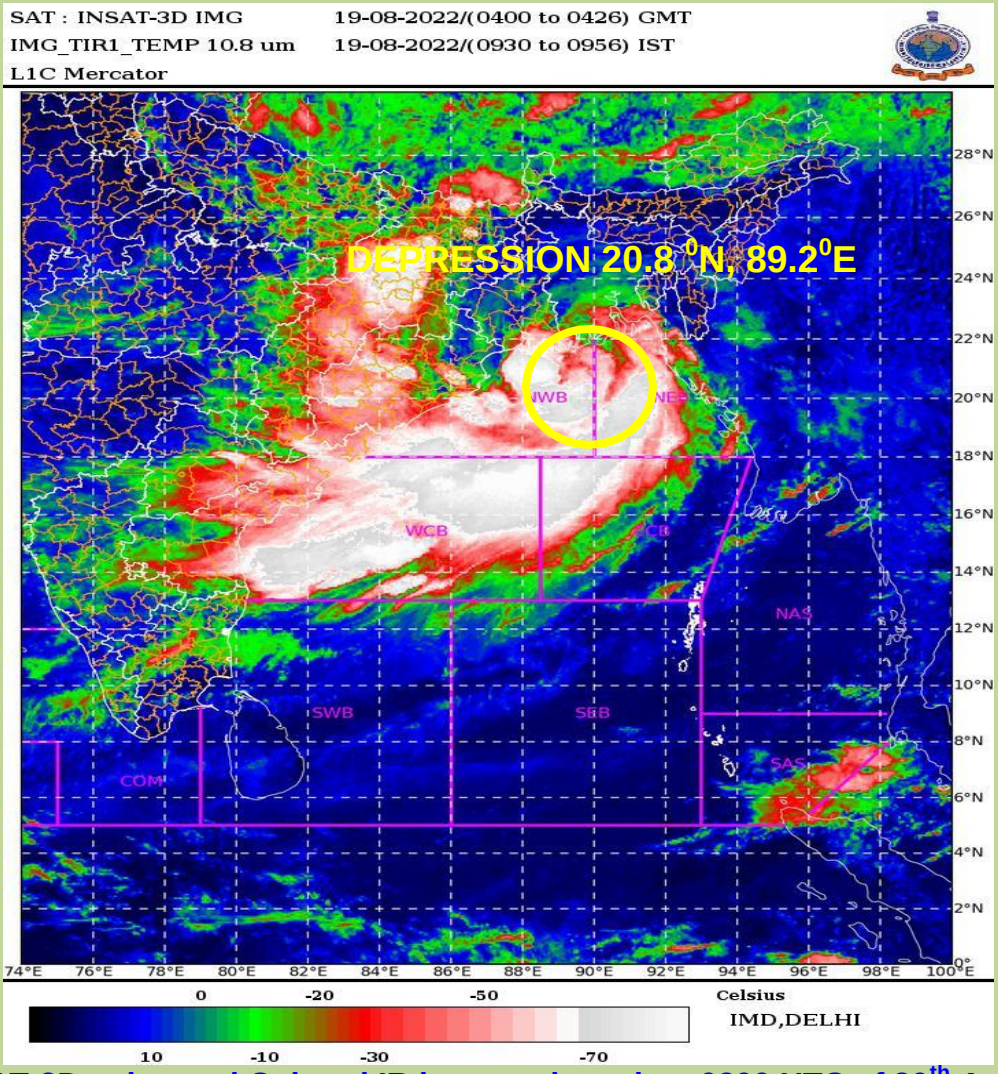
GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
INDIA METEOROLOGICAL DEPARTMENT

Deep Depression over northwest & adjoining northeast Bay of Bengal (19th- 23rd August, 2022): A Report



INSAT-3D enhanced Colored IR imagery based on 0300 UTC of 20th August

Cyclone Warning Division

India Meteorological Department

New Delhi

August 2022

Deep depression over northwest & adjoining northeast Bay of Bengal during 19-23 August, 2022

1. Introduction

A upper air cyclonic circulation lay over south Myanmar & neighbourhood on 17th August. Under it's influence, a low pressure area formed over northeast and adjoining areas of eastcentral Bay of Bengal, Bangladesh & Myanmar Coasts at 0530 hours IST (0000 UTC) of 18th August, 2022. Under favourable environmental conditions, it concentrated into a depression over northwest & adjoining northeast Bay of Bengal and lay centered at 0530 hrs IST(0000 UTC) of 19th August 2022, near latitude 20.5°N and longitude 89.7°E, about 310 km east-southeast of Balasore (Odisha), 250 km east-southeast of Digha (West Bengal) and 210 km east-southeast of Sagar Islands. It then moved west-northwestwards, intensified in a deep depression over same region and lay centered at 1130 hrs IST of 19th August, 2022, about 200 km east-southeast of Balasore (Odisha), 140 km east-southeast of Digha (West Bengal), 100 km southeast of Sagar Islands (West Bengal) and 120 km south-southeast of Canning (West Bengal). Continuing to move west-northwestwards, it crossed West Bengal and adjoining North Odisha coasts between Balasore and Sagar Islands, close to Digha during 1900 to 2000 hours IST(1330-1430 UTC) of 19th August, 2022 and lay centered at 1730 hrs IST of 19th August, 2022 over coastal areas of Odisha and West Bengal and neighbourhood

It lay centred over south Jharkhand and adjoining North Odisha at 0830 hours IST of 20th August, 2022 and over north Chhattisgarh and adjoining Jharkhand at 1730 hours IST of the same day. Continuing to move west-northwestwards, it weakened into a Depression and lay centered at 0530 hrs IST of 21st August, 2022 over northwest Chhattisgarh, adjoining areas of Northeast Madhya Pradesh & Southeast Uttar Pradesh near latitude 23.6°N and longitude 82.1°E, about 120 km west-northwest of Ambikapur (Chhattisgarh) and 120 km east of Umaria (Madhya Pradesh). It further weakened into a Well Marked Low Pressure Area over East Rajasthan and adjoining Northwest Madhya Pradesh the same region at 0830 hours IST of 23rd August, 2022.

The observed track and best track parameters of the system are presented in Fig. 1 and table 1

Table 1: Best track positions and other parameters of the Deep Depression over the Northwest & adjoining northeast Bay of Bengal during 19th-23rd August, 2022

Date	Time (UTC)	Lat.	Long	C.I.No	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Category
19.08.22	0000	20.5	89.7	**1.5**	994	25	4	D
	0300	20.8	89.2	**1.5**	994	25	4	D
	0600	21.1	88.8	2.0	993	30	5	DD
	1200	21.5	88.1	2.0	992	30	6	DD
	Crossed West Bengal and adjoining North Odisha coasts between Balasore and Sagar Islands, close to Digha during 1330 to 1430 UTC of 19th August.							
	1500	21.8	87.6	-	992	30	6	DD
	1800	22.1	87.0	-	992	30	6	DD
20.08.22	0000	22.5	86.0	-	992	30	6	DD
	0300	22.6	85.6	-	992	30	6	DD
	0600	22.9	84.8	-	993	30	5	DD
	1200	23.3	83.6	-	993	30	5	DD
	1800	23.5	82.9	-	993	30	5	DD
21.08.22	0000	23.7	82.2	-	994	25	4	D
	0300	23.8	81.7	-	994	25	4	D
	0600	24.0	81.2	-	994	25	4	D
	1200	24.2	80.5	-	994	25	4	D
	1800	24.25	79.8	-	995	25	4	D
22.08.22	0000	24.3	79.1	-	995	25	4	D
	0300	24.3	78.4	-	995	25	4	D
	0600	24.4	77.8	-	996	25	4	D
	1200	24.4	77.4	-	996	25	4	D
	1800	24.6	76.6	-	997	20	3	D
23.08.22	0000	24.8	76.2	-	997	20	3	D
	0300	Weakened into a Well Marked Low Pressure Area over East Rajasthan and adjoining Northwest Madhya Pradesh.						

Knots: kt, 1 kt = 1.85 kmph, Time in IST= Time in UTC + 0530 hrs

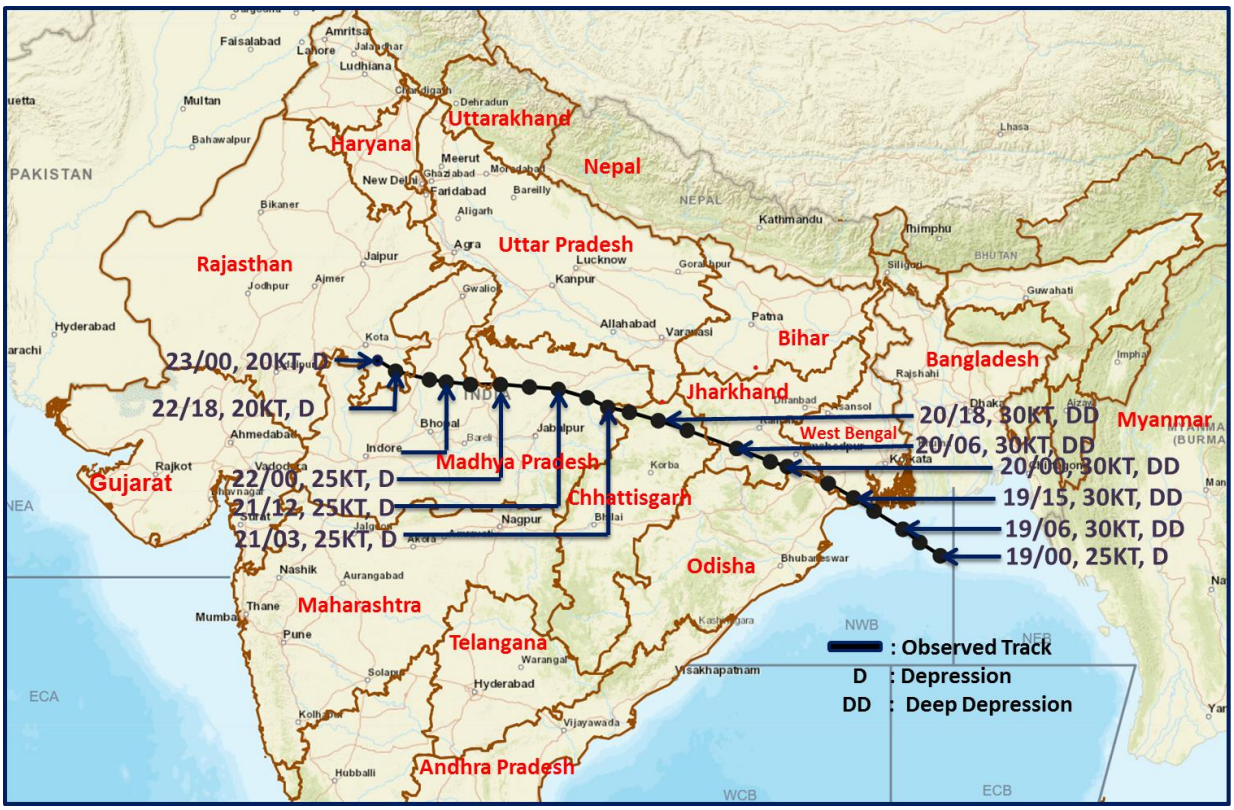


Fig.1 : Best track of Deep Depression over Bay of Bengal (19-23 August 2022)

2. Brief life history

2.1. Genesis

A upper air cyclonic circulation lay over south Myanmar & neighbourhood on 17th August. Under it's influence, a low pressure area formed over northeast and adjoining areas of eastcentral Bay of Bengal, Bangladesh & Myanmar Coasts at 0530 hours IST (0000 UTC) of 18th August, 2022.

The system was in favourable environment with sea surface temperature of about 29-30°C over north Bay of Bengal. Low level positive vorticity was about $100x10^{-6}$ s^{-1} to the south of system centre. Low level convergence was about $20x10^{-5}$ s^{-1} to the southwest of system centre. Positive upper level divergence increased and was about $40x10^{-5}$ s^{-1} to the southwest of system centre. Robust westward outflow was seen in upper levels. Moderate vertical wind shear about 15-20 knots was prevailing over the system area. Under favourable environmental conditions, the low pressure area concentrated into a depression over northwest & adjoining northeast Bay of Bengal and lay centered at 0530 hrs IST(0000 UTC) of 19th August 2022, near latitude 20.5°N and longitude 89.7°E, about 310 km east-southeast of Balasore (Odisha), 250 km east-southeast of Digha (West Bengal) and 210 km east-southeast of Sagar Islands.

2.2. Intensification and movement:

At 0000UTC of 19th August ,the system over northwest Bay of Bengal was in favourable environment with sea surface temperature of about 29-30°C over north Bay of Bengal. Ocean thermal energy is about 35-50 KJ/cm^2 near system centre. Low level relative vorticity was around to 150x10^{-6}s^{-1} to the south of system centre. Low level convergence was about 10x10^{-5} s^{-1} to the northwest of system centre. Upper level divergence was about 20x10^{-5} s^{-1} to the northwest of the system centre. Westward outflow was prevailing in upper levels. High vertical wind shear of about 25-30 knots was prevailing over northwest Bay of Bengal and along the forecast track.

