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**TROPICAL CYCLONE OPERATIONAL PLAN  
FOR THE BAY OF BENGAL AND THE ARABIAN SEA**

**Edition 2024**

**SECRETARIAT OF THE WORLD METEOROLOGICAL ORGANIZATION  
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## CHAPTER I

### GENERAL

#### **1.1 Introduction**

The loss of life, property and human suffering caused by tropical cyclones in coastal areas in various parts of the globe are well known. These disasters are on occasion, particularly severe in the Bay of Bengal region. The northern part of the Bay of Bengal is known for its potential to generate dangerous high storm tides, a major killer when associated with cyclonic storms. In the past, out of 10 recorded cases of very heavy loss of life (ranging from about 40,000 to well over 200,000) in the world due to tropical cyclones, 8 cases were in the Bay of Bengal and the Arabian Sea (5 in Bangladesh and 3 in India). The world's highest recorded storm tide of 45 feet occurred in this region (1876, Bakherganj cyclone near Meghna Estuary, Bangladesh). These facts amply illustrate the importance of an efficient cyclone warning service in this region. Recognizing these facts, the World Meteorological Organization (WMO) and the Economic and Social Commission for Asia and the Pacific (ESCAP) jointly established the Panel on Tropical Cyclones in 1972 as an intergovernmental body. Its membership comprises countries affected by tropical cyclones in the Bay of Bengal and the Arabian Sea. Originally its member countries were Bangladesh, India, Myanmar, Pakistan, Sri Lanka and Thailand. Later Maldives joined this Panel in 1982 followed by Sultanate of Oman in 1997, Yemen joined in 2016 and Iran, Qatar, Saudi Arabia & United Arab Emirates joined in 2018.

The Panel is one of the five regional tropical cyclone bodies established as part of the WMO Tropical Cyclone Programme (TCP) which aims at promoting and coordinating the planning and implementation of measures to mitigate tropical cyclone disasters on a worldwide basis.

The main objective of the WMO/ESCAP Panel on Tropical Cyclones is to promote measures to improve tropical cyclone warning system in the Bay of Bengal and the Arabian Sea.

As part of this endeavor, the Panel at its twelfth session adopted a comprehensive cyclone operational plan for this region. The basic purpose of the operational plan is to facilitate the most effective tropical cyclone warning system for the region with existing facilities. In doing so the plan defines the sharing of responsibilities among Panel countries for the various segments of the system and records the coordination and cooperation achieved. The plan records the agreed arrangements for standardization of operational procedures, efficient exchange of various data related to tropical cyclone warnings, issue of cyclone advisories from a central location having the required facilities for this purpose, archival of data and issue of a tropical weather outlook for the benefit of the region.

The operational plan contains an explicit formulation of the procedures adopted in the Bay of Bengal and Arabian Sea region for the preparation, distribution and exchange of information and warnings pertaining to tropical cyclones. Experience has shown that it is of great advantage to have an explicit statement of the regional procedures to be followed in the event of a cyclone, and this document is designed to serve as a valuable source of information always available for reference by the forecaster and other users, particularly under operational conditions. Relevant information, which is not subject to regional agreement, is given in the annexes to the plan.

A technical plan aiming at the development and improvement of the cyclone warning system of the region has been drawn up by the Panel. Implementation of some items under the technical plan would lead to a strengthening of the operational plan.

The operational plan is evolutionary in nature. It is intended that the text of the plan be updated or revised from time to time by the Panel and that each item of information given in the annexes to the plan be kept up to date by the member country concerned.

## 1.2 Terminology used in the region

### 1.2.1 General

Panel member countries or member countries  
Zone of disturbed weather\*

### 1.2.2 Classification of cyclonic disturbances and tropical cyclones

Cyclonic disturbance (generic term)

- (i) Low or low pressure area
- (ii) Well marked low pressure area+
- (iii) Depression or tropical depression
- (iv) Deep Depression\*

Tropical cyclone (generic term)

- (v) Cyclonic storm
- (vi) Severe Cyclonic storm
- (vii) Very severe cyclonic storm
- (viii) Extremely severe cyclonic storm
- (ix) Super cyclonic storm

### 1.2.3 Tropical cyclone characteristics

- i) Position or location
- ii) Eye
- iii) Centre
- iv) Centre fix
- v) Central pressure
- vi) Pressure depth
- vii) Direction of movement
- viii) Speed of movement
- ix) Mean wind speed or sustained wind speed
- x) Maximum wind speed
- xi) Gust
- xii) Storm surge
- xiii) Storm tide
- xiv) Coastal inundation
- xv) Heavy rainfall

### 1.2.4 Terms related to the warning and warning system

- i) Name of the Tropical Cyclone
- ii) Tropical cyclone season or cyclone season
- iii) Tropical weather Outlook
- iv) Tropical cyclone advisories
- v) Satellite and Radar information
- vi) Pre-cyclone watch\*\*
- vii) Cyclone Alert\*
- viii) Cyclone Warning\*
- ix) Post landfall outlook\*\*
- x) Dewarning Message\*\*
- xi) Visual storm signal
- xii) Squally wind and gale wind
- xiii) High sea area bulletin and Coastal weather bulletin
- xiv) Bulletin or cyclone warning bulletin for India coast
- xv) Warning graphics on observed and forecast track with cone of uncertainty

- xvi) Observed and forecast winds in four geographical quadrants
- xvii) Heavy rainfall warning graphics\*\*
- xviii) Storm surge warning graphics

\*\* Term used nationally in India. \* Term used nationally in Bangladesh, India and Pakistan, + Term used nationally in Bangladesh and India

### **1.3 Meaning of terms used for international exchange**

**Average wind speed:** Speed of the wind averaged over the previous 10 minutes (mean surface wind) as read from the anemogram or the 3 minutes mean determined with the non recording anemometer or estimated wind at sea by the mariners using the Beaufort scale.

**Bulletin:** Cyclone warning bulletin or cyclone advisory bulletin

**Central pressure of a tropical cyclone:** Surface pressure at the centre of the tropical cyclone as measured or estimated.

**Centre fix of the tropical cyclone:** The estimated location of the centre of a tropical cyclone (obtained by means other than the aircraft probing of the cyclone i.e. fixation of the centre with the help of land based and other radars, satellite and conventional observations like surface and upper air observations, ships' reports, commercial aircraft observations, etc.)

**Centre of the tropical cyclone:** The centre of the cloud eye or if not discernible, of the wind / pressure centre.

**Coastal Inundation forecast:** IMD issues the coastal inundation forecast during the warning period of the tropical cyclone based on Advanced Circulation (ADCIRC) model run at Indian National Centre for Ocean Information Services (INCOIS), Hyderabad. It provides location specific combined height of storm surge and astronomical tide and area of inundation.

**Confidence in the centre position:** Degree of confidence in the centre position of a tropical cyclone expressed as the radius of the smallest circle within which the centre may be located by the analysis.

“Position good” implies a radius of 30 nautical miles (55 kilometers) or less,

“Position fair”, a radius of 30 to 60 nautical miles (55 to 110 km) and

“Position poor”, a radius of greater than 60 nautical miles (110 km).

**Cyclone:** Tropical cyclone

**Cyclone Alert\*:** A priority message for the Government officials containing tropical cyclone information and advisories issued generally 48 hours before the commencement of adverse weather in case of cyclogenesis occurring in deep sea. This is not applicable in case of the genesis taking place close to coast or in case of rapid intensification near the coast. In such situation, the cyclone warning can be issued directly without issuing the pre-cyclone watch or cyclone alert bulletin.

**Cyclone warning\*:** A priority message containing tropical cyclone warning and advisories issued generally 24 hours in advance of the commencement of adverse weather in case of cyclogenesis occurring in deep sea. This is not applicable in case of the genesis taking place close to coast or in case of rapid intensification near the coast. In such situation, the cyclone warning can be issued immediately without issuing the pre-cyclone watch and alert bulletins.

**Cyclone warning bulletin:** A priority message for exchange of tropical cyclone information and advisories.

**Cyclonic disturbance:** A non-frontal synoptic scale low pressure area originating over tropical waters with organized convection and definite cyclonic wind circulation. RSMC New Delhi considers depression and above intensity systems as cyclonic disturbance.

**Cyclonic storm:** A cyclonic disturbance in which the maximum average surface wind speed is in the range of 34 to 47 knots (62 to 88 km/h).

**Depression\***: A cyclonic disturbance in which the maximum sustained surface wind speed is between 17 and 27 knots (31 and 51 km/h). If the maximum sustained wind speed lies in the range 28 knots (52 km/h) to 33 knots (61 km/h) the system may be called a "deep depression".

**Direction of movement of the tropical cyclone:** The past direction and speed of movement mentioned in the bulletin is the average speed and direction during past six hours. The direction and speed mentioned in TCAC advisory bulletin is the forecast speed and direction of movement for next six hours.

**Dewarning Message:** As and when a given coastal belt is expected to become free from the impact of TCs, a dewarning message is issued to the ports and disaster management agencies as a part of four stage warning system.

\* Term used nationally in Bangladesh, India and Pakistan.

\*\* Predefined, based on minimum limit of rainfall during 24 hours or actual wind speed or both.

**Extremely Severe Cyclonic Storm:** A cyclonic disturbance in which the maximum average surface wind speed is in the range of 90 to 119 knots (167 to 221 km/h).

**Eye of the tropical cyclone:** The relatively clear and calm area inside the circular wall of convective clouds, the geometric centre of which is the centre of the tropical cyclone.

**Gale force wind:** Average surface wind speed of 34 to 47 knots (62 to 88 km/h).

**GMDSS:** Global Maritime Distress and Safety System.

**Gust:** Instantaneous peak value of surface wind speed recorded or expected.

**Hurricane force wind:** Average maximum sustained surface wind speed  $\geq 64$  knots.

**Low or low pressure area:** An area enclosed by 1 closed isobar within  $5^{\circ}$  latitude and longitude with minimum pressure inside and the associated maximum sustained wind speed is less than 17 knots (31 km/h).

**Maximum sustained wind:** Average wind speed at the surface calculated over a period of 3 minutes.

**Mean wind speed:** Average wind speed.

**Name of the Tropical Cyclone:** Once maximum sustained wind speed in a cyclonic disturbance attains a 34 knots threshold value, anywhere within the TC field, it will be given an identification name by RSMC tropical cyclones, New Delhi from the consolidated name list.

**Panel members countries or member countries:** Countries constituting the WMO/ESCAP Panel on Tropical Cyclones viz. Bangladesh, India, Iran, Maldives, Myanmar, Oman (Sultanate of), Pakistan, Qatar, Saudi Arabia, Sri Lanka, Thailand, United Arab Emirates (UAE) and Yemen.

**Post Landfall Outlook:** This bulletin is issued 12 hours before cyclone landfall and contains more specific forecasts about place and time of landfall.

**\*Pre Cyclone Watch:** This bulletin contains early warning about likely development of a cyclonic storm and an indication of the coastal belt likely to experience adverse weather. This is a priority message for the Government officials containing information on the formation of a tropical disturbance as soon as it is detected and which is expected to affect the coast. It is issued at least 72 hours in advance of commencement of adverse weather along the coast in case of cyclogenesis occurring in deep sea. This is not applicable in case of the genesis taking place close to coast or in case of rapid intensification near the coast. In such situation, the cyclone alert or warning can be issued directly without issuing the pre-cyclone watch.

**Pre-Genesis Forecast:** It is the forecast of track and intensity provided at the stage of low pressure area/ well marked low pressure area, before the formation of depression (genesis) for next 72 hours. It is issued once daily. RSMC New Delhi commenced issue of pre-genesis forecast in March, 2022.

**Radius of Maximum Wind:** It is the distance from the centre to the location of maximum sustained surface wind in association with a cyclone.

**Severe cyclonic storm:** A cyclonic disturbance in which the maximum average surface wind speed is in the range of 48 to 63 knots (89 to 118 km/h).

**Severe cyclonic storm with a core of hurricane winds<sup>+</sup>:** A cyclonic disturbance in which the maximum average surface wind speed is 64 knots (119 km/h) or more.

**Speed of movement of the tropical cyclone:** Speed of movement of the centre of the tropical cyclone averaged over a period of 6 hours.

**Squally wind:** When sudden increases of wind speed occur in squalls with the increased speed reaching a minimum of 22 knots (40 km/h) and persist for at least one minute.

**Storm force wind:** Average maximum sustained surface wind speed in the range 34 to 63 knots.

**Storm season:** The periods April to June and October to December during which most of the cyclonic storms occur in the Bay of Bengal and Arabian Sea.

**Storm surge:** The difference between the actual water level under the influence of a meteorological disturbance (storm tide) and the level, which would have been reached in the absence of the meteorological disturbance (i.e. astronomical tide). (Storm surge results mainly from the shoreward movement of water under the action of wind stress. A minor contribution is also made by the hydrostatic rise of water resulting from the lowered barometric pressure).

**Storm tide:** The actual water level as influenced by a weather disturbance. The storm tide consists of the normal astronomical tide and the storm surge.

**Super cyclonic storm:** A cyclonic disturbance in which maximum sustained wind speed is 120 knots and above (222 km/h and above).

**Tropical cyclone:** Generic term for a non frontal synoptic scale cyclone originating over tropical or subtropical waters with organized convection and definite cyclonic surface wind circulation. The term is also used for a storm in the Southwest Indian Ocean in which the maximum of the sustained wind speed<sup>#</sup> is estimated to be in the range of 64 to 90 knots and in the South Pacific and Southeast Indian Ocean with the maximum of the sustained wind speed over 33 knots.)

(Note: # Maximum sustained wind speed: Average period of one, three or ten minutes depending upon the regional practices).

**Tropical cyclone advisory:** A priority message for exchanging information, internationally, on tropical cyclones in the north Indian Ocean including Bay of Bengal and the Arabian Sea.

**Tropical depression:** Depression.

**Tropical storm:** Tropical cyclone.

**Tropical Weather Outlook:** A priority message for exchange between the Panel countries of synoptic and satellite inferences for the north Indian Ocean including Bay of Bengal and the Arabian Sea region. It is issued daily based on 0300 UTC observations.

**TCAC Bulletin:** The tropical cyclone advisory bulletin issued every six hourly by Tropical Cyclone Advisory Centre (TCAC), New Delhi for the purpose of international civil aviation valid for next 24 hours.

**TCAC Graphics Bulletin:** The tropical cyclone advisory bulletin is also issued every six hourly by Tropical Cyclone Advisory Centre (TCAC), New Delhi in graphics form (PNG format) for the purpose of international civil aviation and transmitted through GTS and website.

**TCAC Bulletin for Aviation Disaster Risk Reduction (ADRR):** The tropical cyclone advisory bulletin in text format is issued every six hourly through ftp by Tropical Cyclone Advisory Centre (TCAC), New Delhi to WMO's ADRR centre, Hong Kong for the purpose of international civil aviation

**TC Vital Bulletin for modeling group:** The TC Vital Bulletin is issued every six hourly to the modeling group in text form to generate track, intensity and storm surge forecast. It contains information about the location, past movement (speed & direction), intensity of the system (estimated central pressure, maximum sustained wind speed), size of the system (radius of outermost closed isobar), radius of maximum wind and radial extension of 34 knots wind in four geographical quadrants around the system centre in a coded form. It is transmitted by email and through ftp to the modeling group. This information is mainly utilised for synthetic vortex generation and model initialisation as per existing conditions.

**Very severe cyclonic storm:** A cyclonic disturbance in which maximum sustained wind speed is 64 knots to 89 knots (118 to 166 km/h).

**Visual storm signals:** Visual signals displayed at coastal points of the port to warn ships of squally winds, gales and tropical cyclones.

**Weather warning:** Meteorological message issued to provide appropriate warnings of hazardous weather conditions.

**Well marked low pressure area:** An area enclosed by 2 closed isobars with 1 isobar within 5° latitude & longitude and another isobar beyond it. The isobars are drawn at an interval of 2 hPa. The associated maximum sustained surface wind is less than 17 knots (31 km/h).

**WWMIWS:** The IMO/WMO Worldwide Met-Ocean Information and Warning Service (WWMIWS) is the internationally coordinated service for the promulgation of meteorological warnings and forecasts to vessels undertaking international or national voyages. Tropical cyclone warnings issued for the WWMIWS are promulgated through GMDSS satellite and radio communication channels.

**Zone of disturbed weather:** A zone in which the pressure is low relative to the surrounding region and there is convective cloud masses which are not organized.

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+ Meaning of term as used nationally in Bangladesh

## 1.4 Units used

### 1.4.1 Units used in international exchange

- (i) Distance in nautical miles and km, the unit (nm and km) being stated.
- (ii) Location (position) by degrees and where possible tenths of degrees of latitude and longitude preferably expressed by words.
- (iii) Direction to the nearest sixteen points of the compass given in words.
- (iv) Speed (wind speed and direction of movement of tropical cyclones) in knots and kilometer per hour, the unit (kt and kmph) being stated.

### 1.4.2 Units used in national bulletins

- (i) Distance in kilometers (km).
- (ii) Location in longitude and latitude (degrees and tenths of degrees) or bearing in sixteen points of compass and distance from two or three well known fixed place.
- (iii) Direction in sixteen points of compass.
- (iv) Speed in km/h.

### **1.4.3 Units used in WWMIWS marine warnings**

The following units/indicators are used for marine purposes, in accordance with the WMO Manual on Marine Meteorological Services (WMO No.558):

Distance in nautical miles, the unit (nm) being stated;

Location (position) by degrees and where possible tenths of degrees of latitude and longitude, preferably expressed in numbers;

e.g. "12.2S, 168.4E"

Direction of motion to the nearest sixteen points of the compass or in degrees to the nearest ten, given in figures;

e.g. "SOUTHSOUTHEAST" or "160 DEGREES"

Speed (wind speed and direction of movement of tropical cyclones) in knots, the unit (kt) being stated;

Pressure in hectopascals (hPa), the unit being stated;

Time in Universal Time Co-ordinated (UTC), unit being stated.

TC warnings for the WWMIWS shall use the following wind warning category labels:

- Gale force wind warning (Beaufort force 8 or 9);
  - Storm-force wind warning (Beaufort force 10 or 11);
  - Hurricane-force wind warning (Beaufort force 12 or over).
-

## C H A P T E R II

### TROPICAL CYCLONE WARNINGS AND ADVISORIES

#### **2.1 General**

The responsibility of warning for the human settlements on land which are threatened by a tropical cyclone rest in all cases with the National Meteorological Services (NMS). These national responsibilities are not subject to regional agreement. Therefore, the cyclone warning systems pertaining to shipping (WWMWS), and other international users, and exchanges among the Panel countries are described in this chapter. The cyclone warning systems for Panel countries are described briefly in the annex to this chapter.

#### **2.2 Classification of cyclonic disturbances followed by RSMC, New Delhi**

Classifications of cyclonic disturbances for the north Indian Ocean region for the exchange of messages among the Panel countries are given below:

<u>Weather system</u>	<u>Maximum wind speed</u>
1. Low pressure area	Wind speed less than 17 kt (31 km/h)
2. Depression	Wind speed between 17 and 27 kt (31 and 49 km/h)
3. Deep Depression	Wind speed between 28 and 33 kt (50 and 61 km/h)
4. Cyclonic storm	Wind speed between 34 and 47 kt (62 and 88 km/h)
5. Severe cyclonic storm	Wind speed between 48 and 63 kt (89 and 117 km/h)
6. Very severe cyclonic storm	Wind speed between 64 and 89 kt (118 and 166 km/h)
7. Extremely severe cyclonic storm	Wind speed between 90 and 119 kt (167 and 221 km/h)
8. Super cyclonic storm	Wind speed 120 kt (222 km/h) and above

#### **2.3 Identification of tropical cyclones**

As soon as wind speed in a cyclonic disturbance attains a 34 kt threshold value, it will be given an identification name by RSMC Tropical Cyclones, New Delhi from the consolidated name list (**Table II-1**). The identification system will cover the whole north Indian Ocean.

If the life of a cyclonic disturbance spans two calendar years it will be accounted for in the year in which it has intensified to the stage where the wind speed has attained the 34 kt threshold value.

If there is migration of a cyclonic disturbance from the area under RSMC Tokyo to area under RSMC New Delhi or vice versa, following procedure will be adopted for issue of take-over message and giving name to the system:

When a tropical cyclone is expected to migrate from one RSMC (refer to as *former*) into the neighboring (refer to as *latter*) RSMC's area of service within at least 24 hours with tropical storm (TS) / cyclonic storm (CS) intensity or higher, the former RSMC will inform the latter RSMC of the possibility of cross-border migration via e-mail and through GTS. When a tropical cyclone is expected to cross the border within around 6 hours, the former RSMC will issue advisory with remark referring to the take-over according to its issuance time (00, 03, 06, 09, 12, 15, 18 and 21 UTC for RSMC New Delhi and 00, 06, 12 and 18 UTC for RSMC Tokyo). The latter RSMC uses the name given by the former RSMC for the tropical cyclone's entire lifetime. However, if a named tropical cyclone weakens to a tropical depression (TD) / deep

depression (DD) or depression (D) and again develops to be a named tropical cyclone, RSMC New Delhi will give a new name for it, while RSMC Tokyo will use the same name except when it re-develops after once transformed into an extratropical cyclone.

Table II-1: New list of tropical cyclone names adopted by WMO/ESCAP Panel Member Countries in April 2020 for naming of tropical cyclones over North Indian Ocean including Bay of Bengal and Arabian Sea (First name was used in June, 2021 with Nisarga crossing Maharashtra coast). So far 18 names have been used from this list.

WMO/ESCAP Panel Member countries	Column 1		Column 2		Column 3		Column 4	
	Name	Pron'	Name	Pron'	Name	Pron'	Name	Pron'
Bangladesh	Nisar ga	Nisarga	Biparjoy	Biporjoy	Arnab	Ornab	Upakul	Upokul
India	Gati	Gati	Tej	Tej	Murasu	Murasu	Aag	Aag
Iran	Nivar	Nivar	Hamoon	Hamoon	Akvan	Akvan	Sepand	Sepand
Maldives	Bure vi	Burevi	Midhili	Midhili	Kaani	Kaani	Odi	Odi
Myanmar	Taukt ae	Tau'Te	Michaung	Migjaum	Ngaman n	Ngaman	Kyarthit	Kjathi
Oman	Yaas	Yass	Remal	Re-Mal	Sail	Sail	Naseem	Naseem
Pakistan	Gula b	Gul-Aab	Asna	As-Na	Sahab	Sa-Hab	Afshan	Af-Shan
Qatar	Shahe en	Shahee n	Dana	Dana	Lulu	Lulu	Mouj	Mouj
Saudi Arabia	Jawa d	Jowad	Fengal	Feinjal	Ghazeer	Razeer	Asif	Aasif
Sri Lanka	Asani	Asani	Shakhti	Shakhti	Gigum	Gigum	Gagana	Gagana
Thailand	Sitra ng	Si-Trang	Montha	Mon-Tha	Thian-Yot	Thian-Yot	Bulan	Bu-Lan
United Arab Emirates	Mando s	Man-Dous	Senyar	Sen-Yaar	Afoor	Aa-Foor	Nahhaam	Nah-Haam
Yemen	Moch a	Mokha	Ditwah	Ditwah	Diksam	Diksam	Sira	Sira

(contd.)

<b>WMO/ESCAP Panel Member countries</b>	<b>Column 5</b>		<b>Column 6</b>		<b>Column 7</b>		<b>Column 8</b>	
	Name	Pron'	Name	Pron'	Name	Pron'	Name	Pron'
Bangladesh	Barsho n	Borshon	Rajani	Rojoni	Nishith	Nishith	Urmi	Urmi
India	Vyom	Vyom	Jhar	Jhor	Probah	Probaho	Neer	Neer
Iran	Booran	Booran	Anahita	Anahita	Azar	Azar	Pooyan	Pooyan
Maldives	Kenau	Kenau	Endheri	Endheri	Riyau	Riyau	Guruva	Guruva
Myanmar	Sapakye e	Zabagji	Wetwun	We'wum	Mwaihout	Mwei'hau	Kywe	Kjwe
Oman	Muzn	Muzn	Sadeem	Sadeem	Dima	Dima	Manjour	Manjour
Pakistan	Manahi I	Ma-Na-Hil	Shujana	Shu-Ja-Na	Parwaz	Par-Waaz	Zannata	Zan Naa Ta
Qatar	Suhail	Es'hail	Sadaf	Sadaf	Reem	Reem	Rayhan	Rayhan
Saudi Arabia	Sidrah	Sadrah	Hareed	Haareed	Faid	Faid	Kaseer	Kusaer
Sri Lanka	Veramb ha	Ve-Ram-Bha	Garjana	Garjana	Neeba	Neeba	Ninnada	Nin-Na- Da
Thailand	Phutala	Phu-Ta-La	Aiyara	Ai-Ya- Ra	Samin g	Sa-Ming	Kraison	Krai-Son
United Arab Emirates	Quffal	Quf-Faal	Daaman	Daa- Man	Deem	Deem	Gargoor	Gar-Goor
Yemen	Bakhur	Bakhoor	Ghwyzi	Ghwayzi	Hawf	Hawf	Balhaf	Balhaf

(contd.)

WMO/ ESCAP Panel Member countries	Column 9		Column 10		Column 11		Column 12		Column 13	
	Name	Pron'	Name	Pron'	Name	Pron'	Name	Pron'	Name	Pron'
Bangladesh	Megh ala	Meghla	Samiron	Somiron	Pratikul	Protikul	Sarobor	Sorobo	Mahanisha	Mohanisha
India	Prabhan jan	Prabhanja n	Ghurn i	Ghurni	Ambud	Ambud	Jaladhi	Jaladhi	Vega	Vega
Iran	Arsha m	Arsha m	Hengam e	Hengame	Savas	Savas	Tahamtan	Tahamtan	Toofan	Toofan
Maldives	Kurangi	Kurangi	Kuredhi	Kuredhi	Horangu	Horangu	Thundi	Thundi	Faana	Faana
Myanmar	Pinku	Pinnku	Yinkaung	Jin Gaun	Linyone	Lin Joun	Kyeekan	Kji Gan	Bautphat	Bau'hpa
Oman	Rukam	Roukaam	Watad	Wa Tad	Al-jarz	Al-Jarouz	Rabab	Rabab	Raad	Raad
Pakistan	Sarsar	Sar-Sar	Badban	Baad-Baan	Sarrab	Sarrab	Gulnar	Gul-Nar	Waseq	Waa-Seq
Qatar	Anbar	Anbar	Oud	Oud	Bahar	Bahar	Seef	Seef	Fanar	Fanaar
Saudi Arabia	Nakheel	Nakhee l	Habo ob	Haboob	Bareq	Bariq	Alreem	Areem	Wabil	Wobil
Sri Lanka	Viduli	Viduli	Ogha	Ogha	Salitha	Salitha	Rivi	Rivi	Rudu	Rudu
Thailand	Matcha	Mat-Cha	Mahingsa	Ma-Hing-Sa	Phraewa	Phrae-Wa	Asuri	A-Su-Ri	Thara	Tha-Ra
United Arab Emirates	Khubb	Khubb	Degl	Degl	Athmada	Ath-Md	Boom	Boom	Saffar	Saf-Faar
Yemen	Brom	Brom	Shuqra	Shuqrah	Fartak	Fartak	Darsah	Darsah	Samhah	Samhah

**Note:**

1. Panel Members name are listed alphabetically country wise
2. The names will be used sequentially column-wise
3. The first name will start from the first row of column one and continue sequentially to the last row in the column thirteen
4. Table will be used only once
5. The names already used from the list till December 2024 are shown in red colour.

**Table.II-2: Table for naming tropical cyclones for the north Indian Ocean region (including Bay of Bengal and Arabian Sea) effective from September, 2004 (All names in this list have been used).**

Panel Member	Column one		Column two		Column three		Column four	
	Names	Pron'	Names	Pron'	Names	Pron'	Names	Pron'
B'desh	Onil	Onil	Ogni	Og-ni	Nisha	Ni-sha	Giri	Gi-ri
India	Agni	Ag'ni	Akash	Aakaa'sh	Bijli	Bij'li	Jal	Jal
Maldives	Hibaru	--	Gonu	--	Aila	--	Keila	--
Myanmar	Pyarr	Pyarr	Yemyin	Ye-myin	Phyan	Phyan	Thane	Thane
Oman	Baaz	Ba-az	Sidr	Sidr'	Ward	War'd	Murjan	Mur'jaan
Pakistan	Fanoos	Fanoos	Nargis	Nar gis	Laila	Lai la	Nilam	Ni lam
Sri Lanka	Mala	--	Rashmi	Rash'mi	Bandu	--	Viyaru	Viyaru
Thailand	Mukda	Muuk-dar	Khai Muk	Ki-muuk	Phet	Pet	Phailin	Pi-lin

Panel Member	Column five		Column six		Column seven		Column eight	
	Names	Pron'	Names	Pron'	Names	Pron'	Names	Pron'
B'desh	Helen	Helen	Chapala	Cho-po-la	Ockhi	Ok-khi	Fani	Foni
India	Lehar	Le'har	Megh	Me'gh	Sagar	Saa'gar	Vayu	Vaa'yu
Maldives	Madi	--	Roanu	--	Mekunu	--	Hikaa	--
Myanmar	Nanauk	Na-nauk	Kyant	Kyant	Daye	Da-ye	Kyarr	Kyarr
Oman	Hudhud	Hud'hud	Nada	N'nada	Luban	L'luban	Maha	M'maha
Pakistan	Nilofar	Ni lofar	Vardah	Var dah	Titli	Titli	Bulbul	Bul bul
Sri Lanka	Ashobaa	Ashobaa	Maarutha	Maarutha	Gaja	Gaja	Pawan	Pavan
Thailand	Komen	Goh-men	Mora	Moh-rar	Phethai	Pay-ti	Amphan	Um-pun

## 2.4 Bulletins issued by RSMC, New Delhi

### 2.4.1 Extended range outlook:

IMD started issuing Extended Range Outlook (ERO) for cyclogenesis during next two weeks every Thursday from 22<sup>nd</sup> April, 2018. The impact expected over the area of cyclogenesis was introduced from 07<sup>th</sup> May, 2022. IMD also introduced guidance on expected formation of cyclonic circulation and low pressure area over the region from June, 2021. The ERO contains information about large scale features over the region, guidance on probable cyclogenesis from various global/regional models, probability of cyclogenesis as LOW (0-33%), MODERATE (34-67%) and HIGH (68-100%) along with verification of forecast issued during last two weeks. The product is available on RSMC website at <http://www.rsmcnewdelhi.imd.gov.in/images/bulletin/eroc.pdf>. The archive of all ERO bulletins since May 2018 is also available on RSMC website.

**Example 1: Extended Range Outlook issued on 16<sup>th</sup> May 2024 is presented below.**

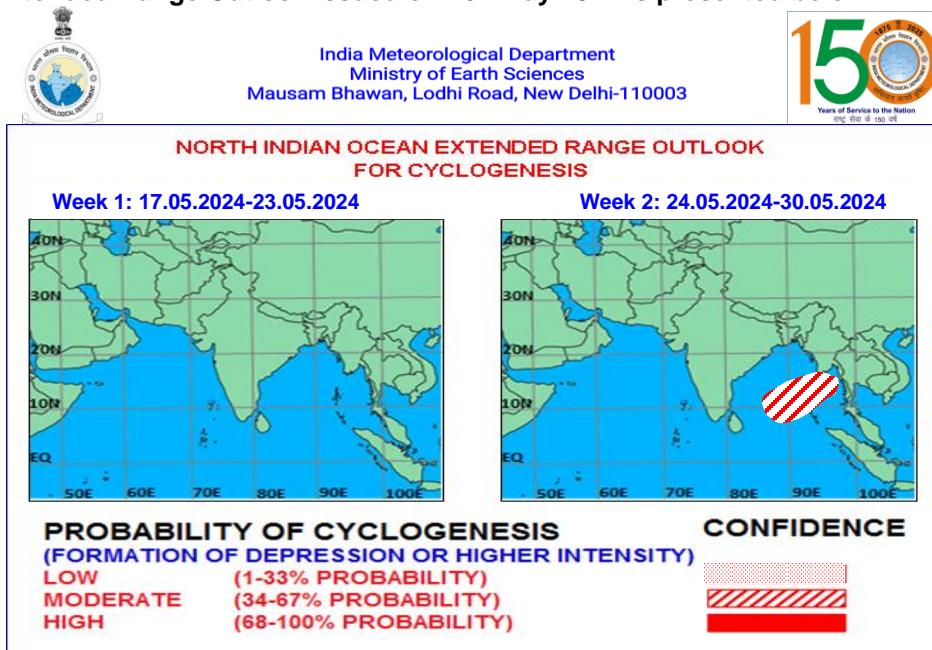


Fig. 2.4.1(a): Graphical Cyclogenesis over north Indian Ocean during next two weeks

#### I. Environmental features:

ECMWF bias corrected forecast indicates that Madden Julian Oscillation (MJO) index is currently in Phase 3 with amplitude more than 1. Thereafter, it will enter into phase 4 from 18<sup>th</sup> May onwards and would continue in same phase during entire forecast period with large amplitude (around 2). Thus MJO, phase and amplitude are highly favourable for enhancement of convective activity and hence cyclogenesis over the Bay of Bengal (BoB) during the entire forecast period.

The NCICS based forecasts for zonal winds indicate strong easterly winds (5 to 7 mps) over both the basins i.e., the Bay of Bengal (BoB) and the Arabian Sea (AS) during next 2 days. During middle of week 1, easterly winds (3-5 mps) are likely to prevail over south BoB and westcentral AS along with westerly winds (5-7 mps) over southeast AS and adjoining Comorin Area, Equatorial Rossby Waves (ERW) over South Andaman Sea are likely. During later part of week 1, strong westerly winds (5-7 mps), ERW, KW and MJO waves are likely over south BoB and adjoining areas of south AS along with easterly winds (3-5mps) over North Andaman Sea & adjoining eastcentral BoB. Similar features are likely to continue during beginning of week 2. The coupling between various equatorial waves is likely to increase positive vorticity at lower levels over the south BoB and also adjoining areas of southeast AS.

High sea surface temperatures (30-31°C) are prevailing over major parts of BoB and southeast & adjoining eastcentral AS, thereby creating a very conducive environment for cyclogenesis over the region. The guidance from INCOIS HYCOM model indicates, tropical cyclone heat potential of the order of 100-120 KJ/cm<sup>2</sup> over south BoB and adjoining Equatorial Indian Ocean (EIO) and over southeast & adjoining eastcentral AS. Neutral Indian Ocean Dipole conditions are prevailing currently.

Above environmental conditions are likely to support cyclogenesis over BoB and over southeast AS during week 2.

## **II. Model Guidance:**

IMD GFS and GEFS are indicating development of a low pressure area (LPA) over southeast Arabian Sea off Kerala and Karnataka Coasts around 22<sup>nd</sup> May which is likely to persists for next 2-3 days over the same region with a little intensification. In addition, IMD GFS is indicating formation of a LPA ahead of monsoon surge over southeast and adjoining Andaman Sea around 24<sup>th</sup> May. It is likely to intensify further into a depression with probable east-northeastward movement towards south Myanmar coast. NCEP GFS model is predicting the formation of an LPA over southeast BoB around 23<sup>rd</sup> May, 2024. Thereafter, according to the model forecasts with initial northward movement the system is likely to intensify gradually into a depression over eastcentral BoB on 24<sup>th</sup> May and into a cyclonic storm by 25<sup>th</sup> May. Subsequently moving west-northwestward, it is likely to intensify into a severe cyclonic storm over westcentral & adjoining northwest BoB off north Andhra Pradesh-south Odisha coasts on 26<sup>th</sup> May. It is likely to cross the north Andhra Pradesh-south Odisha coasts on 27<sup>th</sup> May, 2024. NCUM and NEPS are also indicating the formation of an LPA around 23<sup>rd</sup> May which likely to move north-northeastward towards north Myanmar and Bangladesh coasts and intensify into a depression on 26<sup>th</sup> May, 2024. ECMWF deterministic dynamical model is demonstrating the formation of an LPA southwest BoB on 23<sup>rd</sup> May which is moving east-northeastwards towards Andaman Islands before the system is dissipated over eastcentral & adjoining north Andaman Sea around 24<sup>th</sup> May, 2024. ECMWF ensemble is indicating low probability (less than 20%) of cyclogenesis over southeast BoB around 22<sup>nd</sup> May. The area of cyclogenesis is likely to move north-northeastwards and probability is likely to increase to 30 % over eastcentral BoB during next two days further reaching 40% over north BoB during 26 & 27<sup>th</sup> May, 2024.

IMD extended range forecast (ERF) model furnishing moderate (30-40%) probability of cyclogenesis over southeast AS & adjoining Comorin Area off Kerala coast during first week. It is also showing moderate probability (30-40%) of cyclogenesis over southeast BoB and south Andaman Sea during both the weeks. The ECMWF ERF is indicating 10-20% probability of cyclogenesis over north & adjoining eastcentral BoB during week 1 and similar probability over eastcentral & adjoining northeast AS during second week.

**Legends:** NCICS: North Carolina Institute for Climate Studies (for Equatorial waves Forecast), IMD GFS: India Meteorological Department Global Forecast System, NCUM: National Centre for Medium Range Weather Forecasting Centre (NCMRWF) Unified Model, European Centre for Medium Range Weather Forecasting (ECMWF), GPP: Genesis Potential Parameter, National Centre for Environment Prediction (NCEP) GFS, ECMM: ECMWF multi model, GEFS: GFS ensemble, NEPS: NCUM ensemble prediction system, CNCUM: Coupled NCUM, CPC: Climate Prediction Centre, NWS: National Weather Service, INCOIS: Indian National Centre for Ocean Information Services.

## **III. Inference:**

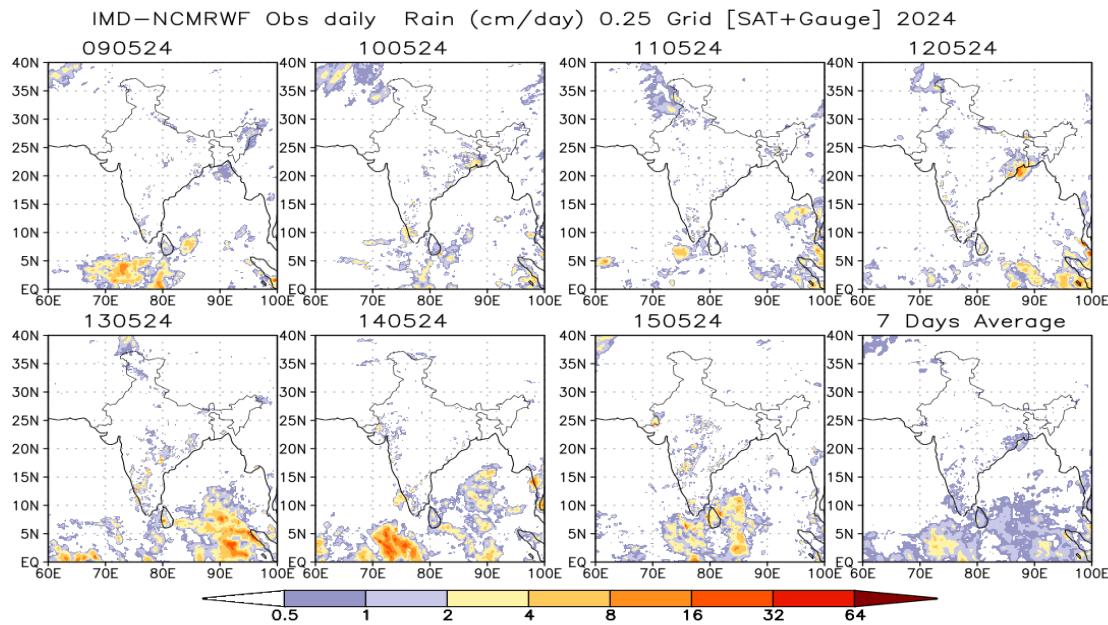
Considering various environmental conditions and model guidance, it is inferred that

- (i) A low pressure area is likely to form over southeast Bay of Bengal and adjoining Andaman Sea around 23<sup>rd</sup> May and there is a moderate probability for its further intensification into a depression over southeast Bay of Bengal and adjoining north Andaman Sea in the beginning of the second week. The system is likely to intensify further and move north-northeastwards during later part of the week.
- (ii) A cyclonic circulation / low pressure area is likely to form over southeast Arabian Sea off Kerala coast during second half of the first week.

#### IV. Verification of forecast issued during last two weeks:

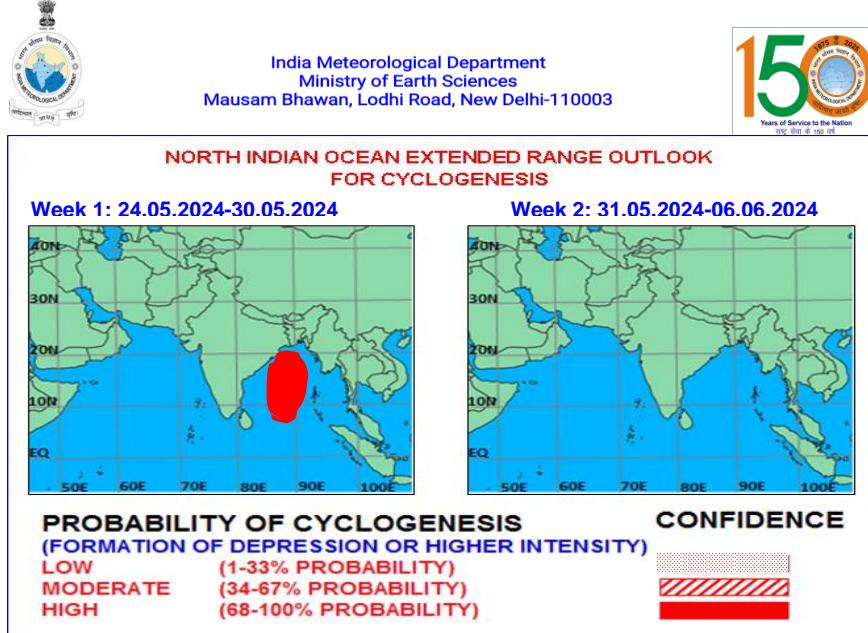
Forecast issued on 2<sup>nd</sup> May for second week (10.05.2024-16.05.2024) and forecast issued on 9<sup>th</sup> May for first week (10.05.2024-16.05.2024) indicated no cyclogenesis over the NIO during the forecast period. Actually, no cyclogenesis occurred over the region during the forecast period week. Thus no cyclogenesis was correctly predicted for the forecast period.

NCMRWF-IMD satellite gauge merged data plots of 24 hours accumulated realized rainfall during 9<sup>th</sup> May to 15<sup>th</sup> May, 2024 are presented in **Fig. 2.4.1(b)**.



**Fig.2.4.1(b): NCMRWF-IMD satellite gauge merged data plots of 24 hours accumulated realized rainfall during 9<sup>th</sup> May to 15<sup>th</sup> May, 2024.**

Example 2: Extended Range Outlook issued on 23<sup>rd</sup> May 2024 is presented below.



**Fig. 2.4.2(a): Graphical Cyclogenesis over north Indian Ocean during next two weeks**

### **1. Environmental features:**

Madden Julian Oscillation (MJO) index is currently in Phase 4 with amplitude more than 1. It will continue in same phase 4 with increasing amplitude during week 1. During week 2, it would enter in phase 2 with a decreasing trend in amplitude, but remaining more than 1 throughout the week. Thus MJO, phase and amplitude are highly favourable for enhancement of convective activity and cyclogenesis over the Bay of Bengal (BoB) during the entire forecast period.

The NCICS based forecasts for zonal winds indicate strong westerly winds (5 to 7 mps) over southern & adjoining central parts of both the basins i.e., the Bay of Bengal (BoB) and the Arabian Sea (AS) during week 1 and easterlies to the north. In addition, Equatorial Rossby Waves (ERW) are also prevailing over the southern parts of both the basins. The coupling of MJO and ERW will support cyclogenesis over BoB. During week 2, strong westerly winds (5-7 mps) are likely over south BoB and South Andaman Sea. ERW and strong westerly winds are seen over southwest AS with weak easterlies (3-5 mps) over westcentral AS.

High sea surface temperatures (30-31°C) are prevailing over major parts of BoB and southeast & adjoining eastcentral AS, thereby creating a very conducive environment for cyclogenesis over the region. The guidance from INCOIS HYCOM model indicates, tropical cyclone heat potential of the order of 100-120 KJ/cm<sup>2</sup> over south BoB and adjoining Equatorial Indian Ocean (EIO) and over southeast & adjoining eastcentral AS. Neutral Indian Ocean Dipole conditions are prevailing currently.

Above environmental conditions are likely to support cyclogenesis over BoB during week 1.

### **2. Model Guidance:**

Various models are indicating formation of depression during 23/1200 UTC to 24/1200 UTC over central parts of Bay of Bengal. Hence high probability has been assigned to formation of depression during next 24-48 hours. There is large variation among various models with respect to movement and intensification of the system. The landfall point is varying from Odisha to Bangladesh coasts. Models like ECAI & NCEP GFS are indicating crossing over Odisha coast, ECMWF over West Bengal coast and IMD GFS, NCUM & MME over Bangladesh coast. Regarding intensification, models like NCEP GFS, IMD GFS and NCUM are indicating intensification upto very severe cyclonic storm category (65-75 kt). Models like IMD MME, ECAI and ECMWF are indicating intensification upto severe cyclonic storm stage (upto 55 kt). The landfall time is varying between 26th/1200-26th/2100 UTC.

IMD extended range forecast (ERF) model is indicating moderate (60-70%) probability of cyclogenesis over central and North Bay of Bengal during week 1. During week 2, model is indicating low probability of cyclogenesis over northeast Bay of Bengal and also over eastcentral AS off eastcentral AS.

**Legends:** NCICS: North Carolina Institute for Climate Studies (for Equatorial waves Forecast), IMD GFS: India Meteorological Department Global Forecast System, NCUM: National Centre for Medium Range Weather Forecasting Centre (NCMRWF) Unified Model, European Centre for Medium Range Weather Forecasting (ECMWF), GPP: Genesis Potential Parameter, National Centre for Environment Prediction (NCEP) GFS, ECMM: ECMWF multi model, GEFS: GFS ensemble, NEPS: NCUM ensemble prediction system, CNCUM: Coupled NCUM, CPC: Climate Prediction Centre, NWS: National Weather Service, INCOIS: Indian National Centre for Ocean Information Services.

### **3. Inference:**

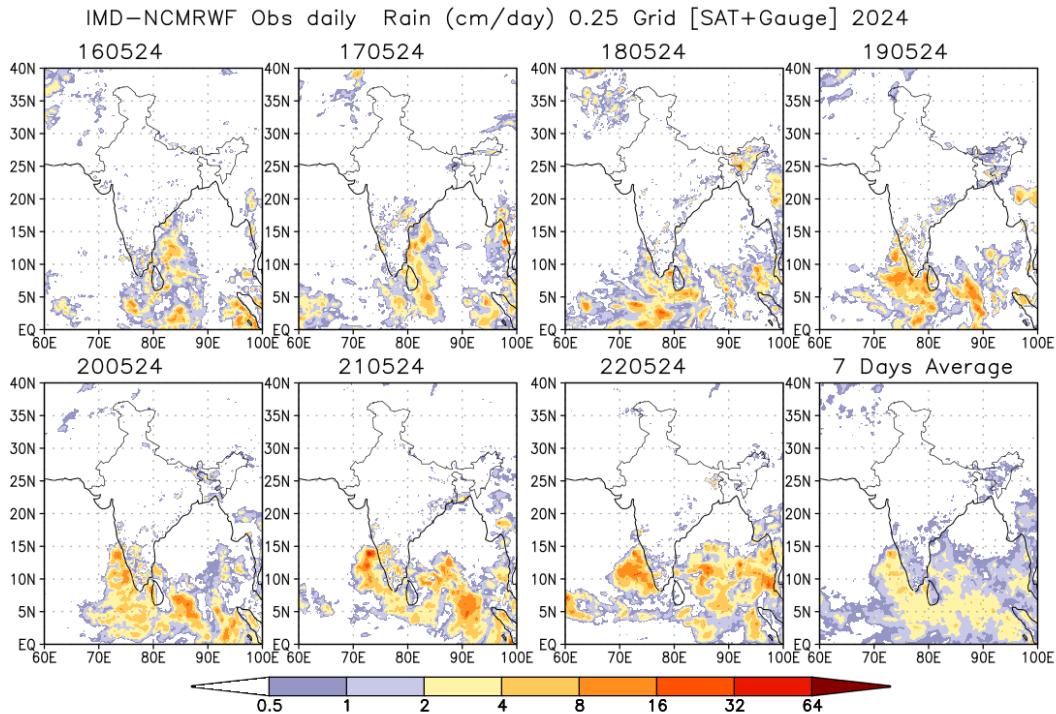
Considering various environmental conditions and model guidance, it is inferred that

The well-marked low pressure area over westcentral & adjoining south Bay of Bengal is very likely to continue to move northeastwards and concentrate into a Depression over central parts of Bay of Bengal by morning of 24th May, 2024. Thereafter, it is very likely to continue to move northeastwards, intensify further into a cyclonic storm over eastcentral Bay of Bengal by 25th May morning. Subsequently, it would move nearly northwards and reach near Bangladesh and adjoining West Bengal coasts by 26th May evening as a severe cyclonic storm.

#### 4. Verification of forecast issued during last two weeks:

Forecast issued on 9<sup>th</sup> May for second week (17.05.2024-23.05.2024) and forecast issued on 16<sup>th</sup> May for first week (17.05.2024-23.05.2024) indicated no cyclogenesis over the NIO during the forecast period. Actually, no cyclogenesis occurred over the region during the forecast period week. Thus absence of cyclogenesis was correctly predicted for the forecast period.

NCMRWF-IMD satellite gauge merged data plots of 24 hours accumulated realized rainfall during 16<sup>th</sup> May to 22<sup>nd</sup> May, 2024 are presented in **Fig. 2.4.2(b)**.



**Fig.2.4.2(b): NCMRWF-IMD satellite gauge merged data plots of 24 hours accumulated realized rainfall during 16<sup>th</sup> May to 22<sup>nd</sup> May, 2024.**

#### **2.4.2. Tropical Weather Outlook**

The tropical weather outlook is prepared once daily by RSMC tropical cyclones, New Delhi throughout the year. It is transmitted through GTS at 06 UTC every day. The outlook covering the North Indian Ocean indicates possible development of tropical depressions over the Sea. The probability of cyclogenesis (formation of depression) has been extended from 3 to 5 days since April 2018 over the Bay of Bengal and Arabian Sea. It has further been extended to 7 days since September, 2023. The terms used are (i) NIL (0%), LOW (1-33%), MODERATE (34-67%) and HIGH (68-100%). An example of this bulletin is given below. It includes the description of convective clouds over the region and the satellite imagery of the day with probability of cyclogenesis for next 24 hours in addition to above. Tropical Weather outlook will be replaced by Special Tropical Weather Outlook when a depression is located over the north Indian Ocean region based on 0000, 0300, 0600, 1200 and 1800 UTC observations or at any other synoptic hour depending upon the development of depression. The additional bulletins will be issued as and when felt necessary by RSMC, New Delhi.

#### **Examples-1 (Tropical Weather Outlook under normal situation)**

#### **REGIONAL SPECIALISED METEOROLOGICAL CENTRE-TROPICAL CYCLONES, NEW DELHI TROPICAL WEATHER OUTLOOK**

**DEMS-RSMC TROPICAL CYCLONES NEW DELHI DATED 15.05.2024**

**TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND THE ARABIAN SEA) VALID FOR NEXT 168 HOURS ISSUED AT 0600 UTC OF 15.05.2024 BASED ON 0300 UTC OF 15.05.2024.**

##### **BAY OF BENGAL:**

A FRESH CYCLONIC CIRCULATION LAY OVER SOUTHWEST BAY OF BENGAL & ADJOINING SOUTH SRI LANKA EXTENDING UPTO 4.5 KM ABOVE MEAN SEA LEVEL TILTING SOUTHWESTWARDS WITH HEIGHT AT 0300 UTC OF TODAY, 15<sup>TH</sup> MAY, 2024.

SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH ADJOINING WESTCENTRAL BAY OF BENGAL (MINIMUM CLOUD TOP TEMPERATURE -93°C) SOUTH ANDAMAN SEA AND MODERATE TO INTENSE CONVECTION LAY OVER NORTH ANDAMAN SEA. SCATTERED LOW AND MEDIUM CLOUDS WITH WEAK TO MODERATE CONVECTION LAY OVER REST OF BAY OF BENGAL.

##### **\*PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 168 HRS:**

24 HOUR S	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS	120-144 HOURS	144-168 HOURS
NIL	NIL	NIL	NIL	NIL	NIL	NIL

**\*NOTE: EVERY 24HR FORECAST IS VALID UPTO 0300 UTC (0830 IST) OF NEXT DAY**

##### **ARABIAN SEA:**

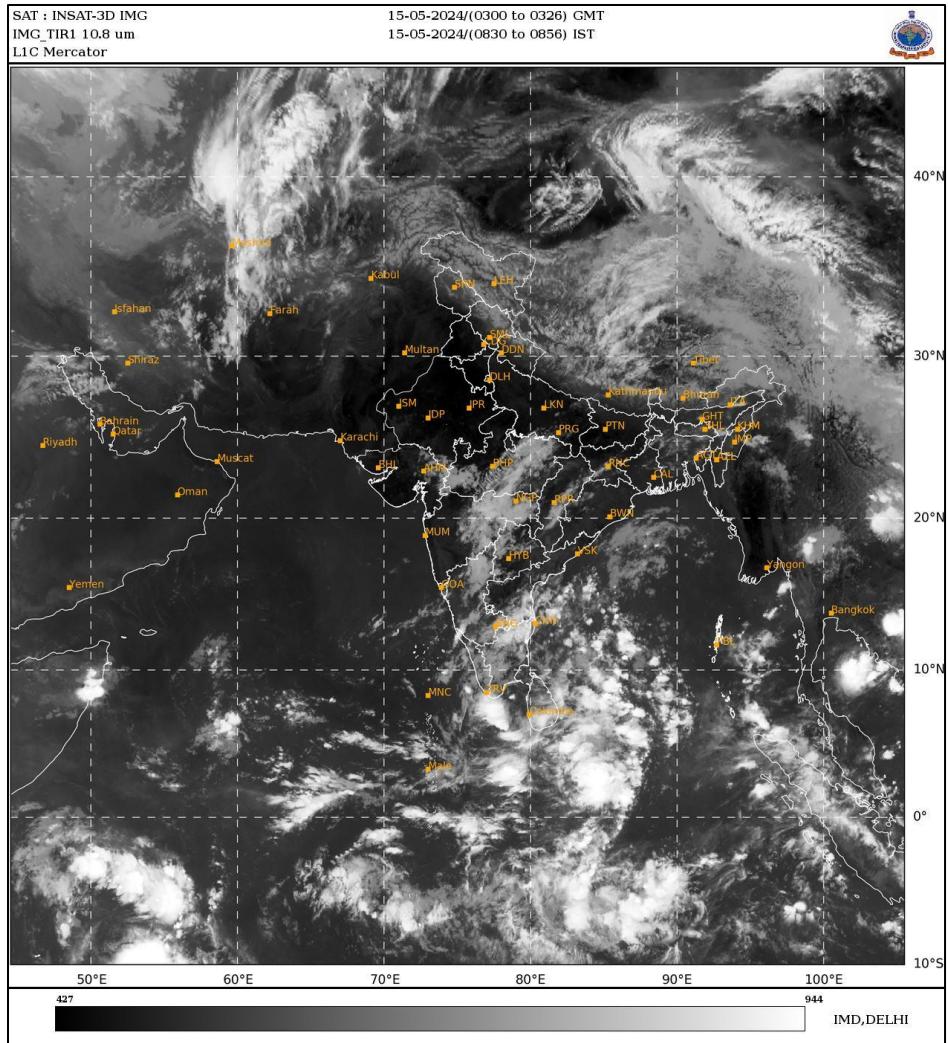
SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER COMORIN AREA & SOUTHWEST ARABIAN SEA.

##### **\*PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 168 HRS:**

24 HOURS	24-48 HOURS	48-72 HOUR S	72-96 HOURS	96-120 HOURS	120-144 HOURS	144-168 HOURS
NIL	NIL	NIL	NIL	NIL	NIL	NIL

**\*NOTE: EVERY 24HR FORECAST IS VALID UPTO 0300 UTC (0830 IST) OF NEXT DAY**

**REMARKS:** NIL.



**Fig 2.4.3: INSAT 3D Image for 0300 UTC of 15<sup>th</sup> May, 2024**

## **Examples-2 (Tropical Weather Outlook in association with Low Pressure Area)**

**REGIONAL SPECIALISED METEOROLOGICAL CENTRE-TROPICAL CYCLONES, NEW DELHI  
TROPICAL WEATHER OUTLOOK**

DEMS-RSMC TROPICAL CYCLONES NEW DELHI DATED 22.05.2024

**TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND THE ARABIAN SEA) VALID FOR NEXT 168 HOURS ISSUED AT 0800 UTC OF 22.05.2024 BASED ON 0300 UTC OF 22.05.2024.**

## BAY OF BENGAL:

**BAY OF BENGAL:** UNDER THE INFLUENCE OF THE CYCLONIC CIRCULATION OVER SOUTHWEST BAY OF BENGAL, A LOW PRESSURE AREA FORMED OVER SOUTHWEST & ADJOINING WESTCENTRAL BAY OF BENGAL AT 0000 UTC AND PERSISTED OVER THE SAME REGION AT 0300 UTC OF TODAY, THE 22ND MAY, 2024. IT IS VERY LIKELY TO MOVE NORTHEASTWARDS AND CONCENTRATE INTO A DEPRESSION OVER CENTRAL PARTS OF BAY OF BENGAL BY 0000-0300 UTC OF 24TH MAY, 2024.

IT IS LIKELY TO MOVE NORTHEASTWARDS, INTENSIFY FURTHER AND REACH NORTHEAST & ADJOINING NORTHWEST BAY OF BENGAL BY 1200 UTC OF 25TH MAY.

AS PER INSAT-3D IMAGERY, A LOW LEVEL CIRCULATION LAY OVER SOUTHWEST & ADJOINING WESTCENTRAL BAY OF BENGAL OFF NORTH TAMIL NADU – SOUTH ANDHRA PRADESH COASTS. ASSOCIATED SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH & CENTRAL BAY OF BENGAL & NORTH COASTAL TAMIL NADU (MINIMUM CLOUD TOP TEMPERATURE -93°C). THE WATER VAPOUR IMAGERY IS INDICATING HIGH HUMIDITY IN MID TROPOSPHERIC LEVELS.

SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH & CENTRAL BAY OF BENGAL ANDAMAN SEA (MINIMUM CLOUD TOP TEMPERATURE -93°C) TENASSERIM COAST AND GULF OF MARTABAN (MINIMUM CLOUD TOP TEMPERATURE -80°C).

#### \*PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 168 HRS:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS	120-144 HOURS	144-168 HOURS
LOW	MOD	HIGH	-	-	-	-

\*NOTE: EVERY 24HR FORECAST IS VALID UPTO 0300 UTC (0830 IST) OF NEXT DAY

AS PER LATEST OBSERVATIONS, ESTIMATED CENTRAL PRESSURE IS 1004 HPA. AT 0300 UTC A BUOY NEAR 13.440N/ 84.10E INDICATES MEAN SEA LEVEL PRESSURE (MSLP) OF 1004.3 HPA AND MAXIMUM SUSTAINED WIND SPEED (MSW) OF 13.1KT/300.

#### WIND WARNING:

SQUALLY WEATHER WITH WIND SPEED REACHING 35-45 KMPH GUSTING TO 55 KMPH IS LIKELY OVER SOUTH BAY OF BENGAL ON 22ND MAY. IT WOULD GRADUALLY INCREASE BECOMING SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH OVER CENTRAL AND ADJOINING SOUTH BAY OF BENGAL FROM 23<sup>RD</sup>/0000 UTC. IT WOULD EXTEND TO ADJOINING AREAS OF NORTH BAY OF BENGAL WITH INCREASED WIND SPEED OF 50-60 KMPH GUSTING TO 70 KMPH FROM 24<sup>TH</sup>/0000 UTC AND OVER NORTHEAST AND ADJOINING NORTHWEST & EASTCENTRAL BAY OF BENGAL FROM 25<sup>TH</sup>/0000 UTC TILL 26<sup>TH</sup>/1200 UTC.

#### SEA CONDITION:

SEA CONDITION IS LIKELY TO BE MODERATE TO ROUGH OVER SOUTHWEST BAY OF BENGAL ON 22ND MAY, ROUGH TO VERY ROUGH OVER CENTRAL & ADJOINING SOUTH BAY OF BENGAL FROM 23RD MAY AND OVER NORTH BAY OF BENGAL FROM 24TH MAY ONWARDS TILL 26TH MAY.

#### FISHERMEN WARNING:

FISHERMEN ARE ADVISED NOT TO VENTURE INTO CENTRAL & ADJOINING SOUTH BAY OF BENGAL FROM 23RD MAY AND INTO NORTH BAY OF BENGAL FROM 24TH MAY ONWARDS TILL 26TH MAY. FISHERMEN OUT AT SEA ARE ADVISED TO RETURN TO THE COAST BEFORE 23RD MAY.

#### ARABIAN SEA:

ANOTHER LOW LEVEL CIRCULATION LAY OVER SOUTHEAST ARABIAN SEA OFF KERALA COASTS & NEIGHBOURHOOD AT 0300 UTC OF 22ND MAY. ASSOCIATED SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTHEAST ARABIAN SEA & LAKSHADWEEP ISLANDS AREA (MINIMUM CLOUD TOP TEMPERATURE -93°C).

SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH ARABIAN SEA, LAKSHADWEEP ISLANDS AREA, MALDIVES AND COMORIN AREA (MINIMUM CLOUD TOP TEMPERATURE -93°C). SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED ISOLATED WEAK TO MODERATE CONVECTION LAY OVER EASTCENTRAL ARABIAN SEA.

**\*PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 168 HRS:**

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS	120-144 HOURS	144-168 HOURS
NIL	NIL	NIL	NIL	NIL	NIL	NIL

**\*NOTE: EVERY 24HR FORECAST IS VALID UPTO 0300 UTC (0830 IST) OF NEXT DAY**

**REMARKS:**

THE MADDEN JULIAN INDEX (MJO) CURRENTLY LIES IN PHASE 4 WITH AMPLITUDE MORE THAN 1. IT WILL CONTINUE IN SAME PHASE DURING NEXT 7 DAYS. THUS, MJO PHASE & AMPLITUDE ARE HIGHLY CONDUCIVE FOR CYCLOGENESIS AND FURTHER INTENSIFICATION OVER THE BAY OF BENGAL (BOB) DURING NEXT 5 DAYS.

STRONG EASTERLY WINDS (5-7 MPS) ARE LIKELY TO PREVAIL OVER CENTRAL BOB DURING NEXT 2 DAYS & NORTH BOB DURING SUBSEQUENT 3-5 DAYS IN THE LOWER TROPOSPHERIC LEVELS. STRONG WESTERLY WINDS (5-7 MPS) ARE LIKELY TO PREVAIL OVER THE SOUTH BOB AND ANDAMAN SEA DURING NEXT 5 DAYS AND OVER CENTRAL BOB DURING 25<sup>TH</sup> TO 27<sup>TH</sup> MAY. IN ADDITION, KELVIN WAVES, EQUATORIAL ROSSBY WAVES ARE PREVAILING OVER SOUTH BOB & COUPLED WITH MJO. THESE WAVES WILL PROVIDE A CONDUCIVE ENVIRONMENT FOR CYCLOGENESIS AND INTENSIFICATION OF SYSTEM OVER BOB.

THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM2 OVER MAJOR PARTS OF BOB. IT IS INDICATING SLIGHTLY DECREASING TENDENCY TOWARDS NORTH BOB AND ALONG THE COASTS. SEA SURFACE TEMPERATURE (SST) IS AROUND 30-32°C OVER ENTIRE BOB. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR CYCLOGENESIS AND INTENSIFICATION.

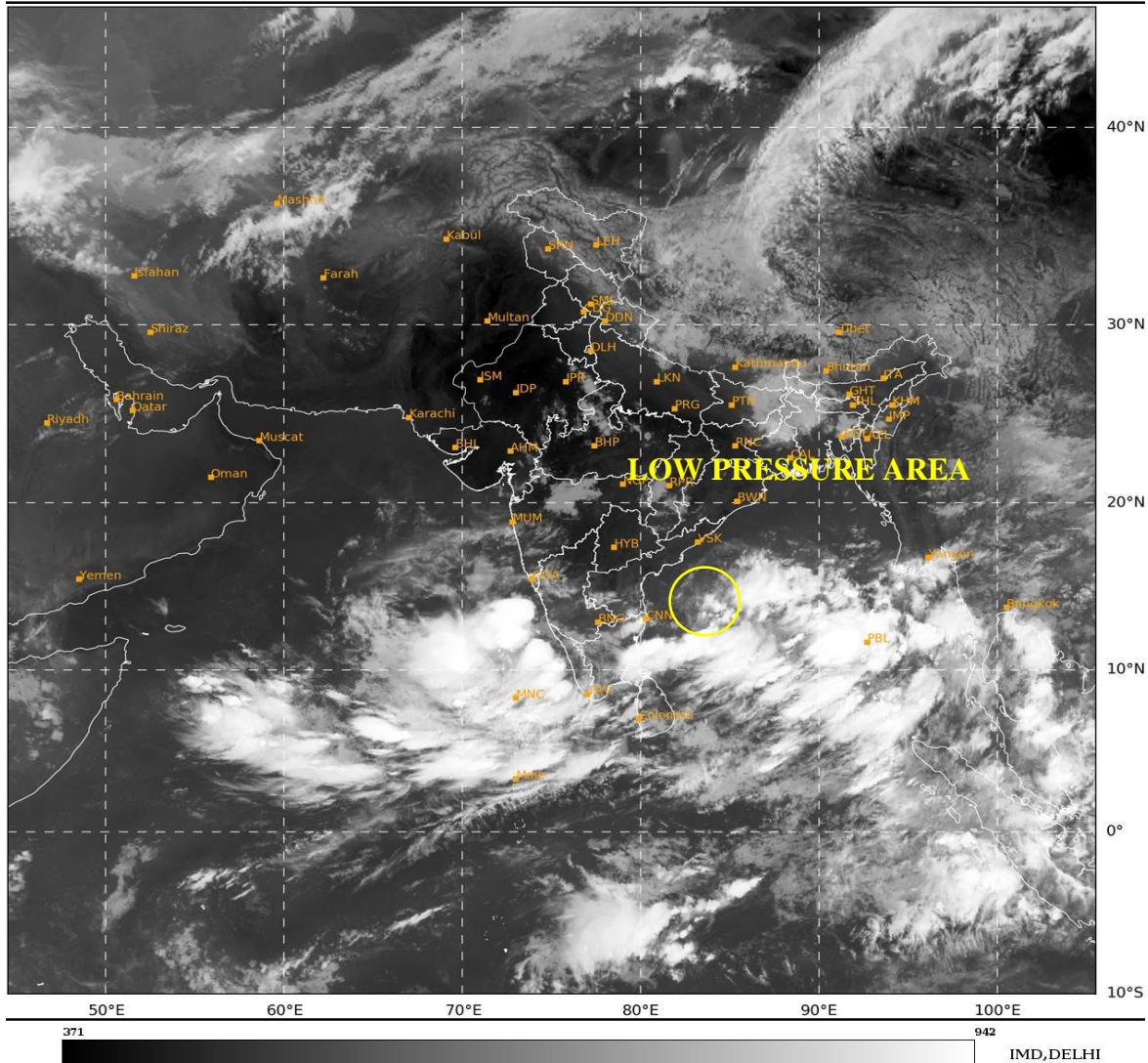
CONSIDERING THE ENVIRONMENTAL CONDITIONS, LOW LEVEL VORTICITY IS ABOUT 50- 60x10-5S-1 OVER SOUTHWEST & ADJOINING WESTCENTRAL BAY OF BENGAL TO THE SOUTH OF SYSTEM CENTRE WITH VERTICAL EXTENSION UPTO 500 HPA LEVELS. TWO VORTICITY CENTERES ONE OVER SOUTHEAST & OTHER OVER SOUTHWEST BOB ARE SEEN AT 850 HPA LEVEL. LOW LEVEL CONVERGENCE HAS INCREASED DURING PAST 24 HOURS AND IS ABOUT 10-15x10-5S-1 OVER SOUTH BOB AND IS EAST-WEST ORIENTED. UPPER LEVEL DIVERGENCE IS 10-20x10-5S -1 OVER SOUTH BOB & SOUTH ANDAMAN SEA. IT IS ALSO EAST-WEST ORIENTED. VERTICAL WIND SHEAR (VWS) IS LOW TO MODERATE OVER MAJOR PARTS OF BOB. MID LEVEL WIND SHEAR IS ANTICYCLONIC OVER SOUTH BOB. VWS WILL THUS SUPPORT FURTHER INTENSIFICATION OF SYSTEM. THE UPPER TROPOSPHERIC RIDGE AT 200 HPA IS LOCATED NEAR 12.0°N IN ASSOCIATION WITH AN ANTICYCLONE OVER EASTCENTRAL BOB. RIDGE IS LOCATED TO THE SOUTH OF SYSTEM CENTRE, INDICATING NORTHEASTWARDS MOVEMENT OF THE SYSTEM.

THERE IS LARGE VARIATION AMONG VARIOUS MODELS WITH RESPECT TO MOVEMENT OF THE SYSTEM. THE MODELS INCLUDING IMD GFS, NCUM AND IMD MME ARE INDICATING MOVEMENT TOWARDS BANGLADESH-MYANMAR COASTS. HOWEVER, NCEP GFS, ECMWF AND ECAI ARE INDICATING MOVEMENT TOWARDS WEST BENGAL COAST. THERE IS CONSENSUS AMONG VARIOUS MODELS THAT THE SYSTEM WOULD REACH CENTRAL PARTS OF NORTH BAY OF BENGAL AROUND 1200 UTC OF 25TH MAY. THERE IS ALSO LARGE VARIATION AMONG VARIOUS MODELS W.R.T. PEAK INTENSIFICATION. MOST OF THE MODELS ARE INDICATING INTENSIFICATION UPTO CYCLONIC STORM STAGE WITH NCUM & NCEP GFS INDICATING HIGHER INTENSIFICATION.

CONSIDERING ALL THE ABOVE, THE LOW PRESSURE AREA OVER SOUTHWEST & ADJOINING WESTCENTRAL BAY OF BENGAL IS VERY LIKELY TO MOVE NORTHEASTWARDS AND CONCENTRATE INTO A DEPRESSION OVER CENTRAL PARTS OF BAY OF BENGAL BY 0000-0300 UTC OF 24TH MAY, 2024. IT IS LIKELY TO MOVE NORTHEASTWARDS, INTENSIFY FURTHER AND REACH NORTHEAST & ADJOINING NORTHWEST BAY OF BENGAL BY 1200 UTC OF 25TH MAY. CURRENT INFERENCE IS BASED ON SYNOPTIC ANALYSIS, ENVIRONMENTAL FEATURES AND GUIDANCE FROM VARIOUS NUMERICAL MODELS.

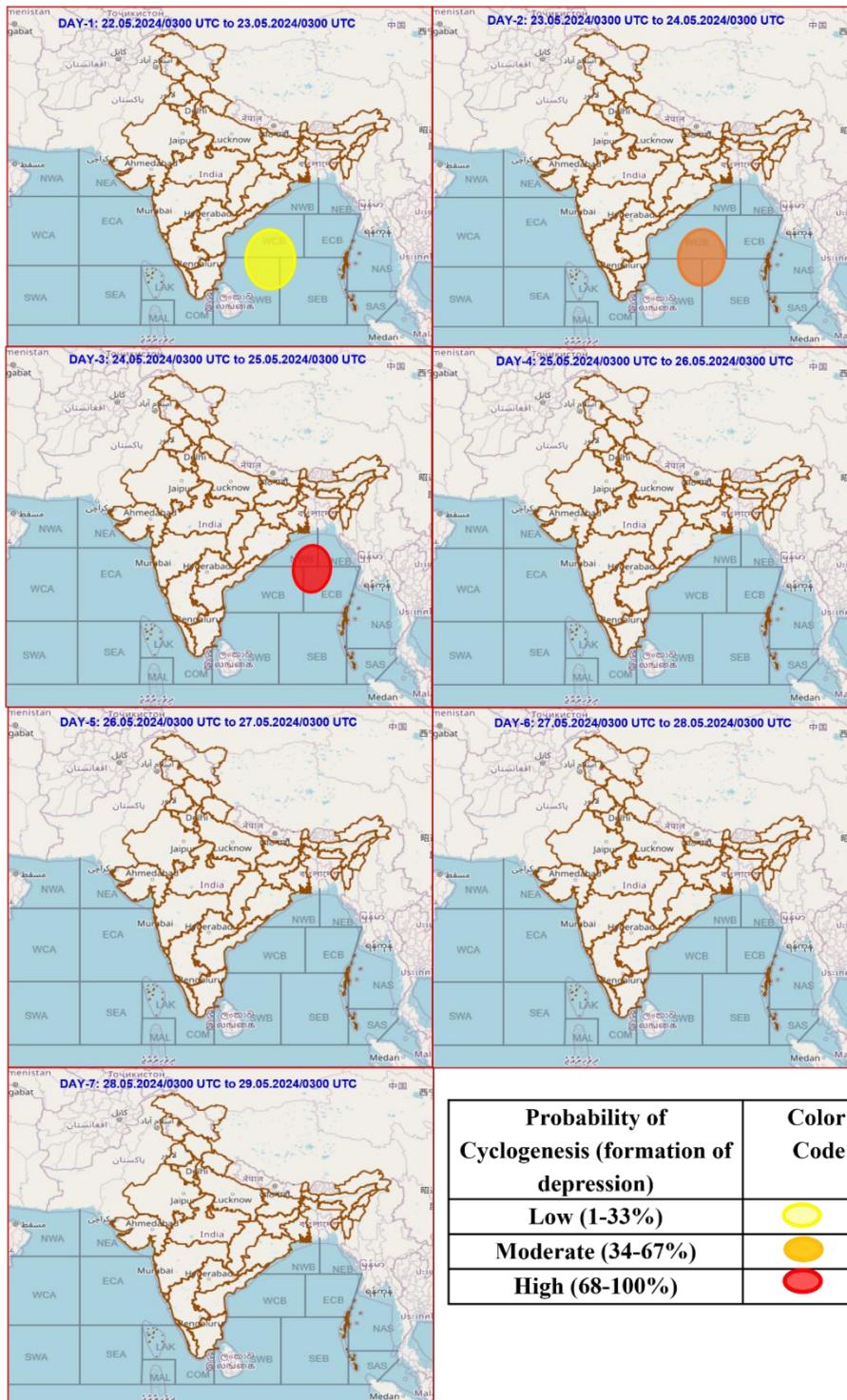
SAT : INSAT-3D IMG  
IMG\_TIR1 10.8 um  
L1C Mercator

22-05-2024/(0300 to 0327) GMT  
22-05-2024/(0830 to 0857) IST



**Fig 2.4.4(a): INSAT 3D Image for 0300 UTC of 22<sup>nd</sup> May,2024**

## Graphical Tropical Weather Outlook indicating probable area of cyclogenesis (formation of depression)



**Fig 2.4.4(b): Graphical Tropical Weather Outlook indicating probable area of Cyclogenesis for 0300 UTC of 22<sup>nd</sup> May,2024**

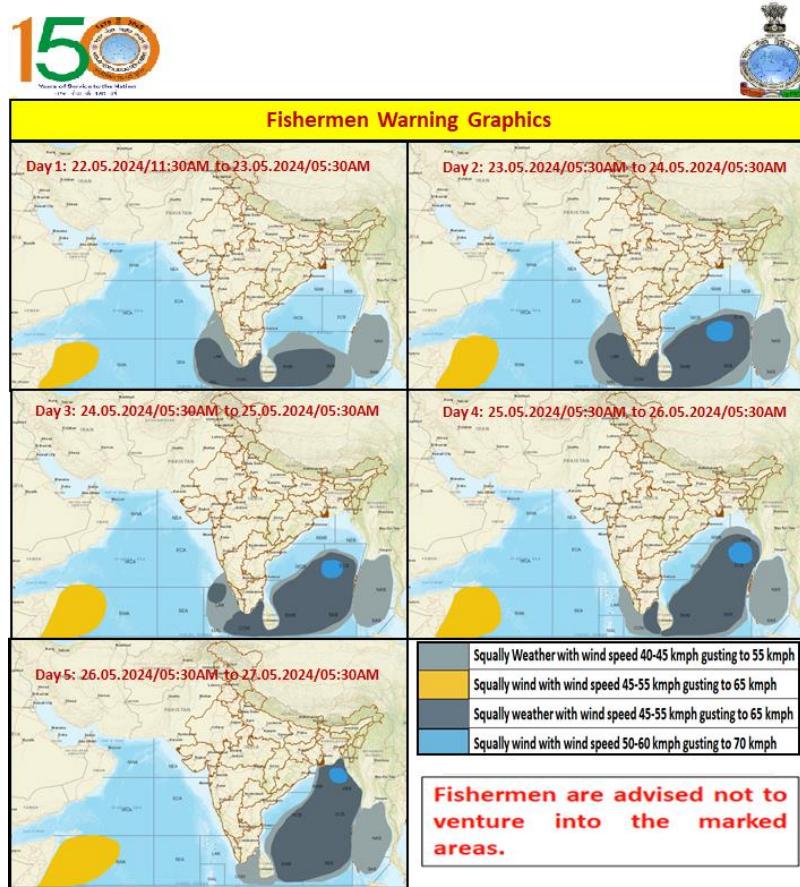


Fig 2.4.4(c): Fishermen Warning Graphics for 0300 UTC of 22<sup>nd</sup> May, 2024

#### Examples-3 (Tropical Weather Outlook in association with Well-Marked Low-Pressure Area)

#### REGIONAL SPECIALISED METEOROLOGICAL CENTRE-TROPICAL CYCLONES, NEW DELHI TROPICAL WEATHER OUTLOOK

DEMS-RSMC TROPICAL CYCLONES NEW DELHI DATED 23.05.2024

**TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND THE ARABIAN SEA) VALID FOR NEXT 168 HOURS ISSUED AT 0800 UTC OF 23.05.2024 BASED ON 0300 UTC OF 23.05.2024.**

##### **BAY OF BENGAL:**

YESTERDAY'S LOW PRESSURE AREA OVER WESTCENTRAL & ADJOINING SOUTHWEST BAY OF BENGAL MOVED NORTHEASTWARDS AND LAY AS A WELL MARKED LOW PRESSURE AREA OVER WESTCENTRAL & ADJOINING SOUTH BAY OF BENGAL AT 0300 UTC OF TODAY, THE 23RD MAY, 2024. IT IS VERY LIKELY TO CONTINUE TO MOVE NORTHEASTWARDS AND CONCENTRATE INTO A DEPRESSION OVER CENTRAL PARTS OF BAY OF BENGAL BY 0000 UTC OF 24TH MAY, 2024. THEREAFTER, IT IS VERY LIKELY TO CONTINUE TO MOVE NORTHEASTWARDS, INTENSIFY FURTHER INTO A CYCLONIC STORM OVER EASTCENTRAL BAY OF BENGAL BY 0000 UTC OF 25TH MAY. SUBSEQUENTLY, IT WOULD MOVE NEARLY NORTHWARDS AND REACH NEAR BANGLADESH AND ADJOINING WEST BENGAL COASTS BY 1200 UTC OF 26TH MAY AS A SEVERE CYCLONIC STORM.

AS PER INSAT-3D IMAGERY, THE CONVECTION HAS FURTHER ORGANISED. INTENSITY OF THE SYSTEM IS T1.0. ASSOCIATED SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH & CENTRAL BAY OF BENGAL ANDAMAN SEA (MINIMUM CLOUD TOP TEMPERATURE -93°C). AS PER MULTISATELLITE WINDS, STRONGER WINDS ARE SEEN IN SOUTHERN SECTOR.

SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH & CENTRAL BAY OF BENGAL ANDAMAN SEA (MINIMUM CLOUD TOP TEMPERATURE -93°C). SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED MODERATE TO INTENSE CONVECTION LAY OVER TENASSERIM COAST AND GULF OF MARTABAN.

**\*PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 168 HRS:**

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS	120-144 HOURS	144-168 HOURS
MOD	HIGH	-	-	-	-	-

\*NOTE: EVERY 24HR FORECAST IS VALID UPTO 0300 UTC (0830 IST) OF NEXT DAY

AS PER LATEST OBSERVATIONS, ESTIMATED CENTRAL PRESSURE IS 999 HPA. AT 0000 UTC A SHIP NEAR 12.3N/ 86E INDICATES MEAN SEA LEVEL PRESSURE (MSLP) OF 998.7 HPA AND MAXIMUM SUSTAINED WIND SPEED (MSW) OF 200DEG/23KT.

**WIND WARNING:**

- ❖ SQUALLY WEATHER WITH WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY TO PREVAIL OVER CENTRAL AND ADJOINING SOUTH BAY OF BENGAL ON 23RD MAY. IT WOULD BECOME 50-60 KMPH GUSTING TO 70 KMPH OVER CENTRAL BAY OF BENGAL ON 24TH MAY.
- ❖ IT WOULD EXTEND TO ADJOINING AREAS OF NORTH BAY OF BENGAL WITH GALE WIND SPEED REACHING 60-70 KMPH GUSTING TO 80 KMPH FROM 0000 UTC OF 25TH MAY IT WOULD FURTHER INCREASE BECOMING 100-110 KMPH GUSTING TO 120 KMPH OVER NORTH BAY OF BENGAL AND 70-80 KMPH GUSTING TO 90 KMPH OVER ADJOINING CENTRAL BAY OF BENGAL FROM 0000 UTC OF 26TH FOR SUBSEQUENT 24 HOURS.
- ❖ SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY ALONG & OFF BANGLADESH, WEST BENGAL AND ADJOINING NORTH ODISHA COASTS FROM 1200 UTC OF 25TH MAY.
- ❖ SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY OVER ANDAMAN ISLANDS AND NORTH ANDAMAN SEA ON 23RD AND 24TH MAY.

**SEA CONDITION:**

- ❖ ROUGH TO VERY ROUGH OVER CENTRAL AND ADJOINING SOUTH BAY OF BENGAL FROM 23RD MAY AND OVER NORTH BAY OF BENGAL FROM 24TH MAY/1200 UTC. IT WOULD BECOME HIGH OVER CENTRAL BAY OF BENGAL FROM 25TH MAY/0000 UTC AND HIGH TO VERY HIGH OVER NORTH BAY OF BENGAL FROM 25TH/ 1200 UTC TILL 27TH MAY/ 0000 UTC.
- ❖ ROUGH TO VERY ROUGH ALONG & OFF BANGLADESH, WEST BENGAL AND ADJOINING NORTH ODISHA COASTS FROM 25TH MAY/ 1200 UTC AND HIGH ALONG & OFF BANGLADESH AND WEST BENGAL COASTS FROM 26TH/ 0600 UTC ONWARDS TILL 27TH MAY/ 0000 UTC.
- ❖ ROUGH TO VERY ROUGH OVER ANDAMAN ISLANDS AND NORTH ANDAMAN SEA ON 23RD AND 24TH MAY.

**FISHERMEN WARNING (GRAPHICS ATTACHED):**

FISHERMEN ARE ADVISED NOT TO VENTURE INTO SOUTH BAY OF BENGAL TILL 24TH MAY, CENTRAL BAY OF BENGAL TILL 26TH MAY AND NORTH BAY OF BENGAL FROM 24TH MAY ONWARDS TILL MORNING OF 27TH MAY. FISHERMEN OUT AT SEA ARE ADVISED TO RETURN TO THE COAST.

**ARABIAN SEA:**

UNDER THE INFLUENCE OF THE CYCLONIC CIRCULATION OVER SOUTH KERALA & NEIGHBOURHOOD, A LOW PRESSURE AREA FORMED OVER SOUTHEAST ARABIAN SEA OFF KERALA COAST WITH ASSOCIATED CYCLONIC CIRCULATION EXTENDING UPTO 7.6 KM ABOVE MEAN SEA LEVEL AT 0300 UTC OF TODAY, THE 25<sup>TH</sup> MAY,2024.

ASSOCIATED SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTHEAST ARABIAN SEA & LAKSHADWEEP ISLANDS AREA (MINIMUM CLOUD TOP TEMPERATURE -93°C).

SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTHEAST ADJOINING EASTCENTRAL ARABIAN SEA LAKSHADWEEP ISLANDS AREA MALDIVES AND COMORIN AREA (MINIMUM CLOUD TOP TEMPERATURE -93°C).

**\*PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 168 HRS:**

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS	120-144 HOURS	144-168 HOURS
NIL	NIL	NIL	NIL	NIL	NIL	NIL

\*NOTE: EVERY 24HR FORECAST IS VALID UPTO 0300 UTC (0830 IST) OF NEXT DAY

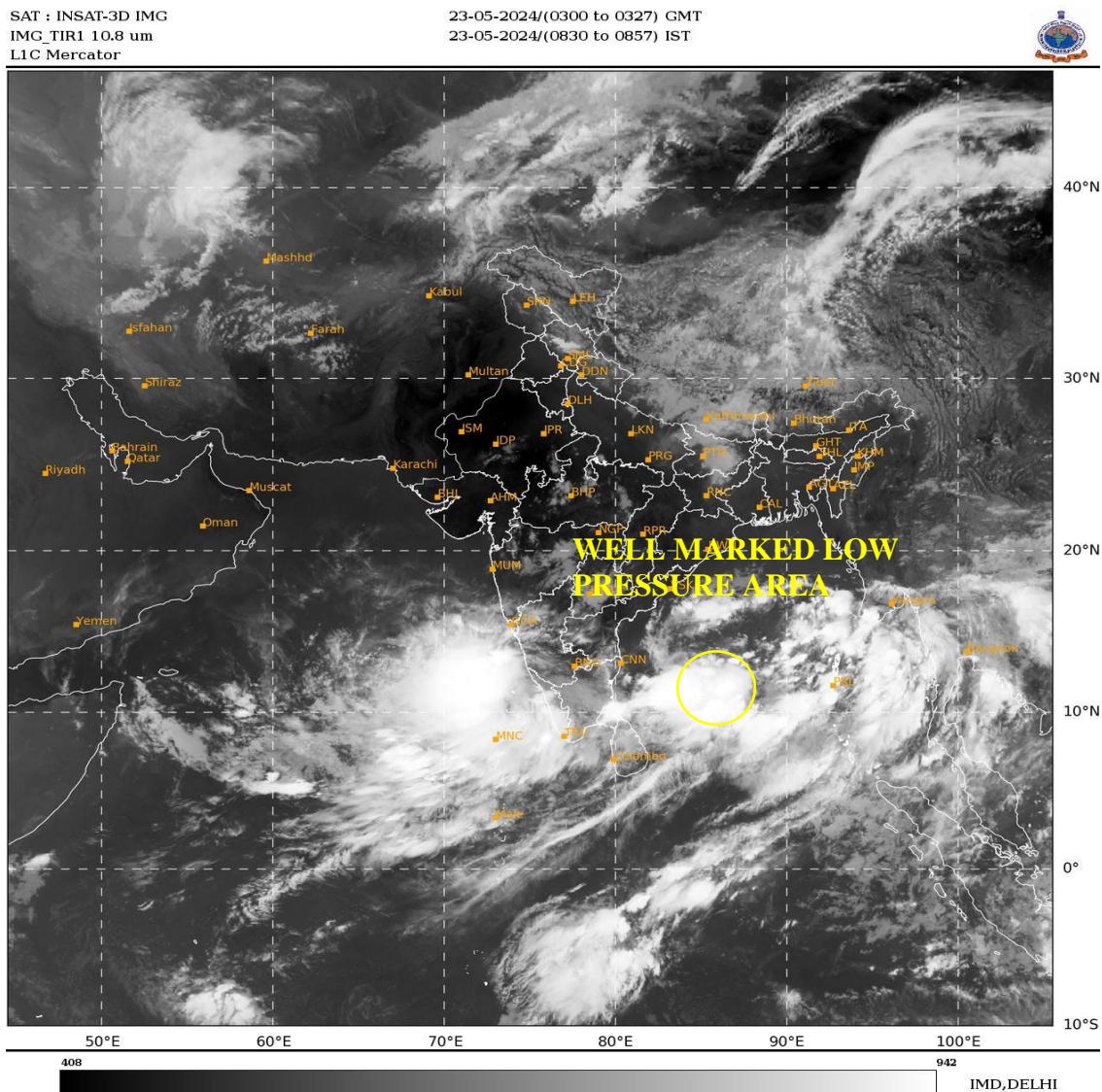
**REMARKS:**

THE MADDEN JULIAN INDEX (MJO) CURRENTLY LIES IN PHASE 4 WITH AMPLITUDE MORE THAN 1. IT WILL CONTINUE IN SAME PHASE DURING NEXT 7 DAYS. THUS, MJO PHASE & AMPLITUDE ARE HIGHLY CONDUCIVE FOR CYCLOGENESIS AND FURTHER INTENSIFICATION OVER THE BAY OF BENGAL (BOB) DURING NEXT 5 DAYS. STRONG EASTERLY WINDS (5-7 MPS) ARE LIKELY TO PREVAIL OVER CENTRAL BOB DURING NEXT 24 HOURS & NORTH BOB DURING SUBSEQUENT 3-4 DAYS IN THE LOWER TROPOSPHERIC LEVELS. STRONG WESTERLY WINDS (5-7 MPS) ARE LIKELY TO PREVAIL OVER THE SOUTH BOB AND ANDAMAN SEA DURING NEXT 5 DAYS AND OVER CENTRAL BOB DURING 25<sup>TH</sup> TO 27<sup>TH</sup> MAY. IN ADDITION, KELVIN WAVES, EQUATORIAL ROSSBY WAVES ARE PREVAILING OVER SOUTH BOB & COUPLED WITH MJO. THESE WAVES WILL PROVIDE A CONDUCIVE ENVIRONMENT FOR CYCLOGENESIS AND INTENSIFICATION OF SYSTEM OVER BOB. THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM<sup>2</sup> OVER MAJOR PARTS OF BOB. IT IS INDICATING SLIGHTLY DECREASING TENDENCY TOWARDS NORTH BOB AND ALONG THE COASTS. SEA SURFACE TEMPERATURE (SST) IS AROUND 30-32°C OVER ENTIRE BOB. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR CYCLOGENESIS AND INTENSIFICATION.

