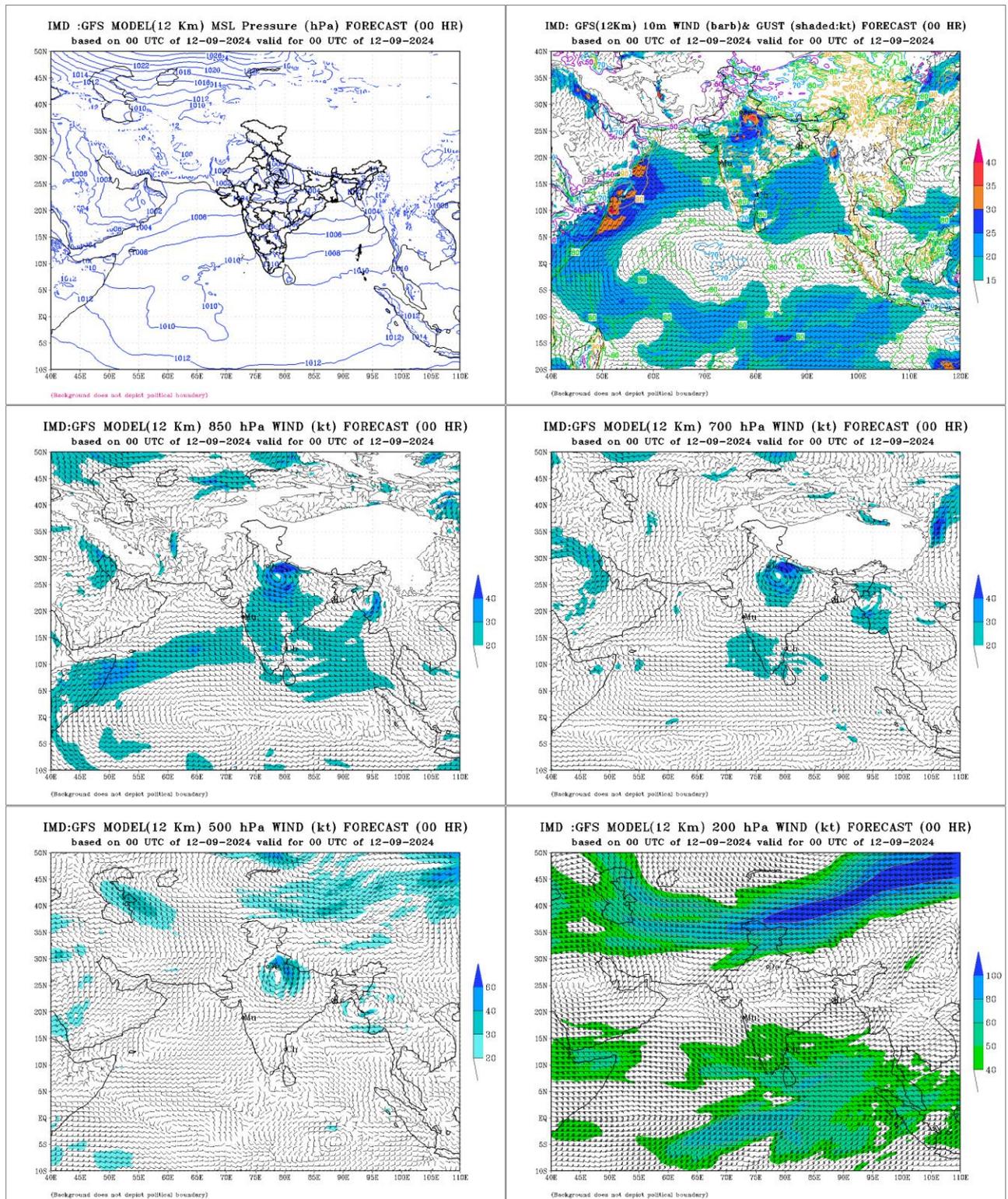


Fig. 3(b): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500, and 200 hPa levels based on 0000 UTC of 12th September 2024

At 0000 UTC of 13th September, the MSLP analysis field indicated a depression over northwest Uttar Pradesh. Actually, the system was located over northwest Uttar Pradesh based on the best track at 0000 UTC of 13th September.