The Madden Julian Oscillation (MJO) index was in phase 1 with amplitude more than 1. At 0600 UTC the vorticity increased becoming around 200x10^{-6} s^{-1} to the south of system centre. Low level convergence is about 20x10^{-5} s^{-1} to the southeast of system centre. Upper level divergence is about 20x10^{-5} s^{-1} to the southeast of the system centre and associated westward outflow is prevailing in upper levels. Vertical wind shear was around 20 knots near system. Under these conditions, the depression moved west-northwestwards, intensified in a deep depression over same region and lay centered at 1130 hrs IST of 19th August, 2022, about 200 km east-southeast of Balasore (Odisha), 140 km east-southeast of Digha (West Bengal), 100 km southeast of Sagar Islands (West Bengal) and 120 km south-southeast of Canning (West Bengal). Continuing to move west-northwestwards, it crossed West Bengal and adjoining North Odisha coasts between Balasore and Sagar Islands, close to Digha during 1900 to 2000 hours IST(1330-1430 UTC) of 19th August, 2022 and lay centered at 1730 hrs IST of 19th August, 2022 over coastal areas of Odisha and West Bengal and neighbourhood

3. Monitoring through satellite and radar:

India Meteorological Department (IMD) maintained round the clock watch over the all-weather systems over Bay of Bengal as well as over land area during the monsoon season 2022. The formation of low pressure system over north Bay of Bengal was monitored since 11th August, about 7 days prior to the formation of LPA over north BoB on 18th. The evolution and movement of the cyclonic disturbance was monitored over both land and sea with the help of available satellite observations from INSAT 3D and 3DR, polar orbiting satellites and available ships & buoy observations in the region. The system was also monitored by Doppler Weather RADARs (DWR), Paradip whenever it was within the range of the radar. Typical satellite and radar imageries for different stages of the system are shown in Fig.2.

3.1 Detailed feature observed through Satellites:

At 0300UTC of 18th August, as per INSAT 3D imagery at 0300 UTC, low level cyclonic circulation lay over Arakan coast and adjoining northeast Bay of Bengal & neighbouhood. Scattered to broken low and medium clouds with embedded intense

to very intense convection lay over north and adjoining central Bay of Bengal & Arakan coast. Minimum cloud top temperature is -93^{0}C.

At 0000UTC of 19th August, as per INSAT 3D imagery intensity of the system was characterized as T1.5. Clouds became organized and took the shear pattern with convection sheared to the west of the system centre. Scattered to broken low and medium clouds with embedded intense to very intense convection lay over north and adjoining central Bay of Bengal. Minimum cloud top temperature is -93^{0}C. As per multisat winds at 0000 UTC, stronger winds are prevailing in the northeast & northwest sectors of the system over north Bay of Bengal & adjoining west Bengal & Bangladesh coasts.

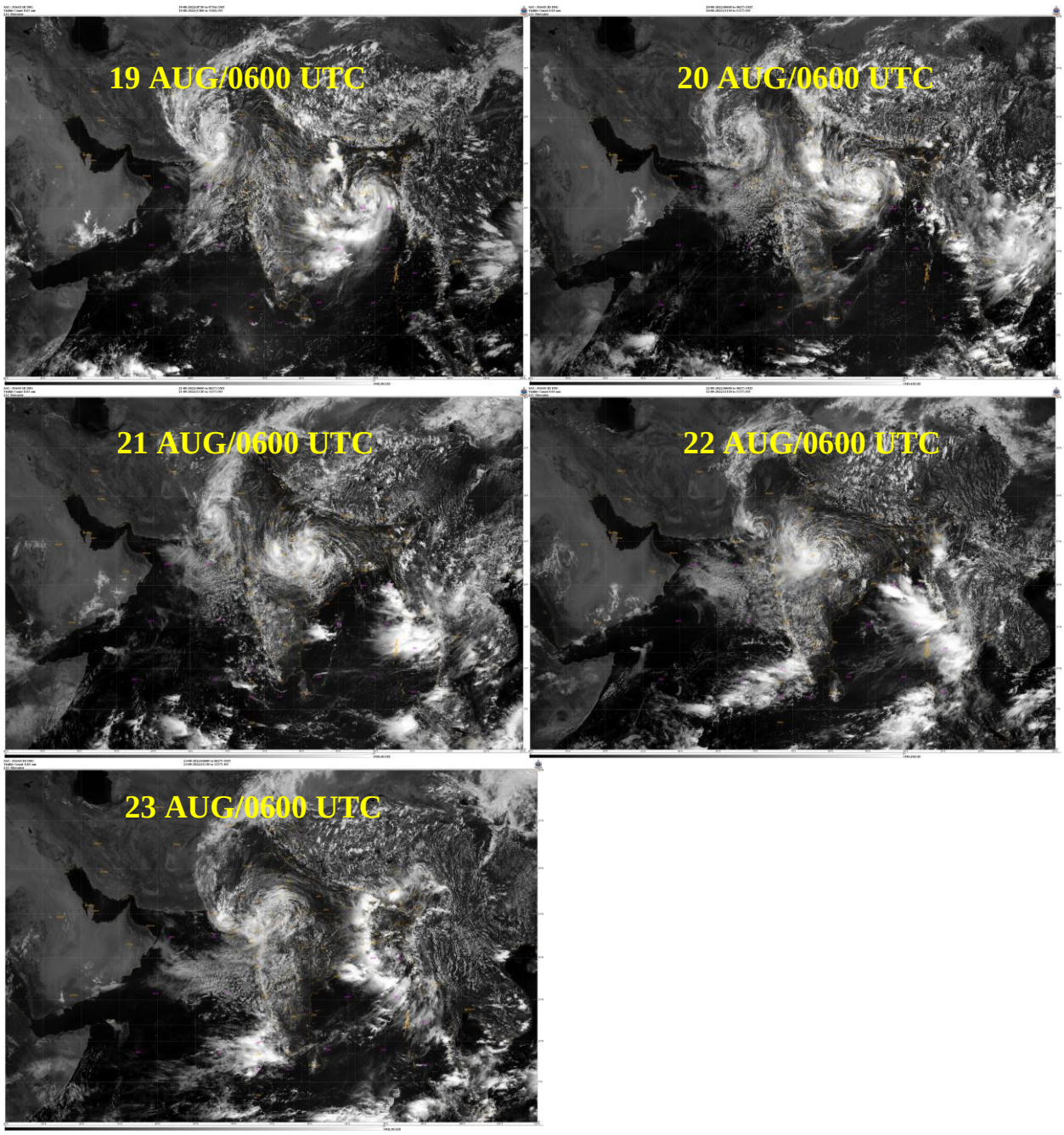


Fig. 2(i): INSAT-3D Visible imageries during 19th-23th August, 2022

At 0600UTC of 19th August, as per INSAT 3D imagery intensity of the system was characterised as T 2.0 with increase in convection and its organisation. Scattered to broken low and medium clouds with embedded intense to very intense convection lay over north and adjoining central Bay of Bengal. Minimum cloud top temperature is -93^{0}C.