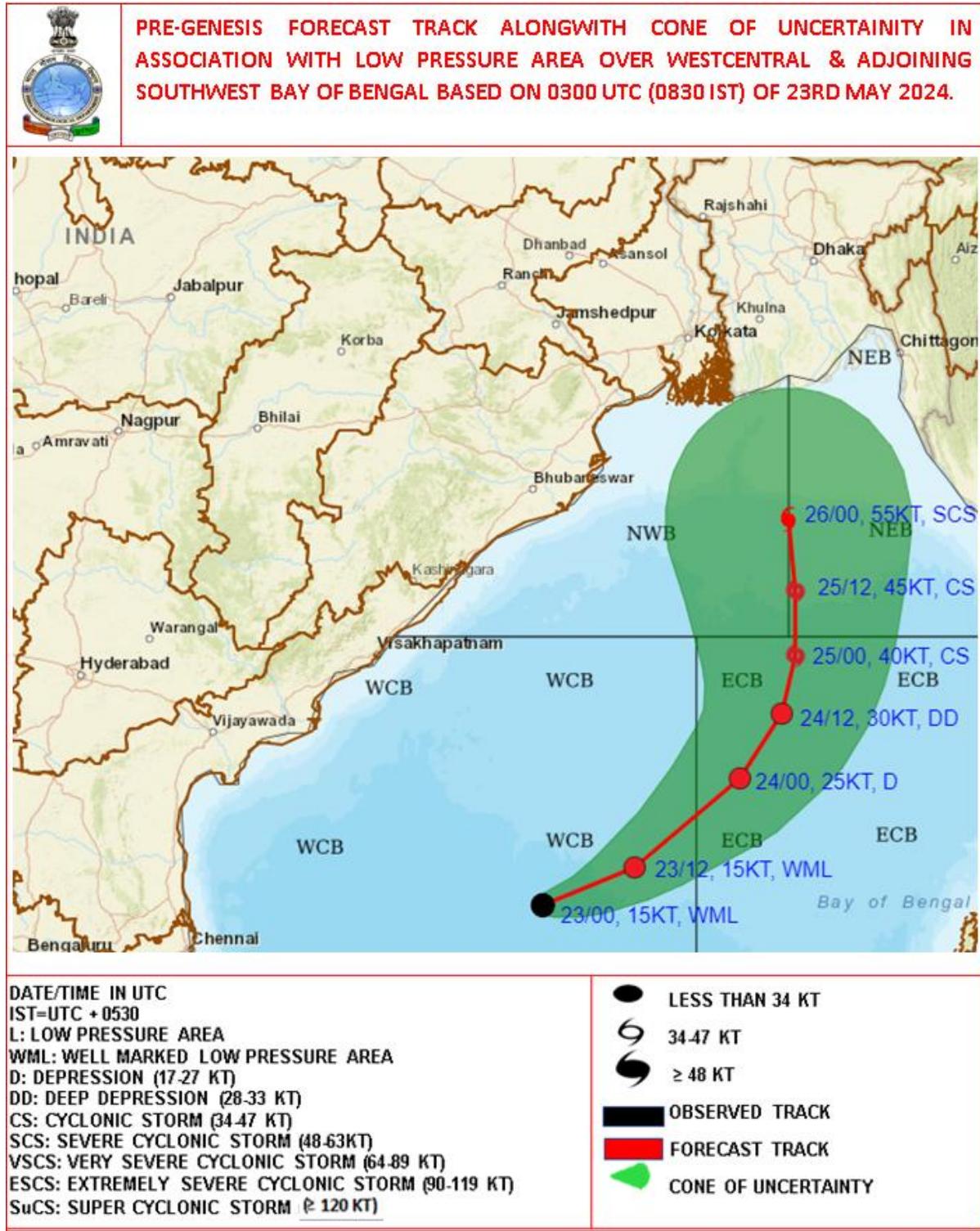
CONSIDERING THE ENVIRONMENTAL CONDITIONS, LOW LEVEL VORTICITY HAS INCREASED DURING PAST 24 HOURS AND IS ABOUT  $100 \times 10^{-5} \text{ s}^{-1}$  TO THE SOUTH OF SYSTEM CENTRE OVER SOUTHWEST BAY OF BENGAL OF BENGAL WITH VERTICAL EXTENSION UPTO 200 HPA LEVELS. LOW LEVEL CONVERGENCE IS THE SAME AND IS ABOUT  $10-15 \times 10^{-5} \text{ s}^{-1}$  OVER SOUTH BOB AND IS EAST-WEST ORIENTED. UPPER LEVEL DIVERGENCE HAS INCREASED AND IS ABOUT  $20 \times 10^{-5} \text{ s}^{-1}$  OVER SOUTH BOB & SOUTH ANDAMAN SEA. IT IS ALSO EAST-WEST ORIENTED. VERTICAL WIND SHEAR (VWS) IS LOW TO MODERATE OVER MAJOR PARTS OF BOB. MID LEVEL WIND SHEAR IS ANTICYCLONIC OVER SOUTH BOB. VWS WILL THUS SUPPORT FURTHER INTENSIFICATION OF SYSTEM. CURRENTLY, THE SYSTEM IS MOVING NORTHEASTWARDS UNDER THE INFLUENCE OF SOUTHWESTERLY WINDS ASSOCIATED WITH ADVANCE OF SOUTHWEST MONSOON OVER THE SOUTH BAY OF BENGAL. THE UPPER TROPOSPHERIC RIDGE AT 200 HPA IS LOCATED NEAR 15.0°N. THE RIDGE IS LIKELY TO SHIFT NORTHWARDS LEADING TO NEAR NORTHWARDS MOVEMENT OF THE SYSTEM FROM 24<sup>TH</sup> MAY.

VARIOUS MODELS ARE INDICATING FORMATION OF DEPRESSION DURING 23/1200 UTC TO 24/1200 UTC OVER CENTRAL PARTS OF BAY OF BENGAL. HENCE HIGH PROBABILITY HAS BEEN ASSIGNED TO FORMATION OF DEPRESSION DURING NEXT 24-48 HOURS. THERE IS LARGE

VARIATION AMONG VARIOUS MODELS WITH RESPECT TO MOVEMENT AND INTENSIFICATION OF THE SYSTEM. THE LANDFALL POINT IS VARYING FROM ODISHA TO BANGLADESH COASTS. MODELS LIKE ECAI & NCEP GFS ARE INDICATING CROSSING OVER ODISHA COAST, ECMWF OVER WEST BENGAL COAST AND IMD GFS, NCUM & IMD MME OVER BANGLADESH COAST. REGARDING INTENSIFICATION, MODELS LIKE NCEP GFS, IMD GFS AND NCUM ARE INDICATING INTENSIFICATION UPTO VERY SEVERE CYCLONIC STORM CATEGORY (65-75 KT). MODELS LIKE IMD MME, ECAI AND ECMWF ARE INDICATING INTENSIFICATION UPTO SEVERE CYCLONIC STORM STAGE (UPTO 55 KT). THE LANDFALL TIME IS VARYING BETWEEN 26<sup>TH</sup>/1200-26<sup>TH</sup>/2100 UTC. CONSIDERING ALL THE ABOVE, THE WELL MARKED LOW PRESSURE AREA OVER WESTCENTRAL & ADJOINING SOUTH BAY OF BENGAL IS VERY LIKELY TO CONTINUE TO MOVE NORTHEASTWARDS AND CONCENTRATE INTO A DEPRESSION OVER CENTRAL PARTS OF BAY OF BENGAL BY 0000 UTC OF 24TH MAY, 2024. THEREAFTER, IT IS VERY LIKELY TO CONTINUE TO MOVE NORTHEASTWARDS, INTENSIFY FURTHER INTO A CYCLONIC STORM OVER EASTCENTRAL BAY OF BENGAL BY 0000 UTC OF 25TH MAY. SUBSEQUENTLY, IT WOULD MOVE NEARLY NORTHWARDS AND REACH NEAR BANGLADESH AND ADJOINING WEST BENGAL COASTS BY 1200 UTC OF 26TH MAY AS A SEVERE CYCLONIC STORM.



**Fig 2.4.5(a): INSAT 3D Image for 0300 UTC of 23<sup>rd</sup> May, 2024**



**Fig 2.4.5(b): Pre-genesis track forecast issued at the stage of well-marked low pressure area on 23rd May 2024**

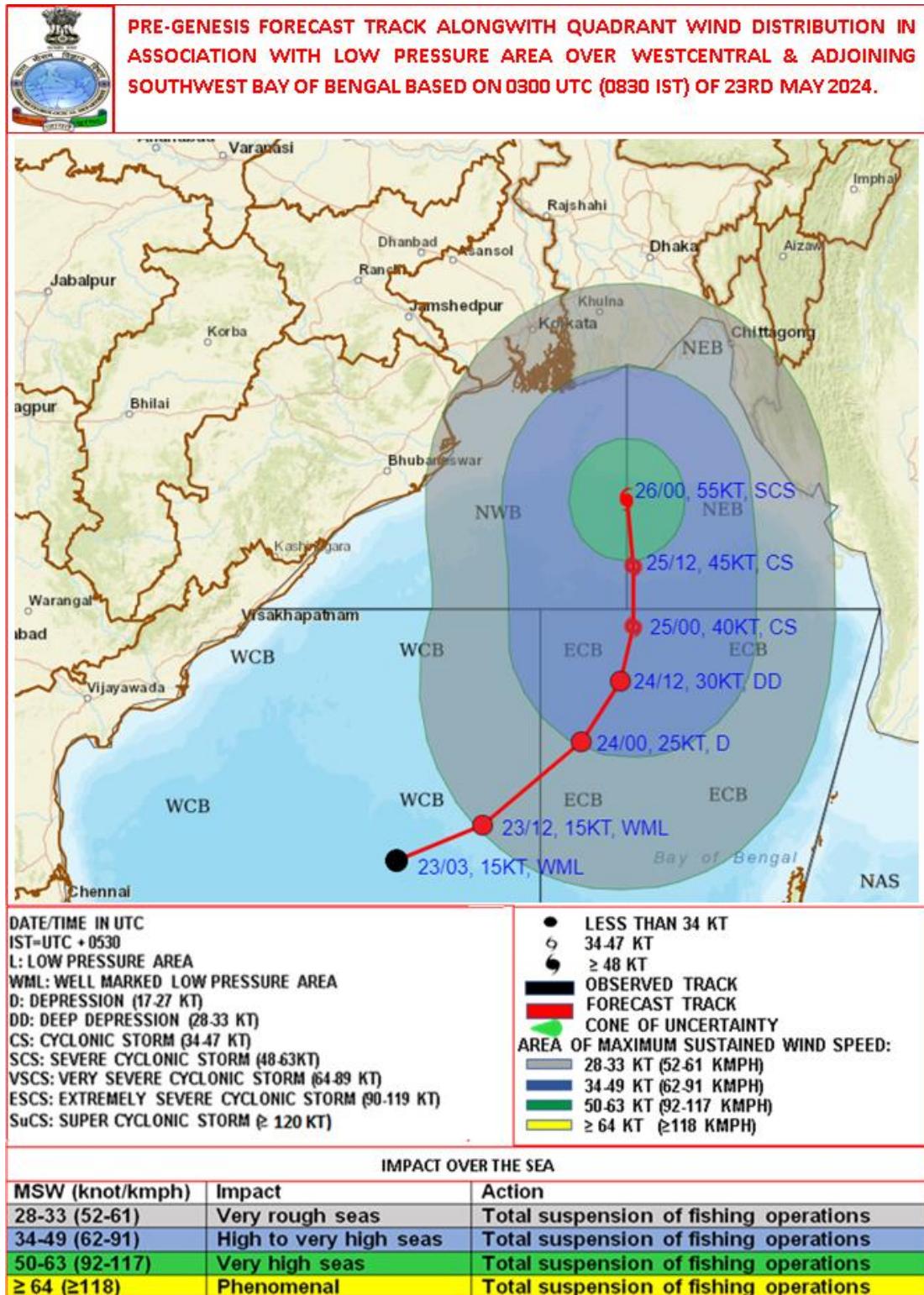
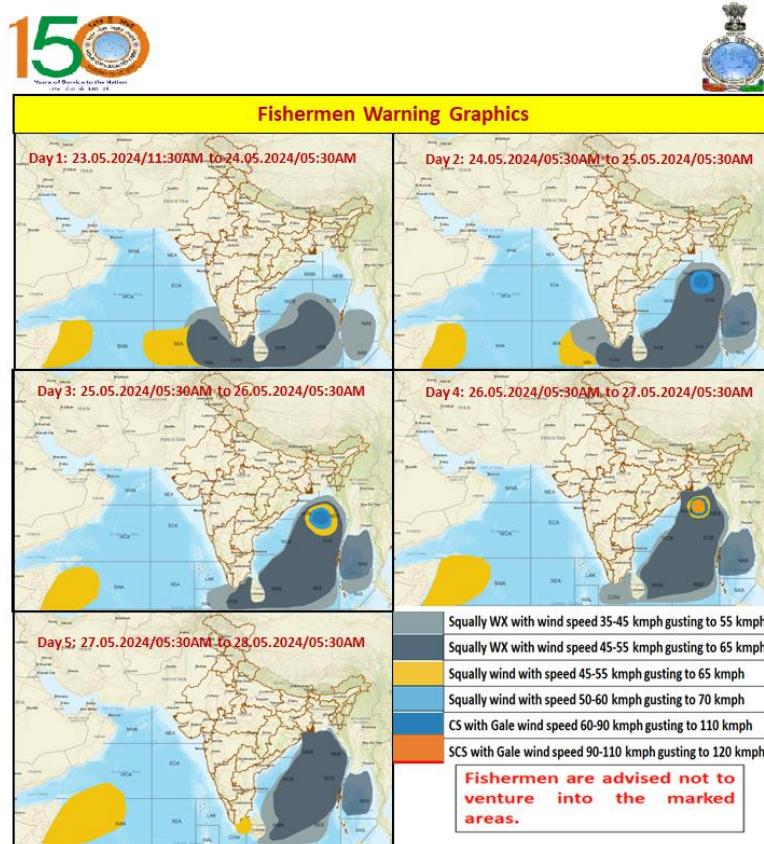


Fig 2.4.5(c): Pre-genesis intensity forecast issued at the stage of well-marked low pressure area on 23<sup>rd</sup> May 2024



**Fig 2.4.5(d): Fishermen Warning Graphics issued at 0300 UTC on 23<sup>rd</sup> May 2024**

#### 2.4.3 Special Tropical Weather Outlook

The special tropical weather outlook issued in association with the depression/deep depression will provide brief descriptions of tropical depressions affecting the area. It will give the location, intensity and movement of the system as well as a general statement of land areas coming under threat. It will also contain description of the convective clouds in satellite imageries and diagnostic & prognostic features of the system. It is issued five times a day based on 0000, 0300, 0600, 1200 and 1800 UTC observations will in addition contain the 120 hrs forecast track and intensity of the system in a tabular form. These track and intensity forecasts are issued for +6, +12, +18, +24, +36, +48, +60, +72, +84, +96, +108 and +120 hrs since May 2013. Since 2018, the above objective track and intensity forecast is also being issued from depression stage for next +12, +24, +36, +48, +60, +72 hrs, if the depression is expected to intensify into a cyclonic storm.

When a system reaches the cyclonic storm stage (wind speed 34 kt), RSMC tropical cyclones, New Delhi will issue cyclonic storm advisories.

**Examples-4: (Special Tropical Weather Outlook in association with a depression)**

**REGIONAL SPECIALISED METEOROLOGICAL CENTRE-TROPICAL CYCLONES, NEW DELHI  
TROPICAL WEATHER OUTLOOK**

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**DEMS-RSMC TROPICAL CYCLONES NEW DELHI DATED 24.05.2024**

**SPECIAL TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND THE ARABIAN SEA) VALID FOR NEXT 168 HOURS ISSUED AT 0300 UTC OF 24.05.2024 BASED ON 0000 UTC OF 24.05.2024.**

**BAY OF BENGAL:**

THE WELL-MARKED LOW PRESSURE AREA OVER WESTCENTRAL & ADJOINING SOUTH BAY OF BENGAL MOVED NORTHEASTWARDS DURING PAST 12 HOURS, CONCENTRATED INTO A DEPRESSION AND LAY CENTERED AT 0000 UTC OF TODAY, THE 24<sup>TH</sup> MAY, 2024 OVER CENTRAL BAY OF BENGAL NEAR LATITUDE 15.0 0N AND LONGITUDE 88.4 0E, ABOUT 800 KM SOUTH-SOUTHWEST OF KHEPUPARA (41984, BANGLADESH) AND 810 KM SOUTH OF CANNING (42812, WEST BENGAL).

IT IS VERY LIKELY TO CONTINUE TO MOVE NORTHEASTWARDS AND INTENSIFY FURTHER INTO A CYCLONIC STORM OVER EASTCENTRAL BAY OF BENGAL BY 0000 UTC OF 25TH MAY. SUBSEQUENTLY, IT WOULD MOVE NEARLY NORTHWARDS, INTENSIFY INTO A SEVERE CYCLONIC STORM BY 1800 UTC OF 25TH. CONTINUING TO MOVE NEARLY NORTHWARD, IT IS VERY LIKELY TO CROSS BANGLADESH AND ADJOINING WEST BENGAL COASTS BETWEEN SAGAR ISLAND AND KHEPUPARA AROUND 1800 UTC 26TH MAY AS A SEVERE CYCLONIC STORM.

PRE-GENESIS FORECAST TRACK AND INTENSITY ARE GIVEN IN THE FOLLOWING TABLE:

DATE/TIME (UTC)	POSITION LAT. °N/ LONG. °E	MAXIMUM SUSTAINED SURFACE WIND SPEED (KMPH)	CATEGORY OF CYCLONIC DISTURBANCE
24.05.24/0000	15.0/88.4	40-50 GUSTING TO 60	DEPRESSION
24.05.24/1200	15.9/89.2	50-60 GUSTING 70	DEEP DEPRESSION
25.05.24/0000	17.1/89.5	60-70 GUSTING TO 80	CYCLONIC STORM
25.05.24/1200	18.0/89.7	80-90 GUSTING TO 100	CYCLONIC STORM
26.05.24/0000	19.3/89.8	100-110 GUSTING TO 120	SEVERE CYCLONIC STORM
26.05.24/1200	20.9/89.6	110-120 GUSTING TO 130	SEVERE CYCLONIC STORM
27.05.24/0000	21.9/89.4	110-120 GUSTING TO 130	SEVERE CYCLONIC STORM
27.05.24/1200	23.1/89.5	70-80 GUSTING TO 90	CYCLONIC STORM
28.05.24/0000	23.9/89.8	40-50 GUSTING TO 60	DEPRESSION

AS PER INSAT-3D IMAGERY, THE CONVECTION HAS FURTHER ORGANISED. INTENSITY OF THE SYSTEM IS T1.5. ASSOCIATED SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER CENTRAL & SOUTH BAY OF BENGAL AND NORTH ANDAMAN SEA (MINIMUM CLOUD TOP TEMPERATURE -93°C). AS PER MULTISATELLITE WINDS, STRONGER WINDS ARE SEEN IN SOUTHERN SECTOR. THE TOTAL PRECIPITABLE WATER IMAGERY INDICATES WARM MOIST AIR INCURSION INTO THE CORE OF THE SYSTEM.

AS PER LATEST OBSERVATIONS, ESTIMATED CENTRAL PRESSURE IS 996 HPA AT 0000 UTC. A SHIP NEAR 12.1N/ 85.9E INDICATES MEAN SEA LEVEL PRESSURE (MSLP) OF 997.7 HPA AND MAXIMUM SUSTAINED WIND SPEED (MSW) OF 260DEG/20KT. A BUOY NEAR 13.5N/ 84.0E INDICATES MEAN SEA LEVEL PRESSURE (MSLP) OF 999.2 HPA AND MAXIMUM SUSTAINED WIND SPEED (MSW) OF 307DEG/06KT AND ANOTHER BUOY LOCATED NEAR 16.2N/ 88.0E INDICATES MEAN SEA LEVEL PRESSURE (MSLP) OF 997 HPA AND MAXIMUM SUSTAINED WIND SPEED (MSW) OF 3607DEG/09KT.

**WIND WARNING:**

- ❖ SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY TO PREVAIL OVER CENTRAL AND ADJOINING SOUTH BAY OF BENGAL ON 24TH MAY. IT WOULD BECOME 50-60 KMPH GUSTING TO 70 KMPH OVER CENTRAL BAY OF BENGAL ON 24TH MAY EVENING.
- ❖ IT WOULD EXTEND TO ADJOINING AREAS OF NORTH BAY OF BENGAL WITH GALE WIND SPEED REACHING 60-70 KMPH GUSTING TO 80 KMPH FROM 0000 UTC OF 25TH MAY. IT WOULD FURTHER INCREASE BECOMING 100-110 KMPH GUSTING TO 120 KMPH OVER NORTH BAY OF BENGAL FROM MORNING AND 110-120 KMPH GUSTING TO 120 KMPH FROM 1200 UTC OF 26TH MAY. GALE WIND SPEED REACHING 70-80 KMPH GUSTING TO 90 KMPH IS LIKELY OVER ADJOINING CENTRAL BAY OF BENGAL FROM 0000 UTC OF 26TH FOR SUBSEQUENT 24 HOURS.
- ❖ SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY ALONG & OFF BANGLADESH, WEST BENGAL AND ADJOINING NORTH ODISHA COASTS FROM 1200 UTC OF 25TH MAY. IT IS LIKELY TO INCREASE BECOMING GALE WIND SPEED REACHING 60-70 KMPH GUSTING TO 80 KMPH FROM 0000 UTC OF 26TH MAY AND 100-120 KMPH GUSTING TO 135 KMPH ALONG & OFF BANGLADESH AND ADJOINING WEST BENGAL COASTS FROM EVENING OF 1200 UTC 26TH FOR SUBSEQUENT 12 HOURS.
- ❖ SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY OVER ANDAMAN ISLANDS AND NORTH ANDAMAN SEA ON 24TH MAY.

**SEA CONDITION:**

- ❖ ROUGH TO VERY ROUGH SEA CONDITION IS LIKELY OVER CENTRAL AND ADJOINING SOUTH BAY OF BENGAL ON 24<sup>TH</sup> MAY. IT WOULD BECOME HIGH OVER CENTRAL BAY OF BENGAL ON 25<sup>TH</sup> MAY & 26<sup>TH</sup> MAY AND HIGH TO VERY HIGH OVER NORTH BAY OF BENGAL FROM 1200 UTC OF 25<sup>TH</sup> TILL 0000 UTC OF 27<sup>TH</sup> MAY.
- ❖ ROUGH TO VERY ROUGH SEA CONDITION IS LIKELY ALONG & OFF BANGLADESH, WEST BENGAL AND ADJOINING NORTH ODISHA COASTS FROM 1200 UTC OF 25<sup>TH</sup> MAY AND HIGH TO VERY HIGH ALONG & OFF BANGLADESH AND WEST BENGAL COASTS FROM 0000 UTC OF 26<sup>TH</sup> ONWARDS TILL 0000 UTC OF 27<sup>TH</sup> MAY.
- ❖ ROUGH TO VERY ROUGH SEA CONDITION IS LIKELY OVER ANDAMAN ISLANDS AND NORTH ANDAMAN SEA ON 24<sup>TH</sup> MAY.

**FISHERMEN WARNING (GRAPHICS ATTACHED):**

FISHERMEN ARE ADVISED NOT TO VENTURE INTO SOUTH BAY OF BENGAL AND ANDAMAN SEA TILL 24<sup>TH</sup> MAY, CENTRAL BAY OF BENGAL TILL 26<sup>TH</sup> MAY AND NORTH BAY OF BENGAL FROM 25<sup>TH</sup> MAY TILL 27<sup>TH</sup> MAY. FISHERMEN OUT AT SEA ARE ADVISED TO RETURN TO THE COAST.

**ARABIAN SEA:**

THE LOW PRESSURE AREA OVER SOUTHEAST ARABIAN SEA OFF KERALA COAST PERSISTED OVER THE SAME REGION AT 0000 UTC OF TODAY, THE 24<sup>TH</sup> MAY, 2024.  
 LOW LEVEL CIRCULATION (LLC) OVER SE ARSEA OFF KER COAST & N/HOOD (.) ASSTD SCT TO BKN LOW/MED CLOUDS WITH EMBDD INT TO V INT CONVTN OVER SE ADJ EC ARSEA OFF KER-KRNTK COASTS AND LKSDP ILS AREA (MINIMUM CTT MINUS 93 DEG CEL) (.)  
 ASSOCIATED SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTHEAST AND ADJOINING EASTCENTRAL ARABIAN SEA, LAKSHADWEEP ISLANDS AREA AND MALDIEVE & COMORIN AREA. (MINIMUM CLOUD TOP TEMPERATURE -93°C).

**\*PROBABILITY OF CYCOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 168 HRS:**

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS	120-144 HOURS	144-168 HOURS
NIL	NIL	NIL	NIL	NIL	NIL	NIL

\*NOTE: EVERY 24HR FORECAST IS VALID UPTO 0300 UTC (0830 IST) OF NEXT DAY

**REMARKS:**

THE MADDEN JULIAN INDEX (MJO) CURRENTLY LIES IN PHASE 4 WITH AMPLITUDE MORE THAN 1. IT WILL CONTINUE IN SAME PHASE DURING NEXT 7 DAYS. THUS, MJO PHASE & AMPLITUDE

ARE HIGHLY CONDUCIVE FOR CYCLOGENESIS AND FURTHER INTENSIFICATION OVER THE BAY OF BENGAL (BOB) DURING NEXT 5 DAYS.

STRONG EASTERLY WINDS (5-7 MPS) ARE LIKELY TO PREVAIL OVER CENTRAL BOB DURING NEXT 24 HOURS & NORTH BOB DURING SUBSEQUENT 3-4 DAYS IN THE LOWER TROPOSPHERIC LEVELS. STRONG WESTERLY WINDS (5-7 MPS) ARE LIKELY TO PREVAIL OVER THE SOUTH BOB AND ANDAMAN SEA DURING NEXT 5 DAYS AND OVER CENTRAL BOB DURING 25<sup>TH</sup> TO 27<sup>TH</sup> MAY. IN ADDITION, KELVIN WAVES, EQUATORIAL ROSSBY WAVES ARE PREVAILING OVER SOUTH BOB & COUPLED WITH MJO. THESE WAVES WILL PROVIDE A CONDUCIVE ENVIRONMENT FOR CYCLOGENESIS AND INTENSIFICATION OF SYSTEM OVER BOB.

THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM<sup>2</sup> OVER MAJOR PARTS OF BOB. IT IS INDICATING SLIGHTLY DECREASING TENDENCY TOWARDS NORTH BOB AND ALONG THE COASTS. SEA SURFACE TEMPERATURE (SST) IS AROUND 30-32°C OVER ENTIRE BOB. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR CYCLOGENESIS AND INTENSIFICATION.

CONSIDERING THE ENVIRONMENTAL CONDITIONS, LOW LEVEL VORTICITY IS ABOUT  $150 \times 10^{-5} \text{ s}^{-1}$  TO THE SOUTH OF SYSTEM CENTRE OVER WESTCENTRAL & ADJOINING EASTCENTRAL BAY OF BENGAL WITH VERTICAL EXTENSION UPTO 200 HPA LEVELS. LOW LEVEL CONVERGENCE HAS INCREASES AND IS ABOUT  $30 \times 10^{-5} \text{ s}^{-1}$  TO THE SOUTH OF THE SYSTEM CENTER. UPPER LEVEL DIVERGENCE HAS TWO PATCHES WITH EAST-WEST ORIENTATION AND IT IS ABOUT  $30 \times 10^{-5} \text{ s}^{-1}$  TO SOUTHWEST OF THE SYSTEM CENTER AND IT IS ABOUT  $40 \times 10^{-5} \text{ s}^{-1}$  TO SOUTHEAST OF THE SYSTEM CENTER. VERTICAL WIND SHEAR (VWS) IS LOW TO MODERATE OVER NEAR THE SYSTEM CENTER AND ALONG THE FORECAST TRACK. MID LEVEL WIND SHEAR IS ANTICYCLONIC OVER CENTRAL AND NORTHWEST BOB. VWS WILL THUS SUPPORT FURTHER INTENSIFICATION OF SYSTEM. CURRENTLY, THE SYSTEM IS MOVING NORTHEASTWARDS UNDER THE INFLUENCE OF SOUTHWEST MONSOON OVER THE SOUTH BAY OF BENGAL. THE UPPER TROPOSPHERIC RIDGE AT 200 HPA IS LOCATED NEAR 17.5°N.

VARIOUS MODELS ARE INDICATING INTENSIFICATION INTO DEEP DEPRESSION AROUND 24/1200 UTC AND FURTHER INTO CYCLONIC STORM AROUND 25/0000 UTC. THERE IS SOME VARIATION AMONG MODELS WITH RESPECT TO MOVEMENT OF THE SYSTEM AND ITS LANDFALL POINT AND TIME.

CONSIDERING ALL THE ABOVE, THE WELL-MARKED LOW PRESSURE AREA OVER WESTCENTRAL & ADJOINING SOUTH BAY OF BENGAL MOVED NORTHEASTWARDS DURING PAST 12 HOURS, CONCENTRATED INTO A DEPRESSION AND LAY CENTERED AT 0000 UTC OF TODAY, THE 23RD MAY, 2024 OVER CENTRAL BAY OF BENGAL NEAR LATITUDE 15.0 ON AND LONGITUDE 88.4 0E, ABOUT 800 KM SOUTH-SOUTHWEST OF KHEPUPARA (41984, BANGLADESH) AND 810 KM SOUTH OF CANNING (42812, WEST BENGAL).

IT IS VERY LIKELY TO CONTINUE TO MOVE NORTHEASTWARDS AND INTENSIFY FURTHER INTO A CYCLONIC STORM OVER EASTCENTRAL BAY OF BENGAL BY 0000 UTC OF 25TH MAY. SUBSEQUENTLY, IT WOULD MOVE NEARLY NORTHWARDS, INTENSIFY INTO A SEVERE CYCLONIC STORM BY 1800 UTC OF 25TH. CONTINUING TO MOVE NEARLY NORTHWARD, IT IS VERY LIKELY TO CROSS BANGLADESH AND ADJOINING WEST BENGAL COASTS BETWEEN SAGAR ISLAND AND KHEPUPARA AROUND 1800 UTC 26TH MAY AS A SEVERE CYCLONIC STORM.

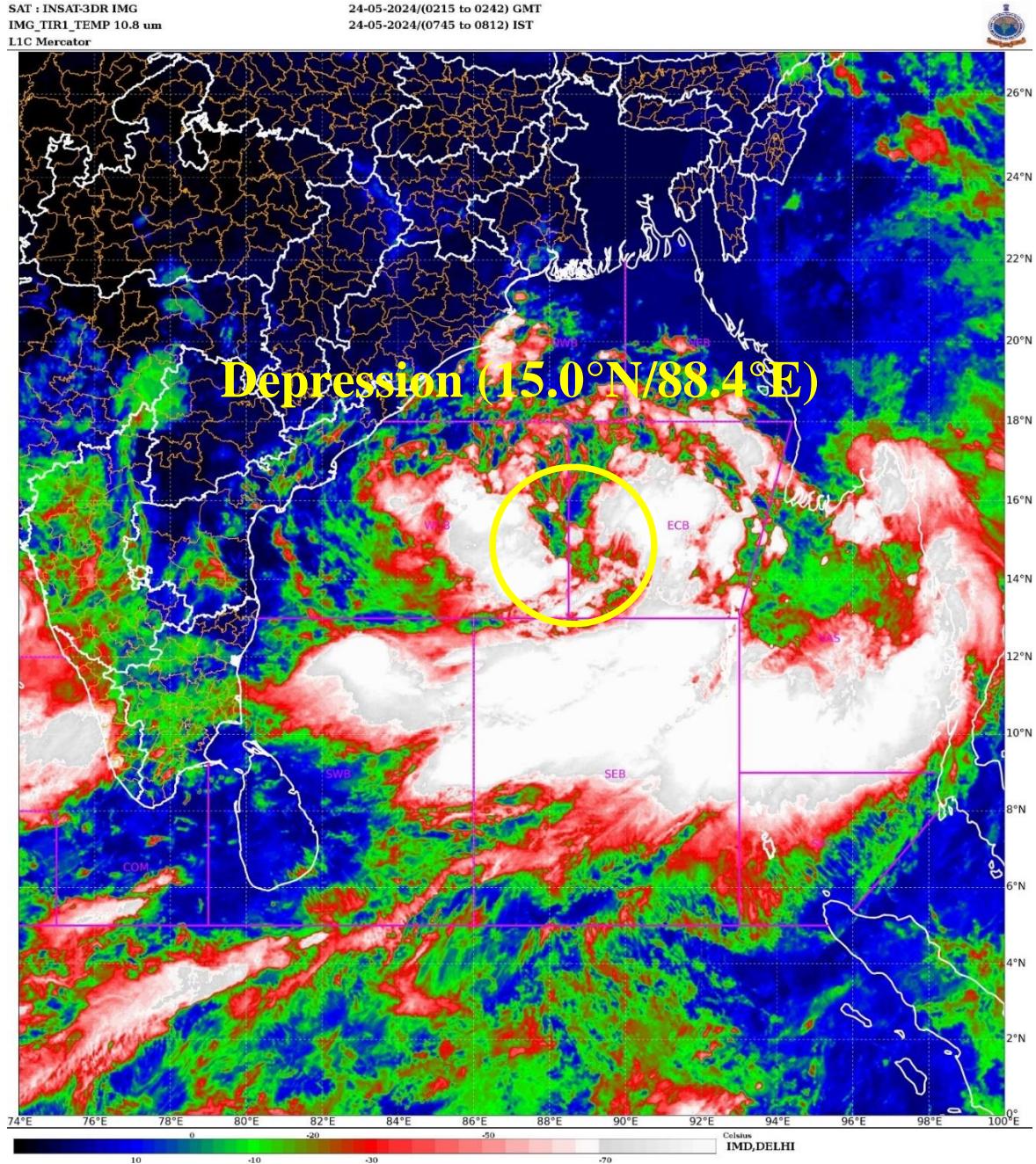
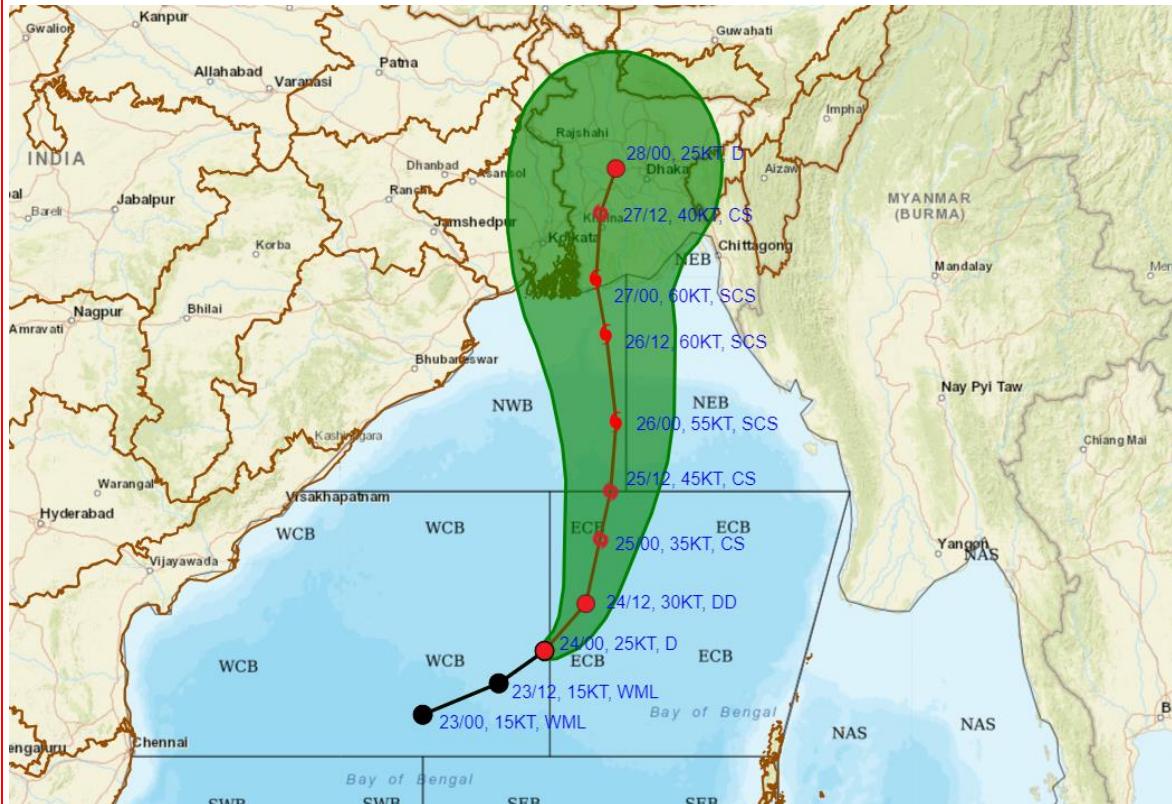


Fig 2.4.6(a): INSAT 3DR Image issued at 0215 UTC of 24<sup>th</sup> May, 2024



**FORECAST TRACK ALONG WITH CONE OF UNCERTAINTY  
IN ASSOCIATION WITH DEPRESSION OVER CENTRAL BAY  
OF BENGAL BASED ON 0000 UTC OF 24<sup>TH</sup> MAY 2024.**



**DATE/TIME IN UTC**

IST=UTC + 0530

L: LOW PRESSURE AREA

WML: WELL MARKED LOW PRESSURE AREA

D: DEPRESSION (17-27 KT)

DD: DEEP DEPRESSION (28-33 KT)

CS: CYCLONIC STORM (34-47 KT)

SCS: SEVERE CYCLONIC STORM (48-63 KT)

VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)

ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)

SuCS: SUPER CYCLONIC STORM ( $\geq 120$  KT)

LESS THAN 34 KT

34-47 KT

$\geq 48$  KT

OBSERVED TRACK

FORECAST TRACK

CONE OF UNCERTAINTY

**Fig 2.4.6(b): Forecast track along with cone of uncertainty in association with depression over central Bay of Bengal based on 0000 UTC of 24<sup>th</sup> May 2024**

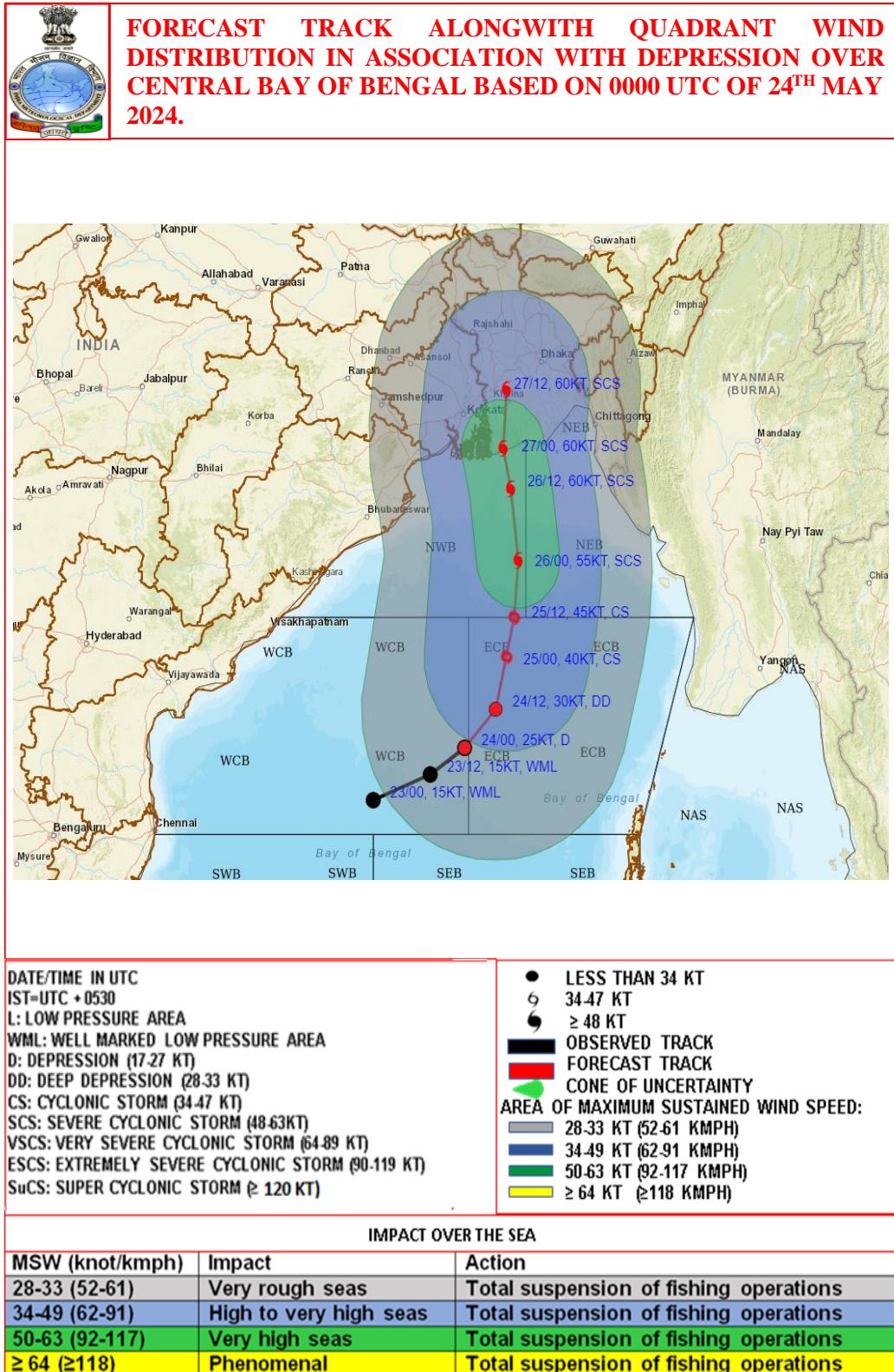


Fig 2.4.6(c): Forecast track along with quadrant wind distribution in association with depression over central Bay of Bengal based on 0000 UTC of 24<sup>th</sup> May 2024.

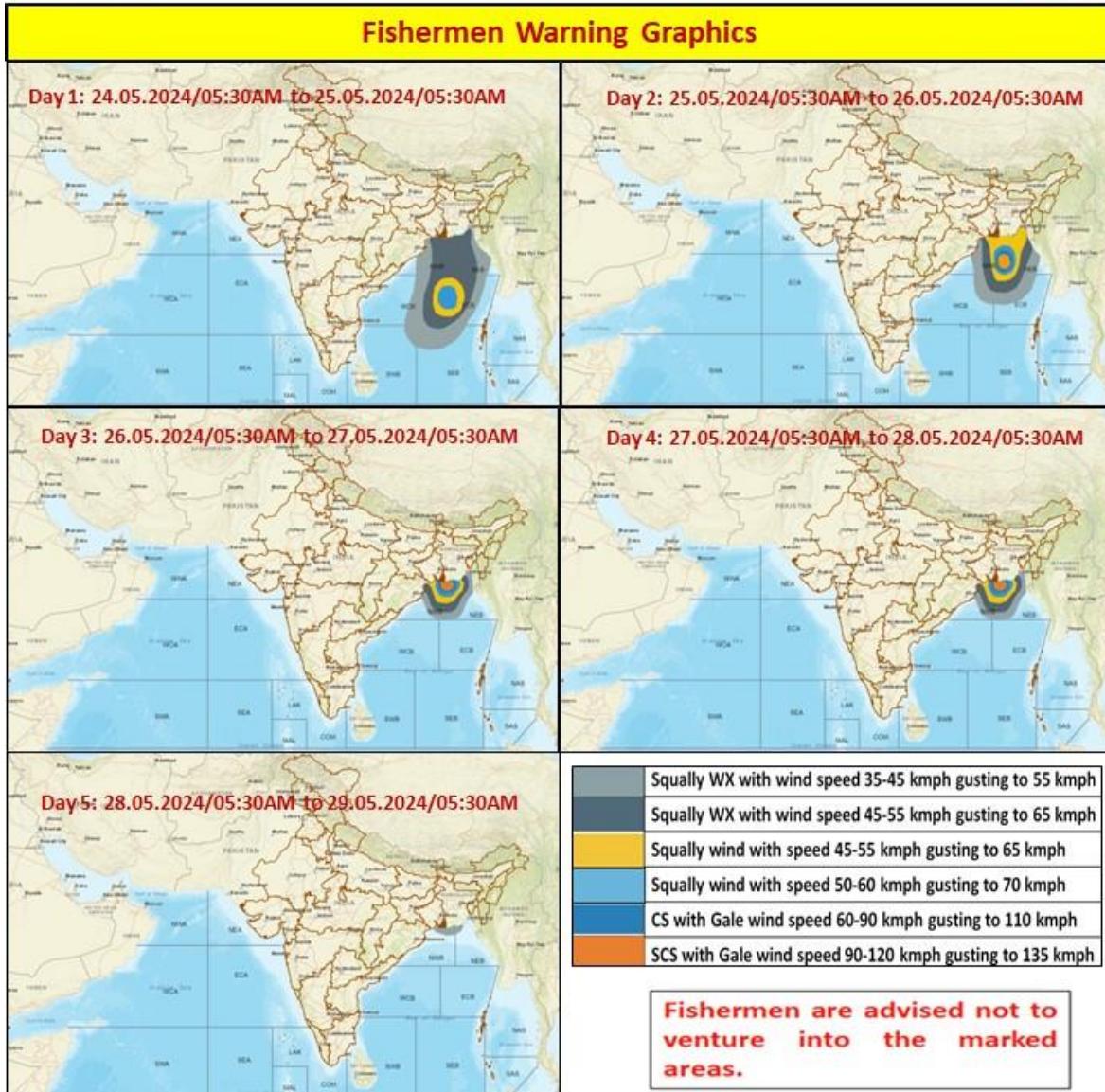


Fig 2.4.6(d): Fishermen Warning Graphics issued at 0000 UTC of 24<sup>th</sup> May, 2024

**Examples-5: (Special Tropical Weather Outlook in association with a deep depression)**

**REGIONAL SPECIALISED METEOROLOGICAL CENTRE-TROPICAL CYCLONES, NEW DELHI  
SPECIAL TROPICAL WEATHER OUTLOOK**

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**DEMS-RSMC TROPICAL CYCLONES NEW DELHI DATED 25.05.2024**

**SPECIAL TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND THE ARABIAN SEA) VALID FOR NEXT 168 HOURS ISSUED AT 0330 UTC OF 25.05.2024 BASED ON 0000 UTC OF 25.05.2024.**

**BAY OF BENGAL:**

THE DEPRESSION OVER EASTCENTRAL BAY OF BENGAL MOVED NORTH-NORTHEASTWARDS WITH A SPEED OF 15 KMPH DURING PAST 06 HOURS, **INTENSIFIED INTO A DEEP DEPRESSION AND LAY CENTERED AT 0000 UTC OF 25TH MAY, 2024 OVER EASTCENTRAL BAY OF BENGAL NEAR LATITUDE 17.6°N AND LONGITUDE 89.7°E, ABOUT 490 KM SOUTH OF KHEPUPARA (41984, BANGLADESH), ABOUT 380 KM SOUTH-SOUTHEAST OF SAGAR ISLANDS (42731, WEST BENGAL) AND 530 KM SOUTH-SOUTHEAST OF CANNING (42812, WEST BENGAL).**

IT IS VERY LIKELY TO MOVE NEARLY NORTHWARDS AND INTENSIFY INTO A **CYCLONIC STORM OVER EASTCENTRAL AND ADJOINING NORTH BAY OF BENGAL BY 1200 UTC OF TODAY, THE 25TH MAY**. IT IS LIKELY TO CONTINUE TO MOVE NEARLY NORTHWARDS, INTENSIFY INTO A **SEVERE CYCLONIC STORM OVER NORTHWEST AND ADJOINING NORTHEAST BAY OF BENGAL BY 0000 UTC OF 26TH MAY**. CONTINUING TO MOVE NEARLY NORTHWARDS, THEREAFTER IT IS VERY LIKELY TO CROSS BANGLADESH AND ADJOINING WEST BENGAL COASTS BETWEEN SAGAR ISLAND (42731, WEST BENGAL) AND KHEPUPARA (41984, BANGLADESH), BY 1600-1800 UTC OF 26TH MAY AS A **SEVERE CYCLONIC STORM WITH WIND SPEED OF 110-120 GUSTING TO 135 KMPH**.

FORECAST TRACK AND INTENSITY ARE GIVEN IN THE FOLLOWING TABLE:

DATE/TIME (UTC)	POSITION (LAT. °N / LONG. °E)	MAXIMUM SUSTAINED SURFACE WIND SPEED (KMPH)	CATEGORY OF CYCLONIC DISTURBANCE
25.05.24/0000	17.6/89.7	50-60 GUSTING TO 70	DEEP DEPRESSION
25.05.24/0600	18.1/89.8	60-70 GUSTING TO 80	CYCLONIC STORM
25.05.24/1200	18.5/89.8	70-80 GUSTING TO 90	CYCLONIC STORM
25.05.24/1800	19.1/89.7	80-90 GUSTING TO 100	CYCLONIC STORM
26.05.24/0000	19.9/89.6	100-110 GUSTING TO 120	SEVERE CYCLONIC STORM
26.05.24/1200	21.2/89.5	110-120 GUSTING TO 135	SEVERE CYCLONIC STORM
27.05.24/0000	22.5/89.5	70-80 GUSTING TO 90	CYCLONIC STORM
27.05.24/1200	23.6/89.7	50-60 GUSTING TO 70	DEEP DEPRESSION
28.05.24/0000	24.7/90.1	35-45 GUSTING TO 55	DEPRESSION

AS PER INSAT-3D IMAGERY, THE CONVECTION HAS FURTHER ORGANISED. INTENSITY OF THE SYSTEM IS T2.0 CENTERED AT 17.6°N LATITUDE AND 89.5°E LONGITUDE. ASSOCIATED SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER CENTRAL & SOUTH BAY OF BENGAL AND ANDAMAN SEA GULF OF MARTABAN & TENASSERIM COAST (MINIMUM CLOUD TOP TEMPERATURE -93°C). SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE MODERATE TO INTENSE CONVECTION OVER NORTH BAY OF BENGAL. AS PER MULTISATELLITE WINDS, STRONGER WINDS ARE SEEN IN SOUTHERN EASTERN SECTOR. THE TOTAL PRECIPITABLE WATER IMAGERY INDICATES WARM MOIST AIR INCURSION INTO THE CORE OF THE SYSTEM.

AS PER LATEST OBSERVATIONS, ESTIMATED CENTRAL PRESSURE IS 993 HPA AT 0000 UTC. BOUY AND SHIP DATA AT 0000 UTC ARE AS FOLLOWS:

<b>BOUY (LAT°N/LONG°E)</b>	<b>SHIP (LAT°N/LONG°E)</b>	<b>WIND DIRECTION/% SPEED (KNOTS)</b>	<b>MSLP(hPa)</b>
17.8/89.2	-	352.0/4.2	993.1
17.5/89.2	-	116.0/0	993.6

**WIND WARNING:****(A) BAY OF BENGAL:**

- ❖ SQUALLY WIND SPEED REACHING 50-60 KMPH GUSTING TO 70 KMPH IS PREVAILING OVER CENTRAL BAY OF BENGAL. IT IS LIKELY TO BECOME GALE WIND SPEED REACHING 60-70 KMPH GUSTING TO 80 KMPH FROM 1200 UTC OF TODAY, THE 25<sup>TH</sup> MAY.
- ❖ IT WOULD INCREASE FURTHER AND EXTEND TO ADJOINING AREAS OF NORTH BAY OF BENGAL BECOMING 70-80 KMPH GUSTING TO 90 KMPH FROM 1200 UTC OF TODAY, THE 25<sup>TH</sup> MAY AND 100-110 KMPH GUSTING TO 120 KMPH OVER NORTH BAY OF BENGAL FROM 0000 UTC AND 110-120 KMPH GUSTING TO 135 KMPH FROM 1200 UTC OF 26<sup>TH</sup> MAY. GALE WIND SPEED REACHING 70-80 KMPH GUSTING TO 90 KMPH IS LIKELY OVER ADJOINING CENTRAL BAY OF BENGAL FROM 26<sup>TH</sup> 0000 UTC FOR SUBSEQUENT 24 HOURS AND DECREASE THEREAFTER.

**(B) ALONG & OFF BANGLADESH AND WEST BENGAL & ADJOINING ODISHA COASTS:**

- ❖ SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY ALONG & OFF BANGLADESH AND WEST BENGAL & ADJOINING NORTH ODISHA COASTS FROM 25<sup>TH</sup> MAY 1200 UTC IT IS LIKELY TO INCREASE BECOMING GALE WIND SPEED REACHING 60-70 KMPH GUSTING TO 80 KMPH FROM 0000 UTC OF 26<sup>TH</sup> MAY AND 100-120 KMPH GUSTING TO 135 KMPH ALONG & OFF BANGLADESH AND ADJOINING WEST BENGAL COASTS FROM EVENING OF 26<sup>TH</sup> 1200 UTC FOR SUBSEQUENT 12 HOURS.

**(C) ALONG & OFF ODISHA COASTS:**

SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY FROM 25<sup>TH</sup> MAY 1200 UTC TO 27<sup>TH</sup> MAY 0000 UTC.

**(D) SOUTH BAY OF BENGAL, ANDAMAN ISLANDS AND ANDAMAN SEA:**

SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY OVER ANDAMAN ISLANDS AND NORTH ANDAMAN SEA DURING NEXT 12 HOURS.

**(E) NORTHEASTERN STATES:**

SQUALLY WIND SPEED REACHING 50-60 KMPH GUSTING TO 70 KMPH IS LIKELY OVER MIZORAM AND TRIPURA AND 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY OVER SOUTH ASSAM AND MEGHALAYA ON 27<sup>TH</sup> MAY.

**SEA CONDITION:****(A) CENTRAL AND NORTH BAY OF BENGAL:**

ROUGH TO VERY ROUGH SEA CONDITION IS PREVAILING OVER CENTRAL BAY OF BENGAL. IT WOULD BECOME HIGH OVER CENTRAL BAY OF BENGAL ON 25<sup>TH</sup> MAY & 26<sup>TH</sup> MAY AND HIGH TO VERY HIGH OVER NORTH BAY OF BENGAL FROM 25<sup>TH</sup> 1200 UTC TILL 27<sup>TH</sup> MAY 0000 UTC.

**(B) ALONG & OFF BANGLADESH AND WEST BENGAL COASTS**

ROUGH TO VERY ROUGH SEA CONDITION IS LIKELY ALONG & OFF BANGLADESH AND WEST BENGAL COASTS FROM 25<sup>TH</sup> MAY 1200 UTC. IT WOULD BECOME HIGH TO VERY HIGH ALONG & OFF BANGLADESH AND WEST BENGAL COASTS FROM 26<sup>TH</sup> 0000 UTC ONWARDS TILL 27<sup>TH</sup> MAY 0000 UTC.

**(C) ALONG & OFF NORTH ODISHA COAST:**

ROUGH TO VERY ROUGH SEA CONDITION IS LIKELY OVER ALONG & OFF NORTH ODISHA COAST FROM 25<sup>TH</sup> MAY 1200 UTC TO 27<sup>TH</sup> MAY 0000 UTC.

**(D) ALONG & OFF ANDAMAN ISLANDS:**

ROUGH TO VERY ROUGH SEA CONDITION IS LIKELY OVER ANDAMAN ISLANDS AND NORTH ANDAMAN SEA DURING NEXT 12 HOURS.

**STORM SURGE:**

STORM SURGE OF ABOUT 1 METER ABOVE ASTRONOMICAL TIDE IS LIKELY TO INUNDATE LOW LYING AREAS OF COASTAL WEST BENGAL AND 3-4 M ABOVE ASTRONOMICAL TIDE LIKELY TO INUNDATE LOW LYING AREAS OF COASTAL BANGLADESH AROUND THE TIME OF LANDFALL.

**FISHERMEN WARNING (GRAPHICS ATTACHED):**

FISHERMEN ARE ADVISED NOT TO VENTURE INTO SOUTH BAY OF BENGAL AND ANDAMAN SEA TILL 27<sup>TH</sup> MAY, CENTRAL BAY OF BENGAL TILL 26<sup>TH</sup> MAY AND NORTH BAY OF BENGAL FROM 25<sup>TH</sup> MAY TILL 27<sup>TH</sup> MAY. FISHERMEN OUT AT SEA ARE ADVISED TO RETURN TO THE COAST.

**REMARKS:**

THE MADDEN JULIAN INDEX (MJO) CURRENTLY LIES IN PHASE 4 WITH AMPLITUDE MORE THAN 1. IT WILL CONTINUE IN SAME PHASE DURING NEXT 7 DAYS. THUS, MJO PHASE & AMPLITUDE ARE HIGHLY CONDUCIVE FOR CYCLOGENESIS AND FURTHER INTENSIFICATION OVER THE BAY OF BENGAL (BOB) DURING NEXT 5 DAYS.

STRONG EASTERLY WINDS (5-7 MPS) ARE LIKELY TO PREVAIL OVER CENTRAL BOB DURING NEXT 24 HOURS & NORTH BOB DURING SUBSEQUENT 3-4 DAYS IN THE LOWER TROPOSPHERIC LEVELS. STRONG WESTERLY WINDS (5-7 MPS) ARE LIKELY TO PREVAIL OVER THE SOUTH BAY OF BENGAL AND ANDAMAN SEA DURING NEXT 5 DAYS AND OVER CENTRAL BAY OF BENGAL DURING 25<sup>TH</sup> TO 27<sup>TH</sup> MAY. IN ADDITION, KELVIN WAVES, EQUATORIAL ROSSBY WAVES ARE PREVAILING OVER SOUTH BAY OF BENGAL & COUPLED WITH MJO. THESE WAVES WILL PROVIDE A CONDUCIVE ENVIRONMENT FOR CYCLOGENESIS AND INTENSIFICATION OF SYSTEM OVER BOB.

THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM<sup>2</sup> OVER MAJOR PARTS OF BAY OF BENGAL. IT IS INDICATING SLIGHTLY DECREASING TENDENCY TOWARDS NORTH BOB AND ALONG THE COASTS. SEA SURFACE TEMPERATURE (SST) IS AROUND 30-32°C OVER ENTIRE BOB. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR CYCLOGENESIS AND INTENSIFICATION.

CONSIDERING THE ENVIRONMENTAL CONDITIONS, LOW LEVEL VORTICITY HAS INCREASED AND NOW IS ABOUT  $150-200 \times 10^{-5} \text{ s}^{-1}$  TO THE EAST OF SYSTEM CENTRE OVER EASTCENTRAL & ADJOINING WESTCENTRAL BAY OF BENGAL WITH VERTICAL EXTENSION UPTO 200 HPA LEVEL. LOW LEVEL CONVERGENCE IS ABOUT  $20 \times 10^{-5} \text{ s}^{-1}$  TO THE EAST-NORTHEAST OF THE SYSTEM CENTER. UPPER LEVEL DIVERGENCE IS ABOUT  $20 \times 10^{-5} \text{ s}^{-1}$  AND  $30 \times 10^{-5} \text{ s}^{-1}$  TO SOUTHEAST AND SOUTHWEST OF THE SYSTEM CENTER, RESPECTIVELY. VERTICAL WIND SHEAR (VWS) IS LOW TO MODERATE (15-20 M/S) ORIENTED THE EAST-WEST OF THE SYSTEM CENTRE AND ALONG THE FORECAST TRACK. IT IS HIGH TO THE SOUTHWEST OF THE SYSTEM CENTRE. THE HIGH WIND SHEAR TO THE SOUTHWEST IS HELPING THE SYSTEM TO SEGREGATE ITSELF FROM THE COMORIAN AREA CONVECTION. MID LEVEL WIND SHEAR IS ANTICYCLONIC OVER CENTRAL AND NORTHWEST BOB. VWS WILL THUS SUPPORT FURTHER INTENSIFICATION OF SYSTEM. CURRENTLY, THE SYSTEM IS MOVING NORTHEASTWARDS UNDER THE INFLUENCE OF SOUTHWESTERLY WINDS ASSOCIATED WITH ADVANCE OF SOUTHWEST MONSOON OVER THE SOUTH BAY OF BENGAL. THE UPPER TROPOSPHERIC RIDGE AT 200 HPA IS LOCATED NEAR 18.7°N.

VARIOUS MODELS ARE INDICATING INTENSIFICATION INTO CYCLONIC STORM AROUND 25<sup>TH</sup> 0600 UTC FURTHER INTO SEVERE CYCLONIC STORM BY 26<sup>TH</sup> 0000 UTC. THERE IS SOME DIVERGENCE AMONG MODELS WITH RESPECT TO MOVEMENT OF THE SYSTEM AND ITS LANDFALL POINT AND TIME.

CONSIDERING ALL THE ABOVE, THE DEPRESSION OVER EASTCENTRAL BAY OF BENGAL MOVED NORTH-NORTHEASTWARDS WITH A SPEED OF 15 KMPH DURING PAST 06 HOURS, **INTENSIFIED INTO A DEEP DEPRESSION AND LAY CENTERED AT 0000 UTC OF 25TH MAY, 2024 OVER EASTCENTRAL BAY OF BENGAL NEAR LATITUDE 17.8°N AND LONGITUDE 89.7°E, ABOUT 490 KM SOUTH OF KHEPUPARA (41984, BANGLADESH), ABOUT 380 KM SOUTH-SOUTHEAST OF SAGAR ISLANDS (42731, WEST BENGAL) AND 530 KM SOUTH-SOUTHEAST OF CANNING (42812, WEST BENGAL). IT IS VERY LIKELY TO MOVE NEARLY NORTHWARDS AND INTENSIFY INTO A CYCLONIC STORM OVER EASTCENTRAL AND ADJOINING NORTH BAY OF BENGAL BY 1200 UTC OF TODAY, THE 25TH MAY. IT IS LIKELY TO CONTINUE TO MOVE NEARLY NORTHWARDS, INTENSIFY INTO A SEVERE CYCLONIC STORM OVER NORTHWEST AND ADJOINING NORTHEAST BAY OF BENGAL BY 0000 UTC OF 26TH MAY. CONTINUING TO MOVE NEARLY NORTHWARDS, THEREAFTER IT IS VERY LIKELY TO CROSS BANGLADESH AND ADJOINING WEST BENGAL COASTS BETWEEN SAGAR ISLAND (42731, WEST BENGAL) AND KHEPUPARA (41984, BANGLADESH), BY 1600-1800 UTC OF 26TH MAY AS A SEVERE CYCLONIC STORM WITH WIND SPEED OF 110-120 GUSTING TO 135 KMPH.**

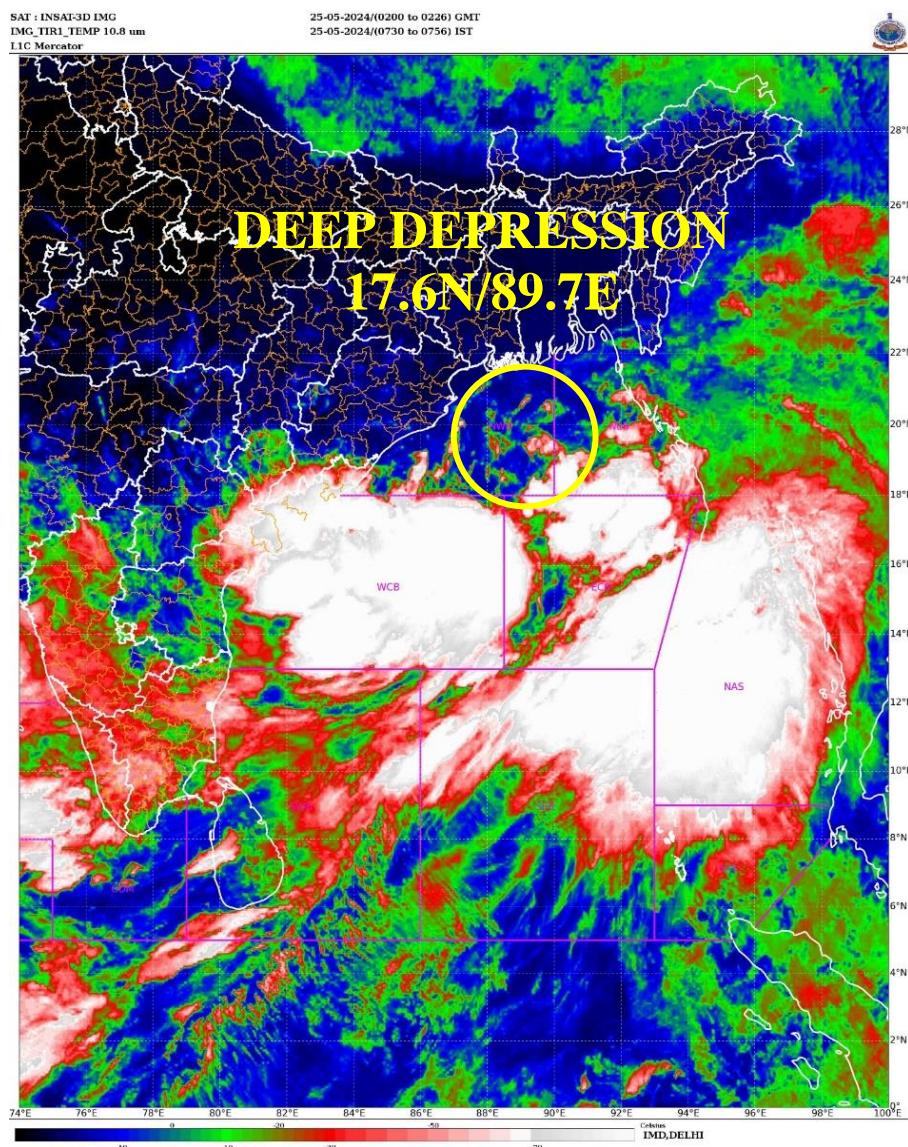
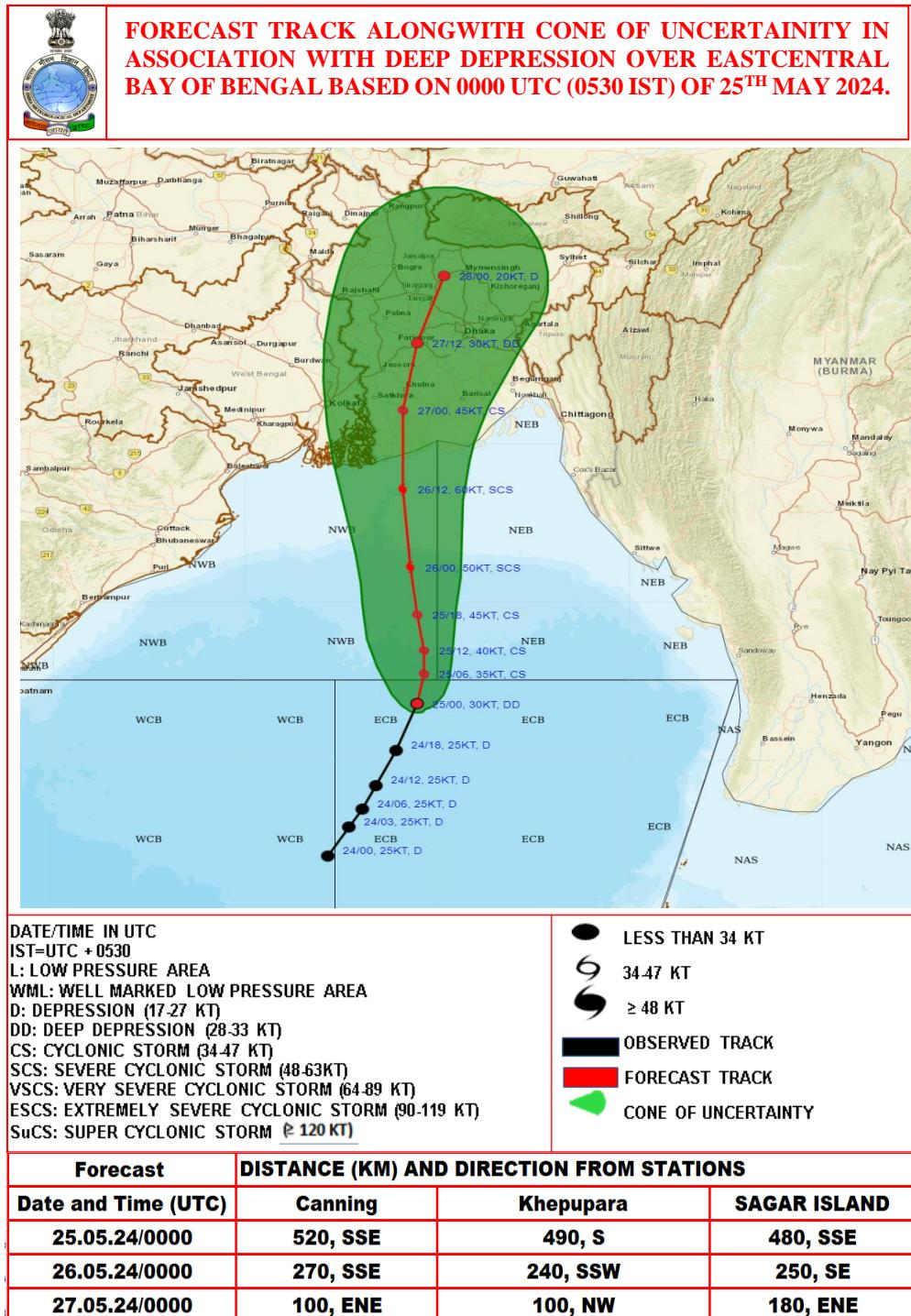


Fig 2.4.7(a): INSAT 3DR Image issued at 0200 UTC of 25<sup>th</sup> May,2024



**Fig 2.4.7(b): Forecast track along with cone of uncertainty in association with deep depression over eastcentral Bay of Bengal based on 0000 UTC of 25<sup>th</sup> May 2024**

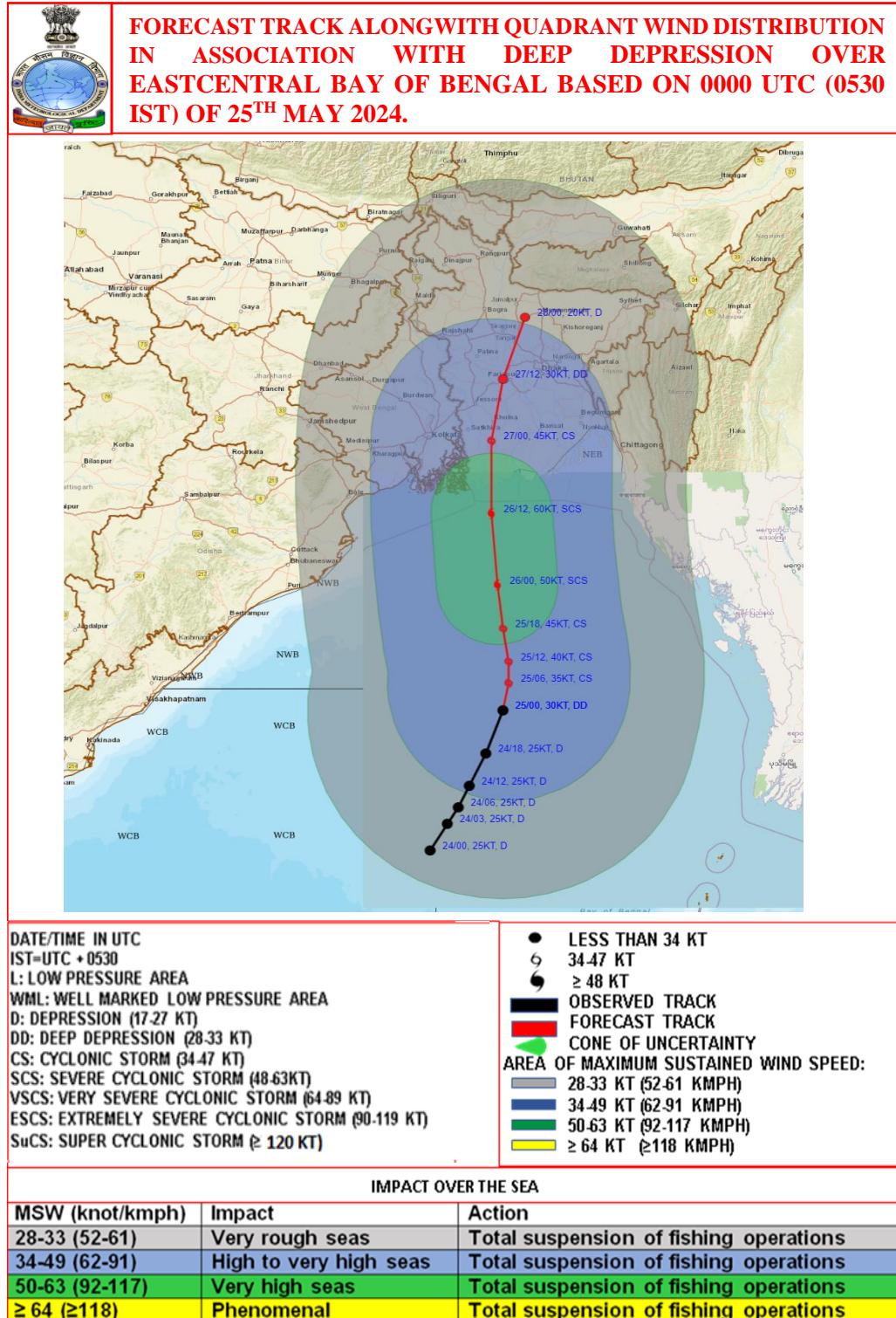


Fig 2.4.7(c): Forecast track along with quadrant wind distribution in association with deep depression over eastcentral Bay of Bengal based on 0000 UTC of 25<sup>th</sup> May 2024.

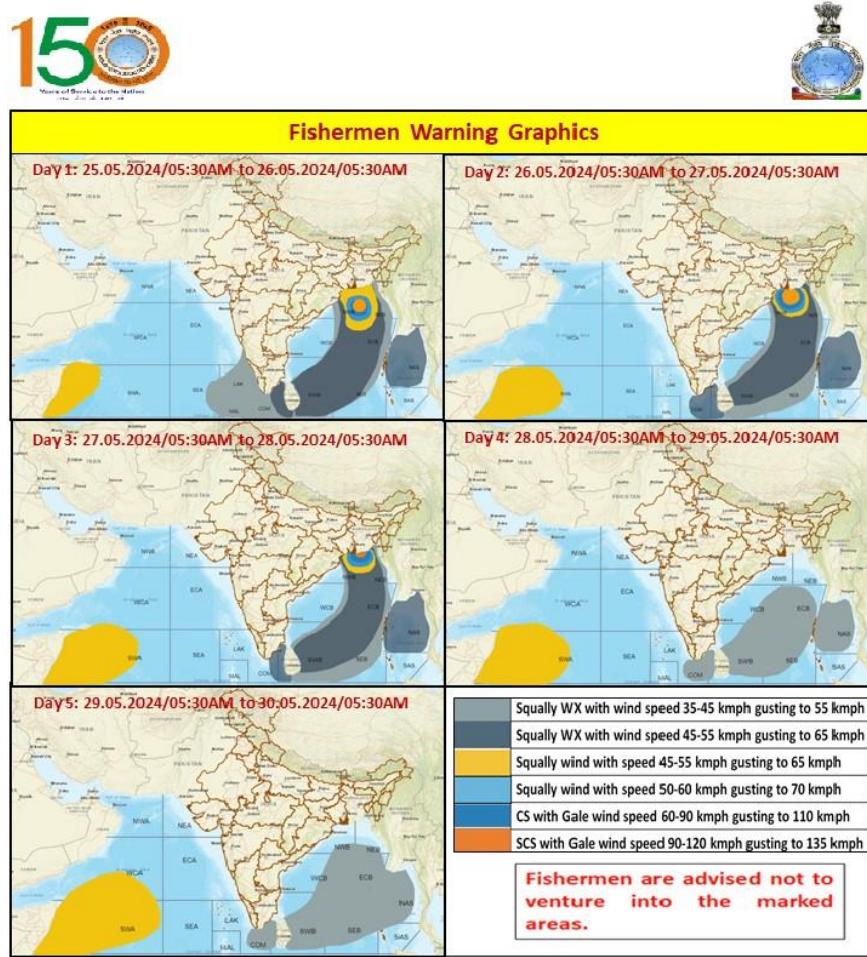


Fig 2.4.7(d) Fishermen Warning Graphics issued at 0000 UTC of 25<sup>th</sup> May, 2024

#### Storm Surge Warning Graphic

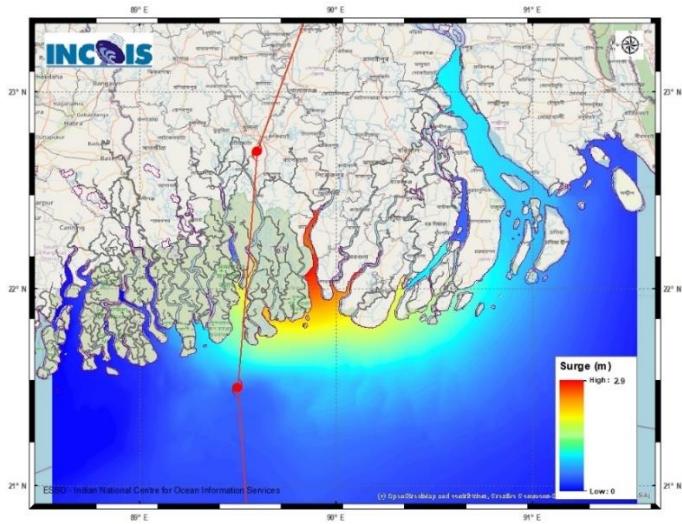


Fig 2.4.7(e) Storm Surge Warning Graphic issued at 25<sup>th</sup> May, 2024

#### **2.4.4 Tropical cyclone advisories**

When a tropical low pressure system reaches the cyclonic storm stage, or is shortly expected to reach that intensity, RSMC tropical cyclones, New Delhi will issue tropical cyclone advisories. Advisories will be issued three hourly at 00, 03, 06, 09, 12, 15, 18 and 21 UTC. The area of responsibility for the issue of tropical cyclone advisories by RSMC Tropical Cyclones, New Delhi cover sea areas of north Indian Ocean has been extended between 40°E to 100°E from 2018 onwards from long. 45° E to 100° E.

#### **Example 6: (TROPICAL CYCLONE ADVISORY IN ASSOCIATION WITH TROPICAL CYCLONE)**

**REGIONALSPECIALISED METEOROLOGICALCENTRE-TROPICALCYCLONES, NEW DELHI  
TROPICAL CYCLONE ADVISORY**

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**DEMS-RSMCSPECIAL TROPICAL CYCLONES NEW DELHI DATED 25.05.2024**

**FROM: RSMC –TROPICAL CYCLONES, NEW DELHI**

**TO:**

STORM WARNING CENTRE, NAYPYI TAW (MYANMAR)  
 STORM WARNING CENTRE, BANGKOK (THAILAND)  
 STORM WARNING CENTRE, COLOMBO (SRILANKA)  
 STORM WARNING CENTRE, DHAKA (BANGLADESH)  
 STORM WARNING CENTRE, KARACHI (PAKISTAN)  
 METEOROLOGICAL OFFICE, MALE (MALDIVES)  
 OMAN METEOROLOGICAL DEPARTMENT,  
 MUSCAT (THROUGH RTH JEDDAH)  
 YEMEN METEOROLOGICAL SERVICES,  
 REPUBLIC OF YEMEN (THROUGH RTH JEDDAH)  
 NATIONAL CENTRE FOR METEOROLOGY, UAE (THROUGH RTH JEDDAH)  
 PRESIDENCY OF METEOROLOGY AND ENVIRONMENT,  
 SAUDI ARABIA (THROUGH RTH JEDDAH)  
 IRAN METEOROLOGICAL ORGANISATION, (THROUGH RTH JEDDAH)  
 QATAR METEOROLOGICAL DEPARTMENT (THROUGH RTH JEDDAH)

**TROPICAL CYCLONE ADVISORY NO. 1 FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND ARABIAN SEA) VALID FOR NEXT 120 HOURS ISSUED AT 1500 UTC OF 20.05.2024 BASED ON 1200 UTC OF 20.05.2024**

**SUB: CYCLONIC STORM “REMAL” PRONOUNCED AS “RE-MAL” OVER NORTH AND ADJOINING EASTCENTRAL BAY OF BENGAL**

THE DEEP DEPRESSION OVER EASTCENTRAL BAY OF BENGAL MOVED NEARLY NORTHWARDS WITH A SPEED OF 12 KMPH DURING PAST 06 HOURS, INTENSIFIED INTO A CYCLONIC STORM “REMAL” (PRONOUNCED AS “RE-MAL”) AND LAY CENTERED AT 1200 UTC OF TODAY, THE 25TH MAY, 2024 OVER THE NORTH & ADJOINING EASTCENTRAL BAY OF BENGAL NEAR LATITUDE 18.8°N AND LONGITUDE 89.5°E, ABOUT 360 KM SOUTH-SOUTHEAST OF KHEPUPARA (41984, BANGLADESH), 350 KM SOUTH-SOUTHEAST OF SAGAR ISLANDS (42731, WEST BENGAL) AND 390 KM SOUTH-SOUTHEAST OF CANNING (42812, WEST BENGAL).IT IS VERY LIKELY TO CONTINUE TO MOVE NEARLY NORTHWARDS AND INTENSIFY INTO A SEVERE CYCLONIC STORM BY 0000 UTC OF 26TH MAY OVER NORTH BAY OF BENGAL AND CROSS BANGLADESH AND ADJOINING WEST BENGAL COASTS BETWEEN SAGAR ISLAND (42731) AND KHEPUPARA (41984) BY 1800 UTC OF 26TH MAY AS A SEVERE CYCLONIC STORM WITH WIND SPEED OF 110-120 GUSTING TO 135 KMPH.

FORECAST TRACK AND INTENSITY ARE GIVEN IN THE FOLLOWING TABLE:

DATE/TIME (UTC)	POSITION LAT. °N LONG. °E	MAXIMUM SUSTAINED SURFACE WIND SPEED (KMPH)	CATEGORY OF CYCLONIC DISTURBANCE
25.05.24/1200	18.8/89.5	60-70 GUSTING TO 80	CYCLONIC STORM
25.05.24/1800	19.4/89.4	75-85 GUSTING TO 95	CYCLONIC STORM
26.05.24/0000	20.0/89.4	95-105 GUSTING TO 115	SEVERE CYCLONIC STORM
26.05.24/0600	20.7/89.4	110-120 GUSTING TO 135	SEVERE CYCLONIC STORM
26.05.24/1200	21.4/89.4	110-120 GUSTING TO 135	SEVERE CYCLONIC STORM
27.05.24/0000	22.6/89.6	70-80 GUSTING TO 90	CYCLONIC STORM
27.05.24/1200	23.8/90.0	50-60 GUSTING TO 70	DEEP DEPRESSION
28.05.24/0000	24.9/90.5	30-40 GUSTING TO 50	DEPRESSION

AS PER INSAT-3D IMAGERY, THE CONVECTION HAS INTENSIFIED. CLOUDS ARE ORGANISED IN CURVED BAND PATTERN. INTENSITY OF THE SYSTEM IS T2.5. ASSOCIATED BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER CENTRAL AND ADJOINING SOUTH BAY OF BENGAL AND NORTH ANDAMAN SEA (MINIMUM CLOUD TOP TEMPERATURE IS -93 DEG CESIUS). AS PER MULTISATELLITE WINDS, STRONGER WINDS ARE SEEN IN SOUTHERN EASTERN SECTOR. THE TOTAL PRECIPITABLE WATER IMAGERY INDICATES WARM MOIST AIR INCURSION INTO THE CORE OF THE SYSTEM. MULTISATELLITE WINDS INDICATE STRONGER WINDS IN EASTERN SECTOR.

AS PER LATEST OBSERVATIONS, ESTIMATED CENTRAL PRESSURE IS 986 hPa AT 1200 UTC. ESTIMATED MAXIMUM SUSTAINED WIND SPEED IS 35 KNOTS GUSTING TO 45 KNOTS. SEA CONDITION IS HIGH OVER CENTRAL & ADJOINING NORTH BAY OF BENGAL.

SHIP/BOUY OBSERVATION AT 1200 IS GIVEN BELOW:

BOUY & SHIP (LAT°N/LONG°E)	WIND DIRECTION/% SPEED (KNOTS)	MSLP(hPa)
BOUY 17.8/89.2	170/6.0 KT	988.9
BOUY 17.5/89.2	251/15 KT	988.9

#### WIND WARNING:

##### (A) BAY OF BENGAL:

- ❖ **GALE WIND SPEED REACHING 60-70 KMPH GUSTING TO 80 KMPH IS LIKELY TO PREVAIL OVER CENTRAL BAY OF BENGAL TILL 0000 UTC OF 26<sup>TH</sup> MAY AND DECREASE THEREAFTER BECOMING SQUALLY WIND SPEED REACHING 50-60 KMPH GUSTING TO 70 KMPH TILL 0000 UTC OF 27<sup>TH</sup> MAY.**

- ❖ **GALE WIND SPEED REACHING 60-70 KMPH GUSTING TO 80 KMPH PREVAILING OVER NORTH BAY OF BENGAL IS LIKELY TO INCREASE BECOMING 95-105 KMPH GUSTING TO 115 KMPH FROM 0000 UTC AND 110-120 KMPH GUSTING TO 135 KMPH FROM 0600 UTC TILL 1800 UTC OF 26<sup>TH</sup> MAY. IT IS LIKELY DECREASE THEREAFTER BECOMING 70-80 KMPH GUSTING TO 90 KMPH BY 0000 UTC OF 27<sup>TH</sup> MAY AND SQUALLY WIND SPEED REACHING 45-55 KMPH GUSTING TO 65 KMPH BY 1200 UTC OF 27<sup>TH</sup> MAY.**

**(B) ALONG & OFF BANGLADESH AND WEST BENGAL COASTS:**

- ❖ **SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY TO PREVAIL ALONG & OFF BANGLADESH AND WEST BENGAL & ADJOINING NORTH ODISHA COASTS FROM 1500 UTC OF 25<sup>TH</sup> MAY. IT IS LIKELY TO INCREASE BECOMING **GALE WIND SPEED REACHING 60-70 KMPH GUSTING TO 80 KMPH** FROM 0000 UTC OF 26<sup>TH</sup> MAY AND **100-120 KMPH GUSTING TO 135 KMPH** ALONG & OFF BANGLADESH AND ADJOINING WEST BENGAL COASTS FROM 1200 UTC OF 26<sup>TH</sup> MAY TILL 0000 UTC OF 27<sup>TH</sup> MAY. IT IS LIKELY DECREASE THEREAFTER TO BECOME 60-70 KMPH GUSTING TO 80 KMPH BY 0600 UTC AND SQUALLY WIND 50-60 KMPH GUSTING TO 70 KMPH BY 1500 UTC OF 27<sup>TH</sup> MAY.**
- ❖ **SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY TO COMMENCE OVER HOWRAH, HOOGLY, KOLKATA AND EAST MEDINIPUR DISTRICTS FROM 1200 UTC OF 26<sup>TH</sup> MAY. IT WILL INCREASE GRADUALLY BECOMING **GALE WIND SPEED REACHING 70-80 KMPH GUSTING TO 90 KMPH** OVER THESE DISTRICTS DURING 1500 OF 26<sup>TH</sup> MAY TILL 0000 UTC OF 27<sup>TH</sup> MAY EXCEPT EAST MEDINIPUR WHERE THE WIND SPEED MAY REACH UP TO **60-70 KMPH GUSTING TO 80 KMPH** DURING THE SAME PERIOD.**

**(C) ALONG & OFF ODISHA COASTS:**

**SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY TO PREVAIL TILL 0000 UTC OF 27<sup>TH</sup> MAY.**

**(D) SOUTH BAY OF BENGAL, ANDAMAN ISLANDS AND ANDAMAN SEA:**

**SQUALLY WIND SPEED REACHING 40-50 KMPH GUSTING TO 60 KMPH IS LIKELY OVER ANDAMAN ISLANDS AND NORTH ANDAMAN SEA DURING NEXT 12 HOURS.**

**(E) NORTHEASTERN STATES:**

**SQUALLY WIND SPEED REACHING 50-60 KMPH GUSTING TO 70 KMPH IS LIKELY OVER MIZORAM TRIPURA & SOUTH MANIPUR ON 26<sup>TH</sup> & 27<sup>TH</sup> MAY AND **40-50 KMPH GUSTING TO 60 KMPH** IS LIKELY OVER SOUTH ASSAM AND MEGHALAYA ON 27<sup>TH</sup> MAY.**

**SEA CONDITION WARNING:**

**(A) CENTRAL AND NORTH BAY OF BENGAL:**

VERY ROUGH TO HIGH SEA CONDITION IS LIKELY TO PREVAIL OVER CENTRAL BAY OF BENGAL ON 25<sup>TH</sup> MAY & 26<sup>TH</sup> MAY AND HIGH TO VERY HIGH OVER NORTH BAY OF BENGAL FROM 25<sup>TH</sup>/1200 UTC TILL 27<sup>TH</sup> MAY/0000 UTC.

**(B) ALONG & OFF BANGLADESH AND WEST BENGAL COASTS**

ROUGH TO VERY ROUGH SEA CONDITION IS PREVAILING ALONG & OFF BANGLADESH AND WEST BENGAL COASTS. IT WOULD BECOME HIGH TO VERY HIGH ALONG & OFF BANGLADESH AND WEST BENGAL COASTS FROM 0000 UTC OF 26<sup>TH</sup> ONWARDS TILL 0000 UTC OF 27<sup>TH</sup> MAY.

**(C) ALONG & OFF NORTH ODISHA COAST:**

ROUGH TO VERY ROUGH SEA CONDITION IS LIKELY ALONG & OFF NORTH ODISHA COAST TILL 0000 UTC OF 27<sup>TH</sup> MAY.

**(D) ALONG & OFF ANDAMAN ISLANDS:**

ROUGH TO VERY ROUGH SEA CONDITION IS LIKELY OVER ANDAMAN ISLANDS AND NORTH ANDAMAN SEA DURING NEXT 12 HOURS.

**STORM SURGE:**

STORM SURGE OF ABOUT 1 METER HEIGHT ABOVE ASTRONOMICAL TIDE IS LIKELY TO INUNDATE LOW LYING AREAS OF COASTAL WEST BENGAL AND 3-4 M HEIGHT ABOVE ASTRONOMICAL TIDE LIKELY TO INUNDATE LOW LYING AREAS OF COASTAL BANGLADESH AROUND THE TIME OF LANDFALL. THERE IS A PROBABILITY OF 80% FOR THE STORM SURGE HEIGHT EXCEEDING 3 M ALONG & OFF BANGLADESH COAST BETWEEN 90° E & 90.8°E. THERE COULD BE COASTAL INUNDATION ALONG THE RIVERS AND CREEKS INCLUDING MEGHNA RIVER.

**FISHERMEN WARNING (GRAPHICS ATTACHED):**

FISHERMEN ARE ADVISED NOT TO VENTURE INTO SOUTH BAY OF BENGAL AND ANDAMAN SEA TILL 27<sup>TH</sup> MAY, CENTRAL BAY OF BENGAL TILL 26<sup>TH</sup> MAY AND NORTH BAY OF BENGAL FROM 25<sup>TH</sup> MAY TILL 27<sup>TH</sup> MAY. FISHERMEN OUT AT SEA ARE ADVISED TO RETURN TO THE COAST.

**REMARKS:**

THE MADDEN JULIAN INDEX (MJO) CURRENTLY LIES IN PHASE 4 WITH AMPLITUDE MORE THAN 1. IT WILL CONTINUE IN SAME PHASE DURING NEXT 3 DAYS. THUS, MJO PHASE & AMPLITUDE ARE HIGHLY CONDUCIVE FOR CYCLOGENESIS AND FURTHER INTENSIFICATION OVER THE BAY OF BENGAL (BOB) DURING NEXT 3 DAYS.

STRONG EASTERLY WINDS (5-7 MPS) ARE LIKELY TO PREVAIL OVER NORTH BOB DURING 3 DAYS IN THE LOWER TROPOSPHERIC LEVELS. STRONG WESTERLY WINDS (5-7 MPS) ARE LIKELY TO PREVAIL OVER THE SOUTH & CENTRAL BAY OF BENGAL AND ANDAMAN SEA DURING NEXT 3 DAYS. IN ADDITION, KELVIN WAVES, EQUATORIAL ROSSBY WAVES ARE ALSO PREVAILING OVER SOUTH BAY OF BENGAL & COUPLED WITH MJO. THESE WAVES WILL PROVIDE A CONDUCIVE ENVIRONMENT FOR FURTHER INTENSIFICATION OF DEEP DEPRESSION OVER BOB.

THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM<sup>2</sup> OVER MAJOR PARTS OF BAY OF BENGAL. IT IS INDICATING SLIGHTLY DECREASING TENDENCY TOWARDS NORTH BOB AND ALONG THE COASTS. SEA SURFACE TEMPERATURE (SST) IS AROUND 30-32°C OVER ENTIRE BOB, BEING MORE THAN 32°C OVER SOME PARTS OF NORTH BOB. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR FURTHER INTENSIFICATION OF SYSTEM.