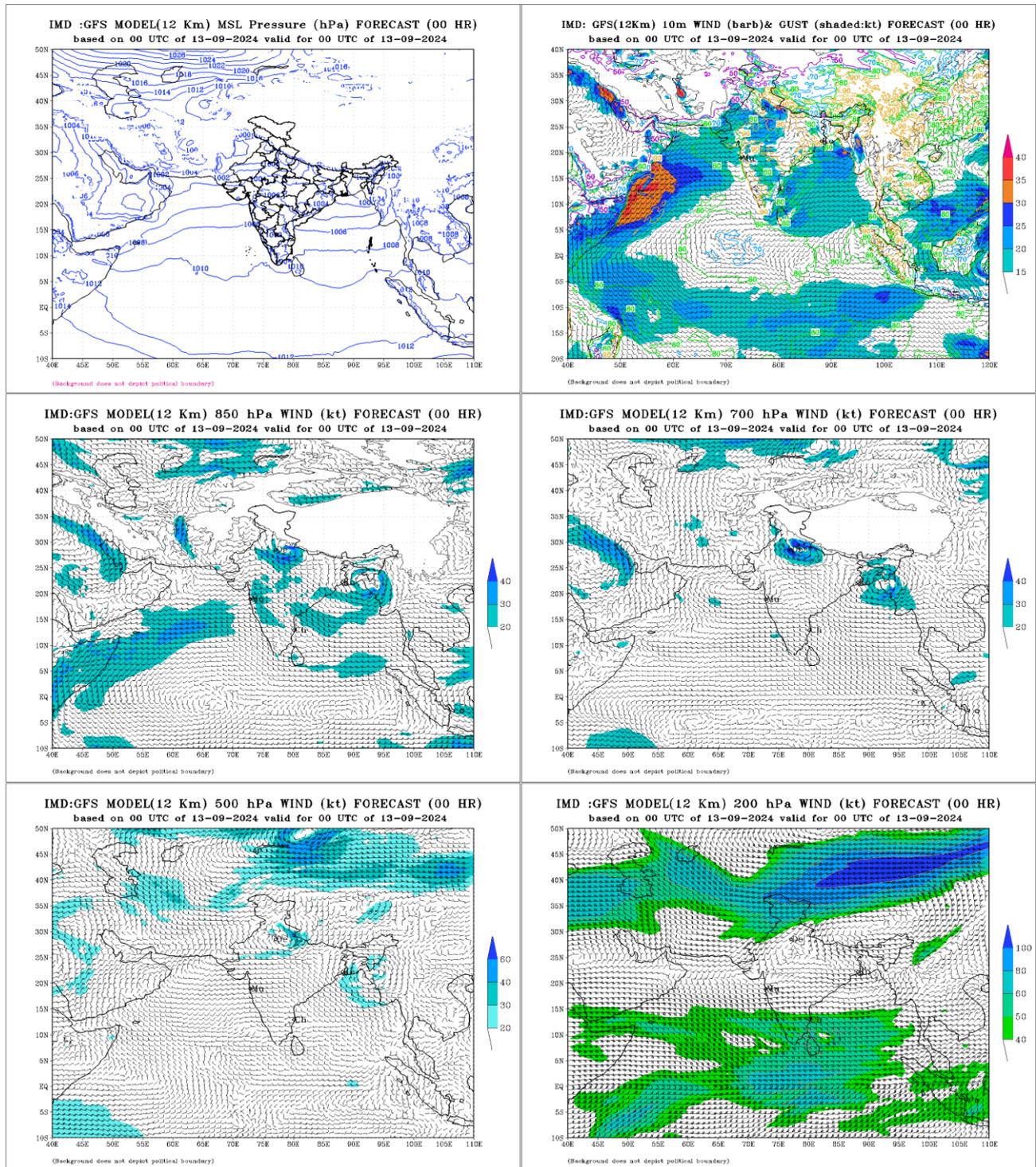


Fig. 3(c): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 13th September 2024