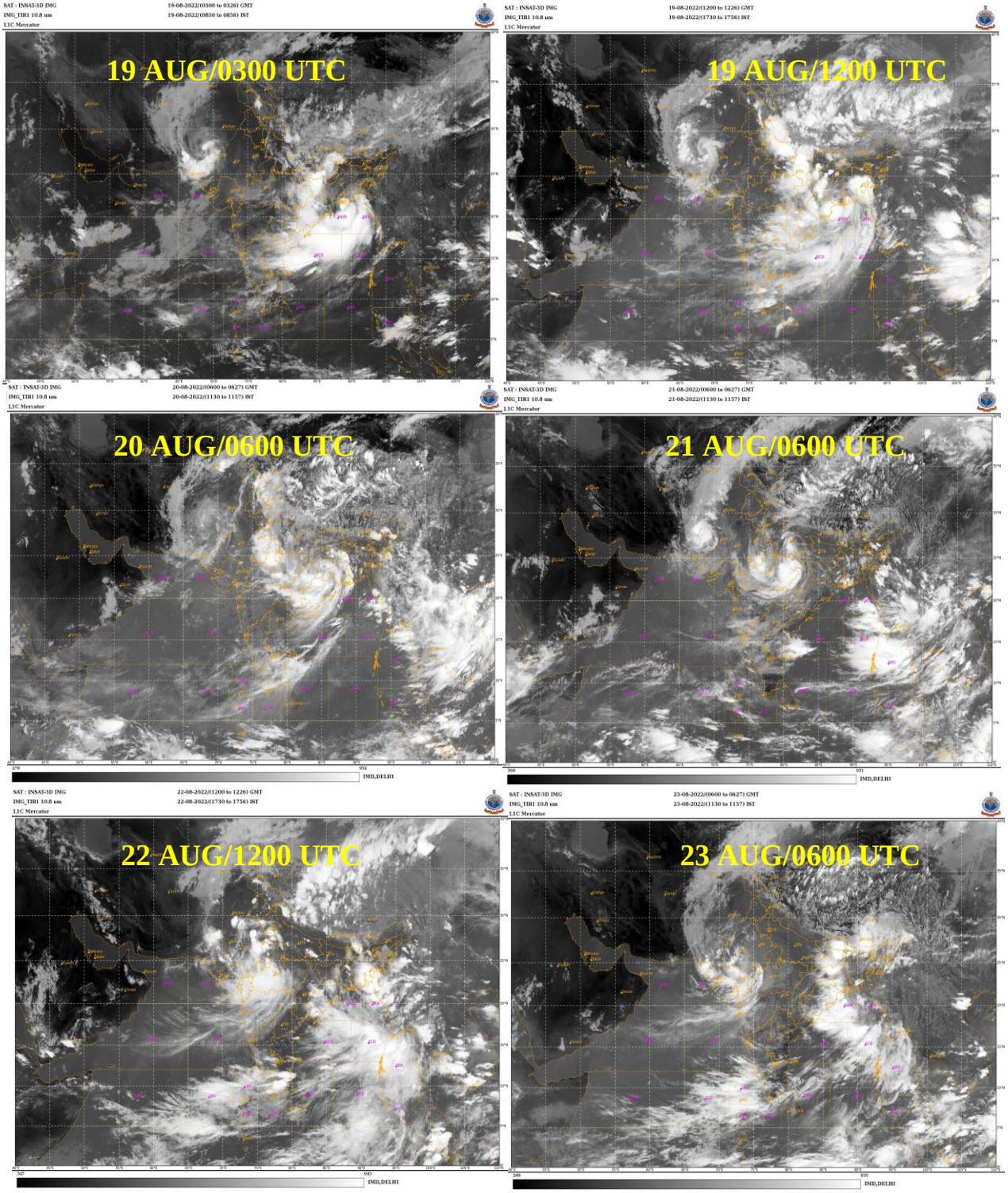


Fig. 2(ii): INSAT-3D IR imageries during 19th-23th August, 2022

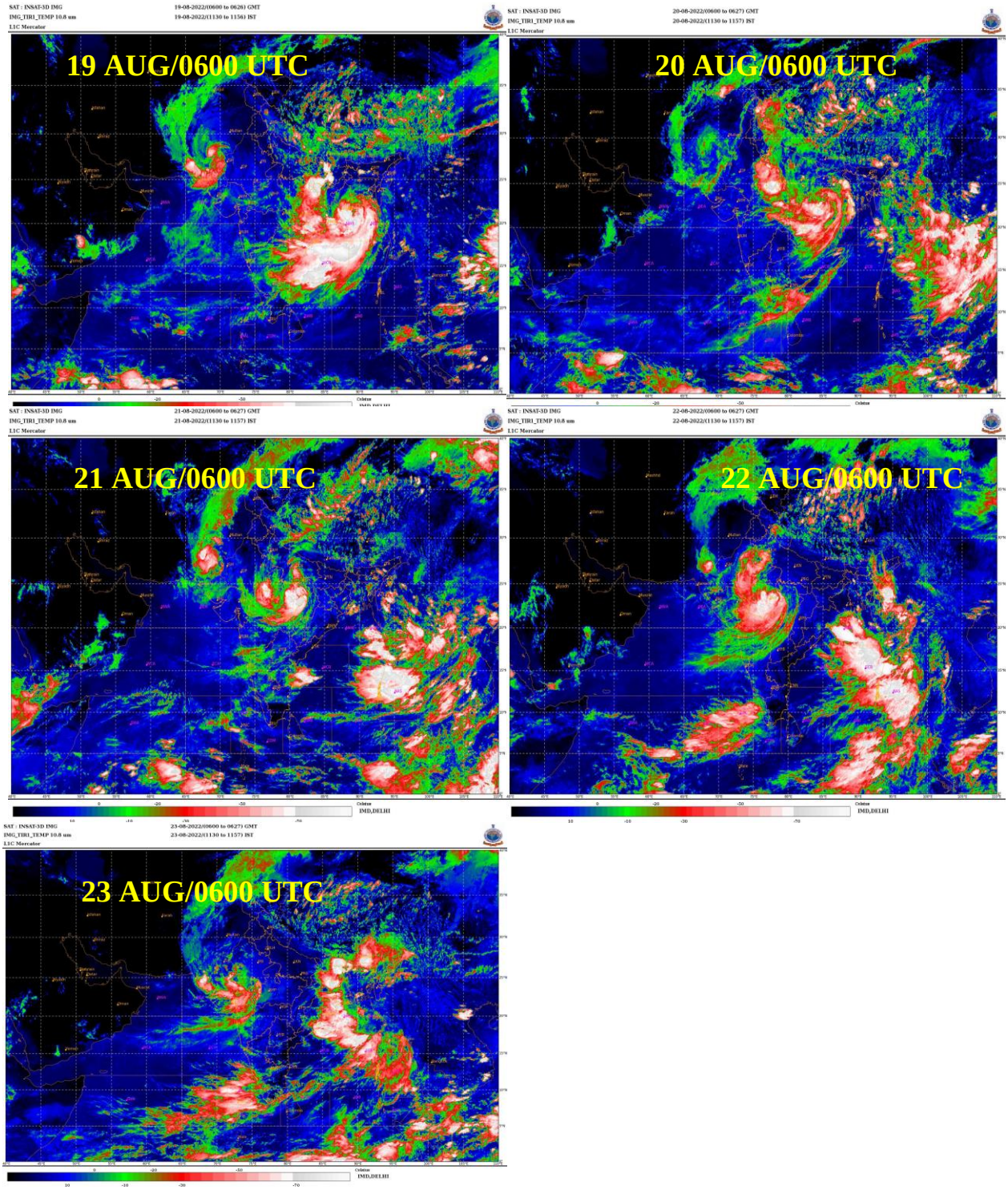


Fig. 2(iii): INSAT-3D NHC imageries during 19th-23th August, 2022

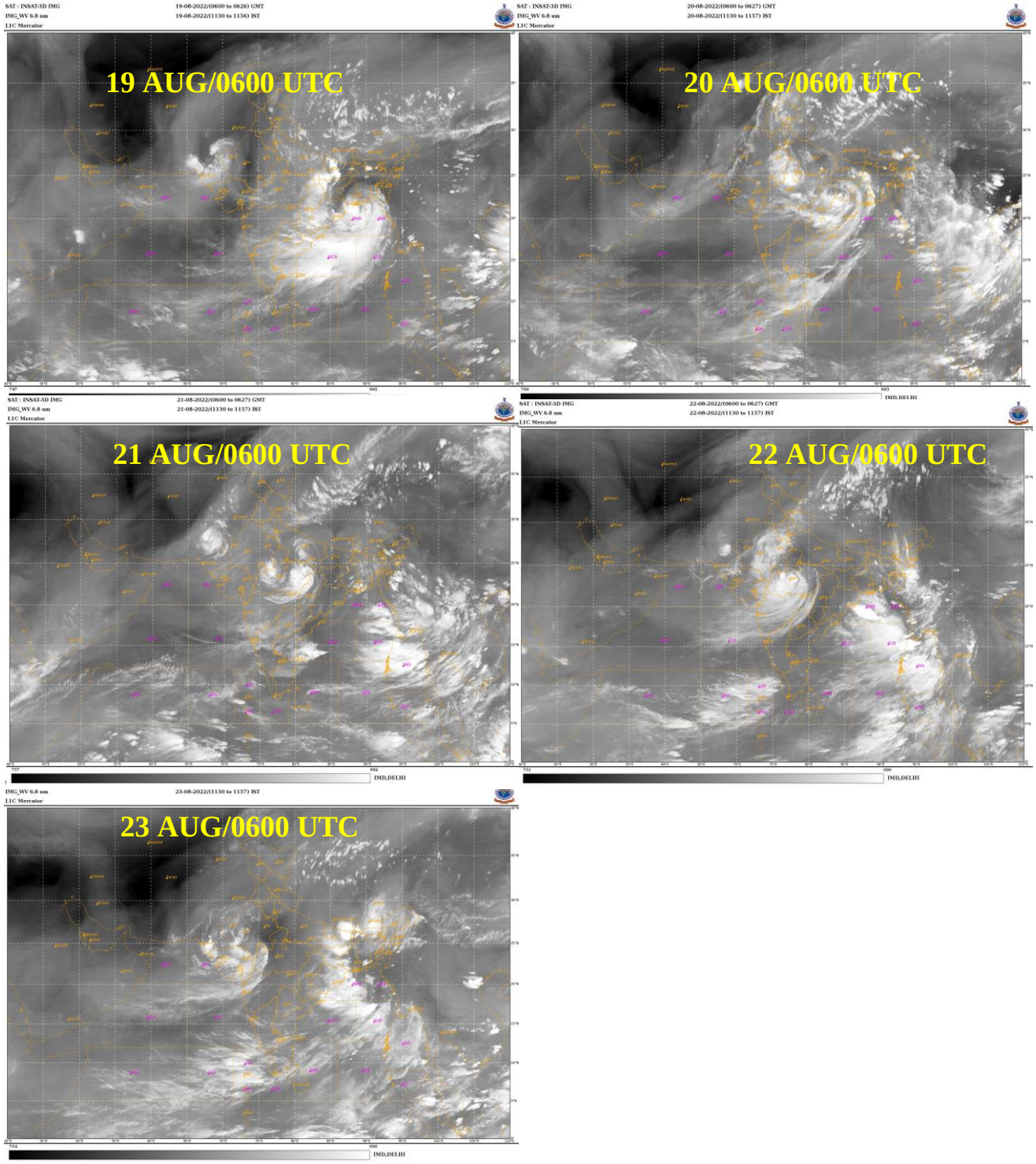


Fig. 2(iv): INSAT-3D Water Vapour imageries during 19th-23th August, 2022

4. Dynamical features

IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10 m, 850, 500 and 200 hPa levels are presented in Fig.3(i) to (v). The analysis fields of IMD GFS at 0000 UTC of 19th August indicated a deep depression over northwest BoB off West Bengal & Bangladesh coasts with vertical extension up to 500 hPa level. East-

southeasterly winds prevailed in the upper level indicating equatorward outflows and west-northwestwards movement. GFS analysis slightly overestimated the intensity at 0000 UTC of 19th, as system lay as a depression over northwest BoB at that time.

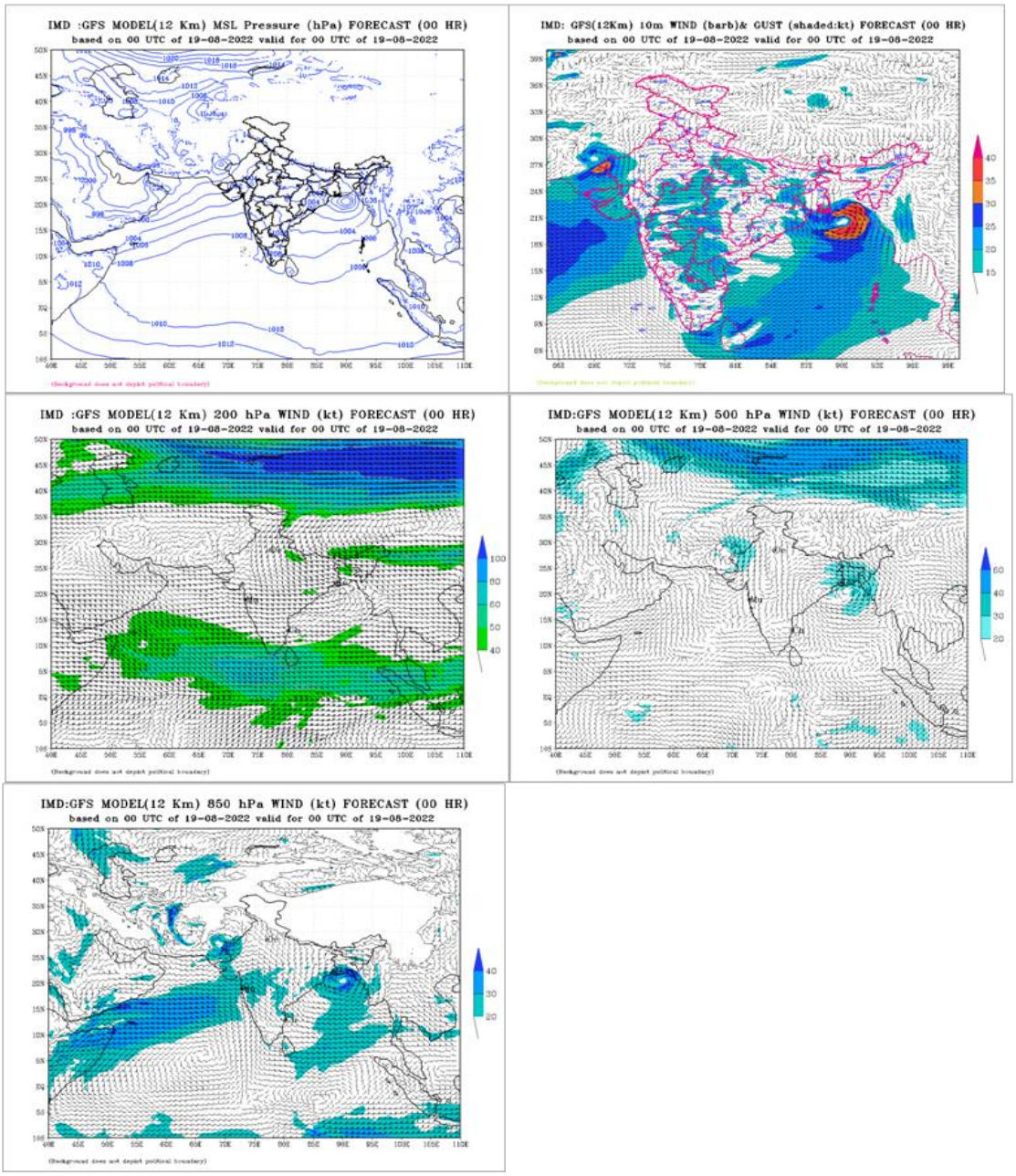


Fig 3(i): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 19th August 2022

The analysis field of IMD GFS at 0000 UTC of 20th August portrayed further intensification of the system over coastal areas of Gangetic West & north Odisha with vertical extension up to 500 hPa level. The overestimation trend in capturing the intensity of the system was again seen in the GFS analysis at 0000 UTC of 20th as system lay as a deep depression over north coastal Odisha & adjoining area at that time. However, movement and landfall time was well picked up.

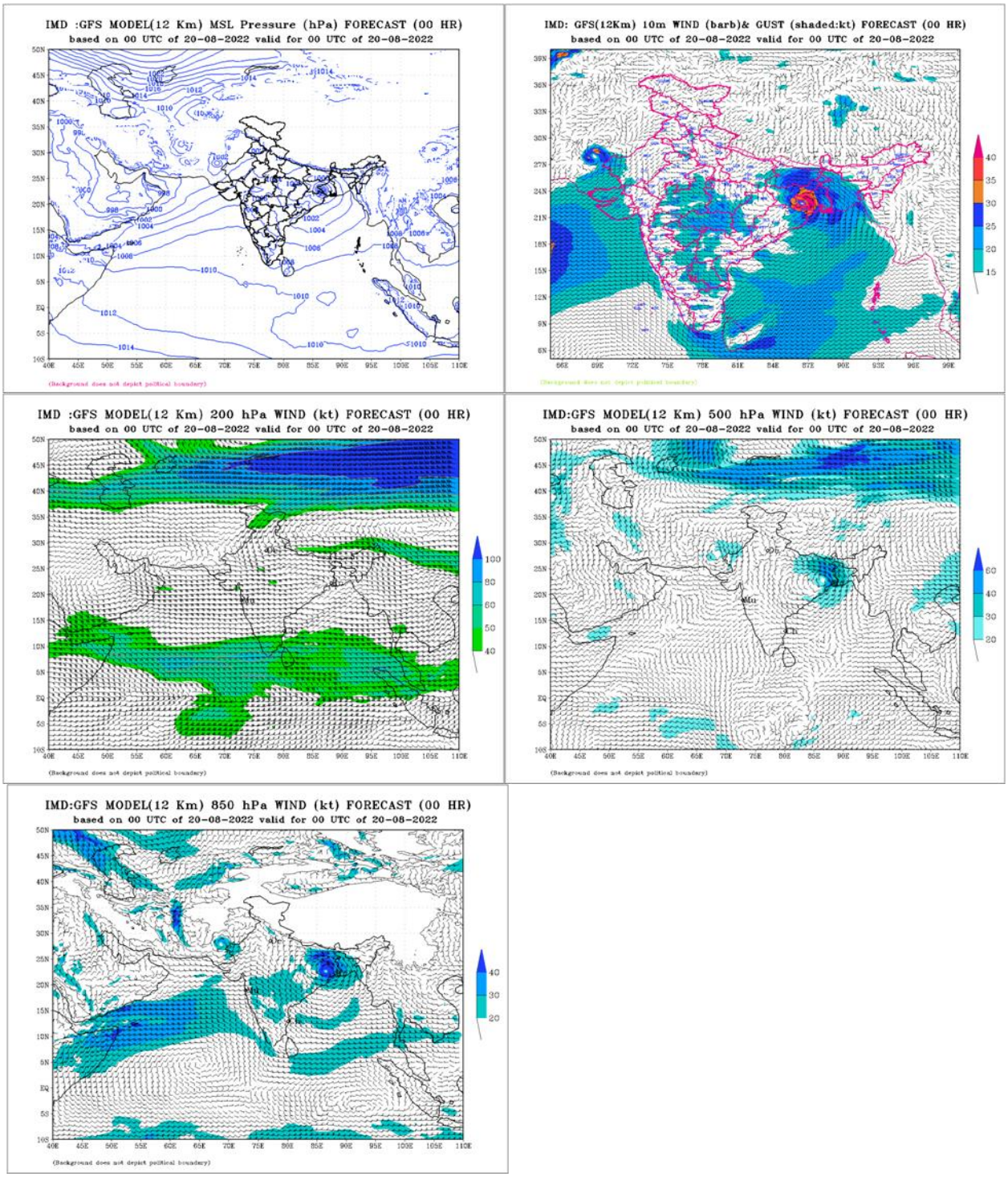


Fig 3(ii): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 20th August 2022

The analysis field of IMD GFS at 0000 UTC of 21st August indicated weakening of system over northeast Madhya Pradesh & adjoining North Chhattisgarh but with a little higher intensity keeping the initial overestimation trend in indicating the intensity in terms of pressure drop at the center. The system therefore showed west-northwestward movement in the model analyses which agreed well with the observed track.