CONSIDERING THE ENVIRONMENTAL CONDITIONS, LOW LEVEL VORTICITY HAS INCREASED AND IS ABOUT  $200 \times 10^{-5} \text{ s}^{-1}$  TO THE SOUTH OF SYSTEM CENTRE OVER EASTCENTRAL BAY OF BENGAL WITH VERTICAL EXTENSION UPTO 200 HPA LEVEL. LOW LEVEL CONVERGENCE IS ABOUT  $20 \times 10^{-5} \text{ s}^{-1}$  TO THE SOUTHEAST OF THE SYSTEM CENTER. STRONG EQUATORWARD OUTFLOW IS SEEN. UPPER LEVEL IS ABOUT  $30 \times 10^{-5} \text{ s}^{-1}$  TO THE SOUTHEAST OF SYSTEM CENTRE. VERTICAL WIND SHEAR (VWS) IS MODERATE (AROUND 20 KT) ALONG THE FORECAST TRACK. MID LEVEL WIND SHEAR IS ANTYCLONIC OVER THE SYSTEM AREA WHICH WILL SUPPORT FURTHER INTENSIFICATION OF THE SYSTEM. CURRENTLY, THE SYSTEM IS MOVING NEARLY NORTHWARDS ALONG THE PERIPHERY OF THE UPPER TROPOSPHERIC RIDGE AT 200 HPA LOCATED NEAR 18.0°N.

THE GUIDANCE FROM VARIOUS NUMERICAL MODELS IS INDICATING CROSSING OVER BANGLADESH. THE MODELS LIKE IMD GFS, GEFS HAVE ALSO SHIFTED TRACK EASTWARDS. ECMWF IS CONSISTENTLY INDICATING CROSSING OVER WEST BENGAL & ADJOINING BANGLADESH COASTS. IMD MME IS INDICATING CROSSING OVER BANGLADESH COAST. THE LANDFALL TIME IS VARYING BETWEEN 1500-2100 UTC OF 26<sup>TH</sup> MAY. MOST OF THE MODELS ARE INDICATING THE SYSTEM TO CROSS AS A SEVERE CYCLONIC STORM (50-60 KT).

**THE CYCLONIC STORM "REMAL" IS VERY LIKELY TO CONTINUE TO MOVE NEARLY NORTHWARDS AND INTENSIFY INTO A SEVERE CYCLONIC STORM BY 0000 UTC OF 26TH MAY OVER NORTH BAY OF BENGAL AND CROSS BANGLADESH AND ADJOINING WEST BENGAL COASTS BETWEEN SAGAR ISLAND (42731) AND KHEPUPARA (41984) BY 1800 UTC OF 26TH MAY AS A SEVERE CYCLONIC STORM WITH WIND SPEED OF 110-120 GUSTING TO 135 KMPH.**

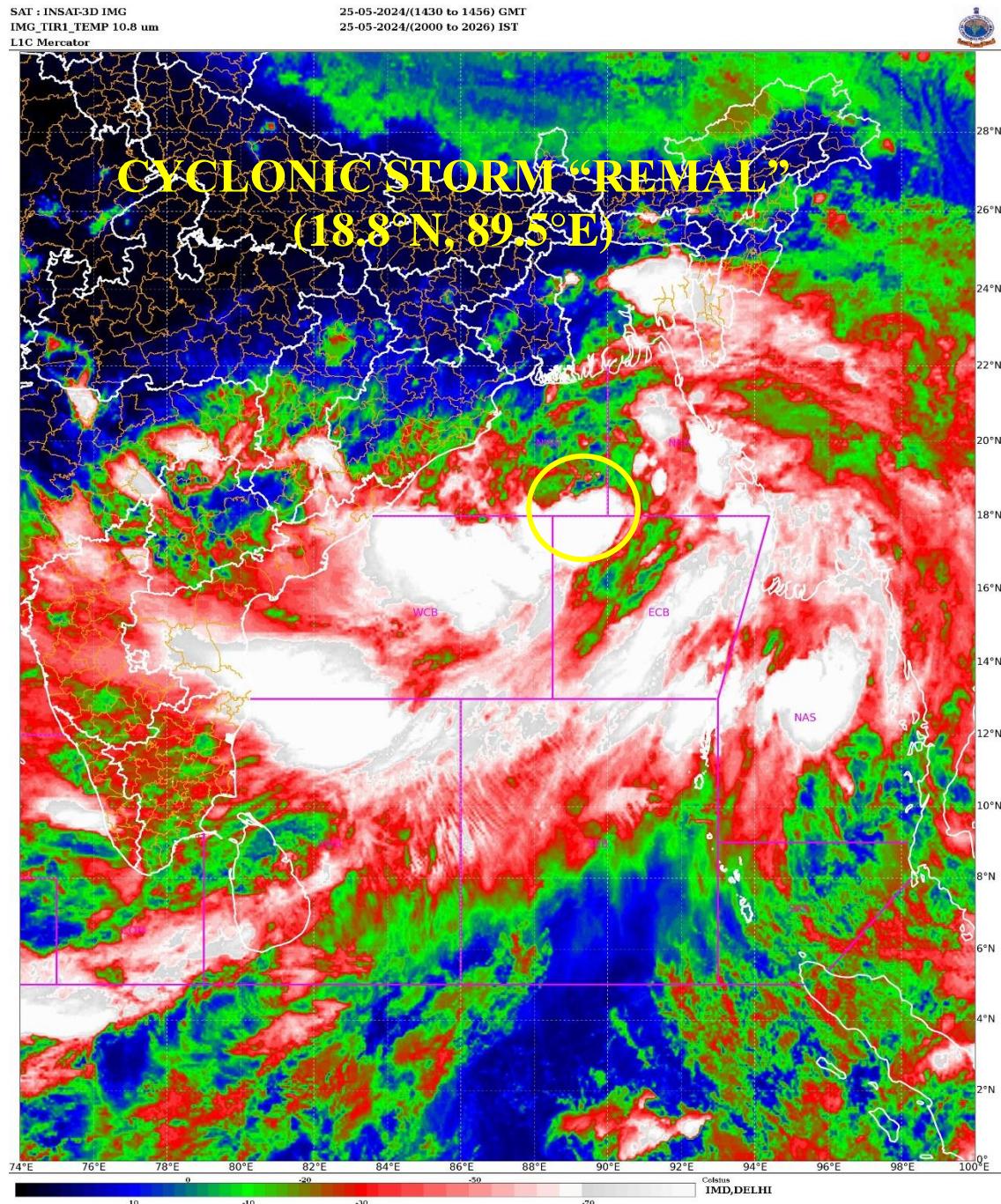


Fig 2.4.8(a): INSAT 3D Image issued at 1430 UTC of 25<sup>th</sup> May, 2024

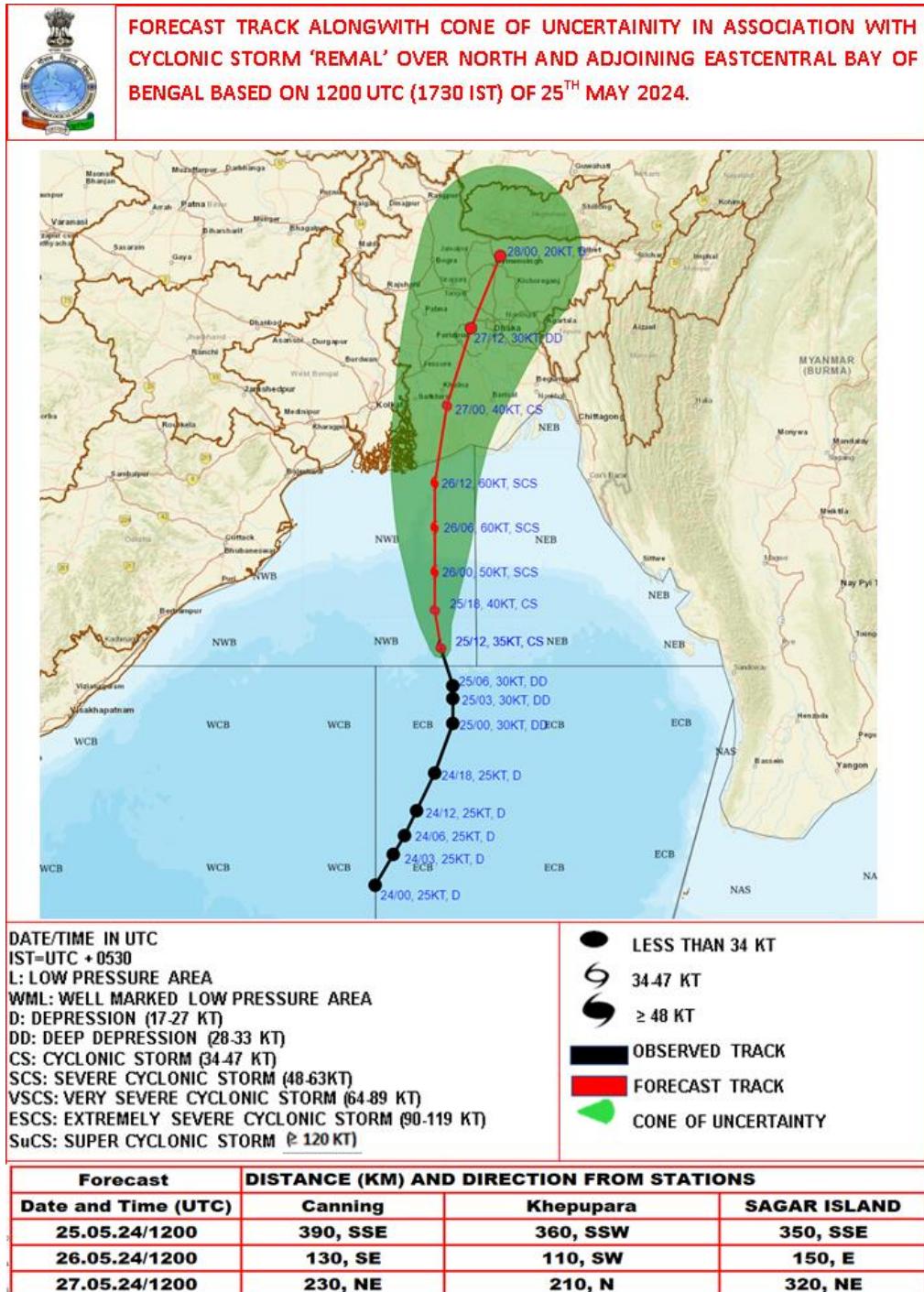


Fig 2.4.8(b): Forecast track along with cone of uncertainty in association with cyclonic storm REMAL issued at 1200 UTC of 25<sup>th</sup> May, 2024

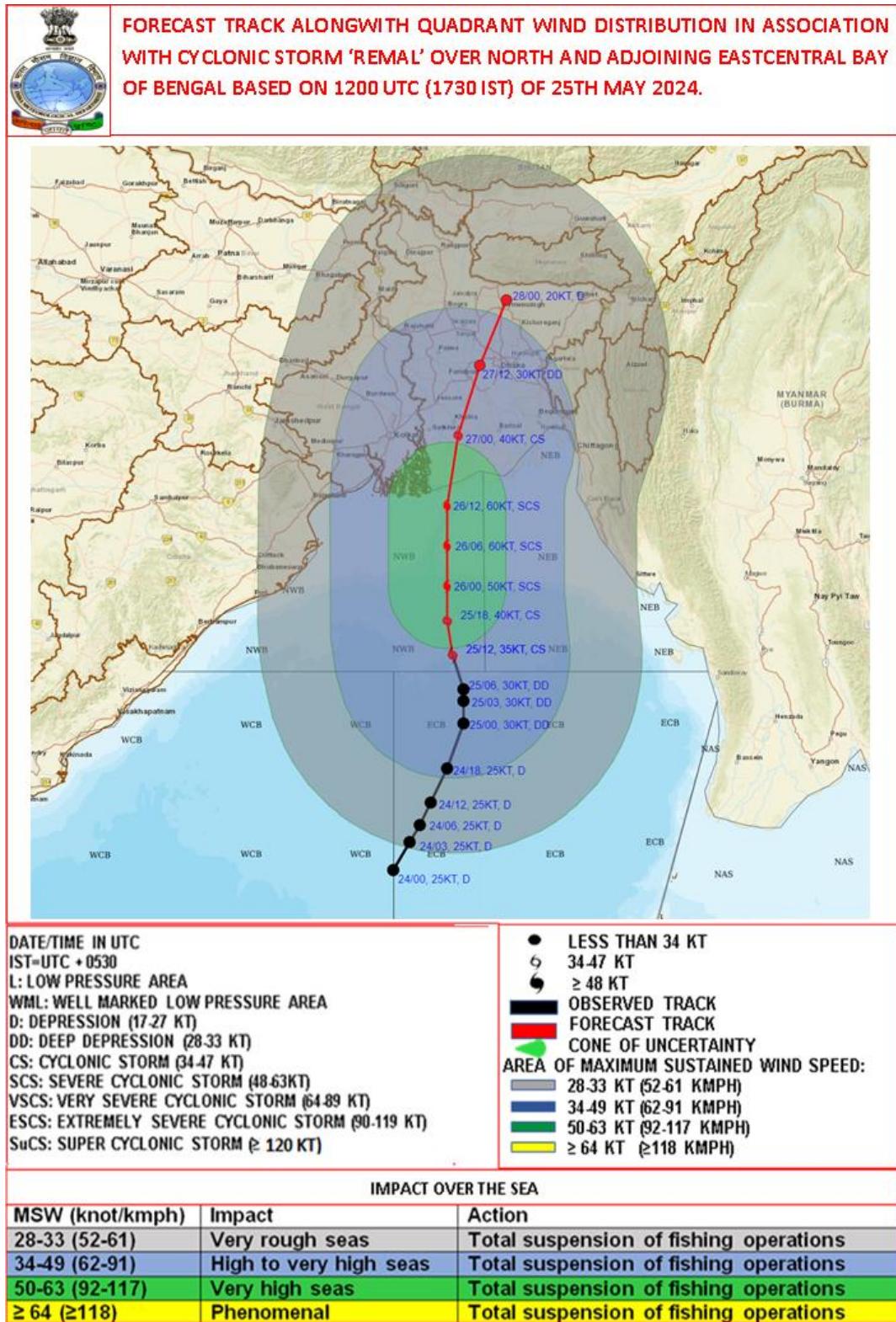
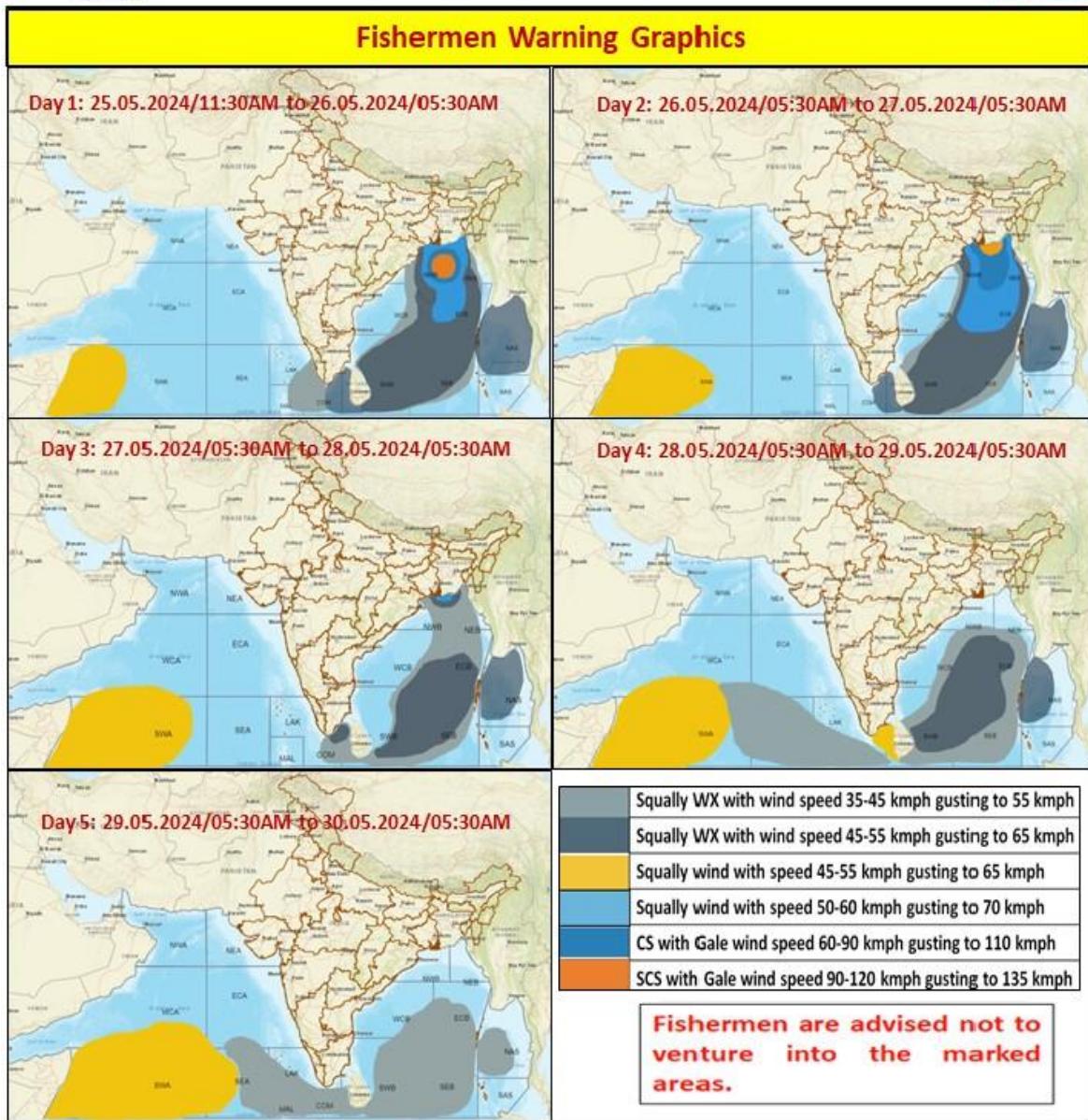


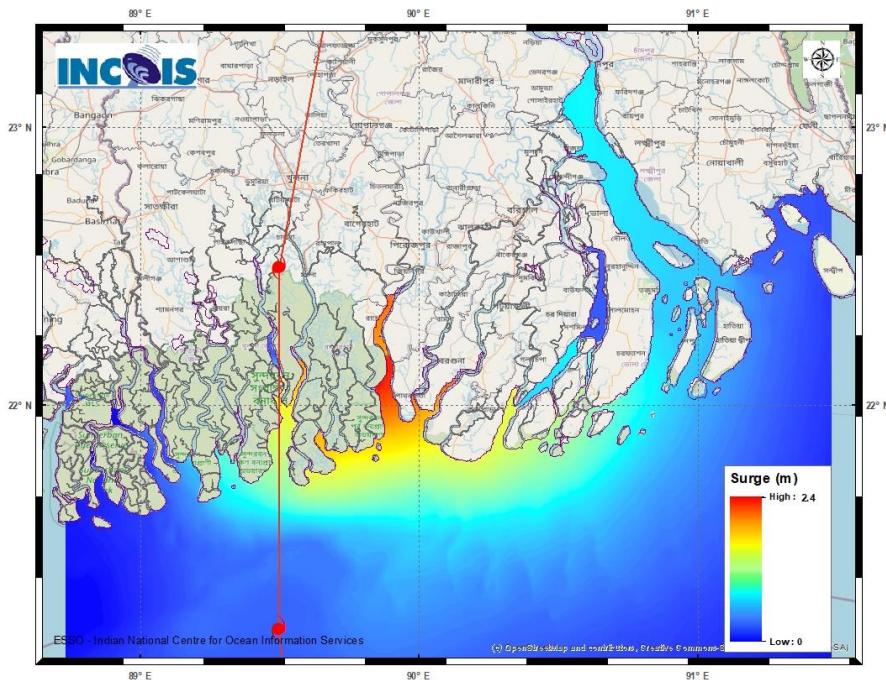
Fig 2.4.8(c): Forecast track along with quadrant wind distribution in association with cyclonic storm REMAL issued at 1200 UTC of 25<sup>th</sup> May, 2024

### Fishermen Warning Graphics



**Fig 2.4.8(d): Fishermen Warning Graphics in association with cyclonic storm REMAL issued at 0600 UTC of 25<sup>th</sup> May, 2024**

### Storm Surge Warning Graphics



**Fig 2.4.8(e): Storm Surge Warning Graphics in association with cyclonic storm REMAL issued at 0600 UTC of 25<sup>th</sup> May, 2024**

#### 2.4.5. Hourly update bulletin

The hourly update bulletin of system before landfall has been introduced in October, 2014 since Cyclone 'Hudhud' (7-14 October, 2014). This bulletin contains location (lat/long) and intensity of the system. A sample of hourly bulletin issued is given below:

#### EXAMPLE 7: Sample Hourly bulletin

##### BULLETIN NO. nn

DATE: DD-MM-YYYY

TIME OF ISSUE: gggg HRS IST

DATE/TIME (IST) OF OBSERVATION	BASED ON DD-MM-YYYY (gggg HRS IST)
LOCATION LATITUDE/LONGITUDE	
CURRENT INTENSITY NEAR CENTRE	
PAST MOVEMENT	
FORECAST MOVEMENT	
FORECAST INTENSITY	
FORECAST WIND ALONG THE COAST	
FORECAST RAINFALL	
FORECAST STORM SURGE	

**EXAMPLE 8:** Hourly Bulletin issued during REMAL on the day of landfall on 26th May:

**India Meteorological Department  
(Ministry of Earth Sciences)**

**HOURLY UPDATE ON CYCLONIC STORM “REMAL”**

**BULLETIN NO. 01**

DATE: 26-05-2024 TIME OF ISSUE: 1900 HRS IST

DATE/TIME(IST) OF OBSERVATION	BASED ON 26-05-2024 (1730 HRS IST)
LOCATION LATITUDE/LONGITUDE	<p>The <b>Severe Cyclonic Storm “Remal”</b> (pronounced as “Re-Mal”) over the North Bay of Bengal moved nearly northwards, with a speed of 16kmph during past 06 hours and lay centered at 1730 hrs IST of today, the 26th May, 2024 over the same region near latitude 21.1°N and longitude 89.2°E about 130 km east-southeast of Sagar Islands (West Bengal), 140 km southwest of Khepupara (Bangladesh), 140 km south southeast of Canning (West Bengal) and 160 km south-southwest of Mongla (Bangladesh).</p> <p><b>The outer cloud band lies over coastal areas of Bangladesh &amp; West Bengal, India. The landfall process will commence in next few hours.</b></p>
CURRENT INTENSITY NEAR CENTRE	<b>110-120 Kmph Gusting To 135 Kmph.</b>
OBSERVATIONS (1730 HOURS IST)	<p><b>WINDSPEED (Kmph):-</b> Canning-38 ,Digha-50  <b>RAINFALL (since 0830 IST in mm) :-</b> Digha-38, Haldia-31.</p>
FORECAST MOVEMENT, INTENSITY AND LANDFALL	<p>It is very likely to continue to move nearly northwards and cross Bangladesh and adjoining West Bengal coasts between Sagar Island and Khepupara, close to southwest of Mongla (Bangladesh) by midnight of today, the 26<sup>th</sup> may 2024 as a severe cyclonic storm with maximum sustained wind speed of 110-120 kmph gusting to 135 kmph.</p>
RECAST WIND	<p><b>(a) Bay of Bengal:</b></p> <ul style="list-style-type: none"> <li>❖ <b>Gale wind speed reaching 80-90 kmph gusting to 100 kmph</b> is prevailing over central Bay of Bengal and likely to decrease gradually becoming Squally wind speed reaching 50-60 kmph gusting to 70 kmph till morning of 27<sup>th</sup> May.</li> <li>❖ <b>Gale wind speed reaching 110-120 kmph gusting to 135 kmph</b> prevailing over North Bay of Bengal is likely to continue till midnight of 26<sup>th</sup> May. It is likely decrease thereafter becoming 70-80 kmph gusting to 90 kmph by morning on 27<sup>th</sup> May and squally wind speed reaching 45-55 kmph gusting to 65 kmph by evening of 27<sup>th</sup> May.</li> </ul> <p><b>(b) Along &amp; off Bangladesh and West Bengal coasts:</b></p> <ul style="list-style-type: none"> <li>❖ <b>Gale wind speed reaching 80-90 kmph gusting to 100 kmph is prevailing</b> along &amp; off Bangladesh and West Bengal &amp; adjoining North Odisha coasts and likely to become <b>110-120 kmph gusting to 135 kmph</b> during next 2 hours. It is likely to continue till early morning of 27<sup>th</sup> May. It is likely to decrease thereafter to become 60- 70 kmph gusting to 80 kmph by afternoon and squally wind 50-60</li> </ul>

	<p>kmph gusting to 70 kmph by night of 27<sup>th</sup> May.</p> <p>❖ <b>Squally wind speed reaching 50-60 kmph gusting to 70 kmph</b> is prevailing over Howrah, Hoogly, and Kolkata and East Medinipur districts. It will increase gradually becoming <b>Gale wind speed reaching 70-80 kmph gusting to 90 kmph</b> over these districts during night of 26<sup>th</sup> May except East Medinipur where the wind speed may reach up to <b>60-70 kmph gusting to 80 kmph</b> during the same period.</p> <p>(c) <b>Along &amp; off North Odisha coasts:</b>  <b>Squally wind speed reaching 50-60 kmph gusting to 70 kmph</b> is likely to prevail till 27<sup>th</sup> May morning.</p> <p>(d) <b>Northeastern States:</b>  <b>Squally wind speed reaching 50-60 kmph gusting to 70 kmph</b> is likely over Mizoram Tripura &amp; south Manipur on 26<sup>th</sup> &amp; 27<sup>th</sup> May and <b>40-50 kmph gusting to 60 kmph</b> is likely over South Assam and Meghalaya on 27<sup>th</sup> May</p>
FORECAST RAINFALL	<p><b>Heavy Rainfall Warning:</b></p> <p>(a) <b>West Bengal:</b> Light to moderate rainfall at most places with <b>heavy to very heavy rainfall</b> at a few places is likely over coastal districts of West Bengal and eastern districts of Gangetic West Bengal adjacent to Bangladesh on 26<sup>th</sup> &amp; 27<sup>th</sup> with isolated <b>extremely heavy rainfall</b> (<math>\geq 20</math> cm) over these districts on 26<sup>th</sup> May. The peak rainfall activity is likely during noon of 26<sup>th</sup> to noon of 27<sup>th</sup> May.  Light to moderate rainfall at most places with <b>heavy to very heavy rainfall</b> at isolated places likely over eastern districts of Sub Himalayan West Bengal on 27<sup>th</sup> and 28<sup>th</sup> May.</p> <p>(b) <b>Odisha:</b> Light to moderate rainfall at most places with isolated <b>heavy rainfall</b> likely over North Coastal Odisha on 26<sup>th</sup> May.</p> <p>(c) <b>Northeastern States:</b> Light to moderate rainfall at most places with <b>heavy to very heavy rainfall</b> at isolated places is likely over Mizoram, Tripura and South Manipur on 26<sup>th</sup> and over Assam, Meghalaya, Arunachal Pradesh, Nagaland, Mizoram, Manipur &amp; Tripura on 27<sup>th</sup> &amp; 28<sup>th</sup> May. Isolated <b>extremely heavy rainfall</b> (<math>\geq 20</math> cm) is also likely over Assam, Meghalaya on 27<sup>th</sup> &amp; 28<sup>th</sup> May, Arunachal Pradesh on 28<sup>th</sup> May and Mizoram &amp; Tripura on 27<sup>th</sup> May.</p>
FORECAST STORM SURGE	Storm surge of about 1 meter height above astronomical tide is likely to inundate low lying areas of coastal West Bengal and 3-4 m above astronomical tide likely to inundate low lying areas of coastal Bangladesh around the time of landfall

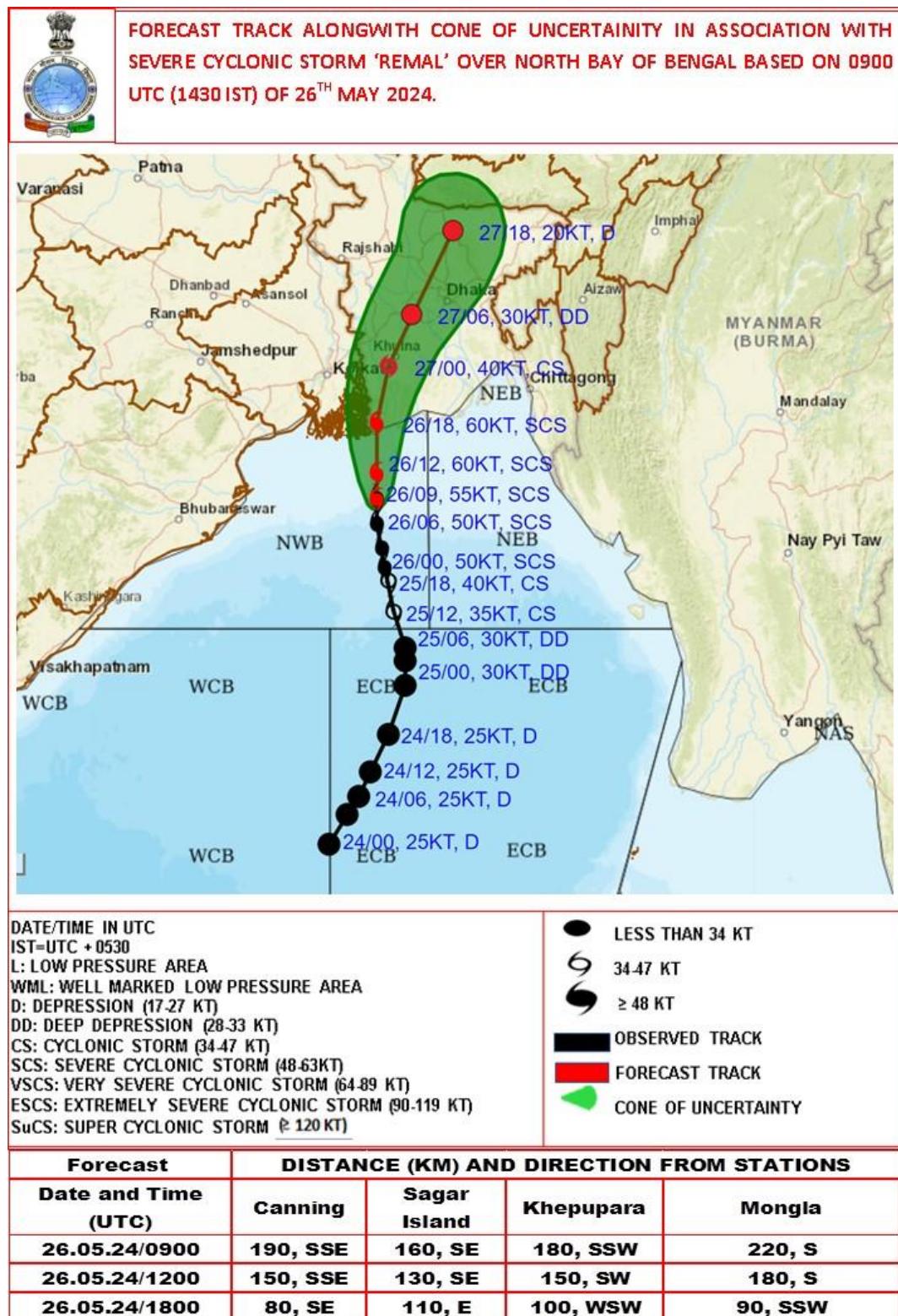


Fig 2.4.9(a): Forecast track along with cone of uncertainty in association with Severe cyclonic storm REMAL issued at 0900 UTC of 26<sup>th</sup> May, 2024

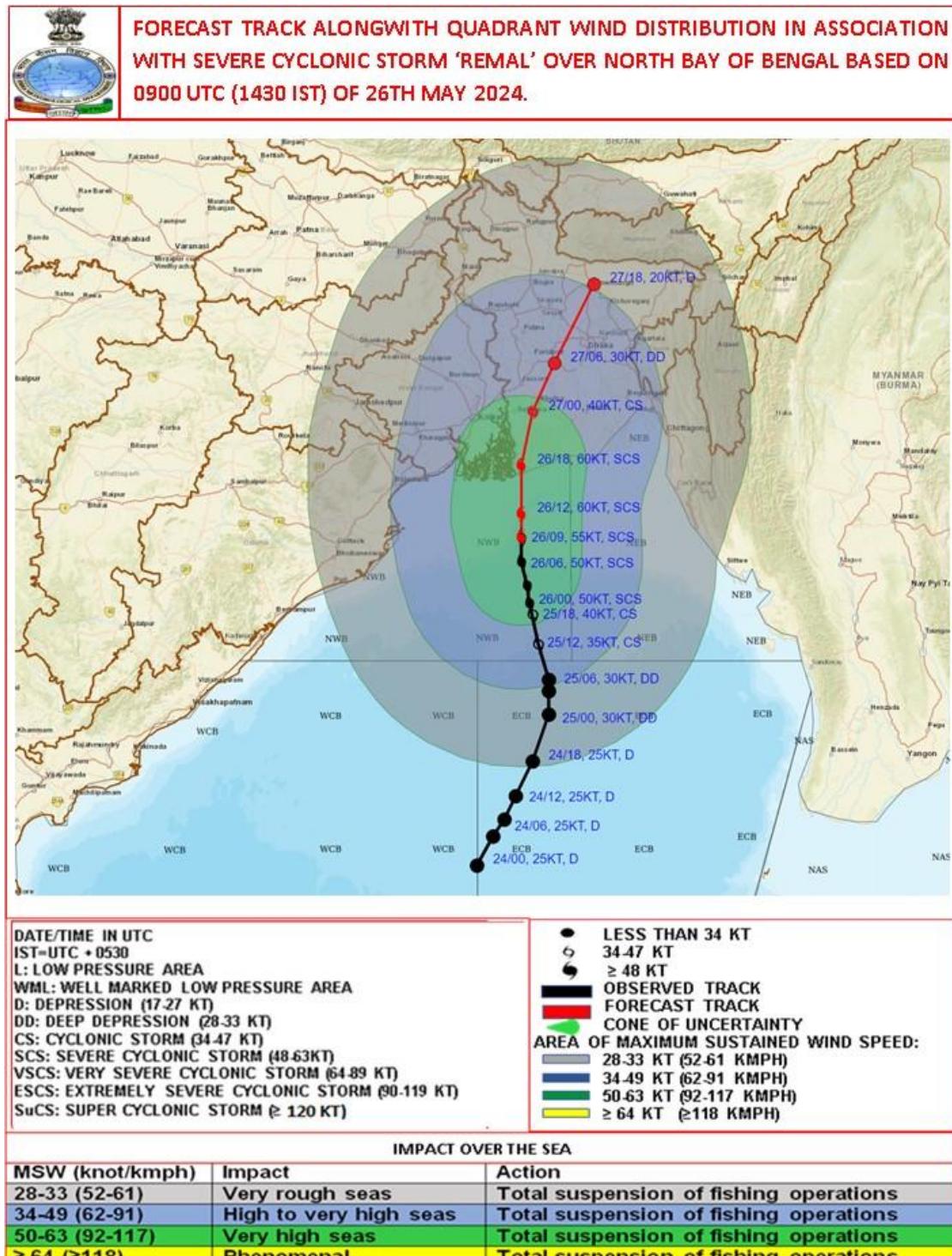
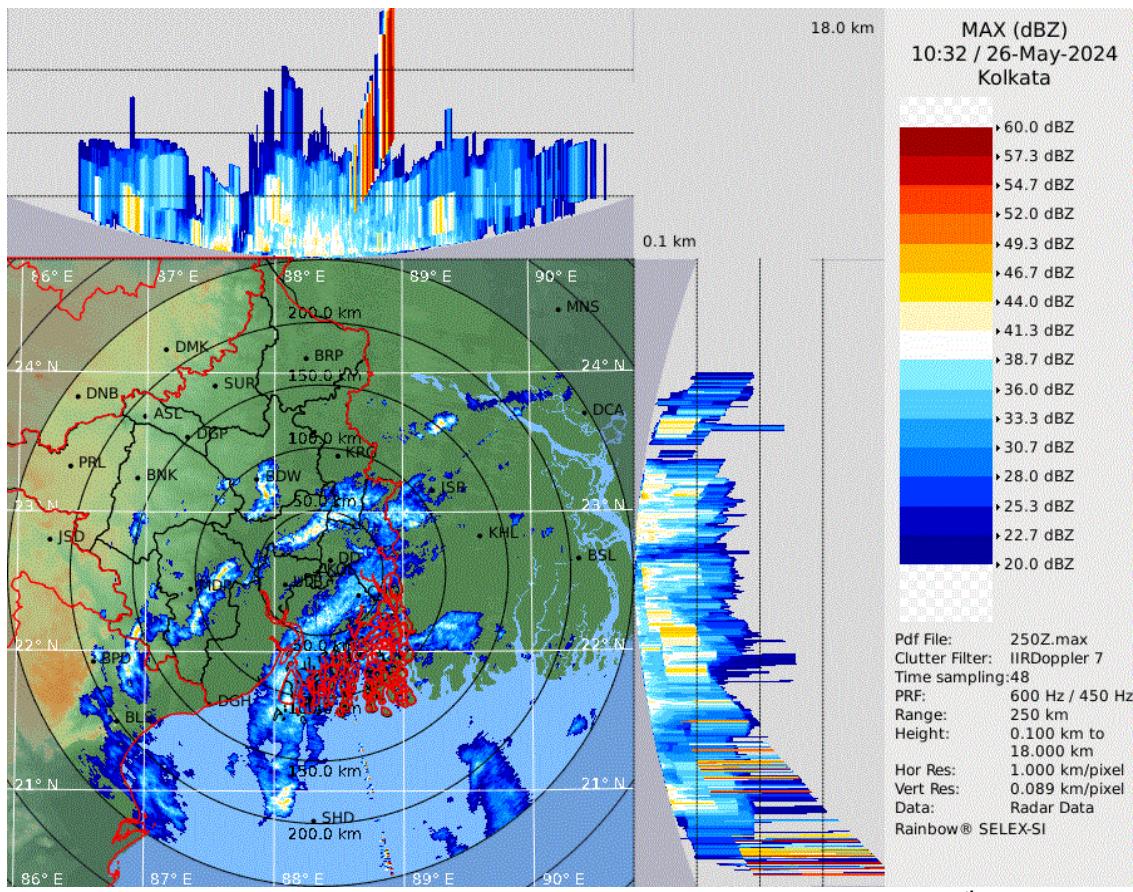


Fig 2.4.9(b): Forecast track along with quadrant wind distribution in association with Severe cyclonic storm REMAL issued at 0900 UTC of 26<sup>th</sup> May, 2024



**Fig 2.4.9(c): MAX (dBZ) image for Kolkata Radar issued at 1032 UTC of 26<sup>th</sup> May, 2024**

#### 2.4.6 Tropical cyclone warnings for the high Seas (WWMIWS)

The IMO/WMO Worldwide Met-Ocean Information and Warning Service (WWMIWS) is the internationally coordinated service for the promulgation of meteorological warnings and forecasts.

The WWMIWS guidance and coordination for marine meteorological maritime safety information messages issued on EGC (SafetyNET), NAVTEX and HF NBDP communication systems covering the following areas:

- warnings and forecasts for the High Seas;
- warnings and forecasts for coastal, offshore and local waters (including ports, lakes, harbour areas).

Operational guidance for handling and formatting meteorological information is given in detail in the Annex IV of the WMO Technical Regulations (Manual on Marine Meteorological Services – WMO-No. 558). The provision of warnings for weather systems that produce average wind speeds of 34 knots and greater are a mandatory requirement of the WWMIWS.

In relation to international marine requirements, the WWMIWS coordinates the broadcast of forecasts and warnings to vessels at sea through the Global Maritime Distress and Safety System (GMDSS), which includes SafetyNET satellite communications.

As part of the WWMIWS coordination, there are the following types of Centres:

Issuing service means a National Meteorological Service which has accepted responsibility for ensuring that meteorological warnings and forecasts for shipping are disseminated through the Inmarsat SafetyNET service to the designated area (METAREA) for which the Service has accepted responsibility under the WWMIWS.

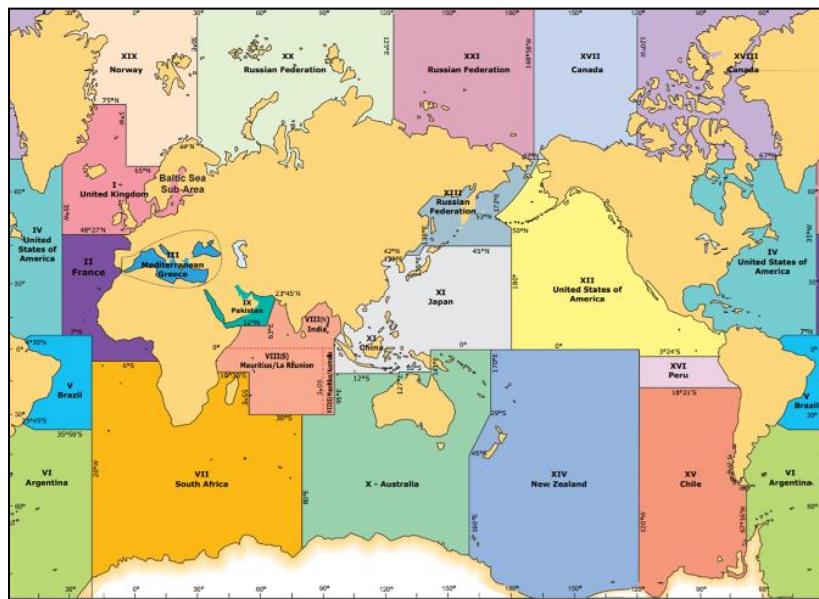
Preparation service means a National Meteorological Service which has accepted responsibility for the preparation of warnings and forecasts for parts of or an entire designated area (METAREA) in the WMO

system for the dissemination of meteorological forecasts and warning to shipping under the WWMIWS and for their transfer to the relevant Issuing Service for broadcast.

The METAREA Coordinator is responsible for ensuring that TC warnings for the WWMIWS in their METAREA are issued onto the appropriate GMDSS communication system.

Areas of responsibility (METAREAs) of the WWMIWS for the purpose of disseminating tropical storm warnings to vessels are given in **Fig.2.4.10**.

The cyclone warning centres broadcasting forecasts and warnings on coastal radio stations for the benefit of the ships in the Panel countries are listed in the **Table II-2**. The area covered by these stations in their bulletins, name of the coastal radio stations with their call signs from where the tropical cyclone warnings are broadcast, are also given in **Table II-2**.



**Fig. 2.4.10: AREAS OF RESPONSIBILITY AND DESIGNATED NATIONAL METEOROLOGICAL SERVICES FOR THE ISSUE OF WARNINGS AND WEATHER AND SEA BULLETINS FOR THE WWMIWS**

The cyclone warning centres issuing forecasts and warnings for the benefit of the ships on the high seas in the Panel countries are listed in the **Table II-2**. The area covered by these stations in their bulletins, name of the coastal radio stations with their call signs from where the tropical cyclone warnings are broadcast, are also given in **Table II-2**.

**TABLE II- 2: Stations issuing cyclone warnings for ships on the high seas**

<b>Station</b>	<b>Call sign of Coastal Radio Station</b>	<b>Area covered</b>
<b>Bangladesh,</b> Chittagong	ASC	Bay of Bengal north of 18°N Lat.
<b>India, Mumbai</b>		Arabian Sea north of Lat. 5°N and east of Long. 60°E excluding the area north of Lat. 20°N and west of Long. 68°E. The eastern boundary of the Arabian Sea for which these bulletins are issued by Mumbai is Long. 80°E meridian excluding the Gulf of Mannar.
<b>India, Kolkata</b>		Bay of Bengal north of Lat. 5°N except the area between the coastline on the east and the line drawn through the points 18°N 94.5°E, 18°N 92°E, 13.5°N 92°E, 13.5°N 94°E, 10°N 94°E, 10°N 95°E and 5°N 95°E. The western boundary of the sea area for which bulletins are issued by Kolkata is up to and inclusive of the Gulf of Mannar (i.e., 77.5°E meridian).
<b>India, Chennai</b>		Bay of Bengal bulletins issued by ACWC Kolkata are being broadcast through Navtex, Chennai by Narrow Band Direct Printing (NBDP)
<b>Myanmar</b> , Yangon	XYR	Bay of Bengal except area west of Long. 92°E and South of 10°N Lat.
<b>Oman (Sultanate of)</b>	A4M	Muscat Coastal Radio Station
<b>Pakistan</b> , Karachi	ASK	Arabian Sea north of 20°N, Gulf of Oman and Persian Gulf (12°N-63°E)
<b>Sri Lanka</b> , Colombo	4PB	Indian Ocean, Arabian Sea and Bay of Bengal from the equator to 10°N between 60°E and 95°E. The area 5°N to 10°N between 60°E and 95°E is an overlap with India.
<b>Thailand</b> , Bangkok Malacca	HSA	Gulf of Thailand, west of southern Thailand, Strait of and South China Sea.
<b>Qatar</b>		Arabian Gulf North of 26.5°N - AAA=AGN Arabian Gulf South of 26.5°N including the Strait of Hormuz - AAA=AGS (in association with Pakistan Met Department)

**Format and content of warnings for the WWMIWS**

The format and content of warnings issued for the WWMIWS, as outlined below, has been derived from guidance provided in the Manual on Marine Meteorological Services (WMO No.558).

TC warnings for the WWMIWS shall use the following wind warning category labels:

- Gale force wind warning (Beaufort force 8 or 9);
- Storm-force wind warning (Beaufort force 10 or 11);
- Hurricane-force wind warning (Beaufort force 12 or over).

Any TC-related wind warning issued for the WWMIWS should include the following content (excluding any relevant system metadata requirements):

Tropical cyclone warnings for the high Seas contain the following information:

- (a) Header label for marine radio broadcast purposes ("SECURITE")  
Note: This label needs to be visible on any product provided to mariners with the potential to be read out on marine radio systems.
- (b) Type of warning (GALE, STORM-FORCE, HURRICANE-FORCE WIND WARNING)
- (c) Name of the issuing centre
- (d) Name of the system and name of the basin
- (e) Date and time of reference in UTC
- (f) Type of disturbance (Tropical cyclone)
- (g) Location of disturbance (latitude and longitude)
- (h) Central pressure (hPa)
- (i) Intensity (maximum 10-minute average winds in knots)
- (j) Direction and speed of movement of the disturbance
- (k) Extent of affected area in nautical miles
- (l) Wind speed (knots) and direction in the affected areas
- (m) Sea and swell condition in affected areas (in qualitative terms)
- (n) Expected location and intensity at 12 and 24 hours time periods.
- (o) Indication of when next warning will be issued.

**Example 8: Sample GMDSS Bulletin is presented here:**

GLOBAL MARITIME 261530 IST

DATE/TIME OF ISSUE: 26-05-2024/1000 UTC SPL

GMDSS BULLETIN NO-8 261000

ISSUED BY: -INDIA METEOROLOGICAL DEPARTMENT, NEW DELHI HIGH SEA FORECAST FOR MET. AREA VIII (N)

AREA OF COVERAGE: AREA OF THE INDIAN OCEAN ENCLOSED BY LINES FROM THE INDO-PAKISTAN FRONTIER AT 23°45'N 68 DEG E TO 12 DEG N 6 DEG E, THENCE TO CAPE GARDAFUI; THE EAST AFRICAN COAST SOUTH TO THE EQUATOR, THENCE TO 95 DEG E, TO 6 DEG N, THENCE NORTHEASTWARDS TO MYANMAR/THAIL FRONTIER IN 10 DEG N 98 DEG

30'E NORTHWARDS COVERING ENTIRE BAY OF BENGAL.

**VALID FROM 10 UTC OF 26<sup>TH</sup> MAY 2024 TO 00 UTC OF 28<sup>TH</sup> MAY 2024.**

PART-I STORM WARNING:

**SUB: SEVERE CYCLONIC STORM "REMAL" (PRONOUNCED AS "RE-MAL") OVER NORTH BAY OF BENGAL (CYCLONE WARNING FOR WEST BENGAL COAST: RED MESSAGE)**

THE SEVERE CYCLONIC STORM "REMAL" (PRONOUNCED AS "RE-MAL") OVER THE NORTH BAY OF BENGAL MOVED NEARLY NORTHWARDS, WITH A SPEED OF 13 KMPH DURING PAST 06 HOURS AND LAY CENTERED AT 0600 UTC OF TODAY, THE 26<sup>TH</sup> MAY, 2024 OVER THE SAME REGION NEAR LATITUDE 20.2 DEG N AND LONGITUDE 89.2 DEG E ABOUT 220 KM SOUTH-SOUTHWEST OF KHEPUPARA (BANGLADESH), 260 KM SOUTH OF MONGLA (BANGLADESH), 210 KM SOUTHEAST OF SAGAR ISLANDS (WEST BENGAL) AND 230 KM SOUTH-SOUTHEAST OF CANNING (WEST BENGAL). CURRENTLY MAXIMUM SUSTAINED WIND SPEED OF 95-105 KMPH GUSTING TO 115 KMPH PREVAILS AROUND THE CYCLONE CENTRE.

IT IS VERY LIKELY TO CONTINUE TO MOVE NEARLY NORTHWARDS, INTENSIFY FURTHER AND **CROSS BANGLADESH AND ADJOINING WEST BENGAL COASTS BETWEEN SAGAR ISLAND AND KHEPUPARA, CLOSE TO SOUTHWEST OF MONGLA (BANGLADESH) BY MIDNIGHT OF TODAY,**

**THE 26<sup>TH</sup> MAY 2024 AS A SEVERE CYCLONIC STORM WITH MAXIMUM SUSTAINED WIND SPEED OF 110-120 KMPH GUSTING TO 135 KMPH.**

FORECAST TRACK AND INTENSITY ARE GIVEN IN THE FOLLOWING TABLE:

DATE/TIME (UTC)	POSITION (LAT. °N/ LONG. °E)	MAXIMUM SUSTAINED SURFACE WIND SPEED (KMPH)
26.05.24/0600	20.2/89.2	95-105 gusting to 115
26.05.24/1200	21.0/89.1	110-120 gusting to 135
26.05.24/1800	21.8/89.2	110-120 gusting to 135
27.05.24/0000	22.7/89.5	70-80 gusting to 90
27.05.24/0600	23.5/89.8	50-60 gusting to 70
27.05.24/1800	24.8/90.5	30-40 gusting to 50
26.05.24/0600	20.2/89.2	95-105 gusting to 115

#### QUADRANT WIND INFORMATION:

GALE WINDS REACHING 34 KT AT AROUND 100 NM RADIUS FROM THE CENTRE IN THE NW, SW & SE QUADRANTS, EXTENDING UP TO 130 NM IN THE NE QUADRANT.

GALE WINDS REACHING 50 KT AT AROUND 60 NM RADIUS FROM THE CENTRE IN THE NW, 65 NM IN THE SE & SW, AND 75NM IN THE NE QUADRANTS.

PART-II SYNOPTIC WEATHER SYSTEM AT 0600 UTC: SEASONAL WEATHER.

#### PART-III AREA FORECAST:

AREA: ARB A1 (ARABIAN SEA)-EQUATOR TO 10 DEG. N W OF 80 DEG.E (.)

#### ARB A1-Forecast valid from 10 UTC of 26<sup>th</sup> May 2024. To 00 UTC of 27<sup>th</sup> May 2024.

- I) WIND DIRECTION AND SPEED: SW/W-LY 15/25 KTS.
- II) WAVE HEIGHT: 2.5-3.0 MTR.
- III) WEATHER: 1) E OF 55 DEG E: WIDESPREAD RA/TS.  
 2) S OF 5 DEG N TO THE W OF 60 DEG E: FAIRLY WIDESPREAD RA/TS.  
 3) REST AREA: FAIR.
- IV) VISIBILITY: 1) E OF 55 DEG E: VERY POOR.  
 2) S OF 5 DEG N TO THE W OF 60 DEG E: POOR.  
 3) REST AREA: GOOD

#### ARB A1-Forecast valid from 00 UTC of 27<sup>th</sup> May 2024. To 00 UTC of 28<sup>th</sup> May 2024.

- I) WIND DIRECTION AND SPEED: 1) W OF 65 DEG E: SW/W-LY 15/30 KTS.  
 2) REST AREA: SW/W-LY 10/20 KTS.
- II) WAVE HEIGHT: 1.5-3.0 MTR.
- III) WEATHER: 1) E OF 55 DEG E: WIDESPREAD RA/TS.  
 2) REST AREA: ISOLATED RA/TS.
- IV) VISIBILITY: 1) E OF 55 DEG E: VERY POOR.  
 2) REST AREA: GOOD

ARB A2-ARABIAN SEA: -23 DEG 45 MIN N 68 DEG E TO 12 DEG N 63 DEG E TO CAPE GARDAFUI TO N OF 10 DEG N (.)

ARB A2-Forecast valid from 10 UTC of 26<sup>th</sup> May 2024. to 00 UTC of 27<sup>th</sup> May 2024.

- I) Wind direction and speed: 1) N of 20 deg N; SW/W-LY 10/20 KTS.  
2) Rest area: SW/W-LY 10/20 KTS BEC W/NW-LY 10/15 KTS TO THE E OF 70 DEG E.
- II) Wave height: 1.5-2.5 MTR.
- III) Weather: 1) S of 15 deg N to the E of 55 deg E: FAIRLY WIDESPREAD RA/TS.  
2) Rest area: FAIR.
- IV) Visibility: 1) S of 15 deg N to the E of 55 deg E: POOR.  
2) Rest area: GOOD.

ARB A2-Forecast valid from 00 UTC of 27<sup>th</sup> May 2024. to 00 UTC of 28<sup>th</sup> May 2024.

- I) Wind direction and speed: 1) N of 20 deg N; SW/W-LY 10/20 KTS.  
2) Rest area: SW/W-LY 15/25 KTS BEC W/NW-LY 10/20 KTS TO THE E OF 70 DEG E.
- II) Wave height: 1.5-2.5 MTR.
- III) Weather: 1) S of 15 deg N to the E of 58 deg E: WIDESPREAD RA/TS.  
2) Rest area: FAIR.
- IV) Visibility: 1) S of 15 deg N to the E of 58 deg E: VERY POOR.  
2) Rest area: GOOD.

BOB A3-Bay of Bengal: Equator to 10 deg N between E of 80 deg E west of 10 deg N/98 deg 30 min E to 6 deg N/95 deg E thence S-wards to Equator (.)

BOB A3-Forecast valid from 10 UTC of 26<sup>th</sup> May 2024. to 00 UTC of 27<sup>th</sup> May 2024.

- I) Wind direction and speed: SW-LY 15/30 KTS.
- II) Wave height: 2.5-4.0 MTR.
- III) Weather: 1) N of 5 deg N: FAIRLY WIDESPREAD RA/TS.  
2) Rest area: SCATTERED RA/TS.
- IV) Visibility: 1) N of 5 deg N: POOR.  
2) Rest area: MODERATE.

BOB A3-Forecast valid from 00 UTC of 27<sup>th</sup> May 2024. to 00 UTC of 28<sup>th</sup> May 2024.

- I) Wind direction and speed: SW-LY 15/25 KTS.
- II) Wave height: 2.5-4.0 MTR.
- III) Weather: FAIRLY WIDESPREAD RA/TS.
- IV) Visibility: POOR.

BOB: A4: Bay of Bengal N of 10 deg N E of 80 deg E (.)

BOB A4-Forecast valid from 10 UTC of 26<sup>th</sup> May 2024. to 00 UTC of 27<sup>th</sup> May 2024.

- I) Wind direction and speed: 1) N of 15 deg N: CYCLONIC 50/60 KTS.  
2) S of 15 deg N: SW-LY 20/30 KTS.
- II) Wave height: OVER 14.0 MTR.
- III) Weather: 1) N of 18 deg N: WIDESPREAD RA/TS.  
2) S of 18 deg N to the E of 82 deg E: WIDESPREAD RA/TS.  
3) Rest area: FAIR.
- IV) Visibility: 1) N of 18 deg N: VERY POOR.  
2) S of 18 deg N to the E of 82 deg E: VERY POOR.  
3) Rest area: GOOD.

BOB A4-FORECAST VALID FROM 00 UTC OF 27<sup>TH</sup> MAY 2024.TO 00 UTC OF 28<sup>TH</sup> MAY 2024.

- I) WIND DIRECTION AND SPEED: SW-LY 30/40 KTS.
- II) WAVE HEIGHT: 6.0-9.0 M.
- III) WEATHER: 1) N OF 15 DEG N TO THE E OF 90 DEG E: WIDESPREAD RA/TS.  
2) S OF 15 DEG N TO THE E OF 85 DEG E: FAIRLY WIDESPREAD RA/TS.  
3) REST AREA: FAIR.
- IV) VISIBILITY: 1) N OF 15 DEG N TO THE E OF 90 DEG E: VERY POOR.  
2) S OF 15 DEG N TO THE E OF 85 DEG E: POOR.  
3) REST AREA: GOOD.

ADVISORY: PLEASE BE AWARE. WIND WAVE FORECASTS ARE AVERAGES. WIND GUSTS CAN BE 40 PER CENT STRONGER THAN THE FORECAST. MAXIMUM WAVE HEIGHT CAN BE TWICE THE FORECAST WAVE HEIGHT.

NEXT FORECAST WILL BE ISSUED AT 26/1700 UTC.

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TOO: 26/1530

#### **2.4.7. Search & Rescue and Marine Emergency Response Bulletin:**

IMD and INCOIS have jointly agreed to provide bulletin for weather and ocean state and forecast as Regional Specialised Meteorological Centre for Marine Emergency Response RSMC (MER-SAR). The area of responsibility extends between 10°S & 35°N and longitude 40°E & 100°E. The bulletin is issued as and when request from the member country is received by RSMC (MER-SAR). The test messages in this regard were issued in November, 2023 to WMO.

##### **Typical example of Marine Emergency Response Bulletin**



India Meteorological Department

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##### **Regional Specialised Meteorological Centre – Marine Emergency Response (RSMC-MER):**

**Indian National Centre for Ocean Information Services, Hyderabad–  
India Meteorological Department, New Delhi  
Ministry of Earth Sciences, Govt of India**

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##### **MER Search and Rescue Bulletin (SAR-20231127-01)**

**Issued at: 28/11/2023 0600 UTC**

**Valid up to: 30/11/2023 0600 UTC**

**Probable drift areas information generated using the Search and Aid Rescue Tool (SARAT) to search for the lost object/person (From the Last Known Time to 48 hrs)**

**Last Known Position (LKP): -5°20'30", 54°20'23"**

**Last Known Time (LKT): 28/11/2023 0700 UTC**

**Object Type: Person in water (PIW)**

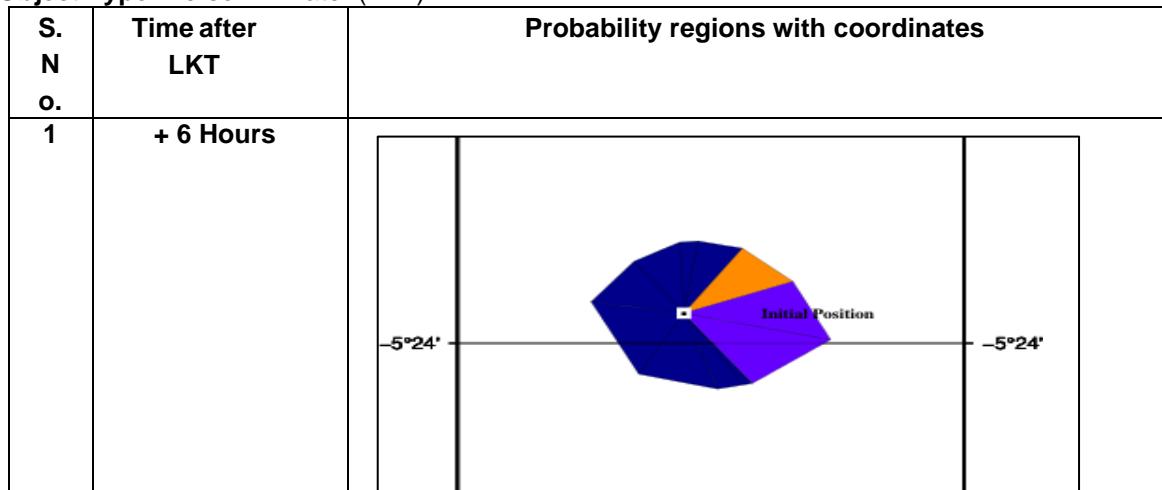
**Probable drift areas information generated using the Search and AidRescue Tool (SARAT) to search for the lost object/person**

**(From the Last Known Time to 48 hrs)**

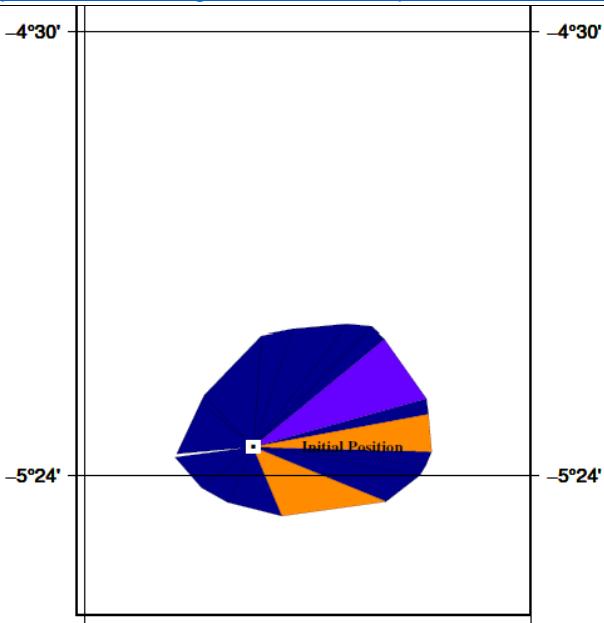
**Last Known Position (LKP):**  $5^{\circ}20'30''$  S &  $54^{\circ}20'23''$  E

**Last Known Time (LKT):** 28/11/2023 0700 UTC (corresponds to 28/11/2023 1230 IST)

**Object Type:** Person in water (PIW)



		<p>REGION 1: Advised to search the triangular area bounded by the following lat. Lon. Positions for finding the missing objects with 30 % probability.</p> <ol style="list-style-type: none"> <li>1) 54 deg 20 min 24 sec, -5 deg 20 min 31 sec</li> <li>2) 54 deg 26 min 34 sec, -5 deg 28 min 36 sec</li> <li>3) 54 deg 30 min 10 sec, -5 deg 16 min 51 sec</li> <li>4) 54 deg 33 min 34 sec, -5 deg 23 min 34 sec</li> </ol> <p>REGION 2: Advised to search the triangular area bounded by the following lat. Lon. Positions for finding the missing objects with 20 % probability.</p> <ol style="list-style-type: none"> <li>1) 54 deg 20 min 24 sec, -5 deg 20 min 31 sec</li> <li>2) 54 deg 25 min 39 sec, -5 deg 13 min 8395385742188400 sec</li> <li>3) 54 deg 30 min 10 sec, -5 deg 16 min 51 sec</li> </ol> <p><b>Coordinates of the highest probable region(s):</b></p> <p><b>Link to SARAT advisory in PDF format:</b>  <a href="https://sarat.incois.gov.in/sarat/data/pdf/bulletin-5424.pdf">https://sarat.incois.gov.in/sarat/data/pdf/bulletin-5424.pdf</a></p>
2	+ 12 hours	<p><b>Link to SARAT advisory in PDF format:</b>  <a href="https://sarat.incois.gov.in/sarat/data/pdf/bulletin-5426.pdf">https://sarat.incois.gov.in/sarat/data/pdf/bulletin-5426.pdf</a></p>
3	+ 18 hours	<p><b>Link to SARAT advisory in PDF format:</b>  <a href="https://sarat.incois.gov.in/sarat/data/pdf/bulletin-5427.pdf">https://sarat.incois.gov.in/sarat/data/pdf/bulletin-5427.pdf</a></p>
4	+ 24 hours	<p><b>Link to SARAT advisory in PDF format:</b>  <a href="https://sarat.incois.gov.in/sarat/data/pdf/bulletin-5428.pdf">https://sarat.incois.gov.in/sarat/data/pdf/bulletin-5428.pdf</a></p>

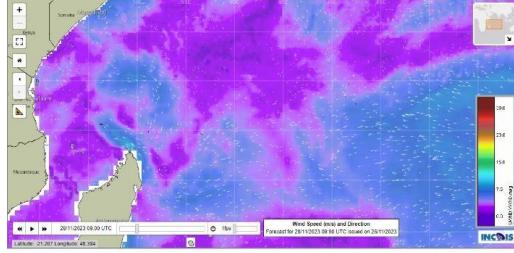
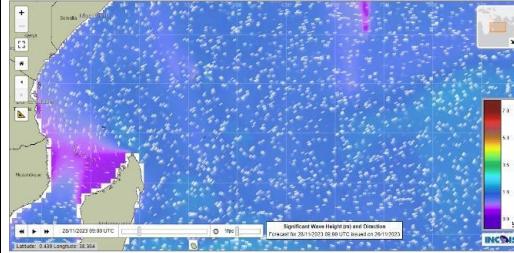
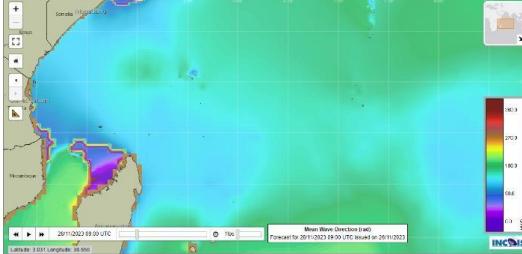
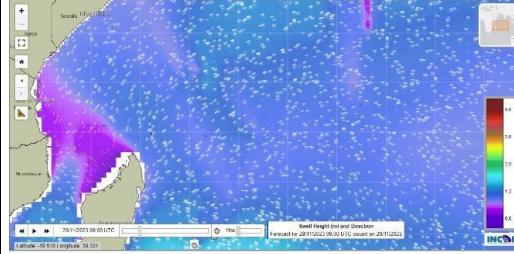
<b>5</b>	<b>+ 30 hours</b>	<b>Link to SARAT advisory in PDF format:</b> <a href="https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5430.pdf">https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5430.pdf</a>
<b>6</b>	<b>+ 36 hours</b>	<b>Link to SARAT advisory in PDF format:</b> <a href="https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5431.pdf">https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5431.pdf</a>
<b>7</b>	<b>+ 42 hours</b>	<b>Link to SARAT advisory in PDF format:</b> <a href="https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5433.pdf">https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5433.pdf</a>
<b>8</b>	<b>+ 48 hours</b>	 <p>REGION 1: Advised to search the triangular area bounded by the following lat. Lon. Positions for finding the missing objects with 30 % probability.</p> <ul style="list-style-type: none"> <li>1) 54 deg 20 min 24 sec, -5 deg 20 min 31 sec</li> <li>2) 54 deg 36 min 17 sec, -5 deg 7 min 25 sec</li> <li>3) 54 deg 41 min 22 sec, -5 deg 14 min 38 sec</li> </ul> <p>REGION 2: Advised to search the triangular area bounded by the following lat. Lon. Positions for finding the missing objects with 20 % probability.</p> <ul style="list-style-type: none"> <li>1) 54 deg 20 min 24 sec, -5 deg 20 min 31 sec</li> <li>2) 54 deg 23 min 53 sec, -5 deg 28 min 55 sec</li> <li>3) 54 deg 36 min 28 sec, -5 deg 27 min 10 sec</li> <li>4) 54 deg 41 min 38 sec, -5 deg 16 min 32 sec</li> <li>5) 54 deg 42 min 1 sec, -5 deg 21 min 4 sec</li> </ul>

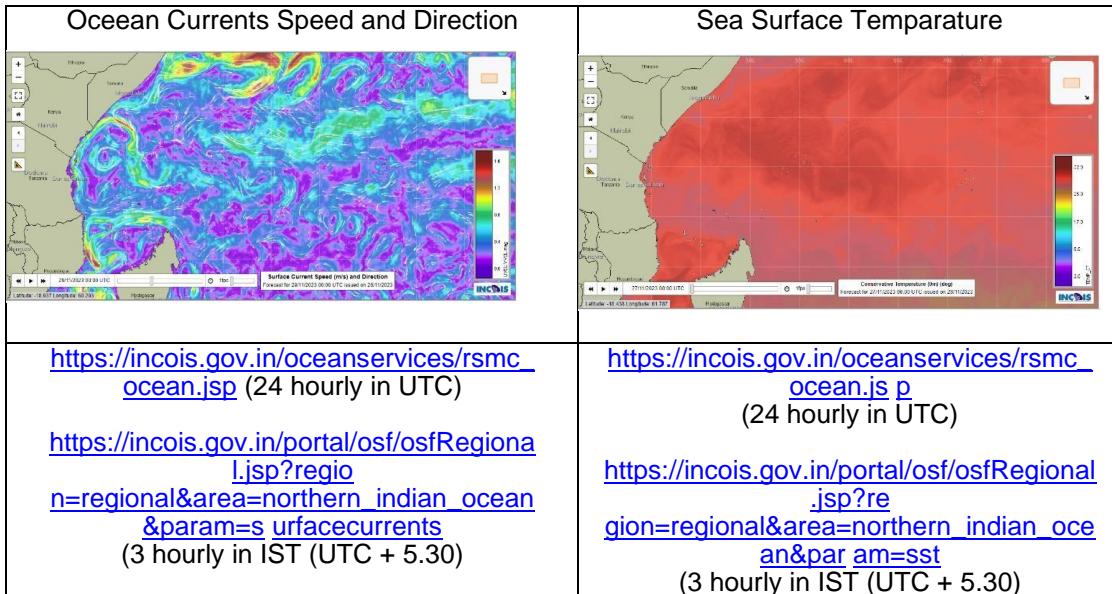
	<b>Coordinates of the highest probable region(s):</b>
	<b>Link to SARAT advisory in PDF format:</b> <a href="https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5425.pdf">https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5425.pdf</a>

### SAR Advisory:

Based on the RSMC-MER simulations, REGION 1 indicates the highest probable region. REGION 2 and 3 indicate the next highest probable regions and so on. The coordinates enclosing the triangular/polygonal regions are provided. The corresponding SAR advisories in a .pdf format can be obtained from the links provided. Depending on the time when the SAR operation is conducted at sea, the SARAT simulation closest to the time can be considered. For example, if the search time is after 7 hours after the object was lost, the SARAT simulation for the LKT+12 (i.e., > 6 hours) hours may be considered. The SAR authorities may search for the lost object or person in the highest probability region first. If the object cannot be located there, then they can search in the region of the next highest probability, and so on. Further, if high-probability regions of almost equal probabilities happen to be adjacent to each other, then the combined region may be treated as one region for SAR operations. However, if such high-probability regions of almost equal probabilities are not adjacent to each other, then simultaneous SAR operations may have to be planned. This can enhance the chance of finding the object or saving a life and reduce the cost of operations. The coordinates enclosing such combined areas or polygonal region is already provided in the .pdf format, for the convenience of the user.

### Forecast of Ocean State and Weather Parameters

<p>Graphical Products available at  <a href="https://incois.gov.in/oceanservices/rsmc.jsp">https://incois.gov.in/oceanservices/rsmc.jsp</a>            (Forecast at specific location and parameter can be obtained by clicking on interactive webmap)  <a href="https://incois.gov.in/portal/osf/osfRegional.jsp?region=regional&amp;area=northern_indian_ocean&amp;param=wind">https://incois.gov.in/portal/osf/osfRegional.jsp?region=regional&amp;area=northern_indian_ocean&amp;param=wind</a> (6 hourly animations)</p>	
<b>Wind Speed and Direction</b> 	<b>Significant Wave Height and Direction</b> 
Animated Images: <a href="https://incois.gov.in/oceanservices/rsmc_waves.jsp#">https://incois.gov.in/oceanservices/rsmc_waves.jsp#</a>	Animated Images: <a href="https://incois.gov.in/oceanservices/rsmc_waves.jsp#">https://incois.gov.in/oceanservices/rsmc_waves.jsp#</a>
<b>Mean Wave Direction</b> 	<b>Swell Wave Height and Direction</b> 
Animated Images: <a href="https://incois.gov.in/oceanservices/rsmc_waves.jsp#">https://incois.gov.in/oceanservices/rsmc_waves.jsp#</a>	Animated Images: <a href="https://incois.gov.in/oceanservices/rsmc_waves.jsp#">https://incois.gov.in/oceanservices/rsmc_waves.jsp#</a>



The six-hourly animations of ocean statell-41 forecast and SAR advisories are also available at INCOIS FTP server.

**Server URL:** <ftpser.incois.gov.in>

**Path:** /home1/incois/RSMC-MER/SAR/SAR-20231128-01

**Username :** incois

**Password :** incois@123

<ul style="list-style-type: none"> <li><b>Significant Weather:</b> (Low Pressure system if any): No significant weather</li> </ul>
<ul style="list-style-type: none"> <li><b>Wind:</b> North-northeasterly to North-northwesterly/05-10 knots during 0600 UTC of 28<sup>th</sup> to 0600 UTC of 29<sup>th</sup> November. South-southwesterly to southeasterly/ 05-10 knots during 0600 UTC of 29<sup>th</sup> to 0600 UTC of 30<sup>th</sup> November.</li> </ul>
<ul style="list-style-type: none"> <li><b>Rainfall:</b> Light to moderate rainfall (0.5-3.0 mm) during next 48 hours.</li> </ul>
<ul style="list-style-type: none"> <li><b>Visibility:</b> Good to fair during next 48 hours.</li> </ul>
<ul style="list-style-type: none"> <li><b>Cloud Cover:</b> Mainly cloudy sky (6-8 oktas) during 0600 UTC of 28<sup>th</sup> November to 0600 UTC of 30<sup>th</sup> November.</li> </ul>
<ul style="list-style-type: none"> <li><b>Surface Relative Humidity:</b> It is likely to be 60-70% over the Area of concern during next 48 hours.</li> </ul>

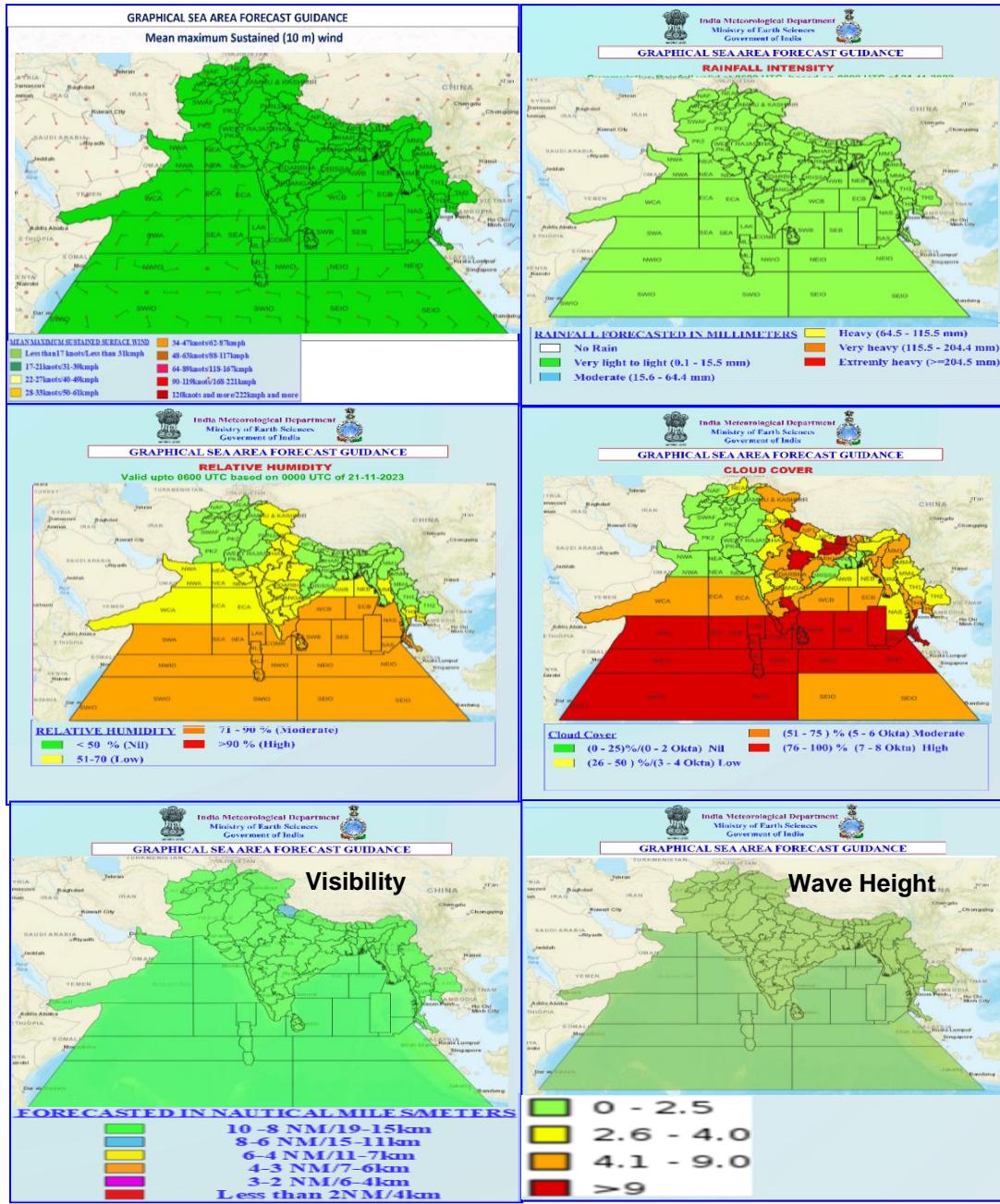
**Location Specific MME based 6 hourly forecasts for the search region during next 48 hours based on 0600 UTC model run:**

(Location : -5°20'30", 54°20'23")

Hour	Rainfall (mm)	10m Wind speed (knots)	10m Wind Direction	2m Relative Humidity (%)	Total Cloud Cover (%)
6	0	6.0	NNE	70	100
12	0	4.0	NNW	67	100
18	0	2.0	NNW	67	100
24	0	2.5	N	68	100
30	3.0	3.5	ENE	70	100
36	0.1	2.5	SSW	69	100
42	0.0	2.0	S	70	100
48	0.0	2.0	SE	70	96

## Annexure – I

**Multi Model Ensemble based Graphical Forecast for Weather State Parameters:**  
**(Mean maximum Sustained Wind, Rainfall Intensity, Relative Humidity,**  
**Cloud Cover, Visibility, Wave Height)**



## **2.4.8 Warnings and advisories for Aviation**

In accordance with the International Civil Aviation Organization (ICAO) Annex 3 — *Meteorological Service for International Air Navigation/ WMO Technical Regulations [C.3.1]*, tropical cyclone warnings, required

for the international air navigation, are issued by designated Meteorological Watch Offices (MWO) as SIGMET messages, including an outlook, giving information up to 24 hours ahead concerning the expected positions and maximum surface wind of the centre of the tropical cyclone. Each MWO provides information for one or more specified Flight Information Regions (FIRs) or Upper Information Regions (UIRs). The boundaries of the FIRs/UIRs are defined in ICAO Air Navigation Plans (ANP) for the Asia (ASIA), Middle East (MID) and Pacific (PAC) Regions.

The content and order of elements in a SIGMET message for tropical cyclone shall be in accordance with WMO Technical Regulations [C.3.1]. The data type designator to be included in the WMO abbreviated header of such messages shall be T1T 2 = WC (WMO No. 386, Manual on GTS refers).

The designated Tropical Cyclone Advisory Centre (TCAC), New Delhi shall monitor the development of tropical cyclones in its area of responsibility, in accordance with the ASIA/PAC ANP and issue advisory information concerning the positions of the centre of the cyclone, its direction and speed of movement, central pressure and maximum surface wind near the centre. These advisories are disseminated to the MWOs in the TCAC New Delhi area of responsibility, to be used in the preparation of the OUTLOOK appended to SIGMETs for tropical cyclones. In addition, the tropical cyclone advisories shall be disseminated to the other TCACs, whose areas of responsibility may be affected, to the World Area Forecast Centers (WAFC) London and Washington and international OPMET data banks and centers operating the satellite distribution systems (SADIS and ISCS).

[C.3.1]. The data type designator to be included in the WMO abbreviated header of such messages shall be T1T2 = FK (WMO-No. 386, Manual on GTS, refers).

TCAC New Delhi is issuing Tropical Cyclone Advisories for its area of responsibility, for each tropical cyclone, as necessary, in the format specified by ICAO every six hourly since 2003 and along with graphics from 2012.

### **TC ADVISORY**

- (i) **Text message:** A text message is sent through GTS under the header BMBB01 to various users as per the following format

#### **TC ADVISORY**

**TCAC: NEW DELHI**

**DTG: 20240526/0000Z**

**TC: Remal**

**NR: 07**

**PSN: N1930 E08918**

**MOV: N07KT**

**INTST CHANGE: INTSF**

**C: 982HPA**

**MAX WIND: 50KT**

**FCST PSN+06HR: 26/0600Z N2012 E08912**

**FCST MAX WIND +06HRS: 55 KT**

**FCST PSN+12HR: 26/1200Z N2054 E08912**

**FCST MAX WIND +12HRS: 60 KT**

**FCST PSN+18HR: 26/1800Z N2148 E08918**

**FCST MAX WIND +18HRS: 60 KT**

**FCST PSN+24HR: 27/0000Z N2242 E08930**

**FCST MAX WIND +24HRS: 40 KT**

**RMK: NIL**

**NEXT MSG: 20240526/0900Z**

**TOO: 260828HRS IST**

(\*\*) Change in intensity at the time of observation hours. Reported as "INTSF" (intensifying), "WKN" (weakening) and "NC" (no change). (In real-time, during Amphan it was not mentioned, as this practice has been introduced in November, 2020)

- (ii) **Graphical TC advisory:** The graphical advisory is sent in graphics in PNG format including text in it through GTS under the header T\_PZXE89\_C\_DEMS. An example is shown in **Fig.2.4.11.**

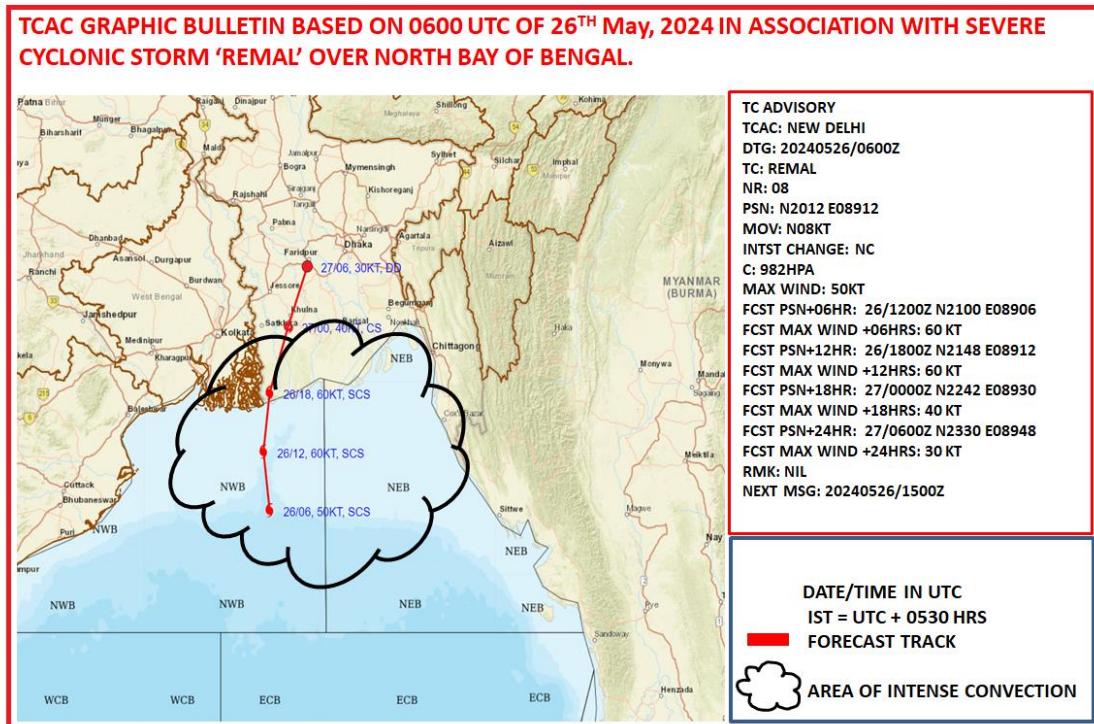


Fig 2.4.11: Typical graphical TCAC bulletin during SCS DANA

- (iii) **TC Advisory to ADRR Hong Kong:** TC advisory containing 24 hours forecast is also given to ADRR Hong Kong through FTP based on 00, 06, 12 and 18 UTC observation in the following format.

Example:

```

0001
Remal
202405240000 15.0 088.4 025 O
202405240600 15.8 088.9 025 O
202405241200 16.2 089.1 025 O
202405241800 16.8 089.4 025 O
202405250000 17.6 089.7 030 O
202405250600 18.2 089.7 030 O
202405251200 18.8 089.5 035 O
202405251800 19.3 089.4 040 O
202405260000 20.0 089.4 050 F
202405260600 20.7 089.3 055 F
202405261200 21.4 089.3 060 F
202405261800 22.0 089.3 060 F

```

## **2.4.9 Tropical cyclone warnings for national purposes**

Information on tropical cyclone warnings provided nationally by Panel member countries, including the port warning system, is given in Annex II- A to Annex II- I to this Chapter.

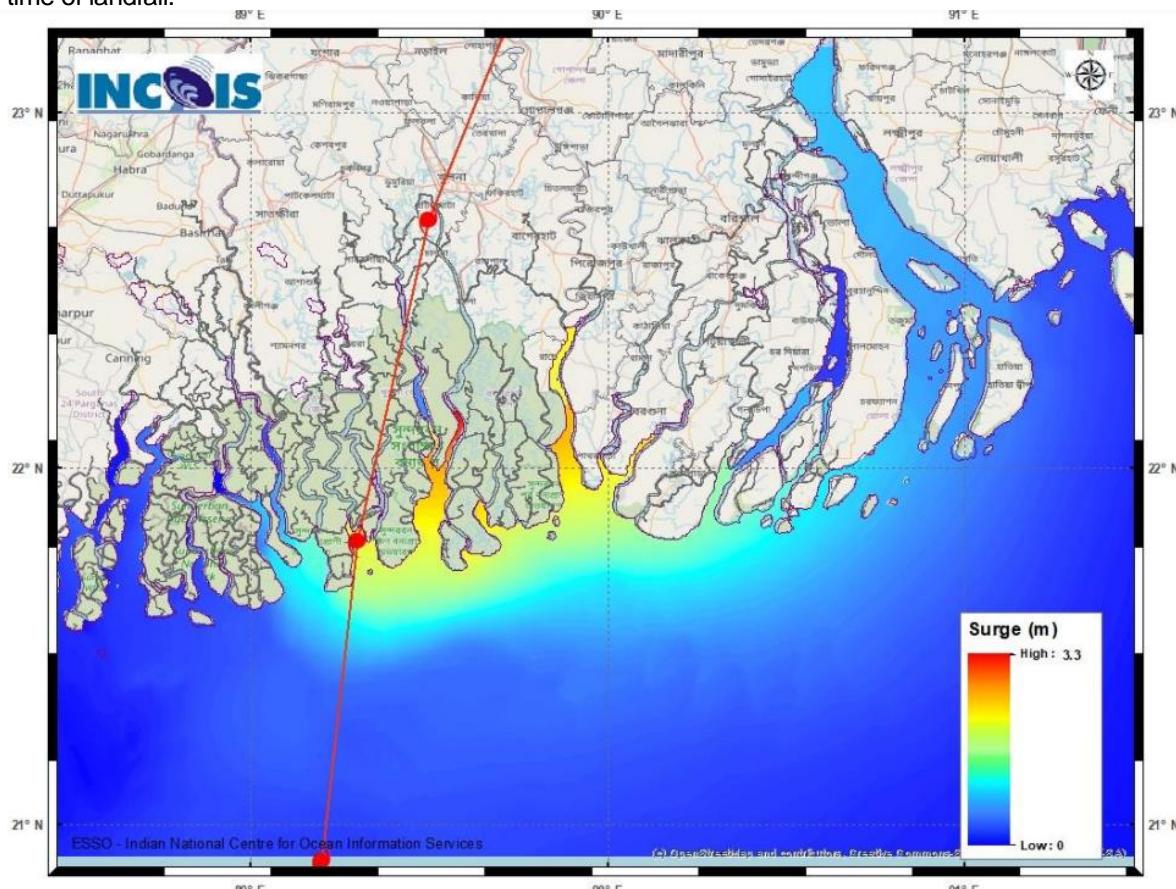
## **2.4.10 Storm surge guidance**

Storm surge warnings will be the responsibility of the National Meteorological Services. However, storm surge guidance will be issued and incorporated in the tropical cyclone advisory bulletin by RSMC-New Delhi based on IIT, Delhi Storm Surge prediction model and INCOIS, Hyderabad Advanced Circulation coastal inundation model. The storm surge guidance is appended in the Tropical Cyclone Advisory bulletin for Panel member countries. The graphical product from IIT Delhi and INCOIS, Hyderabad is also uploaded in cyclone page of IMD website. An example of this product is shown in Fig. II-11. The textual message is given in bulletin.

### **STORM SURGE GUIDANCE BASED ON 0000 UTC OF 26th May, 2024**

#### **STORM SURGE GUIDANCE (GRAPHICS ATTACHED) FOR BAY OF BENGAL AND BANGLADESH COASTS:**

Storm surge of about 1 meter height above astronomical tide is likely to inundate low lying areas of coastal west Bengal and 3-4 m above astronomical tide likely to inundate low lying areas of coastal Bangladesh around the time of landfall.



**Fig 2.4.12: Storm Surge Warning Graphics issued at 0000 UTC of 26<sup>th</sup> May, 2024**

## **2.5 Graphical presentation of track and intensity**

The track and intensity of the system are updated and put in cyclone page of IMD website time to time, based on the special tropical weather outlook and tropical cyclone advisory bulletin issued by RSMC, New Delhi from the stage of depression and based on 00, 06, 12 and 18 UTC. This information is also available on GIS Platform since 2020 at the link ([https://ddgmuimod.gov.in/dwr\\_img/GIS/cyclone.html](https://ddgmuimod.gov.in/dwr_img/GIS/cyclone.html)). These are also sent by e-mail to the Panel member countries. An example of this product is shown in **Fig. 2.5.1(a)**.

### **2.5.1 Cone of uncertainty:**

The cone of uncertainty in the forecast was introduced with effect from the cyclone, 'WARD' during December, 2009 for the lead time 72 hours at an interval of 12 hrs. It was further revised with effect from cyclone 'VIYARU' during May, 2013 and extended upto 120 hrs for the same interval of time. It is helpful to the decision makers as it indicates the standard forecast errors in the forecast for different periods like 00, 06, 12, 18, 24, 36, 48, 60, 72, 84, 96, 108, 120 hrs. Recently during 2019, it has been revised w.e.f. cyclone FANI based on the errors during 2014-18. There has been a reduction of 20-30% errors for various lead periods in 2019 as compared to the values during 2014 due to reduction in track forecast errors during 2014-18 as compared to that during 2009-13. The standard errors (nm) as radius of the circle around the forecast position (lat/long) so as to construct the cone of uncertainty in the track forecast are given below.