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 a few places over Madhya Pradesh, West Uttar Pradesh on 11th September. Light to moderate rainfall occurred at most places with extremely heavy rainfall at isolated places and heavy to very heavy rainfall at many places over West Madhya Pradesh, West Uttar Pradesh, light to moderate rainfall at many places with heavy to very heavy rainfall at a few places over East Madhya Pradesh, East Rajasthan and isolated heavy rainfall over Uttarakhand and East Uttar Pradesh on 12th September. Light to moderate rainfall occurred at many places with extremely heavy rainfall at isolated places over Uttarakhand and heavy to very heavy rainfall at a few places over Uttar Pradesh and isolated heavy rainfall over East Rajasthan, Delhi, Bihar, West Madhya Pradesh on 13th September. Light to moderate rainfall occurred at many places with heavy to very heavy rainfall at a few places over Haryana- Chandigarh, Gangetic West Bengal, Uttarakhand and heavy rainfall at isolated places over Odisha, Bihar, Uttar Pradesh, Himachal Pradesh, Delhi, Jharkhand, Chhattisgarh and Sub-Himalayan West Bengal on 14th September.

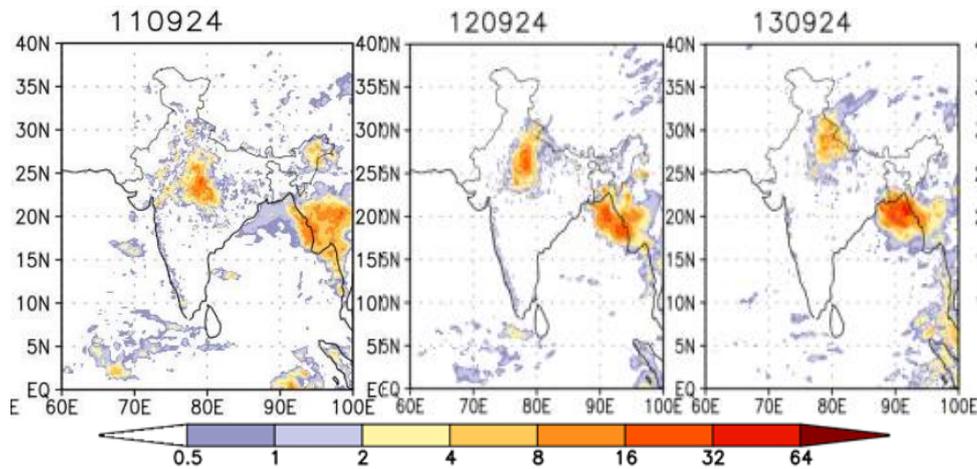


Fig. 4: NCMRWF-IMD satellite gauge merged data plots of realized 24 hours accumulated rainfall from 11th to 13th Sept, 2024.

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: Day wise daily 24 hours cumulative rainfall forecast verification with station observations

| Date/Base Time of observation | 24 hr Heavy rainfall warning ending at 0300 UTC of next day | Realized 24-hour heavy rainfall (≥ 7 cm) ending at 0300 UTC of date |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11.09.2024 / 0830 | <p>East Madhya Pradesh: Heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places on 11th; heavy to very heavy rainfall at few places on 12th and heavy rainfall at isolated places on 13th and 14th September.</p> <p>West Madhya Pradesh: Heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places on 11th & 12th; heavy to very heavy rainfall at a few places on 13th & 14th September and heavy rainfall at a few places on 15th September.</p> <p>West Uttar Pradesh: Heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places on 11th, 12th and 13th and heavy rainfall at a few places on 14th & 15th September.</p> <p>East Uttar Pradesh: Heavy rainfall at isolated places on 11th; heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places on 12th and heavy rainfall at a few places on 13th, 14th & 15th September.</p> <p>East Rajasthan: Heavy to very heavy rainfall at a few places on 11th, 12th & 13th</p> | <p>12.09.2024/ 0830</p> <p>West Madhya Pradesh: Biaora 36, Gohad & Karera 22 each, Narwar & Rajgarh 21 each, Gwalior & Mau 20 each, Bhandar , Sabalgarh and Datia 19 each, Dabra 18, Ater , Ambah , Porsa , Ghatigaon and Bhitwarwar 17 each, Mihona , Mehgaon and Lahar 16 each, Chinor , Gormi , Bhindaws and Badoda 15 each, Alipur 14, Morena , Narsingarh , Pachmarhi and Roan 12 each, Badarwas & Shivpuri 11 each, Vijaypur & Pichhore 10 each, Seodha , Shamshabad , Khaniyadana and Indergarh 9 each, Bamori & Kailaras 9 each, Navibagh Aet , Kolaras and Ashoknagar 8 each, Bairad & Sheopur 7 each.</p> <p>West Uttar Pradesh: Agra 29, Jalesar & Sadabad 23 each, Sikandra Rao 20, Hathras 19, Tundla , Khairagarh , Kasganj and Sahawar 17 each, Tahrauli 15, Jhansi 14, Fatehabad 13, Etawah , Sasani , Sahaswan and Vrindavan 12 each, Talbehat , Moth , Narora , Etah , Jasrana and Aligarh 11 each, Karhal & Etmadpur 10 each, Bah , Auraiya , Gunnaur , Madawara and Mainpuri 9 each, Shikohabad , Kurawali , Mauranipur , Kalpi Tehsil , Kalpi, Moradabad, Moradabad and Bareilly 8 each, Pali , Moradabad , Kasba Tanda , Aliganj , Etawah and Ghiror 7 each.</p> <p>East Rajasthan: Rajakhera 24, Dholpur Tehsil 19, Sawaimadhopur Tesil 16, Aklera 13, Sapau, Bari and</p> |