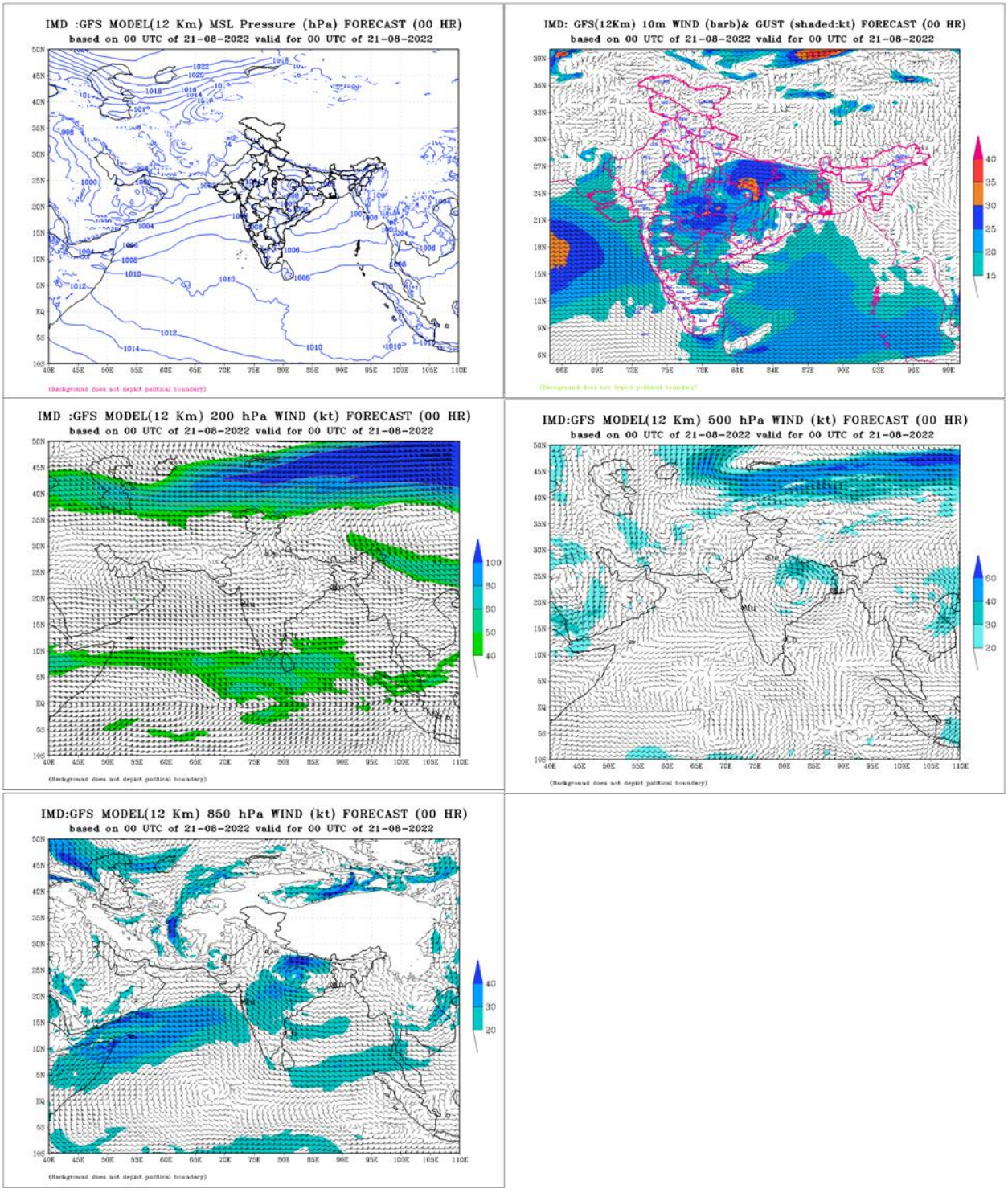


Fig 3(iii): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 21st August 2022

The GFS analysis at 0000 UTC of 22nd August indicated further westward movement of the system over north Madhya Pradesh with associated cyclonic circulation extending up to 500 hPa with its axis tilting southwestward. The model indicated persisting intensity with well-defined structure and very slow weakening during this stage.

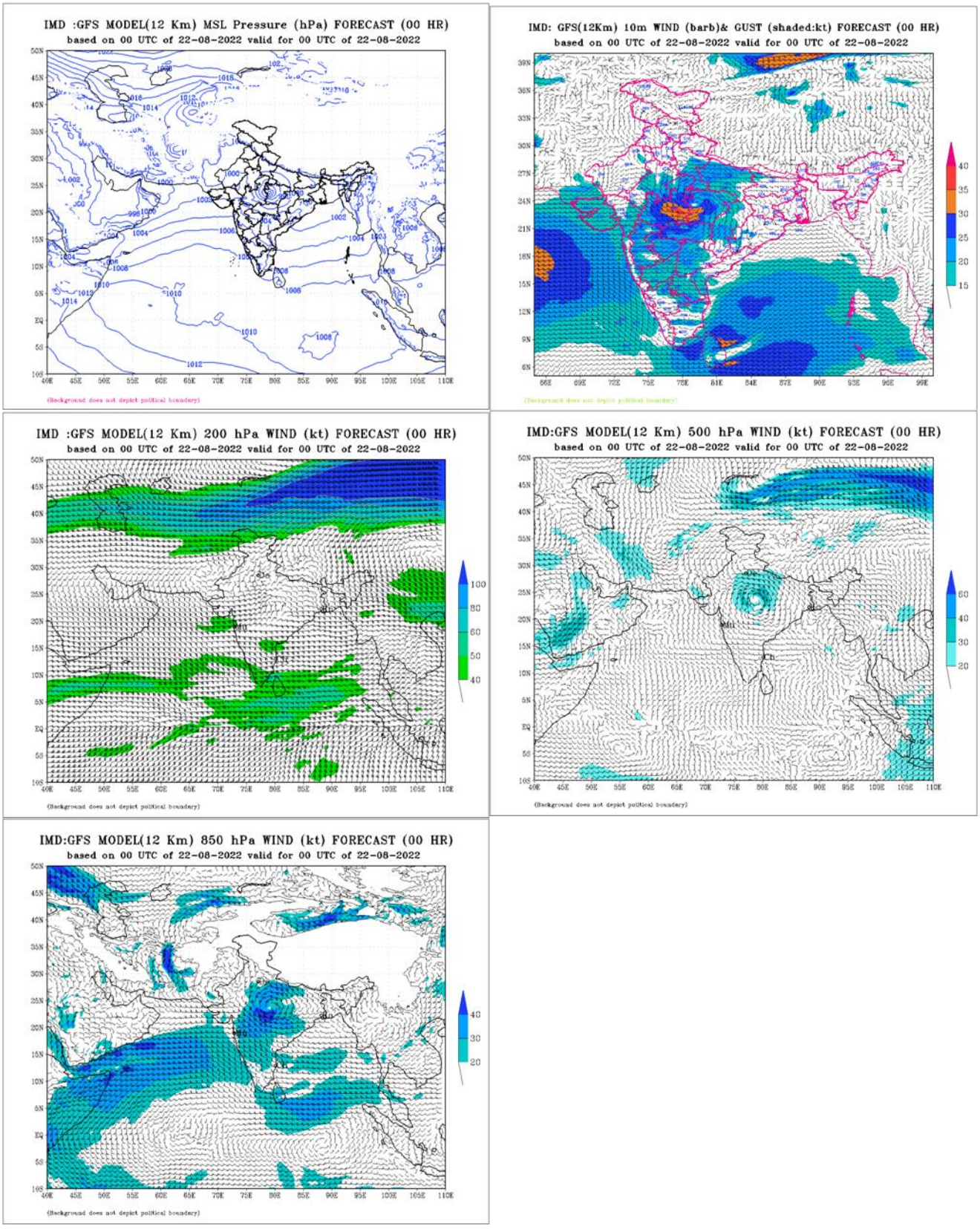


Fig 3(iv): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 22nd August 2022

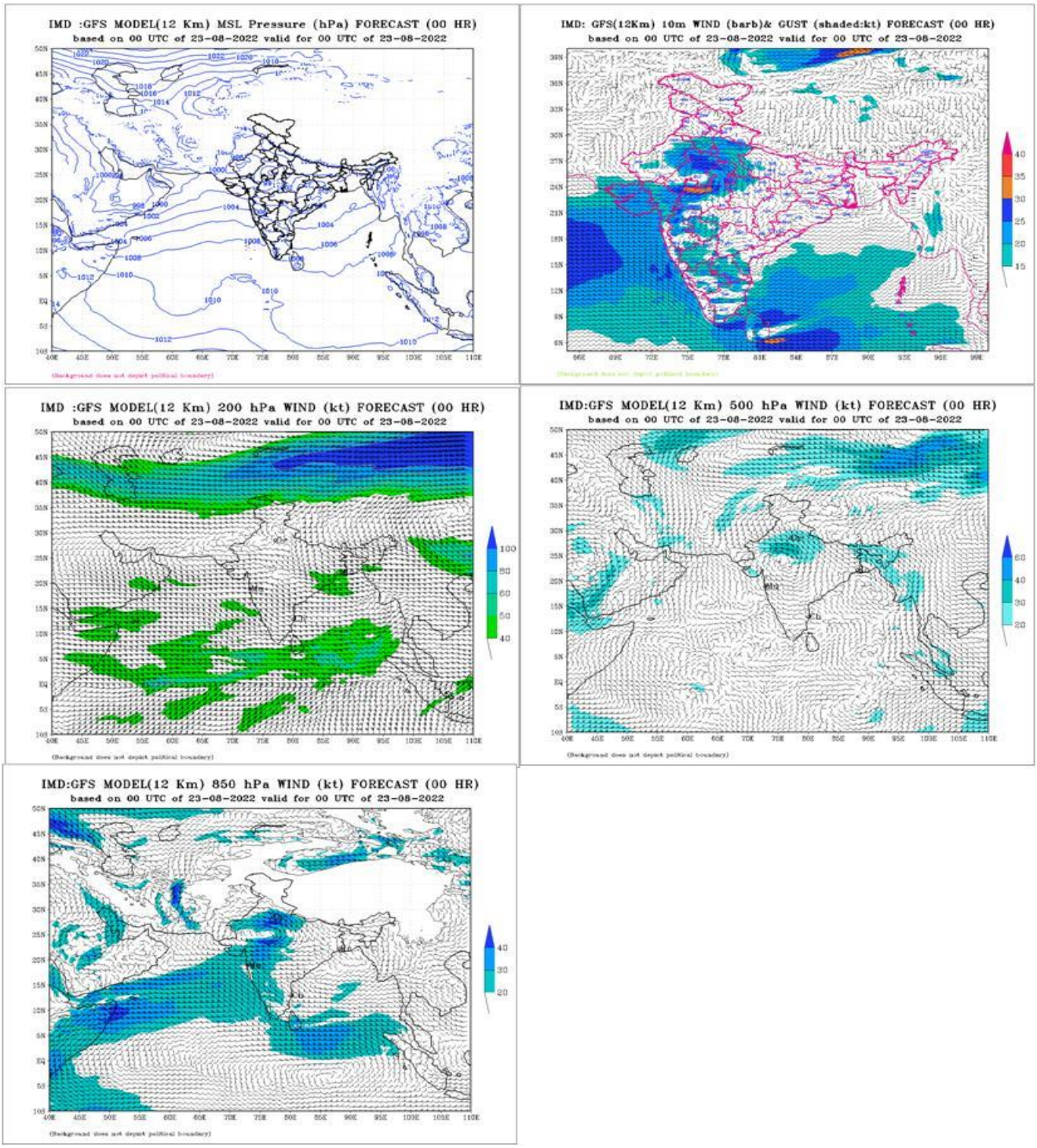


Fig 3(v): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 23rd August 2022

The GFS analysis at 0000 UTC of 23rd August displayed further westward movement of the system over east Rajasthan and quick weakening to a well-marked low pressure area which agrees well with the observed characteristics of the system.

Thus, IMD GFS analyses could capture the genesis and movement correctly. However, it slightly over estimated the intensity of the system.

5. NWP Model performance:

5.1 Track Prediction by GEFS model:

Fig. 4 shows ensemble tracks of DD, GFS(control i.e. AC00), ensemble mean (AEMN) based on different initial conditions such as 00UTC 19 August, 00UTC 20 August, 00UTC 21August, 00UTC 22August, 00 UTC 23 August and 00UTC 25 March. Initially with 00UTC 19th August IC, the ensemble is able to capture the west-northwestward movement of the system and the observed track of the was within the shaded region of the probabilistic track forecasts, whereas the forewcasts based 20th August 0000 UTC, was showing a little deviation from the reality initially with a more northerly component compared westerly in the movement. But the probabilistic track forecasts by the model from the ICs at 0000 UTC of 21st to 22nd August represented good agreement with the observed track of the system.

5.2 Intensity Prediction by GEFS model:

The lower panels of Fig 4(i) to (ii) show the intensity forecast in terms of Maximum sustained wind speed (MSW) in knots at various initial conditions. The probabilistic intensity forecasts by the model based on all ICs could capture the sustenance of the system as a depression over Madhya Pradesh from 21st August to 23rd August morning. The intensity of the system during initial deep depression stage were also predicted well by the model. But, for most of the ICs, intensity prediction shows a little overestimation by GEFS model.