Lead time (hrs)	Standard error (nm) used for uncertainty forecast w.e.f. April, 2019
00	010
06	020
12	030
18	040
24	045
36	055
48	070
60	085
72	095
84	115
96	130

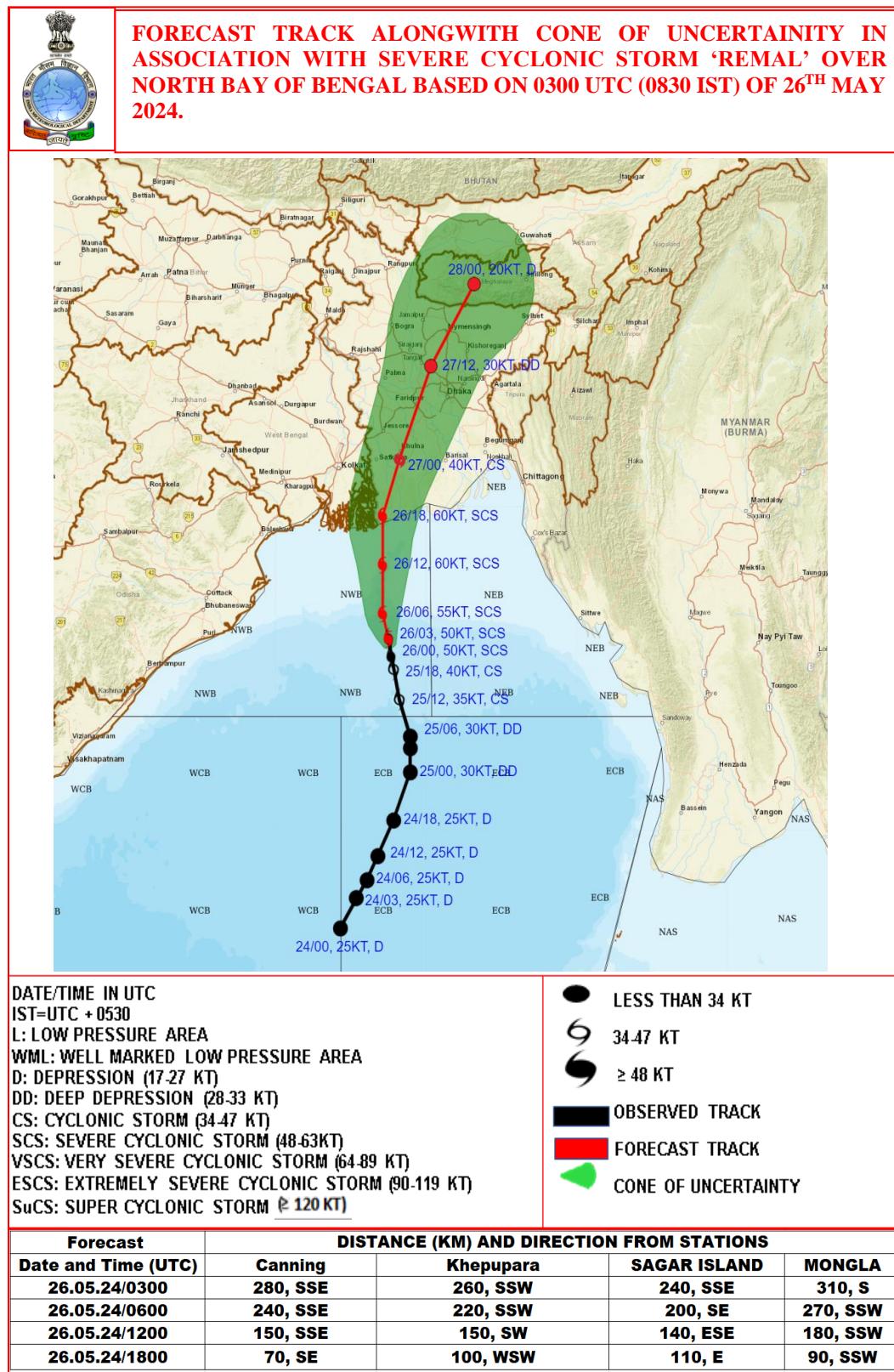


Fig.2.5.1(a) Observed and forecast track based on 0300 UTC of 26<sup>th</sup> May in association with SCS Remal.

### 2.5.2 Quadrant wind forecast:

#### (i) Graphical Product:

The forecast of maximum wind in four quadrants of a cyclone commenced with effect from cyclone, GIRI during October 2010. In this forecast, the radius of 28, 34, 50 and 64 knot winds were given for various forecast periods like +06, +12, +18, +24, +36, +48, +60 and +72 hrs. It was further revised with effect from cyclone 'Viyaru' during May, 2013 and extended upto 120 hrs for same interval of time. A typical graphical presentation of this forecast is shown in Fig.2.5.1(b). This bulletin is issued from Deep Depression stage onwards based on 00, 06, 12 and 18 UTC. It is uploaded in IMD website and sent to focal points of WMO/ESCAP Panel countries by e-mail.

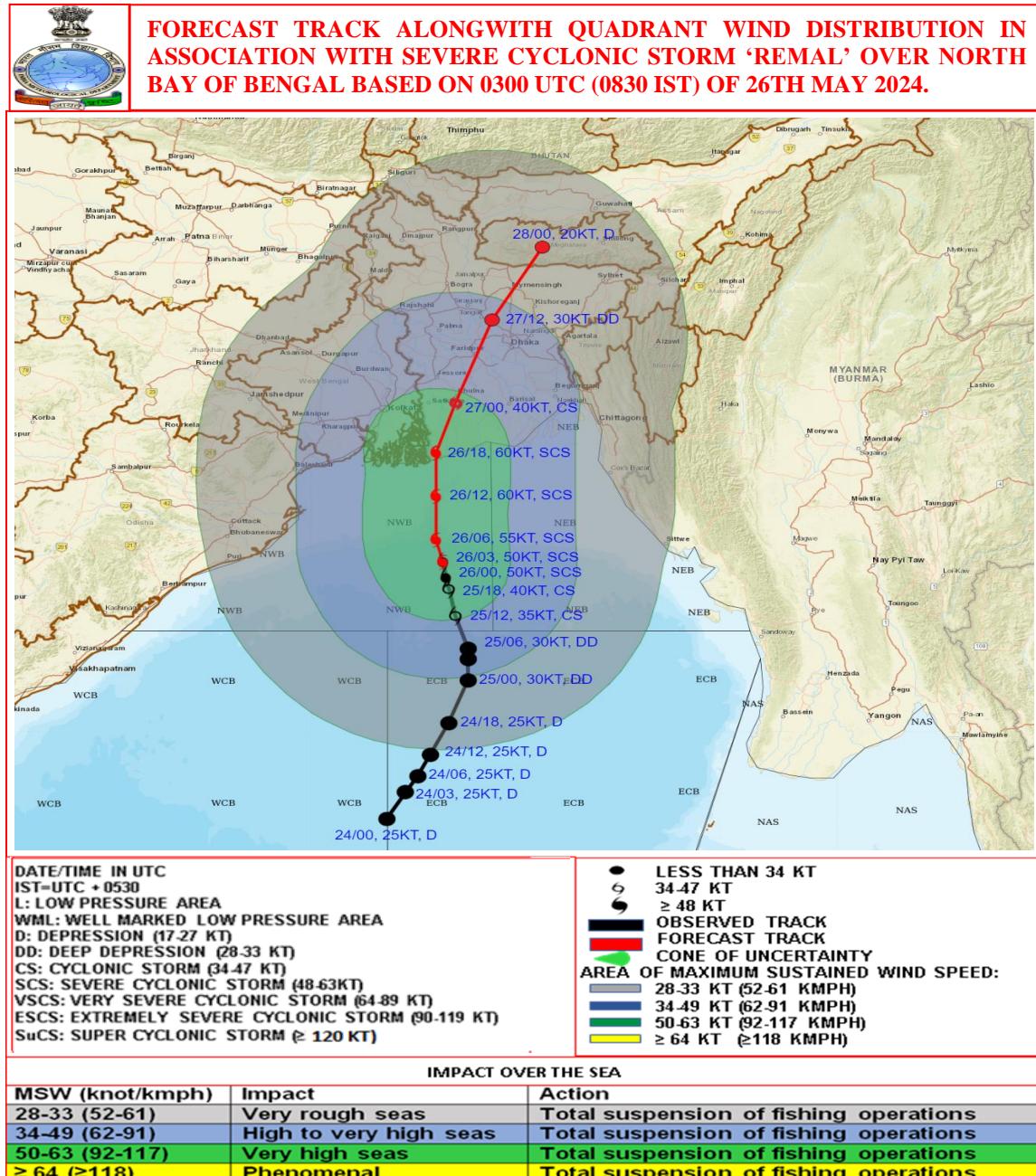


Fig.2.5.1(b): A typical example of observed track and forecast area of maximum sustained wind in association based on 0300 UTC of 26<sup>th</sup> May in association with SCS Remal

**(iii) Graphical Presentation of Estimated Maximum Sustained Wind Speed:**

The estimated maximum sustained wind speed based on the best estimate of intensity is presented in Fig. 2.5.1(c) in association with SCS REMAL

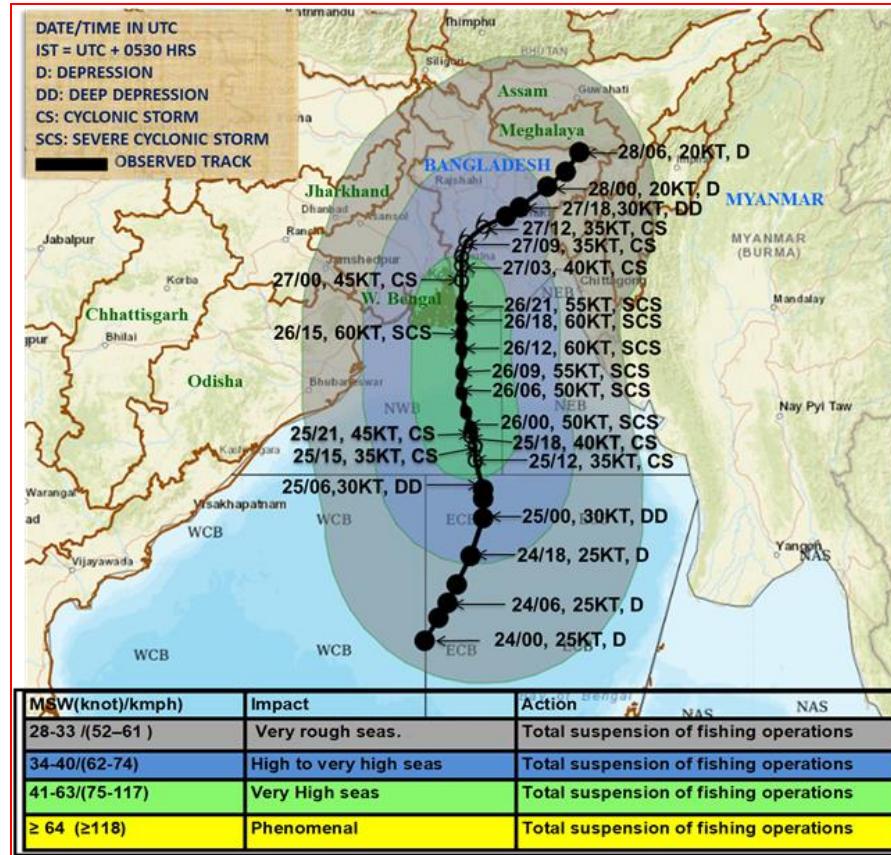


Fig. 2.5.1(c): Estimated maximum sustained wind during the life cycle of SCS REMAL

**(iv) Graphical Presentation of Estimated Storm Surge:**

Typical example of the estimated storm surge based on the best estimate of track and intensity is presented in Fig. 2.5.1(d) in association with SCS REMAL.

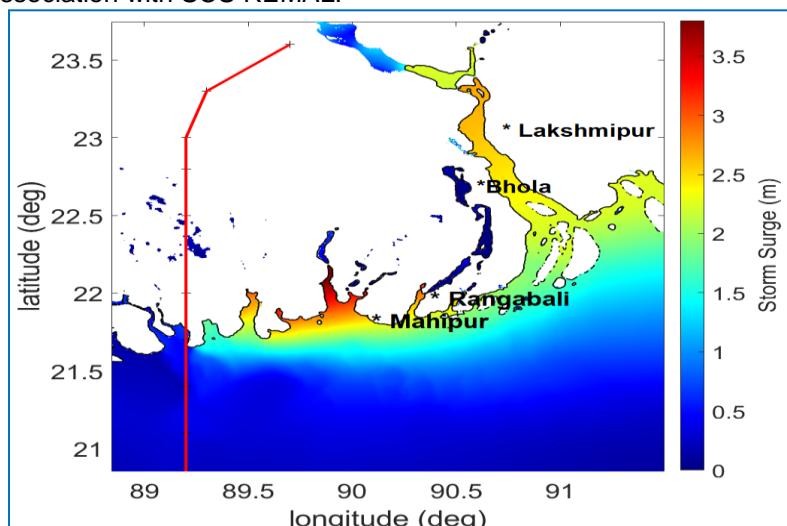


Fig. 2.5.1(d): Estimated storm surge based on best track parameters of SCS REMAL

**(ii) Text Product:**

The quadrant wind is also issued in text format and sent to various users through-email and GTS under the header-WTIN31. It is also sent to various NWP modeling groups including NCMRWF, IIT Delhi for vortex relocation in coded form through ftp. It is provided to IIT Delhi & INCOIS storm surge modeling group also for their use.

**Example (i):**

**QUADRANT WIND DISTRIBUTION IN ASSOCIATION WITH Remal OVER BAY OF BENGAL ON 0000 UTC OF 26-05-2024 FOR WHICH FORECAST IS PREPARED:**

PRESENT DATE AND TIME: **260000**

PRESENT POSITION: **19.5°N/89.3°E**

POSITION ACCURATE TO 20 KM

PRESENT MOVEMENT (DDD/FF) PAST SIX HOURS: 333/02KT PRESENT

WIND DISTRIBUTION:

MAX SUSTAINED WINDS: 50 KT, GUSTS 60 KT RADIUS OF

**MAXIMUM WIND 33 NM**

WINDS VARY IN EACH QUADRANT

RADIi ARE LARGEST RADi EXPECTED ANYWHERE IN THE QUADRANT WIND

RADIi VALID OVER OPEN WATER ONLY

**RADIUS OF 027KT WINDS:**

- 210 NM NORTHEAST QUADRANT
- 200 NM SOUTHEAST QUADRANT
- 180 NM SOUTHWEST QUADRANT
- 150 NM NORTHWEST QUADRANT

**RADIUS OF 034KT WINDS:**

- 130 NM NORTHEAST QUADRANT
- 110 NM SOUTHEAST QUADRANT
- 100 NM SOUTHWEST QUADRANT
- 100 NM NORTHWEST QUADRANT

**RADIUS OF 050KT WINDS:**

- 75 NM NORTHEAST QUADRANT
- 65 NM SOUTHEAST QUADRANT
- 65 NM SOUTHWEST QUADRANT
- 60 NM NORTHWEST QUADRANT

**FORECASTS:**

06 HRS, VALID AT:

**260600Z 20.2°N/89.2°E**

MAX SUSTAINED WINDS: 55 KT, GUSTS 65 KT

RADIUS OF 027KT WINDS:

210 NM NORTHEAST QUADRANT  
200 NM SOUTHEAST QUADRANT  
180 NM SOUTHWEST QUADRANT  
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:

130 NM NORTHEAST QUADRANT  
110 NM SOUTHEAST QUADRANT  
100 NM SOUTHWEST QUADRANT  
100 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:

75 NM NORTHEAST QUADRANT  
65 NM SOUTHEAST QUADRANT  
65 NM SOUTHWEST QUADRANT  
60 NM NORTHWEST QUADRANT

12 HRS, VALID AT:

261200Z 20.9°N/89.2°E

MAX SUSTAINED WINDS: 60 KT, GUSTS 70 KT

RADIUS OF 027KT WINDS:

210 NM NORTHEAST QUADRANT  
200 NM SOUTHEAST QUADRANT  
180 NM SOUTHWEST QUADRANT  
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:

130 NM NORTHEAST QUADRANT  
110 NM SOUTHEAST QUADRANT  
100 NM SOUTHWEST QUADRANT  
100 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:

75 NM NORTHEAST QUADRANT  
65 NM SOUTHEAST QUADRANT  
65 NM SOUTHWEST QUADRANT  
60 NM NORTHWEST QUADRANT

18 HRS, VALID AT:

261800Z 21.8°N/89.3°E

MAX SUSTAINED WINDS: 60 KT, GUSTS 70 KT

RADIUS OF 027KT WINDS:

210 NM NORTHEAST QUADRANT  
200 NM SOUTHEAST QUADRANT  
180 NM SOUTHWEST QUADRANT  
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:

130 NM NORTHEAST QUADRANT  
110 NM SOUTHEAST QUADRANT  
100 NM SOUTHWEST QUADRANT  
100 NM NORTHWEST QUADRANT

**RADIUS OF 050KT WINDS:**

75 NM NORTHEAST QUADRANT  
 65 NM SOUTHEAST QUADRANT  
 65 NM SOUTHWEST QUADRANT  
 60 NM NORTHWEST QUADRANT

**24 HRS, VALID AT:****270000Z 22.7°N/89.5°E****MAX SUSTAINED WINDS: 40 KT, GUSTS 50 KT****RADIUS OF 027KT WINDS:**

210 NM NORTHEAST QUADRANT  
 200 NM SOUTHEAST QUADRANT  
 180 NM SOUTHWEST QUADRANT  
 150 NM NORTHWEST QUADRANT

**RADIUS OF 034KT WINDS:**

130 NM NORTHEAST QUADRANT  
 110 NM SOUTHEAST QUADRANT  
 100 NM SOUTHWEST QUADRANT  
 100 NM NORTHWEST QUADRANT

**36 HRS, VALID AT:****271200Z 24.2°N/90.1°E****MAX SUSTAINED WINDS: 30 KT, GUSTS 40 KT****RADIUS OF 027KT WINDS:**

210 NM NORTHEAST QUADRANT  
 200 NM SOUTHEAST QUADRANT  
 180 NM SOUTHWEST QUADRANT  
 150 NM NORTHWEST QUADRANT

**48 HRS, VALID AT:****280000Z 25.5°N/90.9°E****MAX SUSTAINED WINDS: 20 KT, GUSTS 30 KT**

\*\*\*\*\*

**2.5.3 TC Vital:**

TC vital sent through ftp has been introduced in 2013. The format of TC vital bulletin sent to NWP modelers is given below

**Format**

No. of characters	Description of characters	Example
character*4 tcv_center	Hurricane Center Acronym	IMD
character*3 tcv_storm_id	Storm Identifier (02B, etc)	01B
character*9 tcv_storm_name	Storm name	REMAL
integer tcv_century	2-digit century id (19 or 20)	20
integer tcv_yymmdd	Date of observation	240526
integer tcv_hhmm	Time of observation (UTC)	0000
integer tcv_lat	Storm Lat (X10), always >0	195 (for 19.5° latitude)
character*1 tcv_latns	'N' or 'S'	N
integer tcv_lon	Storm Lon (*10), always >0	0893 (for 89.3° longitude)
character*1 tcv_lonew	'E' or 'W'	E

integer tcv_stdir	Storm motion vector (in degree)	<b>350</b> (Past six hours) (north-northwestwards)
integer tcv_stspd	Speed of storm movement (m/sX10)	031 (Past six hours Reported in 3 digits)
integer tcv_pcen	Min central pressure (mb)	0982 (Reported in 4 digits)
integer tcv_penv	outermost closed isobar(mb)	0997 (Reported in 4 digits)
integer tcv_penvrad	rad outermost closed isobar(km)	0380 (Reported in 4 digits) (300 km)
integer tcv_vmax	max sfc wind speed (m/s)	026 (Reported in 3 digits)
integer tcv_vmaxrad	rad of max sfc wind spd (km)	080 (Reported in 4 digits) (half of average of radius of MSW)
integer tcv_r15ne	NE rad of 34 knots winds (km)	0240 (Reported in 4 digits)
integer tcv_r15se	SE rad of 34 knots winds (km)	0230 (Reported in 4 digits)
integer tcv_r15sw	SW rad of 34 knots winds (km)	0185 (Reported in 4 digits)
integer tcv_r15nw	NW rad of 34 knots winds (km)	0185 (Reported in 4 digits)
character*1 tcv_depth	Storm depth (S,M,D,X) S stands for shallow (for D), M stands for Medium (for DD), D stands for Deep (for CS and above) and X stands for missing	D

**Example:**

IMD 01B REMAL 20240526 0000 195N 0893E 350 031 0982 0997 0380 026 080 0240 0230 0185  
0185 D

**2.5.4 Customised Location Specific Forecast:**

IMD commenced customized location specific forecast for offshore/onshore industries in October 2022. The bulletin contains information about the system, information about track, intensity, maximum sustained wind speed, radial extension of winds in the threshold of  $\geq 28$  knots,  $\geq 34$  knots,  $\geq 50$  knots,  $\geq 64$  knots, state of sea, significant wave height and uncertainty in track and intensity. This service has been extended for other important installations as well in 2024 including Indian Air Force stations, HPCIL installations and Indian Oil Corporation installations. Typical sample bulletin is presented herewith.

**Contact details:**

Email: cyclonewarningdivision@gmail.com

Tel: 011-47100160

BULLETIN NO.	: BOB/13/2024
CYCLONE / DISTURBANCE NAME	: Remal
ISSUED ON	: 26 MAY 2024
BASED ON	: 1130 IST
CURRENT LOCATION OF CYCLONIC DISTURBANCE	: LATITUDE 20.2°N AND LONGITUDE 89.2°E
GEOGRAPHIC REFERENCE	: North Bay of Bengal
CENTRAL PRESSURE	: 982 HPA
DIRECTION AND SPEED OF MOVEMENT DURING PAST 6 HOURS	: Moved nearly northwards, with a speed of 13 kmph during past 06 hours

SYNOPSIS	<p>The Severe Cyclonic Storm "Remal" (pronounced as "Re-Mal") over the North Bay of Bengal moved nearly northwards, with a speed of 13 kmph during past 06 hours and lay centered at 1130 hrs IST of today, the 26th May, 2024 over the same region near latitude 20.2°N and longitude 89.2°E about 220 km south-southwest of Khepupara (Bangladesh), 260 km south of Mongla (Bangladesh), 210 km southeast of Sagar Islands (West Bengal) and 230 km south-southeast of Canning (West Bengal). Currently maximum sustained wind speed of 95-105 kmph gusting to 115 kmph prevails around the cyclone centre.</p> <p>It is very likely to continue to move nearly northwards, intensify further and cross Bangladesh and adjoining West Bengal coasts between Sagar Island and Khepupara, close to southwest of Mongla (Bangladesh) by midnight of today, the 26th May 2024 as a Severe Cyclonic Storm with maximum sustained wind speed of 110-120 kmph gusting to 135 kmph.</p>											

**Table 1: General forecast in association with cyclonic disturbance over the Bay of Bengal based on 1130 hrs IST of 26th May, 2024**

FORECAST HOUR	DATE/TIME (IST)	POSITION		FORECAST INTENSIT Y CATEGOR Y	FORECAST MOVEMENT		FORECAST WIND(KT)		UNCERTAINTY IN FORECAST		SIGNIFICA NT WAVE HEIGHT(M)	STAT E OF SEA
		LAT (°N )	LONG (°E)		SPEED (KMP H)	DIRECTI ON	MS W	GUS T	PAT H (NM)	INTENSI TY (KT)		
0	26.05.24/ 1130	20. 2	89.2	SCS			50	60	10	10	9-14	Very High
6	26.05.24/ 1730	21. 0	89.1	SCS	15	N	60	70	20	10	9-14	Very High
12	26.05.24/ 2330	21. 8	89.2	SCS	15	N	60	70	30	10	9-14	Very High
18	27.05.24/ 0530	22. 7	89.5	CS	17	NNE	40	50	40	10	9-14	Very High
24	27.05.24/ 1130	23. 5	89.8	DD	16	NNE	30	40	45	5	4-6	Very Rough
36	27.05.24/ 2330	24. 8	90.5	D	13	NNE	20	30	55	5	2.5-4.0	Rough

**Table 2: Wind forecast with radii of influence in association with cyclonic disturbance over the Bay of Bengal based on 1130 hrs IST of 26th May,2024**

### Forecast Track Graphics

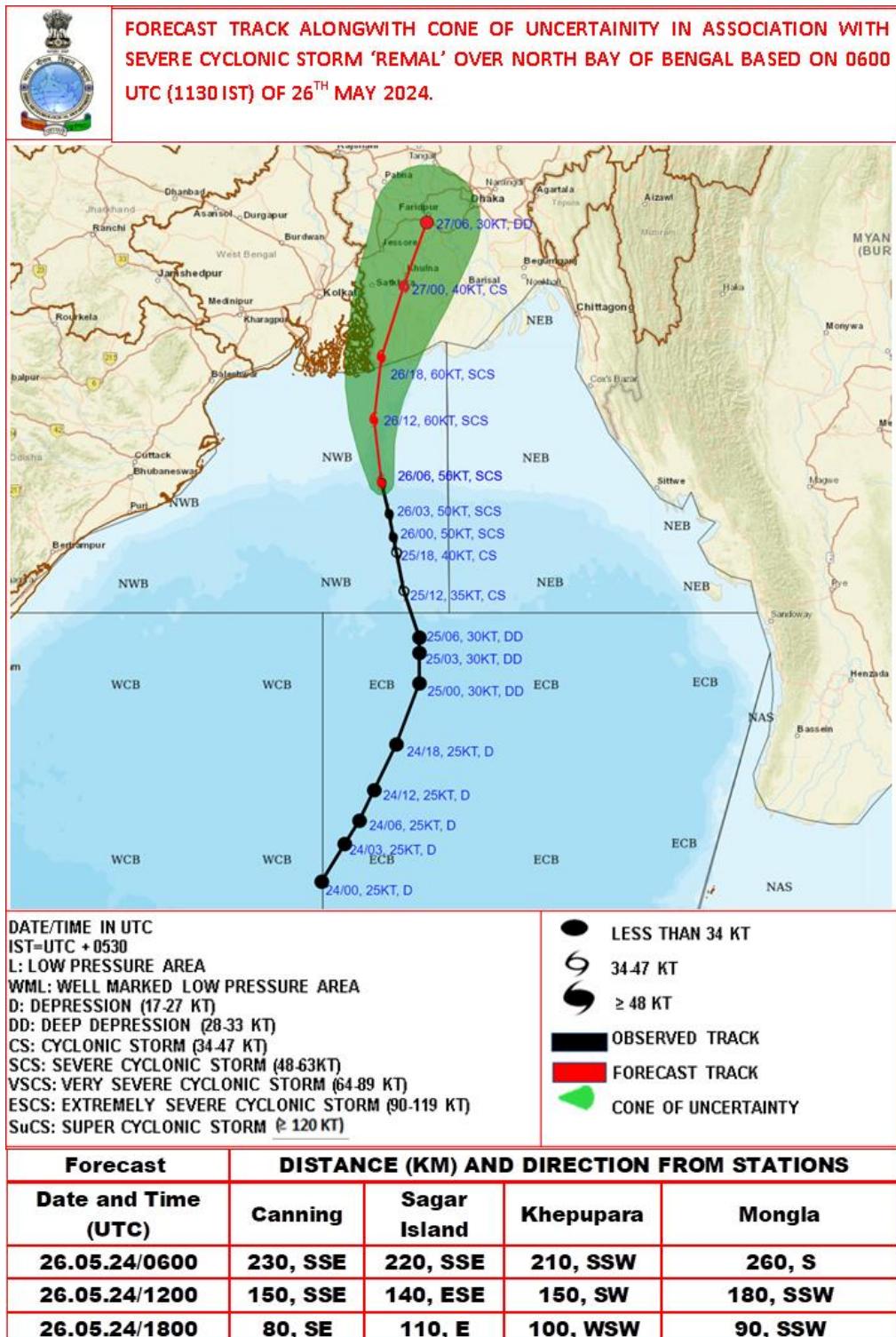


Fig 2.5.2(a): Forecast track along with cone of uncertainty in association with severe cyclonic storm "REMAL" based on 0600 UTC of 26<sup>th</sup> May, 2024

## Quadrant Wind Graphics

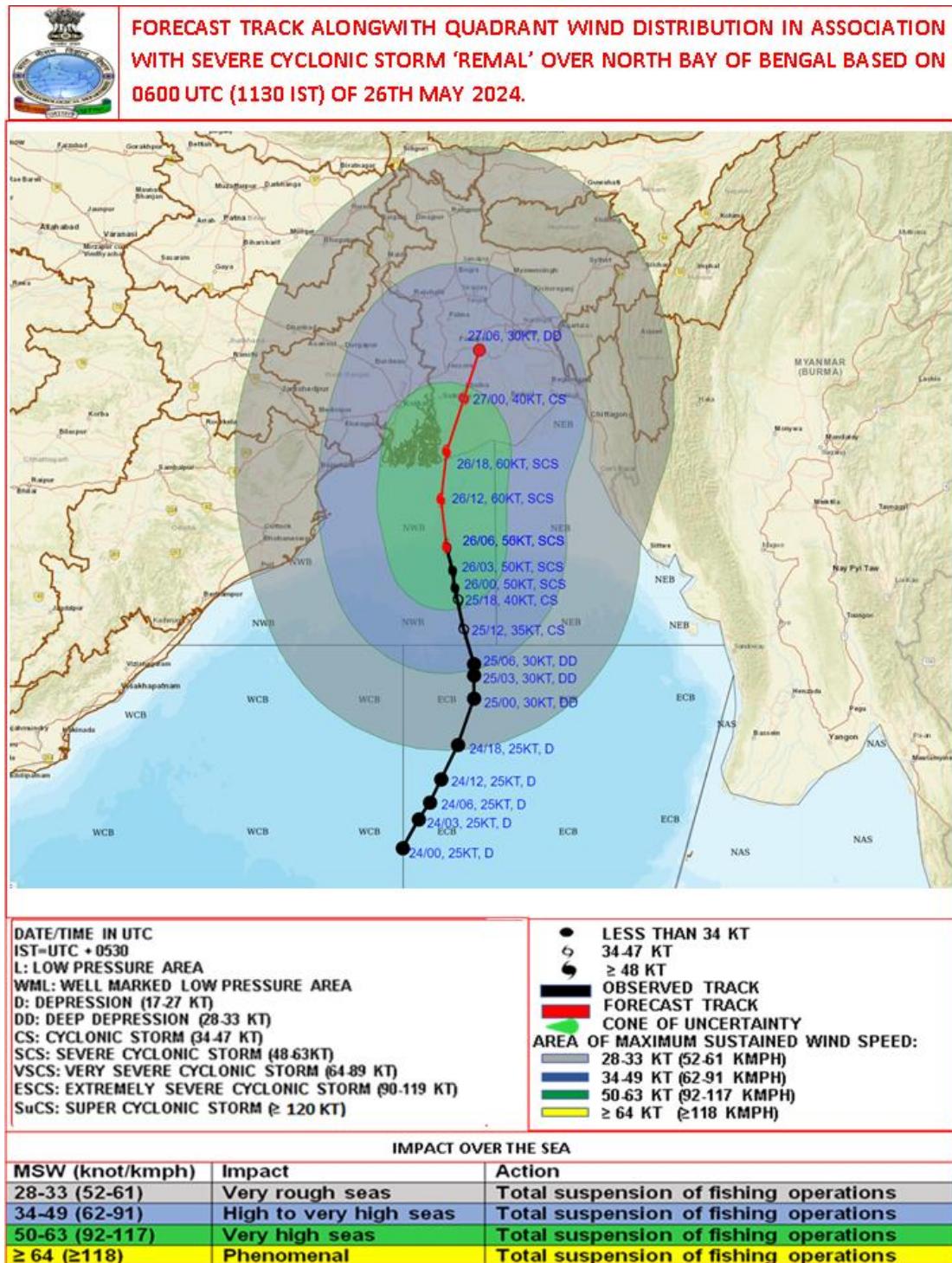


Fig 2.5.2(a): Forecast track along with quadrant wind distribution in association with severe cyclonic storm "REMAL" based on 0600 UTC of 26<sup>th</sup> May, 2024

**TABLE 4: CYCLONIC DISTURBANCE FORECAST FOR IOCL COASTAL LOCATIONS IN BAY OF BENGAL REGION BASED ON 1130 hrs IST of 26th May,2024**

S I	DESCRIPTION OF SITE NAME(LAT°N /LON°E)	LOCATION		CURRENT LOCATION FROM CENTRE OF CYCLONIC DISTURBANCE		FORECAST PARAMETERS WHEN THE SITE WOULD BE NEAREST TO THE CYCLONE PATH								STATE OF SEA
						DATE/TIME(I ST) OF OCCU RREN CE	DIST ANC E OF SITE FRO M PAT H	DIRE CTIO N OF SITE FROM PATH	UNC ERT AINT Y IN DIST ANC E OVE R PAT H(N M)	MSW OVE R SITE (KTS )	UN CE RT AIN TY IN MS W OV ER SIT E(K T)	SIGN IFIC ANT WAV E HEIG HT		
		LA T (°N )	LO N (°E)	DIST ANCE (NM)	DIRECT ION									
<b>Marketing - POL</b>														
1.	Vizag Terminal (17.69,83.26)	20.2	89.2	369	WSW	26.05.24/1130	369	WSW	10	<27	5	<4	Rough	
2.	Kakinada (17.02,82.28)	20.2	89.2	437	WSW	26.05.24/1130	437	WSW	10	<27	5	<4	Rough	
3.	Bhubaneshwar Terminal (20.18,85.73)	20.2	89.2	196	W	26.05.24/1430	194	W	10	<27	5	<4	Rough	
4.	Paradeep Terminal (20.29,86.63)	20.2	89.2	145	W	26.05.24/1430	143	W	10	33	5	4-6	Very Rough	
5.	Balasore (21.5,86.85)	20.2	89.2	153	WNW	26.05.24/1730	129	WNW	20	33	5	4-6	Very Rough	
6.	FST Chennai (13.12,80.3)	20.2	89.2	666	SW	26.05.24/1130	666	SW	10	<27	5	<4	Rough	
7.	Tuticorin (8.76,78.19)	20.2	89.2	939	SW	26.05.24/1130	939	SW	10	<27	5	<4	Rough	
8.	Tondiarpet (13.14,80.28)	20.2	89.2	665	SW	26.05.24/1130	665	SW	10	<27	5	<4	Rough	
9.	Budge Budge Terminal (22.48,88.18)	20.2	89.2	148	NNW	27.05.24/0230	66	NNW	30	49	10	6-10	High	
10.	Haldia-A Terminal (22.04,88.1)	20.2	89.2	126	NNW	26.05.24/2330	63	NNW	30	63	15	10-14	Very High	
11.	Haldia-B Terminal (22.07,88.16)	20.2	89.2	126	NNW	26.05.24/2330	60	NNW	30	63	15	10-14	Very High	
12.	Port Blair Terminal (11.68,92.72)	20.2	89.2	550	SSE	26.05.24/1130	550	SSE	10	<27	5	<4	Rough	

1 3.	Kalyani (22.96,88.46)	20. 2	89.2	171	NNW	27.05.2 4/0530	59	WNW	40	49	10	6-10	High
1 4.	Port Blair (11.69,92.74)	20. 2	89.2	550	SSE	26.05.2 4/1130	550	SSE	10	<27	5	<4	Rough
1 5.	Budge-Budge (22.46,88.17)	20. 2	89.2	147	NNW	27.05.2 4/0230	67	W	30	49	10	6-10	High
1 6.	Paradip (20.29,86.63)	20. 2	89.2	145	W	26.05.2 4/1430	143	W	10	33	5	4-6	Very Rough
1 7.	Ennore (13.26,80.3)	20. 2	89.2	660	SW	26.05.2 4/1130	660	SW	10	<27	5	<4	Rough
1 8.	Mayiladuthurai (11.07,79.58)	20. 2	89.2	781	SW	26.05.2 4/1130	781	SW	10	<27	5	<4	Rough
1 9.	Chengelpet (12.6,79.92)	20. 2	89.2	703	SW	26.05.2 4/1130	703	SW	10	<27	5	<4	Rough
2 0.	Mannargudi (10.62,79.46)	20. 2	89.2	805	SW	26.05.2 4/1130	805	SW	10	<27	5	<4	Rough
2 1.	Illyangudi (9.68,78.57)	20. 2	89.2	882	SW	26.05.2 4/1130	882	SW	10	<27	5	<4	Rough
2 2.	Vijayawada (16.65,80.56)	20. 2	89.2	537	WSW	26.05.2 4/1130	537	WSW	10	<27	5	<4	Rough
2 3.	Vizag (17.66,83.08)	20. 2	89.2	380	WSW	26.05.2 4/1130	380	WSW	10	<27	5	<4	Rough
2 4.	Kharagpur (22.37,87.35)	20. 2	89.2	166	NW	26.05.2 4/2330	108	WNW	30	33	5	4-6	Very Rough
2 5.	Khurda Road LPG Project (20.13,85.58)	20. 2	89.2	204	W	26.05.2 4/1430	203	W	10	<27	5	<4	Rough

**Marketing - AFS**

2 6.	Bhubaneshwar AFS (20.25,85.82)	20. 2	89.2	190	W	26.05.2 4/1430	189	W	10	<27	5	<4	Rough
2 7.	Charbatia AFS (20.33,85.64)	20. 2	89.2	201	W	26.05.2 4/1430	198	W	10	<27	5	<4	Rough
2 8.	Sunabeda AFS (18.43,82.49)	20. 2	89.2	394	WSW	26.05.2 4/1130	394	WSW	10	<27	5	<4	Rough
2 9.	Kolkatta AFS (22.65,88.45)	20. 2	89.2	153	NNW	27.05.2 4/0230	55	WNW	30	63	15	10- 14	Very High
3 0.	Portblair AFS (11.38,92.43)	20. 2	89.2	562	SSE	26.05.2 4/1130	562	SSE	10	<27	5	<4	Rough
3 1.	Carnicobar AFS (9.15,92.82)	20. 2	89.2	696	SSE	26.05.2 4/1130	696	SSE	10	<27	5	<4	Rough
3 2.	Vizag AFS (17.73,83.23)	20. 2	89.2	370	WSW	26.05.2 4/1130	370	WSW	10	<27	5	<4	Rough

3.3.	Chennai AFS (12.99,80.17)	20. 2	89.2	677	SW	26.05.2 4/1130	677	SW	10	<27	5	<4	Rough
3.4.	Puducherry AFS (11.97,79.81)	20. 2	89.2	733	SW	26.05.2 4/1130	733	SW	10	<27	5	<4	Rough
3.5.	Tuticorin AFS (8.73,78.03)	20. 2	89.2	947	SW	26.05.2 4/1130	947	SW	10	<27	5	<4	Rough
3.6.	Campbell Bay AFS (7.05,93.55)	20. 2	89.2	830	SSE	26.05.2 4/1130	830	SSE	10	<27	5	<4	Rough
<b>Marketing - Lubes</b>													
3.7.	Kolkatta LBP (22.54,88.3)	20. 2	89.2	149	NNW	27.05.2 4/0230	61	WNW	30	63	15	10- 14	Very High
3.8.	Budge Budge LBP (22.49,88.18)	20. 2	89.2	149	NNW	27.05.2 4/0230	66	WNW	30	49	10	6-10	High
3.9.	Vijaywada (16.47,80.59)	20. 2	89.2	539	WSW	26.05.2 4/1130	539	WSW	10	<27	5	<4	Rough
4.0.	Chennai LBP (13.14,80.28)	20. 2	89.2	665	SW	26.05.2 4/1130	665	SW	10	<27	5	<4	Rough
<b>Refineries</b>													
4.1.	Paradip Refinery (20.15,86.35)	20. 2	89.2	160	W	26.05.2 4/1430	159	W	10	33	5	4-6	Very Rough
4.2.	Haldia Refinery (22.05,88.11)	20. 2	89.2	126	NNW	26.05.2 4/2330	62	WNW	30	63	15	10- 14	Very High
4.3.	CPCL (13.16,80.28)	20. 2	89.2	665	SW	26.05.2 4/1130	665	SW	10	<27	5	<4	Rough
<b>Pipelines &amp; BD</b>													
4.4.	Product Pipeline (PPL) Paradip (20.15,86.36)	20. 2	89.2	159	W	26.05.2 4/1130	159	W	10	33	5	4-6	Very Rough
4.5.	PHBPL Paradip (20.14,86.36)	20. 2	89.2	160	W	26.05.2 4/1430	159	W	10	33	5	4-6	Very Rough
4.6.	PHBPL Balasore (21.47,86.97)	20. 2	89.2	146	NNW	26.05.2 4/1730	122	WNW	20	33	5	4-6	Very Rough
4.7.	Paradip Haldia Durgapur Pipeline (PHDPL) -Balasore (21.29,86.53)	20. 2	89.2	163	NNW	26.05.2 4/1730	144	W	20	33	5	4-6	Very Rough

4.8.	Paradip Somnathpur Haldia Pipeline (PHDPL) -Balasore (21.29,86.5)	20.2	89.2	165	WNW	26.05.2 4/1730	146	W	20	33	5	4-6	Very Rough
4.9.	Paradip Raipur Ranchi Pipeline (PRRPL) -Jatni (20.1,85.43)	20.2	89.2	212	W	26.05.2 4/1430	211	W	10	<27	5	<4	Rough
5.0.	Paradip Hyderabad Pipeline (PHPL) -Berhampur (19.15,84.43)	20.2	89.2	277	WSW	26.05.2 4/1130	277	WSW	10	<27	5	<4	Rough
5.1.	Paradip Hyderabad Pipeline (PHPL) -Accutapuram (17.3,82.58)	20.2	89.2	414	WSW	26.05.2 4/1130	414	WSW	10	<27	5	<4	Rough
5.2.	Paradip Hyderabad Pipeline (PHPL) -Vijaywada (16.39,80.33)	20.2	89.2	555	WSW	26.05.2 4/1130	555	WSW	10	<27	5	<4	Rough
5.3.	Paradip Hyderabad Pipeline (PHPL) -Rajahmundry (17.12,81.5)	20.2	89.2	475	WSW	26.05.2 4/1130	475	WSW	10	<27	5	<4	Rough
5.4.	Paradip Haldia Barauni Pipeline (PHBPL) -Haldia (22.08,88.12)	20.2	89.2	128	NNW	26.05.2 4/2330	62	WNW	30	63	15	10-14	Very High
5.5.	Haldia Mourigram Rajbandh Barauni Pipeline (HMRBPL) -Haldia (22.04,88.1)	20.2	89.2	126	NNW	26.05.2 4/2330	63	WNW	30	63	15	10-14	Very High

5 6.	Paradip Petrochemical and Marketing Complex (PDPMC) (20.32,86.62)	20. 2	89.2	145	W	26.05.2 4/1430	143	W	10	33	5	4-6	Very Rough
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**Color Code for generating impact-based forecast:**

ZONE	PARAMETERS
GREEN	NORMAL SITUATION, NO FORECAST OF CYCLONE
YELLOW	(1) THE STORM CENTRE WITHIN 800 NM FROM LOCATION AND (2) THE FORECAST TRACK IS FORECAST TO BE WITHIN 300 NM FROM LOCATION AND (3) SUSTAINED WIND SPEED ALONG THE PATH IS FORECAST TO EXCEED 28 KTS
ORANGE	(1) THE STORM CENTRE WITHIN 600 NM FROM LOCATION AND (2) THE FORECAST TRACK IS FORECAST TO BE WITHIN 200 NM FROM LOCATION AND (3) SUSTAINED WIND SPEED ALONG THE PATH IS FORECAST TO EXCEED 50 KTS
RED	(1) THE STORM CENTRE WITHIN 300 NM FROM LOCATION AND (2) THE FORECAST TRACK IS FORECAST TO BE WITHIN 150 NM FROM LOCATION AND (3) SUSTAINED WIND SPEED ALONG THE PATH IS FORECAST TO EXCEED 65 KTS

Notes:

- (1) Under each zone, all three parameters are to be fulfilled to declare the site under that zone
- (2) The distance from Forecast Track in SI No.2 of each zone is the minimum distance of the site from the track/path when it is passing through; i.e., when it is closest to the site

**ANNEX II-A-1****CLASSIFICATION OF TROPICAL CYCLONE WARNING SYSTEMS IN THE PANEL COUNTRIES**

Existing classifications of low pressure systems (cyclonic disturbances) in the Panel countries are given below together with the WMO classifications.

***Classification of low pressure systems (cyclonic disturbances)  
Presently in use by Panel countries for national purposes)***

<b><u>Country</u></b>	<b><u>Type of Disturbance</u></b>	<b><u>Corresponding Wind Speed</u></b>
<b>Bangladesh</b>	Low pressure area	Less than 17 knots (less than 31km/h)
	Well marked low	17- 21 knots (31-40km/h)
	Depression	22- 27 knots (41-51km/h)
	Deep Depression	28- 33 knots (52-61km/h)
	Cyclonic storm	34 -47 knots (62-88 km/h)
	Severe cyclonic storm	48- 63knots (89-117 km/h)
	Very Severe cyclonic storm	64 – 119 knots (118-221km/h)
	Super Cyclonic Storm	120 knots and above (222 km/h or more)
<b>Iran</b>	Low pressure area	Less than 17 knots (less than 31 km/h)
	Well marked low	17- 21 knots (31-40 km/h)
	22- 27 knots (41-51km/h)	Depression
	28- 33 knots (52-61km/h)	Deep Depression
	34 -47 knots (62-88 km/h)	Cyclonic storm
	48- 63knots (89-117 km/h)	Severe cyclonic storm
	64 – 119 knots (118-221km/h)	Very Severe cyclonic storm
	120 knots and above (222 km/h or more)	Super Cyclonic Storm
<b>India</b>	Low pressure area	Less than 17 knots
	Depression	17 -27 knots
	Deep Depression	28- 33 knots
	Cyclonic storm	34 -47 knots
	Severe cyclonic storm	48 -63 knots
	Very severe cyclonic storm	64 -89 knots
	Extremely severe cyclonic storm	90 -119 knots

	Super cyclonic storm	120 knots and above
<b>Maldives</b>	Low pressure area	Less than 17 knots
	Depression	17- 27 knots
	Deep Depression	28 -33 knots
	Cyclonic storm	34 -47 knots
	Severe cyclonic storm	48 -63 knots
	Very severe cyclonic storm	64 -119 knots
	Super cyclonic storm	120 knots and above
<b>Myanmar</b>	Low pressure area	Less than 17 knots
	Depression	17- 27 knots
	Deep Depression	28 -33 knots
	Cyclonic storm	34 -47 knots
	Severe cyclonic storm	48 -63 knots
	Very severe cyclonic storm	64 -119 knots
	Extremely Severe Cyclonic Storm	90 -119 knots
	Super cyclonic storm	120 knots and above
<b>Oman (Sultanate of Oman)</b>		
	Low	Less than 17 knots
	Depression	17-27 knots
	Deep depression	28-33 knots
	Tropical storm	34-63 knots
	Tropical cyclone	64 knots or more
	Tropical cyclone:	
	Category 1	64-82 knots
	Category 2	83-95 knots
	Category 3	96- 112 knots
	Category 4	113-136 knots
	Category 5	More than 136 knots
<b>Pakistan</b>	Depression	22- 27 knots
	Deep Depression	28- 33 knots
	Cyclonic storm	34 -47 knots
	Severe cyclonic storm	48- 63 knots
	Very severe cyclonic storm	64- 119 knots

II-A-3

	Super cyclonic storm	120 knots or more
<b>Qatar</b>	Depression	less than 34 knots
	Tropical storm	34-63 knots
	Tropical cyclone	64 knots or more
	Tropical cyclone:	
	Category 1	64-82 knots
	Category 2	83-95 knots
	Category 3	96- 112 knots
	Category 4	113-136 knots
	Category 5	More than 136 knots
<b>Sri Lanka</b>	Low pressure area	Less than 17 knots (31 km/h)
	Depression	17- 27 knots (31 and 49 km/h)
	Deep Depression	28- 33 knots (50 and 61 km/h)
	Cyclonic storm	34 -47 knots (62 and 88 km/h)
	Severe cyclonic storm	48- 63 knots (89 and 117 km/h)
	Very severe cyclonic storm	64 -119 knots (118 and 166 km/h)
	Extremely severe cyclonic storm	90 -119 knots (167 and 221 km/h)
	Super cyclonic storm	120 knots and above ( $\geq$ 222 km/h)
<b>Thailand</b>	Tropical depression	27 - 33 knots
	Tropical Cyclones	34 knots and more
<b>UAE</b>	Tropical Depression	<63 kmph
	Tropical Storm	63-118 kmph
	Tropical Cyclone CAT (1)	119-153 kmph
	Tropical Cyclone CAT (2)	154-177 kmph

	Tropical Cyclone CAT (3)	178-208 kmph
	Tropical Cyclone CAT (4)	209-251 kmph
	Tropical Cyclone CAT (5)	>251 kmph
<b>Yemen</b>	Low pressure area	Less than 17 knots
	Depression	17 -27 knots
	Deep Depression	28- 33 knots
	Cyclonic storm	34 -47 knots
	Severe cyclonic storm	48 -63 knots
	Very severe cyclonic storm	64 -89 knots
	Extremely severe cyclonic storm	90 -119 knots
	Super cyclonic storm	120 knots and above
<b>Iran</b>	Low pressure area	Less than 17 knots (less than 31 km/h)
	Well marked low	17- 21 knots (31-40 km/h)
	Depression	22- 27 knots (41-51 km/h)
	Deep Depression	28- 33 knots (52-61 km/h)
	Cyclonic storm	34 -47 knots (62-88 km/h)
	Severe cyclonic storm	48- 63 knots (89-117 km/h)
	Very Severe cyclonic storm	64 – 119 knots (118-221 km/h)
	Super Cyclonic Storm	120 knots and above (222 km/h or more)
<b>WMO Classification</b>	Tropical depression	Up to 34 knots
(Vide WMONo.471)	Moderate tropical storm	34- 47 knots
	Severe tropical storm	48 -63 knots
	Hurricane (or local synonym) Winds	64 knots and more
	Tropical disturbance of Unknown intensity	Wind speed uncertain

## **Tropical Cyclone Warning System in Bangladesh**

### ***Organization***

The Bangladesh Meteorological Department is responsible for providing tropical cyclone warnings to Bangladesh and its coastal areas and for a designated portion of the high Seas in the Bay of Bengal. Warnings and forecasts are issued under the authority of the Director, Bangladesh Meteorological Department.

The tropical storm warnings are provided from the Storm Warning Centre, E-24, Agargaon, Dhaka. This Centre is also responsible for issuing the weather warnings like "Nor'westers" (severe local storms) warning, etc.

### ***Tracking***

The tropical cyclones are tracked with the help of conventional observations, radar, satellite observations and model derived products.

### ***Tropical cyclone warnings***

Tropical cyclone warnings are provided to:

- (i) The Honorable President
- (ii) The Honorable Prime Minister
- (iii) Control room, Ministry of Disaster Management and Relief (MoDMR)
- (iv) All Ministries
- (v) The Sea Port Authorities at Chittagong, Mongla, Payra and Cox's Bazar
- (vi) The Cyclone Preparedness Programme (CPP), Bangladesh Red Crescent Society
- (vii) The Armed Forces division, Bangladesh Navy, Bangladesh Air Force
- (viii) Inland River Port Authorities
- (ix) Airport Authorities
- (x) Concerned Government Officials
- (xi) The general public (through Betar (Radio) Television, print and electronic media & mass media)
- (xii) Fishing boats and trawlers in the sea
- (xiii) Coast Guard
- (xiv) The NGOs

### ***Stages of warnings***

Warnings are issued in four stages for the Government Officials. The first stage called "Alert" is issued to all concerned whenever a disturbance is detected in the Bay as per Standing Orders for Disasters (SOD) of Bangladesh. In the second stage, cyclone warnings are issued in four stages as detailed below:

- (i)
  - (a) Distant Cautionary Signal- issued if a ship might run into danger during its voyage after leaving the harbour.
  - (b) Distant Warning Signal issued when there is no immediate danger of the port but a ship might run into the storm after leaving the port.
- (ii)
  - (a) Local Cautionary Signal – issued when port is threatened by squally weather from tropical disturbances like cyclone, monsoon low, monsoon depression, synoptic forcing or nor'westers.
- (b)
  - Local Warning Signal issued when the port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution. It is issued minimum 24 hours before the landfall.
- (iii)
  - Danger Signal issued when the port is likely to experience severe weather from a storm of slight or moderate intensity. The Signal is issued minimum 18 hours before the landfall.
  - Great Danger Signal issued when the port is likely to experience severe weather from a storm of great intensity. The signal is issued minimum 10 hours before the landfall.

### ***Format of the cyclone warning bulletin***

Cyclone warning bulletins contain the following information:

- (i) Name of the storm
- (ii) Position of the storm centre
- (iii) Direction and speed of movement in knots for international use and km/h for national use.
- (iv) Distance of the storm centre from the ports.
- (v) Maximum sustained wind within the radius of maximum wind of the disturbance.
- (vi) Signals for the maritime ports.
- (vii) Areas likely to be affected specifying Administrative Districts or sub-districts (Upazila) as far as possible.
- (viii) Approximate time of commencement of gale winds (speed more than 51 km/h).
- (ix) Storm surge height in feet and areas likely to be inundated.
- (x) Advisory for fishing boats and trawlers over North Bay and Deep Sea.

### ***Tropical cyclone warnings for the high seas***

Tropical cyclone warnings for the high seas in Bangladesh are provided from the Storm Warning Centre at Dhaka and are broadcast from the coastal radio station at Chittagong (ASC). Warnings are issued for the Bay of Bengal region north of 18° N latitude.

India is an Issuing Service for METAREA VII(N) of the WWMIWS, and is responsible for broadcasting the products on SafetyNET to mariners at sea.

### ***Warnings to ports***

In accordance with international procedure, ports are warned and advised to hoist "Signals" whenever adverse weather is expected over the ports for the oceanic areas, in which it is located due to the tropical cyclone. However, regional difference exists. The warning messages normally contain information on the location, intensity, direction and speed of movement of the tropical cyclone and the expected weather over the port. The tropical cyclone signals used in Bangladesh ports along with their meaning are given in Attachment to Annex II-B.

### ***Dissemination***

Warnings are disseminated through high priority landline telephone, fax, e-mail & website. In addition, warnings are also transmitted to Betar (Radio) Bangladesh, Dhaka, Chittagong, Khulna, Rangpur, Rajshahi and Sylhet for broadcast. Alert messages are broadcast four to five times or as frequent as required a day. "Warnings" are broadcast every hour and "Danger" and "Great Danger" messages are broadcast more frequently.

### ***Dissemination of tropical cyclone warnings***

- (i) Fax
- (ii) Telephones
- (iii) Automatic Message Switching System (AMSS)
- (iv) Bangladesh Betar ( Radio)
- (v) Television
- (vi) Through print & electronic media
- (vii) Wireless Transmission (W/T)
- (viii) Internet, by keeping information on BMD website (<http://www.bmd.gov.bd>).
- (IX) Mobile App (BMD Weather App)
- (X) IVR (Interactive Voice Response)
- (XI) E-mail
- (XII) Social Media (Facebook)
- (XIII) SMS

## Cyclone warning system in India

The India Meteorological Department is responsible for providing tropical cyclone warnings in India. The tropical cyclone warning service is one of the most important functions of the India Meteorological Department and it was the first service undertaken by the Department in 1865 with the issue of Port Warnings for Calcutta. Thus, cyclone warning service is more than 150 years old.

### **Organization**

Tropical cyclone warnings in India are provided through three Area Cyclone Warning Centres (ACWCs) located at Kolkata, Chennai and Mumbai and four Cyclone Warning Centres at Bhubaneswar, Visakhapatnam, Ahmedabad and Thiruvananthapuram. The entire cyclone warning work is coordinated by the Cyclone Warning Division at Headquarter.

### **Tracking of tropical cyclones**

Tracking of the tropical cyclones in India is done with the help of:

- (i) Conventional surface and upper air observations from inland and island stations, coastal Automatic Weather Station (AWS), ships and buoy observations;
- (ii) Cyclone detection radar including Doppler Weather Radar;
- (iii) Satellite cloud pictures from the Geostationary Satellite (INSAT 3D, INSAT 3DR) and polar orbiting satellites.

More details on the observing system are provided in a separate chapter.

### **Tropical Cyclone Forecasting**

Details about tropical forecasting procedures are discussed in Chapter-IV.

### **Tropical cyclone warnings**

The bulletins and warnings issued in connection with tropical cyclones in India may be divided into the following broad categories:

- (i) Warning bulletins for shipping on the high Seas.
- (ii) Warning bulletins for ships plying in the coastal waters.
- (iii) Port warnings.
- (iv) Fisheries warnings. (Fishermen & Fisheries Officials)
- (v) Four stage warnings for the State and Central Government officials.
- (vi) Warnings for recipients who are registered with the department (Designated/registered users).
- (vii) Warning for aviation.
- (viii) Warnings for the general public through All India Radio, TV (including Doordarshan), Press and other electronic media.
- (ix) Warning for Indian Navy.

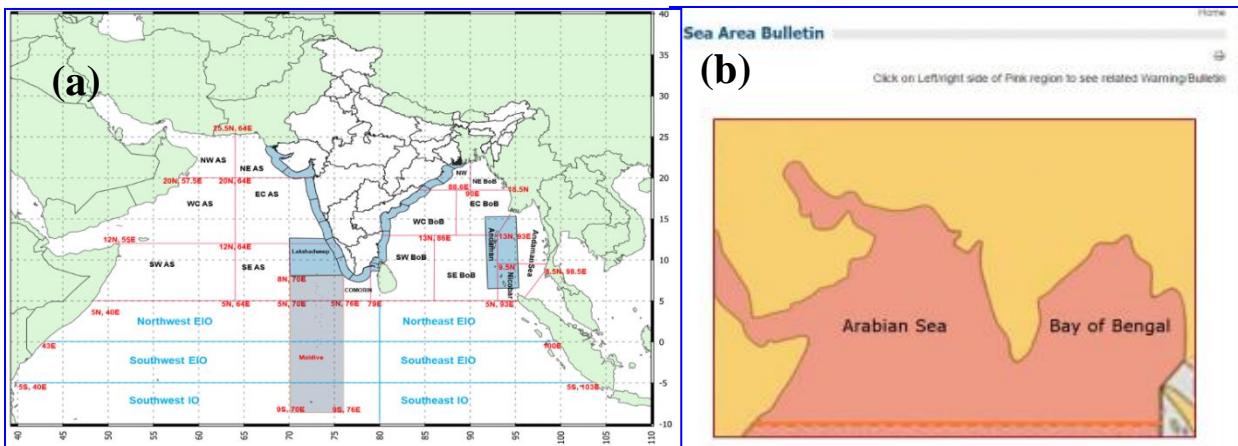
Format and examples of all these bulletins are shown as Attachment to Annex II-C-2

### **Bulletins for the high Seas**

These bulletins are for the shipping interests on the high Seas. The area covered by these bulletins is the Sea area between the Asian Coast and the line joining the points 24°N 68°E, 20°N 68°E, 20°N 60°E, 5°N 60°E, 5°N 95°E, 10°N 95°E, 10°N 94°E, 13°30'N 94°E, 13°30'N 92°E, 18°N 92°E and 18°N 94°30'E. The exact area of coverage is shown below (Fig.- II-C-1).

India is an Issuing Service for METAREA VII (N) of the WWRM, and is responsible for broadcasting the products on SafetyNET to mariners at Sea. These bulletins are issued by the Area Cyclone Warning Centres at Kolkata and are broadcast by the Coastal Radio Stations of the Department of Telecommunication (DoT) and "NAVTEX Chennai". These bulletins are issued by the Area Cyclone Warning Centres; Mumbai is available to the users through e-mail/fax and uploaded in the website of RMC Mumbai. The bulletins for the Arabian Sea are broadcast from Mumbai Radio. For the Bay of Bengal the

bulletins are broadcast from Kolkata and Chennai Radio and issued by the Area Cyclone Warning Centre at Kolkata.



**Fig II-C-1. (a): The exact area of responsibility of RSMC New Delhi and (b) areal coverage as indicated on RSMC website for sea area bulletin**

In normal undisturbed weather, two bulletins are broadcast at fixed hours known as "Daily" bulletins. In the event of disturbed weather (depression in the Bay of Bengal and the Arabian Sea), a third bulletin known as "Extra" bulletin is broadcast. When a cyclonic storm has developed, three additional bulletins known as 'Storm' bulletins are broadcast. In addition to these six bulletins, if any unexpected development of weather warrants urgent communication to ships, a "Special" bulletin is issued which may be broadcast at any time. These bulletins are broadcast according to a schedule at fixed hours. Sample bulletin is presented in Fig. II-C-2.



Government of India  
India Meteorological Department  
Regional Meteorological Centre, Alipore, Kolkata - 700027

AURORA OBSERVATION: Dated - Thursday 24/10/2024

From: Area Cyclone Warning Center Kolkata (Alipore Weather office) To: Port Blair Radio, Kolkata Port

Part One

TTT SEVERE CYCLONE WARNING OVER BAY OF BENGAL 240300UTC

Wireless, Directorate General of Shipping, Directorate General of Lighthouses And Lightships

## Part Two

Yesterday's cyclonic storm intensified into a severe cyclonic storm "DANA" (pronounced as Dana) over northwest & adjoining central Bay of Bengal moved north northwestwards with a speed of 12 kmph during past 6 hours and lay centered at 0830 hrs IST of today, the 24th October, over northwest Bay of Bengal, near latitude 18.9° N and longitude 88.0°E, about 210 km southeast of Paradip (Odisha), 240 km south-southeast of Dhamara (Odisha) and 310 km south of Sagar Island (West Bengal). It is very likely to move north-northwestwards and cross north Odisha and West Bengal coasts between Puri and Sagar Island close to Bhitarkanika and Dhamara (Odisha) during mid-night of 24th to morning of 25th October, 2024 as a severe Cyclonic Storm with a wind speed of 100-110 kmph gusting 120 kmph.

## Part Three : Sea area forecast valid from 9 UTC to 21 UTC of 24/10/2024

<b>North West Bay</b>	Wind	CYCLONIC 55 TO 60 KNOTS GUSTING TO 65 KNOTS AROUND 100 NM OF CYCLONIC STORM CENTRE ELSEWHERE 40 TO 45 KNOTS GUSTING TO 50 KNOTS
	Weather	WIDESPREAD RAIN OR THUNDERSHOWERS WITH SCATTERED HEAVY TO VERY HEAVY RAIN, ISOLATED EXTREMELY HEAVY RAIN
	Visibility	POOR BECOMING VERY POOR IN VERY HEAVY RAIN TO EXTREMELY VERY HEAVY RAIN
	Sea condition	HIGH TO VERY HIGH
<b>North East Bay</b>	Wind	MAINLY SOUTHEASTERLY 30 TO 35 KNOTS GUSTING TO 40 KNOTS
	Weather	WIDESPREAD RAIN OR THUNDERSHOWERS
	Visibility	MODERATE BECOMING POOR IN HEAVY RAIN
	Sea condition	VERY ROUGH TO HIGH
<b>West Central Bay</b>	Wind	SOUTHWEST TO WESTERLY 40 TO 45 KNOTS GUSTING 50 KNOTS
	Weather	SCATTERED RAIN OR THUNDERSHOWERS
	Visibility	MODERATE BECOMING POOR IN HEAVY RAIN
	Sea condition	HIGH TO VERY HIGH
<b>East Central Bay(WEST OF LONG. 92° EAST)</b>	Wind	SOUTHEAST TO SOUTHERLY 25 TO 35 KNOTS GUSTING 40 KNOTS
	Weather	FAIRLY WIDESPREAD RAIN OR THUNDERSHOWERS
	Visibility	MODERATE BECOMING POOR IN HEAVY RAIN
	Sea condition	ROUGH TO VERY ROUGH AAA
<b>South Bay</b>	Wind	:MAINLY SOUTHWESTERLY 15 TO 20 KNOTS

	Weather	SCATTERED RAIN OR THUNDERSHOWERS
	Visibility	GOOD BECOMING MODERATE IN RAIN
	Sea condition	SLIGHT TO MODERATE
<b>Andaman Sea(WES T OF LONG. 95° EAST)</b>	Wind	SOUTH TO SOUTHWESTERLY 15 TO 20 KNOTS
	Weather	FAIRLY WIDESPREAD RAIN OR THUNDERSHOWERS
	Visibility	GOOD BECOMING MODERATE IN RAIN
	Sea condition	SLIGHT TO MODERATE

#### Part Four

NIL

#### Part Five

NIL

#### Part Six

AAXX 02403 99942 807 21495 80703 10256 40085 811 21496 80703 10250 40077 901  
 21496  
 80208 10250 40049 806 21496 80205 10248 40072 903 22596 80408 10252 40054 895 21495  
  
 99943 049 21495 82906 10256 40054 053 21495 83406 10248 40027 105 31996 63202 10260  
 40061 150 31596 72904 10284 40076 185 31596 73203 10266 40088 245 32597 42705 10286  
 40101 346 32597 62504 10296 40112 279 32597 73202 10274 40108

**TOO:** 12.30 IST 24/10/2024

RSMC New Delhi has commenced preparation of these bulletins in graphical format using QGIS tool and are also available over GIS platform since January, 2021 based on multi model ensemble guidance. Sample graphical products on QGIS are placed at Fig. II-C-3.

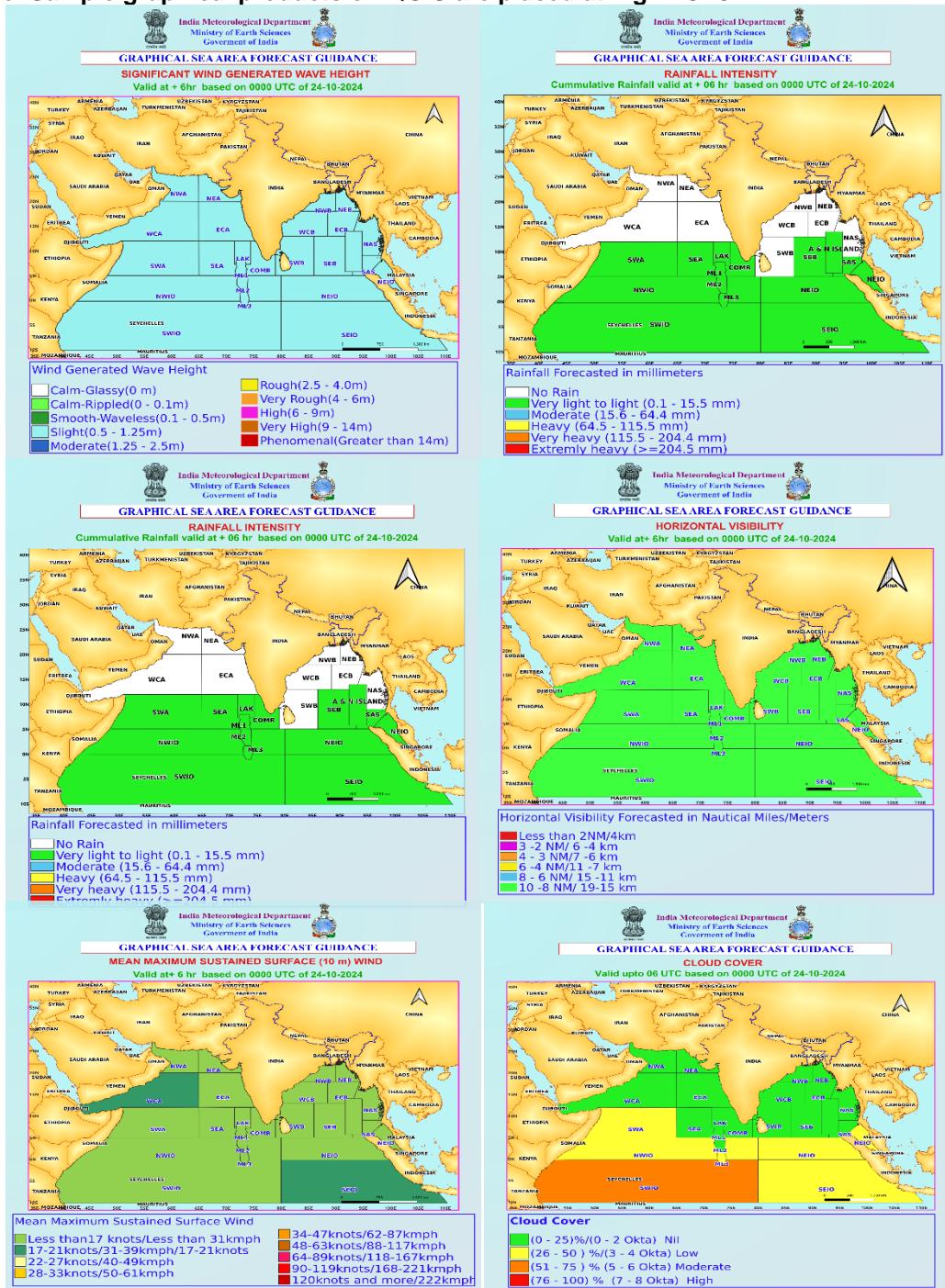


Fig. II-C-3: Sample Sea Area bulletin on QGIS based on multi model ensemble guidance

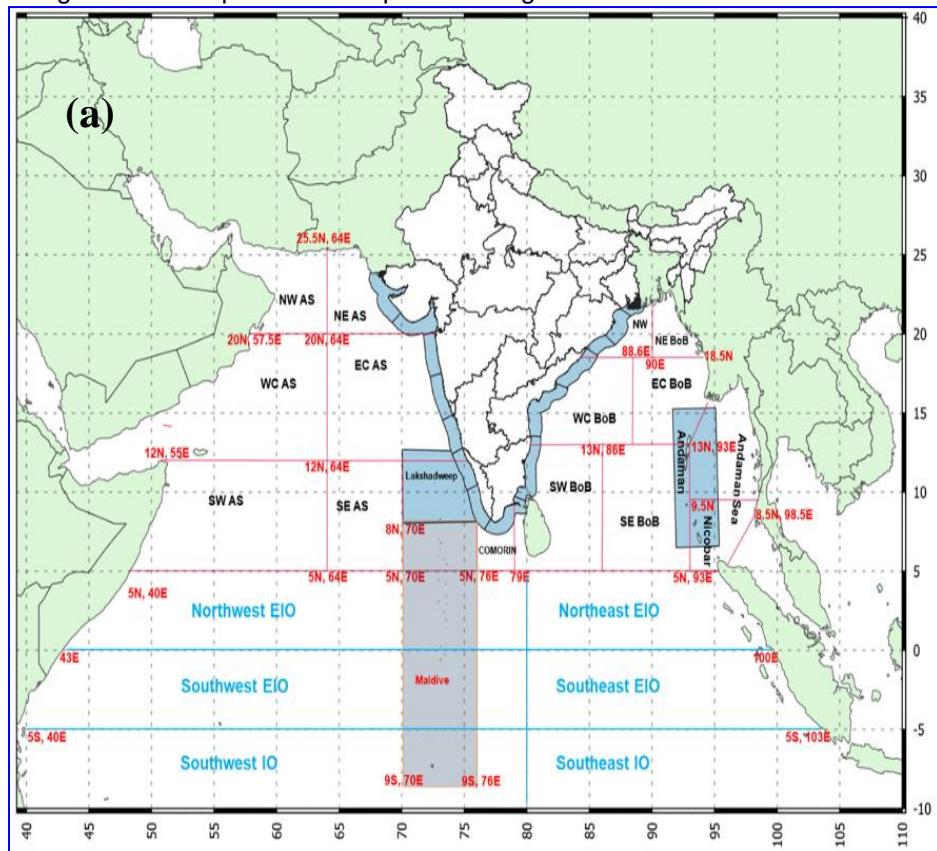
**ANNEX II-C-2****Coastal Weather Bulletins**

These bulletins give weather information in greater detail in the coastal areas for the benefit of ships plying mainly in coastal areas. For the purpose of these bulletins, the coastal area is defined as the sea area up to 75 km off the coastline.

As in the case of sea bulletins for merchant ships, the coastal bulletins are broadcast from Navtex, Chennai. In normal weather, coastal bulletins are broadcast twice daily (Daily One at 0630 UTC and Daily Two at 1830 UTC respectively). These are known as "Daily" bulletins. Whenever a depression, tropical cyclone or some other phenomenon influences the weather of the coastal strip concerned "Extra", "Storm" and "Special" bulletins for the coastal strip are also broadcast in addition to "Daily" bulletins.

Each bulletin first gives the name of the coastal strip to which it pertains followed by the details of the weather system, if any, affecting the coastal area. It also includes a forecast of wind, weather, visibility and state of sea for the coastal strip. Information on storm surges/tidal waves and areas likely to be affected are given whenever necessary. The bulletins also give information regarding storm warning signals, if any, hoisted at the ports in the coastal strip concerned.

The coastal bulletins pertaining to India coast are sent to control room of Director General of Lighthouse and Light ships (DGLL) at Mumbai through e-mail and Automated message switching System (AMSS) at IMD, Mumbai for broadcast through 11 Navtex stations along the coast. These bulletins are also uploaded on RSMC Website ([www.rsmcnewdelhi.imd.gov.in](http://www.rsmcnewdelhi.imd.gov.in)). Areal coverage for coastal weather bulletin is shown in Fig. II C-4. Sample bulletin is placed at Fig. II-C-5.



**Fig. II-C-4: Sample areal coverage for coastal Weather bulletin along the coast of India**

<p>Government of India Ministry of Earth Sciences India Meteorological Department Meteorological Centre Bhubaneswar, Odisha-751020</p>		<p>भारतसरकार पृथ्वीविज्ञानमंत्रालय भारतमौसमविज्ञानविभाग मौसमविज्ञानकेंद्र भुवनेश्वर, ओडिशा -751020</p>
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### COASTAL AREA BULLETIN

DATE- 24.10.2024  
TIME OF ISSUE- 1000 IST

B1:S

B2:B

PRIORITY OF MESSAGE:- VITAL

STORM ONE COASTAL BULLETIN VALIDITY:- 0500 UTC OF 24-05-2024 TO 1700 UTC OF 24-05-2024

**SYNOPTIC SYSTEM**:- The severe cyclonic storm "DANA" (pronounced as Dana) over central & adjoining northwest Bay of Bengal moved north-northwestwards with a speed of 12 kmph during past 6 hours, and lay centred at 0530 hrs IST of today, the 24<sup>th</sup> October, over northwest & adjoining central Bay of Bengal, near latitude 18.5° N and longitude 88.2°E, about 260 km southeast of Paradip (Odisha), 290 km south-southeast of Dhamara (Odisha) and 350 km south of Sagar Island (West Bengal). It is very likely to move northwestwards and cross north Odisha and West Bengal coasts between Puri and Sagar Island close to Bhitarkanika and Dhamara (Odisha) during mid-night of 24th to morning of 25th October, 2024 as a severe Cyclonic Storm with a wind speed of 100-110 kmph gusting 120 kmph.

**NORTH ODISHA COAST:-**

WIND:- MAINLY NE-LY 35-40 KT GUSTING TO 45 KT

WEATHER:- RA/TSH AT MOST PLACES WITH HEAVY TO VERY HEAVY FALLS AT ONE OR TWO PLACES

VISIBILITY:- POOR BECOMING VERY POOR IN HEAVY FALLS

SEA CONDITION:- HIGH TO VERY HIGH

**PORT WARNING:-** Keep hoisted GREAT DANGER SIGNAL NO-10 (GD-10) at Puri, Dhamara/ Chandbali, Paradip ports and GREAT DANGER SIGNAL-08(GD-08) at Gopalpur port of Odisha.

**STORM SURGE/TIDAL WARNING:-** Storm surge of 1.0 to 2.0 m height above astronomical tide is very likely to inundate low lying areas of Kendrapara, Bhadrak & Balasore districts of Odisha during the time of landfall.

Storm surge of 0.5 to 1.0 m height above astronomical tide is very likely to inundate low lying areas of Jagatsinghpur district of Odisha during the time of landfall.

**SOUTH ODISHA COAST:-**

**WIND-: MAINLY NW-LY 35-40 KT GUSTING TO 45 KT**

**WEATHER-: RA/TSH AT MOST PLACES WITH HEAVY TO VERY HEAVY FALLS AT ONE OR TWO PLACES**

**VISIBILITY-: POOR BECOMING VERY POOR IN HEAVY FALLS**

**SEA CONDITION-: HIGH TO VERY HIGH**

**PORT WARNING-: Keep hoisted GREAT DANGER SIGNAL NO-10 (GD-10) at Puri, Dhamara/ Chandbali , Paradip ports and GREAT DANGER SIGNAL-08(GD-08) at Gopalpur port of Odisha.**

**STORM SURGE/TIDAL WARNING:- NIL**

**DUTY OFFICER  
FOR HEAD&SC-F  
MC BHUBANESWAR**

RSMC New Delhi has commenced preparation of these bulletins in graphical format using QGIS tool and are also available over GIS platform since January, 2021 based on multi model ensemble Sample graphical products on QGIS dated 12<sup>th</sup> November 2024 (as a represented example) are placed at Fig. II-C-6.

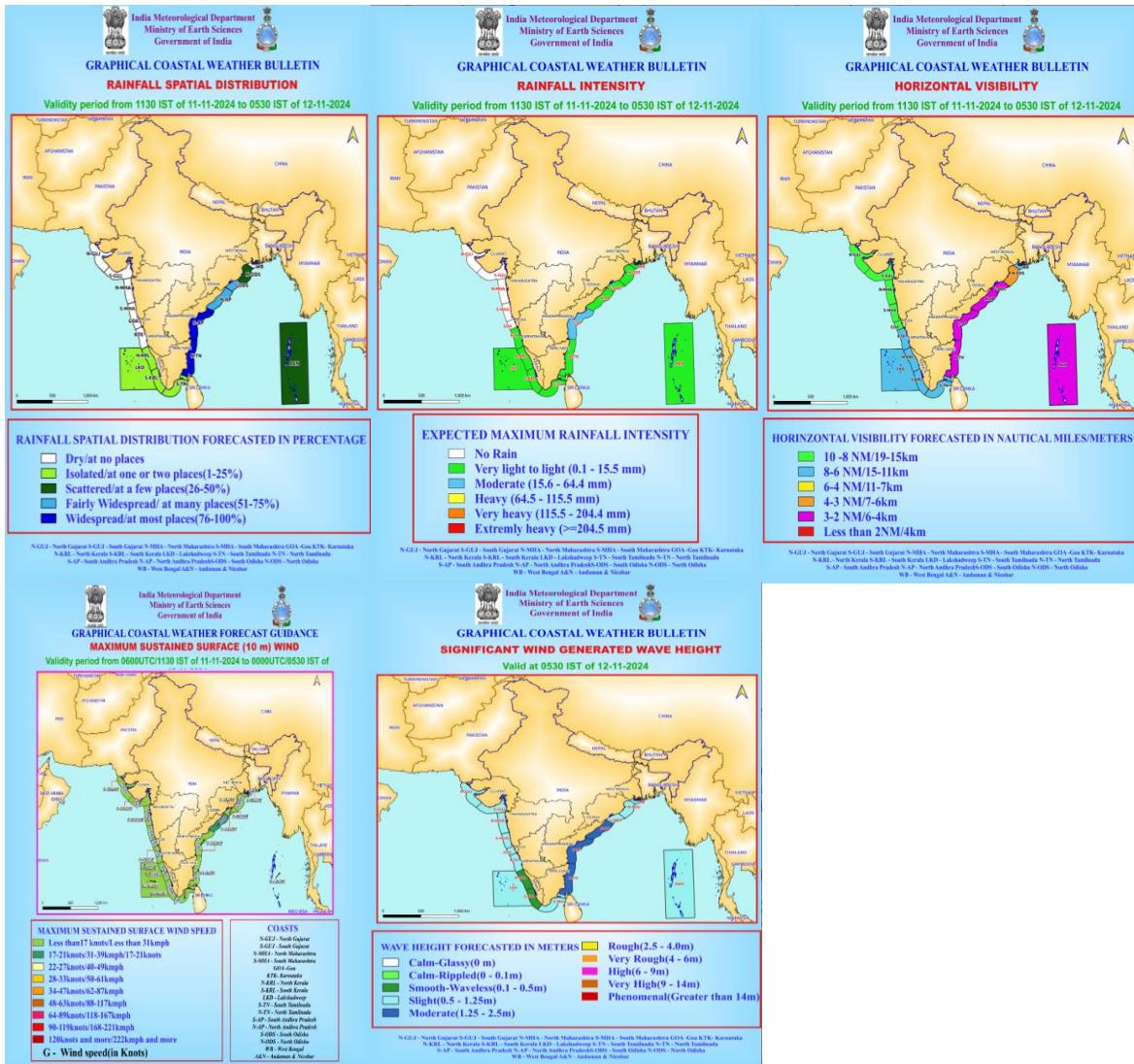


Fig. II-C-6: Sample Coastal area bulletin on QGIS based on multi model ensemble guidance

**ANNEX II-C-3*****Storm warnings to ports***

A visual storm warning signal system for the Bay of Bengal ports, chiefly for the port of Kolkata, has been in existence since 1865. A similar system for the ports on the west coast was started in 1880. A uniform system applicable to all Indian ports was introduced in 1898.

The India Meteorological Department issues storm warnings to port officers whose ports are likely to be affected by adverse weather. They are also advised to hoist visual storm warning signals for the benefit of ships at the port and those out at Sea. The information is, in most cases, conveyed by very high priority telegrams/fax/e-mail.

The storm warning signals, which are displayed prominently on masts in ports, are in the form of cones and cylinders for day signals and red and white lamps for night signals. In addition to hoisting signals, port officers have, in most cases, arrangements for disseminating the information and warnings received by them to country crafts and sailing vessels in the harbor. These bulletins are also uploaded on RSMC Website ([www.rsmcnewdelhi.imd.gov.in](http://www.rsmcnewdelhi.imd.gov.in)). A sample is shown in Fig. II-C-7.

The meaning of the signals used in Indian ports is given in attachment to ANNEX II-C3

(a)

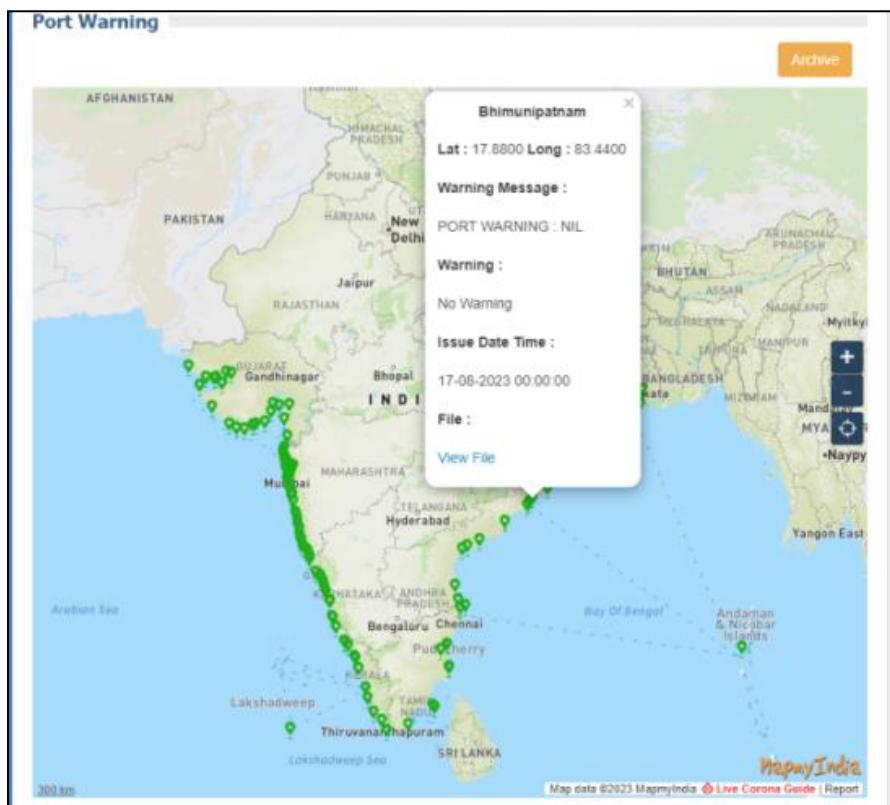


Fig. II-C-7(a): Sample Port Warning bulletin available at RSMC New Delhi website

**Sample Port Warning bulletin issued by CWC Bhubaneswar based on 0900 UTC of 24<sup>th</sup> October 2024 in association with SCS DANA.**



**INDIA METEOROLOGICAL DEPARTMENT  
CYCLONE WARNING CENTRE BHUBANESWAR**

**Port Warning for all ports in Odisha**

**Date: 24.10.2024**

**Time: 1430 Hours IST.**

**Sub: Severe Cyclonic storm “DANA” over northwest Bay of Bengal (Cyclone Warning for Odisha and West Bengal coasts: Red Message)**

**Synoptic Situation:-** The severe cyclonic storm “DANA” (pronounced as Dana) over northwest & adjoining central Bay of Bengal moved north-northwestwards with a speed of 12 kmph during past 6 hours and lay centred at 0830 hrs IST of today, the 24<sup>th</sup> October, over northwest Bay of Bengal, near latitude 18.9° N and longitude 88.0°E, about 210 km southeast of Paradip (Odisha), 240 km south-southeast of Dhamara (Odisha) and 310 km south of Sagar Island (West Bengal).

It is very likely to move north-northwestwards and cross north Odisha and West Bengal coasts between Puri and Sagar Island close to Bhitarkanika and Dhamara (Odisha) during mid-night of 24th to morning of 25th October, 2024 as a severe Cyclonic Storm with a wind speed of 100-110 kmph gusting 120 kmph.

**Wind Warning for sea area & Sea conditions:**

Sea Area	Wind Warning	Sea Conditions
<b>Central Bay of Bengal</b>	Gale wind speed reaching 95-105 kmph gusting to 115 kmph is prevailing and likely to continue till 24 <sup>th</sup> Oct afternoon. It is likely to decrease gradually thereafter.	Sea condition is likely to be <b>very high to high</b> till 24 <sup>th</sup> October evening. It is likely to improve gradually thereafter.
<b>Northwest Bay of Bengal</b>	Gale wind speed reaching 95-105 kmph gusting to 115 kmph is prevailing. It is likely to increase gradually becoming 105-115 kmph gusting to 125 kmph from 24 <sup>th</sup> Oct evening.	Sea condition is likely to be <b>Very High</b> till 25 <sup>th</sup> morning and improve gradually thereafter.
<b>Northeast Bay of Bengal</b>	Squally wind speed reaching 50-60 kmph gusting to 70 kmph is likely to prevail till 25 <sup>th</sup> morning and decrease gradually thereafter.	Sea condition is likely to be Rough to Very Rough till 25 <sup>th</sup> morning and improve gradually thereafter.
<b>Along &amp; off Odisha coasts</b>	Gale wind speed reaching 60-70 kmph gusting to 80 kmph is prevailing. It would gradually increase becoming 100-110 kmph gusting to 120 kmph along & off north Odisha from 24 <sup>th</sup> afternoon till morning of 25 <sup>th</sup> October and decrease gradually thereafter.  Gale wind speed reaching 60-80 kmph gusting to 90 kmph is likely along & off south Odisha from 24 <sup>th</sup> evening till 25 <sup>th</sup> Oct morning and decrease gradually thereafter.	High to Very High till 25 <sup>th</sup> Oct forenoon and improve gradually thereafter.

**Port Warning:**

Keep hoisted GREAT DANGER SIGNAL NO-10 (GD-10) at Puri, Dhamara/ Chandbali, Paradip ports and Local Cautionary Signal No-III (LC-III) at Gopalpur port of Odisha.

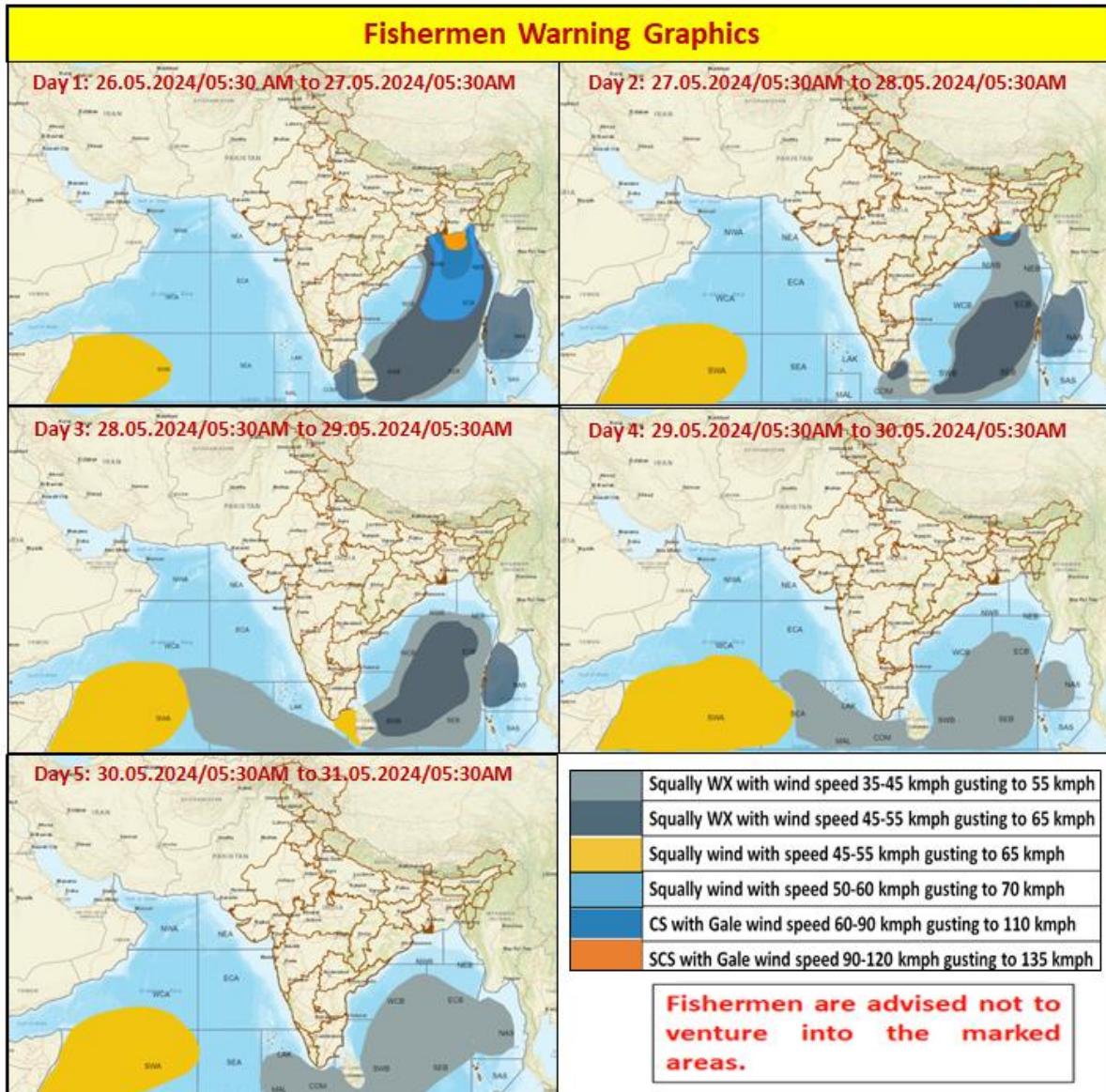
**ANNEX II-C-4**

**Fisherman Warnings**

Warnings for fisherman and fishery officials are issued by Area Cyclone Warning Centres as per their area of responsibility and uploaded on RSMC website. Fishermen warnings in graphical form for next 5 days commenced w.e.f. April, 2018 and are available at RSMC website. RSMC New Delhi has commenced development of fishermen graphics on GIS platform based on multi model ensemble (MME) guidance along with probability of exceedance of maximum sustained winds speed (MSW) of 25 knots & more since 28<sup>th</sup> July, 2022. Sample areal coverage is presented in Fig. II-C-8. Fishermen warning graphics bulletin issued during cyclone REMAL is presented in Fig. II-C-9. Sample graphics showing fishermen warning area based on MME and graphics showing probability of exceedance of  $MSW \geq 25$  knots is presented in Fig. II-C-10 and II-C-11.