| | | |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <p>and heavy rainfall at isolated places on 14th & 15th September.</p> <p>West Rajasthan: Heavy rainfall at a few places on 11th & 12th September.</p> | <p>Shahabad 11 each, Manohar Thana , Baseri and Bharatpur Tehsil 10 each, Rupbas & Pipalda 9 each, Kathumer , Sarmathura, Kumher, Khandar, Beir and Deeg 8 each, Lalsot , Nagar, Nadbai , Bayana , Karauli , Baran , Atru and Dhariabad 7 each.</p> <p>East Madhya Pradesh: Prithvipur 23, Orchha 15, Niwari & Chahtarpur 12 each, Nowgong 11, Mohangarh 10, Lidhora 9, Rajnagar 8, Patera , Banda and Lavkushnagar 7 each,</p> <p>Uttarakhand: Banbasa 12, Champawat 9, Pantnagar & Lohaghat 8 each, Haldwani 7, East Uttar Pradesh: Itwa 11, Bhanpur 7.</p> |
| <p>12.09.2024 / 0830</p> | <p>Uttarakhand: Heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places on 12th & 13th; heavy rainfall at isolated places on 14th September.</p> <p>West Uttar Pradesh: Heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places on 12th, heavy to very heavy rainfall at isolated places on 13th and heavy rainfall at a few places on 14th September.</p> <p>East Uttar Pradesh: Heavy rainfall at a few places on 12th and at isolated places on 13th & 14th September.</p> <p>West Madhya Pradesh: Heavy to very heavy rainfall at a few places over northwest Madhya Pradesh on 12th; heavy rainfall at isolated places on 13th & 14th September.</p> <p>East Madhya Pradesh: Heavy rainfall at few places</p> | <p>13.09.2024/ 0830</p> <p>Uttarakhand: Lohaghat 26, Champawat 20, Banbasa & Khatima 13 each, Kashipur & Pithoragarh 11 each, Jaspur , Mukteshwar , Pantnagar , Pati and Haldwani 9 each, Almora 8, Betalghat , Ranikhet , Nainital , Haridwar and Gairsain 7 each.</p> <p>West Uttar Pradesh: Bijnor 18, Kasganj & Sahawar 15 each, Budaun 14, Mirganj , Sahaswan and Pawayan 13 each, Baheri & Nauganva Sadat 12 each, Sikandra Rao , Amroha and Moradabad 11 each, Hasanpur , Dhampur , Dataganj and Aligarh 10 each, Bilari 10, Moradabad , Thakurdwara , Kasba Tanda , Jansath , Jastrana , Nagina , Moradabad, Shahjahapur Obsy and Bisauli 9 each, Narora , Aonla , Mawana , Nawabganj , Aliganj , Etawah , Chandpur , Bareilly and Suar 8 each, Agra , Gunnaur , Chandausi , Pilibhit Tehsil , Shahjahanpur , Tundla , Bisalpur and Bareilly 7 each. East Uttar Pradesh: Muhammadi 14,</p> |