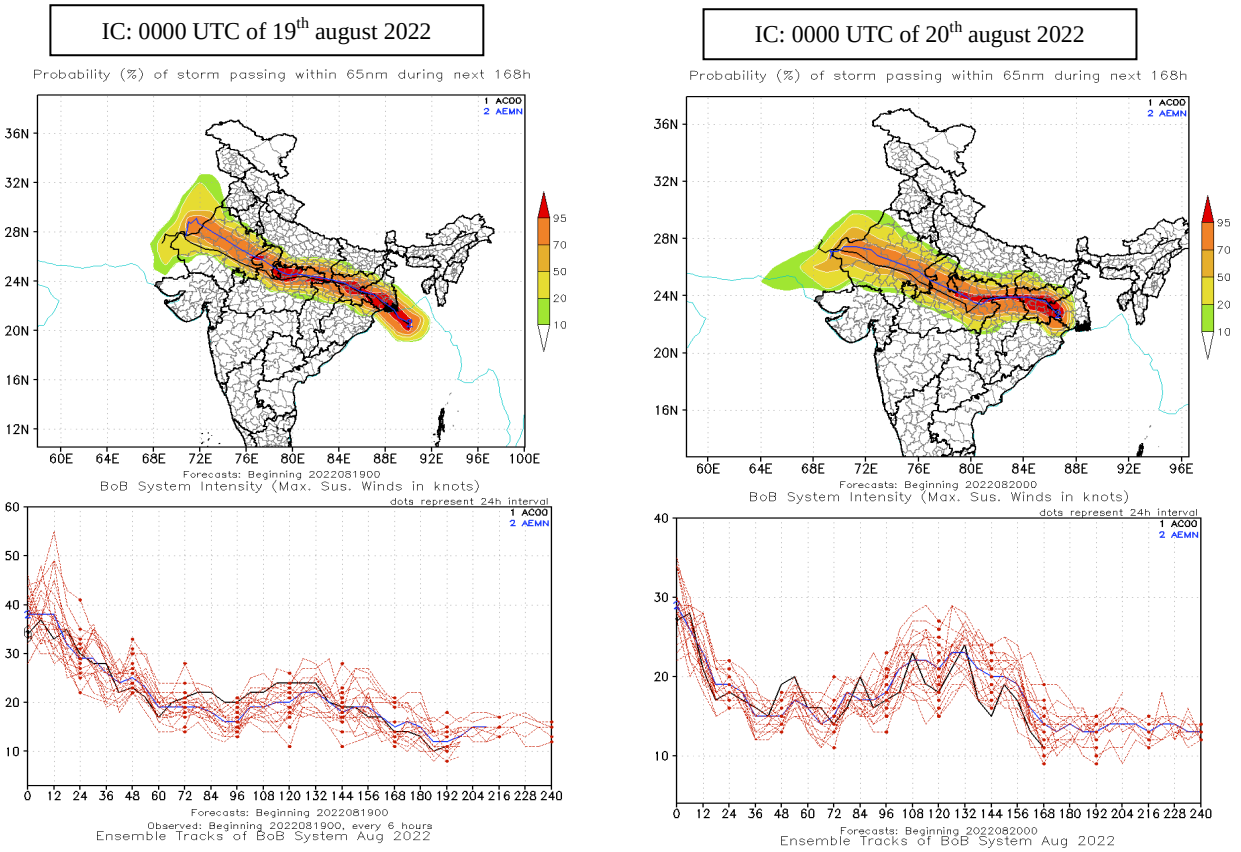
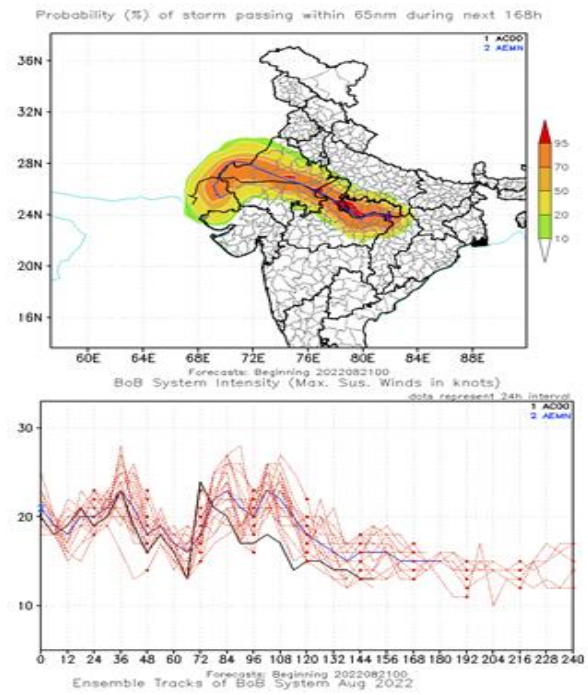


Fig 4(i) GEFS Ensemble Tracks and intensity Left Panel: for ICs : 2022081900, Right Panel: 2022082000 respectively.

IC: 0000 UTC of 21st august 2022



IC: 0000 UTC of 22nd august 2022

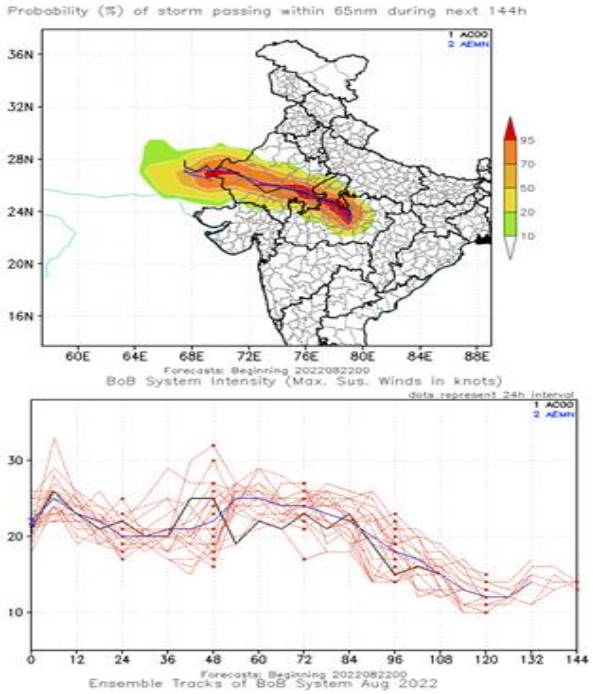


Fig 4(ii) GEFS Ensemble Tracks and intensity Left Panel: for ICs : 2022082100, Right Pannel: 2022082200 respectively.

6. Realized Weather:

6.1 Rainfall distribution:

Under the influence of deep depression, active to vigorous monsoon conditions prevailed leading to extremely heavy rainfall at a few places over Odisha on 12th & 13th, at isolated places over Chhattisgarh on 13th and over East Madhya Pradesh on 14th. In conjunction with another low pressure area over Gujarat, extremely heavy rainfall at a few places also occurred over Saurashtra and north Konkan on 13th September. Low level convergence of wind & enhanced moisture incursion from the Bay of Bengal in association with a trough extending eastwards across the system also caused extremely heavy rains at isolated places over West Bengal on 14th September.

The daily rainfall distribution ending at 0300 UTC of each date during 9-15 Sept, 2021 based on merged gridded rainfall data of IMD/NCMRWF is shown in Fig.7(i)

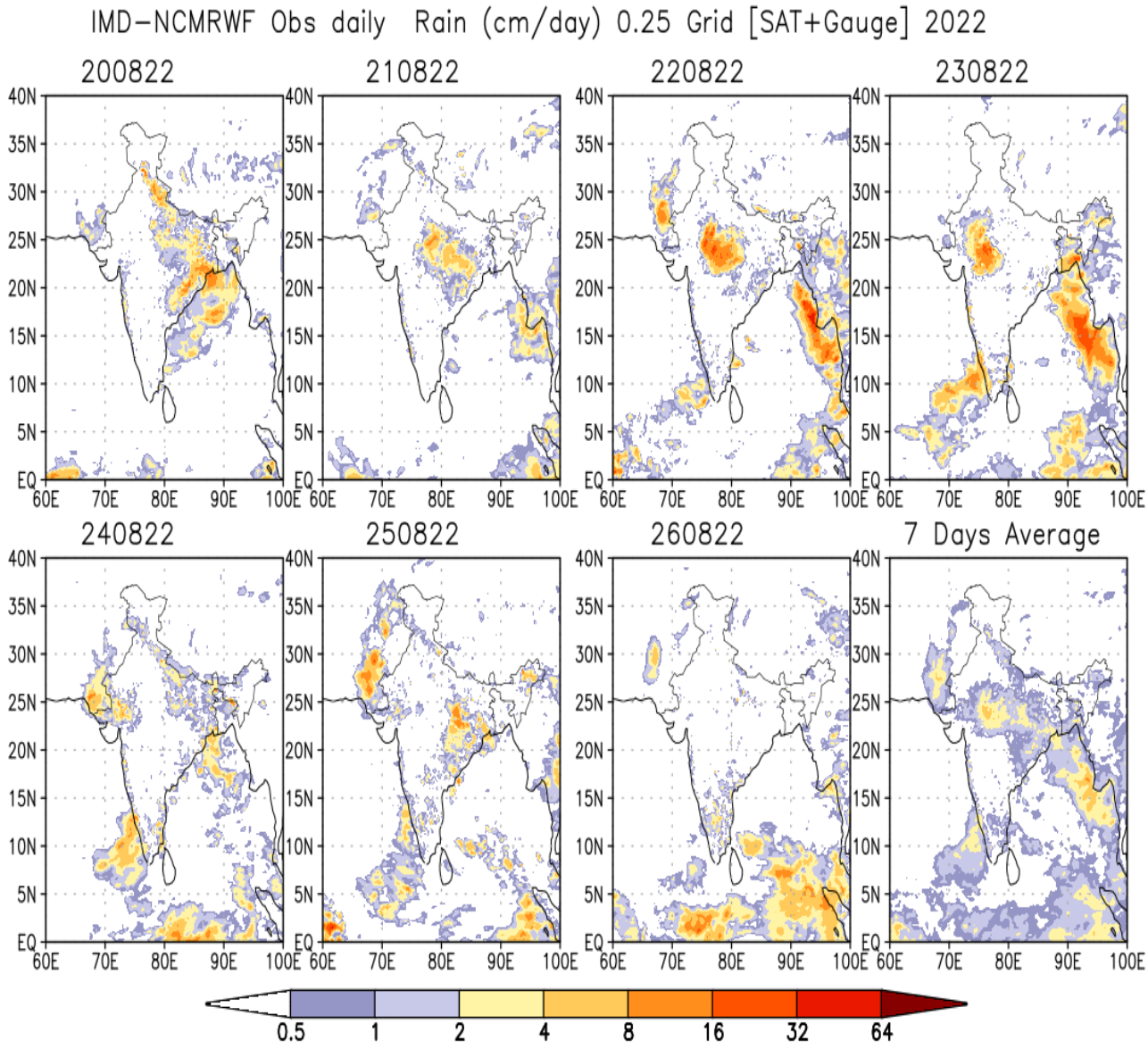


Fig. 5(i): Daily rainfall distribution based on merged grided rainfall data of IMD/NCMRWF during 20 August- 23 August, 2022

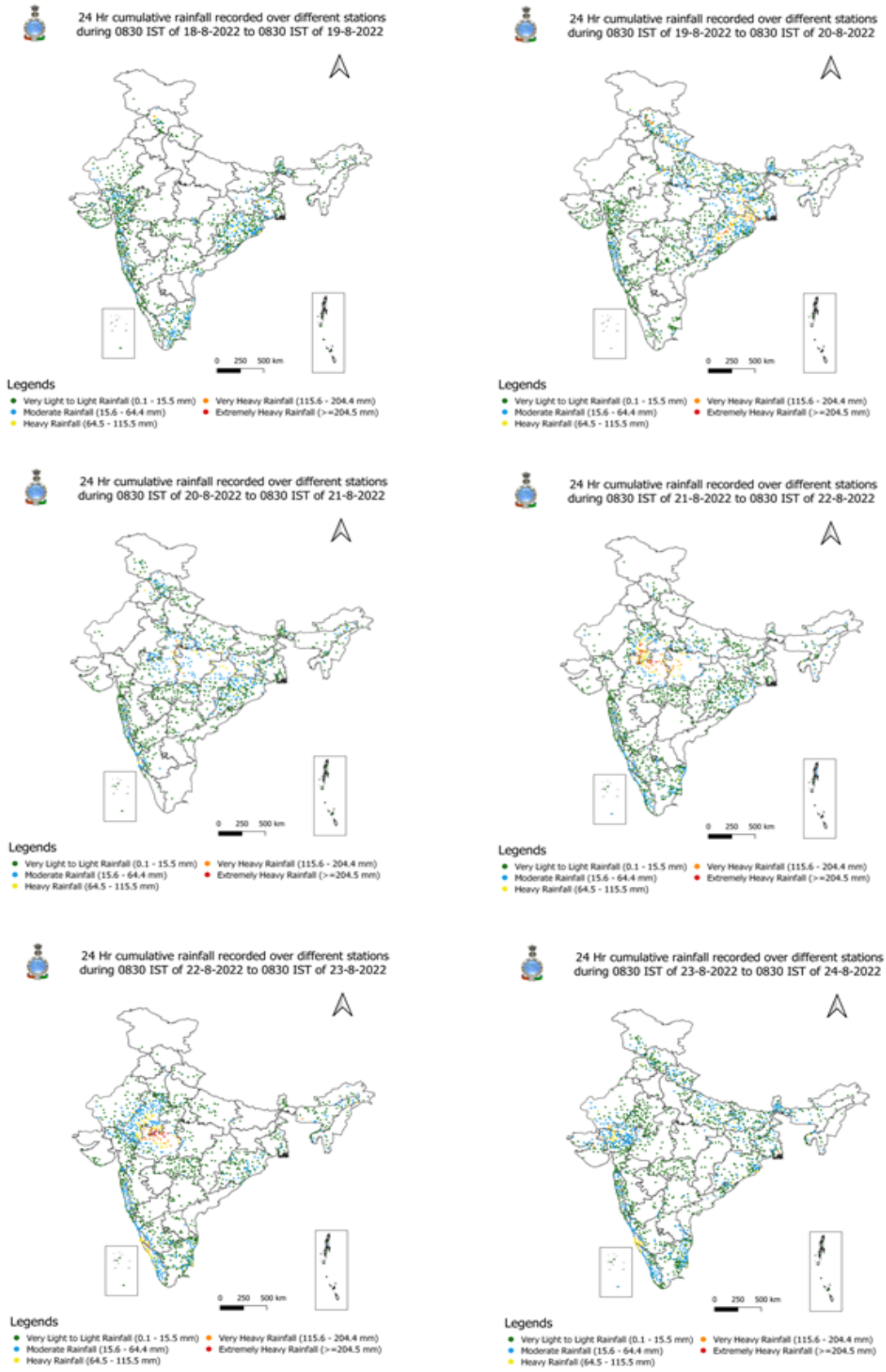


Fig. 5(ii): 24 hr cumulative rainfall distribution recorded over different stations of IMD during 19 August- 24 August, 2022

6.2 Daily cumulative rainfall at stations:

Datewise and sub-division-wise 24 hours accumulated rainfall (≥ 7cm) ending at 0830 hours IST of date in association with the system during 19th to 23rd August are given below:

19 August

Gangetic West Bengal:-Durgapur-17, Panagarh (Iaf)-13, Luchipur-9, Purulia&Simula-8 each, Gheropara&Burnpur-7each

Odisha:-Gop-12, Paradeep Cwr&Kantamal-11 each, Phiringia, Deogarh, Angul, Phulbani&Mohakalapada-9 each, Boudhgarh, K Nuagaon&Batagaon-8 each, Jujumura, Athmalik, Tensa, Kujanga&Rajnagar-7 each

Jharkhand:-Maithon-9, Panchet-8

Coastal Andhra Pradesh & Yanam:-Palakonda-8

Tamilnadu, Puducherry & Karaikal:-Dindigul-10, R.S.Mangalam-9, Kollidam-7

20 August

Assam & Meghalaya:-Williamnagar-10

Sub-Himalayan West Bengal & Sikkim:-Chengmari/Diana-7

Gangetic West Bengal:-Digha-18, Contai-15, Kharidwar-12, Phulberia&Jhargram (Pto)-11 each, Purihansa-10, Kalaikunda (Iaf)-9, Kansabati Dam, Tusuma, Lalgarh&Amfu Kharagpur-8each, Durgachack-7

Odisha:-Bhograi-23, Phiringia-21, Nawana&Tikabali-20 each, Chakapad, Bahalda&Batagaon-19 each, Kusumi-18, Phulbani, Tiring&Udala-17 each, Junagarh, Joshipur&Tikarpara-16 each, Rajghat, Betanati&Balasore-15 each, Baliguda, Boudhgarh&Kotagarh-14 each, Lanjigarh, Madanpur Rampur, K Nuagaon&Khajuripada-13 each, G B Nagar, Golamunda, Harabhanga, Muruda, Tensa, Jaleswar&Jaipur-12 each, Nh5 Gobindpur, Balimundali, Baripada, Remuna, Jamda, Rairangpur&Dharmagarh-11 each, Kotraguda, Jamsolaghat, Samakhunta, Lamataput, Champua, Joda, Suliapada, Talcher&Jhumpura-10 each, Naktideul, Muniguda, Narla, Raruana, Barmul, Sukruli, Bangiriposi, Thakurmunda, Kalampur&Chendipada-9 each, G Udayagiri, Bahanga, Kaniha, Th Rampur, Bissem-Cuttack, Bhawanipatna, Karanjia, Deogarh, Reamal, Ambadola, Nandapur&Chandanpur-8 each, Gurundia, Similiguda, Banaigarh, Kotpad, Jeypore, Rajkishorenagar, Barkote, Karlamunda, Raikia, Kesinga, Dabugan&Pallahara-7 each

Jharkhand:-Ramgarh&Jamshedpur Aero-14 each, Jaganathpur Bau Kvk Aws-13, Kharsema&Mandar-12 each, Chakradharpur, Chandil, Nimdih&Arki-11 each, Ramgarh(Bdo)-10, Gomia, Ghatsila, Jamshedpur, Icar Namkum&Parsabad-9 each, Chatra, Mandu&Balumath-8 each, Bano Simdega Kvk Aws, Chandrapura, Tenughat, Kuru, Koderma, Koner, Diyakel Khunti Kvk Aws, Ramgarh Kvk Aws&Chandankiary-7 each

Bihar:-Dharhara-13, Rajauli&Itarahi-10, Motihari, Bihar Shrif, Barhampur&Jahanabad-9 each, Kako, Simri&Ekangersarai-8 each, Charpokhiri, Arwal, Hisua, Narhat, Islampur, Nawada&Barhiya-7 each
East Uttar Pradesh:-Fatehpur Tehsil-15, Elgin Bridge&Karwi-9 each, Chanderdeepghat-8, Nawabganj Tehsil-7, Hasanganj&Kaiserganj-7 each
West Uttar Pradesh:-Baheri-10, Bilaspur-7
Uttarakhand:-Rishikesh-29, Narendranagar-18, Khatima-16, Mussoorie-14, Jollygrant&Kashipur-14 each, Yamkeshwar-13, Uttar Kashi (Cwc)&Nainital-12 each, Uttar Kashi-11, Chakrata, Betalghat, Hardwar&Gairsain-10 each, Dhanaulti&Sama-9 each, Kotdwara&Haldwani-8 each, Jakholi, Loharkhet, Pithoragarh, Banbasa, Deoprayag&Someshwar-7 each
Himachal Pradesh:-Kangra Aero-35, Dharmsala-33, Jogindarnagar-21, Naina Davi-18, Baijnath-15, Gohar&Bijahi-13 each, Mandi&Pandoh-12 each, Palampur, Dalhousi Alha Aws, Sarkaghat&Mashobra Aws-11 each, Theog-9, Sundarnagar-8, Kandaghat, Hmo Shillaro, Kahu&Kufri Aws-7 each
Jammu, Kashmir & Ladakh:-Reasi Arg-8, Udhampur(Iaf)-7
East Rajasthan:-Rajakhera-8, Bari-7
West Madhya Pradesh:-Bhind-Aws-10, Alipur(Jaura)-9, Ambah-7
East Madhya Pradesh:-Umaria-Aws-9, Nagode&Teonthar-8 each, Rewa-Aws, Majhgaon&Dindori-Aws-7 each
Chhattisgarh:-Kusmi-9, Odagi-8

21 August

Odisha:- Banaigarh-14, Ambadola-10, Deogarh-10, Bargaon-9, K Nuagaon, Lahunipara, Jamankira&Tikabali-8 each, Phiringia, Balisankara, Kutra, Rajgangpur&Kantamal-7 each
East Uttar Pradesh:- Karwi&Kunda-9 each, Ghorawal-8
West Uttar Pradesh:- Mauranipur-12, Lalitpur&Talbehat-9 each
West Madhya Pradesh:- Chanderi-15, Pichhore-13, Pathari-12, Khaniyadana-10, Gairatgang-9, Isagarh-8, Begumganj&Mungaoli-8 each, Udaipura, Badarwas, Ater, Pipariya, Guna-Aws, Kumbhraj&Ganjbasoda-7 each
East Madhya Pradesh:- Channodi-17, Orchha&Benibari-16 each, Niwari, Anuppur-Aws, Panna-Aws&Mohangarh-15 each, Umaria-Aws&Venkatnagar-14 each, Amarpur-13, Jaitpur, Pushprajgarh, Kareli, Pali&Dindori-Aws-12 each, Jaisingh Nagar, Mohgaon, Bajag, Chandia, Lidhora, Naigarhi, Gohparu&Gudh-11 each, Bijadandi-10, Niwas, Bina, Palera, Prithvipur, Shahpura (District: Dindori)&Majhauli-10 each, Ramnagar-9, Mada, Katni(Mudwara), Sidhi (Gopadbanas), Hanumana, Mawai, Kotma, Bijawar, Tikamgarh-Aws, Barhi, Manpur, Budhar&Amarkantak-9 each, Khurai, Karanjia, Mangawan, Ajaigarh, Beohari, Jaithari, Sihawal, Kusmi, Shahdole(Sohagpur), Rahatgarh, Simariya, Harrai&Deori-8 each, Devendranagar, Baihar, Rajnagar, Samnapur, Bijuri, Pawai, Bichhia, Mauganj, Gadarwara, Singrauli-Aws, Huzur, Narsinghpur-Aws, Ghughri&Gaurihar-7 each

Chhattisgarh:- Kusmi-15, Ramanujnagar-13, Premnagar-9, Rajpur, Khadgava, Surajpur, Balrampur&Odagi-9 each, Bhaiyathan-8, Sonhat, Baikunthpur, Bagicha&Lailunga-8 each, Duldula, Janakpur, Jashpurnagar, Pendra Road, Ambikapur&Manora-7 each

Coastal Karnataka:- Udupi-11, Karkala&Kota-8 each

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Nagaland, Manipur, Mizoram & Tripura:-Khowai-10

Odisha:-Banki-11, Athgarh-7

East Rajasthan:-Dug-23, Kota-Aero-22, Degod Sr&Nainwa-22 each, Ladpura Sr-19, Tonk Tehsil Sr-18, Pipalda Sr&Anta Sr-17 each, Patan&Nagrarfort Sr-16 each, Ramganjmandi Sr-14, Bhainsroadgarh Sr-13, Mangrol, Mandana Sr, Pachpahar Sr&Manohar Thana-13 each, Uniara / Aligarh-12, Chothkabarwara Sr&Aklera-12 each, Sangod-11, Khanpur&Asnawar Sr-11 each, Gangdhar Sr, Bundi, Kishanganj, Bonli&Chabra-10 each, Pirawa, Jhalarapatan Sr, Khandar Sr&Bakani Sr-9 each, Jhalawar, Niwai, Hindoli&Sawaimadhopur Tesil Sr-8 each, Talera Sr-7, Lalsot, Sapotra, Indergarh Sr, Sikrai&Atru Sr-7 each

West Madhya Pradesh:-Biaora-35, Raghogarh&Chachoda-29 each, Lateri-21, Zirapur&Begumganj-20 each, Bairagarh Airport&Aron&Bhanpura-19 each, Guna-Aws-17, Kumbhraj-17, Gairatgang&Shamshabad-17 each, Udaipura-16, Raisen-Aws&Rajgarh-16 each, Bamori, Vidisha, Pathari, Kalapipal, Narsingarh, Pachmarhi, Ganjbasoda&Ashoknagar-Aws-15 each, Bhopal Arera Hills, Shujalpur, Navibagh Aet, Sironj&Pachore-14 each, Deori, Shyampur, Kolar, Berasia, Barod, Kurwai, Sheopur-Aws, Sarangpur, Gulabganj, Isagarh&Khilchipur-13 each, Nateran, Moman Badodiya, Suvasara&Salwani-12 each, Badoda, Sehore-Aws, Gulana, Garoth, Agar, Sohagpur, Pipariya&Nalkheda-11 each, Itarsi, Goharganj, Pichhore, Narmadapuram, Bankhedi&Ichhawar-10 each, Budhni, Manasa, Sultanpur, Chanderi, Bareli, Badi, Mungaoli, Babai (Makhan Nagar)&Jawad-9 each, Shajapur, Susner, Khaniyadana, Jawar&Badarwas-8 each, Ashta-Aws, Bhimpur, Gyaraspur, Malhargarh&Rehti-7 each

East Madhya Pradesh:-Jaisinagar-19, Kesli-18, Simariya&Rehli-18 each, Sagar-Aws-17, Jabalpur-Aws&Rahatgarh-16 each, Banda-15, Patharia&Hatta-15 each, Garhakota-14, Tendukheda (District: Narsinghpur)-14, Tendukheda (District: Damoh)-14, Deori-14, Bina-13, Badagaon Dhasan-12, Narsinghpur-Aws&Bargi-12 each, Gotegaon, Shahgarh, Buxwaha, Batiyagarh, Patan, Niwas&Jabera-11 each, Patera, Damoh-Aws, Malthone, Lakhnadon, Kareli&Khurai-10 each, Sihora, Ajaigarh, Raipura, Amanganj, Kumdam, Sleemanabad, Panna-Aws&Umreth-9 each, Chhapara, Mehadwani, Tamia, Rajnagar, Majhgaon, Dheemarkheda, Shahpura (District: Dindori), Barela, Prithvipur, Gadarwara&Pali-8 each, Vijayraghogarh, Maihar, Khajuraho Aero, Ramnagar, Umariyapan, Majholi, Manpur, Badamalhera, Panagar, Amarpatan, Singodi, Narayanganj, Shahpura (District: Jabalpur)&Orchha-7 each

Tamilnadu, Puducherry & Karaikal:-Panruti-7

Coastal Karnataka:-Gersoppa&Siddapura Arg-7 each

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Assam & Meghalaya:- Williamnagar-17, Williamnagar Aws-12, Margherita-7, Bihubar-7

Odisha:- Khairamal-9

West Rajasthan:- Jaitran-11, Marwar Junction-7, Desuri-7

East Rajasthan:- Dug-29, Arnod Sr-26, Pirawa-23, Bakani Sr-23, Pachpahar Sr-17, Gangdhar Sr-17, Aklera-16, Asnawar Sr-15, Jhalarapatan Sr-13, Jahazpur-12, Manohar Thana-11, Pratapgarh-11, Bijoliya Sr-11, Kekri Sr-11, Pipalkhunt Sr-10, Chabra-10, Jhalawar-10, Chhotisadri-10, Chipabarod Sr-9, Nimbahera-9, Piplu Sr-9, Hindoli-9, Danpur-9, Bhungra Sr-9, Kotkasim Sr-9, Khanpur-9, Nagrarfort Sr-9, Deoli-9, Mandalgarh-9, Uniara / Aligarh-8, Garhi-8, Kotri-8, Chittorgarh-8, Todaraisingh Sr-7, Nainwa-7, Vijaynagar Sr-7, Begu Sr-7, Chothkabarwara Sr-7, Ghatol-7, Nithuwa Sr-7, Rashmi Sr-7, Gangrar-7, Banera Sr-7, Jagpura Sr-7, Nayanagar/Beawar-7, Ramganjmandi Sr-7, Dhariabad-7, Bundi-7, Atru Sr-7