**Fig.II-C-8: Areal coverage for fisherman warning**



**Fig.II-C-9: Sample graphics showing fishermen warning area based on MME issued on 26<sup>th</sup> May,2024**

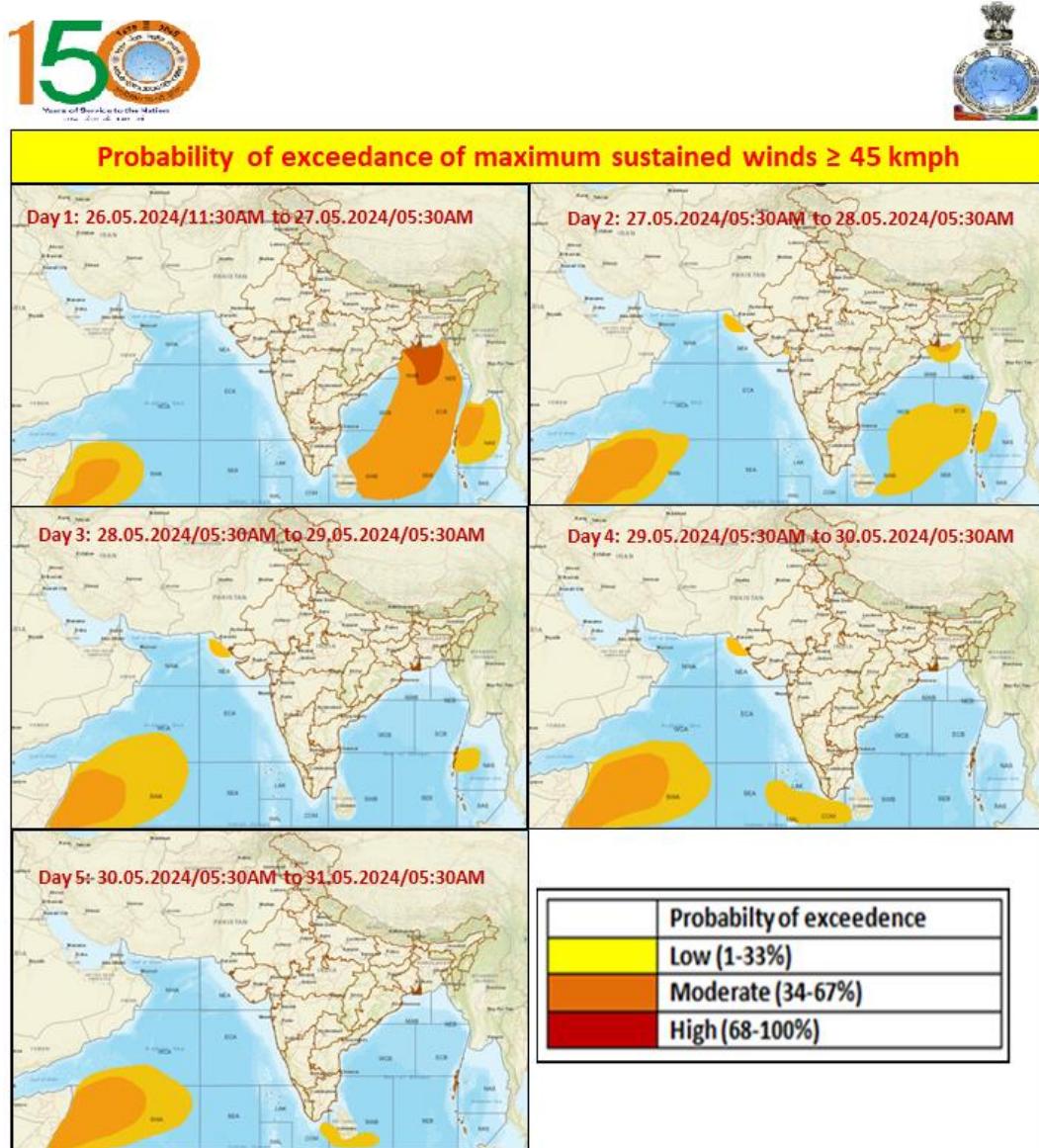
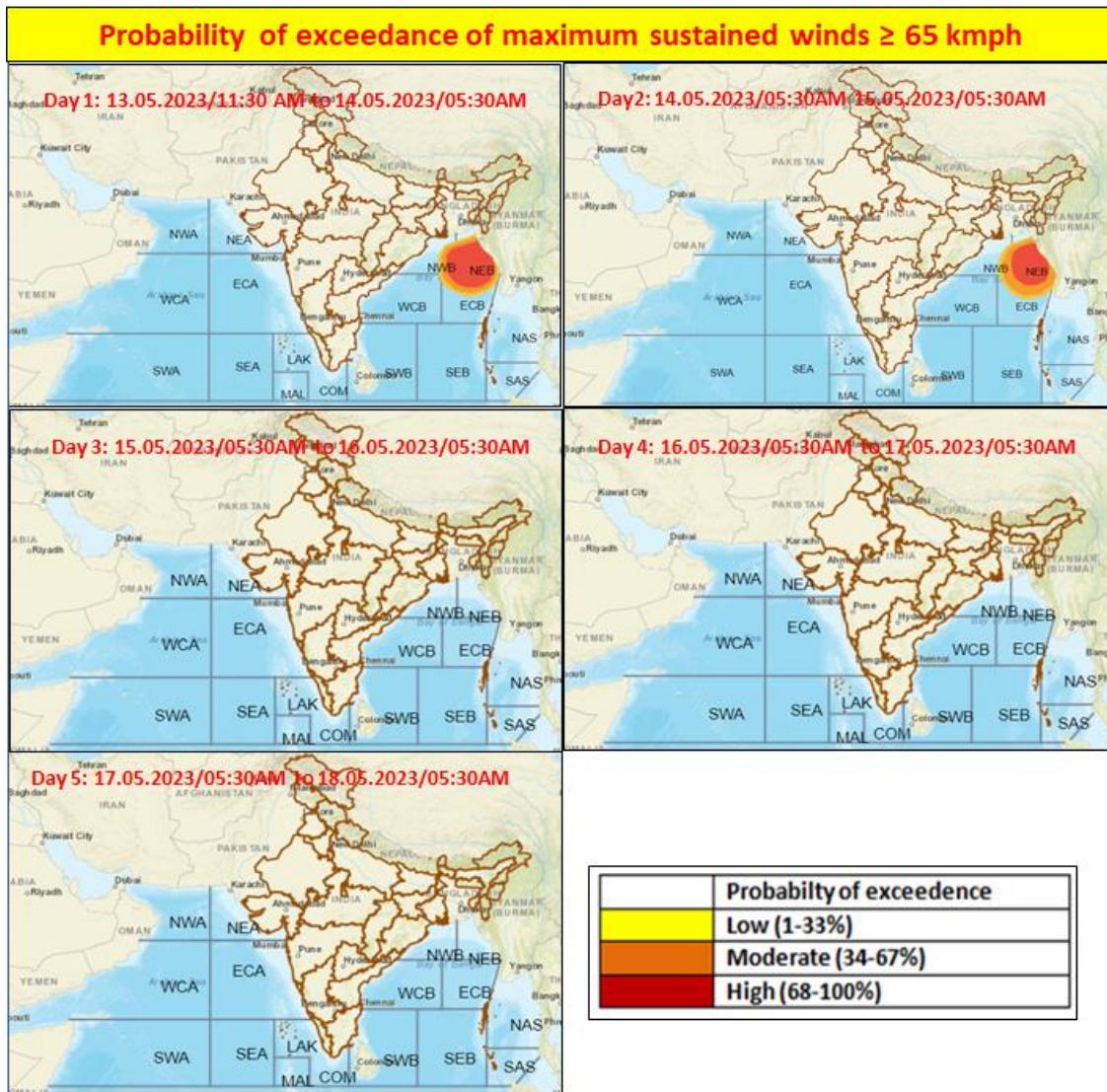


Fig.II-C-10: Sample graphics showing probability of exceedance of in areas having  $MSW \geq 45$  kmph issued on 26<sup>th</sup> May



**Fig.II-C-11: Sample graphics showing probability of exceedance of in areas having MSW $\geq 65$  kmph issued on 13<sup>th</sup> May**

**ANNEX II-C-5*****Tropical storm warnings to government officials (Four stage warnings)***

At the initial stage a special “**Informatory Message**” is issued at low pressure area stage when it has the potential to intensify into a cyclonic storm at 0300 UTC or at any synoptic hour depending upon time of formation of low pressure system to all the disaster managers and press.

A “**pre-cyclone watch**” bulletin is issued by DGM himself soon after the formation of a depression informing senior central government officials including chief secretary of coastal maritime States about likely development of a cyclonic storm, its movements, coastal belt of India likely to experience adverse weather. This bulletin is issued at least 72 hours in advance of commencement of adverse weather.

At the second stage, a “**cyclone alert**” is issued at least 48 hours in advance of the expected commencement of adverse weather in association with the cyclonic storm over the coastal area.

The third stage of the warning, known as “**cyclone warning**” is issued at least 24 hours in advance of commencement of severe weather.

The last stage of warning covering the **post-landfall** scenario is included in the cyclone warnings issued 12 hrs before the expected time of landfall and is continued till the cyclonic wind force is maintained in the core area of the cyclonic storm over land.

However, this is not applicable in case of cyclonic disturbances developing near the coast and in case of rapidly intensifying systems. In such cases, the cyclone warning can be issued directly without issuing cyclone alert and watch bulletins and similarly cyclone watch can be issued directly without issuing pre-cyclone watch.

***Post landfall outlook***

Post-landfall outlook will be issued as a part of cyclone warning at least 12 hours in advance of the landfall of the system by RSMC New Delhi and the concerned ACWC. On the basis of this outlook, the concerned RMC/MC which are likely to be affected will also issue cyclone warnings for the interior area. This is the regular cyclone warning.

***Dewarning Message***

As and when a given coastal belt is expected to become free from the impact of TCs, a dewarning message is issued to the ports and disaster management agencies in India as a part of four stage warning system.

***Tropical cyclone bulletins to All India Radio (AIR) for broadcast***

In general, weather bulletins are issued by the meteorological offices to the AIR stations for broadcast in the midday transmissions. These are based on 0300 UTC charts. The areas covered by the bulletins are the areas served by the respective AIR stations (AM and FM). These bulletins include:

- (i) A summary of the past weather;
- (ii) special weather warnings for public services such as the Public Works Department, Irrigation, DoT, Railways, etc. &
- (iii) General forecast including warnings.

Points (ii) and (iii) are valid until the morning of the second day. The summary of weather includes information about tropical storms and depressions affecting the area. The centre of the system is included with reference to the nearest well-known place and latitude and longitude. Warnings in bulletins once included are repeated in the subsequent daily bulletins also as long as adverse weather is anticipated. In addition, meteorological centres in the maritime states include suitable warnings for fishermen. These general bulletins are broadcast at a fixed time (midday) by the AIR stations and are intended to meet the requirements of the public in general and the needs of various categories of officials in particular.

In addition, special AIR bulletins containing cyclone alert messages issued 48 hours prior to the commencement of the adverse weather and tropical cyclone warning messages issued 24 hours prior to the commencement of the adverse weather in the coastal areas due to an approaching tropical storm are broadcast. These broadcasts are meant to alert the agencies entrusted with the responsibility of carrying out cyclone preparedness works and also the general public.

(For framing the tropical storm warning bulletins to AIR and Doordarshan abbreviated terms like “cyclone” for cyclonic storm, “severe cyclone” for the severe cyclonic storm and “super cyclone” for super cyclonic storm etc. are also used.)

The height of the storm surge is included in the bulletin in meters and it represents height above the normal tide level. The coastal districts likely to be affected by the storm are mentioned in the first sentence of the bulletins. The types of damage likely to be expected from systems of various intensities along with the suggested action are also included. For this purpose, the following table is referred

**Table II-C.1: Damage Potential and Action Suggested**

Category/ T.No/ Wind Speed	Structur es	Comm unicati on & Power	Road /Rail	Agricultu re	Marin e Inter ests	Coastal Zone	Overall I Dama ge Categ ory	Sugges ted Actions
Deep Depressio n T 2.0 52 – 61 kmph (28-33 knots)	Minor damage to loose / unsecur ed struc tures		Some breaches in Kutch Road due to flooding.	Minor damage to Banana trees and near coastal agricultur e due to salt spray. Damage to ripe paddy crops.	Very rough seas. Sea waves about 4-6 m high.	Minor damage to Kutch embankment s.	Minor	Fisherm en advised not to venture into the open seas.
Cyclonic Storm T 2.5-T 3.0 62 – 87 kmph (34-47 knots)	Damage to thatche d huts.	Minor damage to power and communi cation lines due to breaking of branche s.	Major damage to Kutcha and minor damage to Pucca roads.	Some damage to paddy crops, banana, papaya trees and orchards.	High to very high sea wave s about 6-9 m high.	Sea water inundation in low lying areas after erosion of Kutcha embankment s.	Minor to moder ate.	Total suspens ion of fishing operatio ns.
Severe Cyclonic Storm T 3.5 88-117 kmph (48-63 knots)	Major damag e to thatche d houses/ huts. Roof tops may blow off. Unattac hed metal sheets may fly.	Minor damag e to power and communi cation lines.	Major damage to Kutcha and some damage to Pucca roads. Flooding of escape routes.	Breaking of tree branches , uprooting of large avenue trees. Moderate damage to banana and papaya trees. Large dead limbs blown from trees.	Pheno menal seas with wave height 9-14 m. Move ment in motor boats unsafe .	Major damage to coastal crops. Storm surge upto 1.5 m (area specific) causing damage to embankment s/ salt pans. Inundation upto 5 km in specific areas.	Moder ate	Total suspens ion of fishing operatio ns. Coastal hutment dwellers to be moved to safer places. People in affected areas to remain indoors.

## II-C-18

Very Severe Cyclonic Storm T 4.0- T 4.5 118-166 kmph (64-89 knots)	Total destruction of thatched houses/ extensive damage to kutchha houses. Some damage to pucca houses. Potentia l threat from flying objects.	Bending / uprooting of power and communication poles.	Major damage to Kutchha and Pucca roads. Flooding of escape routes. Minor disruption of railways, overhead powerlines and signaling systems.	Widespread damage to standing crops, plantations, orchards, falling of green coconuts and tearing of palm fronds. Blowing down of bushy trees like mango.	Phenomenal seas with wave height more than 14 m. Visibility severely affected. Movement in motor boats and small ships unsafe .	Storm surge upto 2 m. Inundation upto 10 km in specific areas. Small boats, country crafts may get detached from moorings.	Large	Total suspension of fishing operations. Mobilise evacuation from coastal areas. Judicious regulation of rail and road traffic. People in affected areas to remain indoors.
Extremely Severe Cyclonic Storm T 5.0- T 6.0 167-221 kmph (90-119 knots)	Extensive damage to all types of kutchha houses, some damage to old badly managed Pucca structures. Potentia l threat from flying objects.	Extensive uprooting of communication and power poles.	Disruption of rail/road link at several places.	Extensive damage to standing crops, plantations, orchards. Blowing down of Palm and coconut trees. Uprooting of large bushy trees.	Phenomenal seas with wave height more than 14 m. Movement in motor boats and small ships not advisable.	Storm surge upto 2-5 m. Inundation may extend upto 10-15 km in specific areas. Large boats and ships may get torn from their moorings.	Extensive	Total suspension of fishing operations. Extensive evacuation from coastal areas. Diversification or suspension of rail and road traffic. People in affected areas to remain indoors.

Super Cyclonic Storm T 6.5 and above 222 kmph and more (120 knots and more)	Extensive damage to non-concrete residential and industrial buildings. Structural damage to concrete structures. Air full of large projectiles.	Uprooting of communication and power poles. Total disruption of communication and power supply.	Extensive damage to Kutcha roads and some damage to poorly repaired pucca roads. Large scale submerging of coastal roads due to flooding and sea water inundation. Total disruption of railway and road traffic due to major damages to bridges, signals and railway tracks. Washing away of rail/road links at several places.	Total destruction of standing crops/orchards. Uprooting of large trees and blowing away of palm and coconut crowns, stripping of tree barks.	Phenomenal seas with wave heights of more than 14m. All shipping activities unsafe.	Extensive damage to port installations. Storm surge more than 5m, inundation upto 40 km in specific areas and extensive beach erosion. All ships torn from their moorings. Flooding of escape routes.	Catastrophic	Total suspension of fishing operations. Large-scale evacuation of coastal population. Total suspension of rail and road traffic in vulnerable areas. People in affected areas to remain indoors.
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These bulletins are generally issued at the time of each sea area bulletin. The frequency of the bulletin can be raised when the tropical storm is tracked with the help of radar and previous warnings issued needs modification.

A third set of bulletins issued to AIR is the coastal weather bulletins. Whenever a cyclonic storm is likely to affect the Indian coastal areas, coastal weather bulletins issued by the India Meteorological Department are broadcast in the All India News Cycles of All India Radio from New Delhi in English, Hindi and in the regional language of the area affected. These bulletins contain information on the following:

- 1) Time of issue of bulletin in IST
- 2) Coastal strip for which bulletin issued and period of validity
- 3) Position, intensity and movement of cyclonic storm
- 4) Forecast point and time of landfall
- 5) Signals hoisted at the ports in the coastal strip
- 6) Information of storm surges/tidal waves

**ANNEX II-C-7*****Dissemination of tropical cyclone warnings***

The modes of telecommunication used for the dissemination of tropical cyclone warnings in India are:

- (i) Telefax
- (ii) Telephones
- (iii) Automatic Message Switching System (AMSS)
- (iv) All India Radio
- (v) Television
- (vi) FM Radio
- (vii) Community Radio
- (viii) DTH
- (ix) W/T (especially police W/T)
- (x) Internet, by keeping information on IMD website (<http://www.mausam.gov.in> )/ RSMC website([www.rsmcnewdelhi.imd.gov.in](http://www.rsmcnewdelhi.imd.gov.in)).
- (xi) Microwave link of the railways
- (xii) IVRS
- (xiii) e-mail
- (xiv) SMS and Mobile App.
- (xv) GMDSS
- (xvi) Warnings to fishermen in deep sea through through NavIC system\*
- (xvii) NAVTEX for coastal weather bulletin
- (xviii) Social Media (Face Book, Whatsapp, Twitter, Instagram, Blog)
- (xix) Common Alert Protocol
- (xx) Application Programming Interface
- (xxi) Crowd sourcing (January, 2021)

CAP feeds are automatically aggregated to the WMO Alert Hub at <https://cap-sources.s3.amazonaws.com/in-imd-en/rss.xml>. These alerts are also disseminated to Google, AccuWeather, Global Multi-Hazard Alert System (GMAS) portal (<https://gmas.asia/>). IMD also participates as one of the alert generating agencies for the CAP alert projects of NDMA developed by CDOT.

\* NavIC is the operational name of the Indian Regional Navigation Satellite System (IRNSS) developed by ISRO. Unlike GPS which is a Global tracking constellation, NavIC has been designed to focus especially on India and adjoining regions (1500 Kms around India) and is a very significant achievement for the country.

Application Programming Interface (API) has been developed for various products like heavy cyclones, rainfall, thunder storms, heat wave etc in 2021. It is used by various stake holders within the country and outside including Global Multi-hazard Alert System (GMAS) of WMO, Google, Apple etc. Stakeholders include Uttar Pradesh Government, Telangana Government, Kerala Government, Umang App, DD News, NDMA, Incredible India, KRC Network, NITI Aayog, Kerala State Disaster Management, Chandigarh Smart City Limited, Apple.com, Tomorrow.io, Uttarakhand Toursim, National Rice Research Institute Odisha, Madhya Pradesh Government, RMSI private limited, TV-9, CDAC etc.

India Meteorological Department launched its Crowd source web interface in January 2021 to allow users to make their own observations and share with service provider. This feature can be found in the "Public Observation" section of Mausam website of IMD

([https://city.imd.gov.in/citywx/crowd/enter\\_th\\_datag.php](https://city.imd.gov.in/citywx/crowd/enter_th_datag.php)). There is no need to register to send observations and the associated weather damages caused. User can report their observations (textual and .png format) along with their location and time of the events.

Rain, Thunder/lightning, Hailstorm, Duststorm, Fog, Snow, Gusty wind and the associated damage caused such as breaking of tree branches, uprooting of small/big trees, Telephone pole / Transmission tower damaged by bending, Telephone pole / Transmission tower uprooting, Damage to Kutch structures (houses, cowsheds), Damage to Pukka structures (houses, shelters), Flooding of land, Damage/Death to livestock, Damage/Death to

Humans, Damage to vegetation/crops. Member countries can also share observations in realtime through website for validation of forecast.

RSMC New Delhi commenced dissemination of warnings through whatsapp with member countries in March, 2022. Bulletins were shared with Department of Meteorology & Hydrology, Myanmar in march 2022.

The following warnings/advisory products are given in the dynamic page of cyclone page of IMD's website/RSMC webstie. When one type of communication channel fails, the alternate channel is used.

Home page of RSMC website is presented in Fig. II-C-12

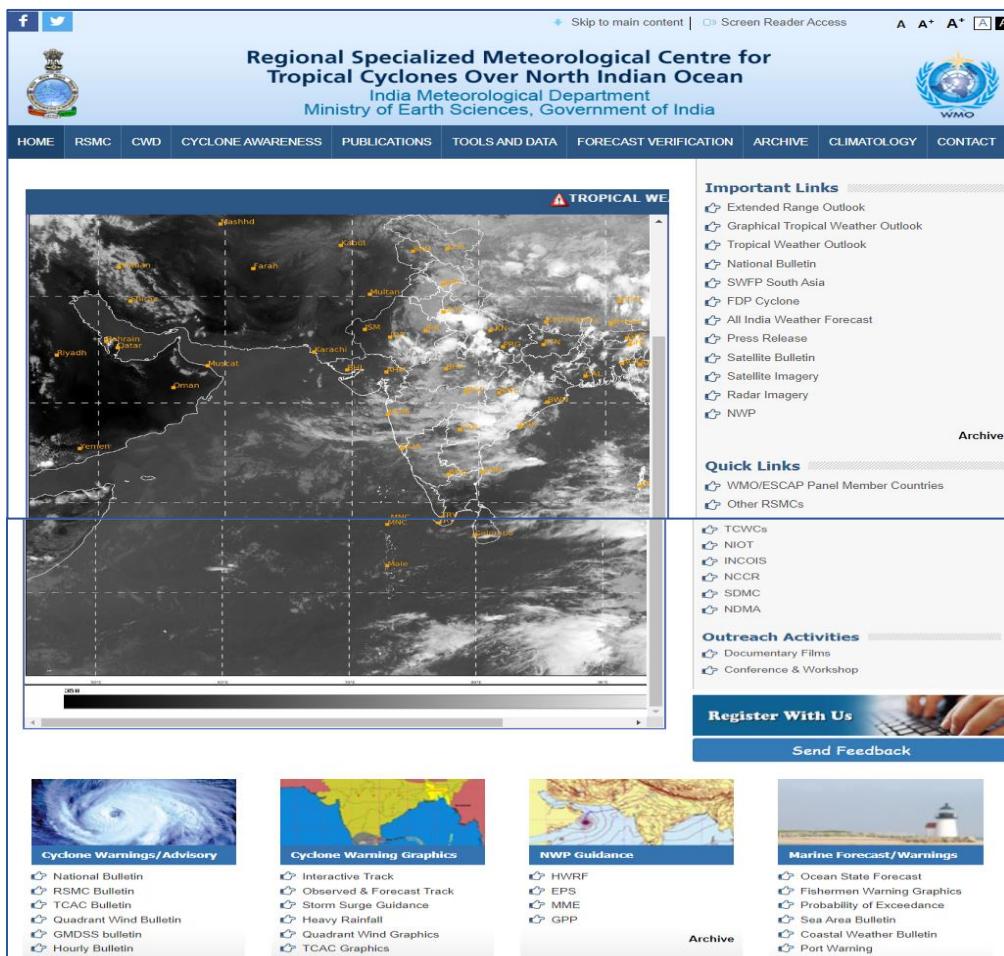


Fig.II-C-12: RSMC Website

## **Cyclone warning system in Maldives**

The Maldives Meteorological Service (MMS) issue tropical cyclone and severe weather warning to the public and travelers across the country.

### ***Tracking of Tropical Cyclone***

Conventional observations, such as surface, upper air observations, automatic weather stations, ship reports, and radar and satellite observations are utilized for observing, detecting and tracking tropical cyclones. Numerical Weather Prediction models produced in-house and NWP charts provided by RIMES and advisories from RSMC are also used by forecasters.

### ***Advisories and Warnings***

Advisories and Warnings are issued for:

Heavy Rain, Thunderstorms

Strong Wind, Tornado

Rough Seas, Tidal/ Swell Waves

Advisories and Warnings are sent to:

Government's Executive Management

National Disaster Management

Ministry of Defense and National Security

Maldives Police Service

Coast Guard

Aviation Sectors

Tourism, Transport, Health Sectors

Fisheries, Agriculture, Education Sectors

TV media, Print media, Radio service.

### ***Dissemination of Warning***

The National Meteorological Centre has established the following means of communication for the dissemination of the warning.

Hotlines - Dedicated point to point telephone line between stake holders and NMC

SMS text messages

Local TV Channels

Local Radio Channels

Internet (<http://www.meteorology.gov.mv>) and email

Faxsimile

***Alert and Warning criteria***

Alert Level	Description	Action
1	WHITE	<ul style="list-style-type: none"> <li>- Mean wind speed is expected or prevailed between 23 – 30 mph.</li> <li>- Rainfall of more than 50 mm is expected to occur within 24 hours.</li> <li>- High tidal waves are expected.</li> </ul> <p>Weather Information, but no immediate threat.</p>
2	YELLOW	<ul style="list-style-type: none"> <li>- Mean wind speed is expected or prevailed between 30 – 40 mph.</li> <li>- Torrential rain is expected and if heavy rain occurred for more than 2 hours.</li> <li>- A severe thunderstorm is expected or experienced.</li> <li>- Tropical Cyclone is formed within effective areas of Maldives.</li> <li>- Significant tidal or swell waves expected or experienced.</li> </ul> <p>Concern authorities and people living in the area to be on alert &amp; be ready to take action. Travel by sea not advisable.</p>
3	RED	<ul style="list-style-type: none"> <li>-Flash flood is expected.</li> <li>-A tropical Cyclone is tracked to move closer or cross Maldives islands.</li> <li>-Destructive tidal or swell waves or storm surge is expected or observed.</li> </ul> <p>Evacuation of population from threatened areas to safer places. Prohibition of sea transportation.</p>
4	GREEN	<p>The condition has improved.</p> <p>Cancel warning</p>

## Cyclone warning system in Myanmar

### ***Organization***

Tropical cyclone warnings in Myanmar are provided by the Department of Meteorology and Hydrology (DMH), Myanmar. Tropical cyclone warnings are provided from the Multi-Hazard Early Warning Center of DMH in Nay Pyi Taw.

### ***Tracking of Tropical Cyclone***

Conventional observations, such as surface and upper air observations, ships' reports, and radar and satellite observations are utilized for observing, detecting and tracking tropical cyclones.

### ***Tropical cyclone warnings***

The Multi-Hazard Early Warning Center of DMH in Nay Pyi Taw is responsible for providing tropical cyclone and storm surge warnings to its coastal population, the ports along the Myanmar coast and for the designated area of the high Seas in the Bay of Bengal. 24x7 Storm Watch Centers: Nay Pyi Taw Multi Hazard Early Warning Centre, Yangon Forecasting office, Mingaladon International Airport Aviation Forecasting office and all coastline observatories watch the storms whenever cyclones develop in the Bay of Bengal.

Storm news and warnings are issued at frequent intervals for national and international users in various sectors. Special storm warnings accompanied with color code and possible storm affected specific areas are issued hourly to all news media. National televisions televised all hourly news continuously in footnote rolling format frequently. These storm news and warnings include the 5 stage warnings viz. Yellow Stage, Orange Stage, Red Stage, Brown Stage and Green Stage during cyclone situations.

The area designated for Myanmar for providing warnings is the area of the Bay of Bengal east of 92° E and north of 10° N. Warnings are broadcast through the coastal radio station at Yangon (call sign XYR).

Port warning signals and their meanings used in the ports of Myanmar are given in Attachment to Annex II-E.

### ***Dissemination of Storm Warning***

Collection and dissemination of meteorological data and warnings are done with the Phone, Single Side Band Transceiver (SSB), Email, Fax, SMS, GTS through RTHs and RSMC New Delhi. The modes of telecommunication used for the dissemination of tropical cyclone warnings in Myanmar are:

1. Telephone
2. Facsimile
3. Local TV (3 Channel)
4. Myanmar Radio
5. FM Radio
6. DMH website- [www.moezala.gov.mm/www.dmh.gov.mm](http://www.moezala.gov.mm/www.dmh.gov.mm)
7. Single Side Band Transceiver (SSB)
8. DMH Facebook

***Tropical storm news and warnings for various sectors in Myanmar  
(Five stage warnings)***

**Yellow Color Stage**

Yellow color means a storm is formed but it not moving towards Myanmar Coasts.

**Orange color Emergency Stage**

Orange color means storm is heading towards Myanmar Coasts.

**Red color Emergency stage**

Red color emergency stage mean the storm is heading towards Myanmar Coasts and cross within next (12) hours.

**Brown color Emergency Stage**

Brown color Emergency Stage means the storm is crossing Myanmar Coasts currently.

**Green color Stage**

Green color Stage means the storm abated and situation is clear by storm.

## **Tropical Cyclone Warning System in Oman**

### ***Organization***

Tropical cyclone warnings in Oman are provided by the Central Forecasting Office under the Directorate General of Meteorology (DGMET) which falls under Public Authority for Civil Aviation in co-operation with the National Committee for Emergency Management (NCEM).

### ***Tracking***

The Oman Regional Model as well as other international numerical weather prediction products are used for early warning. The Tropical Cyclones are tracked with the help of surface and upper air observation, satellite imagery and aircraft observations.

The tropical cyclones are tracked with the help of conventional surface, upper air observations, weather radars, and satellite images from Eumetsat and NOAA. Images from Indian Satellites are being utilized via IMD website.

### ***Tropical Cyclone Warning***

Tropical cyclone warnings are provided for:

- (i) The high Seas
- (ii) Coastal waters
- (iii) Ports
- (iv) Civilian and military aviation
- (v) Governmental officials
- (vi) General public including fishermen
- (vii) Recipients registered with the DGMET

### ***Warning Procedures***

Directorate General of Meteorology (DGMET) will issue tropical storm reports, advisories, warnings and amendments every 24 hours, 12 hours, 6 hours, or more frequently if required by changing conditions according to an internal SOP. The Advisory or warning will contain the following information

- (i) Number
- (ii) Date and time
- (iii) Name of Storm
- (iv) Classification
- (v) Position of the Tropical storm
- (vi) Intensity
- (vii) Central pressure
- (viii) Movement the direction and speed
- (ix) Wind direction and speed around the centre
- (x) Destination from a coastal point
- (xi) Outlook

In the event the storm is expected to approach the coast of Oman, the following bulletins will be issued according to the stage:

**ANNEX II-F-2****Reports**

When it is expected that a depression, storm, severe storm or cyclone may approach Oman coast before 72 hours, a report will be issued and it will be renewed every other 48 hours.

**Advisory**

When it is expected that a depression, storm, severe storm or cyclone May approach Oman coast within 72 hours an advisory will be issued and it will be renewed every other 24 hours.

**Alert**

When it is expected that a depression, storm, severe storm or cyclone May approach Oman coast within 48 hours an alert will be issued and it will be renewed every other 12 hours.

**Warning**

When it is expected that a depression, storm, severe storm or cyclone may approach Oman coast within 24 hours a warning will be issued and it will be renewed every other 6 hours.

**Last Report**

When it is expected that a depression, storm, severe storm or cyclone is dissipating a report will be issued clearing the event.

**Bulletins for high sea**

Tropical cyclones warnings for the high seas in Oman are provided by the Central Forecasting Office located at Muscat International Airport and broadcasted from the Muscat coastal radio station at Muscat whose call sign is A4M.

Pakistan is an Issuing Service for METAREA IX of the WWMIWS, and is responsible for broadcasting the products on SafetyNET to mariners at sea.

**Warnings for Ports**

Directorate General of Meteorology (DGMET) issues warnings to ports whenever adverse weather is expected to affect them

The main ports are:

- 1- Mina Sultan Qaboos in Muscat
- 2- Mina Salalah
- 3- Mina Sohar
- 4- Wudam Naval Base
- 5- Khasab
- 6- Qalhat
- 7- Al-Duqm

**Dissemination of the Tropical Cyclone Warnings**

The modes of telecommunication used for the dissemination of tropical cyclone warnings and advisories to different categories of recipients are:

- 1- Telephones
- 2- Telefax
- 3- Internet (E-mail, web site & Facebook and Twitter Page)
- 4- Short Massages Service (SMS)
- 5- Wireless Application protocol WAP
- 6- Voice Mail Pager System
- 7- Oman Radio
- 8- Oman Television
- 9- Muscat Radio Coastal Station
- 10- Cell Broadcast System (CBS)sss

### **Tropical cyclone warning system in Pakistan**

Pakistan Meteorological Department is responsible for the preparation and issuance of tropical cyclone warnings in Pakistan. The tropical cyclone warnings are issued by Marine Meteorology & Tropical Cyclone Warning Centre of PMD.

#### ***Tracking of the tropical cyclones***

Tracking of the tropical cyclone in Pakistan is done with the help of following:

- (i) Conventional surface and upper air observations from inland stations and ships' observations
- (ii) Model outputs and guidance from the global tropical cyclones warning centres
- (iii) The NWP products of High resolution Regional Model (implemented at PMD)
- (iv) Cyclone detection radar
- (v) Meteorological satellites data products.
- (vi) AWSs installed at coast along Sindh and Makran (Balochistan)

#### ***Tropical cyclone Watch, Alert and Warning***

Tropical cyclone Watch, Alert and Warning are issued by PMD's Marine Meteorology & Tropical Cyclone Warning Centre as per following criteria:

**Tropical cyclone Watch** is issued when a tropical cyclone gets formed or enters the Arabian Sea north of Lat. 10°N. Tropical cyclone Watch is issued irrespective of cyclone's threat to affect Pakistan's coastal areas. The issuance of tropical cyclone Watch requires the concerned authorities to be watchful.

**Tropical cyclone Alert** is issued when there is likelihood that tropical cyclone may affect Pakistan's coastal areas.

**Tropical cyclone Warning** is issued when there is very likelihood that tropical cyclone may affect Pakistan coast. Tropical cyclone warnings are issued every three (3) or six (6) hours and/or whenever necessary and imperative.

#### ***Tropical cyclone warnings***

The bulletins and warnings issued in connection with tropical cyclones in Pakistan are divided into the following broad categories:

- i. Warning bulletins for shipping on the high seas
- ii. Warning bulletins for ships plying in the coastal waters
- iii. Port warnings
- iv. Fisheries warnings
- v. Warnings for Government officials and functionaries including National Disaster Management Authority (NDMA) and Provincial Disaster Management Authorities (PDMA) and District Management Authorities (DDMAs)
- vi. Warnings for recipients who are registered with PMD
- vii. Warnings for aviation
- viii. Warnings for the general public through electronic and print media
- ix. Warnings to CBOs, NGOs and INGOs
- x. Warning to Search and Rescue (SAR) Operations

### **Types of warnings**

#### **Bulletins for the high seas**

These bulletins are for the shipping interests on the high seas. The area covered includes the North Arabian Sea (north of 20° N). Coverage is shown in Fig. II-C-1

These bulletins are issued by the PMD's Marine Meteorology -Tropical Cyclone Warning Centre, Karachi and are broadcast by the Coastal Radio Stations.

Pakistan is an Issuing Service for METAREA IX of the WWMIWS, and is responsible for broadcasting the products on SafetyNET to mariners at sea.

#### **Storm warnings to ports**

PMD's Marine Meteorology &Tropical Cyclone Warning Centre issues warnings to the Ports whose parts are likely to be affected by adverse weather. They are also advised to hoist the visual storm warning signals for the benefit of ships at the port and those out at sea. The information is, in most cases, conveyed by facsimile, SMS and telephone. The meaning of the port warning signals used in Pakistan ports is given in Attachment to Annex-II-G.

#### **Dissemination of tropical cyclone warnings**

The modes of telecommunication used for the dissemination of tropical cyclone warnings in Pakistan is:

- i. Coastal Radio (ASK)
- ii. Telephones
- iii. Electronic and print media
- iv. Radio Pakistan
- v. Pakistan television
- vi. Telex/Telefax
- vii. Internet, PMD's website: [www.pmd.gov.pk](http://www.pmd.gov.pk)
- viii. SMS and
- ix. FM radios

The mode of telecommunication differs for different types of messages. When one type of communication channel fails, the alternate channel is used.

#### **Storm Surge Analysis**

The storm surge analysis (using IIT\_D model) is carried out on the basis of available climatological data for the guidance and awareness of public in general and concerned authorities in particular for preparedness and evacuation of coastal communities and safety of lives and properties; well in advance.

## Cyclone warning system in Sri Lanka

### **Organization**

The responsibility of the cyclone warning in Sri Lanka rests with the Department of Meteorology, Sri Lanka. Tropical cyclone warnings are provided from the National Meteorological Centre (NMC) Colombo.

When the cyclone is located in the Colombo Flight Information Region, SIGMET/AIRMERT provided by Aviation Meteorological Watch Office, Bandaranaike International Airport Katunayake.

### **Tracking**

Tropical cyclones are tracked with the help of conventional observations, radar, satellite observations and aircraft reports. These are dealt with in more detail in a separate chapter.

### **Tropical cyclone warnings**

Tropical cyclone advisories/ alerts/ warnings are issued under two criteria, viz., Distance from the Coast and Intensity of the System, each criterion having key stages.

#### **(a). Distance Criterion**

##### **(i) When a depression or a cyclonic storm is less than 600 km off the coast.**

In addition to distance of storm centre from coast, this bulletin indicates forecast conditions on the (a) speed and direction of movement and (b) maximum surface wind speed likely. This bulletin is issued every twelve (12) hours with validity period of 48 to 72 hours and wherever imperative.

##### **(ii) When the cyclonic storm is less than 500 km off the coast.**

In addition to distance of storm centre from coast, this bulletin indicates forecast conditions on the (a) speed and direction of movement and (b) maximum surface wind speed likely. This bulletin is issued every six (6) hours with validity period of 36 to 48 hours and wherever imperative.

##### **(iii) When the cyclonic storm is less than 300 km off the coast.**

If landfall is indicated, a bulletin is issued every three (3) hour and wherever imperative. This bulletin includes additional information on point of landfall, landfall time, storm surges and areas likely to be inundated with validity period of 18 hours.

Four colour code with flags are used for easy and quick understanding

<b>Signal No.</b>	<b>Colour</b>	<b>Description</b>	<b>Action required</b>
1	White  Information	Potential area of possibility to development of vortex /disturbance / Cyclone has formed	Information only, Vessels at sea to be vigilant and avoid the area, Listen to media
2	Amber  Alert	Cyclone has formed in the vicinity, Heavy rain and strong wind, rough sea ( 30-40kts, 50-80kmph)	Stay away from beach/sea, vessels in danger/be inside building
3	Amber  Alert	Cyclone has formed in the vicinity, very heavy rain with very strong winds, very rough seas ( Winds > 40kts, 80kmph)	Be ready to leave buildings with weak structures (in relevant areas only) and low lying (flood prone) areas, secure your home/valuables.
4	Red	Heavy rain with very strong wind >40 kts, cyclone expected to cross land	Evacuate to pre-designated safe places

	 Warning	Cyclone is expected to cross land, Very heavy rain/very strong winds (v>50kts,100kmph)	
5	 Threat over	Cyclone warning cancellation/withdrawal bulletin	

**(b). Intensity Criterion (Signal levels)**

**(i) When the cyclonic storm is less than 300 km off the coast.**

If landfall is indicated, a bulletin is issued every three (3) hour and wherever imperative. This bulletin includes additional information on point of landfall, landfall time, storm surges and areas likely to be inundated with validity period of 18 hours.

**Tropical cyclone warnings for different users**

- Relevant Government Officials including HE President & Prime Minister
- Disaster Management Centre (DMC)
- General Public
- Media
- The Armed Services & Police
- Local Administrations of relevant districts and
- Irrigation, National Building Research organization, Ministry of Health, Highways etc.

**Specific users**

- Coastal fishing
- Shipping
- Port and Harbours
- Aviation

**Tropical cyclonic warnings for the high seas**

For the high seas, the tropical cyclone warnings are provided from NMC Colombo and broadcast through the coastal radio station Colombo Radio (4PB). The area covered by the warnings is the Indian Ocean, Arabian Sea and the Bay of Bengal from the equator to  $10^{\circ}$  N between  $60^{\circ}$  E and  $95^{\circ}$  E. The port warning signal used are given in Attachment to Annex II-H

India is an Issuing Service for METAREA VII(N) of the WWMIWS, and is responsible for broadcasting the products on SafetyNET to mariners at Sea.

**Dissemination of tropical cyclone warnings**

The warnings/bulletins for the high seas are disseminated through Colombo (4PB). Other modes are:

- State and Private Radio
- State and Private Television
- Press/Print Media
- Telephones/Pager/ SMS
- Police Communication
- Tele-printer
- Telefax
- Internet SLMD website ( <http://www.meteo.gov.lk> )
- Through warning towers of Disaster Management Centre
- Social Media/Facebook/WhatsApp

### **Cyclone warning system in Qatar**

There are no direct impacts of tropical cyclones on the country. However, Qatar Meteorology Department is responsible to provide marine weather-related services to shipping and other coastal communities for the Arabian Gulf (sub area No 5) as part of METAREA IX in cooperation with Pakistan Met Department. Qatar Meteorology Department has a lot of tools and capabilities available to track tropical cyclones such as access of real time satellite and radar images, high resolution numerical weather prediction models as well as real time access to surface, upper air observations and ship reports.

Four colour code with flags are used for easy and quick understanding

Signal No	Colours	Description	Action Required
1	white		Potential area of possibility to development of vortex /disturbance /
2	Yellow		Cyclone has formed in the vicinity, heavy rain with strong winds, rough seas (30-40 kts, 55-75kmph)
3	Red		Cyclone is expected to cross land, very heavy rain/very strong winds (v>50kts,100kmph)
4	Green		Cyclone warning cancellation/withdrawal bulletin

**(b). Intensity Criterion (Signal levels)**

**(i) When the cyclonic storm is 300 km off the coast.**

In addition to above contents, information on areas likely to be affected are provided. This bulletin is issued every six (6) hours and wherever imperative and

**(ii) When the cyclonic storm is 200 km off the coast and if landfall is indicated, a bulletin is issued every three (3) hour and wherever imperative. This bulletin includes additional information on point of landfall, storm surges and areas likely to be inundated.**

#### **Tropical cyclone warning**

##### **Tropical cyclone warnings for different users**

- Relevant Government Officials including HE President & Prime Minister
- Disaster Management Centre (DMC)
- General Public
- Media
- The Armed Services & Police
- Local Administrations of relevant districts and
- Irrigation, Highways etc.

**Specific users**

- Coastal fishing
- Shipping and
- Aviation

**Tropical cyclonic warnings for the high seas**

For the high seas, the tropical cyclone warnings are provided from NMC Colombo and broadcast through the coastal radio station Colombo Radio (4PB). The area covered by the warnings is the Indian Ocean, Arabian Sea and the Bay of Bengal from the equator to 100 N between 600 E and 950 E. The port warning signal used are given in Attachment to Annex II-H

India is an Issuing Service for METAREA VII(N) of the WWMIWS, and is responsible for broadcasting the products on SafetyNET to mariners at Sea.

**Dissemination of tropical cyclone warnings**

The warnings/bulletins for the high seas are disseminated through Colombo (4PB). Other general modes are:

- State and Private Radio
- State and Private Television
- Press/Print Media
- Telephones/Pager/ SMS
- Police Communication
- Tele-printer
- Telefax
- Internet SLMD website ( <http://www.meteo.gov.lk>)
- Through warning towers of Disaster Management Centre

## Tropical cyclone warnings in Thailand

### **Organization**

Tropical cyclone and severe weather warnings and advisories in Thailand are provided by the Thai Meteorological Department (TMD), Thailand, from the Weather Forecast Bureau, TMD Headquarters at Bangkok to the government agencies concerned, specific users, high seas and general public throughout the country.

### **Tracking of Tropical Cyclones**

Tracking of tropical cyclones in Thailand is done with the help of conventional surface and upper air observations, ships and buoy observations, radar and satellites observations, model outputs and guidance from the global tropical cyclones warning centers. These are deal with in more details in a separate chapter.

### **Tropical Cyclones Warning Procedure**

System Intensity	Action taken by TMD	Dissemination and Modes of Telecommunications
Active low trends to be storm (Less than 27 Knots)	Weather Report will be issued every 6 hours containing information on date and time, weather situation, and weather forecasting.	<b>To high seas</b> By broadcasting through the Bangkok coastal radio stations (HSA,) for the areas covered by the Gulf of Thailand, west of Southern Thailand, Strait of Malacca and the South China Sea. <b>(every 3 hours)</b> <b>To coastal stations and ports</b> By: Telephone, Facsimile, Email, SMS, social media (Facebook, Line), Thailand Radios/ and Thailand TVs, TMD Mobile Application, TMD Radio, TMD Website: <a href="http://www.tmd.go.th">www.tmd.go.th</a> , <a href="http://www.metalarm.tmd.go.th">http://www.metalarm.tmd.go.th</a> <b>(every 6 hours)</b>
Tropical depression (27-33 Knots)	Comprehensive Warning/ Advisory will be issued every 6 hours containing: (i) Issuing number (ii) Date and time (iii) Classification by intensity (iv) Position of the tropical storm (v) Central pressure (vi) Movement the direction and speed (vii) Wind direction and maximum wind near the centre (viii) Destination from a coastal point	<b>To high seas</b> By broadcasting through the Bangkok coastal radio stations (HSA,) for the areas covered by the Gulf of Thailand, west of Southern Thailand, Strait of Malacca and the South China Sea. <b>(every 3 hours)</b> <b>To coastal stations and ports</b> By: Telephone, Facsimile, Email, SMS, social media (Facebook, Line), Thailand Radios/ and Thailand TVs, TMD Mobile Application, TMD Radio, TMD Website: <a href="http://www.tmd.go.th">www.tmd.go.th</a> , <a href="http://www.metalarm.tmd.go.th">http://www.metalarm.tmd.go.th</a> <b>(every 6 hours)</b> Port warning signals used in Thailand Ports are given in Attachment to Annex II-I.

		(Facebook, Line), Thailand Radios/ and Thailand TVs, TMD Mobile Application, TMD Radio, TMD Website: <a href="http://www.tmd.go.th">www.tmd.go.th</a> , <a href="http://www.metalarm.tmd.go.th">http://www.metalarm.tmd.go.th</a> (every 6 hours)
Tropical Cyclones (34 knots and more)	<p>Comprehensive Warning/ Advisory will be issued every 3 hours containing:</p> <ul style="list-style-type: none"> <li>(i) Issuing number</li> <li>(ii) Date and time</li> <li>(iii) Name of storm</li> <li>(iv) Classification by intensity</li> <li>(v) Position of the tropical storm</li> <li>(vi) Central pressure</li> <li>(vii) Movement the direction and speed</li> <li>(viii) Wind direction and maximum wind near the centre</li> <li>(ix) Destination from a coastal point</li> </ul>	<p><b>To high seas</b> By broadcasting through the Bangkok coastal radio stations (HSA,) for the areas covered by the Gulf of Thailand, west of Southern Thailand, Strait of Malacca and the South China Sea. <b>(every 3 hours)</b></p> <p><b>To coastal stations and ports</b> By: Telephone, Facsimile, Email, SMS, social media (Facebook, Line), Thailand Radios/ and Thailand TVs, TMD Mobile Application, TMD Radio, TMD Website: <a href="http://www.tmd.go.th">www.tmd.go.th</a>, <a href="http://www.metalarm.tmd.go.th">http://www.metalarm.tmd.go.th</a> <b>(every 3 hours)</b> Port warning signals used in Thailand Ports are given in Attachment to Annex II-I.</p> <p><b>To government agencies concerned namely:</b></p> <ul style="list-style-type: none"> <li>• Department of Disaster Prevention and Mitigation (DDPM)</li> <li>• Port Authority of Thailand (PAT)</li> <li>• Marine Department (MD)</li> <li>• National Disaster Warning Center (NDWC)</li> <li>• Governors of risk provinces</li> </ul> <p><b>To specific users (aviation, fishery, etc.), media and general public</b> By: Telephone, Facsimile, Email, SMS, social media (Facebook, Line), Thailand Radios/ and Thailand TVs, Mobile Application, TMD Radio, TMD Website: <a href="http://www.tmd.go.th">www.tmd.go.th</a>, <a href="http://www.metalarm.tmd.go.th">http://www.metalarm.tmd.go.th</a> <b>(every 3 hours)</b></p>

## **Tropical Cyclone Warning System in United Arab Emirates**

### ***Organization***

Tropical cyclone warnings and advisories in United Arab Emirates are provided by the Meteorological Department, National Center of Meteorology (NCM) in cooperation with the National Emergency Crisis and Disasters Management Authority (NCEMA).

### ***Tracking of tropical cyclones***

The tropical cyclones tracking is done through satellite Imageries, conventional surface, ship and upper air observations, weather radar, regional Model outputs and RSMCs reports.

### ***Tropical cyclone warning***

Tropical cyclone warnings are provided for:

- (i) National Emergency Crisis and Disasters Management Authority (NCEMA).
- (ii) Ministry of Interior (MOI).
- (iii) Coast Guard.
- (iv) General public.
- (ii) Sea Ports.
- (iii) Gas, Oil and shipping Marine companies.
- (iv) Civilian and military aviation.
- (v) Governmental and non-Governmental entities.

### ***Dissemination of the Tropical Cyclone Warnings***

The modes of telecommunication used for the dissemination of tropical cyclone warnings and advisories to different categories of recipients are:

- 1- Hot line landline and hot mobile-line connected with stakeholders.
- 2- Secured intranet connected with stakeholders.
- 3- Decoded fax-ware connected with stakeholders.
- 4- Internet (E-mail, website: ncm.ae & albahar.ncm.ae, mobile applications, social media).
- 5- SMS text messages.
- 6- Media (Local radio channels, local TV channels, local press).

**Attachment to ANNEX II-B**

Day Signals*	Specifications	Night Signals*	Remarks
<b><u>Bangladesh</u> (8.XI.1976)</b>			
<b>Signals Meant for Maritime Ports</b>			
16a I.	<u>Distant Cautionary Signal Number One</u>	3b )	
	There is a region of squally weather in which a storm may be forming (well marked low or depression with surface winds up to 61 km/h. (33 knots))	)	These signals indicate that ships may be exposed to danger after leaving the harbour
10a II.	<u>Distant Warning Signal Number Two</u>	2b )	
	A storm has formed (cyclonic storm with surface winds 62-88 kmph. (34-47 knots))	)	
3a III.	<u>Local Cautionary Signal Number Three</u>	5b )	
	The port is threatened by squally weather (cyclonic circulation with surface winds 40-50 km/h. (22-27 knots)) or squalls due Nor'westers)	)	These signals indicate that the port itself and the ships in it are in danger
2a IV.	<u>Local Warning Signal Number Four</u>	4b )	
	The port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution (cyclonic circulation with surface winds 51-61 km/h. (28-33 knots))	)	
17a V.	<u>Danger Signal Number Five</u>	16b )	
	The port will experience severe weather from a storm of light or moderate intensity (wind speed of 62-88 km/h (34-47 knots)) That is expected to cross the coast to the South of Chattogram Port or Cox's Bazar Port and to the east of Mongla Port	)	These signals indicate that the port itself and the ships in it are in danger

\* The national systems of visual storm warning signals (day signals and night signals) are reproduced in WMO Publication - WMO-No. 9, TD. 4, Volume D, Part D - Visual Storm Warning Signals Annexes II and III respectively.

Day Signals*	Specifications	Night Signals*	Remarks
<b><u>Bangladesh</u> - continued</b>			
18a	VI. <u>Danger Signal Number Six</u>	17b )	
	The port will experience severe weather from a storm, of light or moderate intensity that is expected to cross the coast to the north of the port Chattogram (or Cox's Bazra) and to the west of the port of Mongla) (wind speed same as in Signal No. V)	) ) ) ) ) )	
19a	VII. <u>Danger Signal Number Seven</u>	18b )	
	The port will experience severe weather from a storm of light or moderate intensity that is expected to cross over or near to the port (wind speed as in Signal No. V)	) ) ) )	
20a	VIII. <u>Great Danger Signal Number Eight</u>	19b )	
	The port will experience severe weather from a storm of great intensity (wind speed of 89 km/h or 48 knots or more) that is expected to cross the coast to the south of the port of Chattogram or Cox's Bazra and to the east of the port of Mongla.	) ) ) ) ) ) )	These signals indicate that the port itself and the ships in it are in danger
21a	IX. <u>Great Danger Signal Number Nine</u>	20b )	
	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the north of the port of Chattogram or Cox's Bazar and to the west of the port Mangla) (wind speed same as in Signal No. VIII)	) ) ) ) ) )	

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\* See footnote on page 1 of Attachment to Annex II-B

Day Signals*	Specifications	Night Signals*	Remarks
<b><u>Bangladesh</u></b> - continued			
22a	X. <u>Great Danger Signal Number Ten</u> The port will experience severe weather from a storm of great intensity that is expected to cross the coast over or near to the port (wind speed same as in Signal No. VIII)	21b )	) these signals indicate that the port itself and the ships in it are in danger
23a	XI. <u>Failure of Communications</u> Communications with the Meteorological Warning Centre have broken down and the local officer considers that a devastating cyclone is following.	7b )	) ) )

**Signals Meant for River Ports**

24a	(I) <u>Cautionary Signal Number One</u>  The area is threatened by squally winds of transient nature (Nor'wester squalls) of wind speed not exceeding 60 km/h (32 knots).	5b )	) these signals are used for the river ports, river and police stations in Bangladesh
	A storm (wind speed of 61 km/h) or a nor'wester (wind speed 61 km/h or more) is likely to strike the area (vessels of 65 feet and under in length are to seek shelter immediately)	)	) these signals are used for the river ports, river and police stations in Bangladesh
2a	(III) <u>Danger Signal Number Three</u>  A storm (wind speed of 62-88 km/h or more) is likely to strike the area soon (All vessel will seek shelter immediately).	2b )	)
		)	)

\*See footnote on page 1 of Attachment to Annex II-B

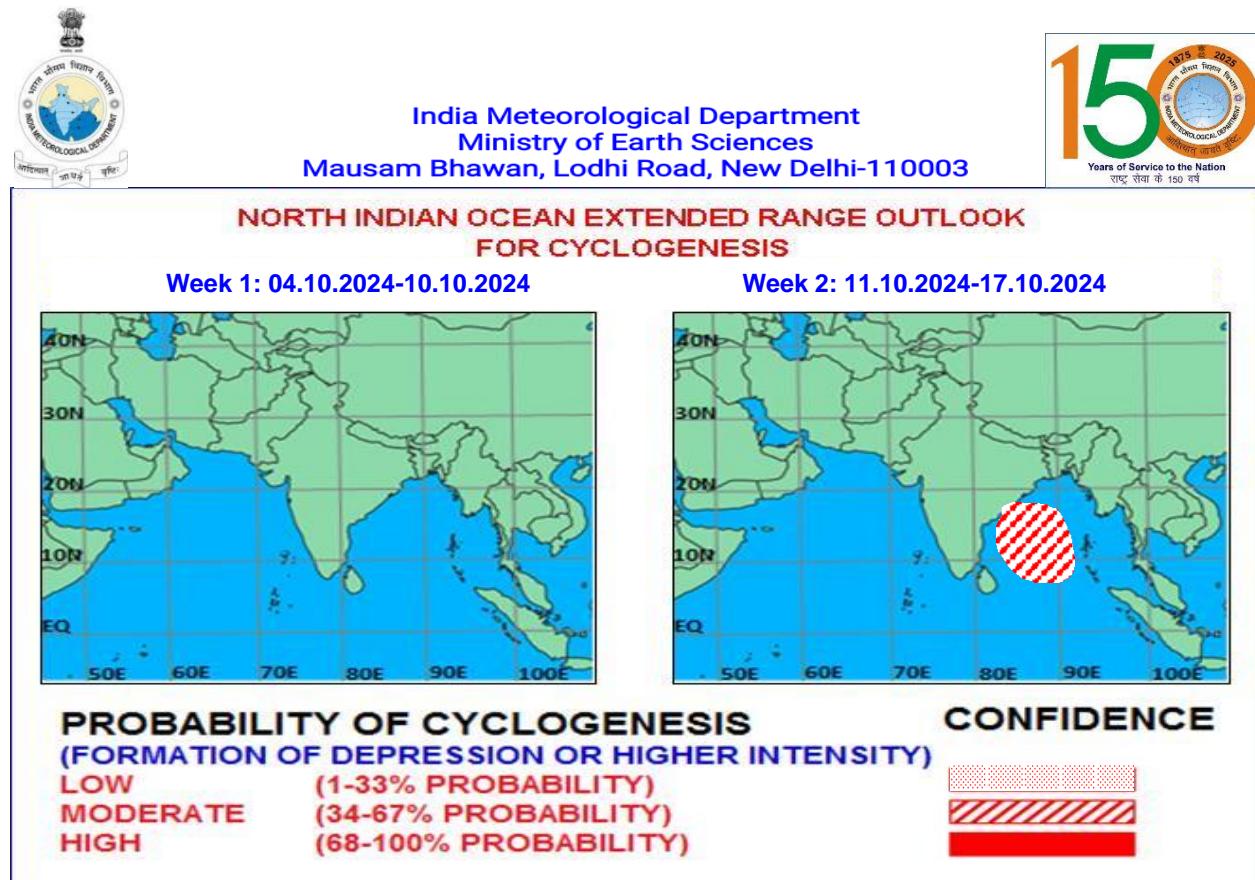
Day Signals*	Specifications	Night Signals*	Remarks
<b><u>Bangladesh</u></b> - continued			
10a	(IV) <u>Great Danger Signal Number Four</u> A violent storm (wind speed of 89 km/h or more) will strike the area soon (All vessels will take shelter immediately).	31b )	) ) ) )

## Attachment to Annex II-C1

**Bulletins issued by India for Indian coast****EXTENDED RANGE OUTLOOK FOR CYCOGENESIS:**

IMD started issuing Extended Range Outlook (ERO) for cyclogenesis during next two weeks every Thursday from 22<sup>nd</sup> April, 2018. The impact expected over the area of cyclogenesis was introduced from 07<sup>th</sup> May, 2022. IMD also introduced guidance on expected formation of cyclonic circulation and low pressure area over the region from June, 2021. The ERO contains information about large scale features over the region, guidance on probable cyclogenesis from various global/regional models, probability of cyclogenesis as LOW (0-33%), MODERATE (34-67%) and HIGH (68-100%) along with verification of forecast issued during last two weeks. The product is available on RSMC website at <http://www.rsmcnewdelhi.imd.gov.in/images/bulletin/eroc.pdf>. The archive of all ERO bulletins since May 2018 is also available on RSMC website.

Example 1: Extended Range Outlook issued on 04<sup>th</sup> October 2024 is presented below.



**Fig. II-C-1(a): Graphical Cyclogenesis over north Indian Ocean during next two weeks**

### I. Environmental features:

The Madden Julian Oscillation (MJO) index is currently in Phase 2 with amplitude less than 1. According to the forecasts by various models, it is likely to move eastward through phases 2 during the first half of the first week and 3 & 4 during the second half of the first week respectively with a decreasing amplitude below 1. Thereafter, the MJO signal is likely to amplify while moving eastward within phase 4 during the first half of the second week and reaching phase 5 by the end of the second week. However, the GEFS ensemble

members indicate large variations in the eastward propagation of MJO during both weeks. The ECMWF ensemble members indicate a littlecoherency during the first week, whereas they show a large spread during the second week. Thus, the MJO phase and amplitude are favourable towards the enhancement of convective activity in the North Indian Ocean (NIO) region over both the sub-basins viz., Arabian Sea and Bay of Bengal(BoB) during the forecast period.

The CICS-NC model forecast for Equatorial Waves indicates westerly wind anomaly over South & Central BoB and easterly wind anomaly over Bangladesh & adjoining eastern parts of India during week 1. These features indicate that equatorial waves would support the formation ofa low pressure area over north BoB and adjoining areas around 4<sup>th</sup> October. Similarly, during week2, it indicates stronger easterly wind anomaly over central and north BoB and Northern plains of India along with stronger westerly wind anomaly over north equatorial Indian Ocean and adjoining south BoB & AS. The MJO will be active over the west equatorial Indian Ocean and adjoining AS along with low frequency background waves. These environmental conditions are likely to continueto support the enhancement of convective activity over the central and south BoB as well as southeast and adjoining eastcentral AS during the second week.

The sea surface temperature over the entire BoB is 28-320C. The values of SST remain within the same range over the entire AS except western sectors of westcentral and southwest AS near coasts of Oman, Yemen and Somalia where the Sea is cooler (SST ~ 24-280C). Tropical Cyclone Heat Potential (TCHP) is high (>100 KJ/cm<sup>2</sup>) over north BoB and southwest BoB off Tamil Nadu coast. Higher values of TCHP (> 100 KJ/cm<sup>2</sup>) are also found over the equatorial North Indian Ocean and southwest AS.

Considering all the environmental features, it is inferred that the conditions are favorable inthe development of a low pressure area over north BoB during the first half and over westcentral BoB during the second half of the first week. Large-scale environmental features will also supportconvective activity over south and central BoB during the second week as well.

## **II. Model Guidance:**

Most of the models (ECMWF, IMD GFS, NCEP GFS, NCUM) do not indicate any cyclogenesis over entire north Indian Ocean till 10th October. However, all the models indicate a likely formation of a low pressure area over North BoB around 4th October, 2024. The NCEP GFS and ECMWF models indicate a likely formation of a low-pressure area over west-central and adjoining southwest BoB around 7th October, 2024, whereas, IMD GFS and NCUM do not support the similar activity over the region. The NCEP GFS, ECMWF and NCUM models are suggesting a possible formation of cyclonic circulation/Low pressure area over eastcentral AS around 11th October which is likely to move west-northwestwards during subsequent 2 days. According to NCEP GFS model, there is the probable formation of a low pressure area around 12th October over southeast BoB which is likely to move west-northwestwards across southwest BoB, Comorin, and southeast AS during next 4-5 days. The system is likely to intensify into a depression around 16th October and reaching the intensity of a cyclone during subsequent 2 days.

The 850 hPa mean wind forecast by IMD Extended Range Model indicates cyclonic circulation over Sub Himalayan West Bengal and adjoining North Bangladesh during week 1 and a fresh cyclonic circulation over westcentral BoB off north Andhra Pradesh coast during week 2. The mean wind anomaly at 850 hPa indicates an east-west trough over Sub Himalayan West Bengal and adjoining North Bangladesh, an east-west trough over central parts of South AS and another over southwest BoB during week 1. During week 2, the anomaly wind field indicates an east-west trough over south & adjoining central parts of India. These features indicate that (a) existing cyclonic circulation over South Bangladesh would move slowly north-northwestwards during the next 2-3 days, (b) existing cyclonic circulation over Lakshadweep is likely to move nearly westwards during next 2-3 days and (c) a fresh cyclonic circulation is likely to form over southeast & adjoining central BoB during later part of week 1. It is likely to become a low pressure area over westcentral BoB during week 2 and move west-northwestwards.

The model indicates a low probability (30-40%) of cyclogenesis over coastal areas of Gangetic West Bengal and Bangladesh during the first week. The model also indicates a low probability (10-20%)

over southeast and adjoining central BoB during week 1 and over westcentral BoB during week 2. The ECMWF ensemble forecast Model also indicates low probability (20-30%) over the eastcentral Arabian Sea off Konkan Goa coast during the 2nd half of the first week. The ECMWF model also suggests moderate probability (40-60%) of cyclogenesis over westcentral and adjoining south Bay of Bengal during the second week.

**Legends:** MJO: Madden Julian Oscillation, ERW: Equatorial Rossby Waves, KW: Kelvin Waves, NCICS: North Carolina Institute for Climate Studies (for Equatorial waves Forecast), IMD GFS: India Meteorological Department Global Forecast System, NCUM: National Centre for Medium Range Weather Forecasting Centre (NCMRWF) Unified Model, ECMWF: European Centre for Medium Range Weather Forecasting, ECMF: ECMWF-Ensemble System, ECMM: ECMWF- Ensemble System Bias Corrected, GPP: Genesis Potential Parameter, NCEP GFS: National Centre for Environment Prediction GFS, GEFS: GFS ensemble forecast system, NEPS: NCUM ensemble prediction system, CNCUM: Coupled NCUM, CPC: Climate Prediction Centre, NWS: National Weather Service, INCOIS: Indian National Centre for Ocean Information Services.

### **III. Inference:**

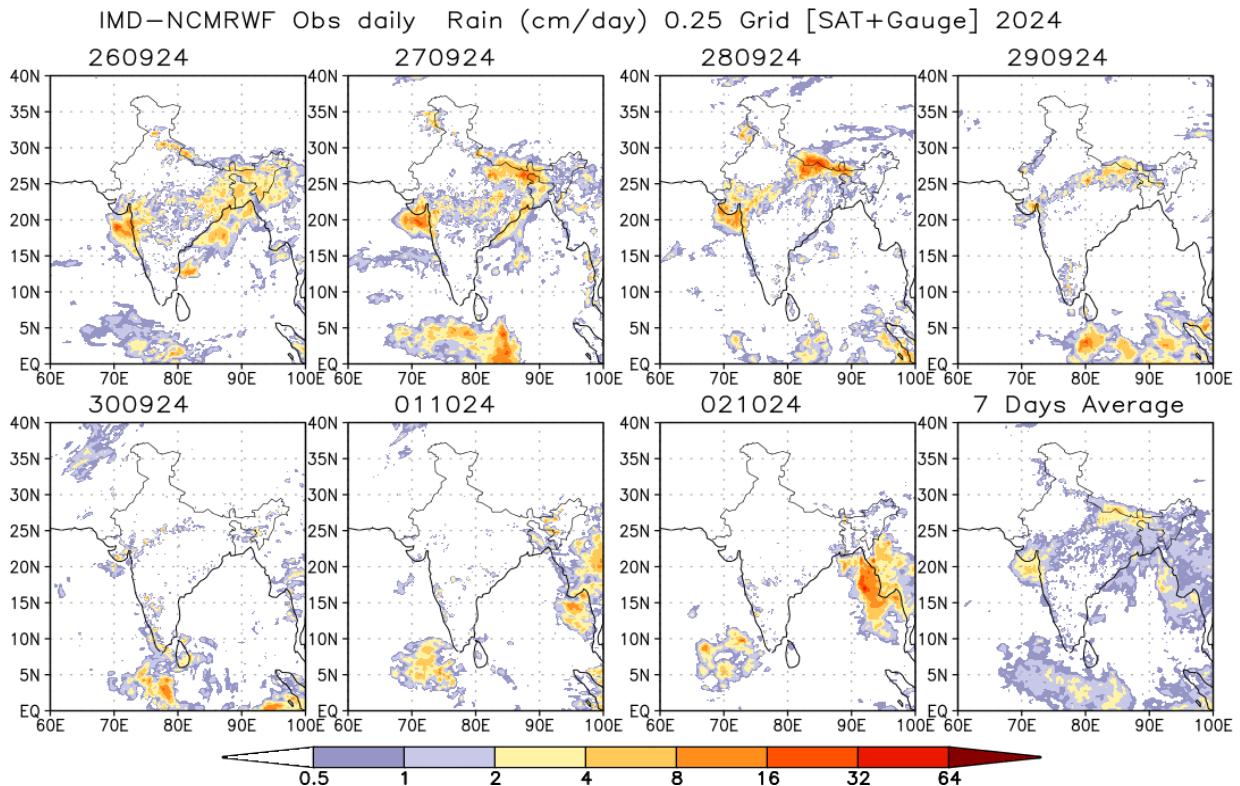
Considering various environmental conditions and model guidance, it is inferred that there is no probability of cyclogenesis over the north India Ocean region during the first week.

- (i) However, a low pressure area is likely to form over north Bay of Bengal and neighbourhood around 4th October and another cyclonic circulation/low pressure area over westcentral Bay of Bengal around 6th October.
- (ii) There is a low to moderate probability of cyclogenesis over the central Bay of Bengal during the first half of the second week.

### **IV. Verification of forecast issued during last two weeks:**

- (i) Week 2 forecast issued on 19th September for the second week (27.09.2024- 03.10.2024) indicated: No cyclogenesis for week 2. Week 1 forecast issued on 26th September for first week (27.09.2024-03.10.2024) indicated: No cyclogenesis for week 1.
- (ii) Realised: A fresh cyclonic circulation lay over Comorin area and adjoining equatorial Indian Ocean and extends up to 1.5 km above mean sea level at 0300 UTC on 1<sup>st</sup> October, 2024. Another upper air cyclonic circulation formed over the north Andaman Sea and adjoining south Myanmar coast at 0000 UTC on 2<sup>nd</sup> and persisted over southeast Bangladesh on 3<sup>rd</sup> October. However, no cyclogenesis occurred during the period.

The observed satellite-gauge merged analysis of 24 hours accumulated rainfall from 26th September to 02<sup>nd</sup> October, 2024 is shown in Fig. II-C-1(b).



**Fig. II-C-1(b): NCMRWF-IMD satellite gauge merged data plots of realized 24 hours Accumulated rainfall from 26th September to 02nd October, 2024.**

**Example 01: Special message bulletin in association with Low pressure area**



**India Meteorological Department  
(Ministry of Earth Sciences)**

**SPECIAL MESSAGE NO. 2 (BOB/06/2024)**

**TIME OF ISSUE: 1000 HOURS IST**

**DATED: 21.10.2024**

**FROM: INDIA METEOROLOGICAL DEPARTMENT  
24643965/24699216/24623220)**

**(FAX NO.**

**TO: CONTROL ROOM, NDM, MINISTRY OF HOME AFFAIRS (FAX.NO. 23093750)  
CONTROL ROOM NDMA (FAX.NO. 26701729)  
CABINET SECRETARIAT (FAX.NO.23012284, 23018638)  
PS TO HON'BLE MINISTER FOR S & T AND EARTH SCIENCES (FAX NO.23316745)  
SECRETARY, MOES (FAX NO. 24629777)  
H.Q. (INTEGRATED DEFENCE STAFF AND CDS) (FAX NO. 23005137/23005147)  
DIRECTOR GENERAL, DOORDARSHAN (23385843)  
DIRECTOR GENERAL, AIR (23421105, 23421219)  
PIB MOES (FAX NO. 23389042)  
UNI (FAX NO. 23355841)  
D.G. NATIONAL DISASTER RESPONSE FORCE (NDRF) (FAX NO. 26105912, 2436 3260)**

DIRECTOR, PUNCTUALITY, INDIAN RAILWAYS (FAX NO. 23388503)  
 CHIEF SECRETARY, ODISHA (FAX NO. 0674-2536660)  
 CHIEF SECRETARY, WEST BENGAL (FAX NO. 033-22144328)  
 CHIEF SECRETARY, ANDAMAN & NICOBAR ISLANDS (FAX NO. 03192-232656) CHIEF  
 SECRETARY, TAMIL NADU (FAX NO. 044-25672304)  
 CHIEF SECRETARY, ANDHRA PRADESH (FAX NO. 0863-2441029)  
 CHIEF SECRETARY, PUDUCHERRY (FAX NO. 0413-2334145)

**Subject: Low Pressure Area formed over eastcentral Bay of Bengal and adjoining North Andaman Sea: Pre-Cyclone Watch for Odisha and West Bengal coasts**

Yesterday's cyclonic circulation lay over North Andaman Sea lay over North Andaman Sea and adjoining eastcentral & southeast Bay of Bengal in the same evening (1730 hours IST of 20<sup>th</sup> October). Under its influence a **\*Low Pressure Area\*** formed over the Eastcentral Bay of Bengal and adjoining north Andaman Sea in the early morning (0530 hours IST) of today, the 21<sup>st</sup> October 2024.

It is very likely to move west-northwestwards and intensify into a depression by 22<sup>nd</sup> October morning and into a cyclonic storm by 23<sup>rd</sup> October, 2024 over eastcentral Bay of Bengal. Thereafter, it is very likely to move northwestwards and reach northwest Bay of Bengal off Odisha-West Bengal coasts by 24<sup>th</sup> October morning.

Forecast track and intensity are given in the following table:

Date/Time (IST)	Position (Lat. °N/ Long. °E)	Maximum Sustained Surface Wind Speed (Kmph)	Category Of Cyclonic Disturbance
21.10.24/0530	14.5/92.0	20-30 gusting to 40	Low Pressure Area
21.10.24/1730	14.7/91.4	35-45 gusting to 55	Well Marked Low
22.10.24/0530	15.0/90.7	45-55 gusting to 65	Depression
22.10.24/1730	15.5/89.8	55-65 gusting to 75	Deep Depression
23.10.24/0530	16.2/89.0	65-75 gusting to 85	Cyclonic Storm
23.10.24/1730	17.4/88.4	80-90 gusting to 100	Cyclonic Storm
24.10.24/0530	19.0/87.8	100-110 gusting to 120	Severe Cyclonic Storm

**Warnings:**

**(i) Rainfall Warning:**

- ❖ Light to moderate rainfall at most places with **heavy to very heavy rainfall (7-20 cm)** at isolated places is very likely over Andaman Islands on 21<sup>st</sup> October.
- ❖ Light to moderate rainfall at most places with **heavy rainfall (07-11 cm)** at isolated places is very likely over Odisha on 23<sup>rd</sup> Oct. & **heavy to very heavy rainfall** at a few places and **extremely heavy rainfall ( $\geq 21$  cm)** at isolated places on 24<sup>th</sup> & 25<sup>th</sup> October.
- ❖ **Light to moderate rainfall at most places with heavy rainfall** at isolated places is very likely over **coastal districts of West Bengal** on 23<sup>rd</sup> October and heavy to very heavy rainfall at a few places **with extremely heavy rainfall** at isolated places over Gangetic West Bengal on 24<sup>th</sup> & 25<sup>th</sup> October.
- ❖ Light to moderate rainfall at many places with **heavy rainfall** at isolated places is very likely over North coastal Andhra Pradesh on 24<sup>th</sup> and 25<sup>th</sup> October.

**(ii) Wind Warning:**

**Andaman Sea:** Squally weather with wind speed reaching 35-45 gusting to 55 kmph is very likely over Andaman Sea on 21<sup>st</sup> October.

**Eastcentral Bay of Bengal:** Squally wind speed reaching 35-45 gusting to 65 kmph is very likely on 21<sup>st</sup> October, 55-65 gusting to 75 kmph by 22<sup>nd</sup> evening, 70-90 kmph gusting to 100 kmph from 23<sup>rd</sup> evening till 24<sup>th</sup> morning.

**Adjoining areas of Westcentral Bay of Bengal:** Squally wind speed reaching 45-55 gusting to 65 kmph is very likely on 23<sup>rd</sup> and 24<sup>th</sup> Oct.

**North Bay of Bengal:** Squally wind speed reaching 40-50 gusting to 60 kmph is very likely to commence from 23<sup>rd</sup> morning. It would gradually increase becoming gale wind speed reaching 100-110 kmph gusting to 120 kmph from 24<sup>th</sup> Oct evening to 25<sup>th</sup> Oct morning and decrease thereafter.

**Along & off Odisha-west Bengal coasts:** Squally wind speed reaching 40-50 gusting to 60 kmph is very likely to commence from 23<sup>rd</sup> Oct evening. It would gradually increase becoming gale wind speed reaching 100-110 kmph gusting to 120 kmph from 24<sup>th</sup> Oct night till 25<sup>th</sup> Oct morning.

### (iii) Sea Condition:

**Andaman Sea:** Sea condition is likely to be **Moderate to Rough** on 21<sup>st</sup> October.

**Eastcentral Bay of Bengal:** Sea condition is likely to become **Rough to Very Rough** from 21<sup>st</sup> October morning to 22<sup>nd</sup> October evening, becoming **very rough to high** thereafter till 24<sup>th</sup> October morning.

**Adjoining areas of Westcentral Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough** on 23<sup>rd</sup> and 24<sup>th</sup> October.

**North Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough from 23<sup>rd</sup> morning** and would become **High** from 24<sup>th</sup> October morning till 25<sup>th</sup> Oct forenoon.

**Along & off Odisha-west Bengal coasts:** Sea condition is likely to be **Rough to Very Rough from 23<sup>rd</sup> evening** and would become **High** from 24<sup>th</sup> October evening to 25<sup>th</sup> Oct forenoon.

### (iv) Fishermen Warning:

Fishermen are advised not to venture into

- Andaman Sea till 21<sup>st</sup> October.
- Eastcentral Bay of Bengal during 21<sup>st</sup>-24<sup>th</sup> October.
- **Adjoining areas of Westcentral Bay of Bengal on 23<sup>rd</sup> and 24<sup>th</sup> Oct.**
- **North Bay of Bengal** and along & off Odisha, West Bengal and Bangladesh coasts during 23<sup>rd</sup> to 25<sup>th</sup> October.

Fishermen out at sea are advised to return to coasts by 21<sup>st</sup> Oct.

### (v) Impact Expected [along Odisha and West Bengal coasts due to heavy rainfall]

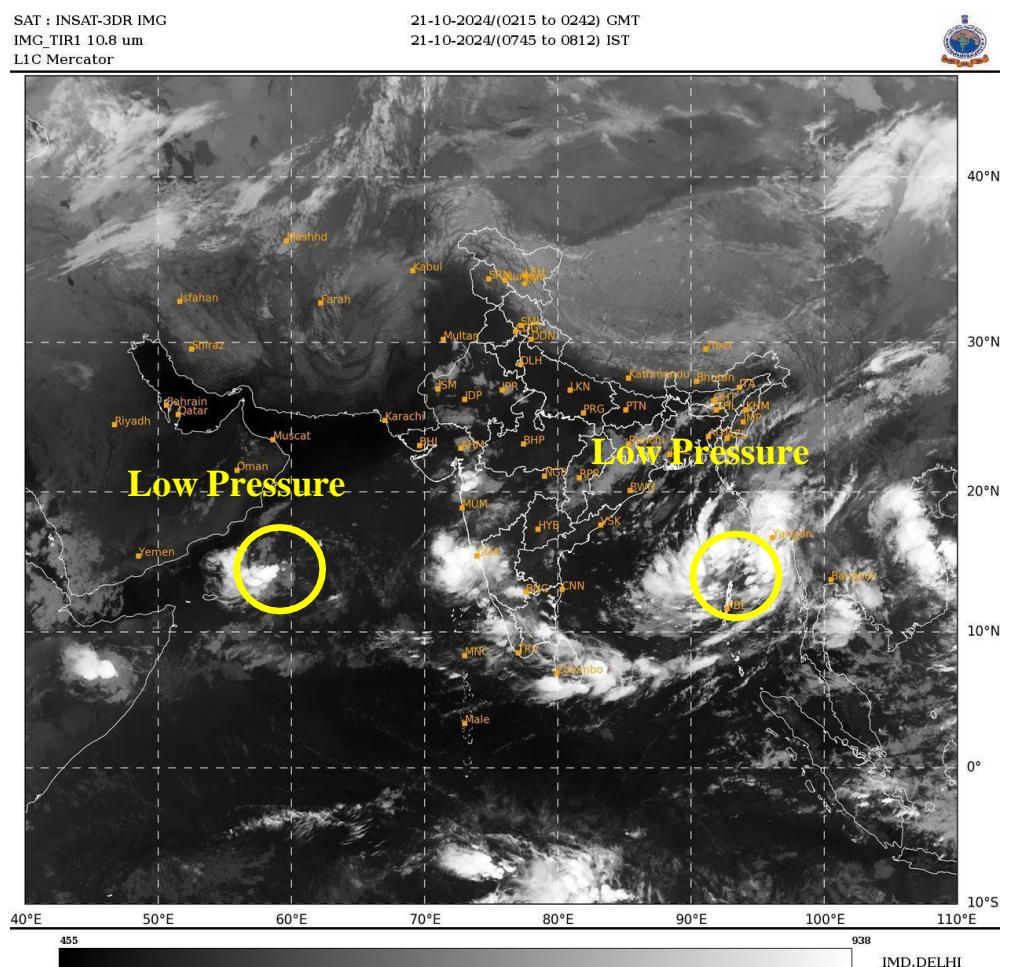
- Localized Flooding of roads, water logging in low lying areas and closure of underpasses mainly in urban areas of the above region.
- Occasional reduction in visibility due to heavy rainfall.
- Disruption of traffic in major cities and roadways due to water logging in roads and poor visibility due to heavy rain leading to increased travel time and incidents
- Localized Landslides/Mudslides/landslips/mud slips/land sinks/mud sinks.
- Likely disruption of marine and inland water transportation like small boats and trawlers.
- Minor damage to kutcha roads.
- Possibilities of damage to vulnerable structure. Breaking of tree branches and uprooting of trees.
- Damage to power and communication lines.
- Damage to horticulture and standing crops in some areas due to inundation and wind.
- It may lead to riverine flooding in some river catchments (for riverine flooding please visit Webpage of Central Water Commission)
- ❖ **Action Suggested [affected areas of Odisha and West Bengal due to heavy rainfall]**

Fishermen are advised not to venture into Andaman Sea till 21<sup>st</sup> October.

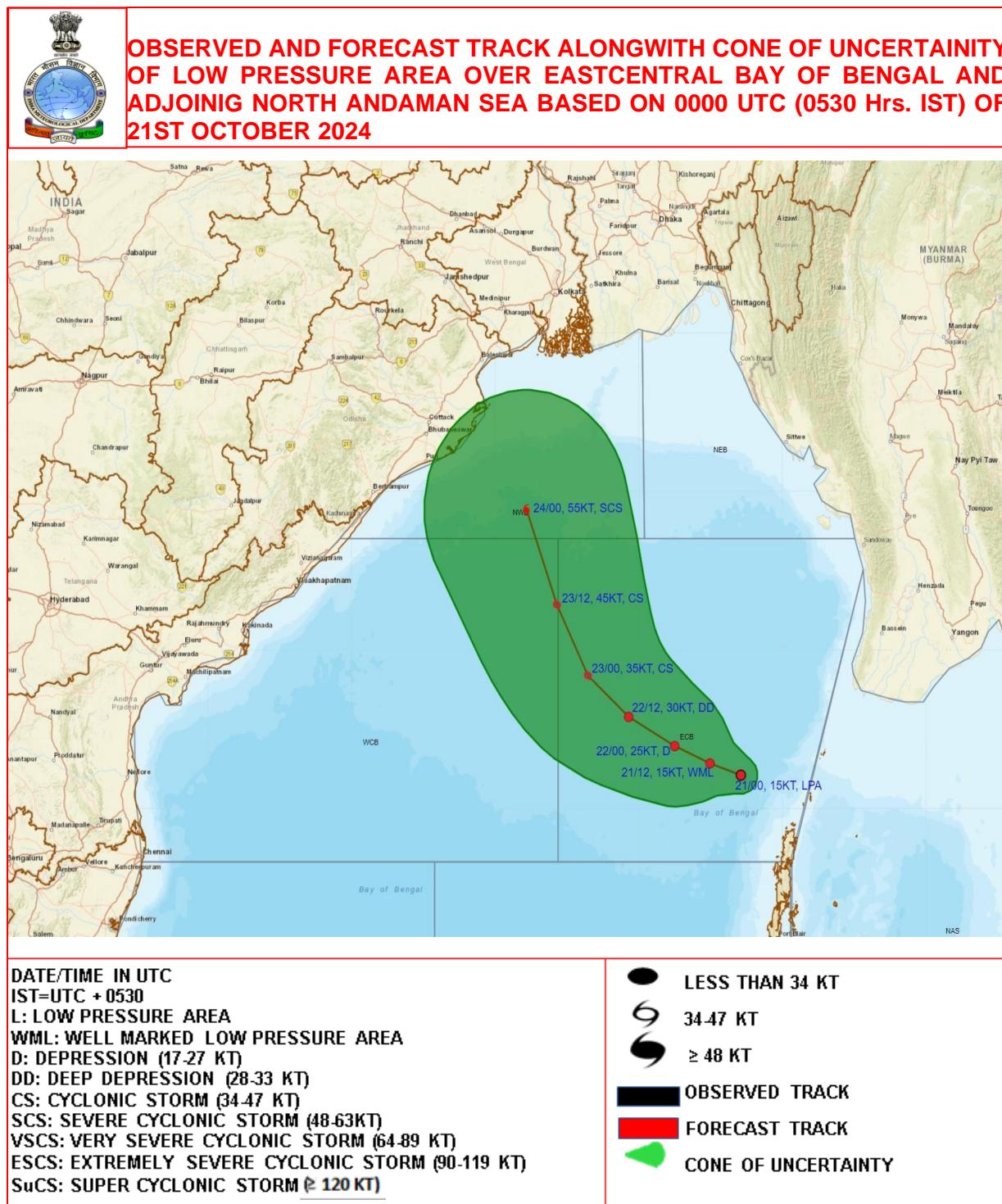
- ✓ Eastcentral Bay of Bengal during 21<sup>st</sup>-24<sup>th</sup> October.
- ✓ **Adjoining areas of Westcentral Bay of Bengal on 23<sup>rd</sup> and 24<sup>th</sup> Oct.**
- ✓ **North Bay of Bengal** and along & off Odisha-West Bengal coasts during 23<sup>rd</sup> to 25<sup>th</sup> October morning.

- Fishermen out at sea are advised to return to coasts by 21<sup>st</sup> October.
- Total suspension of fishing operations during 22<sup>nd</sup> to 25<sup>th</sup> Oct over Central and North Bay of Bengal.
- Judicious regulation of onshore/offshore, Port and maritime activities including shipping.
- Judicious regulation of tourism activities in Andaman & Nicobar Islands.
- Judicious regulation of surface transports including railways and roadways.
- Check for traffic congestion on your route before leaving for your destination.
- Follow any traffic advisories that are issued in this regard.
- Avoid going to areas that face the water logging problems often.
- Avoid staying in vulnerable structure.