| | | |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <p>over northeast Madhya Pradesh on 12th and heavy rainfall at isolated places on 13th and 14th September.</p> <p>East Rajasthan: Heavy to very heavy rainfall at an isolated places over northeast Rajasthan on 12th and heavy rainfall at isolated places on 14th September.</p> <p>Haryana: Heavy to very heavy rainfall at a few places over south Haryana on 12th and heavy rainfall at isolated places on 13th & 14th September.</p> | <p>Ankinghat 12, Nighasan , Neemsar , Daurahara and Kaimganj 11 each, Mahsi & Katarniaghat 10 each, Nanpara & Hardoi 9 each, Dabri Fmo 8, Kheri Lakhimpur , Chhibramau , Bahraich and Shardanagar 7 each.</p> <p>East Rajasthan: Viratnagar & Asnawar 8 each, Bharatpur Tehsil & Shahabad 7 each.</p> <p>Haryana-Chandigarh-Delhi: Hassanpur & Delhi Ridge 7 each.</p> <p>West Madhya Pradesh: Ambah, Karhal and Porsa 7 each.</p> <p>Bihar: Barauni 7.</p> |
| <p>13.09.2024 / 0830</p> | <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>Haryana: Heavy rainfall at isolated places on 13th & 14th September.</p> | <p>14.09.2024/ 0830</p> <p>Haryana-Chandigarh: Pataudi 21, Nahar Rev & Kosli 13 each, Palhawas Rev 9, Taoru & Faridabad 8 each, Dadri , Sohana , Nuh and Bhadkal 7 each.</p> <p>Gangetic West Bengal: Contai 18, Durgachack 17, Digha 12, Bagati & Sagar Island 11 each, Durgapur 10, Diamond Harbour , Panagarh and Suri 9 each, Jangipur , Dum Dum , Alipore , Salar and Suri 8 each, Basirhat , Kalyani , Berhampore , Hetampur , Tilpara Barrage , Mo Saltlake , Sri Niketan and Gheropara 7 each.</p> <p>Uttarakhand: Champawat 18, Haldwani 16, Nainital 15, Lohaghat 11, Pantnagar 9, Pithoragarh 9, Ghansali 8, Banbasa & Bhagwanpur 7 each.</p> <p>Odisha: Kusumi 14, Bhograi 10, Jaleswar 7;</p> <p>Bihar: Beldaur & Khaira 9 each, Lakhisarai, Nabinagar, Halsi and Jamui 8 each, Gogri, Bausi and Begusarai 7 each.</p> <p>West Uttar Pradesh: Kasba Tanda</p> |

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|--|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | <p>9, Bijnor 8, Suar 7.</p> <p>Himachal Pradesh: Kataula 8, Palampur 7;</p> <p>Delhi: Palam 8, Aya Nagar, Lodi Road 7 each.</p> <p>Jharkhand: Giridih, Bengbad and Bengabad 8 each, Sujani & Pakuria 7 each.</p> <p>Chhattisgarh: Surajpur 7.</p> <p>Sub-Himalayan West Bengal: Malda 7.</p> <p>East Uttar Pradesh: Katarniaghat 7.</p> |
|--|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

5. Damage due to the system

No damage was reported in association with this system.

6. 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.
- Adverse weather warning bulletins: The tropical cyclone forecasts along with expected adverse weather like heavy rain were issued with every six hourly updates to central, state and district level disaster management agencies including MHA NDRF, NDMA for all Madhya Pradesh, Uttar Pradesh, Chhattisgarh, and Rajasthan.
- The bulletins also contained the suggested action for disaster managers. These bulletins were also issued to Defence including Indian Navy & Indian Air Force, NDRF, 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 colour codes in the website.
- 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

| S N | Bulletins | No. of Bulletins | Issued to |
|--------|----------------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | National Bulletin | 11 | 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: Madhya Pradesh, Uttar Pradesh, Chhattisgarh, Rajasthan. |
| 2 | RSMC Bulletin | 11 | 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 | 5 | 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). |

7. 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 the system. We acknowledge contribution from WMO/ ESCAP panel member countries for sharing observations. 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, and Space Application Centre, Indian Space Research Organisation (SAC-ISRO) for their valuable support. The contribution from Numerical Weather Prediction Division, Satellite and Radar Division, Surface & Upper air instruments Divisions, New Delhi and Information System and Services Division at IMD is also duly acknowledged.