West Madhya Pradesh:- Zirapur-29, Alot-28, Narsingarh-25, Nalkheda-25, Biaora-24, Khilchipur-24, Shamgarh-24, Sehore-Aws-23, Jaora-23, Goharganj-21, Susner-21, Chachoda-21, Berasia-21, Sanjeet-21, Lateri-21, Barod-21, Kalapipal-20, Shyampur-19, Sarangpur-19, Nagda-19, Agar-19, Suvasara-18, Bairagarh Airport-18, Rajgarh-18, Mahidpur-18, Khachrod-18, Bhopal Arera Hills-17, Raisen-Aws-17, Tal-17, Navibagh Aet-17, Begumganj-16, Bhanpura-16, Kayampur-16, Gairatgang-16, Sailana-16, Budhni-16, Pachore-16, Raghogarh-16, Ichhawar-15, Narmadapuram-15, Kolar-15, Bajna-15, Kumbhraj-15, Sitamau-15, Moman Badodiya-15, Shamshabad-14, Ghatiya-14, Shajapur-14, Dhundhadaka-14, Piploda-14, Manasa-13, Tarana-13, Gulana-13, Garoth-13, Mandsaur-Aws-13, Ratlam-Aws-13, Raoti-13, Vidisha-13, Shujalpur-13, Ujjain-Aws-12, Ashta-Aws-11, Babai (Makhan Nagar)-11, Jharda-10, Rehti-10, Tonkhurd-9, Nasrullahganj-9, Jawad-9, Jawar-9, Sonkatch-9, Sohagpur-8, Malhargarh-8, Neemuch-Aws-8, Kannod-8, Aron-8, Dolariya-7, Bareli-7, Gulabganj-7, Salwani-7, Guna-Aws-7, Udaipura-7, Ganjbasoda-7, Khategaon-7

Gujarat Region:- Patanaws-7

Konkan & Goa:- Dapoliagri-8

Madhya Maharashtra:- Mahabaleshwar- Imd Obsy-10, Gaganbawada-7

Coastal Andhra Pradesh & Yanam:- Sompeta-7

Tamilnadu, Puducherry & Karaikal:- Nagapattinam-10, Nannilam-10, Kodavasal-9, Chinnakalar-9, Arantangi-9, Uthiramerur-7, Vedaranyam-7

Coastal Karnataka:- Mani-16, Mulki-15, Mangaluru Ap Obsy-11, Puttur Hms-9, Sulya-9, Panambur Obsy-9, Mangaluru-8, Uppinangadi-7, Karkala-7

South Interior Karnataka:- Bhagamandala-12

Kerala & Mahe:- Hosdurg-16, Tellichery-12, Irikkur-11, Cheruthazham Arg-11, Vadakara-11, Peruvannamuzhi Arg-11, Kannur-10, Kozhikode-10, Kudulu-10, Mattannur Arg-10, Quilandi-10, Karipur Ap.-9, Idukki-9, Mahe-9, Kannur Airport

Aws-8, Angadipuram-7, Perinthalamanna-7, Taliparamba-7, Vellanikkara-7, Alapuzha-7, Pattembi-7, Ernakulam South-7, Kodungallur-7, Nilambur-7, Kayamkulam Agri-7

(Heavy rainfall distribution: Isolated places: upto 25%, A few places: 26-50%, Many places : 51-75%, Most places: 76-100% of total stations in the region;
Heavy rainfall: 64.5 – 115.5 mm, Very heavy rainfall: 115.6 – 204.4 mm, Extremely heavy rainfall: 204.5 mm or more).

7. Damage due to Deep Depression

No significant damage except water logging and flooding due to heavy rainfall over Odisha state was reported due to Deep Depression. The details of the flooding in details are given below.

The heavy rainfalls resulting from the deep depression along its path had led to overflowing rivers and landslides that have affected at least 13 districts in the Odisha state. The impact was combined with the subsequent heavy rains in the upper catchment of the Subarnarekha River, in the neighbouring state of Jharkhand, has increased water load over river barrages leading to release of floodwaters and worsened the flood situation.

On 22 August, the monsoon rains had affected around 2,500 villages, with more than 900 additional villages still inundated. The floods had affected over 950,000 people in Odisha, and around 170,000 people were temporarily residing in around 440 relief centres.

The floods have severely affected Boudh, Cuttack, Jagatsinghpur, Kendrapara, Khurda, Puri, Sambalpur, and Subarnapur districts, with Puri and Jagatsinghpur being the most affected.

The floods have destroyed farmlands, crops, livestock, roads, bridges, and electricity poles — resulting in power cuts.

8. Operational Forecast performance:

- First information about likely formation of a cyclonic circulation over northwest Bay of Bengal and adjoining coastal areas of West Bengal & North Odisha was given in the extended range outlook issued on 11th August, 2022.
- The daily tropical weather outlook issued at 1130 hours IST of 16th August, 2022 indicated low probability (1-33%) of formation of depression over North Bay of during 19th – 23rd August, 2022.
- Actually, low pressure area formed over northeast and adjoining areas of eastcentral Bay of Bengal, Bangladesh & Myanmar Coasts on morning of 18th

August and depression formed over northwest & adjoining northeast Bay of Bengal at 0530 hours IST of the 19th August, 2022

- In the first bulletin issued on 19th August at 0530 hours IST, it was indicated that the depression would continue to move northwestwards and then intensify into a deep depression on 19th August, 2022 at 1130 hrs IST and continued to move west-northwestwards thereafter
- Thus, the track, initial movement over northwest & adjoining northeast Bay of Bengal, intensification/weakening of the system were well predicted by IMD/RSMC New Delhi.

9. Forecast/ warning Bulletins issued by IMD

IMD issued regular bulletins to WMO/ESCAP Panel member countries including Bangladesh and Myanmar, National & State Disaster Management Agencies of West Bengal, Odisha, Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra, Rajasthan and Gujarat state, general public and media. Regular Bulletins every six hourly were issued since formation of depression over northwest BoB. In addition, RSMC New Delhi also issued Press Release and SMS to registered users.

The system was monitored continuously since 11th August (about 10 days prior to formation of depression over northwest Bay of Bengal and adjoining coastal areas of West Bengal & North Odisha). In association with this system, 2 extended range outlooks, 23 national bulletins to central & state level disaster managers, 8 special tropical weather outlooks for WMO and WMO/ESCAP Panel member countries including Bangladesh & Myanmar, 10 bulletins under global maritime distress system for ships plying in high seas, 5 press release, 6 hourly SMS to registered public at RSMC website & disaster managers and frequent updates on whatsapp, facebook, tweeter were issued by IMD to trigger early action.

IMD also issued regular warning bulletins to the concerned central and state disaster management authorities and press & media. The verification of heavy rainfall warnings issued by IMD for the depression during 19th to 23rd August is presented in Table 3. It can be found that the occurrence of heavy rainfall in association with the system could be predicted well in advance.

Bulletins issued by Cyclone Warning Division of IMD in association with the system are given in Table 2

Table 2(a): Bulletins issued by Cyclone Warning Division, IMD, New Delhi

S. No.	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 Defence Staff, DG Doordarshan, All India Radio, DG-NDRF, Director Indian Railways, Indian Navy, IAF, Administrator, Andaman & Nicobar Islands, Chief Secretary: Odisha, West Bengal, Chhatisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Tamilnadu, Andhra Pradesh and Puducherry
2	RSMC Bulletin	23	1. IMD's website 2. All WMO/ESCAP member countries through GTS and E-mail. 3. Indian Navy, IAF by E-mail
3	Press Release	1	1. Disaster Managers, Media persons by email and uploaded on website
4	Facebook /Twitter	frequently	Highlights uploaded on facebook/twitter since formation of low pressure area.
5	SMS	101008 131446	Sent to general public and fishermen Sent to farmers of Odisha, Chattisgarh and Madhya Pradesh through Kisan portal

Table-2(b): Bulletins issued by Cyclone Warning Centre (CWC) Ahmadabad

S. N.	Type of Bulletin	Number of Bulletins
		MC Ahmadabad
1.	Sea Area Bulletins	
2.	Coastal Weather Bulletins	10(twice a day * 5 days)
3.	Fishermen Warnings issued	20(four times a day * 5 days)
4.	Port Warnings	08
5.	Heavy Rainfall Warning	02
6.	Gale Wind Warning	NIL
7.	Storm surge warning	NIL
8.	Information & Warning issued to State Government and other Agencies	Briefing to C.S , DoR ,CoR , By email ,social media
9.	SMS/ Whatsapp (message in group)	Message through CAP

10. Rainfall forecast verification

The verification of heavy rainfall warning in connection with the deep depression is shown in Table 3.

Table 3: Day wise daily 24 hours cumulative rainfall forecast verification with station observations

S.No.	Rainfall Forecast upto 0300 UTC of date	Verification (Realized Rainfall at 0300 UTC of date)
19/08 0300UTC	**19th August:** Rainfall at most places with heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places is over North Odisha. Rainfall at most places with heavy to very heavy rainfall at a few places over South Odisha & Gangetic West Bengal; isolated heavy to very heavy rainfall over Jharkhand & Chattisgarh and heavy rainfall at isolated places over East Madhya Pradesh. **20th August:** Rainfall at most places with heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places over North Chattisgarh & East Madhya Pradesh. Rainfall at most places with heavy to very heavy rainfall at a few places over Northwest Odisha, Jharkhand & Vidarbha. Rainfall at most places with heavy rainfall at	**19th August:** **Gangetic West Bengal:-**Durgapur-17, Panagarh (Iaf)-13, Luchipur-9, Purulia & Simula-8 each, Gheropara & Burnpur-7 each **Odisha:-**Gop-12, Paradeep Cwr & Kantamal-11 each, Phiringia, Deogarh, Angul, Phulbani & Mohakalapada-9 each, Boudhgarh, K Nuagaon & Batagaon-8 each, Jujumura, Athmalik, Tensa, Kujanga & Rajnagar-7 each **Jharkhand:-**Maithon-9, Panchet-8 **20th August:** **Gangetic West Bengal:-**Digha-18, Contai-15, Kharidwar-12, Phulberia & Jhargram (Pto)-11 each, Purihansa-10, Kalaikunda (Iaf)-9, Kansabati Dam, Tusuma, Lalgarh & Amfu Kharagpur-8 each, Durgachack-7 **Odisha:-**Bhograi-23, Phiringia-21, Nawana & Tikabali-20 each, Chakapad, Bahalda & Batagaon-19 each, Kusumi-18, Phulbani, Tiring & Udala-17 each, Junagarh, Joshipur & Tikarpara-16 each, Rajghat, Betanati & Balasore-15 each, Baliguda, Boudhgarh & Kotagarh-14 each, Lanjigarh, Madanpur Rampur, K Nuagaon & Khajuripada-13 each, G B Nagar, Golamunda, Harabhanga, Muruda, Tensa, Jaleswar & Jaipur-12 each, Nh5 Gobindpur, Balimundali, Baripada, Remuna, Jamda, Rairangpur & Dharmagarh-11 each, Kotraguda,

	isolated places over remaining parts of Odisha, south Chhattisgarh and West Madhya Pradesh. **21st August:** Rainfall at most places with heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places over West Madhya Pradesh. Rainfall at most places with heavy to very heavy rainfall at isolated places over East Madhya Pradesh & East Rajasthan. Rainfall at most places with heavy rainfall at isolated places over Chattisgarh & Vidarbha. **22nd August:** Heavy to very heavy rainfall at isolated places over East Rajasthan. Heavy rainfall at isolated places over West Madhya Pradesh.	Jamsolaghat, Samakhunta, Lamataput, Champua, Joda, Suliapada, Talcher & Jhumpura-10 each, Naktideul, Muniguda, Narla, Raruana, Barmul, Sukruli, Bangiriposi, Thakurmunda, Kalampur & Chendipada-9 each, G Udayagiri, Bahanga, Kaniha, Th Rampur, Bissem-Cuttack, Bhawanipatna, Karanjia, Deogarh, Reamal, Ambadola, Nandapur & Chandanpur-8 each, Gurundia, Similiguda, Banaigarh, Kotpad, Jeypore, Rajkishorenagar, Barkote, Karlamunda, Raikia, Kesinga, Dabugan & Pallahara-7 each **Jharkhand:-**Ramgarh & Jamshedpur Aero-14 each, Jaganathpur Bau Kvk Aws-13, Kharsema & Mandar-12 each, Chakradharpur, Chandil, Nimdih & Arki-11 each, Ramgarh(Bdo)-10, Gomia, Ghatsila, Jamshedpur, Icar Namkum & Parsabad-9 each, Chatra, Mandu & Balumath-8 each, Bano Simdega Kvk Aws, Chandrapura, Tenughat, Kuru, Koderma, Koner, Diyakel Khunti Kvk Aws, Ramgarh Kvk Aws & Chandankiary-7 each **Bihar:-**Dharhara-13, Rajauli & Itarahi-10, Motihari, Bihar Shrif, Barhampur & Jahanabad-9 each, Kako, Simri & Ekangersarai-8 each, Charpokhiri, Arwal, Hisua, Narhat, Islampur, Nawada & Barhiya-7 each
20/08 0300 UTC	**20th August:** Heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places over North Chattisgarh & East Madhya Pradesh. Heavy to very heavy rainfall at a few places over Northwest Odisha, Jharkhand & Vidarbha. Heavy rainfall at isolated	**East Uttar Pradesh:-**Fatehpur Tehsil-15, Elgin Bridge & Karwi-9 each, Chanderdeepghat-8, Nawabganj Tehsil-7, Hasanganj & Kaiserganj-7 each **West Uttar Pradesh:-**Baheri-10, Bilaspur-7 **Uttarakhand:-**Rishikesh-29, Narendranagar-18, Khatima-16, Mussoorie-14, Jollygrant & Kashipur-14 each, Yamkeshwar-13, Uttar Kashi (Cwc) & Nainital-12 each, Uttar Kashi-11, Chakrata, Betalghat, Hardwar & Gairsain-10 each, Dhanaulti & Sama-9 each, Kotdwara &