*Copy to: ACWC Kolkata/ACWC Chennai/CWC Bhubaneswar/CWC Vishakhapatnam/Meteorological Centre Port Blair*



**Fig II-C-2(a): INSAT 3DR Image issued on 21<sup>st</sup> October, 2024**



**Fig II-C-2(b): Observed and forecast track along with cone of uncertainty of low pressure area over eastcentral Bay of Bengal and adjoining north Andaman Sea based on 0000 UTC of 21<sup>st</sup> October 2024**

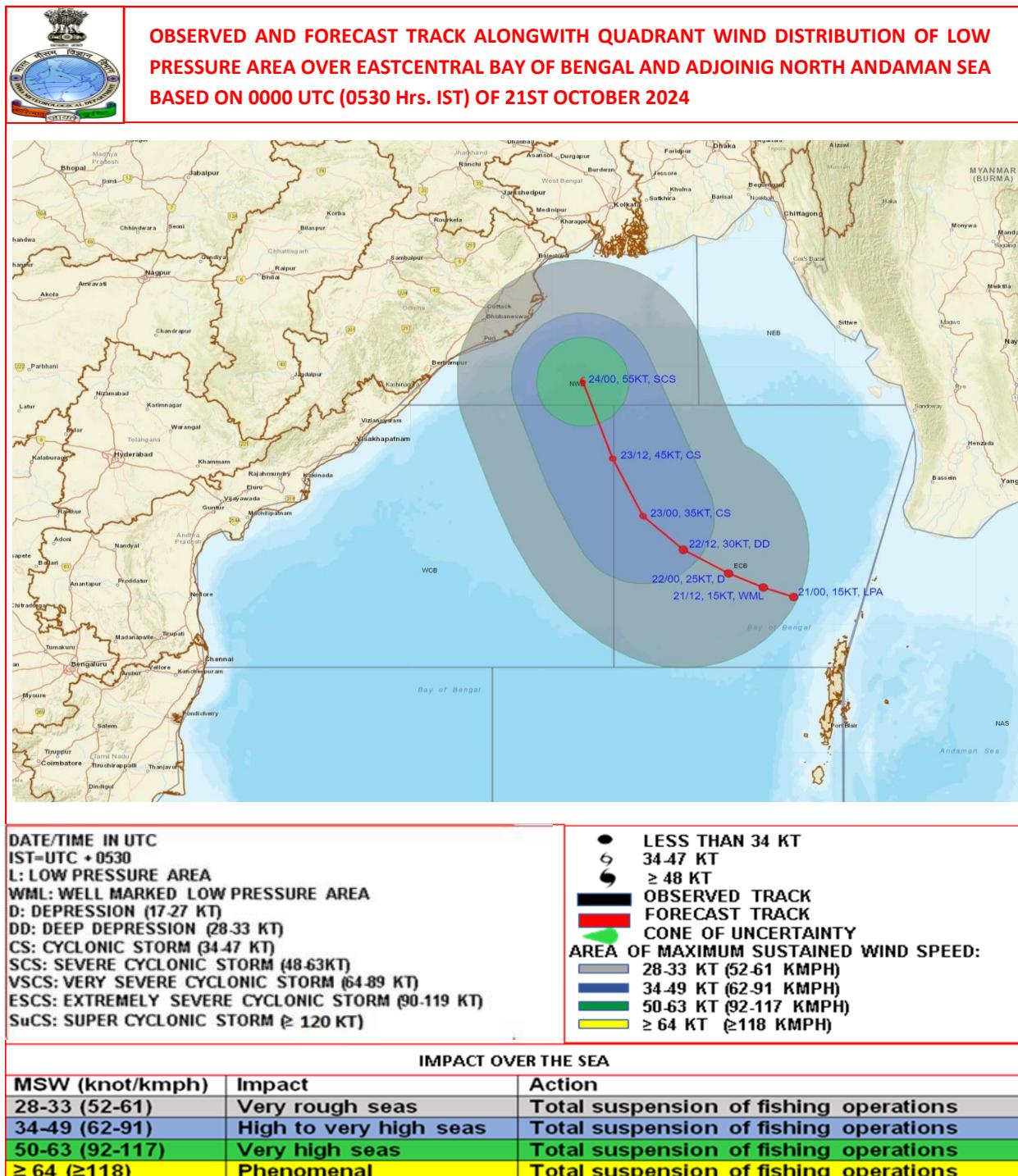
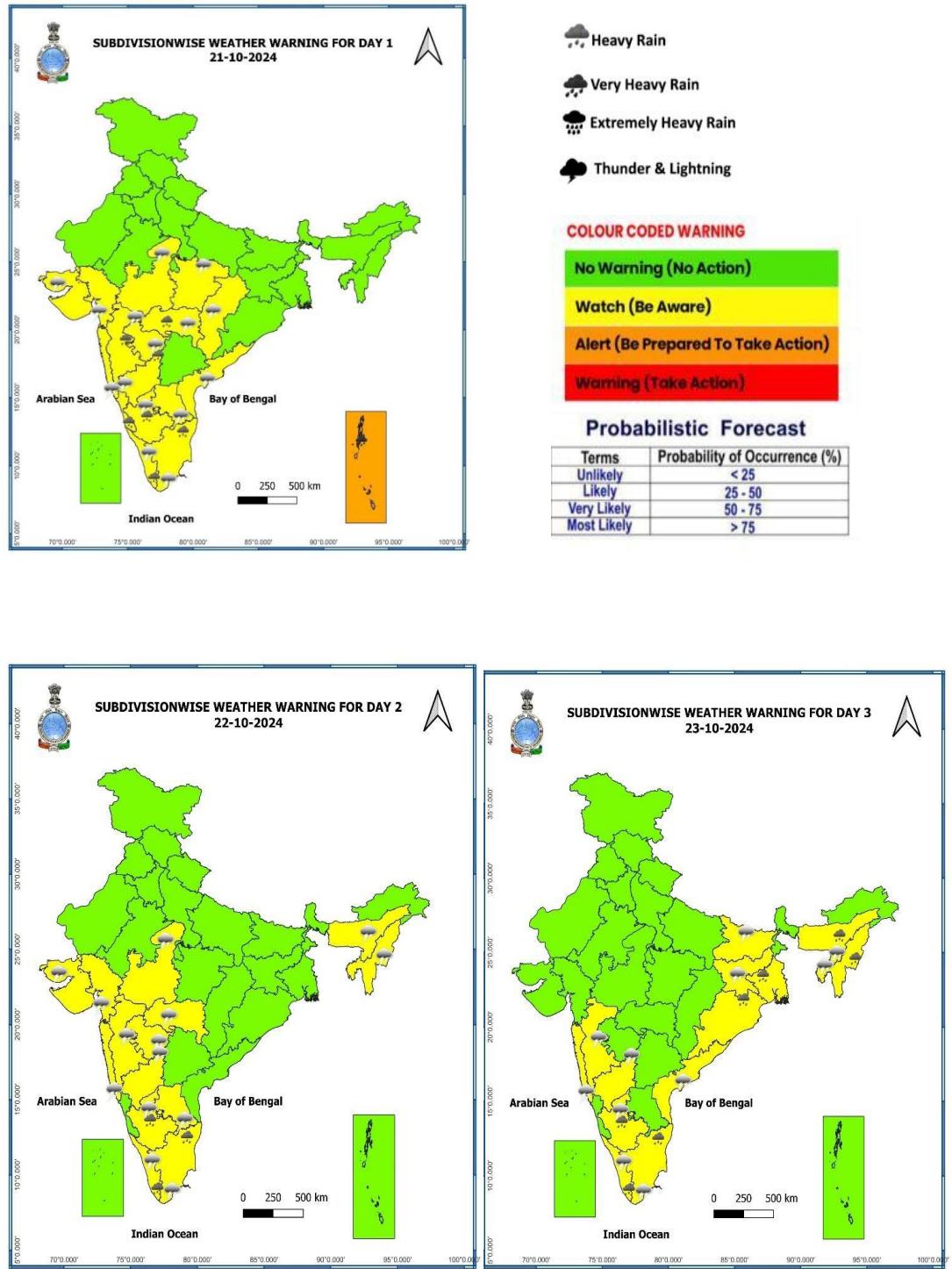
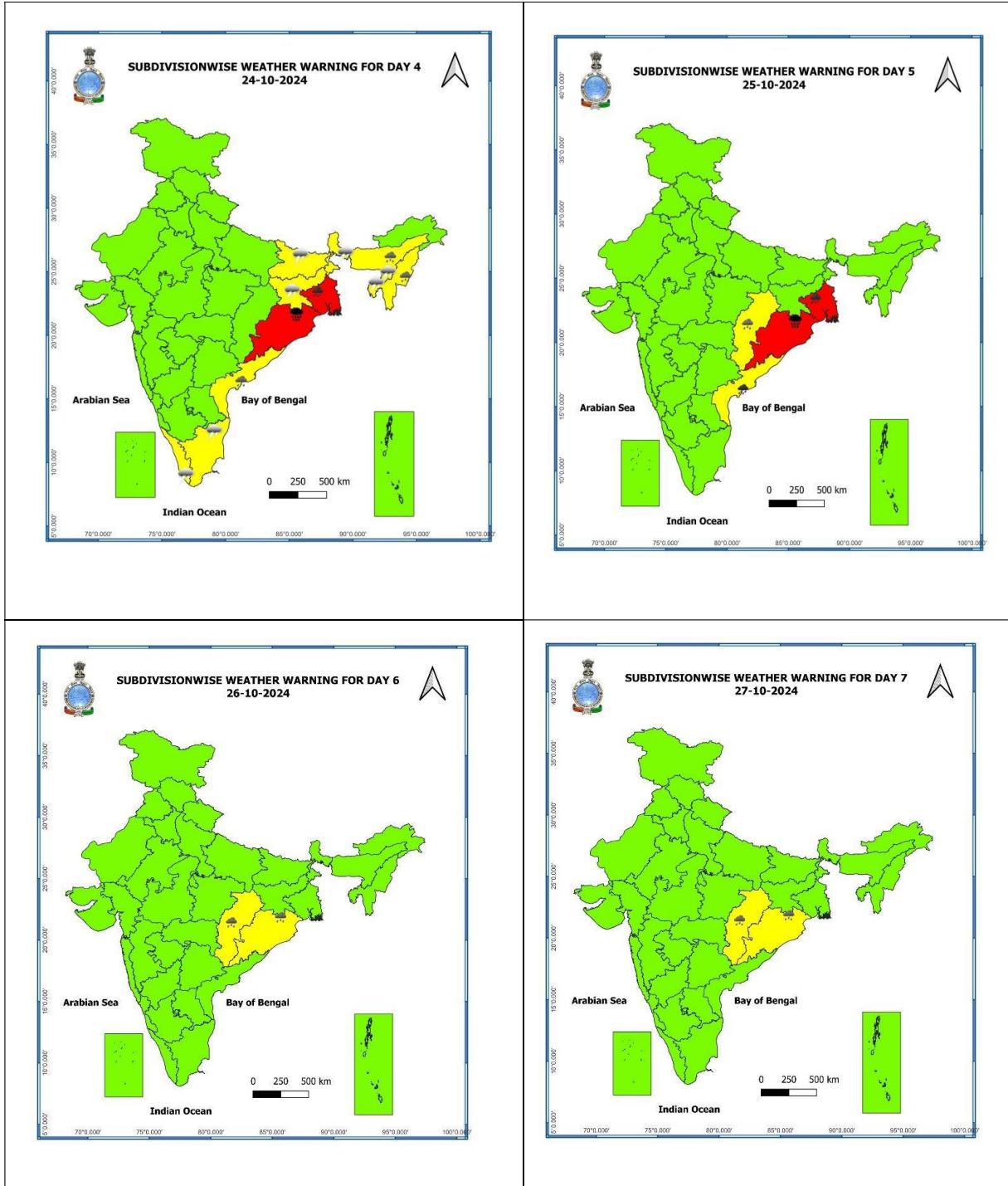


Fig II-C-2(c): Observed and forecast track along with quadrant wind distribution of low pressure area over eastcentral Bay of Bengal and adjoining north Andaman Sea based on 0000 UTC of 21<sup>st</sup> October 2024

## II-C-10





**Fig II-C-2(d): Heavy Rainfall Warning issued on 21<sup>st</sup> October 2024**

- Action may be taken based on **ORANGE AND RED COLOUR** warnings.
- Vulnerable regions likely urban and hilly areas action may be initiated for heavy rainfall warning.
- As the lead period increases forecast accuracy decreases.

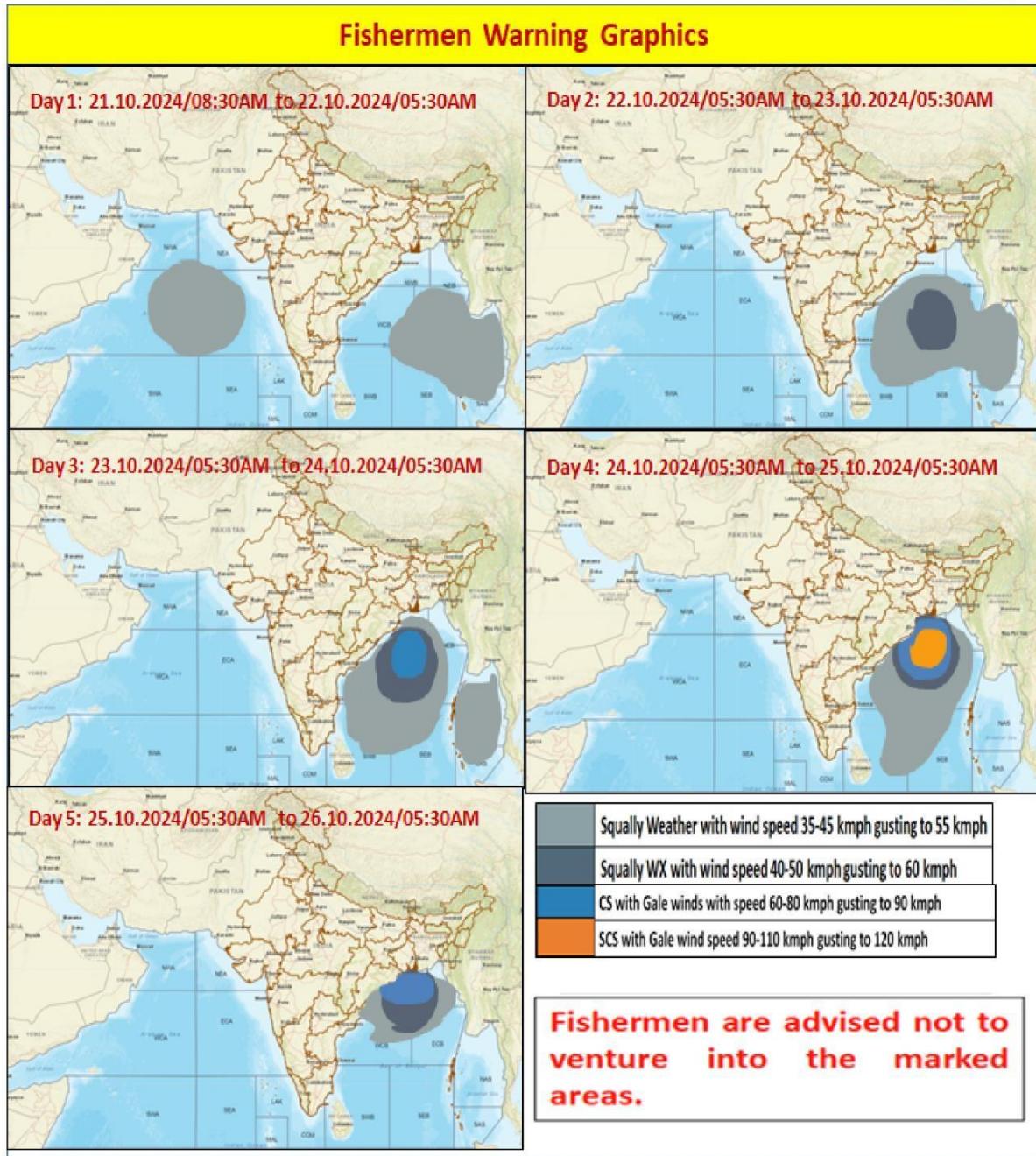


Fig II-C-2(e): Fishermen Warning Graphics issued on 21<sup>st</sup> October 2024

**Example 02: National bulletin in association with depression**
**India Meteorological Department  
(Ministry of Earth Sciences)**
**NATIONAL BULLETIN NO. 1 (BOB/06/2024)**
**TIME OF ISSUE: 0930 HOURS IST****DATED: 22.10.2024****FROM: INDIA METEOROLOGICAL DEPARTMENT (FAX NO. 24643965/24699216/24623220)****TO: CONTROL ROOM, NDM, MINISTRY OF HOME AFFAIRS (FAX.NO. 23093750)****CONTROL ROOM NDMA (FAX.NO. 26701729)****CABINET SECRETARIAT (FAX.NO.23012284, 23018638)****PS TO HON'BLE MINISTER FOR S & T AND EARTH SCIENCES (FAX NO.23316745)****SECRETARY, MOES (FAX NO. 24629777)****H.Q. (INTEGRATED DEFENCE STAFF AND CDS) (FAX NO. 23005137/23005147)****DIRECTOR GENERAL, DOORDARSHAN (23385843)****DIRECTOR GENERAL, AIR (23421105, 23421219)****PIB MOES (FAX NO. 23389042)****UNI (FAX NO. 23355841)****D.G. NATIONAL DISASTER RESPONSE FORCE (NDRF) (FAX NO. 26105912, 2436 3260)****DIRECTOR, PUNCTUALITY, INDIAN RAILWAYS (FAX NO. 23388503)****CHIEF SECRETARY, ODISHA (FAX NO. 0674-2536660)****CHIEF SECRETARY, WEST BENGAL (FAX NO. 033-22144328)****CHIEF SECRETARY, ANDAMAN & NICOBAR ISLANDS (FAX NO. 03192-232656)****CHIEF SECRETARY, TAMIL NADU (FAX NO. 044-25672304)****CHIEF SECRETARY, ANDHRA PRADESH (FAX NO. 0863-2441029)****CHIEF SECRETARY, PUDUCHERRY (FAX NO. 0413-2334145)**

**Subject: Depression over eastcentral Bay of Bengal (Pre-Cyclone Watch for Odisha and West Bengal coasts)**

Yesterday's well marked low pressure area over Eastcentral Bay of Bengal moved west-northwestwards, concentrated into a depression and lay centred at 0530 hrs IST of today, the 22nd October, over the same region near latitude 15.4° N and longitude 91.2°E, about 730 km southeast of Paradip (42976, Odisha), 770 km south-southeast of Sagar Island (42903, West Bengal) and 740 km south-southeast of Khepupara (41984, Bangladesh).

It is very likely to move west-northwestwards and intensify into a cyclonic storm by 23rd October, 2024 over eastcentral Bay of Bengal. Thereafter, continuing to move northwestwards, it is very likely to intensify into a severe cyclonic storm over northwest Bay of Bengal by 0000 UTC of 24th and cross north Odisha and West Bengal coasts between Puri and Sagar Island during 1800 UTC of 24th and 0000 UTC OF 25th October, 2024 as a severe Cyclonic Storm with a wind speed of 100-110 kmph gusting 120 kmph.

Forecast track and intensity are given in the following table:

Date/Time (IST)	Position (Lat. °N/ Long. °E)	Maximum Sustained Surface Wind Speed (Kmph)	Category Of Cyclonic Disturbance
22.10.24/0530	15.4/91.2	35-45 gusting to 55	Depression
22.10.24/1130	15.6/90.7	40-50 gusting to 60	Depression
22.10.24/1730	15.8/90.2	45-55 gusting to 65	Depression
22.10.24/2330	16.1/89.7	50-60 gusting to 70	Deep Depression
23.10.24/0530	16.5/89.2	55-65 gusting to 75	Deep Depression

23.10.24/1730	17.4/88.4	65-75 gusting to 85	Cyclonic Storm
24.10.24/0530	18.7/87.8	80-90 gusting to 100	Cyclonic Storm
24.10.24/1730	20.0/87.5	95-105 gusting to 115	Severe Cyclonic Storm
25.10.24/0530	21.0/86.8	100-110 gusting to 120	Severe Cyclonic Storm
25.10.24/1730	21.5/85.8	70-80 gusting 90	Cyclonic Storm

**(i) Rainfall Warning:**

- ❖ Light to moderate rainfall at most places with **heavy to very heavy rainfall (7-20 cm)** at isolated places is very likely over Andaman Islands on 21<sup>st</sup> October.
- ❖ Light to moderate rainfall at most places with **heavy rainfall (07-11 cm)** at isolated places is very likely over **Balasore, Bhadrak, Kendrapara, Jagatsingpur, Puri, Khorda, Ganjam, Gajapati**, districts of Odisha on 23<sup>rd</sup> Oct. & **heavy to very heavy rainfall** at a few places and **extremely heavy rainfall ( $\geq 21$  cm)** at isolated places over **Baleswar, Mayurbhanj, Bhadrak, Kendrapara, Jagatsingpur Kendujhar, Jajpur, Cuttack and Dhenkanal and Puri** districts of Odisha on 24<sup>th</sup> & 25<sup>th</sup> October.
- ❖ **Light to moderate rainfall at most places with heavy rainfall** at isolated places is very likely on 23<sup>rd</sup> October and heavy to very heavy rainfall at a few places with **extremely heavy rainfall** at isolated places over **South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata and Bankura** districts of Gangetic West Bengal on 24<sup>th</sup> & 25<sup>th</sup> October.
- ❖ Light to moderate rainfall at many places with **heavy rainfall** at isolated places is very likely over **Srikakulam, Vizianagaram and Vishakhapatnam** districts of North coastal Andhra Pradesh on 24<sup>th</sup> and 25<sup>th</sup> October.

**(ii) Wind Warning:**

**Eastcentral Bay of Bengal:** Squally wind speed reaching 40-50 gusting to 60 kmph is very likely on 22<sup>nd</sup> October, 55-65 gusting to 75 kmph by 22<sup>nd</sup> night, 70-90 kmph gusting to 100 kmph from 23<sup>rd</sup> evening till 24<sup>th</sup> morning.

**Adjoining areas of Westcentral Bay of Bengal:** Squally wind speed reaching 40-50 gusting to 60 kmph is very likely to commence from 22<sup>nd</sup> evening, 70-90 gusting to 65 kmph from 23<sup>rd</sup> morning to 24<sup>th</sup> afternoon.

**Northwest Bay of Bengal:** Squally wind speed reaching 40-50 gusting to 60 kmph is very likely to commence from 23<sup>rd</sup> morning. It would gradually increase becoming gale wind speed reaching 70-90 gusting to 100 kmph from 23<sup>rd</sup> night to 24<sup>th</sup> morning and 100-110 kmph gusting to 120 kmph from 24<sup>th</sup> Oct evening to 25<sup>th</sup> Oct morning and decrease gradually thereafter.

**Adjoining areas of northeast Bay of Bengal:** Squally wind speed reaching 40-50 gusting to 60 kmph is very likely to commence from 23<sup>rd</sup> night till 25<sup>th</sup> morning and decrease gradually thereafter.

**Along & off Odisha-west Bengal coasts:** Squally wind speed reaching 40-50 gusting to 60 kmph is very likely to commence from 23<sup>rd</sup> Oct evening. It would gradually increase becoming gale wind speed reaching 100-110 kmph gusting to 120 kmph from 24<sup>th</sup> Oct evening till 25<sup>th</sup> Oct morning and decrease gradually thereafter.

**(iii) Sea Condition:**

**Eastcentral Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough** on 22<sup>nd</sup> October, becoming **very rough to high from 23<sup>rd</sup> morning till 24<sup>th</sup> October morning.**

**Adjoining areas of Westcentral Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough** on 23<sup>rd</sup> and 24<sup>th</sup> October.

**Northwest Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough from 23<sup>rd</sup> morning** and would become **High to Very High** from 23<sup>rd</sup> night till 25<sup>th</sup> morning and improve gradually thereafter.

**Adjoining areas of northeast Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough** from 23<sup>rd</sup> night till 25<sup>th</sup> morning and improve gradually thereafter.

**Along & off Odisha-west Bengal coasts:** Sea condition is likely to be **Rough to Very Rough from 23<sup>rd</sup> evening** and would become **High to Very High** from **24<sup>th</sup> October evening to 25<sup>th</sup> Oct forenoon** and improve gradually thereafter.

**(iv) Fishermen Warning:**

Fishermen are advised not to venture into

- Eastcentral Bay of Bengal during 22<sup>nd</sup>-24<sup>th</sup> October.
- **Adjoining areas of Westcentral Bay of Bengal on 23<sup>rd</sup> and 24<sup>th</sup> Oct.**
- **North Bay of Bengal** and along & off Odisha, West Bengal and Bangladesh coasts during 23<sup>rd</sup> to 25<sup>th</sup> October.

Fishermen out at sea are advised to return to coasts by 22<sup>nd</sup> Oct.

**(v) Impact Expected over districts of Odisha (Baleswar, Bhadrak, Kendrapara, Jagatsinghpur, Puri, Khorda, Mayurbhanj, Kendujhar, Jajpur, Cuttack, Dhenkanal) and West Bengal (South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata, & Bankura)**

- Major damage to thatched houses/ huts. Roof tops may blow off. Unattached metal sheets may fly.
- Minor damage to power and communication lines.
- Major damage to Kutch and some damage to Pucca roads. Flooding of escape routes.
- Possibilities of damage to vulnerable structure. Breaking of tree branches and uprooting of trees.
- Moderate damage to banana and papaya trees. Large dead limbs blown from trees.
- Damage to horticulture and standing crops in some areas due to inundation and wind.
- Damage to embankments/ salt pans.
- Localized Flooding of roads, water logging in low lying areas and closure of underpasses mainly in urban areas of the above region.
- Occasional reduction in visibility due to heavy rainfall.
- Disruption of traffic in major cities and roadways due to water logging in roads and poor visibility due to heavy rain leading to increased travel time and incidents
- Localized Landslides/Mudslides/landslips/mud slips/land sinks/mud sinks.
- Likely disruption of marine and inland water transportation like small boats and trawlers.
- It may lead to riverine flooding in some river catchments (for riverine flooding please visit Webpage of Central Water Commission)

**❖ Action Suggested Baleswar, Bhadrak, Kendrapara, Jagatsinghpur, Puri, Khorda, Mayurbhanj, Kendujhar, Jajpur, Cuttack, Dhenkanal) and West Bengal (South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata & Bankura)**

- Fishermen are advised not to venture into
  - ✓ Eastcentral Bay of Bengal during 22<sup>nd</sup>-24<sup>th</sup> October.
  - ✓ **Adjoining areas of Westcentral Bay of Bengal on 23<sup>rd</sup> and 24<sup>th</sup> Oct.**
  - ✓ **North Bay of Bengal** and along & off Odisha-West Bengal coasts during 23<sup>rd</sup> to 25<sup>th</sup> October morning.
- Fishermen out at sea are advised to return to coasts by 22<sup>nd</sup> October.
- Total suspension of fishing operations during 22<sup>nd</sup> to 25<sup>th</sup> Oct over Central and North Bay of Bengal.
- Movement in motor boats unsafe
- Coastal hutment dwellers to be moved to safer places.
- People in affected areas to remain indoors.
- Judicious regulation of onshore/offshore, Port and maritime activities including shipping.
- Judicious regulation of tourism activities in Andaman & Nicobar Islands.
- Judicious regulation of surface transports including railways and roadways.
- Check for traffic congestion on your route before leaving for your destination.
- Follow any traffic advisories that are issued in this regard.
- Avoid going to areas that face the water logging problems often.
- Avoid staying in vulnerable structure.

Next bulletin will be issued at 1130 hours IST of today, the 22<sup>nd</sup> October, 2024.

Copy to: ACWC Kolkata/ACWC Chennai/CWC Bhubaneswar/CWC Vishakhapatnam/Meteorological Centre Port Blair

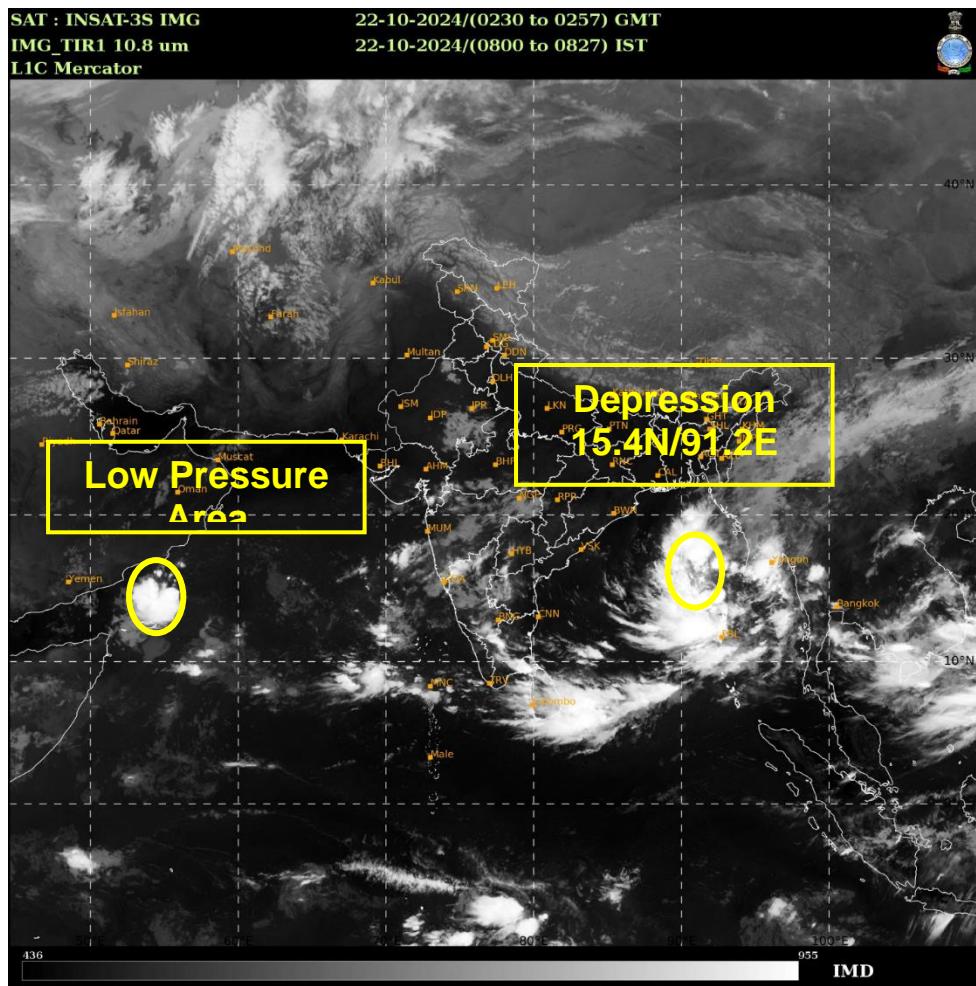
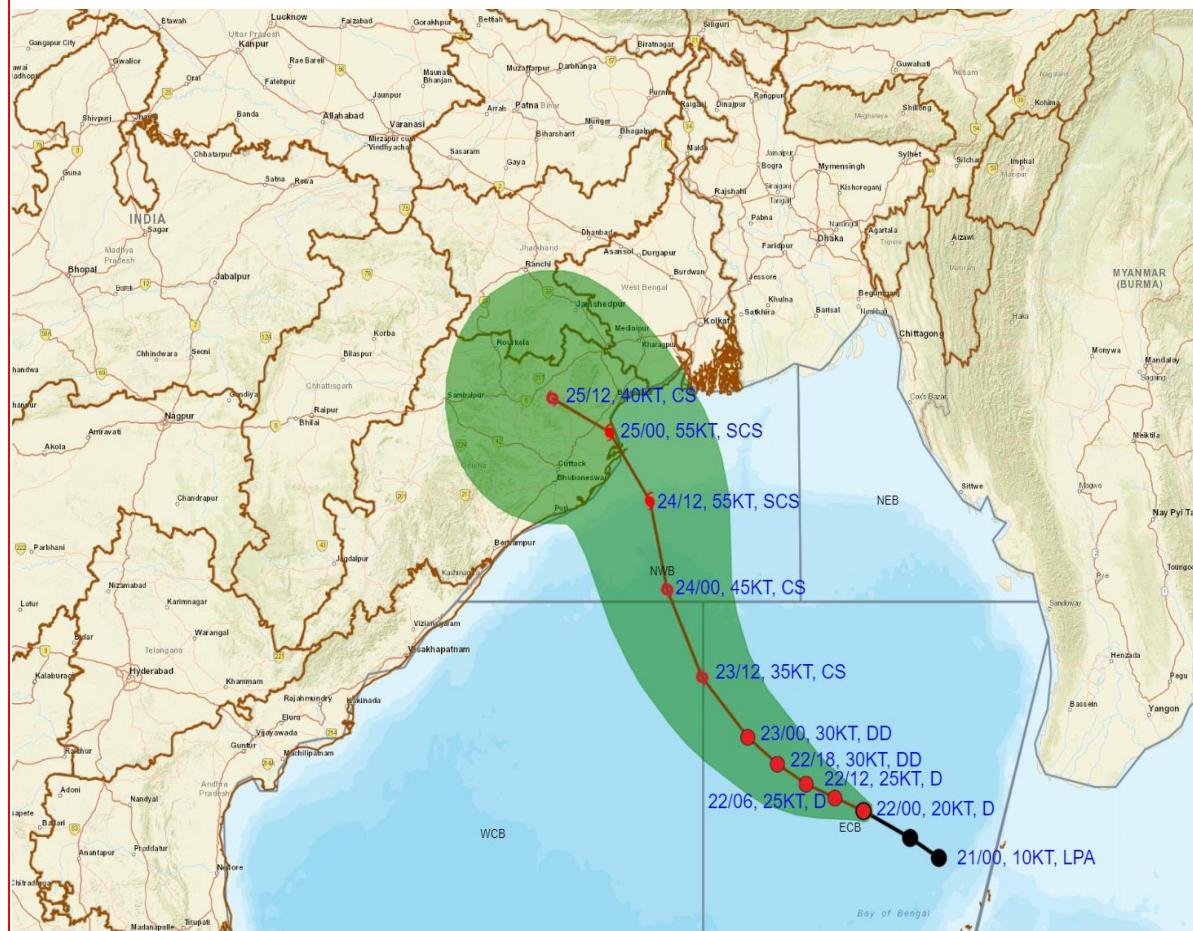


Fig II-C-3(a): INSAT 3S Image issued on 22<sup>nd</sup> October, 2024



## OBSERVED AND FORECAST TRACK ALONGWITH CONE OF UNCERTAINTY OF DEPRESSION OVER EASTCENTRAL BAY OF BENGAL BASED ON 0000 UTC (0530 Hrs. IST) OF 22ND OCTOBER 2024



**DATE/TIME IN UTC  
IST=UTC + 0530**

**1KT=1.85 KMPH**

**L: LOW PRESSURE AREA**

**WML: WELL MARKED LOW PRESSURE AREA**

**D: DEPRESSION (17-27 KT)**

**DD: DEEP DEPRESSION (28-33 KT)**

**CS: CYCLONIC STORM (34-47 KT)**

**SCS: SEVERE CYCLONIC STORM (48-63 KT)**

**VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)**

**ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)**

**SuCS: SUPER CYCLONIC STORM ( $\geq 120$  KT)**

**LESS THAN 34 KT**

**34-47 KT**

**$\geq 48$  KT**

**OBSERVED TRACK**

**FORECAST TRACK**

**CONE OF UNCERTAINTY**

**Fig II-C-3(b): Observed and forecast track along with cone of uncertainty of depression over eastcentral Bay of Bengal based on 0000 UTC of 22nd October 2024**

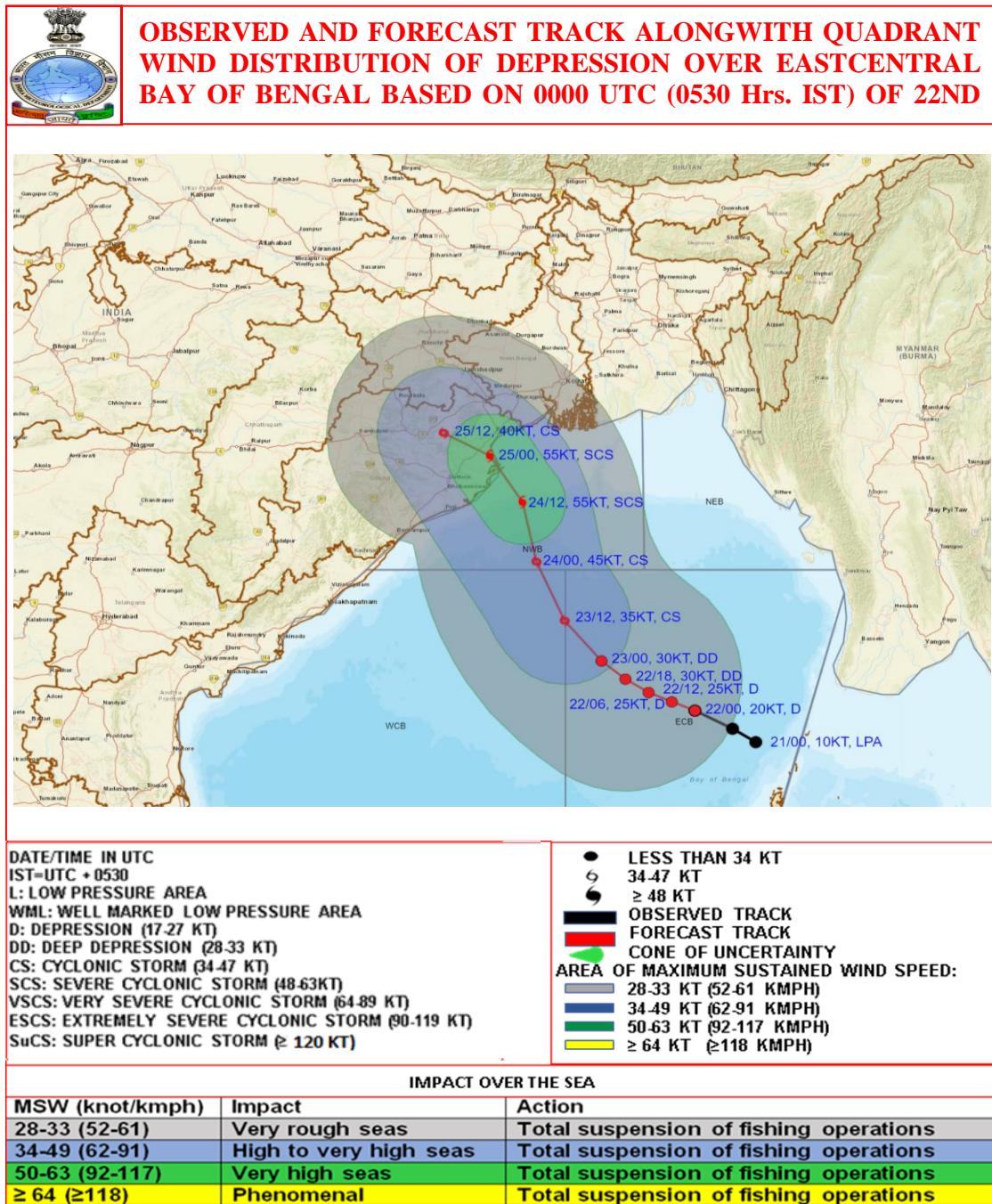
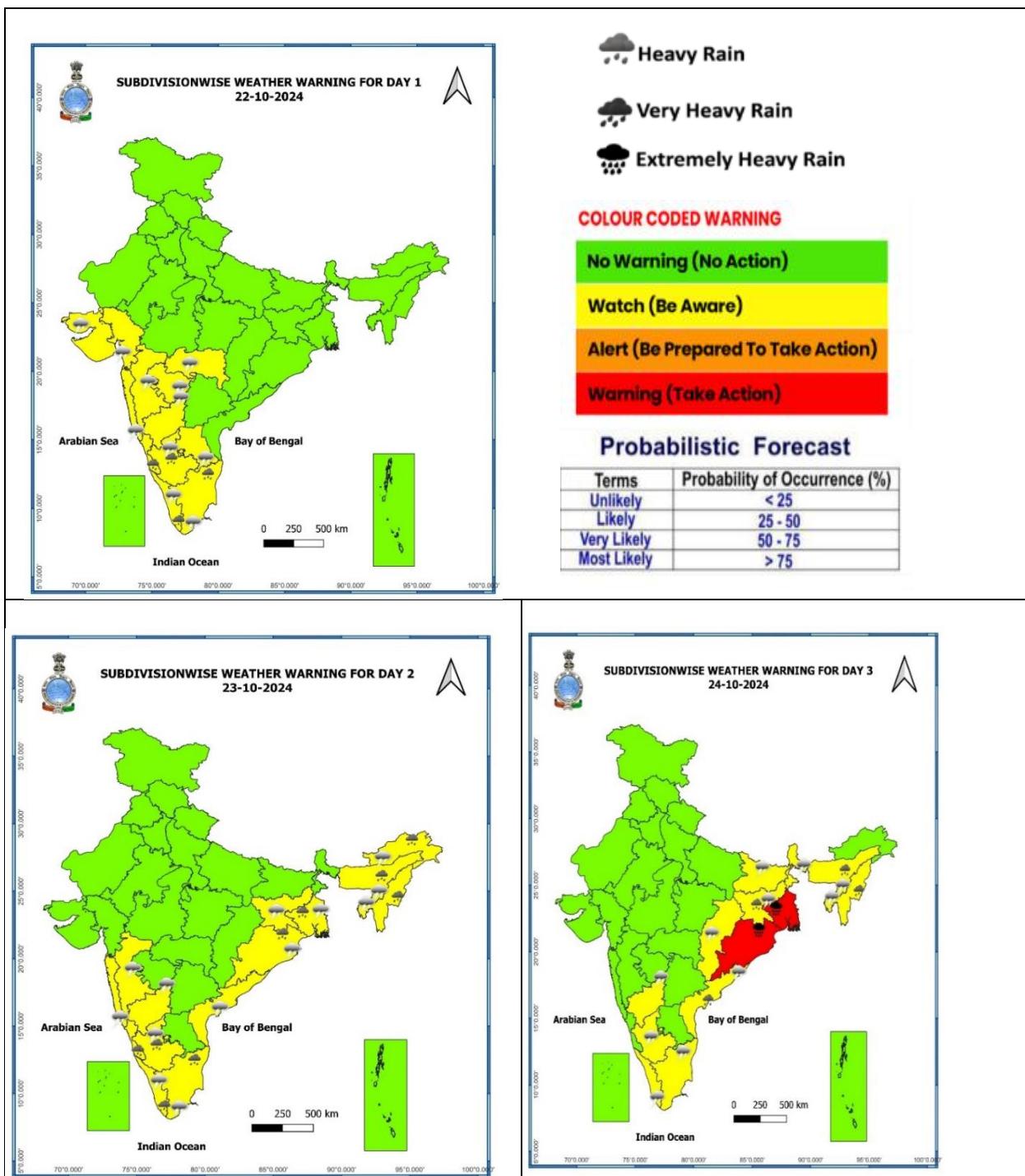


Fig II-C-3(c): Observed and forecast track along with cone of uncertainty of depression over eastcentral Bay of Bengal based on 0000 UTC of 22nd October 2024



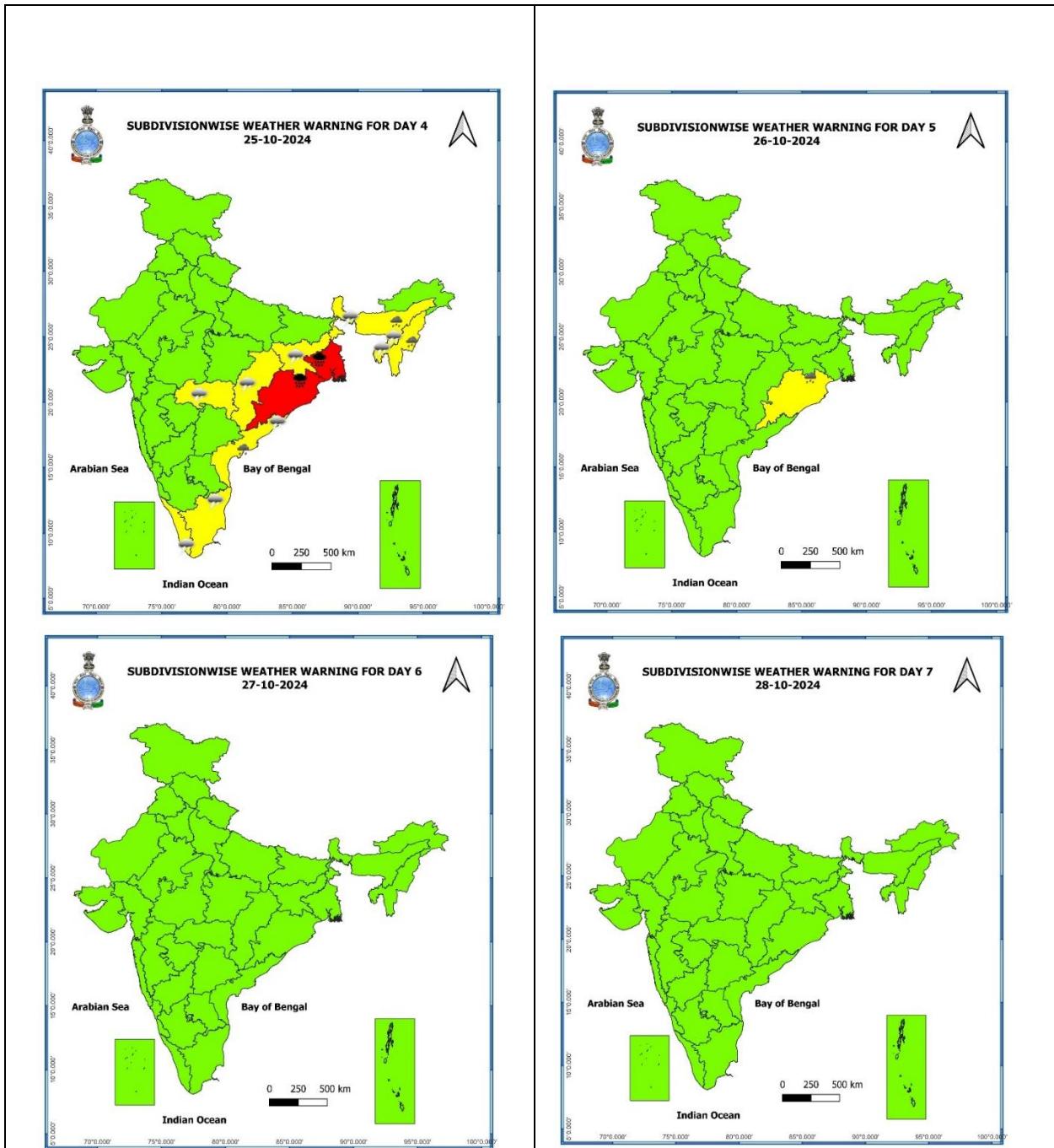
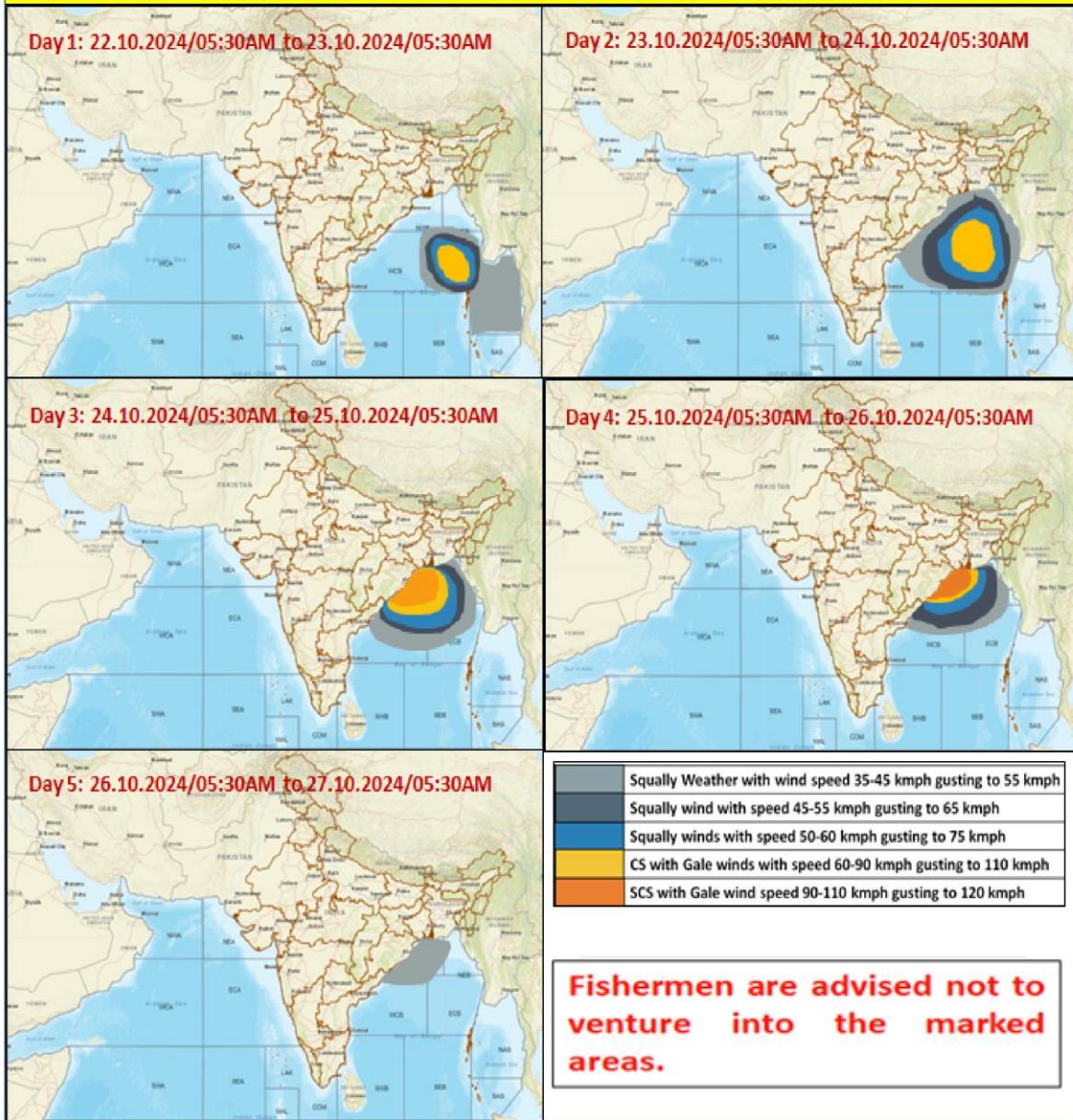


Fig II-C-3(d): Heavy rainfall warning issued on 22nd October 2024

- Action may be taken based on **ORANGE AND RED COLOUR** warnings.
- Vulnerable regions likely urban and hilly areas action may be initiated for heavy rainfall warning.
- As the lead period increases forecast accuracy decreases.



### Fishermen Warning Graphics



- Fig II-C-3(e): Fishermen Warning Graphics issued on 22nd October 2024

**Example 03: National Bulletin associated with Deep Depression.**



**India Meteorological Department  
(Ministry of Earth Sciences)**

**NATIONAL BULLETIN NO. 4  
(BOB/06/2024)**

**TIME OF ISSUE: 2030 HOURS IST**

**DATED: 22.10.2024**

**FROM: INDIA METEOROLOGICAL DEPARTMENT (FAX NO. 24643965/24699216/24623220)  
TO: CONTROL ROOM, NDM, MINISTRY OF HOME AFFAIRS (FAX.NO. 23093750)CONTROL  
ROOM NDMA (FAX.NO. 26701729)  
CABINET SECRETARIAT (FAX.NO.23012284, 23018638)  
PS TO HON'BLE MINISTER FOR S & T AND EARTH SCIENCES (FAX NO.23316745)SECRETARY,  
MOES (FAX NO. 24629777)  
H.Q. (INTEGRATED DEFENCE STAFF AND CDS) (FAX NO. 23005137/23005147)DIRECTOR  
GENERAL, DOORDARSHAN (23385843)  
DIRECTOR GENERAL, AIR (23421105, 23421219)PIB MOES (FAX NO. 23389042)  
UNI (FAX NO. 23355841)  
D.G. NATIONAL DISASTER RESPONSE FORCE (NDRF) (FAX NO. 26105912, 2436 3260)  
DIRECTOR, PUNCTUALITY, INDIAN RAILWAYS (FAX NO. 23388503)  
CHIEF SECRETARY, ODISHA (FAX NO. 0674-2536660) CHIEF SECRETARY, WEST BENGAL  
(FAX NO. 033-22144328)  
CHIEF SECRETARY, ANDAMAN & NICOBAR ISLANDS (FAX NO. 03192-232656)CHIEF  
SECRETARY, TAMIL NADU (FAX NO. 044-25672304)  
CHIEF SECRETARY, ANDHRA PRADESH (FAX NO. 0863-2441029)CHIEF SECRETARY,  
PUDUCHERRY (FAX NO. 0413-2334145)**

**Subject: Deep Depression over Eastcentral Bay of Bengal (Cyclone Alert for Odisha and West  
Bengal coasts: **Yellow Message**)**

The depression over Eastcentral Bay of Bengal moved west-northwestwards with a speed of 7 kmph during past 6 hours, intensified into a Deep Depression and lay centred at 1730 hrs IST of today, the 22nd October, over the same region near latitude 15.6° N and longitude 90.9°E, about 690 km southeast of Paradip (Odisha), 740 km south-southeast of Sagar Island (West Bengal) and 710 km south-southeast of Khepupara (Bangladesh).

It is very likely to move west-northwestwards and intensify into a cyclonic storm by 23rd October, 2024 over eastcentral Bay of Bengal. Thereafter, continuing to move northwestwards, it is very likely to intensify into a severe cyclonic storm over northwest Bay of Bengal by morning of 24th and cross north Odisha and West Bengal coasts between Puri and Sagar Island during night of 24th to morning of 25th October, 2024 as a severe Cyclonic Storm with a wind speed of 100-110 kmph gusting 120 kmph.

Forecast track and intensity are given in the following table:

Date/Time (IST)	Position (Lat. °N/ Long. °E)	Maximum Sustained Surface Wind Speed (Kmph)	Category Of Disturbance	Cyclonic
22.10.24/1730	15.6/90.9	50-60 gusting to 70	Deep Depression	
22.10.24/2330	15.8/90.2	55-65 gusting to 75	Deep Depression	
23.10.24/0530	16.1/89.7	60-70 gusting to 80	Cyclonic Storm	
23.10.24/1130	16.7/89.0	70-80 gusting to 90	Cyclonic Storm	
23.10.24/1730	17.2/88.6	80-90 gusting to 100	Cyclonic Storm	
24.10.24/0530	18.6/87.9	95-105 gusting to 115	Severe Cyclonic Storm	
24.10.24/1730	19.9/87.4	100-110 gusting 120	Severe Cyclonic Storm	
25.10.24/0530	20.9/86.8	100-110 gusting 120	Severe Cyclonic Storm	
25.10.24/1730	21.5/86.0	55-65 gusting to 75	Deep Depression	
26.10.24/0530	21.7/85.0	40-50 gusting to 60	Depression	

**(i) Rainfall Warning:**

- Light to moderate rainfall at most places with **heavy rainfall (07-11 cm)** at isolated places over Andaman Islands on 22<sup>nd</sup> October.
- Light to moderate rainfall at most places with **heavy rainfall (07-11 cm)** at isolated places is very likely over **Balasore, Bhadrak, Kendrapara, Jagatsingpur, Puri and Khorda**, districts of Odisha on 23<sup>rd</sup> Oct. & **heavy to very heavy rainfall** at a few places and **extremely heavy rainfall ( $\geq 21$  cm)** at isolated places over **Baleswar, Mayurbhanj, Bhadrak, Kendrapara, Jagatsingpur, Kendujhar, Jajpur, Cuttack and Dhenkanal, Khorda and Puri** districts of Odisha on 24<sup>th</sup> & 25<sup>th</sup> October.
- Light to moderate rainfall at most places with heavy rainfall** at isolated places is very likely on 23<sup>rd</sup> October and **heavy to very heavy rainfall** at a few places with **extremely heavy rainfall** at isolated places over **South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata and Bankura** districts of Gangetic West Bengal on 24<sup>th</sup> & 25<sup>th</sup> October.
- Light to moderate rainfall at most places is likely over south Jharkhand with **heavy rainfall** at isolated places on 24<sup>th</sup> and **heavy to very heavy rainfall** at isolated places on 25<sup>th</sup> October.

**(ii) Wind Warning:**

**Eastcentral Bay of Bengal:** Squally wind speed reaching 50-60 kmph gusting to 70 kmph is prevailing and likely to increase becoming 70-90 kmph gusting to 100 kmph from 23<sup>rd</sup> evening till 24<sup>th</sup> morning.

**Adjoining areas of Westcentral Bay of Bengal:** Squally wind speed reaching 40-50 kmph gusting to 60 kmph is very likely to commence from 22<sup>nd</sup> evening, 70-80 kmph gusting to 90 kmph from 23<sup>rd</sup> morning to 24<sup>th</sup> afternoon.

**Northwest Bay of Bengal:** Squally wind speed reaching 40-50 kmph gusting to 60 kmph is very likely to commence from 23<sup>rd</sup> morning. It would gradually increase becoming gale wind speed reaching 70-90 kmph gusting to 100 kmph from 23<sup>rd</sup> night to 24<sup>th</sup> morning and 100-110 kmph gusting to 120 kmph from 24<sup>th</sup> Oct evening to 25<sup>th</sup> Oct morning and decrease gradually thereafter.

**Adjoining areas of northeast Bay of Bengal:** Squally wind speed reaching 40-50 kmph gusting to 60 kmph is very likely to commence from 23<sup>rd</sup> night, becoming 50-60 kmph gusting to 70 kmph from 24<sup>th</sup> till 25<sup>th</sup> morning and decrease gradually thereafter.

**Along & off Odisha-west Bengal coasts:** Squally wind speed reaching 40-50 gusting to 60 kmph is very likely to commence from 23<sup>rd</sup> Oct evening. It would gradually increase becoming gale wind speed

reaching 60-70 kmph gusting to 80 kmph from 24<sup>th</sup> morning and reaching 100-110 kmph gusting to 120 kmph from 24<sup>th</sup> night till 25<sup>th</sup> Oct morning and decrease gradually thereafter.

### **(iii) Sea Condition:**

**Eastcentral Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough** on 22<sup>nd</sup> October, becoming **very rough to high from 23<sup>rd</sup> morning till 24<sup>th</sup> October morning.**

**Adjoining areas of Westcentral Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough** on 23<sup>rd</sup> and very rough to high on 24<sup>th</sup> October.

**Northwest Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough from 23<sup>rd</sup> morning** and would become **High to Very High** from 23<sup>rd</sup> night till 25<sup>th</sup> morning and improve gradually thereafter.

**Adjoining areas of northeast Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough** from 23<sup>rd</sup> night till 25<sup>th</sup> morning and improve gradually thereafter.

**Along & off Odisha-west Bengal coasts:** Sea condition is likely to be **Rough to Very Rough from 23<sup>rd</sup> evening** and would become **High to Very High** from **24<sup>th</sup> October morning to 25<sup>th</sup> Oct forenoon** and improve gradually thereafter.

### **(iv) Fishermen Warning:**

Fishermen are advised not to venture into

- Eastcentral Bay of Bengal during 22<sup>nd</sup> to 24<sup>th</sup> October.
- **Adjoining areas of Westcentral Bay of Bengal on 23<sup>rd</sup> and 24<sup>th</sup> Oct.**
- **North Bay of Bengal** and along & off Odisha, West Bengal and Bangladesh coasts during 23<sup>rd</sup> to 25<sup>th</sup> October.

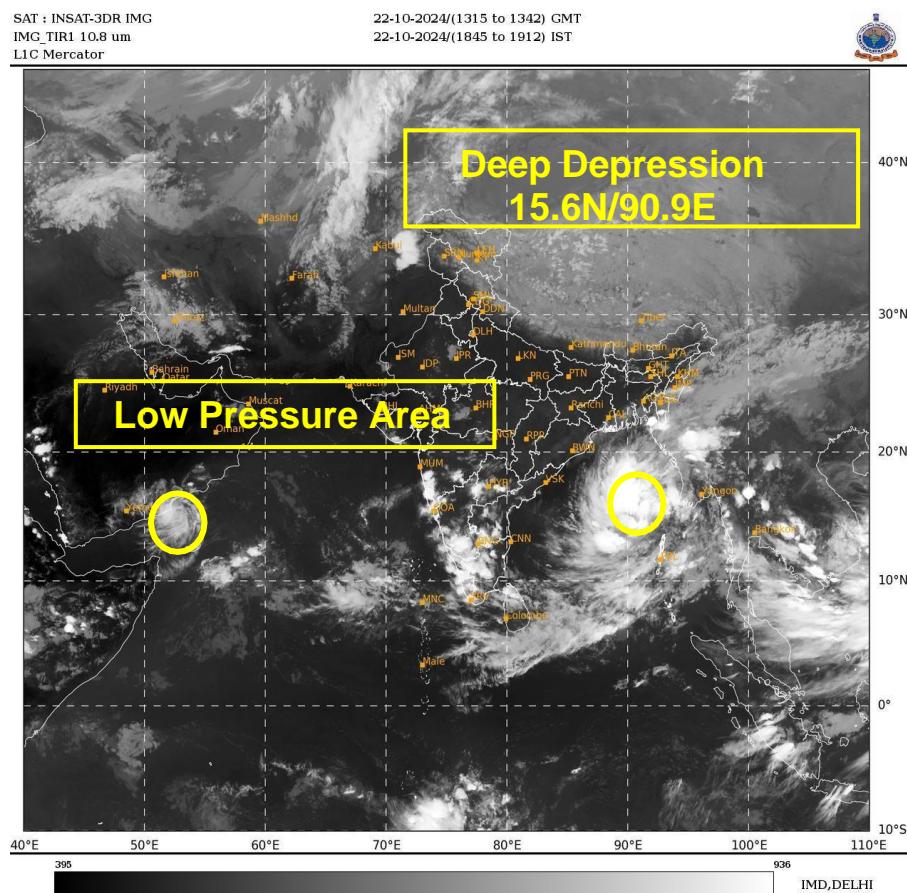
**(v) Impact Expected over districts of Odisha (Baleswar, Bhadrak, Kendrapara, Jagatsinghpur, Puri, Khorda, Mayurbhanj, Kendujhar, Jajpur, Cuttack, Dhenkanal) and West Bengal (South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata, & Bankura)**

- Major damage to thatched houses/ huts. Roof tops may blow off. Unattached metalsheets may fly.
- Breaking of tree branches and uprooting of trees.
- Damage to power and communication lines.
- Major damage to Kutcha and some damage to Pucca roads. Flooding of escaperoutes.
- Possibilities of damage to vulnerable structure.
- Major damage to banana and papaya trees. Large dead limbs blown from trees.
- Damage to horticulture and standing crops due to inundation and wind.
- Damage to embankments/ salt pans.
- Localized Flooding of roads, water logging in low lying areas and closure of underpasses mainly in urban areas of the above region.
- Occasional reduction in visibility due to heavy rainfall.
- Disruption of traffic in major cities and roadways due to water logging in roads and poor visibility due to heavy rain leading to increased travel time and incidents
- Localized Landslides/Mudslides/landslides/mud slips/land sinks/mud sinks.
- Likely disruption of marine and inland water transportation like small boats and trawlers.
- It may lead to riverine flooding in some river catchments (for riverine flooding please visit Webpage of Central Water Commission)

- Action Suggested for districts of Odisha (Baleswar, Bhadrak, Kendrapara, Jagatsinghpur, Puri, Khorda, Mayurbhanj, Kendujhar, Jajpur, Cuttack, Dhenkanal) and West Bengal (South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata & Bankura)

- Total suspension of fishing operations during 22<sup>nd</sup> to 25<sup>th</sup> Oct over Central and North Bay of Bengal.
- Fishermen are advised not to venture into
  - ✓ Eastcentral Bay of Bengal during 22<sup>nd</sup> to 24<sup>th</sup> October.
  - ✓ **Adjoining areas of Westcentral Bay of Bengal on 23<sup>rd</sup> and 24<sup>th</sup> Oct.**
  - ✓ **North Bay of Bengal** and along & off Odisha, West Bengal and Bangladesh coasts during 23<sup>rd</sup> to 25<sup>th</sup> October morning.
- Movement in motor boats unsafe
- Coastal hutment dwellers to be moved to safer places.
- People in affected areas to remain indoors.
- Judicious regulation of onshore/offshore, Port and maritime activities including shipping.
- Judicious regulation of tourism activities in coastal areas.
- Judicious regulation of surface transports including railways and roadways.
- Check for traffic congestion on your route before leaving for your destination.
- Follow any traffic advisories that are issued in this regard.
- Avoid going to areas that face the water logging problems often.
- Avoid staying in vulnerable structure.

**Next bulletin will be issued at 0230 hours IST of tomorrow, the 23<sup>rd</sup> October, 2024.**



**Fig II-C-4(a): INSAT 3DR Image issued on 22<sup>nd</sup> October, 2024**

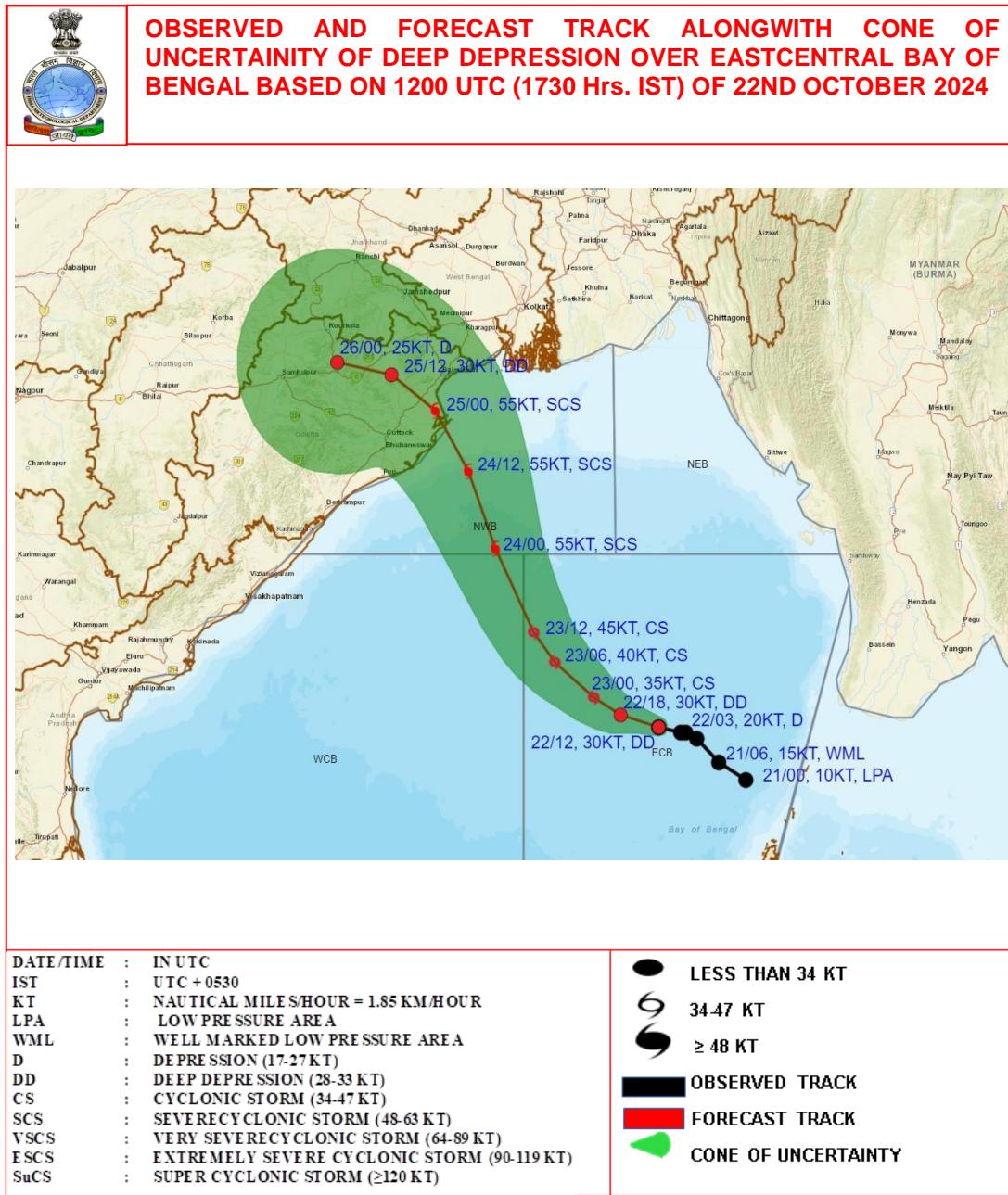


Fig II-C-4(b): Observed and forecast track along with cone of uncertainty of deep depression over eastcentral Bay of Bengal based on 1200 UTC of 22nd October 2024

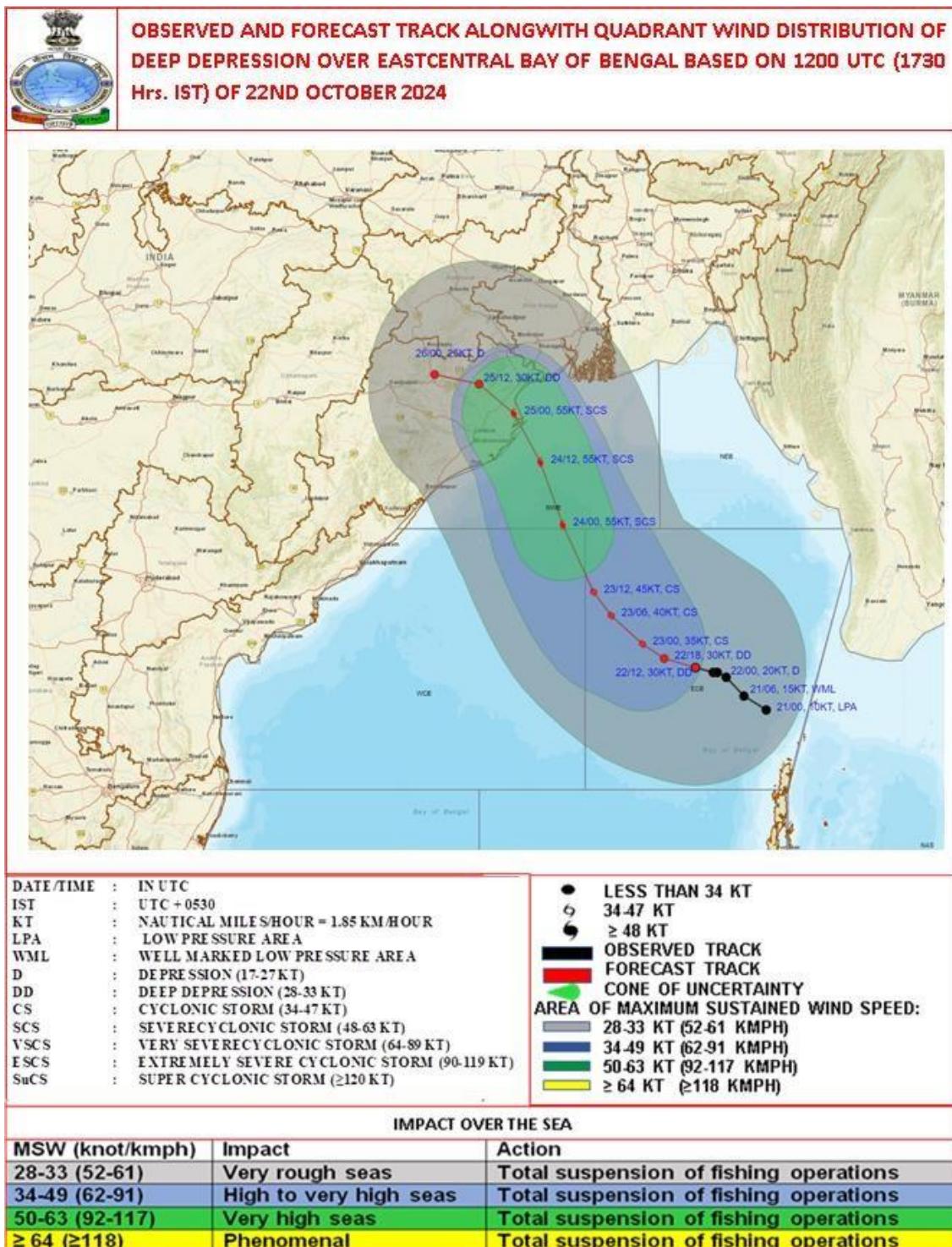
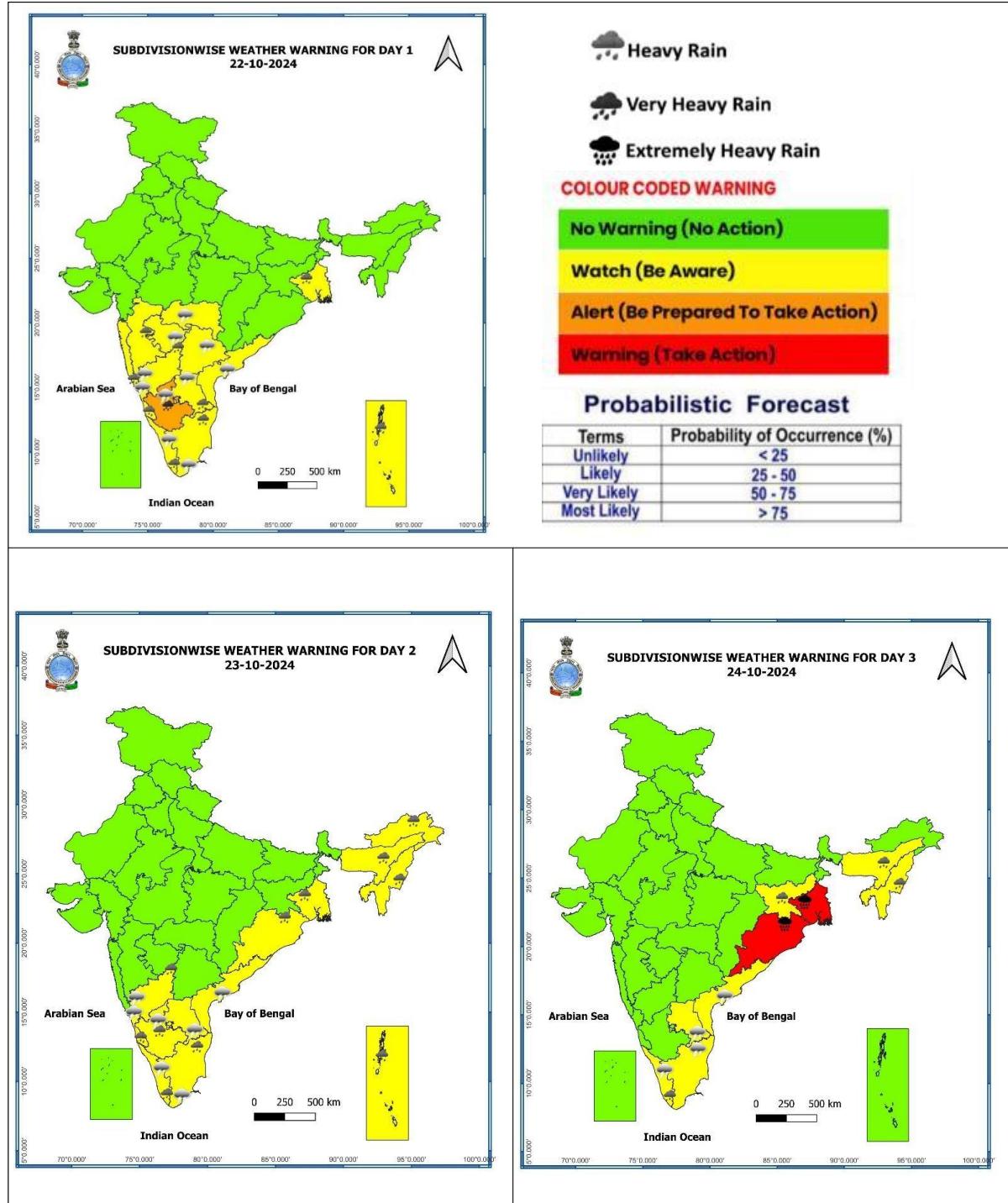
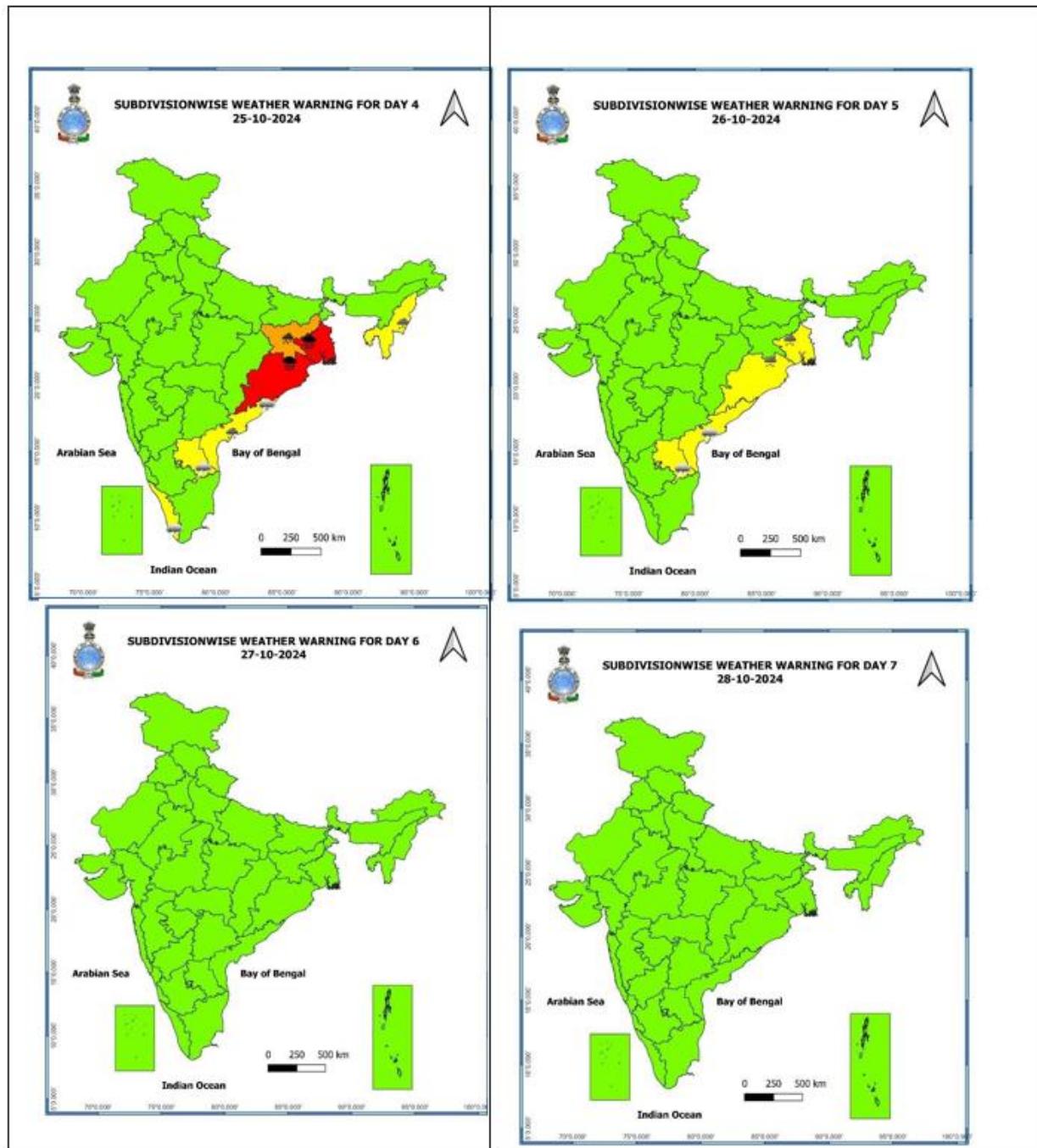


Fig II-C-4(c): Observed and forecast track along with quadrant wind distribution of deep depression over eastcentral Bay of Bengal based on 1200 UTC of 22nd October 2024

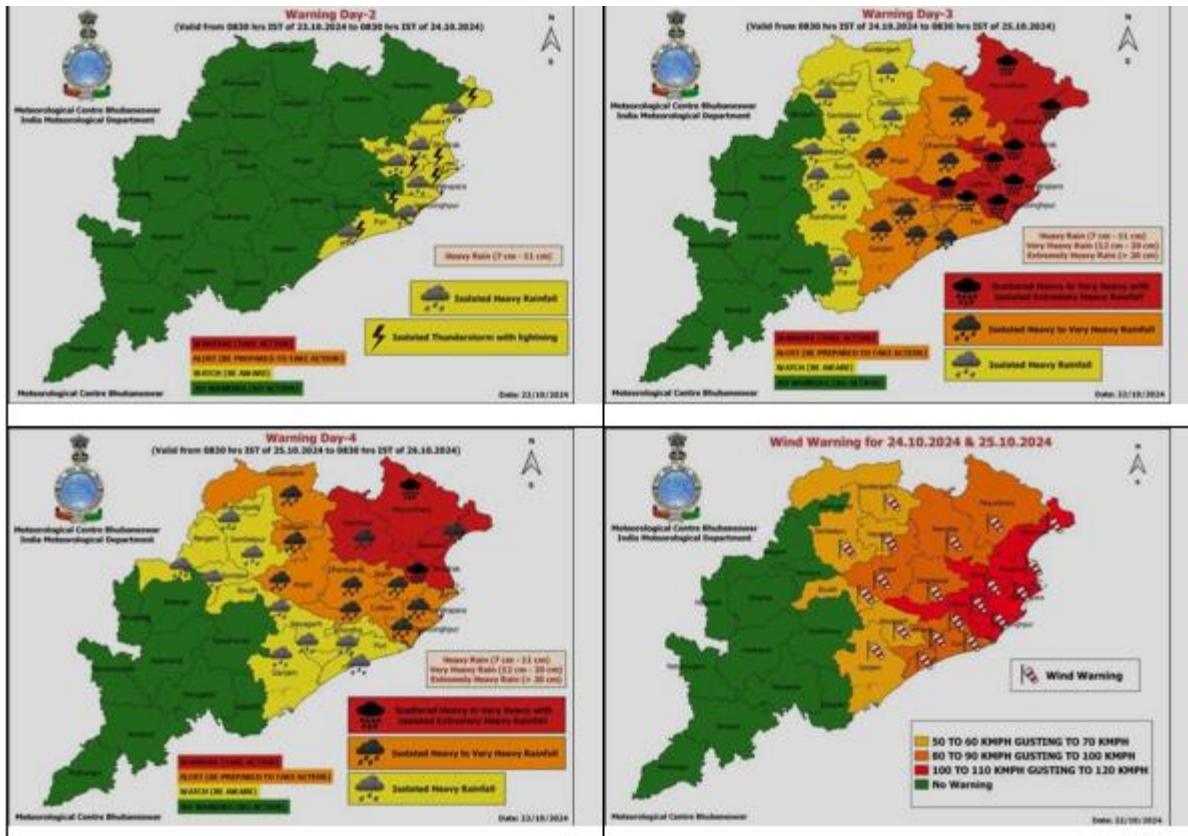




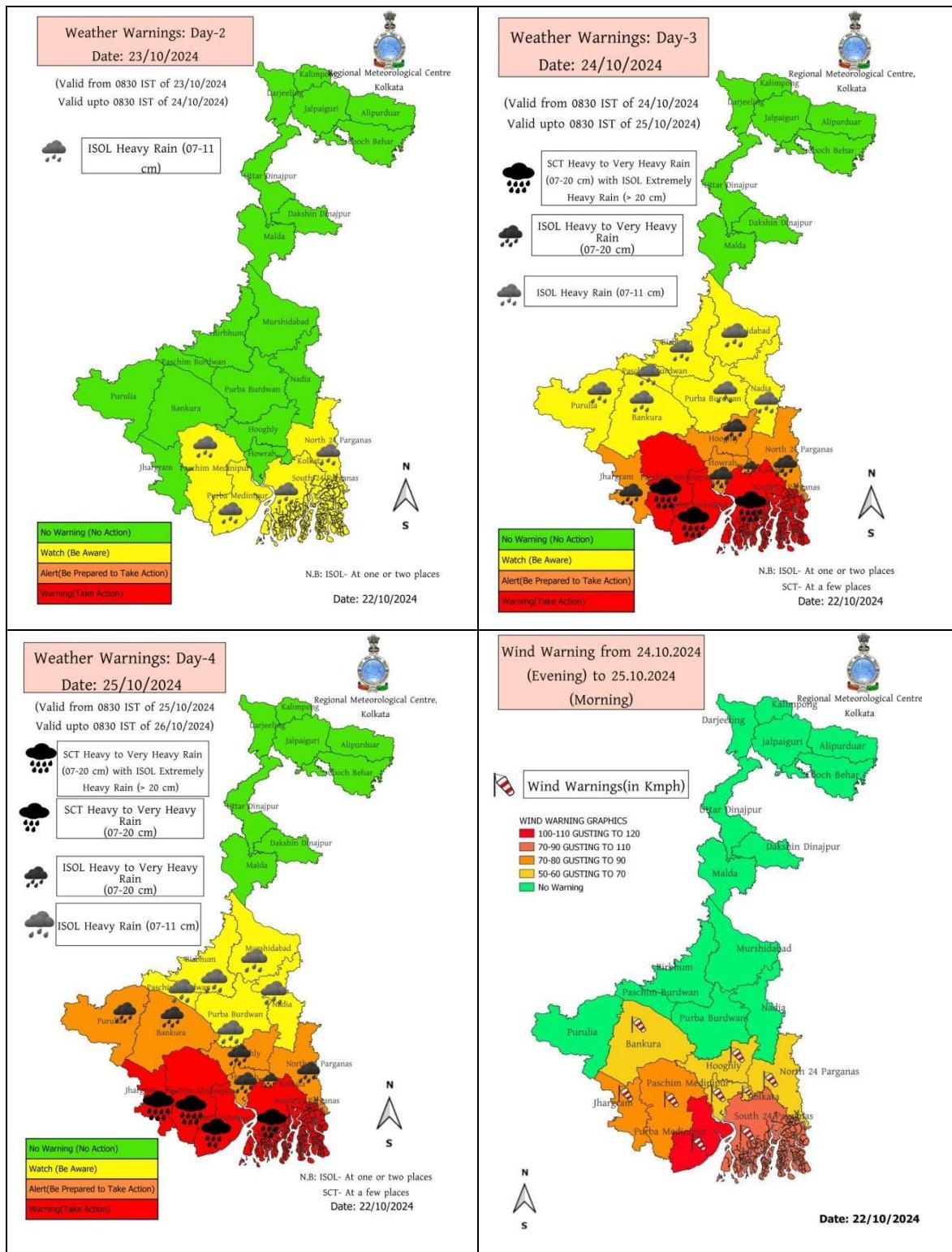
**Fig II-C-4(d): Heavy rainfall warning issued on 22nd October 2024**

- Action may be taken based on **ORANGE AND RED COLOUR** warnings.
- Vulnerable regions likely urban and hilly areas action may be initiated for heavy rainfall warning.
- As the lead period increases forecast accuracy decreases.

### District-wise Warning of Odisha



**Fig II-C-4(e): District wise warning of Odisha issued on 22nd October 2024**

**District-wise Warning of West Bengal****Fig II-C-4(f): District wise warning of West Bengal issued on 22nd October 2024**

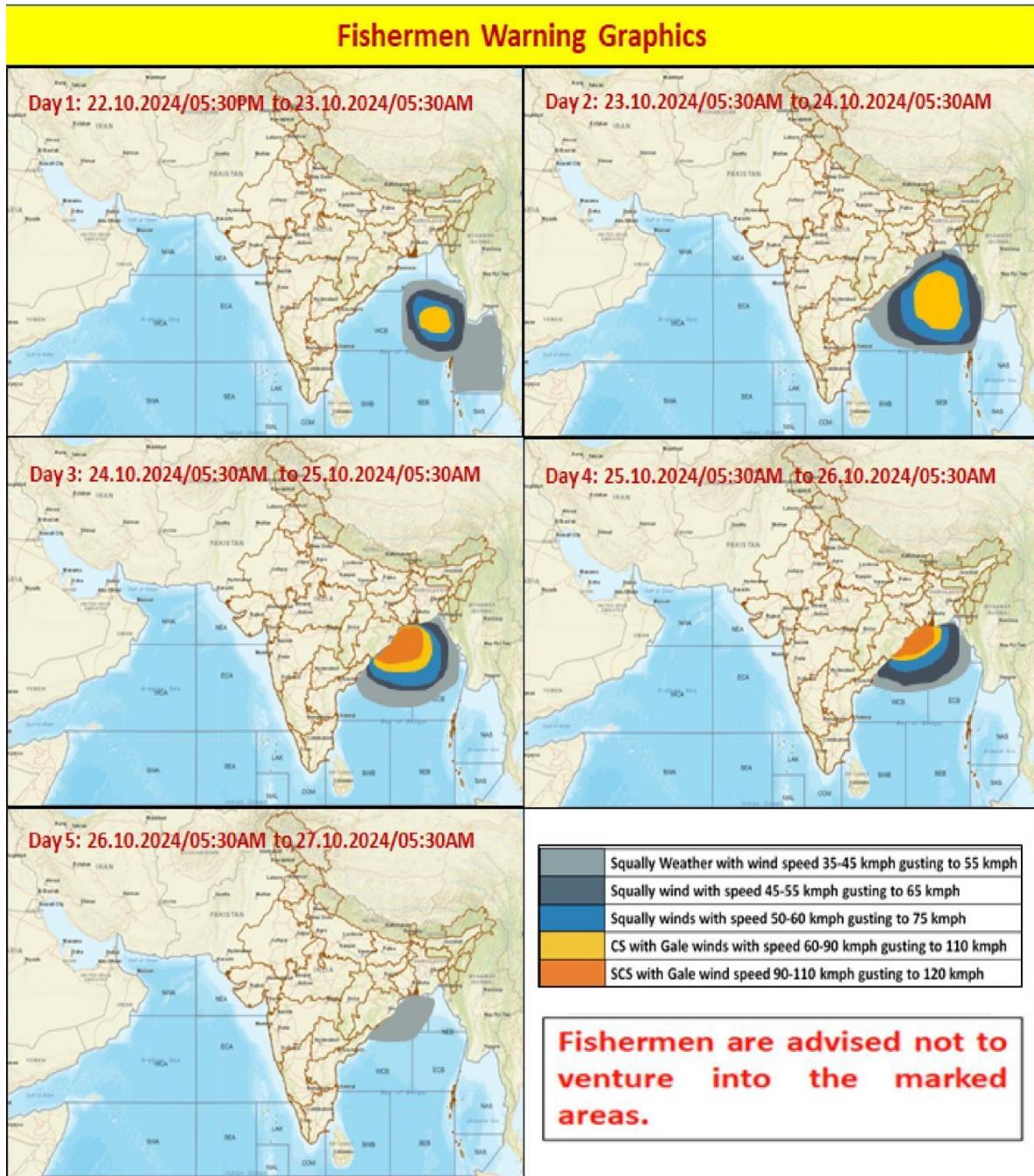


Fig II-C-4(g): Fishermen Warning Graphics issued on 22nd October 2024

**Example 03: National bulletin associated with cyclone DANA.**
**India Meteorological Department  
(Ministry of Earth Sciences)**
**NATIONAL BULLETIN NO. 6 (BOB/06/2024)**
**TIME OF ISSUE: 0940 HOURS IST****DATED: 23.10.2024****FROM: INDIA METEOROLOGICAL DEPARTMENT (FAX NO. 24643965/24699216/24623220)****TO: CONTROL ROOM, NDM, MINISTRY OF HOME AFFAIRS (FAX.NO. 23093750)****CONTROL ROOM NDMA (FAX.NO. 26701729)****CABINET SECRETARIAT (FAX.NO.23012284, 23018638)****PS TO HON'BLE MINISTER FOR S & T AND EARTH SCIENCES (FAX NO.23316745)****SECRETARY, MOES (FAX NO. 24629777)****H.Q. (INTEGRATED DEFENCE STAFF AND CDS) (FAX NO. 23005137/23005147)****DIRECTOR GENERAL, DOORDARSHAN (23385843)****DIRECTOR GENERAL, AIR (23421105, 23421219)****PIB MOES (FAX NO. 23389042)****UNI (FAX NO. 23355841)****D.G. NATIONAL DISASTER RESPONSE FORCE (NDRF) (FAX NO. 26105912, 2436 3260)****DIRECTOR, PUNCTUALITY, INDIAN RAILWAYS (FAX NO. 23388503)****CHIEF SECRETARY, ODISHA (FAX NO. 0674-2536660)****CHIEF SECRETARY, WEST BENGAL (FAX NO. 033-22144328)****CHIEF SECRETARY, ANDAMAN & NICOBAR ISLANDS (FAX NO. 03192-232656)****CHIEF SECRETARY, TAMIL NADU (FAX NO. 044-25672304)****CHIEF SECRETARY, ANDHRA PRADESH (FAX NO. 0863-2441029)****CHIEF SECRETARY, PUDUCHERRY (FAX NO. 0413-2334145)****Subject: Cyclonic storm over eastcentral Bay of Bengal (Cyclone Alert for Odisha and West Bengal****coasts: Orange Message)**

Yesterday's deep depression over Eastcentral Bay of Bengal moved west-northwestwards with a speed of 18 kmph during past 6 hours, intensified into a cyclonic storm "DANA" (pronounced as Dana), and lay centred at 0530 hours IST of today, the 23<sup>rd</sup> October, over the same region near latitude 16.3° N and longitude 89.9°E, about 560 km southeast of Paradip (Odisha), 630 km south-southeast of Sagar Island (West Bengal) and 630 km south-southeast of Khepupara (Bangladesh).

It is very likely to move northwestwards and intensify into a severe cyclonic storm over northwest Bay of Bengal by early morning of 24th and cross north Odisha and West Bengal coasts between Puri and Sagar Island during night of 24th to morning of 25th October, 2024 as a severe Cyclonic Storm with a wind speed of 100-110 kmph gusting 120 kmph.

Forecast track and intensity are given in the following table:

Date/Time (IST)	Position (Lat. °N/ Long. °E)	Maximum Sustained Surface Wind Speed (Kmph)	Category Of Cyclonic Disturbance
23.10.24/0530	16.3/89.9	60-70 gusting to 80	Cyclonic Storm
23.10.24/1130	16.8/89.3	70-80 gusting to 90	Cyclonic Storm
23.10.24/1730	17.4/88.8	80-90 gusting to 100	Cyclonic Storm

23.10.24/2330	18.1/88.4	90-100 gusting to 110	Cyclonic Storm
24.10.24/0530	18.8/88.1	100-110 gusting to 120	Severe Cyclonic Storm
24.10.24/1730	20.0/87.4	100-110 gusting to 120	Severe Cyclonic Storm
25.10.24/0530	20.9/86.9	100-110 gusting to 120	Severe Cyclonic Storm
25.10.24/1730	21.5/86.1	80-90 gusting to 100	Cyclonic Storm
26.10.24/0530	21.7/85.3	45-55 gusting to 85	Depression

**(ii) Rainfall Warning:**

- ❖ Light to moderate rainfall at most places with **heavy rainfall (07-11 cm)** at isolated places is very likely over **Balasore, Bhadrak, Kendrapara, Jagatsingpur, Puri and Khorda**, districts of Odisha commencing from evening of 23<sup>rd</sup> Oct. & **heavy to very heavy rainfall** at a few places and **extremely heavy rainfall ( $\geq 21$  cm)** at isolated places over **Baleswar, Mayurbhanj, Bhadrak, Kendrapara, Jagatsingpur Kendujhar, Jajpur, Cuttack and Dhenkanal, Khorda and Puri** districts of Odisha on 24<sup>th</sup> & 25<sup>th</sup> October.
- ❖ **Light to moderate rainfall at most places with heavy rainfall** at isolated places is very likely on 23<sup>rd</sup> October and heavy to very heavy rainfall at a few places **with extremely heavy rainfall** at isolated places over **South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata and Bankura** districts of Gangetic West Bengal on 24<sup>th</sup> & 25<sup>th</sup> October.
- ❖ Light to moderate rainfall at most places is likely over south Jharkhand with **heavy rainfall** at isolated places on 24<sup>th</sup> and **heavy to very heavy rainfall** at isolated places on 25<sup>th</sup> October.

**(ii) Wind Warning:**

**Eastcentral Bay of Bengal:** Squally wind speed reaching 60-70 kmph gusting to 80 kmph is prevailing and likely to increase becoming 70-90 kmph gusting to 100 kmph from 23<sup>rd</sup> evening till 24<sup>th</sup> morning. It is likely to decrease thereafter.

**Adjoining areas of Westcentral Bay of Bengal:** Squally wind speed reaching 60-70 kmph gusting to 80 kmph is prevailing. It is likely to increase gradually becoming 80-90 kmph gusting to 100 kmph from 23<sup>rd</sup> afternoon and 90-100 kmph gusting to 110 kmph from 24<sup>th</sup> morning till 24<sup>th</sup> afternoon. It is likely to decrease thereafter.

**Northwest Bay of Bengal:** Squally wind speed reaching 40-50 kmph gusting to 60 kmph is prevailing. It is very likely to increase gradually becoming gale wind speed reaching 70-90 kmph gusting to 100 kmph from 23<sup>rd</sup> evening till 24<sup>th</sup> night and thereafter 100-110 kmph gusting to 120 kmph till 25<sup>th</sup> Oct morning. It is likely to decrease gradually thereafter.