	places over remaining parts of southwest Odisha, south Chhattisgarh and West Madhya Pradesh. **21st August:** Heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places over West Madhya Pradesh and adjoining East Madhya Pradesh. Heavy to very heavy rainfall at isolated places over East Rajasthan and heavy rainfall at isolated places over Chattisgarh & Vidarbha. **22nd August:** Heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places over East Rajasthan and heavy rainfall at isolated places over West Rajasthan and North Gujarat region. **23rd August:** Heavy to very heavy rainfall at isolated places over South Rajasthan & adjoining North Gujarat. **24th August:** Heavy rainfall at isolated places over Southwest Rajasthan.	Haldwani-8 each, Jakholi, Loharkhet, Pithoragarh, Banbasa, Deoprayag & Someshwar-7 each **East Rajasthan:-**Rajakhera-8, Bari-7 **West Madhya Pradesh:-**Bhind-Aws-10, Alipur(Jaura)-9, Ambah-7 **East Madhya Pradesh:-**Umaria-Aws-9, Nagode & Teonthar-8 each, Rewa-Aws, Majhgaon & Dindori-Aws-7 each **Chhattisgarh:-**Kusmi-9, Odagi-8 **21st August:** **Odisha:-** Banaigarh-14, Ambadola-10, Deogarh-10, Bargaon-9, K Nuagaon, Lahunipara, Jamankira & Tikabali-8 each, Phiringia, Balisankara, Kutra, Rajgangpur & Kantamal-7 each **East Uttar Pradesh:-** Karwi & Kunda-9 each, Ghorawal-8 **West Uttar Pradesh:-** Mauranipur-12, Lalitpur & Talbehat-9 each **West Madhya Pradesh:-** Chanderi-15, Pichhore-13, Pathari-12, Khaniyadana-10, Gairatgang-9, Isagarh-8, Begumganj & Mungaoli-8 each, Udaipura, Badarwas, Ater, Pipariya, Guna-Aws, Kumbhraj & Ganjbasoda-7 each **East Madhya Pradesh:-** Channodi-17, Orchha & Benibari-16 each, Niwari, Anuppur-Aws, Panna-Aws & Mohangarh-15 each, Umaria-Aws & Venkatnagar-14 each, Amarpur-13, Jaitpur, Pushprajgarh, Kareli, Pali & Dindori-Aws-12 each, Jaisingh Nagar, Mohgaon, Bajag, Chandia, Lidhora, Naigarhi, Gohparu & Gudh-11 each, Bijadandi-10, Niwas, Bina, Palera, Prithvipur, Shahpura (District: Dindori) & Majhauli-10 each, Ramnagar-9, Mada, Katni(Mudwara), Sidhi (Gopadbanas), Hanumana, Mawai, Kotma, Bijawar, Tikamgarh-Aws, Barhi, Manpur, Budhar & Amarkantak-9 each, Khurai, Karanjia,

21/08 0300UTC	**21st August:** Heavy to extremely heavy falls at isolated places over West Madhya Pradesh. Heavy to very heavy rainfall at isolated places over East Rajasthan and East Madhya Pradesh. Heavy rainfall at isolated places over southeast & southwest Uttar Pradesh, Vidarbha and Chhattisgarh. **22nd August:** Heavy to extremely heavy rainfall at isolated places over west Madhya Pradesh and East Rajasthan; heavy to very heavy rainfall at isolated places over Madhya Maharashtra and heavy rainfall at isolated places over West Rajasthan and North Gujarat region. **23rd August:** Heavy to very heavy rainfall at isolated places is over south Rajasthan & adjoining North Gujarat and heavy rainfall at isolated places over Madhya Maharashtra. **24th August:** Heavy rainfall at isolated places over Southwest Rajasthan.	Mangawan, Ajaigarh, Beohari, Jaithari, Sihawal, Kusmi, Shahdole(Sohagpur), Rahatgarh, Simariya, Harrai & Deori-8 each, Devendranagar, Baihar, Rajnagar, Samnapur, Bijuri, Pawai, Bichhia, Mauganj, Gadarwara, Singrauli-Aws, Huzur, Narsinghpur-Aws, Ghughri & Gaurihar-7 each **Chhattisgarh:-** Kusmi-15, Ramanujnagar-13, Premnagar-9, Rajpur, Khadgava, Surajpur, Balrampur & Odagi-9 each, Bhaiyathan-8, Sonhat, Baikunthpur, Bagicha & Lailunga-8 each, Duldula, Janakpur, Jashpurnagar, Pendra Road, Ambikapur & Manora-7 each **22nd August:** **Odisha:-**Banki-11, Athgarh-7 **East Rajasthan:-**Dug-23, Kota-Aero-22, Degod Sr & Nainwa-22 each, Ladpura Sr-19, Tonk Tehsil Sr-18, Pipalda Sr & Anta Sr-17 each, Patan & Nagrarfort Sr-16 each, Ramganjmandi Sr-14, Bhainsroadgarh Sr-13, Mangrol, Mandana Sr, Pachpahar Sr& Manohar Thana-13 each, Uniara / Aligarh-12, Chothkabarwara Sr & Aklera-12 each, Sangod-11, Khanpur & Asnawar Sr-11 each, Gangdhar Sr, Bundi, Kishanganj, Bonli & Chabra-10 each, Pirawa, Jhalarapatan Sr, Khandar Sr & Bakani Sr-9 each, Jhalawar, Niwai, Hindoli & Sawaimadhopur Tesil Sr-8 each, Talera Sr-7, Lalsot, Sapotra, Indergarh Sr, Sikrai & Atru Sr-7 each **West Madhya Pradesh:-**Biaora-35, Raghogarh & Chachoda-29 each, Lateri-21, Zirapur & Begumganj-20 each, Bairagarh Airport & Aron & Bhanpura-19 each, Guna-Aws-17, Kumbhraj-17, Gairatgang & Shamshabad-17 each, Udaipura-16, Raisen-Aws & Rajgarh-16 each, Bamori, Vidisha, Pathari, Kalapipal, Narsingarh,
22/08 0300	**22nd August:** Heavy to extremely heavy rainfall	

UTC	at isolated places over west Madhya Pradesh and East Rajasthan; heavy to very heavy rainfall at isolated places over North Gujarat region and heavy rainfall at isolated places over East Madhya Pradesh, West Rajasthan & north Madhya Maharashtra. **23rd August:** Heavy to very heavy rainfall at isolated places over south Rajasthan & adjoining North Gujarat and heavy rainfall at isolated places over West Madhya Pradesh and Saurashtra & Kutch. **24th August:** Heavy rainfall at isolated places over Southwest Rajasthan and adjoining Gujarat region & Kutch area.	Pachmarhi, Ganjbasoda & Ashoknagar-Aws-15 each, Bhopal Arera Hills, Shujalpur, Navibagh Aet, Sironj & Pachore-14 each, Deori, Shyampur, Kolar, Berasia, Barod, Kurwai, Sheopur-Aws, Sarangpur, Gulabganj, Isagarh & Khilchipur-13 each, Nateran, Moman Badodiya, Suvasara & Salwani-12 each, Badoda, Sehore-Aws, Gulana, Garoth, Agar, Sohagpur, Pipariya & Nalkheda-11 each, Itarsi, Goharganj, Pichhore, Narmadapuram, Bankhedi & Ichhawar-10 each, Budhni, Manasa, Sultanpur, Chanderi, Bareli, Badi, Mungaoli, Babai (Makhan Nagar) & Jawad-9 each, Shajapur, Susner, Khaniyadana, Jawar & Badarwas-8 each, Ashta-Aws, Bhimpur, Gyaraspur, Malhargarh & Rehti-7 each **East Madhya Pradesh:-**Jaisinagar-19, Kesli-18, Simariya & Rehli-18 each, Sagar-Aws-17, Jabalpur-Aws & Rahatgarh-16 each, Banda-15, Patharia & Hatta-15 each, Garhakota-14, Tendukheda (District: Narsinghpur)-14, Tendukheda (District: Damoh)-14, Deori-14, Bina-13, Badagaon Dhasan-12, Narsinghpur-Aws & Bargi-12 each, Gotegaon, Shahgarh, Buxwaha, Batiyagarh, Patan, Niwas & Jabera-11 each, Patera, Damoh-Aws, Malthone, Lakhnadon,
23/08 0300 UTC	**23rd August:** Heavy to very heavy rainfall at isolated places over south Rajasthan, North Gujarat region & Saurashtra & Kutch region and heavy rainfall at isolated places over West Madhya Pradesh & South Gujarat region. **24th August:** Heavy rainfall at isolated places is over Southwest	Kareli & Khurai-10 each, Sihora, Ajaigarh, Raipura, Amanganj, Kumdam, Sleemanabad, Panna-Aws & Umreth-9 each, Chhapara, Mehadwani, Tamia, Rajnagar, Majhgaon, Dheemarkheda, Shahpura (District: Dindori), Barela, Prithvipur, Gadarwara & Pali-8 each, Vijayraghogarh, Maihar, Khajuraho Aero, Ramnagar, Umariyapan, Majholi, Manpur, Badamalhera, Panagar, Amarpatan, Singodi, Narayanganj, Shahpura (District: Jabalpur) & Orchha-7 each **23rd August:** **Odisha:-** Khairamal-9

	Rajasthan.	**West Rajasthan:-** Jaitran-11, Marwar Junction-7, Desuri-7 **East Rajasthan:-** Dug-29, Arnod Sr-26, Pirawa-23, Bakani Sr-23, Pachpahar Sr-17, Gangdhar Sr-17, Aklera-16, Asnawar Sr-15, Jhalarapatan Sr-13, Jahazpur-12, Manohar Thana-11, Pratapgarh-11, Bijoliya Sr-11, Kekri Sr-11, Pipalkhunt Sr-10, Chabra-10, Jhalawar-10, Chhotisadri-10, Chipabarod Sr-9, Nimbahera-9, Piplu Sr-9, Hindoli-9, Danpur-9, Bhungra Sr-9, Kotkasim Sr-9, Khanpur-9, Nagrarfort Sr-9, Deoli-9, Mandalgarh-9, Uniara / Aligarh-8, Garhi-8, Kotri-8, Chittorgarh-8, Todaraisingh Sr-7, Nainwa-7, Vijaynagar Sr-7, Begu Sr-7, Chothkabarwara Sr-7, Ghatol-7, Nithuwa Sr-7, Rashmi Sr-7, Gangrar-7, Banera Sr-7, Jagpura Sr-7, Nayanagar/Beawar-7, Ramganjmandi Sr-7, Dhariabad-7, Bundi-7, Atru Sr-7 **West Madhya Pradesh:-** Zirapur-29, Alot-28, Narsingarh-25, Nalkheda-25, Biaora-24, Khilchipur-24, Shamgarh-24, Sehore-Aws-23, Jaora-23, Goharganj-21, Susner-21, Chachoda-21, Berasia-21, Sanjeet-21, Lateri-21, Barod-21, Kalapipal-20, Shyampur-19, Sarangpur-19, Nagda-19, Agar-19, Suvasara-18, Bairagarh Airport-18, Rajgarh-18, Mahidpur-18, Khachrod-18, Bhopal Arera Hills-17, Raisen-Aws-17, Tal-17, Navibagh Aet-17, Begumganj-16, Bhanpura-16, Kayampur-16, Gairatgang-16, Sailana-16, Budhni-16, Pachore-16, Raghogarh-16, Ichhawar-15, Narmadapuram-15, Kolar-15, Bajna-15, Kumbhraj-15, Sitamau-15, Moman Badodiya-15, Shamshabad-14, Ghatiya-14, Shajapur-14, Dhundhadaka-14, Piploda-14, Manasa-13, Tarana-13, Gulana-13, Garoth-13, Mandsaur-Aws-13, Ratlam-Aws-13, Raoti-13, Vidisha-13, Shujalpur-13, Ujjain-Aws-12, Ashta-Aws-11, Babai (Makhan Nagar)-11, Jharda-10, Rehti-10,

		Tonkhurd-9, Nasrullahganj-9, Jawad-9, Jawar-9, Sonkatch-9, Sohagpur-8, Malhargarh-8, Neemuch-Aws-8, Kannod-8, Aron-8, Dolariya-7, Bareli-7, Gulabganj-7, Salwani-7, Guna-Aws-7, Udaipura-7, Ganjbasoda-7, Khategaon-7 **Gujarat Region:-** Patanaws-7 **Konkan & Goa:-** Dapoliagri-8 **Madhya Maharashtra:-** Mahabaleshwar-Imd Obsy-10, Gaganbawada-7

11. Summary and Conclusions:

A low pressure area (LPA) formed over northeast and adjoining areas of eastcentral Bay of Bengal, Bangladesh & Myanmar Coasts in the early morning (0530 hrs IST) of 18th August, 2022. Under favourable conditions , it intensified into a depression over northwest & adjoining northeast Bay of Bengal and lay centered at 0530 hrs IST of 19th August 2022, near latitude 20.5°N and longitude 89.7°E, about 310 km east-southeast of Balasore (Odisha), 250 km east-southeast of Digha (West Bengal) and 210 km east-southeast of Sagar Islands. Continuing to move northwestwards, it further intensified into a deep depression over same region and lay centered at 1130 hrs IST of 19th August, 2022, about 200 km east-southeast of Balasore (Odisha), 140 km east-southeast of Digha (West Bengal), 100 km southeast of Sagar Islands (West Bengal) and 120 km south-southeast of Canning (West Bengal). The deep depression continued to move west-northwestwards and crossed West Bengal and adjoining North Odisha coasts between Balasore and Sagar Islands, close to Digha during 1900 to 2000 hours IST of 19th August, 2022 and lay centered at 1730 hrs IST of 19th August, 2022 over northwest Bay of Bengal near latitude 21.5°N and longitude 88.1°E, about 20 km south of Sagar Islands (West Bengal), 60 km east-southeast of Digha (West Bengal) and 120 km east of Balasore (Odisha). It weakened into a depression over Northwest Chhattisgarh and adjoining Northeast Madhya Pradesh & Southeast Uttar Pradesh in the morning (0530 hrs IST) of 21st and into a WML over East Rajasthan and adjoining Northwest Madhya Pradesh in the early morning (0530 hrs IST) of 23rd.

The system caused active to vigorous monsoon conditions which produced heavy extremely heavy rainfall over the regions of east and central India along its path. The episodes of heavy rainfall continuously for 2-3 days over an area with saturated soil condition induced flood situation mainly over Odisha. The heavy rainfall also impacted the districts of north Chhattisgarh and Madhya Pradesh.

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