**Adjoining areas of northeast Bay of Bengal:** Squally wind speed reaching 40-50 kmph gusting to 60 kmph is very likely to commence from 23<sup>rd</sup> night, becoming 50-60 kmph gusting to 70 kmph from 24<sup>th</sup> till 25<sup>th</sup> morning and decrease gradually thereafter.

**Along & off Odisha-west Bengal coasts:** Squally wind speed reaching 40-50 gusting to 60 kmph is very likely to commence from 23<sup>rd</sup> Oct evening. It would gradually increase becoming gale wind speed reaching 60-70 kmph gusting to 80 kmph from 24<sup>th</sup> morning and reaching 100-110 kmph gusting to 120 kmph from 24<sup>th</sup> night till 25<sup>th</sup> Oct morning and decrease gradually thereafter.

**(iii) Sea Condition:**

**Eastcentral Bay of Bengal:** Sea condition is likely to be **high till 24<sup>th</sup> October evening** and improve gradually thereafter.

**Adjoining areas of Westcentral Bay of Bengal:** Sea condition is likely to be **very Rough to high** on 23<sup>rd</sup> and **high till 24<sup>th</sup> October evening**. It is likely to improve gradually thereafter.

**Northwest Bay of Bengal:** Sea condition is likely to be **Very Rough till 23<sup>rd</sup> evening** and would become **High to Very High** from 23<sup>rd</sup> night till 25<sup>th</sup> morning and improve gradually thereafter.

**Adjoining areas of northeast Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough** from 23<sup>rd</sup> night till 25<sup>th</sup> morning and improve gradually thereafter.

**Along & off Odisha-west Bengal coasts:** Sea condition is likely to be **Rough to Very Rough** from **23<sup>rd</sup> evening** and would become **High to Very High** from **24<sup>th</sup> October morning to 25<sup>th</sup> Oct forenoon** and improve gradually thereafter.

**(iv) Fishermen Warning:**

Fishermen are advised not to venture into

- Eastcentral Bay of Bengal during 23<sup>rd</sup> to 24<sup>th</sup> October.
- **Adjoining areas of Westcentral Bay of Bengal on 23<sup>rd</sup> and 24<sup>th</sup> Oct.**
- **Northwest & adjoining northeast Bay of Bengal and along & off Odisha, West Bengal and Bangladesh coasts** during 23<sup>rd</sup> to 25<sup>th</sup> October.

**(vi) Storm surge warning:**

Storm surge is likely to be 1.0 to 2.0 m height above astronomical tide and likely to inundate low lying areas of Kendrapara, Bhadrak and Balasore districts of Odisha and East Medinipur districts of West Bengal during the time of landfall.

**❖ Impact Expected over districts of Odisha (Baleswar, Bhadrak, Kendrapara, Jagatsinghpur, Puri, Khorda, Mayurbhanj, Kendujhar, Jajpur, Cuttack, Dhenkanal) and West Bengal (South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata, & Bankura)**

- Major damage to thatched houses/ huts. Roof tops may blow off. Unattached metal sheets may fly.
- Breaking of tree branches and uprooting of trees.
- Damage to power and communication lines.
- Major damage to Kutcha and some damage to Pucca roads. Flooding of escape routes.
- Possibilities of damage to vulnerable structure.
- Major damage to banana and papaya trees. Large dead limbs blown from trees.
- Damage to horticulture and standing crops due to inundation and wind.
- Damage to embankments/ salt pans.
- Localized Flooding of roads, water logging in low lying areas and closure of underpasses mainly in urban areas of the above region.
- Occasional reduction in visibility due to heavy rainfall.
- Disruption of traffic in major cities and roadways due to water logging in roads and poor visibility due to heavy rain leading to increased travel time and incidents
- Localized Landslides/Mudslides/landslips/mud slips/land sinks/mud sinks.
- Likely disruption of marine and inland water transportation like small boats and trawlers.
- It may lead to riverine flooding in some river catchments (for riverine flooding please visit Webpage of Central Water Commission)

**❖ Action Suggested for districts of Odisha (Baleswar, Bhadrak, Kendrapara, Jagatsinghpur, Puri, Khorda, Mayurbhanj, Kendujhar, Jajpur, Cuttack, Dhenkanal) and West Bengal (South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata & Bankura)**

- Total suspension of fishing operations during 23<sup>rd</sup> to 25<sup>th</sup> Oct over Central and North Bay of Bengal.
- Fishermen are advised not to venture into
  - ✓ Eastcentral Bay of Bengal during 23<sup>rd</sup> to 24<sup>th</sup> October.
  - ✓ **Adjoining areas of Westcentral Bay of Bengal on 23<sup>rd</sup> and 24<sup>th</sup> Oct.**
  - ✓ **Northwest and adjoining northeast Bay of Bengal and along & off Odisha, West Bengal and Bangladesh coasts** during 23<sup>rd</sup> to 25<sup>th</sup> October morning.
- Movement in motor boats unsafe
- Coastal hutment dwellers to be moved to safer places.
- People in affected areas to remain indoors.
- Judicious regulation of onshore/offshore, Port and maritime activities including shipping.
- Judicious regulation of tourism activities in coastal areas.
- Judicious regulation of surface transports including railways and roadways.
- Check for traffic congestion on your route before leaving for your destination.
- Follow any traffic advisories that are issued in this regard.
- Avoid going to areas that face the water logging problems often.
- Avoid staying in vulnerable structure.

**Next bulletin will be issued at 1200 hours IST of today, the 23<sup>rd</sup> October, 2024.**

Copy to: ACWC Kolkata/ACWC Chennai/CWC Bhubaneswar/CWC Vishakhapatnam/Meteorological Centre Port Blair

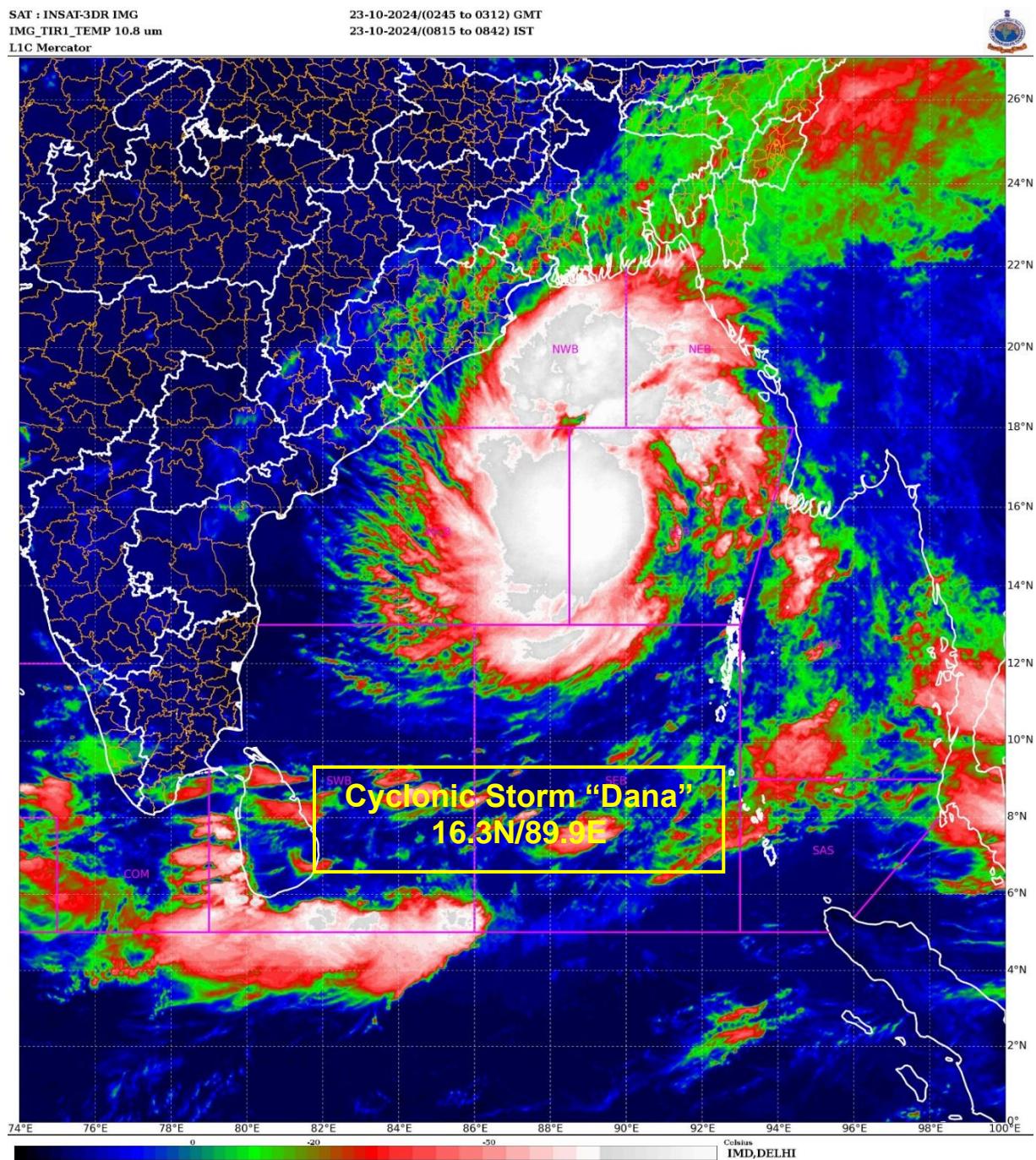
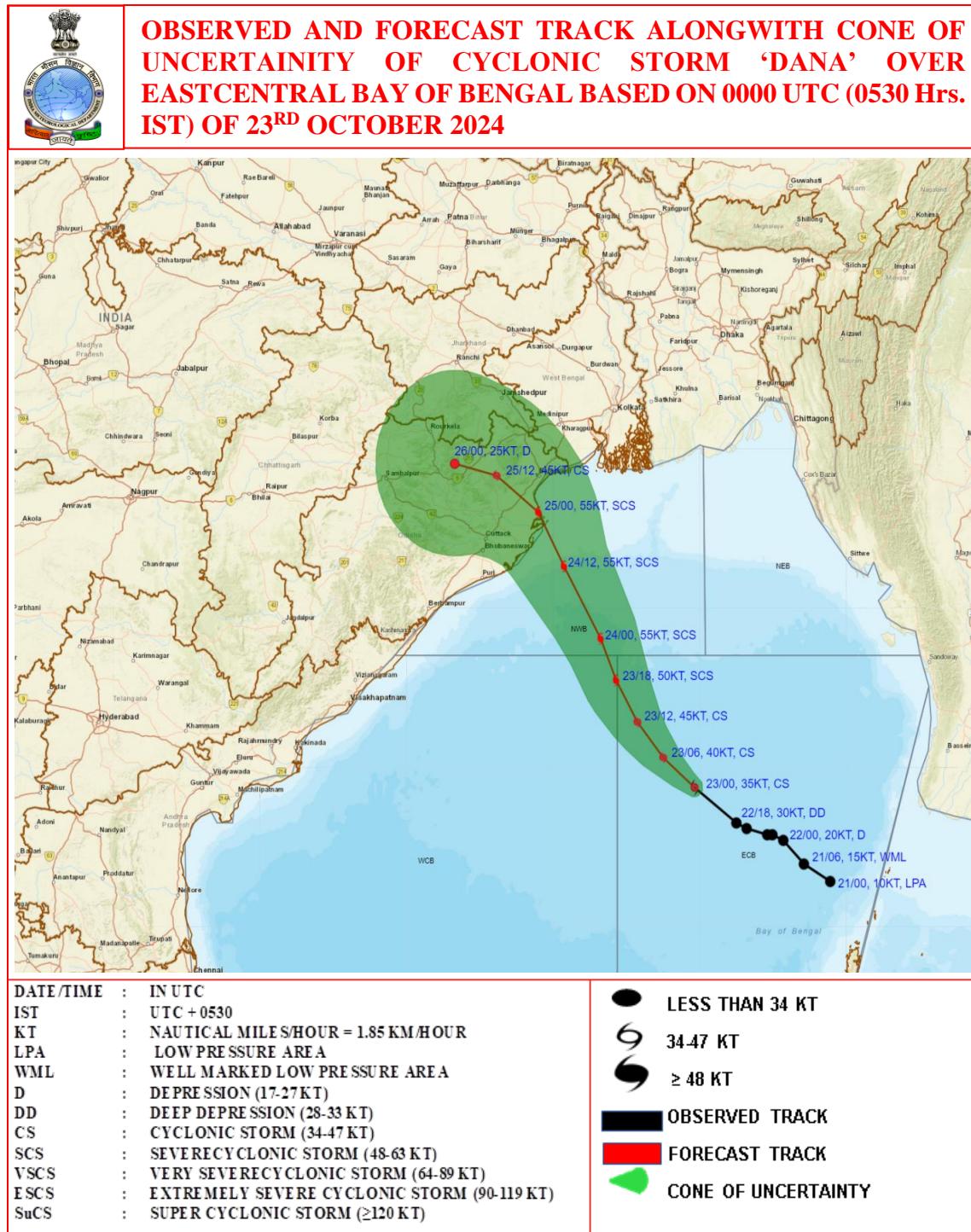


Fig II-C-5(a): INSAT 3DR Image issued on 23<sup>rd</sup> October, 2024



**Fig II-C-5(b): Observed and forecast track along with cone of uncertainty of cyclonic storm 'dana' over eastcentral Bay of Bengal based on 0000 UTC of 23<sup>rd</sup> October 2024**

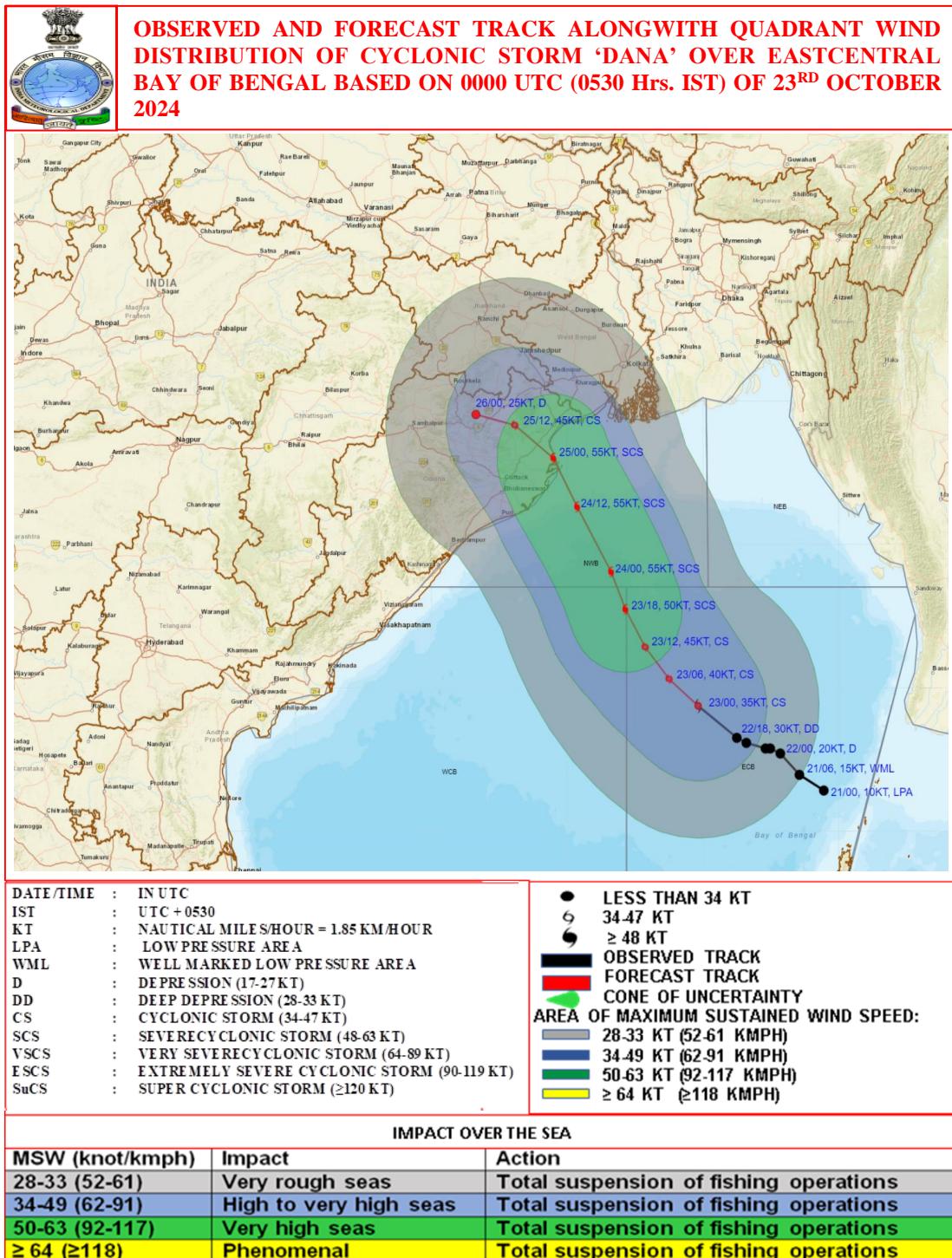
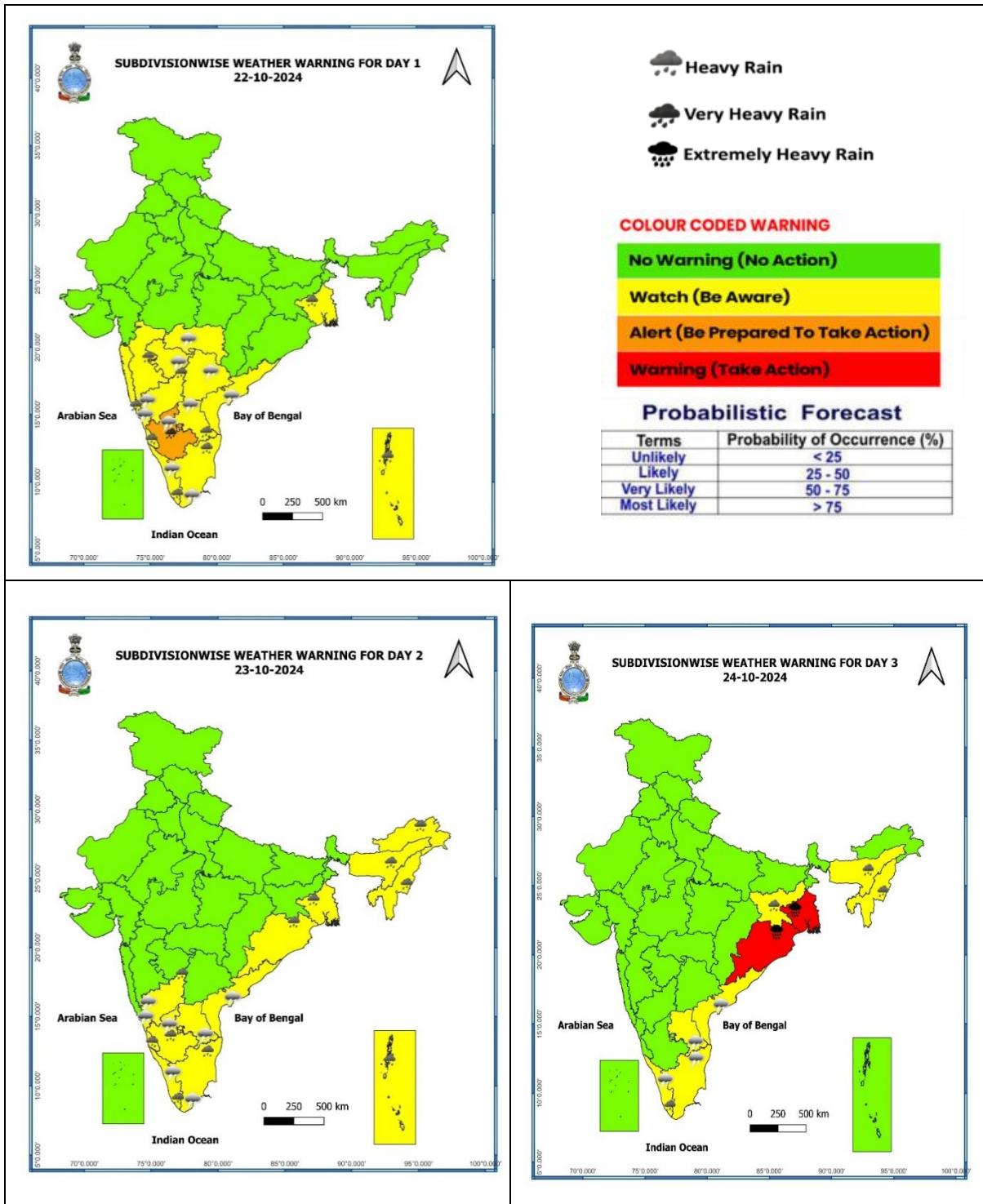
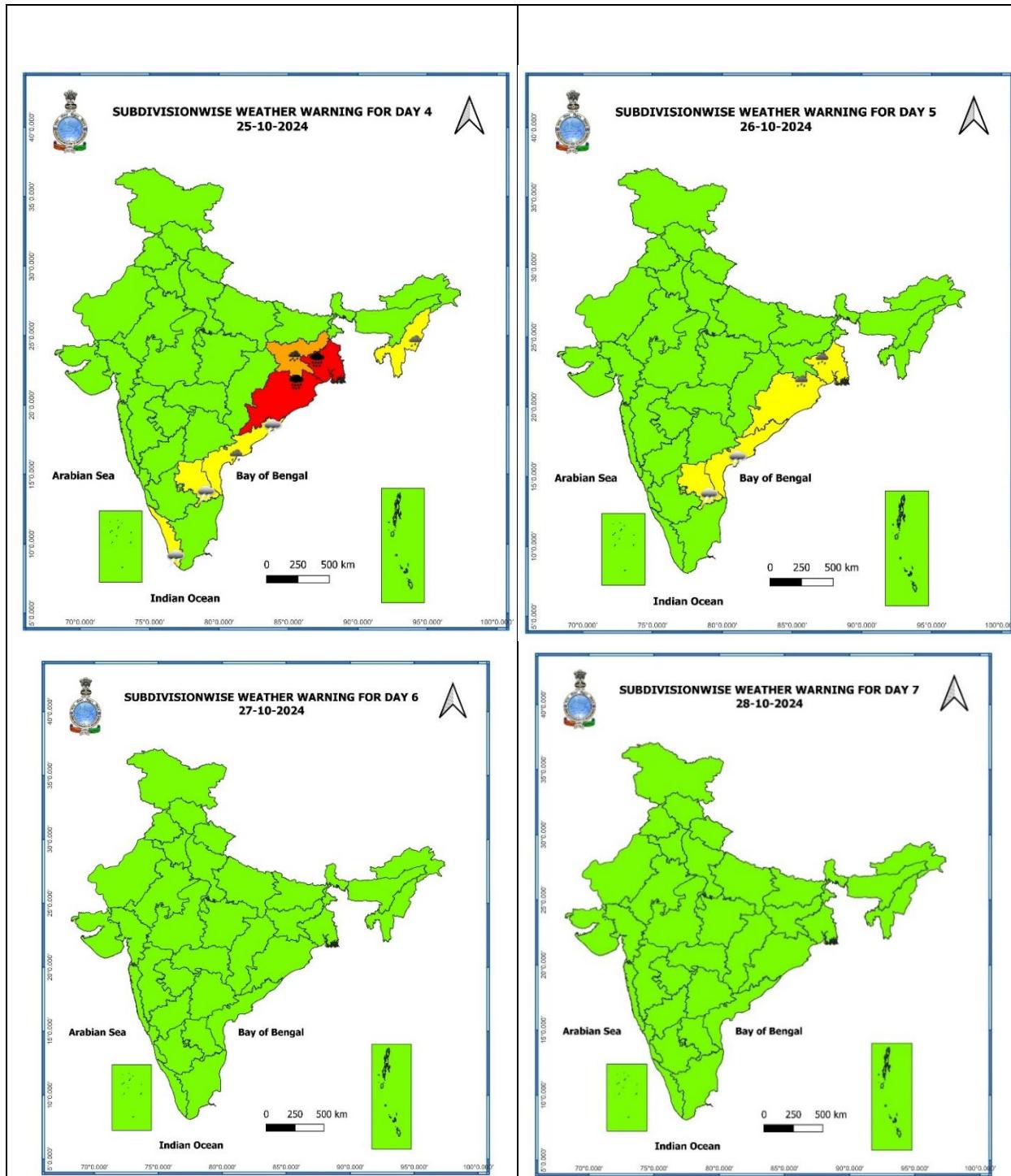


Fig II-C-5(c): Observed and forecast track along with quadrant wind distribution of cyclonic storm 'dana' over eastcentral Bay of Bengal based on 0000 UTC of 23<sup>rd</sup> October 2024



Fig II-C-5(d): Heavy Rainfall Warning issued on 23<sup>rd</sup> October, 2024

- Action may be taken based on **ORANGE AND RED COLOUR** warnings.
- Vulnerable regions likely urban and hilly areas action may be initiated for heavy rainfall warning.
- As the lead period increases forecast accuracy decreases.

### District-wise Warning of Odisha

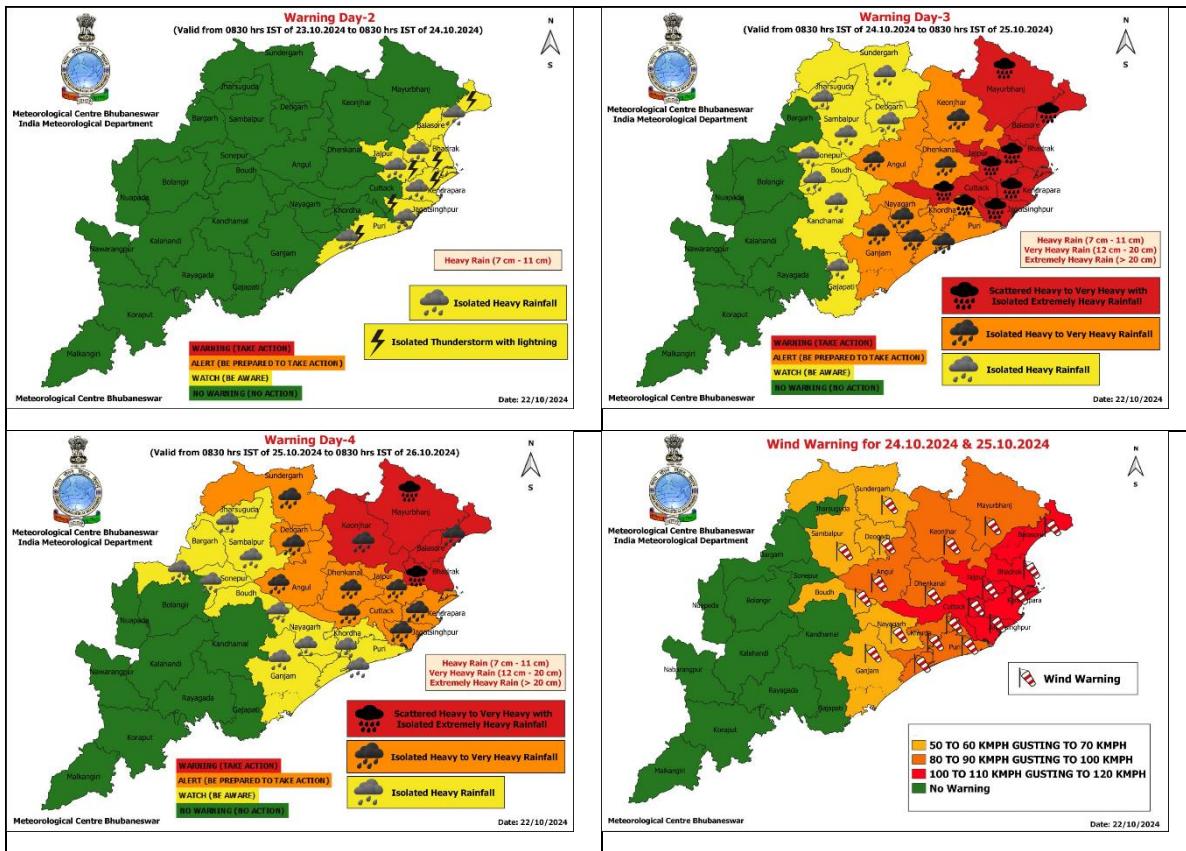
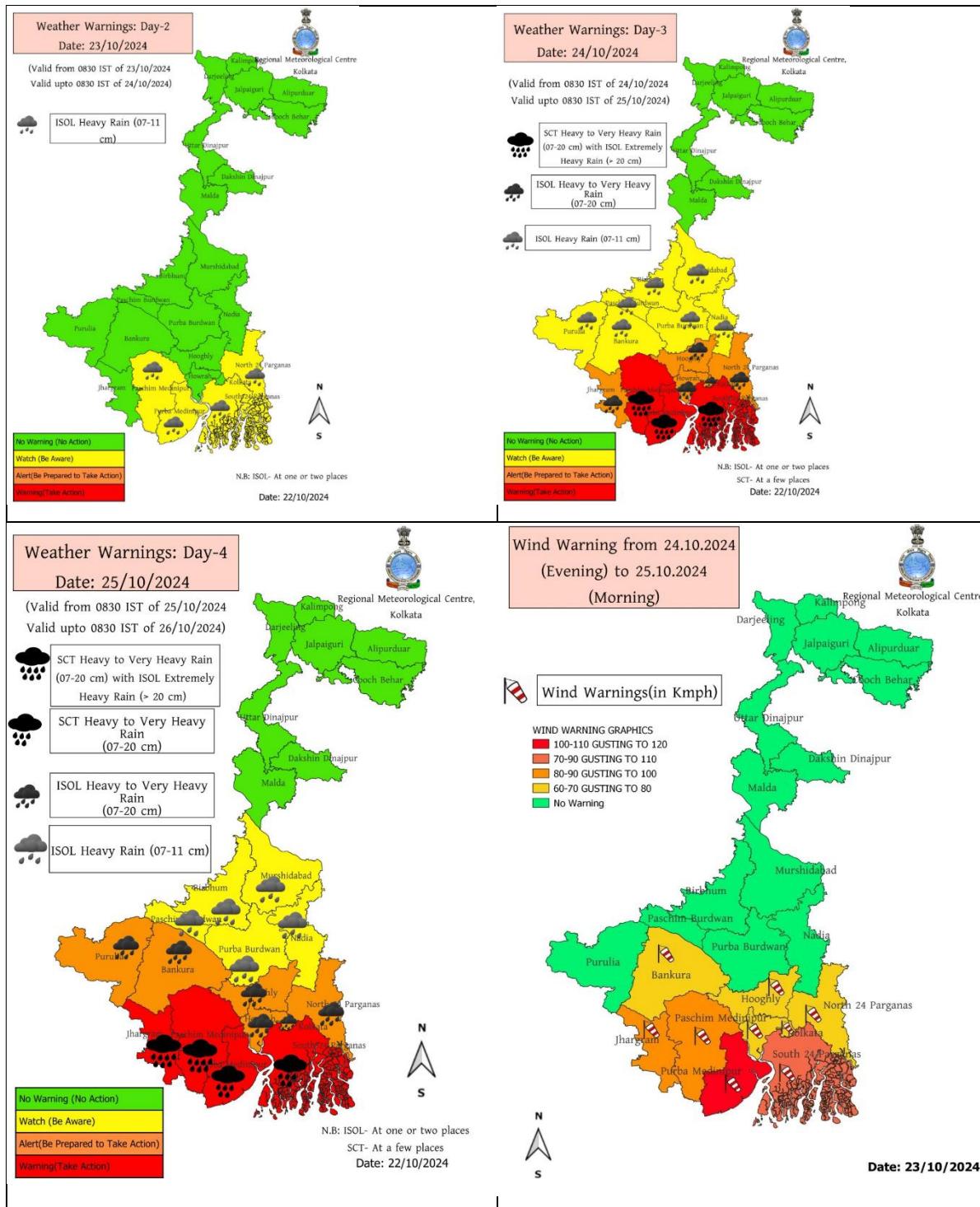
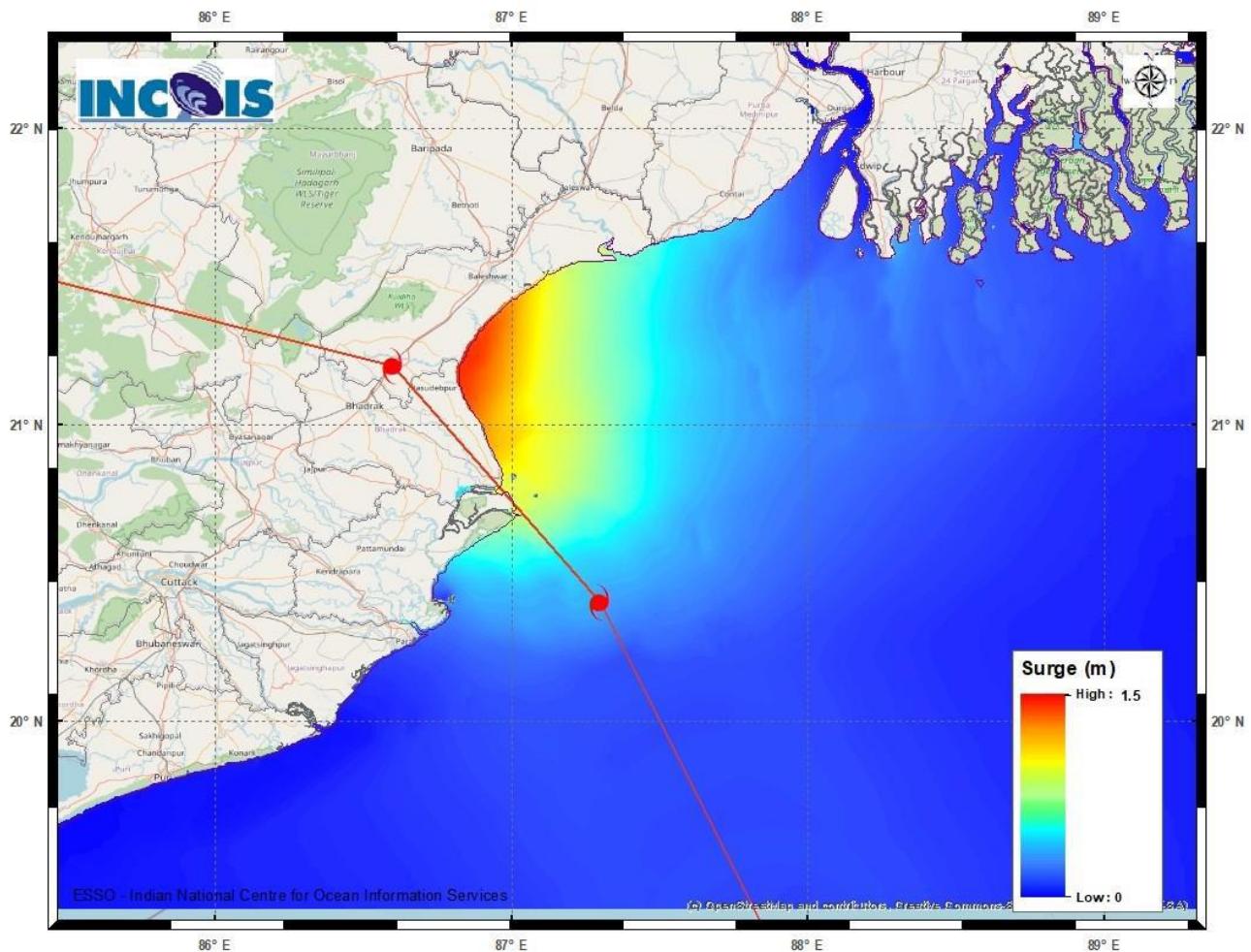


Fig II-C-5(e): District-wise Warning of Odisha issued on 23rd October, 2024

**District-wise Warning of West Bengal****Fig II-C-5(f): District-wise Warning of West Bengal issued on 23rd October, 2024**

### Storm Surge warning graphics



DISTRICT	STATE / UNION TERRITORY	NEAREST PLACE OF HABITATION	STORM SURGE (m)*	EXPECTED INUNDATION EXTENT (km)
Baleshwar	Odisha	Kumbhigari	0.5-1.5	Upto 0.92
Bhadrak	Odisha	Mohanpur	0.8-1.4	Upto 0.82
Kendrapara	Odisha	Tikayat Nagar	0.2-0.9	Upto 3.01
Purba Medinipur	West Bengal	Dakshin Purushottampur	0.4-0.6	Upto 0.98

**Fig II-C-5(g): Storm Surge Warning issued on 23rd October, 2024**



### Fishermen Warning Graphics

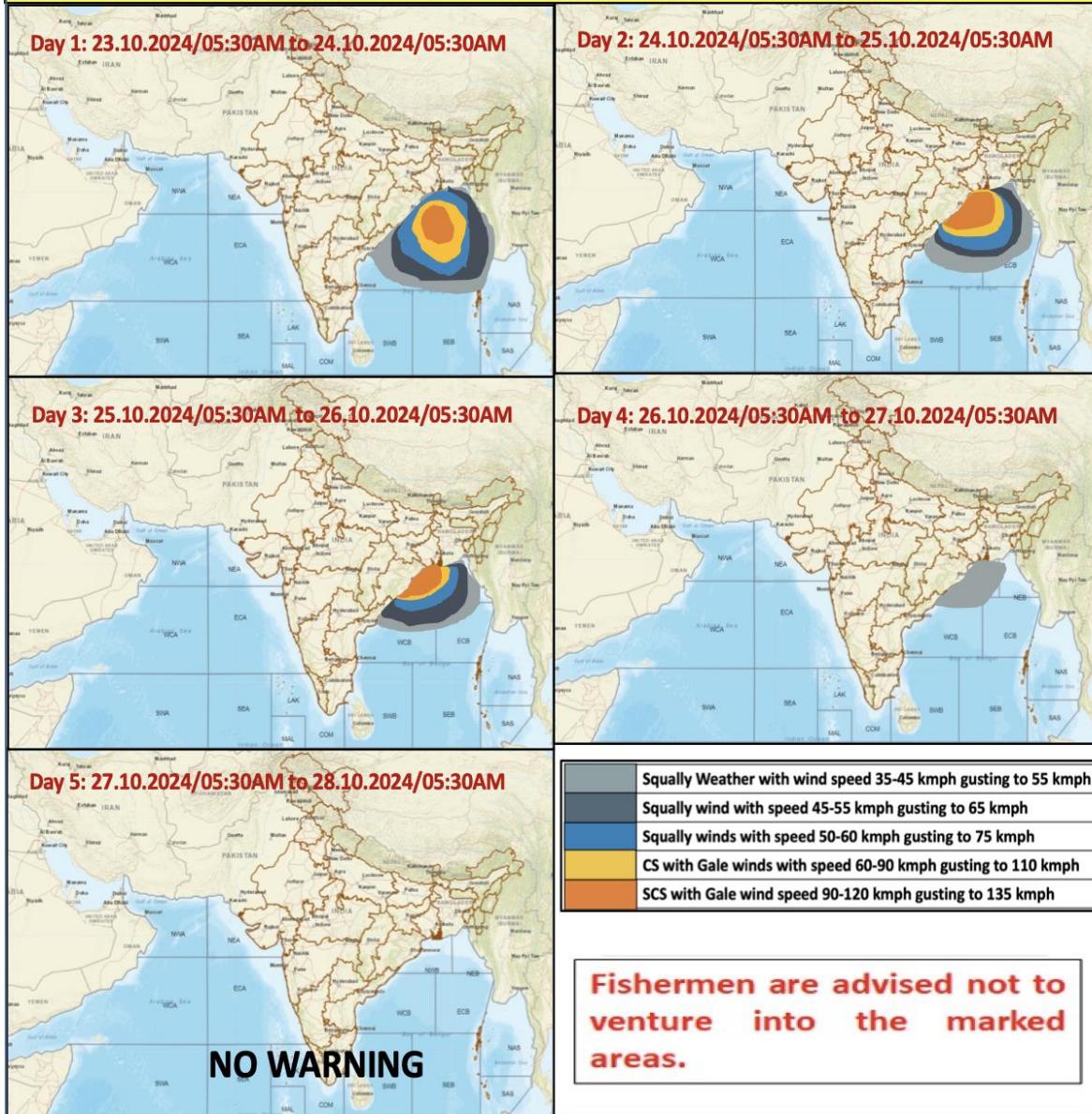


Fig II-C-5(h): Fishermen Warning Graphics issued on 23rd October, 2024

**Example 04: National bulletin associated with severe cyclone DANA.**



**India Meteorological Department  
(Ministry of Earth Sciences)**

**NATIONAL BULLETIN NO. 12 (BOB/06/2024)**

**TIME OF ISSUE:0230 HOURS IST**

**DATED: 24.10.2024**

**FROM: INDIA METEOROLOGICAL DEPARTMENT (FAX NO. 24643965/24699216/24623220)**

**TO: CONTROL ROOM, NDM, MINISTRY OF HOME AFFAIRS (FAX.NO. 23093750)  
CONTROL ROOM NDMA (FAX.NO. 26701729)  
CABINET SECRETARIAT (FAX.NO.23012284, 23018638)  
PS TO HON'BLE MINISTER FOR S & T AND EARTH SCIENCES (FAX NO.23316745)  
SECRETARY, MOES (FAX NO. 24629777)  
H.Q. (INTEGRATED DEFENCE STAFF AND CDS) (FAX NO. 23005137/23005147)  
DIRECTOR GENERAL, DOORDARSHAN (23385843)  
DIRECTOR GENERAL, AIR (23421105, 23421219)  
PIB MOES (FAX NO. 23389042)  
UNI (FAX NO. 23355841)  
D.G. NATIONAL DISASTER RESPONSE FORCE (NDRF) (FAX NO. 26105912, 2436 3260)  
DIRECTOR, PUNCTUALITY, INDIAN RAILWAYS (FAX NO. 23388503)  
CHIEF SECRETARY, ODISHA (FAX NO. 0674-2536660)  
CHIEF SECRETARY, WEST BENGAL (FAX NO. 033-22144328)  
CHIEF SECRETARY, ANDAMAN & NICOBAR ISLANDS (FAX NO. 03192-232656)  
CHIEF SECRETARY, TAMIL NADU (FAX NO. 044-25672304)  
CHIEF SECRETARY, ANDHRA PRADESH (FAX NO. 0863-2441029)  
CHIEF SECRETARY, PUDUCHERRY (FAX NO. 0413-2334145)**

**Subject: Severe Cyclonic storm “DANA” over central & adjoining northwest Bay of Bengal (Cyclone Warning for Odisha and West Bengal coasts: **Red Message**)**

The cyclonic storm “DANA” (pronounced as Dana) over Eastcentral & adjoining westcentral Bay of Bengal moved north-northwestwards with a speed of 15 kmph during past 6 hours, intensified into a severe cyclonic storm over central & adjoining northwest Bay of Bengal and lay centred at 2330 hrs IST of yesterday, the 23<sup>rd</sup> October, near latitude 17.9° N and longitude 88.5°E, about 330 km southeast of Paradip (Odisha), 360 km south-southeast of Dhamara (Odisha) and 420 km south-southeast of Sagar Island (West Bengal). It is very likely to move northwestwards and cross north Odisha and West Bengal coasts between Puri and Sagar Island close to Bhitarkanika and Dhamara (Odisha) during mid-night of 24th to morning of 25th October, 2024 as a severe Cyclonic Storm with a wind speed of 100-110 kmph gusting 120 kmph.

Forecast track and intensity are given in the following table:

Date/Time (IST)	Position (Lat. °N/ Long. °E)	Maximum Sustained Surface Wind Speed (Kmph)	Category Of Cyclonic Disturbance
23.10.24/2330	17.9/88.5	85-95 gusting to 105	Severe Cyclonic Storm
24.10.24/0530	18.5/88.2	95-105 gusting to 115	Severe Cyclonic Storm
24.10.24/1130	19.2/87.9	100-110 gusting to 120	Severe Cyclonic Storm
24.10.24/1730	19.9/87.6	100-110 gusting to 120	Severe Cyclonic Storm
24.10.24/2330	20.5/87.3	100-110 gusting to 120	Severe Cyclonic Storm
25.10.24/1130	21.0/86.7	70-80 gusting to 90	Cyclonic Storm
25.10.24/2330	21.3/85.8	40-50 gusting to 60	Depression
26.10.24/1130	21.4/84.9	30-40 gusting to 50	Well Marked Low Pressure Area

### (iii) Rainfall Warning:

- ❖ Light to moderate rainfall at most places **heavy to very heavy rainfall** at a few places and **extremely heavy rainfall ( $\geq 21$  cm)** at isolated places over **Baleswar, Mayurbhanj, Bhadrak, Kendrapara, Jagatsingpur, Kendujhar, Jajpur, Cuttack and Dhenkanal, Khorda and Puri** districts of Odisha on 24<sup>th</sup> & 25<sup>th</sup> October.
- ❖ **Light to moderate rainfall at most places with heavy to very heavy rainfall** at a few places **with extremely heavy rainfall** at isolated places over **South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata and Bankura** districts of Gangetic West Bengal on 24<sup>th</sup> & 25<sup>th</sup> October.
- ❖ Light to moderate rainfall at most places is likely over south Jharkhand with **heavy rainfall** at isolated places on 24<sup>th</sup> and **heavy to very heavy rainfall** at isolated places on 25<sup>th</sup> October.

### (ii) Wind Warning:

**Eastcentral Bay of Bengal:** Gale wind speed reaching 85-95 kmph gusting to 105 kmph is prevailing and likely to increase becoming 95-105 kmph gusting to 115 kmph by 24<sup>th</sup> morning. It is likely to decrease thereafter.

**Adjoining areas of Westcentral Bay of Bengal:** Gale wind speed reaching 85-95 kmph gusting to 95 kmph is prevailing. It is likely to increase gradually becoming 95-105 kmph gusting to 115 kmph from 24<sup>th</sup> morning till 24<sup>th</sup> afternoon. It is likely to decrease thereafter.

**Northwest Bay of Bengal:** Gale wind speed reaching 85-95 kmph gusting to 105 kmph is prevailing. It is likely to increase gradually becoming 100-110 kmph gusting to 120 kmph till 25<sup>th</sup> Oct morning. It is likely to decrease gradually thereafter.

**Adjoining areas of northeast Bay of Bengal:** Squally wind speed reaching 50-60 kmph gusting to 70 kmph is likely to prevail till 25<sup>th</sup> morning and decrease gradually thereafter.

**Along & off Odisha-west Bengal coasts:** Squally wind speed reaching 55-65 gusting to 75 kmph is prevailing. It would gradually increase becoming gale wind speed reaching 60-70 kmph gusting to 80 kmph from 24<sup>th</sup> morning and 100-110 kmph gusting to 120 kmph along & off north Odisha and east Medinipur district of West Bengal; Gale wind speed reaching 60-80 kmph gusting to 90 kmph is likely along & off south Odisha and remaining districts of coastal West Bengal from 24<sup>th</sup> night till 25<sup>th</sup> Oct morning and decrease gradually thereafter.

**South Jharkhand:** Squally wind speed reaching 40-50 gusting to 60 kmph is very likely to prevail from morning of 25<sup>th</sup> till evening of 26<sup>th</sup> October.

### (iii) Storm surge warning:

Storm surge of 1.0 to 2.0 m height above astronomical tide is very likely to inundate low lying areas of Kendrapara, Bhadrak & Balasore districts of Odisha and East Medinipur districts of West Bengal during the time of landfall.

Storm surge of 0.5 to 1.0 m height above astronomical tide is very likely to inundate low lying areas of South 24-Parganas district of West Bengal and Jagatsinghpur district of Odisha during the time of landfall.

**(iv) Sea Condition:**

**Eastcentral Bay of Bengal:** Sea condition is likely to be **high to very high till 24<sup>th</sup> October evening** and improve gradually thereafter.

**Adjoining areas of Westcentral Bay of Bengal:** Sea condition is likely to be **high to very high till 24<sup>th</sup> October evening**. It is likely to improve gradually thereafter.

**Northwest Bay of Bengal:** Sea condition is likely to be **High to Very High** till 25<sup>th</sup> morning and improve gradually thereafter.

**Adjoining areas of northeast Bay of Bengal:** Sea condition is likely to be **Rough to Very Rough** till 25<sup>th</sup> morning and improve gradually thereafter.

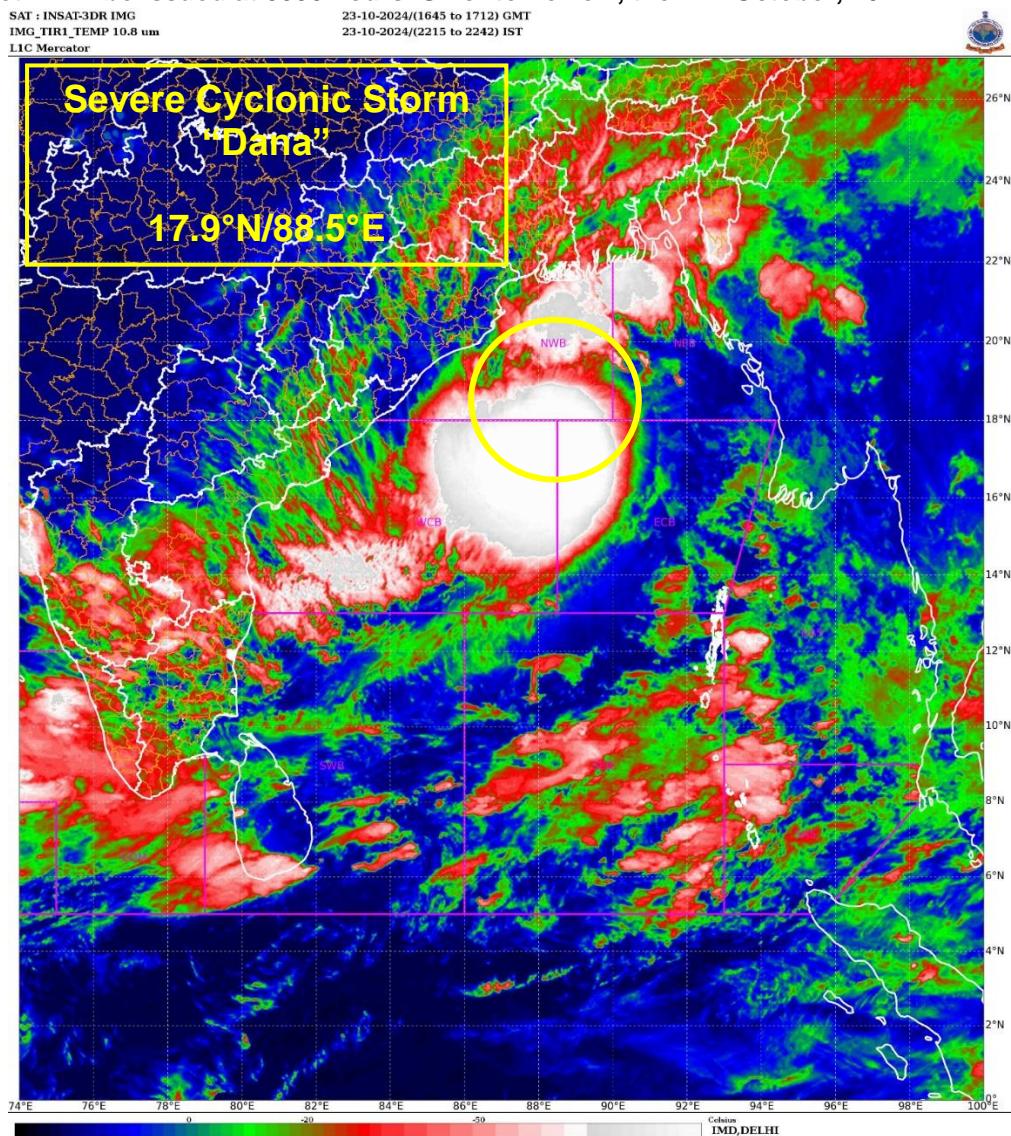
**Along & off Odisha-west Bengal coasts:** **Very Rough** Sea condition is prevailing and likely to become **High to Very High** from 24<sup>th</sup> October **morning to 25<sup>th</sup> Oct forenoon** and improve gradually thereafter.

**(v) Fishermen Warning:**

- Total suspension of fishing operations during 24<sup>th</sup> to 25<sup>th</sup> Oct over Central and North Bay of Bengal.
- Fishermen are advised not to venture into
  - Eastcentral Bay of Bengal till 24<sup>th</sup> October.
  - **Adjoining areas of Westcentral Bay of Bengal till 24<sup>th</sup> Oct.**
  - **Northwest & adjoining northeast Bay of Bengal and along & off Odisha, West Bengal and Bangladesh coasts** during till 25<sup>th</sup> October.
- ❖ **Impact Expected over districts of Odisha (Baleswar, Bhadrak, Kendrapara, Jajpur, Jagatsinghpur, Puri, Khorda, Mayurbhanj, Kendujhar, Cuttack, Dhenkanal) and West Bengal (East & West Medinipur, South & North 24 Parganas, Jhargram, Howrah, Hooghly, Kolkata, & Bankura)**
  - Major damage to thatched houses/ huts. Roof tops may blow off. Unattached metal sheets may fly.
  - Breaking of tree branches and uprooting of trees. Large dead limbs blown from trees.
  - Damage to power and communication lines.
  - Major damage to Kutcha and some damage to Pucca roads. Flooding of escape routes.
  - Damage to vulnerable structure.
  - Major damage to standing crops including banana, papaya, horticultural and vegetable crops due to inundation and wind.
  - Damage to embankments/ salt pans.
  - Localized Flooding of roads, water logging in low lying areas and closure of underpasses mainly in urban areas of the above region.
  - Occasional reduction in visibility due to heavy rainfall.
  - Disruption of traffic in major cities and roadways due to water logging in roads and poor visibility due to heavy rain leading to increased travel time and incidents
  - Localized Landslides/Mudslides/landslips/mud slips/land sinks/mud sinks.
  - Likely disruption of marine and inland water transportation like small boats and trawlers.
  - It may lead to riverine flooding in some river catchments (for riverine flooding please visit Webpage of Central Water Commission)
- ❖ **Action Suggested for districts of Odisha (Baleswar, Bhadrak, Kendrapara, Jajpur, Jagatsinghpur, Puri, Khorda, Mayurbhanj, Kendujhar, Cuttack, Dhenkanal) and West Bengal (South & North 24 Parganas, East & West Medinipur, Jhargram, Howrah, Hooghly, Kolkata & Bankura)**
  - Total suspension of fishing operations during 24<sup>th</sup> to 25<sup>th</sup> Oct over Central and North Bay of Bengal.
  - Fishermen are advised not to venture into
    - ✓ Eastcentral Bay of Bengal till 24<sup>th</sup> October.
    - ✓ **Adjoining areas of Westcentral Bay of Bengal on 24<sup>th</sup> Oct.**
    - ✓ **Northwest and adjoining northeast Bay of Bengal and along & off Odisha, West Bengal and Bangladesh coasts** during 24<sup>th</sup> to 25<sup>th</sup> October morning.

- Movement in motor boats unsafe
- Coastal hutment dwellers to be moved to safer places.
- People in affected areas to remain indoors.
- Judicious regulation of onshore/offshore, Port and maritime activities including shipping.
- Judicious regulation of tourism activities in coastal areas.
- Judicious regulation of surface transports including railways and roadways.
- Check for traffic congestion on your route before leaving for your destination.
- Follow any traffic advisories that are issued in this regard.
- Avoid going to areas that face the water logging problems often.
- Avoid staying in vulnerable structure.

**Next bulletin will be issued at 0530 hours IST of tomorrow, the 24<sup>th</sup> October, 2024.**



**Fig II-C-6(a): INSAT 3DR Image of Severe Cyclonic Storm DANA issued on 23<sup>rd</sup> October, 2024**

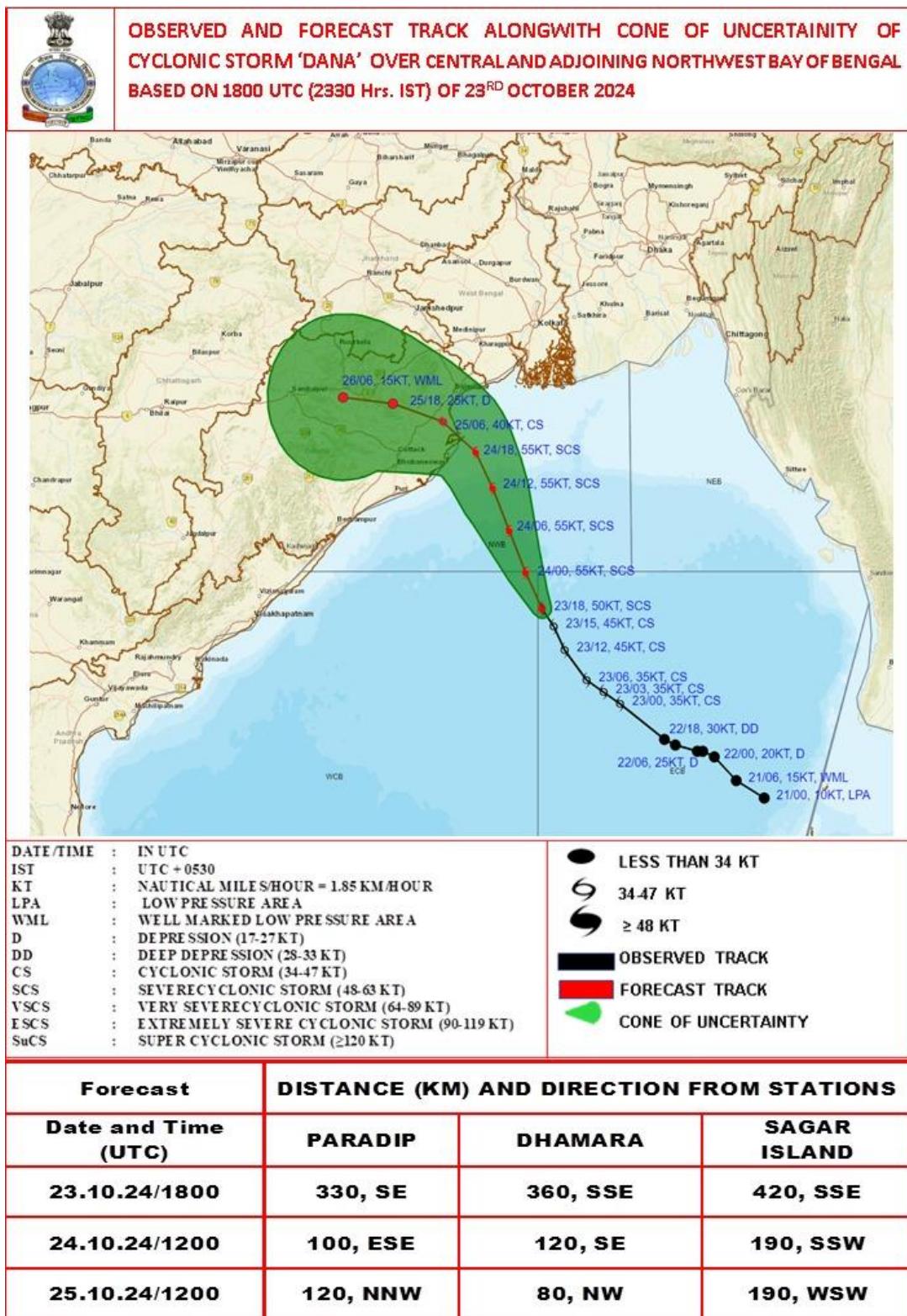


Fig II-C-6(b): Observed and forecast track along with cone of uncertainty of severe cyclonic storm 'dana' based on 1800 UTC of 23<sup>rd</sup> October 2024

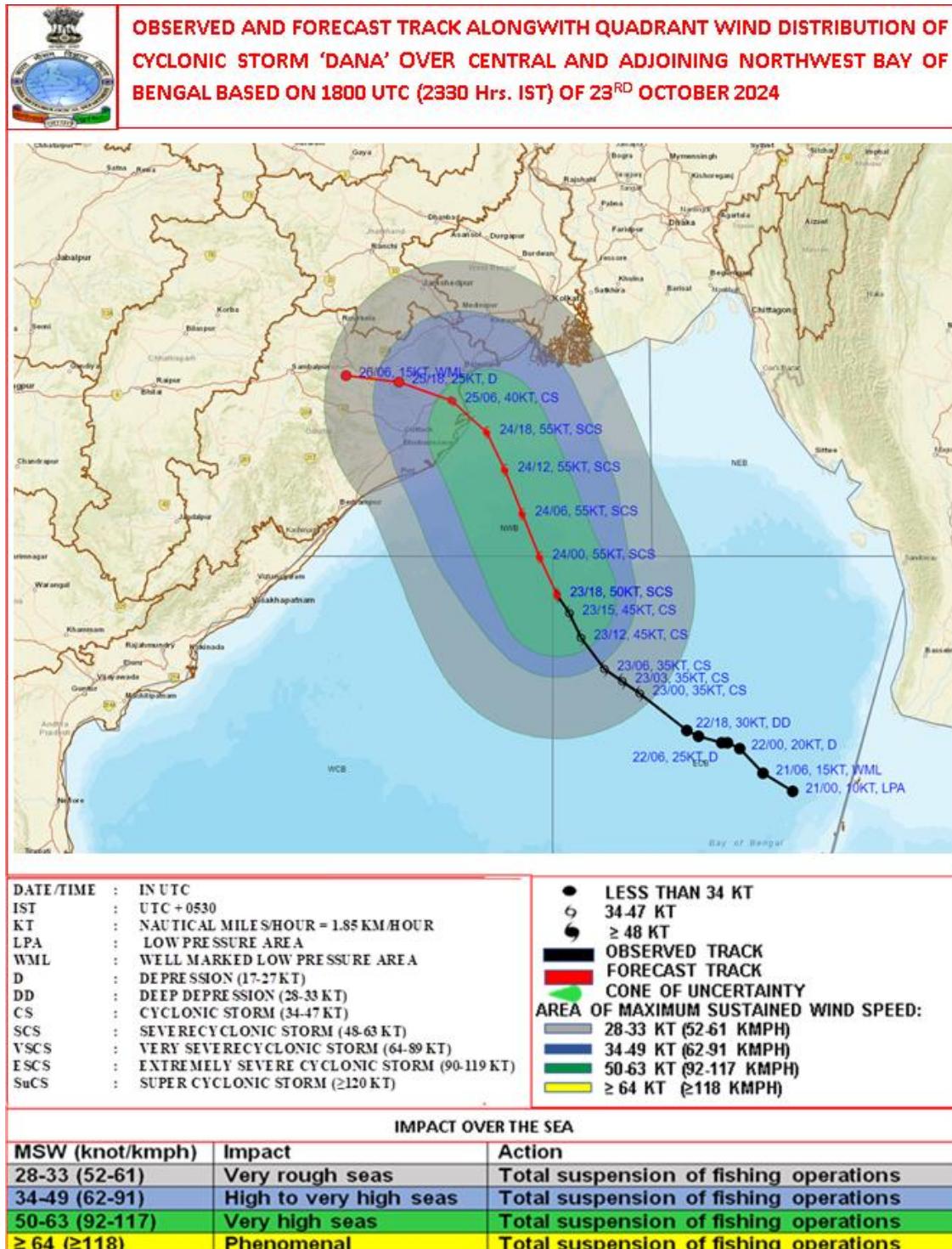
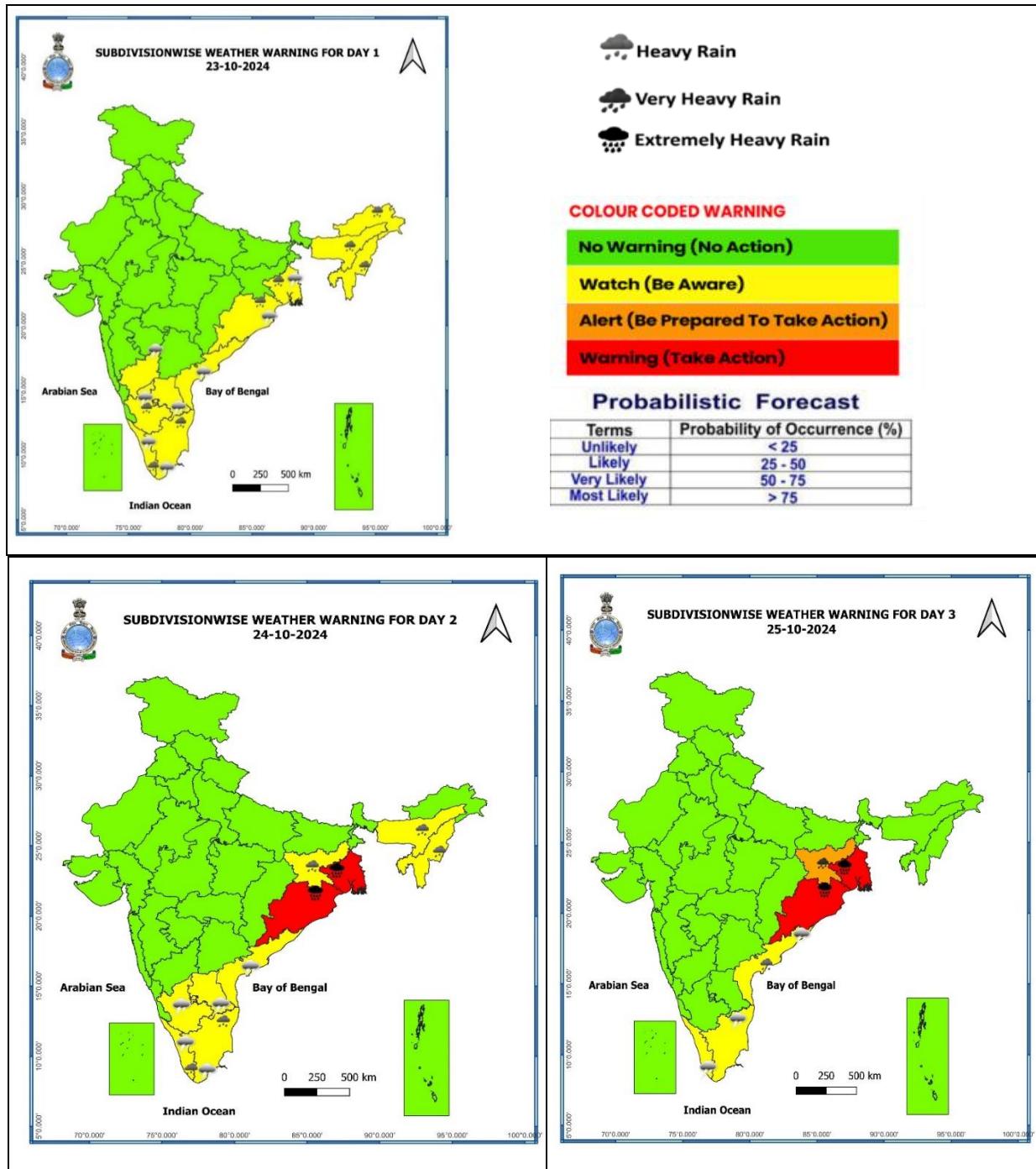


Fig II-C-6(c): Observed and forecast track along with quadrant wind distribution of severe cyclonic storm 'dana' based on 1800 UTC of 23<sup>rd</sup> October 2024



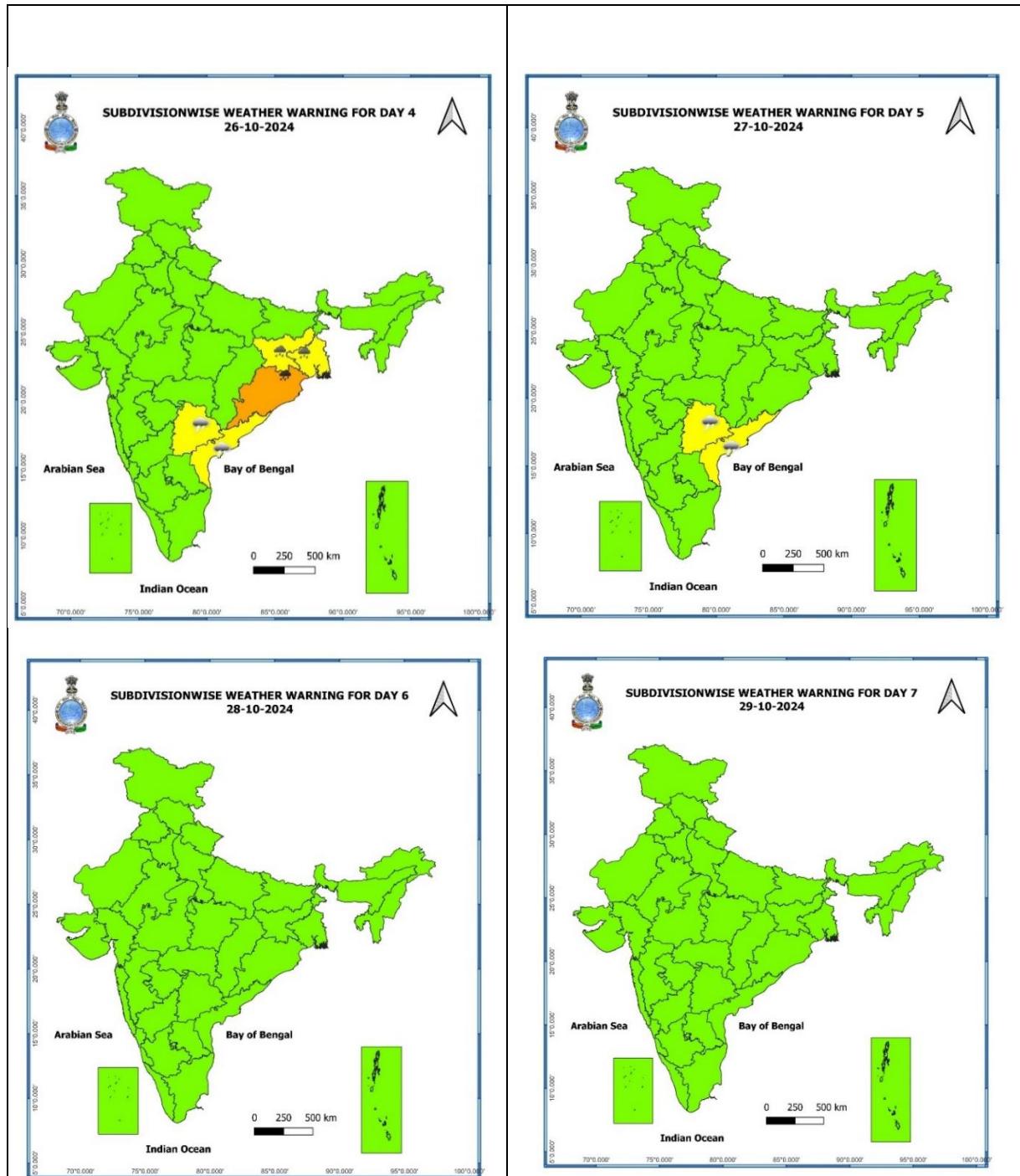


Fig II-C-6(d): Heavy rainfall warning issued on 23<sup>rd</sup> October, 2024

- Action may be taken based on **ORANGE AND RED COLOUR** warnings.
- Vulnerable regions likely urban and hilly areas action may be initiated for heavy rainfall warning.
- As the lead period increases forecast accuracy decreases.

### District-wise Warning of Odisha

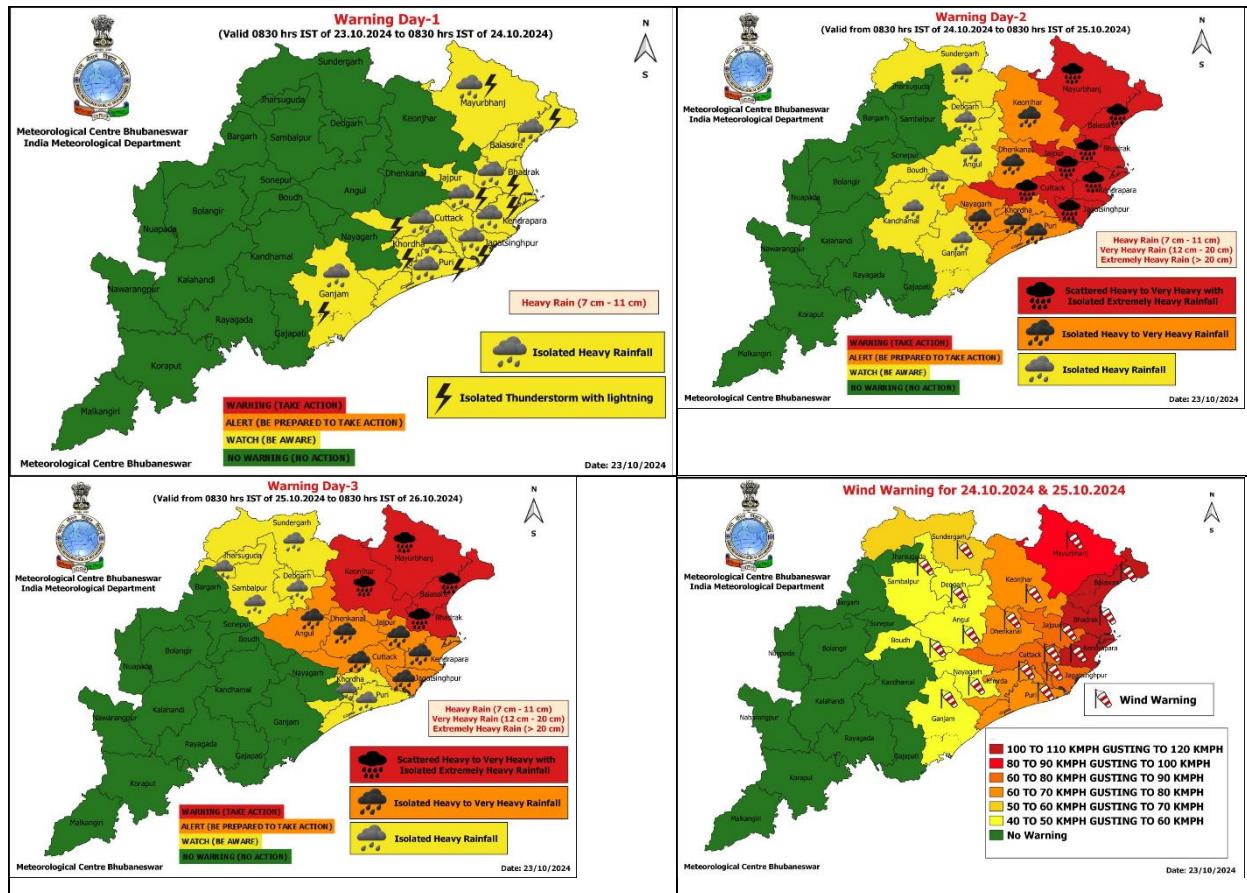
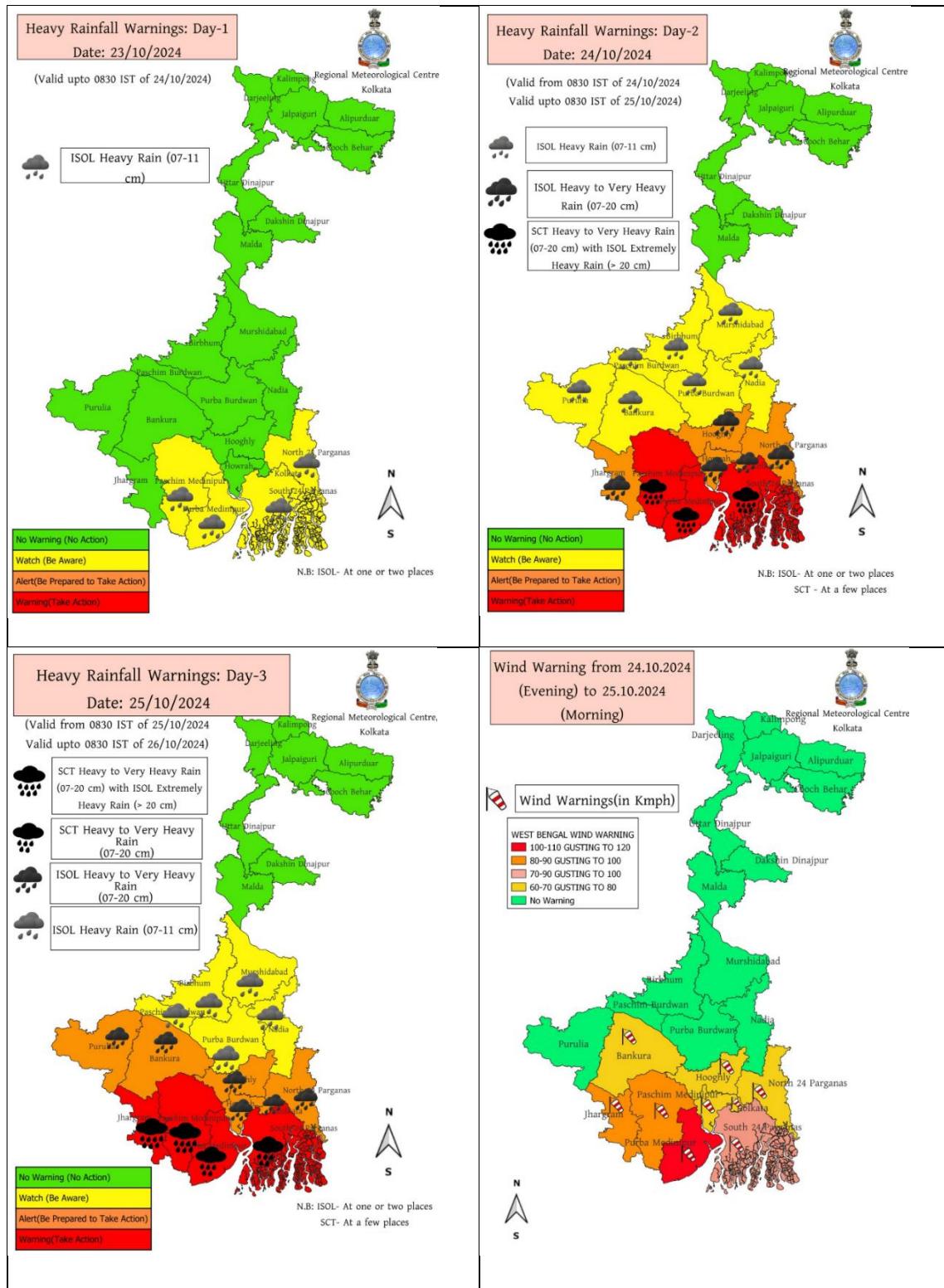
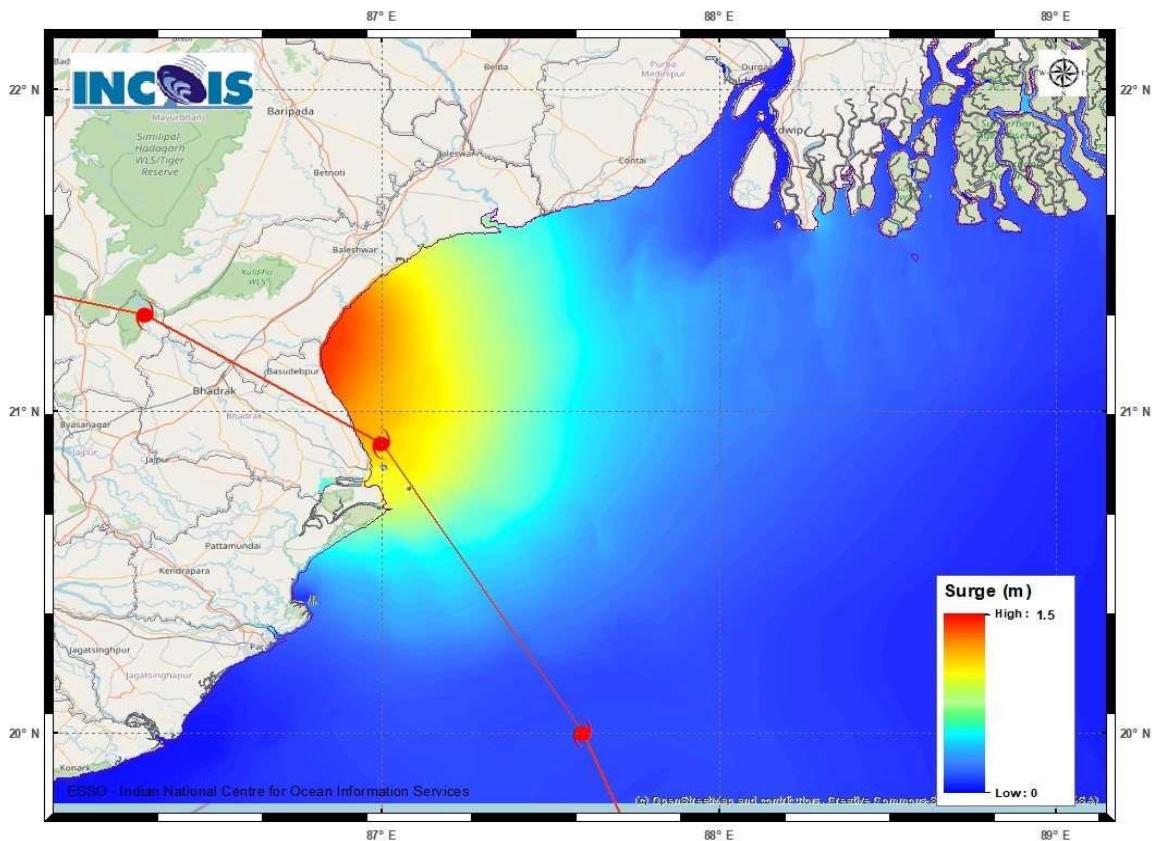


Fig II-C-6(e): District-wise Warning of Odisha issued on 23<sup>rd</sup> October, 2024

**District-wise Warning of West Bengal****Fig II-C-6(f): District-wise Warning of West Bengal issued on 23<sup>rd</sup> October, 2024**

## Storm Surge warning graphics



DISTRICT	STATE / UNION TERRITORY	NEAREST PLACE OF HABITATION	STORM SURGE (m)*	EXPECTED INUNDATION EXTENT (km)
Baleshwar	Odisha	Kumbhirgari	0.4-1.5	Upto 0.92
Bhadrak	Odisha	Mohanpur	0.8-1.5	Upto 0.82
Kendrapara	Odisha	Tikayat Nagar	0.2-1.0	Upto 3.01
Purba Medinipur	West Bengal	Dakshin Purushottampur	0.3-0.5	Upto 0.98
South 24 Parganas	West Bengal	Island	0.4-0.5	Upto 0.11

**Fig II-C-6(f): Storm surge Warning issued on 23<sup>rd</sup> October, 2024**

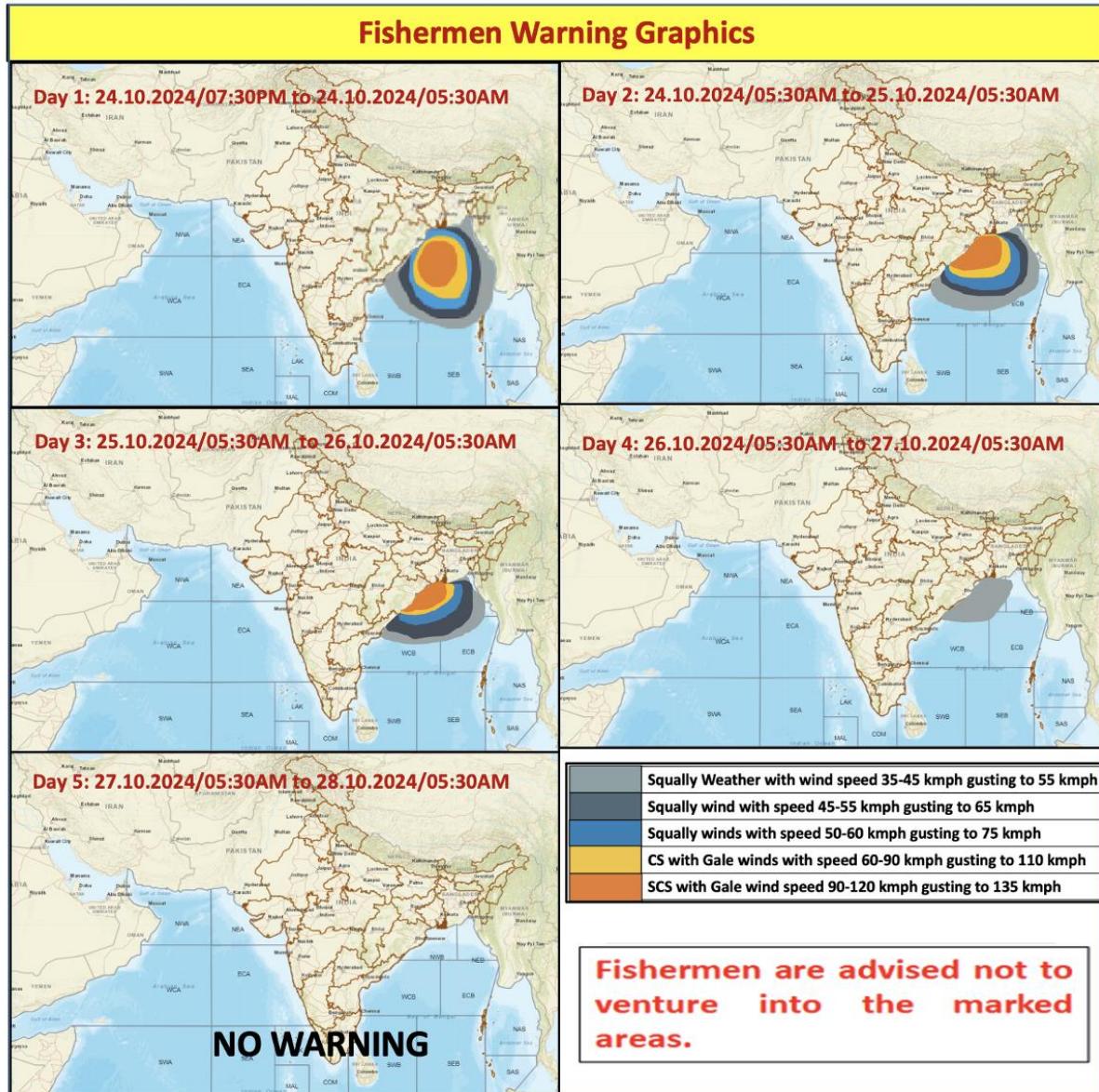


Fig II-C-6(g): Fishermen Warning of Odisha issued on 23<sup>rd</sup> October, 2024

**Example 05: National bulletin associated with landfall of cyclone DANA.**



**India Meteorological Department  
(Ministry of Earth Sciences)**

**NATIONAL BULLETIN NO. 26 (BOB/06/2024)**

**TIME OF ISSUE: 2100 HOURS IST**

**DATED: 25.10.2024**

**FROM: INDIA METEOROLOGICAL DEPARTMENT (FAX NO. 24643965/24699216/24623220)**

**TO: CONTROL ROOM, NDM, MINISTRY OF HOME AFFAIRS (FAX.NO. 23093750)  
CONTROL ROOM NDMA (FAX.NO. 26701729)  
CABINET SECRETARIAT (FAX.NO.23012284, 23018638)  
PS TO HON'BLE MINISTER FOR S & T AND EARTH SCIENCES (FAX NO.23316745)  
SECRETARY, MOES (FAX NO. 24629777)  
HQ. (INTEGRATED DEFENCE STAFF AND CDS) (FAX NO. 23005137/23005147)  
DIRECTOR GENERAL, DOORDARSHAN (23385843)  
DIRECTOR GENERAL, AIR (23421105, 23421219)  
PIB MOES (FAX NO. 23389042)  
UNI (FAX NO. 23355841)  
D.G. NATIONAL DISASTER RESPONSE FORCE (NDRF) (FAX NO. 26105912, 2436 3260)  
DIRECTOR, PUNCTUALITY, INDIAN RAILWAYS (FAX NO. 23388503)  
CHIEF SECRETARY, ODISHA (FAX NO. 0674-2536660)  
CHIEF SECRETARY, WEST BENGAL (FAX NO. 033-22144328)  
CHIEF SECRETARY, ANDAMAN & NICOBAR ISLANDS (FAX NO. 03192-232656)  
CHIEF SECRETARY, ANDHRA PRADESH (FAX NO. 0863-2441029)  
CHIEF SECRETARY, TAMIL NADU (FAX NO. 044-25672304)  
CHIEF SECRETARY, PUDUCHERRY (FAX NO. 0413-2334145)  
CHIEF SECRETARY, JHARKHAND (FAX NO. 0651-2400240)  
CHIEF SECRETARY, BIHAR (FAX NO. 0612-2205800)**

**Subject: Deep Depression (remnant of severe cyclonic storm “DANA”) over north Odisha**

The deep depression (remnant of severe cyclonic storm “DANA”) over north coastal Odisha moved westwards with a speed of 7 kmph during past 6 hours and lay centred near latitude 21.4°N and longitude 86.2°E at 1730 hrs IST of today, the 25th October over north Odisha about 50 km northwest of Bhadrak and 70 km east-southeast of Keonjhar.

It is likely to move nearly westwards across north Odisha and weaken gradually into a depression during next 12 hours.

The system is under continuous surveillance of the doppler weather radar at Paradip.

**Warnings:**

**(iv) Rainfall Warning:**

- ❖ Light to moderate rainfall at most places with **heavy to very heavy rainfall** at isolated places is very likely over **Mayurbhanj, Keonjhar, Balasore and Bhadrak** districts of Odisha on 25<sup>th</sup> October.
- ❖ **Light to moderate rainfall at most places with heavy to very heavy rainfall** at isolated places over coastal districts of West Bengal on 25<sup>th</sup> October.

- ❖ Light to moderate rainfall at many places with **heavy rainfall** at isolated places is likely over south Jharkhand on 25<sup>th</sup> October.

**(ii) Wind Warning:**

**Northwest Bay of Bengal:** Squally wind speed reaching 30-40 gusting to 50 kmph is likely to prevail on 25<sup>th</sup> October 2024.

**Northwest Bay of Bengal and along & off Odisha-West Bengal coasts and adjoining interior districts:** Squally wind speed reaching 40-50 kmph gusting to 60 kmph would prevail over Balasore, Mayurbhanj, Keonjhar, Bhadrak, Kendrapara districts of Odisha and East Medinipur and Jhargram districts of West Bengal on 25<sup>th</sup> October.

**South Jharkhand:** Squally wind speed reaching 30-40 kmph gusting to 60 kmph is very likely to prevail on 25<sup>th</sup> October.

**(iii) Sea Condition:**

**Northwest Bay of Bengal and along & off Odisha-west Bengal coasts:** Sea condition is likely to be **Rough** on 25<sup>th</sup> October and improve gradually thereafter.

**(iv) Fishermen Warning:**

Fishermen are advised not to venture into Northwest Bay of Bengal and along & off Odisha and West Bengal coasts on 25<sup>th</sup> October.

**❖ Impact Expected over districts of Odisha (Balasore, Bhadrak, Mayurbhanj, Keonjhar, Dhenkanal, Kendrapara, Cuttack and Jajpur) and West Bengal (South 24-Parganas, East & West Medinipur and Jhargram) on 25<sup>th</sup> October**

- Damage to thatched houses/ huts. Unattached metal sheets may fly.
- Breaking of tree branches and uprooting of trees.
- Partial damage to power and communication lines.
- Damage to Kutcha and some damage to Pucca roads. Flooding of escape routes.
- Damage to vulnerable structure.
- Damage to standing crops including banana, papaya, horticultural and vegetable crops due to inundation and wind.
- Localized Flooding of roads, water logging in low lying areas and closure of underpasses mainly in urban areas of the above region.
- Occasional reduction in visibility due to heavy rainfall.
- Disruption of traffic in major cities and roadways due to water logging in roads and poor visibility due to heavy rain leading to increased travel time and incidents
- Localized Landslides/Mudslides/landslips/mud slips/land sinks/mud sinks.
- Likely disruption of marine and inland water transportation like small boats and trawlers.
- It may lead to riverine flooding in some river catchments (for riverine flooding please visit Webpage of Central Water Commission)

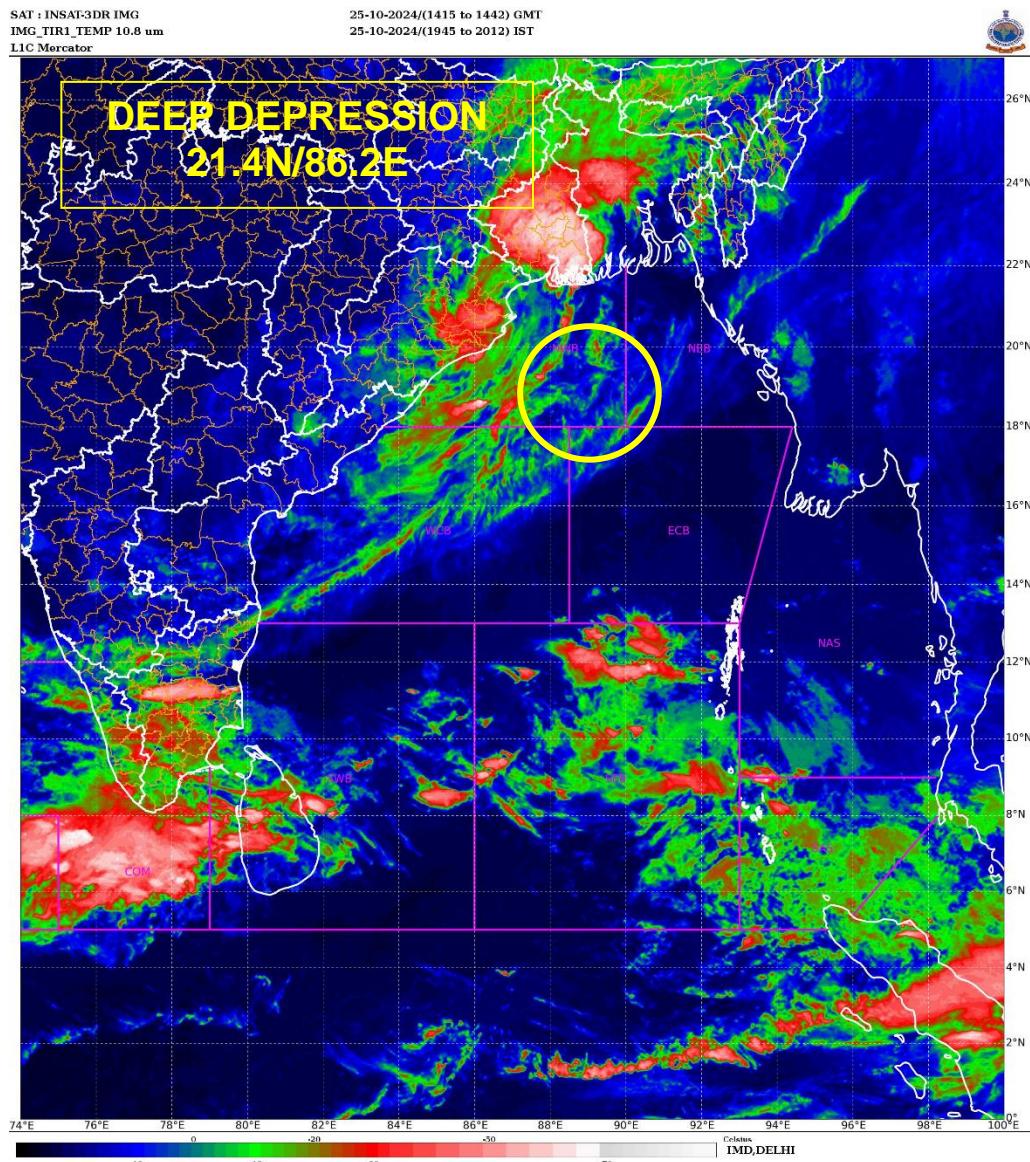
**❖ Action Suggested for districts of Odisha (Balasore, Bhadrak, Mayurbhanj, Keonjhar, Dhenkanal, Kendrapara, Cuttack and Jajpur) and West Bengal (South 24-Parganas, East & West Medinipur and Jhargram) on 25<sup>th</sup> October**

- Fishermen are advised not to venture into Northwest Bay of Bengal and along & off Odisha and West Bengal coasts on 25<sup>th</sup> October.
- Movement in motor boats unsafe
- People in affected areas to remain indoors.
- Judicious regulation of Port and maritime activities including shipping.
- Judicious regulation of tourism activities in coastal areas.
- Judicious regulation of surface transports including railways and roadways.
- Check for traffic congestion on your route before leaving for your destination.
- Follow any traffic advisories that are issued in this regard.
- Avoid going to areas that face the water logging problems often.
- Avoid staying in vulnerable structure.

**Next bulletin will be issued at 0230 hours IST of tomorrow, the 26<sup>th</sup> October, 2024.**

Copy to: ACWC Kolkata/ACWC Chennai/CWC Bhubaneswar/CWC Vishakhapatnam/Meteorological Centre Port Blair/MC Ranchi

### SATELLITE IMAGERY



**Fig II-C-7(a): INSAT 3DR Image issued on 25<sup>th</sup> October, 2024**

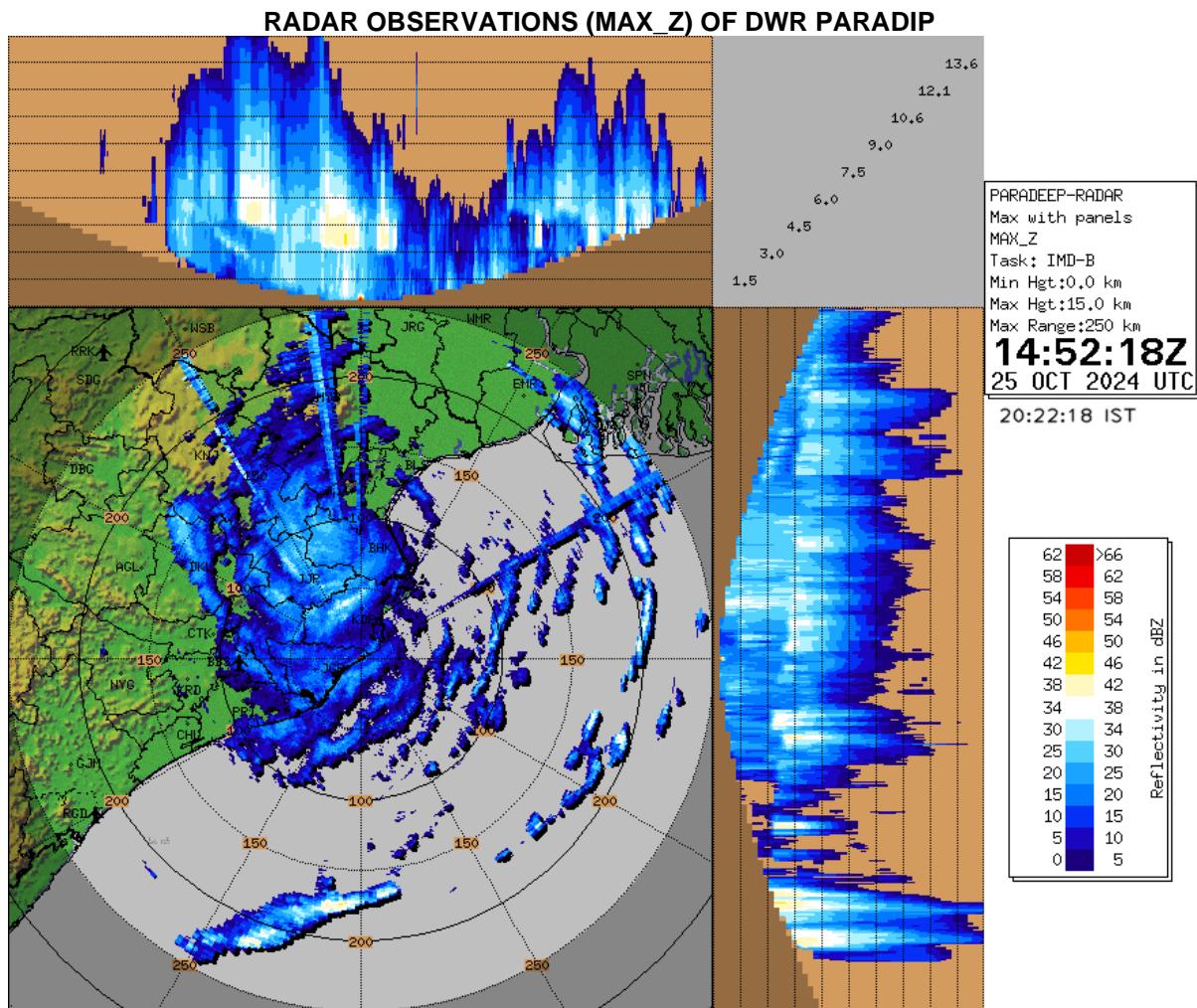
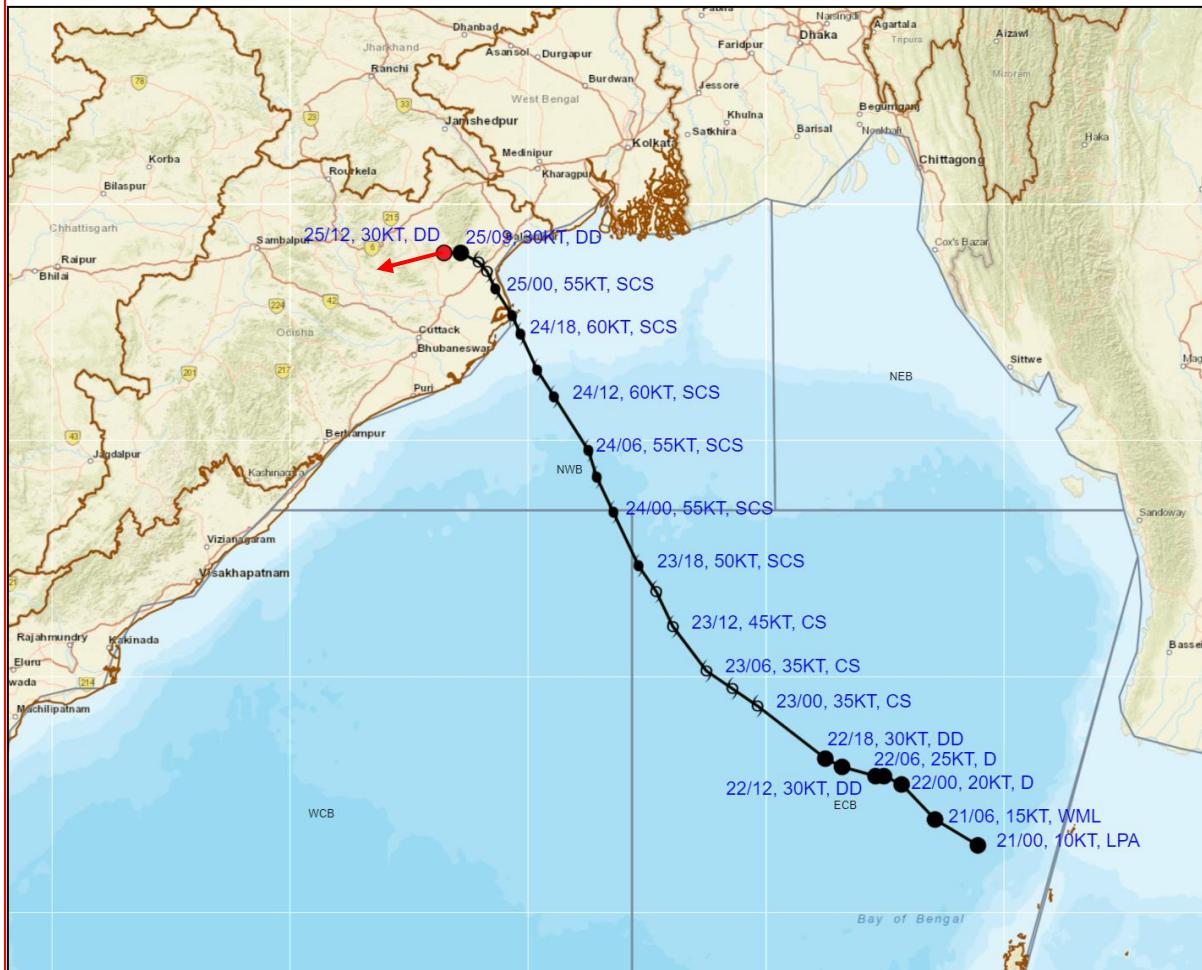


Fig II-C-7(b): Radar observations (Max\_Z) of DWR Paradip issued on 25<sup>th</sup> October, 2024



**OBSERVED AND FORECAST TRACK OF DEEP DEPRESSION  
(REMNANT OF SEVERE CYCLONIC STORM 'DANA') OVER  
NORTH ODISHA BASED ON 1200 UTC (1730 Hrs. IST) OF 25<sup>th</sup>  
OCTOBER 2024**



DATE/TIME :	IN UTC	● LESS THAN 34 KT
IST	UTC + 0530	● 34-47 KT
KT	NAUTICAL MILES/HOUR = 1.85 KM/HOUR	● $\geq 48$ KT
LPA	LOW PRESSURE AREA	■ OBSERVED TRACK
WML	WELL MARKED LOW PRESSURE AREA	■ FORECAST TRACK
D	DEPRESSION (17-27 KT)	▲ CONE OF UNCERTAINTY
DD	DEEP DEPRESSION (28-33 KT)	
CS	CYCLONIC STORM (34-47 KT)	
SCS	SEVERE CYCLONIC STORM (48-63 KT)	
VSCS	VERY SEVERE CYCLONIC STORM (64-89 KT)	
ESCS	EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)	
SuCS	SUPER CYCLONIC STORM ( $\geq 120$ KT)	

Fig II-C-7(c): Observed and forecast track of deep depression (remnant of severe cyclonic storm 'dana') over north Odisha based on 1200 UTC of 25<sup>th</sup> October 2024

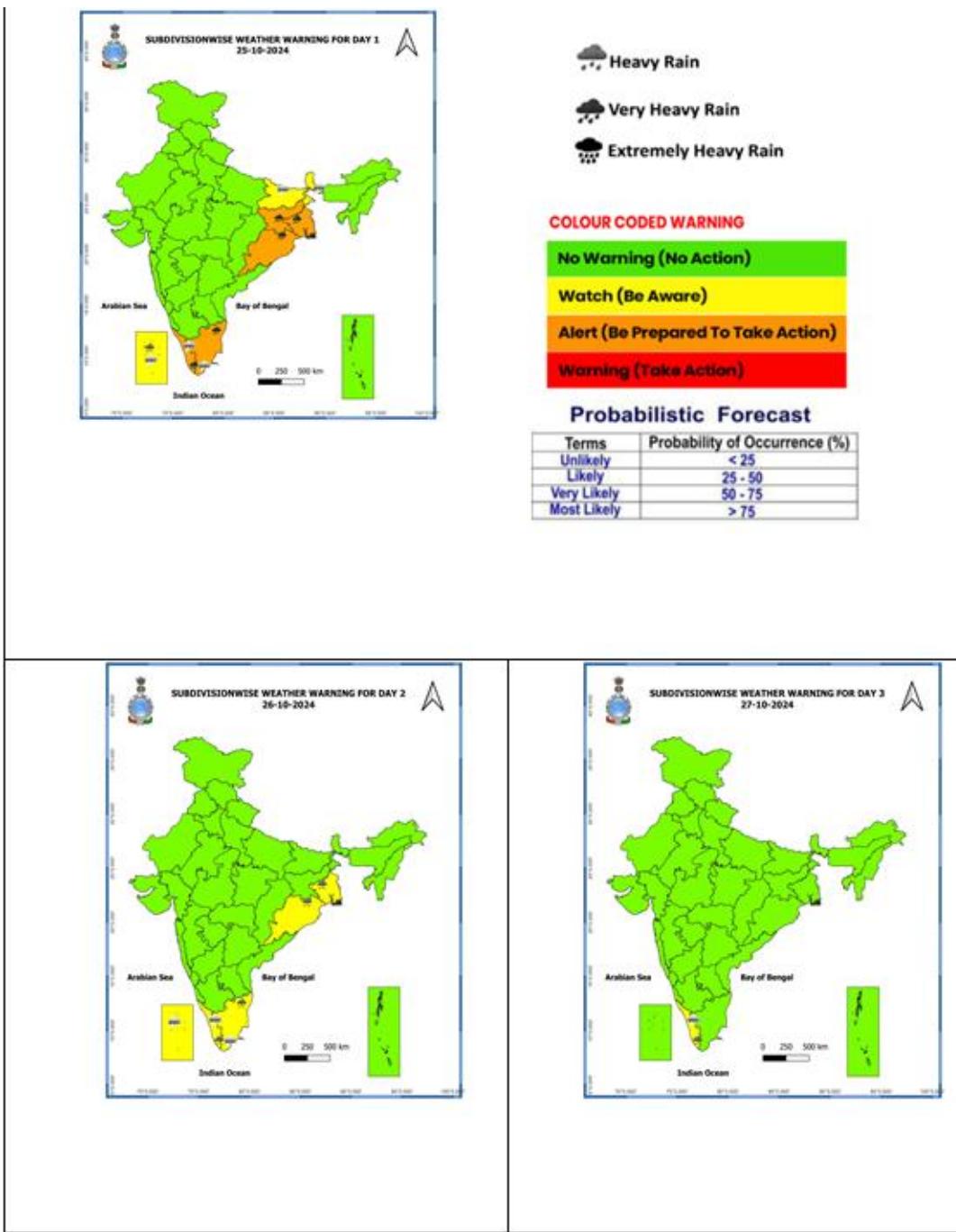


Fig II-C-7(d): Heavy rainfall warning issued on 25<sup>th</sup> October, 2024

- Action may be taken based on **ORANGE AND RED COLOUR** warnings.
- Vulnerable regions likely urban and hilly areas action may be initiated for heavy rainfall warning.
- As the lead period increases forecast accuracy decreases.

### 24 HOURS OUTLOOK FOR THE FLASH FLOOD RISK

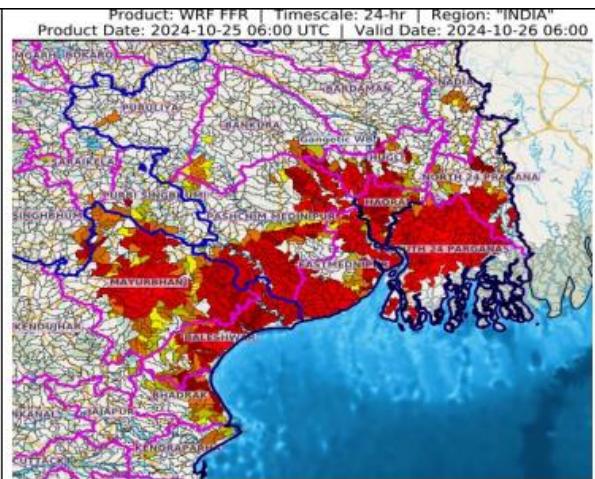
**24 hours Outlook for the Flash Flood Risk (FFR) till 1130 IST of 26-10-2024 :**

**Moderate flash flood risk** likely over few watersheds & neighbourhoods of following Met Sub-divisions during next 24 hours.

**Odisha** - Baleshwar, Bhadrak, Kendraparha and Mayurbhanj districts.

**Gangetic West Bengal** - Bankura, Eastmednipur, Haora, Hugli, Nadia, North 24 Pragana, Pashchim Medinipur, Puruliya and South 24 Parganas districts.

Surface runoff/ Inundation may occur at some fully saturated soils & low-lying areas over AoC as shown in map due to expected rainfall occurrence in next 24 hours.



**Flash Flood Risk**

**High Risk (Take Action)**

**Moderate Risk (Be Prepared)**

**Low Risk (Be Updated)**

**Fig II-C-7(e): Flash flood guidance issued on 25<sup>th</sup> October, 2024**



Fig II-C-7(f): Fishermen Waning Graphics issued on 25<sup>th</sup> October, 2024

**Example 06: National bulletin associated with well marked low remnant of severe cyclonic storm “DANA”.**



**India Meteorological Department  
(Ministry of Earth Sciences)**

**NATIONAL BULLETIN NO. 28 (BOB/06/2024)**

**TIME OF ISSUE: 0820 HOURS IST**

**DATED: 26.10.2024**

**FROM: INDIA METEOROLOGICAL DEPARTMENT (FAX NO. 24643965/24699216/24623220)**

**TO: CONTROL ROOM, NDM, MINISTRY OF HOME AFFAIRS (FAX.NO. 23093750)**

**CONTROL ROOM NDMA (FAX.NO. 26701729)**

**CABINET SECRETARIAT (FAX.NO.23012284, 23018638)**

**PS TO HON’BLE MINISTER FOR S & T AND EARTH SCIENCES (FAX NO.23316745)**

**SECRETARY, MOES (FAX NO. 24629777)**

**H.Q. (INTEGRATED DEFENCE STAFF AND CDS) (FAX NO. 23005137/23005147)**

**DIRECTOR GENERAL, DOORDARSHAN (23385843)**

**DIRECTOR GENERAL, AIR (23421105, 23421219)**

**PIB MOES (FAX NO. 23389042)**

**UNI (FAX NO. 23355841)**

**D.G. NATIONAL DISASTER RESPONSE FORCE (NDRF) (FAX NO. 26105912, 2436 3260)**

**DIRECTOR, PUNCTUALITY, INDIAN RAILWAYS (FAX NO. 23388503)**

**CHIEF SECRETARY, ODISHA (FAX NO. 0674-2536660)**

**CHIEF SECRETARY, WEST BENGAL (FAX NO. 033-22144328)**

**CHIEF SECRETARY, ANDAMAN & NICOBAR ISLANDS (FAX NO. 03192-232656)**

**CHIEF SECRETARY, ANDHRA PRADESH (FAX NO. 0863-2441029)**

**CHIEF SECRETARY, TAMIL NADU (FAX NO. 044-25672304)**

**CHIEF SECRETARY, PUDUCHERRY (FAX NO. 0413-2334145)**

**CHIEF SECRETARY, JHARKHAND (FAX NO. 0651-2400240)**

**CHIEF SECRETARY, BIHAR (FAX NO. 0612-2205800)**

**Subject: Well Marked Low Pressure Area (remnant of severe cyclonic storm “DANA”) over north Odisha**

The depression (remnant of severe cyclonic storm “DANA”) over north Odisha moved slightly westwards during past 6 hours and weakened into a well marked low pressure area over the same region. It is likely to weaken further and become insignificant during next 12 hours.

**Warnings: NIL**

**This is the last bulletin in association with this system. However, regular bulletins would continue from National Weather Forecasting Centre and concerned regional meteorological centre/state meteorological centres.**

Copy to: ACWC Kolkata/ACWC Chennai/CWC Bhubaneswar/CWC Vishakhapatnam/Meteorological Centre Port Blair/MC Ranchi

### SATELLITE IMAGERY

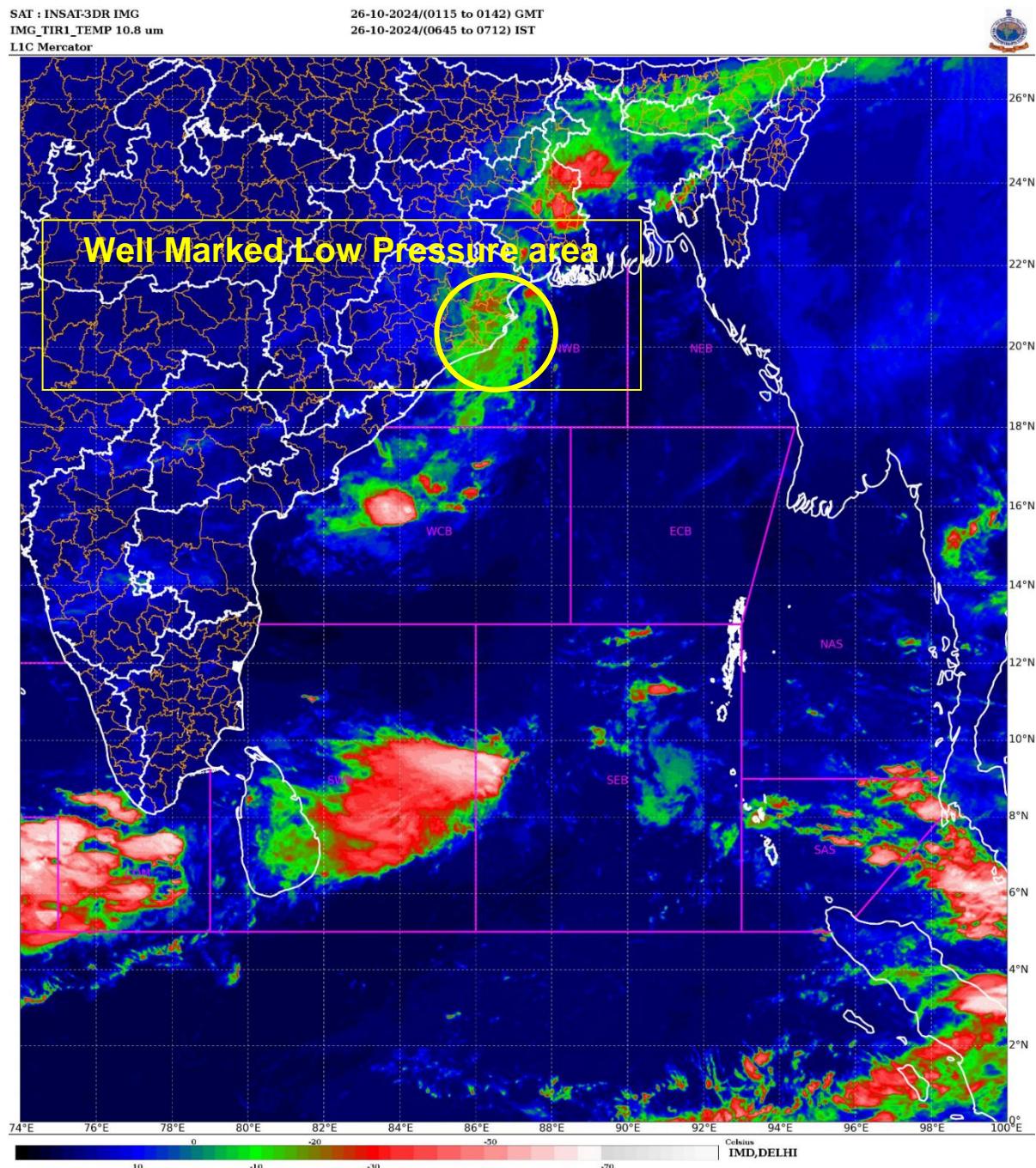
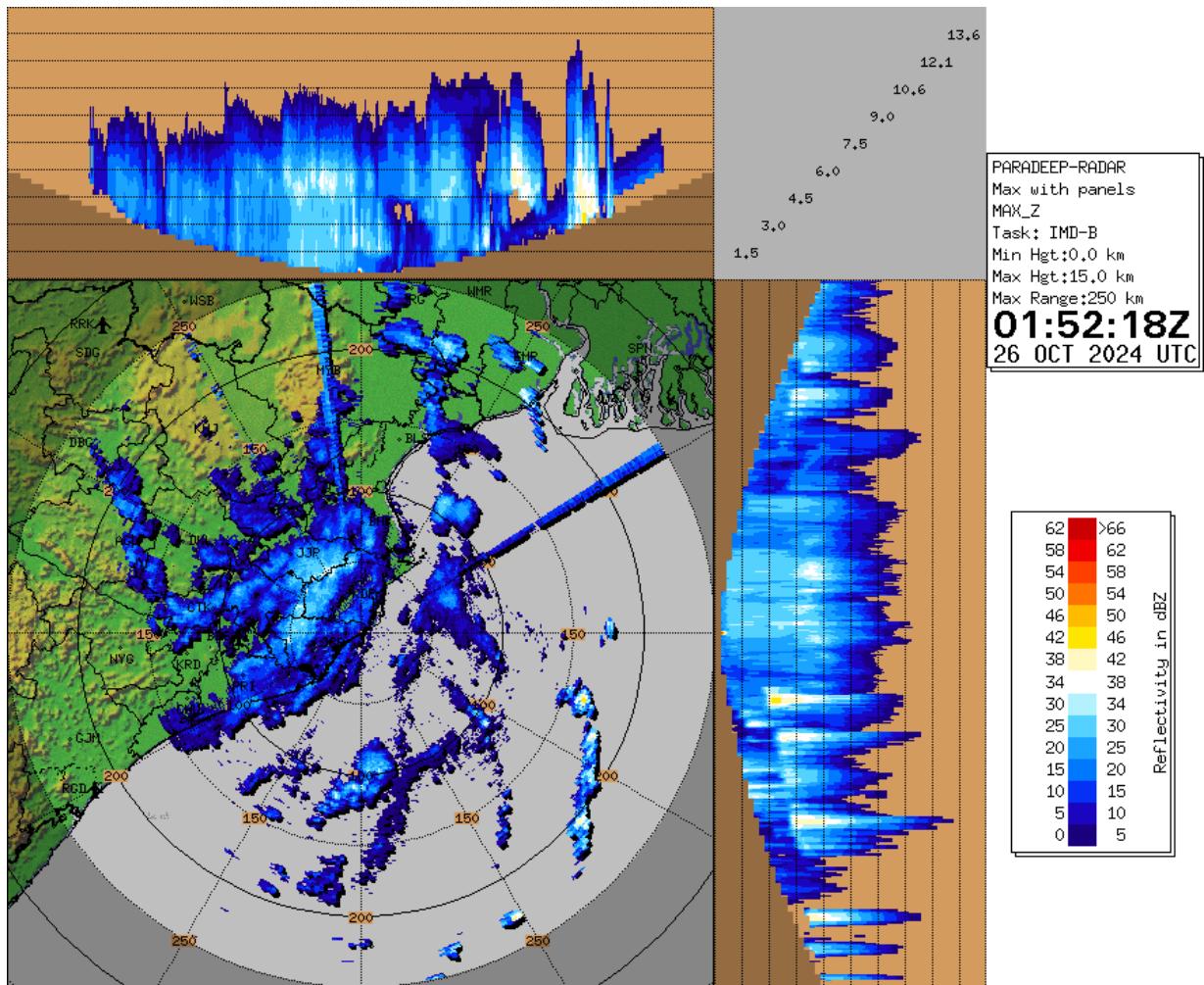


Fig II-C-8(a): INSAT 3DR Image issued on 26<sup>th</sup> October,2024

## RADAR OBSERVATIONS (MAX\_Z) OF DWR PARADIP

Fig II-C-8(a): Radar Observations issued on 26<sup>th</sup> October, 2024

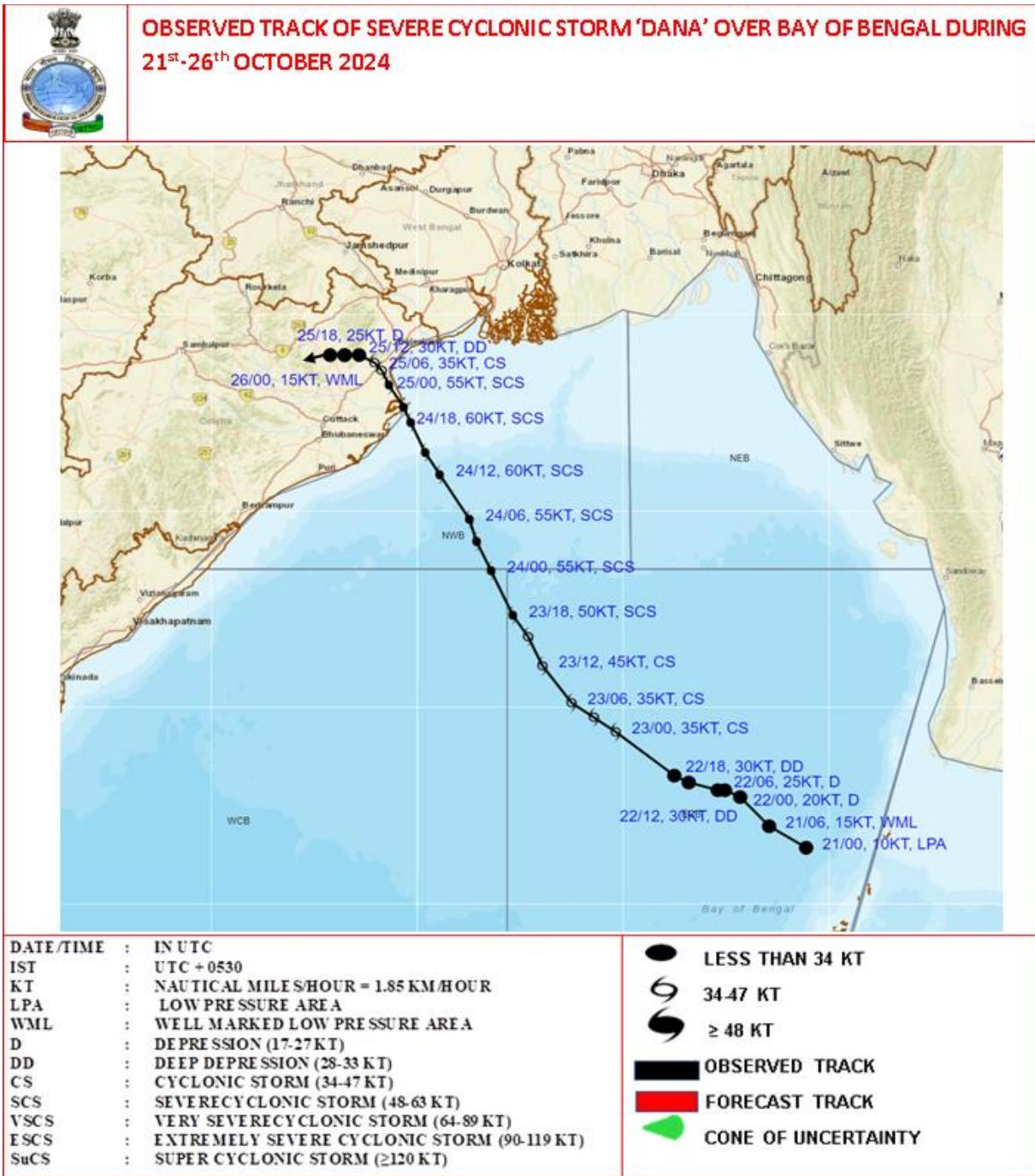


Fig II-C-8(b): Observed track of severe cyclonic storm "DANA" during 21<sup>st</sup>-26<sup>th</sup> October

**Example: Port Warning**

**INDIA METEOROLOGICAL  
DEPARTMENT CYCLONE  
WARNING CENTRE  
BHUBANESWAR**

Port Warning for all ports in Odisha

Date: 25.10.2024 Time: 1000 Hours IST.

**Sub:- Severe Cyclonic storm “DANA” over north coastal Odisha.**

The severe cyclonic storm “DANA” (pronounced as Dana) over north coastal Odisha moved north- northwestwards with a speed of 10 kmph and lay centred at 0530 hrs IST of today, the 25th October, over the same region near latitude 21.0° N and longitude 86.8°E, about 20 km north-northwest of Dhamara, 30 km east of Bhadrak and 40 km north-northwest of Habalikhati nature camp (Bhitarkanika). It is likely to move nearly northwestwards across north Odisha and weaken gradually into a cyclonic storm by forenoon of today, the 25<sup>th</sup> October.

**Wind Warning for sea area & Sea conditions:**

Sea Area	Wind Warning	Sea Conditions
Central Bay of Bengal	Squally wind speed reaching 40-50 kmph gusting to 60 kmph is prevailing and likely to continue till 25 <sup>th</sup> Oct forenoon. It is likely to decrease gradually thereafter.	Sea condition is likely to be <b>very Rough</b> till 25 <sup>th</sup> October forenoon. It is likely to improve gradually thereafter.
Northwest Bay of Bengal	Gale wind speed reaching 95-105 gusting to 115 kmph is likely to prevail till forenoon of 25 <sup>th</sup> October.	Sea condition is likely to be <b>Very High</b> till 25 <sup>th</sup> forenoon and improve gradually thereafter.
Northeast Bay of Bengal	Squally wind speed reaching 50-60 kmph gusting to 70 kmph is likely to prevail till 25 <sup>th</sup> forenoon and decrease gradually thereafter.	Sea condition is likely to be <b>Rough to Very Rough</b> till 25 <sup>th</sup> forenoon and improve gradually thereafter.
Along & off Odisha coasts	Gale wind speed reaching 80-90 kmph gusting to 100 kmph along & off north Odisha (Bhadrak and Balasore districts) is likely till forenoon of 25 <sup>th</sup> October and decrease gradually thereafter. Gale wind speed reaching 60-80 kmph gusting to 90 kmph along & off south Odisha (Kendrapara, Cuttack, Jajpur, Dhenkanal, Keonjhar and Mayurbhanj districts) is likely till 25 <sup>th</sup> Oct forenoon and decrease gradually thereafter.	High to Very High till 25 <sup>th</sup> Oct forenoon and improve gradually thereafter.

## Port Warning:

**Keep hoisted GREAT DANGER SIGNAL NO-10 (GD-10) at Puri, Dhamara/ Chandbali, Paradip ports and Local Cautionary Signal No-III(LC-III) at Gopalpur port of Odisha.**

भारत सरकार  
पृथ्वी विज्ञान मंत्रालय  
भारत मौसम विज्ञान विभाग  
मौसम विज्ञान केंद्र  
भुवनेश्वर, ओडिशा -751020



Government of India  
Ministry of Earth Sciences  
India Meteorological Department  
Meteorological Centre  
Bhubaneswar, Odisha-751020

**FISHERMEN WARNING/ मछुआरों की चेतावनी**

**WEATHER WARNING FOR FISHERMEN OF ODISHA COAST VALID FOR NEXT 05 DAYS COMMENCING FROM 1300 HRS IST ON DATE 24.10.2024**

(ओडिशा तट के मछुआरों के लिए मौसम चेतावनी अगले 05 दिनों के लिए वैध है जो दिनांक 24.10.2024 को 1300 बजे से शुरू होगी)

**Current synoptic situation: -**

The severe cyclonic storm "DANA" (pronounced as Dana) over northwest & adjoining central Bay of Bengal moved north-northwestwards with a speed of 12 kmph during past 6 hours and lay centered at 0830 hrs IST of today, the 24<sup>th</sup> October, over northwest Bay of Bengal, near latitude 18.9° N and longitude 88.0°E, about 210 km southeast of Paradip (Odisha), 240 km south-southeast of Dhamara (Odisha) and 310 km south of Sagar Island (West Bengal).

It is very likely to move north-northwestwards and cross north Odisha and West Bengal coasts between Puri and Sagar Island close to Bhitarkanika and Dhamara (Odisha) during mid-night of 24th to morning of 25th October, 2024 as a severe Cyclonic Storm with a wind speed of 100-110 kmph gusting 120 kmph.

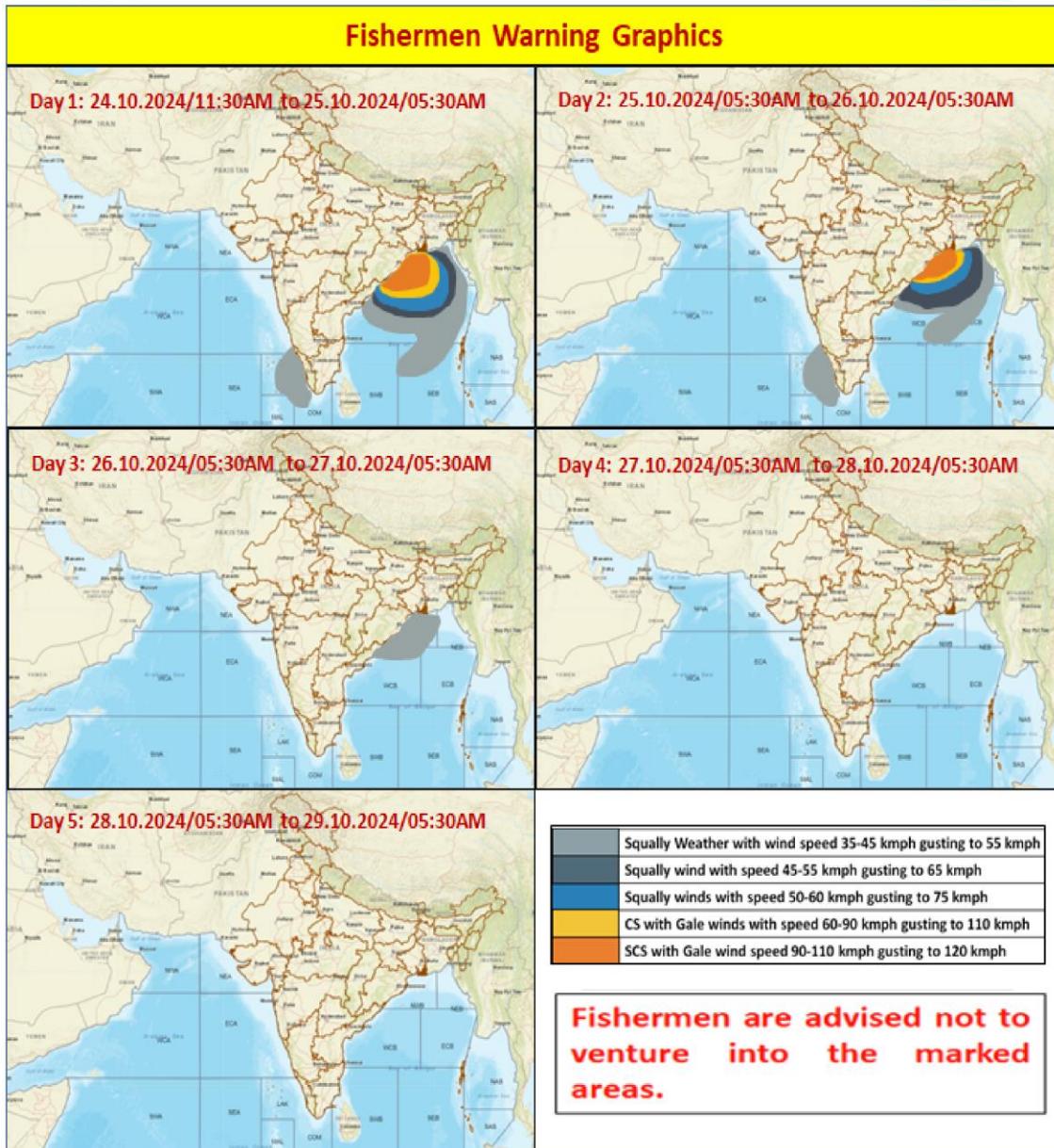
**Under the influence of above system Day 1 & Day 2: - Wind Warning for sea area& Sea**

Sea Area	Wind Warning	Sea Conditions
Central Bay of Bengal	Gale wind speed reaching 95-105 kmph gusting to 115 kmph is prevailing and likely to continue till 24 <sup>th</sup> Oct afternoon. It is likely to decrease gradually thereafter.	Sea condition is likely to be <b>very high to high</b> till 24 <sup>th</sup> October <b>evening</b> . It is likely to improve gradually thereafter.
Northwest Bay of Bengal	Gale wind speed reaching 95-105 kmph gusting to 115 kmph is prevailing. It is likely to increase gradually becoming 105-115 kmph gusting to 125 kmph from 24 <sup>th</sup> Oct evening.	Sea condition is likely to be <b>Very High</b> till 25 <sup>th</sup> morning and improve gradually thereafter.
Northeast Bay of Bengal	Squally wind speed reaching 50-60 kmph gusting to 70 kmph is likely to prevail till 25 <sup>th</sup> morning and decrease gradually thereafter.	Sea condition is likely to be <b>Rough to Very Rough</b> till 25 <sup>th</sup> morning and improve gradually thereafter.
Along & off Odisha coasts	<p>Gale wind speed reaching 60-70 kmph gusting to 80 kmph is prevailing. It would gradually increase becoming 100-110 kmph gusting to 120 kmph along &amp; off north Odisha from 24<sup>th</sup> afternoon till morning of 25<sup>th</sup> October and decrease gradually thereafter.</p> <p>Gale wind speed reaching 60-80 kmph gusting to 90 kmph is likely along &amp; off south Odisha from 24<sup>th</sup> evening till 25<sup>th</sup> Oct morning and decrease gradually thereafter.</p>	<b>High to Very High till 25<sup>th</sup> Oct forenoon and improve gradually thereafter.</b>

Fishermen are advised not to venture into

- Adjoining areas of central Bay of Bengal till 24<sup>th</sup> Oct.
- Northwest & adjoining northeast Bay of Bengal and along & off Odisha till 25<sup>th</sup> October.

## Fisherman Warning Graphics:



**Fig II-C-9: Fishermen Warning Graphis issued on 24<sup>th</sup> October, 2024**

**Example: Sea Area Bulletin**

Government of India  
India Meteorological Department  
Regional Meteorological Centre, Alipore, Kolkata - 700027

**AURORA OBSERVATION: Dated - Thursday 24/10/2024**

From: Area Cyclone Warning Center Kolkata (Alipore Weather office)  
To: Portblair Radio, Kolkata Port Wireless, Directorate General of Shipping, Directorate General of Lighthouses And Lightships

**Part One**

**TTT SEVERE CYCLONE WARNING OVER BAY OF BENGAL 240300UTC**

**Part Two**

Yesterday's cyclonic storm intensified into a severe cyclonic storm "DANA" (pronounced as Dana) over northwest & adjoining central Bay of Bengal moved north northwestwards with a speed of 12 kmph during past 6 hours and lay centered at 0830 hrs IST of today, the 24th October, over northwest Bay of Bengal, near latitude 18.9° N and longitude 88.0°E, about 210 km southeast of Paradip (Odisha), 240 km south-southeast of Dhamara (Odisha) and 310 km south of Sagar Island (West Bengal). It is very likely to move north-northwestwards and cross north Odisha and West Bengal coasts between Puri and Sagar Island close to Bhitarkanika and Dhamara (Odisha) during mid-night of 24th to morning of 25th October, 2024 as a

**Part Three : Sea area forecast valid from 9 UTC to 21 UTC of 24/10/2024**

<b>North West Bay</b>	Wind	CYCLONIC 55 TO 60 KNOTS GUSTING TO 65 KNOTS AROUND 100 NM OF CYCLONIC STORM CENTRE ELSEWHERE 40 TO 45 KNOTS GUSTING TO 50 KNOTS
	Weather	WIDESPREAD RAIN OR THUNDERSHOWERS WITH SCATTERED HEAVY TO VERY HEAVY RAIN, ISOLATED EXTREMELY HEAVY RAIN
	Visibility	POOR BECOMING VERY POOR IN VERY HEAVY RAIN TO EXTREMELY VERY HEAVY RAIN
	Sea condition	HIGH TO VERY HIGH
<b>North East Bay</b>	Wind	MAINLY SOUTHEASTERLY 30 TO 35 KNOTS GUSTING TO 40 KNOTS

## II-C-73

	Weather	WIDESPREAD RAIN OR THUNDERSHOWERS
	Visibility	MODERATE BECOMING POOR IN HEAVY RAIN
	Sea condition	VERY ROUGH TO HIGH
<b>West Central Bay</b>	Wind	SOUTHWEST TO WESTERLY 40 TO 45 KNOTS GUSTING 50 KNOTS
	Weather	SCATTERED RAIN OR THUNDERSHOWERS
	Visibility	MODERATE BECOMING POOR IN HEAVY RAIN
	Sea condition	HIGH TO VERY HIGH
<b>East Central Bay(WEST OF LONG. 92° EAST)</b>	Wind	SOUTHEAST TO SOUTHERLY 25 TO 35 KNOTS GUSTING 40 KNOTS
	Weather	FAIRLY WIDESPREAD RAIN OR THUNDERSHOWERS
	Visibility	MODERATE BECOMING POOR IN HEAVY RAIN
	Sea condition	ROUGH TO VERY ROUGH AAA
<b>South Bay</b>	Wind	:MAINLY SOUTHWESTERLY 15 TO 20 KNOTS
	Weather	SCATTERED RAIN OR THUNDERSHOWERS
	Visibility	GOOD BECOMING MODERATE IN RAIN
	Sea condition	SLIGHT TO MODERATE
<b>Andaman Sea(WEST OF LONG. 95° EAST)</b>	Wind	SOUTH TO SOUTHWESTERLY 15 TO 20 KNOTS
	Weather	FAIRLY WIDESPREAD RAIN OR THUNDERSHOWERS
	Visibility	GOOD BECOMING MODERATE IN RAIN
	Sea condition	SLIGHT TO MODERATE

### Part Four

NIL

### Part Five

NIL

**Part Six**

AAXX 02403 99942 807 21495 80703 10256 40085 811 21496 80703 10250 40077 901  
 21496  
 80208 10250 40049 806 21496 80205 10248 40072 903 22596 80408 10252 40054 895 21495  
 83608 10252 40056 976 21495 83207 10254 40016  
 99943 049 21495 82906 10256 40054 053 21495 83406 10248 40027 105 31996 63202 10260  
 40061 150 31596 72904 10284 40076 185 31596 73203 10266 40088 245 32597 42705 10286

**TOO:** 12.30 IST 24/10/2024

Duty Officer For head

Area Cyclone Warning Centre, Kolkata, 24/10/2024

**Example: Coastal Area Bulletin**

<b>Government of India</b> <b>Ministry of Earth Sciences</b> <b>India Meteorological Department</b> <b>Meteorological Centre</b> <b>Bhubaneswar, Odisha-751020</b>		<b>भारतसरकार</b> <b>पृथ्वीविज्ञानमंत्रालय</b> <b>भारतमौसमविज्ञानविभाग</b> <b>मौसमविज्ञानकेंद्र</b> <b>भुवनेश्वर, ओडिशा -751020</b>
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**COASTAL AREA BULLETIN****DATE- 24.10.2024 TIME OF ISSUE- 1000 IST****B1: S****B2: B****PRIORITY OF MESSAGE: VITAL****STORM ONE COASTAL BULLETIN VALIDITY: - 0500 UTC OF 24-05-2024 TO 1700UTC OF 24-05-2024**

**SYNOPTIC SYSTEM:-** The severe cyclonic storm "DANA" (pronounced as Dana) over central & adjoining northwest Bay of Bengal moved north-northwestwards with a speed of 12 kmph during past 6 hours, and lay centred at 0530 hrs IST of today, the 24<sup>th</sup> October, over northwest & adjoining central Bay of Bengal, near latitude 18.5° N and longitude 88.2°E, about 260 km southeast of Paradip (Odisha), 290 km south-southeast of Dhamara (Odisha) and 350 km south of Sagar Island (West Bengal). It is very likely to move northwestwards and cross north Odisha and West Bengal coasts between Puri and Sagar Island close to Bhitarkanika and Dhamara (Odisha) during midnight of 24th to morning of 25th October, 2024 as a severe Cyclonic Storm with a wind speed of 100-110 kmph gusting 120 kmph.

**NORTH ODISHA COAST:-****WIND:- MAINLY NE-LY 35-40 KT GUSTING TO 45 KT****WEATHER:- RA/TSH AT MOST PLACES WITH HEAVY TO VERY HEAVY FALLS AT ONE OR TWOPLACES****VISIBILITY:- POOR BECOMING VERY POOR IN HEAVY****FALLSSEA CONDITION:- HIGH TO VERY HIGH**

**PORT WARNING:-** Keep hoisted GREAT DANGER SIGNAL NO-10 (GD-10) at Puri, Dhamara/Chandbali , Paradip ports and GREAT DANGER SIGNAL-08(GD-08) at Gopalpur port of Odisha.

**STORM SURGE/TIDAL WARNING:-** Storm surge of 1.0 to 2.0 m height above astronomical tide is very likely to inundate low lying areas of Kendrapara, Bhadrak & Balasore districts of Odisha during the time of landfall.

Storm surge of 0.5 to 1.0 m height above astronomical tide is very likely to inundate low lying areas of Jagatsinghpur district of Odisha during the time of landfall.

#### **SOUTH ODISHA COAST:-**

**WIND:-** MAINLY NW-LY 35-40 KT GUSTING TO 45 KT

**WEATHER:-** RA/TSH AT MOST PLACES WITH HEAVY TO VERY HEAVY FALLS AT ONE OR TWOPLACES

**VISIBILITY:-** POOR BECOMING VERY POOR IN HEAVY

**FALLSSEA CONDITION:-** HIGH TO VERY HIGH

**PORT WARNING:-** Keep hoisted GREAT DANGER SIGNAL NO-10 (GD-10) at Puri, Dhamara/Chandbali , Paradip ports and GREAT DANGER SIGNAL-08(GD-08) at Gopalpur port of Odisha.

**STORM SURGE/TIDAL WARNING: - NIL**

#### **FORMAT:**

##### **Date and Time of Issue:**

(i) **Information on cyclone:** The cyclonic storm lay over..... Bay of Bengal/Arabian Sea Center ..... km. .... (Direction) of ..... place.

(ii) **Forecast**

Further intensification: Direction of Movement: Expected landfall area: Expected time of landfall:

(iii) **Weather Warning**

- ❖ (a) Rainfall ..... in ..... Districts (Names)
- ❖ (b) Gales reaching ..... in ..... Districts (Names)
- ❖ (c) Gale force winds reaching 35 knots in ..... Districts
- ❖ (d) Tidal waves ..... in coastal areas of ..... Districts (Names)
- ❖ (e) Sea condition:
- ❖ (f) Damage (As per IMD instruction) ..... Districts (Names)
- ❖ (g) Likely impacts as per IMD Monograph on "Damage Potential of Tropical [Depending on Intensity of Storm (T-No)]"
  - ❖ (a) Fishermen not to venture into open sea.
  - ❖ (b) Evacuation of people from low lying areas to safer places/Cyclone Shelters.
  - ❖ (c) General public in the threat area advised to be indoors.
  - ❖ (d) Rail & road transport to be regulated.

## **2. Port Warning**

#### **FORMAT:**

Port Warning No. Date and Time for Issue

(i) **Information on cyclone:** The cyclonic storm lay over Bay of Bengal/Arabian Sea near Lat. \_\_\_\_ /Long. \_\_\_\_ at a distance \_\_\_\_ km. from \_\_\_\_ at \_\_\_\_ IST \_\_\_\_ Estimated Central Pressure \_\_\_\_ hPa.

(ii) **Forecast :** Further intensification: Direction of Movement: Expected Landfall Area : Expected Time of Landfall :

(iii) **Advice for hoisting Storm Warning Signals:**

(v) **Likely impacts and actions:** Depending on intensity of the storm as per IMD Monograph on

"Damage Potential of Tropical Cyclones"

### **3. Cyclone Warning Bulletin for AIR/Press / Public:**

#### **FORMAT:**

Cyclone Alert / Warning Bulletin No. \_\_\_\_\_ issued by \_\_\_\_\_ at \_\_\_\_\_ Hrs. IST on \_\_\_\_\_ (Date) for repeated broadcast at hourly / half hourly intervals. Cyclone Alert / Warning for \_\_\_\_\_ Districts. Cyclone centred at \_\_\_\_\_ hrs. IST of \_\_\_\_\_ (date) about \_\_\_\_\_ km. \_\_\_\_\_ of (direction) \_\_\_\_\_ (Place). Expected to intensify further and move in a \_\_\_\_\_ direction and cross \_\_\_\_\_ coast near / between \_\_\_\_\_ (Place) \_\_\_\_\_ (day/time). Under its influence heavy to very heavy rain likely cause floods in \_\_\_\_\_ districts commencing from \_\_\_\_\_ (time/day). Gales speed reaching \_\_\_\_\_ kmph causing \_\_\_\_\_ damage \_\_\_\_\_ in districts commencing from \_\_\_\_\_ (Date/Time) Gale force winds reaching 70 kmph likely extend into \_\_\_\_\_ Districts, causing damage \_\_\_\_\_ in \_\_\_\_\_ districts. Tidal wave of \_\_\_\_\_ m likely inundate low lying area of \_\_\_\_\_ Districts at the time of crossing coast.

Fishermen advised not to venture out. Public advised to cooperate with the State authorities in disaster management efforts.

### **4. Fisheries Warning**

#### **FORMAT:**

Fisheries warning No. \_\_\_\_\_  
Date and Time of Issue \_\_\_\_\_

(i) Information on Cyclone: Cyclonic Storm lay over \_\_\_\_\_ Bay of Bengal / Arabian Sea at a distance \_\_\_\_\_ km. \_\_\_\_\_ from \_\_\_\_\_ at \_\_\_\_\_ time (IST) on \_\_\_\_\_ (date)

(ii) Forecast: Further intensification Direction of Movement

Expected landfall area Expected time of landfall

(iii) Warnings: Wind Sea Condition Tidal Waves

(iv) Storm Warning Signals at ports

Advice and Action: i) Fishermen not to venture into open seas ii) Fishermen at Sea not to come to the ports (names) \_\_\_\_\_ in coast.

### **5. Post Landfall Outlook**

#### **FORMAT:**

1.EVEN AFTER LANDFALL, THE SYSTEM IS LIKELY TO MAINTAIN ITS INTENSITY FOR ..... HOURS AND WEAKEN GRADUALLY AAA UNDER ITS INFLUENCE RAINS AT MOST/MANY PLACES WITH HEAVY TO VERY HEAVY FALLS AT ..... LIKELY COMMENCE/CONTINUE IN ..... (COASTAL DISTRICTS) FROM ..... (TIME).....(DAY).....(DATES) CAUSING INUNDATION OF LOW-LYING AREAS AAA GALE WINDS/SQUALLY WINDS SPEED REACHING ..... KMPH LIKELY COMMENCE/CONTINUE IN .....(COASTAL DISTRICTS) FROM .....(TIME)ON .....(DAY).....(DATE) CAUSING DAMAGES TO ..... PROPERTY AS INDICATED IN IMD MONOGRAPH ON "DAMAGE POTENTIAL OF TROPICAL CYCLONE") AND ..... (VEGETATION) AND GENERAL DISRUPTION OF COMMUNICATION AND POWER SUPPLY FOR .....

2. AS THE CYCLONE MOVES INLAND ..... INTERIOR DISTRICTS MAY ALSO EXPERIENCE HEAVY/VERY HEAVY RAIN ACCOMPANIED WITH GALE WITH SPEEDREACHING ..... KMPH COMMENCING FROM ..... (TIME) ON ..... (DAY) ..... (DATE) FOR ..... HRS, CAUSING FLOODING OF LOW LYING AREAS AND DAMAGE TO PROPERTY AS INDICATED IN IMD MONOGRAPH ON "DAMAGE POTENTIAL OF TROPICAL CYCLONE" (AS PER IMD INSTRUCTION)

PEOPLE ARE ADVISED TO REMAIN INDOORS/IN SAFE PLACES AND COOPERATE WITH STATE GOVERNMENT OFFICIALS AND DISASTER MANAGEMENT AGENCIES.

## Attachment to ANNEX II-C2

India Port warnings largely used

		Day Signals*	Specifications	Night Signals*	Remarks
16a	I.	<u>Distant Cautionary Signal Number One</u>	There is a region of squally weather in which a storm may be forming (well marked low or depression with surface winds up to 61 km/h. (33 knots))	3b )	) These signals indicate that ships may be exposed to danger after leaving the harbour
10a	II.	<u>Distant Warning Signal Number Two</u>	A storm has formed (cyclonic storm with surface winds 63-87 km/h. (34-47 knots))	2b )	)
3a*	III.	<u>Local Cautionary Signal Number Three</u>	The port is threatened by squally weather (cyclonic circulation with surface winds 40-50 km/h. (22-27 knots)) or squalls due Nor'Westers)	5b )	) These signals indicate that the port itself and the ships in it are in danger
2a*	IV.	<u>Local Warning Signal Number Four</u>	The port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution (cyclonic circulation with surface winds 52-61 km/h. (28-33 knots))	4b )	)
17a	V.	<u>Danger Signal Number Five</u>	The port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast keeping the port to the left of its course (to the east of the port in the case of Mangla) (cyclonic storm with surface winds 63-87 km/h. (34-47 knots))	16b )	) These signals indicate that the port itself and the ships in it are in danger
8a	VI.	<u>Danger signal number Six</u>	Port will experience severe weather from a cyclone expected to move keeping the port to the right of its track	17b )	) These signals indicate that the port itself and the ships in it are in danger
19a*	VII.	<u>Danger signal number Seven</u>	Port will experience severe weather from a cyclone expected to move over or close to the port	18b )	) This signal is also hoisted when a storm is expected to skirt the coast without (actually) crossing it
20a	VIII.	<u>Great Danger Signal number Eight</u>	Port will experience severe weather from a severe cyclone expected to move keeping the port to the left of its track	19b )	) These signals indicate that the port itself and the ships in it are in danger

21a IX. Great Danger Signal number Nine

Port will experience severe weather from a severe cyclone expected to move keeping the port to the right of its track

20b ) These signals indicate  
      ) that the port itself  
      ) and the ships in it are  
      ) in danger

22a\* X. Great Danger Signal number Ten

Port will experience severe weather from a severe cyclone expected to move over or close to the port )

21b ) This signal is also hoisted  
      ) when a storm is expected  
      ) to skirt the coast without  
      ) (actually) crossing it

23a\* XI. Failure of Communication

Communications with the meteorological warning centre have broken down, and the local office considers there is a danger of bad weather

7b )  
      )  
      )  
      )

**Brief System**

In the brief system only one of the five signals marked by an asterisk of the general system is hoisted, and the Port Officers are kept informed of the prospects of local bad weather associated with any disturbance in the sea, for the general information of shipping.

**Extended System**

Special section signals, in addition to those of the general system, are exhibited at certain ports in the Bay of Bengal belonging to the extended system.

If the port itself is threatened, the appropriate local signals of the general system are hoisted. But, if there is an area of squally weather or a storm that does not threaten the port, the distant cautionary or distant warning signal of the general system is hoisted, and one or more of the locality signals (described in the next paragraph) are hoisted under the distant signals, to indicate the position of the disturbance in the Bay.

The following shapes, when hung below a distant cautionary or warning signal, become locality signals, indicating the six divisions into which the Bay of Bengal has been divided for this purpose). If, however, the centre of the storm is near the boundary of a division, the hoisting of two locality signals is requested, the first indicating the division in which the centre is thought to be situated and the second the division nearest to the first.

In the event of a storm centre being near the corner where three divisions meet, the hoisting of three locality signals is requested, the first indicating the division in which the storm is estimated to be centred, the second the nearest adjoining division, and the third the remaining division.

Signal Section	3a I	10a II	24a III	16a IV	2a V	23a VI
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\* See footnote on page 1 of Attachment to Annex II-B

1) The divisions are as indicated on the chart given on page II A6. Thus, if there is squally weather in Section I of the Bay, the signal 25a would be hoisted at the various ports, and if a storm has formed in Section II, the signal 11a would be hoisted at all ports which were not directly threatened. As already stated, the ports directly threatened would hoist one or other of the local signals. The Meteorological Department endeavours to keep the number of locality signals on each hoist as small as possible, and generally the number of only that section in which the centre of the storm is situated is given in the Warning bulletin.

## Attachment to ANNEX II-F-1

Day Signals*	Specifications	Night Signals*	Remarks
<b><u>Myanmar (21.II.1977)</u></b>			
<u>General System</u>			
16a	There is a region of squally weather in which a storm may be forming	3b	Distant cautionary signal
10a	A storm has formed	2b	Distant warning signal
3a	The port is threatened by squally weather	5b*	Local cautionary signal
2a*	The port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution	4b*	Local warning signal. The existence of a storm can often be determined before its direction of motion can be fixed. In this case all those ports which the storm could possibly strike are warned by this signal
17a	The port will experience severe weather from a storm, of slight or moderate intensity, that is expected to cross the coast to the south of the port (or to the east in the case of Yangon, Pathein and Diamond Island)	16b	Local danger signal
18a	The port will experience severe weather from a storm, of slight or moderate intensity, that is expected to cross the coast to the north of the port (or to the west in the case of Yangon and Moulmein)	17b	Local danger signal
19a*	The port will experience severe weather from a storm, of slight or moderate intensity, that is expected to cross over or near to the port	18b*	Local danger signal
20a	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the south of the port (or to the east in the case of Yangon, Pathein and Diamond Island)	19b	Local great danger signal

\* See footnote on page 1 of Attachment to Annex II-B

**Myanmar - continued**

Day Signals*	Specifications	Night Signals*	Remarks
21a	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the north of the port (or to the west in the case of Yangon and Moulmein)	20b	Local great danger signal
22a*	The port will experience severe weather from a storm of great intensity that is expected to cross over or near to the port	21b*	Local great danger signal
23a*	Communications with the meteorological warning centre have broken down, and the local officer considers that there is a danger of bad weather	7b*	Local failure of communications signal

**Brief System**

In the brief system only one of the five signals marked by an asterisk of the general system is hoisted, and the Port Officers are kept informed of the prospects of local bad weather associated with any disturbance in the sea, for the general information of shipping.

**Extended System**

Special signals, in addition to those of the general system, are exhibited at certain ports in the Bay of Bengal belonging to the extended system.

If the port itself is threatened, the appropriate local signals of the general system are hoisted. But, if there is an area of squally weather or a storm that does not threaten the port, the distant cautionary or distant warning signal of the general system is hoisted, and one or more of the locality signals (described in the next paragraph) are hoisted under the distant signals, to indicate the position of the disturbance in the Bay. The following shapes, when hung below a distant cautionary or warning signal, become locality signals, indicating the six divisions into which the Bay of Bengal has been divided for this purpose 1) . If, however, the

centre of the storm is near the boundary of a division, the hoisting of two locality signals is requested, the first indicating the division in which the centre is thought to be situated and the second the division nearest to the first.

In the event of a storm centre being near the corner where three divisions meet, the hoisting of three locality signals is requested, the first indicating the division in which the storm is estimated to be centred, the second the nearest adjoining division, and the third the remaining division.

Signal	3a	10a	24a	16a	2a	23a
Section	I	II	III	IV	V	VI

\* See footnote on page 1 of Attachment to Annex II-B

1) The divisions are as indicated on the chart given on page 26 Thus, if there is squally weather in Section I of the Bay, the signal 25a would be hoisted at the various ports, and if a storm has formed in Section II, the signal 11a would be hoisted at all ports which were not directly threatened. As already stated, the ports directly threatened would hoist one or other of the local signals. The Department of Meteorology and Hydrology endeavours to keep the number of locality signals on each hoist as small as possible, and generally the number of only that section in which the centre of the storm is situated is given in the Warning bulletin.

## Attachment to ANNEX II-G-1

Day Signals*	Specifications	Night Signals*	Remarks
<b><u>Pakistan- (10.VI.1984) Port warnings largely used</u></b>			
16a	There is a region of squally weather in which a storm may be forming	3b ) ) ) )	) These signals indicate that ships may be exposed to danger after leaving the harbour
10a	A storm has formed	2b )	
3a	Port is threatened by squally weather	5b )	These signals indicate that the port itself and the ships in it are in danger
2a	Port is threatened by a storm, but it does not appear that danger justifies extreme measures of precaution	4b ) ) ) )	
17a	Severe weather from a storm of slight or moderate intensity, expected to cross the coast to south or east of port	16b ) ) ) )	
18a	Severe weather from a storm of slight or moderate intensity, expected to cross the coast to north or west of port	17b )	These signals indicate that the port itself and the ships in it are in danger
19a	Severe weather from a storm of slight or moderate intensity, expected to cross over or near to the port	18b ) )	
20a	Severe weather from a storm of great intensity, expected to cross the coast to south or east of port	19b ) ) )	

See footnote on page 1 of Attachment to Annex II-B

Pakistan - continued

Day Signals*	Specifications	Night Signals*	Remarks
21a	Severe weather from a storm of great intensity, expected to cross the coast to north or west of port	20b ) )	) These signals indicate that the port itself and the ships in it are in danger
22a	Severe weather from a storm of great intensity, expected to cross over or near to the port	21b ) )	)
23a	Communications with the meteorological -- warning centre have broken down, and the local office considers there is a danger of bad weather	7b )	) These signals indicate that the port itself and the ships in it are in danger

## Attachment to ANNEX II-H-1

**Sri Lanka (20.II.1978) Port Warnings**

Day Signals*	Specifications	Night Signals*	Remarks
16a	There is a region of squally weather in which a storm may be forming	3b	These signals indicate that ships may be exposed to danger after leaving the harbour
10a	A storm has formed	2b	These signals indicate that ships may be exposed to danger after leaving the harbour
3a	The port is threatened by squally weather	5b	These signals indicate that the port itself and the ships in it are in danger
2a	The port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution	4b	These signals indicate that the port itself and the ships in it are in danger
17a	The port will experience severe weather from a storm of slight or moderate and intensity that is expected to cross coast keeping the port to the left of its course	16b	These signals indicate that the port itself and the ships in it are in danger
8a	Port will experience severe weather from a cyclone expected	17b	These signals indicate that the port itself and the ships in it are in danger
19a	Port will experience severe weather from a cyclone expected to move over the coast without (actually) crossing it	18b	This signal is also hoisted when a storm is expected to skirt or close to the port
20a	Port will experience severe weather from a severe cyclone expected to cross the coast to the South of Port	19b	These signals indicate that the port itself and the ships in it are in danger
21a	Port will experience severe weather from a severe cyclone expected to cross the coast to the South or east of Port	20b	These signals indicate that the port itself and the ships in it are in danger
22a	Port will experience severe weather from a severe cyclone expected to cross over or near the Port	21b	These signals indicate that the port itself and the ships in it are in danger
23a	Communications with the meteorological warning centre have broken down, and the local officer considers that there is a danger of bad weather	7b	Local failure of communications signals

## Attachment to ANNEX II-I-1

Thailand (11.IV.1984)

Day Signals*	Specifications	Night Signals*	Remarks
<b>Signals indicating the intensity of storms</b>			
35a	Tropical depression or storm with wind speeds near centre not exceeding 33 knots	1.	Signals indicating the occurrence of storms in the Gulf of Thailand and adjacent seas to be displayed at Port Area (Bangkok) and at Bangkok Harbour Limit I (Pong Pachjamit Fort, Pagklongsarn, Dhonburi)
36a	Tropical storm or storm with wind speeds near centre from 34 knots and over but not exceeding 63 knots		
56a	Typhoon or cyclone or storm with wind speeds near centre 64 knots or more	2	Signals indicating the intensity and locality of storms will be hoisted on the same yard-arm with the pennant indicating the intensity and the flag indicating the locality of the storm. The flag is always hoisted below the pennant

Day Signals*	Specifications	Night Signals*	Remarks
<b>Signals indicating the locality of storms</b>			
37a	Area 1 : Gulf of Thailand east coast to Lat. 5°N and Long. 105°E		
38a	Area 2 : Gulf of Thailand west coast to Lat. 5°N		
43a	Area 3: Andaman Sea bounded by west coast of southern Myanmar, west coast of southern Thailand, Long. 97°E, Lat. 5°N and Lat. 14°N		
51a	Area 4 : South China Sea bounded by southern Viet Nam coast, Lat. 12°N, Lat. 5°N, Long. 105°E and Long. 112°E		
Note:	In normal weather conditions (no tropical depression, storm or typhoon) the white pennant with red circle (52a) will be displayed at the upper yard-arm at Bangkok Harbour Limit I (Pong Pachjamit Fort, Pagklongsarn, Dhonburi).		

\* See footnote on page 1 of Attachment to Annex II-B

## CHAPTER III

**THE OBSERVING SYSTEM AND OBSERVING PROGRAMME****3.1 Networks of surface and upper air stations****3.1.1 *Observations from basic network***

The list of implemented regional basic synoptic networks of surface and upper air stations of the Panel countries is given in **Table III-1**. The network of stations adopted for regional exchange by the World Weather Watch is considered adequate for routine tracking of weather systems. However, in the cyclone season, particularly when a tropical depression or storm exists in the region, special efforts will be made by the national meteorological services to improve the collection and distribution of surface synoptic reports from the coastal stations.

**3.1.2 *Special observations from the WWW network***

National meteorological services will endeavor to arrange for additional observations in areas coming within the circulation of a tropical cyclone. These stations will make round the clock three hourly or hourly observations when the system is of tropical storm intensity and close to the coast and the observations will be passed on real time to the Panel countries.

**3.1.3 *Special observations from stations other than those of the regional basic synoptic network***

National Meteorological Services (NMS) have established a large number of meteorological observing stations, in addition to those in the regional basic synoptic network, observations from which are received by the NMS. When there is a tropical cyclone in the Bay of Bengal or in the Arabian Sea, observations from these stations, particularly from coastal stations, will be exchanged on real time basis on priority. If the observations are not received during a tropical cyclone situation a request for them could be sent to the NMS concerned. A list of these stations is given in **Table III-2 & III-3**.

**TABLE III-1: LIST OF IMPLEMENTED REGIONAL BASIC SYNOPTIC NETWORK STATIONS**

III-3

**TABLE III-1: LIST OF IMPLEMENTED REGIONAL BASIC SYNOPTIC NETWORK STATIONS**



III-6

42809	KOLKATA / DUMDUM	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42840	SURAT	X	X	X	X	X	X	X	X										
42867	NAGPUR /SONEGAON	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42875	RAIPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42886	JHARSUGUDA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42895	BALASORE	X	X	X	X	X	X	X	X	X									
42909	VERAVAL	X	X		X	X	X	X	X	X									
42921	NASIK CITY	X	X	X		X	X	X	X	X									
42933	AKOLA	X	X		X	X	X	X	X	X									
42971	BHUBANESWAR	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42977	SANDHEADS		X			X													

Name of station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		0	3	6	9	12	15	18	21	0	6	12	18	0	12
43003	MUMBAI (SANTACRUZ)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43014	AURANGABAD	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	CHIKALTHANA														
43041	JAGDALPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43063	PUNE	X	X	X	X	X	X	X	X						
43086	RAMGUNDAM	X	X	X	X	X	X	X	X						
43110	RATNAGIRI	X	X	X	X	X	X	X	X						
43117	SHOLAPUR	X	X	X	X	X	X	X	X						
43128	HYDERABAD AIRPORT	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43150	VISHAKHAPATNAM/	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	WALTAIR														
43185	MACHILIPATNAM (FRANCHPET)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43189	KAKINADA	X	X	X	X	X	X	X	X	X					
43192	GOA/PANJIM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43198	BELGAUM/SAMBRE	X	X	X	X	X	X	X	X						
43201	GADAG	X	X	X	X	X	X	X	X						



43450	KATUNAYAK E	X	X	X	X	X	X	X				
43466	COLOMBO	X	X	X	X	X	X	X	X	X	X	X
43473	NUWARA ELIYA	X	X	X	X	X	X	X	X			
43486	RATNAPURA	X	X	X	X	X	X	X	X			
43495	GALLE	X	X	X	X	X	X	X	X			
43497	HAMBANTOTA	X	X	X	X	X	X	X	X	X	X	X
43533	HANIMADHO O	X	X	X	X	X	X	X	X			
43555	MALE	X	X	X	X	X	X	X	X			
43577	KADHDHOO	X	X	X	X	X	X	X	X			
43588	KADEHDHO O	X	X	X	X	X	X	X	X			
43599	GAN	X	X	X	X	X	X	X	X			X
48001	PUTAO	X	X	X	X	X						
48004	HKAMTI	X	X	X	X	X						
48008	MYITKYINA	X	X	X	X	X		X				
48010	HOMALIN	X	X	X	X	X		X				
48017	PINLEBU											
48018	KATHA	X	X	X	X	X		X				
48019	BHAMO	X	X	X	X	X						
48020	MAWLAIK	X	X	X	X	X						
48024	KALEMYO	X	X	X	X	X						
48025	KALEWA	X	X	X	X	X		X				
48030	HAKHA	X	X	X	X	X						
48031	FALAM	X	X	X	X	X						
48033	SHWEBO	X	X	X	X	X						
48034	MOGOKE	X	X	X	X	X						
48035	LASHIO	X	X	X	X	X						
48036	GANGAW											
48037	MONYWA	X	X	X	X	X						
48039	SAGAING	X	X	X	X	X						
48040	HSIPAW											
48042	MANDALAY	X	X	X	X	X		X				X
48043	PYINOOLWIN	X	X	X	X	X						
48045	MINDAT	X	X	X	X	X						
48047	MYINGYAN											
48048	NYUNG-U	X	X	X	X	X						
48051	KYAUKTAW	X	X	X	X	X						
48052	CHAUK	X	X	X	X	X						
48053	MEIKTILA	X	X	X	X	X		X				
48055	NAMSAM	X	X	X	X	X						





Name of station		Surface									Radiowind				Radio sonde	
1		2									3				4	
		0	3	6	9	12	15	18	21	0	6	12	18	0	12	
48432	SURIN	X	X	X	X	X	X	X	X							
48453	BANGKOK	X	X	X	X	X	X	X	X	X	X	X	X		X	
48456	DON MUANG	X	X	X	X	X	X	X	X							
48462	ARANYAPRATHET	X	X	X	X	X	X	X	X							
48475	HUA HIN	X	X	X	X	X	X	X	X							
48477	SATTAHIP	X	X	X	X	X	X	X	X							
48480	CHANTHABURI	X	X	X	X	X	X	X	X	X	X		X			
48500	PRACHUAP KHIRIKHAN	X	X	X	X	X	X	X	X	X	X		X			
48517	CHUMPHON	X	X	X	X	X	X	X	X							
48532	RANONG	X	X	X	X	X	X	X	X							
48551	SURAT THANI	X	X	X	X	X	X	X	X	X	X	X	X	X		
48565	PHUKET AIRPORT	X	X	X	X	X	X	X	X						X	
48567	TRANG	X	X	X	X	X	X	X	X							
48568	SONGKHLA	X	X	X	X	X	X	X	X		X	X			X	
48569	HAT YAI	X	X	X	X	X	X	X	X							
48583	NARATHIWAT	X	X	X	X	X	X	X	X							

**UAE**

Station Name	WMO	ICAO	SYNOP SURFACE	RADIOSONDE
Abu Dhabi International Airport	41217	OMAA	Every 3 hours	0000 – 1200
Dubai International Airport	41194	OMDB	Every 3 hours	-
Sharjah International Airport	41196	OMSJ	Every 3 hours	-
Fujairah International Airport	41198	OMFJ	Every 3 hours	-
RasAlkhaimah International Airport	41184	OMRK	Every 3 hours	-
Abu DhabiBateen Airport	41216	OMAD	Every 3 hours	-
Al-Ain International Airport	41218	OMAL	Every 3 hours	-

**TABLE III-2: List of stations other than those in the  
WWW network from which special observations are  
Available in cyclone situations**

**Country: Bangladesh**

	Name of station	Surface									Radiowind				Radiosonde	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12	
41850	TETULIA	x	x	x	x	x	x	x	x							
41851	DIMLA	x	x	x	x	x	x	x	x							
41856	RAJARHAT	x	x	x	x	x	x	x	x							
41858	SAYEDPUR	x	x	x	x	x	x	x	x							
41859	RANGPUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
41863	DINAJPUR	x	x	x	x	x	x	x	x							
41881	BADALGACHI	x	x	x	x	x	x	x	x							
41883	BOGRA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
41886	MYMENSINGH	x	x	x	x	x	x	x	x							
41888	NETROKONA	x	x	x	x	x	x	x	x							
41891	SYLHET	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
41895	RAJSHAHI	x	x	x	x	x	x	x	x							
41897	TARASH	x	x	x	x	x	x	x	x							
41902	NIKLI	x	x	x	x	x	.	.	.							
41906	BAGHABARI	.	.	.	.	.	.	.	.							
41907	ISHURDI	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
41915	SRIMONGAL	x	x	x	x	x	x	x	x							
41916	ASHUGANJ	.	.	.	.	.	.	.	.							
41923	DHAKA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
41924	NARSINGDI	.	.	.	.	.	.	.	.							
41926	CHUADANGA	x	x	x	x	x	x	x	x							
41927	KUMARKHALI	x	x	x	x	x	x	x	x							
41929	FARIDPUR	x	x	x	x	x	x	x	x							
41930	ARICHA	.	.	.	.	.	.	.	.							
41933	COMILLA	x	x	x	x	x	x	x	x							
41936	JESSORE	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
41938	GOPALGANJ	x	x	x	x	x	x	x	x							
41939	MADARIPUR	x	x	x	x	x	x	x	x							
41940	MAWA	.	.	.	.	.	.	.	.							
41941	CHANDPUR	x	x	x	x	x	x	x	x							
41943	FENI	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
41944	DIGHINALA	.	.	.	.	.	.	.	.							
41946	SATKHIRA	x	x	x	x	x	x	x	x							
41947	KHULNA	x	x	x	x	x	x	x	x							
41948	KOYRA	x	.	.	.	x	.	.	.							
41950	BARISHAL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
41951	BHOLA	x	x	x	x	x	x	x	x							
41953	MAIDI COURT	x	x	x	x	x	x	x	x							
41955	SAINT MARTIN	.	.	.	.	.	.	.	.							
41958	MONGLA	x	x	x	x	x	x	x	x							
41960	PATUAKHALI	x	x	x	x	x	x	x	x							
41961	RAMGATTI	x	.	.	.	x	.	.	.							
41962	HIZLA	.	.	.	.	.	.	.	.							
41963	HATIYA	x	x	x	x	x	x	x	x							

41964	SANDWIP	X	X	X	X	X	X	X	X					
41965	SITAKUNDA	X	X	X	X	X	X	X	X					
41966	RANGAMATI	X	X	X	X	X	X	X	X					
41977	CHITTAGONG(AMBAGAN)	.	.	.	.	.	.	.	.	X	X	X	X	X
41978	CHITTAGONG(PATENGA)	X	X	X	X	X	X	X	X	.	.	.	.	.
41979	KAWKHALI	.	.	.	.	.	.	.	.					
41980	BANDARBAN	.	.	.	.	.	.	.	.					
41981	MONPURA	.	.	.	.	.	.	.	.					
41984	KHEPUPARA	X	X	X	X	X	X	X	X	.	.	.	.	.
41989	KUTUBDIA	X	X	X	X	X	X	X	X	.	.	.	.	.
41992	COX'S BAZAR	X	X	X	X	X	X	X	X	X	X	X	X	X
41998	TEKNAF	X	X	X	X	X	X	X	X					

**TABLE III-3**  
**Buoys over north India Ocean**

Buoy's ID	Surface	Radiowind	Radiosonde
1	2		3
4			
	00 03 06 09 12 15 18 21 00 06 12 18 00 12		

**Indian Buoys**

AD02 (ARB)	X	X	X	X	X							X
AD03 (ARB)	X	X		X	X	X	X	X	X			
AD04 (ARB)	X	X		X	X	X	X	X	X			
AD05 (ARB)	X	X	X	X	X	X	X	X	X			
CB02 (ARB)	X	X		X	X		X	X				
CB03 (ARB)	X	X		X	X		X	X				
SW02 (ARB)	X	X		X	X		X	X				
BD02 (BOB)	X	X	X	X	X	X	X	X	X			
BD07 (BOB)	X	X	X	X	X	X	X	X	X			
BD08 (BOB)	X	X	X	X	X	X	X	X	X			
BD10 (BOB)	X	X		X	X	X	X	X	X			
BD11 (BOB)	X	X	X	X	X	X	X	X	X			
BD12 (BOB)	X	X		X	X	X	X	X	X			
BD13 (BOB)	X	X		X	X		X	X				
CB01 (BOB)	X	X		X	X		X	X				

### **3.1.4 *Upper air stations***

Additional upper wind observations will be made as appropriate whenever a tropical cyclone is centered within 500 nautical miles of the station. The minimum required is two observations per day, but for a better understanding of the ambient wind field three or even four flights on some days will be made when possible. All these additional upper air observations will be distributed among the Panel countries.

### **3.2 Observations from mobile ships**

Efforts will be made to obtain the maximum number of ships' observations from the cyclone field by the NMSs and to pass on these observations to RSMC New Delhi. Whenever there is a tropical cyclone in the Bay of Bengal or in the Arabian Sea, additional ships' reports at frequent intervals will be requested by the storm warning centre/meteorological office concerned.

### **3.3 Aircraft reports**

All reports from aircraft in flight in the area will be passed on real time to RSMC, New Delhi and to other Panel countries. In case the national meteorological service collecting the report deems it to be of interest in the analysis or forecasting of a tropical cyclone situation, it will be prefixed with an agreed high priority symbol.

### **3.4 Radar observations**

As long as a tropical cyclone remains within range of one of the cyclone detection radars in the region, the meteorological centre concerned will keep the system under continuous surveillance and will transmit the radar observations through GTS to RSMC New Delhi and other Panel countries. These reports will be made in accordance with a reestablished schedule, preferably on a regular three hourly basis.

The report will be in the RADOB code (FM20VRADOB) or the code given in **Annex IIIA** and will be transmitted twice to ensure reception of the complete message. The radar imageries will be exchanged through website or e-mail.

In case the report is in plain language, the full range of information available at the radar station will be given. The message will therefore include, where available, the confirmation of the determination of the centre; the shape, definition, size and character tendency of the eye, the distance between the end of the outermost band and the centre of the cyclone and the direction and speed of movement with a statement of the interval of time over which the movement was calculated.

A list of the cyclone detection radar stations in the Panel area is given in **Table III-4**.

**DWR TABLE III-4**  
**WEATHER RADAR STATIONS KEEPING WATCH**  
**OVER THE ARABIAN SEA AND THE BAY OF BENGAL**  
**WEATHER RADAR STATIONS KEEPING WATCH OVER THE ARABIAN SEA AND THE BAY OF**  
**BENGAL**

<b>Country</b>	<b>Station</b>	<b>N</b>	<b>E</b>	<b>Type</b>	<b>Op. Since</b>	
Bangladesh	41992 Cox's Bazar	21°20'	92°17'	Doppler	1970	
	41984 Khepupara	21°59'	90°14'	Doppler	1982	
	41923 Dhaka	23°46'	90°23'	10 cm	1970	
	41859 Rangpur	25°44'	89°14'	10 cm	1999	
	Moulvibazar	24°29'8"	91°46'30"	Doppler	2009	
India	42807 Kolkata	22°33'	88°20'	10 cm	1973	
			DWR		2002	
	42976 Paradip	20°15'	86°39'	10 cm	1973	
			DWR			
	43049 Gopalpur	19°15'	84°53'	10 cm	2017	
			DWR			
	43149 Visakhapatnam	17°44'	83°20'	10 cm	1970	
			DWR		2006	
	43185 Machilipatnam	16°10'	81°08'	10 cm	1981	
			DWR		2004	
	----	Sriharikota	13°39'	80°13'	10 cm	2004
			DWR			
	43278 Chennai	13°04'	80°16'	10 cm	1973	
		DWR			2002	
Maldives	43346 Karaikal	10°54'	79°50'	10 cm	1989	
			DWR		2016	
	43353 Kochi	09°55'	76°15'	10 cm	1987	
			DWR		2016	
	43371 Thiruvananthapuram	08°31'	76°51'	05 cm	2017	
			DWR			
	43192 Goa	15°29'	73°49'	10 cm	2002	
			DWR		2016	
	43057 Mumbai	18°54'	72°48'	10 cm	1989	
			DWR		2016	
Pakistan	42634 Bhuj	23°14'	69°38'	10 cm	1987	
			DWR		2016	
Maldives	43555 Male	04°09'	73°11'	10 cm(DWR)	2008	
Myanmar	48071 Kyaukpyu	19°17'	93°31'	Doppler	2015	
	48097 Yangon	16°52'	96°09'	Doppler	2016	
	48042 Mandalay	21°47'	96°02'	Doppler	2018	
Pakistan	41780 Karachi	24°54'	67°08'	5.6 cm	1991	
Thailand	48455 Bangkok	13° 55'	100°36'	10 cm (DWR)	1992	
	48475 Hau Hin	12°35'	99°57'	10 cm (DWR)	1995	
	48517 Chumphon	10°29'	99°11'	5.6 cm (DWR)	2008	
	48551 Surat Thani	09°08'	99°9'	10 cm (DWR)	1993	
	48565 Phuket	08°08'	98°19'	5.6 cm (DWR)	2006	
	48569 HAT Yai	06°56'	100°23'	5.6 cm (DWR)	2004	
	48563 Krabi	08°06'	98°58'	5.6 cm (DWR)	2006	
	48568 Songkhla	07°26'	100°27'	5.6 cm (DWR)	2011	
	48583 Narathiwat	06°25'	101°45'	5.6 cm (DWR)	2014	

**CODE FOR REPORTING RADAR OBSERVATIONS RELATING TO CYCLONIC DISTURBANCES**

Part "A" (to be reported when centre of the storm can be determined).

CYREP FFAA STATION IiiiiYYGGg 4R wLaLaLa 1LoLoLoLo EYE or SPIRAL  
 6CSDT Pdsdfsfs  
Explanatory Notes

CYREP FFAA : Radar Report giving centre of a cyclone  
 STATION : Name of station in plain language  
 Iiiii : Station Index Number  
 YY : UTC date  
 GGg : Time of observation in hours and tens of minutes UTC  
 4 : Indicator figure  
 1 : Quadrant of globe '1' for our area as per WMO definition  
 Rw : Wavelength of radar  
       3 for 3 cm radar, 5 for 5.6 cm radar, 8 for 10 cm radar  
 LaLaLa : Latitude           }       In tenths of a degree.  
           Tenths are                   } obtained by dividing the number of minutes  
 LoLoLoLo : Longitude           } by six and discarding the remainder.  
 EYE or : Either the word "EYE" or the word "SPIRAL" will be reported,  
 SPIRAL   but not both.

The word "EYE" will be reported if a partial or complete eye is seen by the radar.

If a double walled eye is seen "DOUBLE EYE" will be reported instead of "EYE".

If the storm centre is estimated using only spiral bands the word "SPIRAL" will be reported.

6 : Indicator figure to show that eye characteristics and/or confidence of fix follow.

C : Confidence of fix (Vide Table 1).

S : Shape of eye and length of arc of eyewall seen (Vide Table 2).

D : Diameter or length of major axis of the eye (Vide Table 3).

T : Tendency of the eye determined over the period since the last observation (Vide Table 4).

NOTE: S, D and T will be reported as solidus (/) if the storm centre is fixed from spiral bands only.

P: Period over which the movement of the storm centre has been determined (Vide Table 5).

dsds: Direction in tens of degree towards which the storm centre is moving.

fsfs: Speed of movement of storm centre in kilometres per hour.

If movement over a period of 3 hours or more cannot be estimated, the group pdssdfsf will be dropped.

NOTE: The radar meteorologist may at his discretion add any other operationally useful information not covered above, in plain language at the end of Part A of the message.

**TABLE 1**  
**Confidence of Fix (C)**

<b>Code Figure</b>	<b>Category</b>	<b>Radar echo pattern</b>	<b>Likely accuracy about</b>
1.	Very poor	Spiral bands, ill defined or too few or too short	100 km
2.	Poor	Centre estimated from well defined spiral bands ----- eye not visible	50 km
3.	Fair	Partial eye wall seen	30 km
4.	Good	Closed or nearly closed eye whose geometric centres can be located with confidence	10 km

NOTE: The accuracy and criteria as given above are only illustrative and not definitive.

**TABLE 2**

<b>Code Figure</b>	<b>Shape of eye and length of arc of eyewall seen (S)</b>	
	<b>Length of arc</b>	<b>Shape</b>
0	-----	Ill-defined
1	Less than 180°	{ Shape other than
2	More than 180°	{ circular or elliptical
3	Closed	{
4	Less than 180°	{
5	More than 180°	{ Elliptical
6	Closed	{
7	Less than 180°	{
8	More than 180°	{ Circular
9	Closed	{

**TABLE 3**

<b>D- Diameter or length of major axis of the eye of the tropical cyclone</b>	
<b>Code Figure</b>	<b>Code Figure</b>
0 less than 10 km	6 60 to 69 km
1 10 to 19 km	7 70 to 79 km
2 20 to 29 km	8 80 to 89 km
3 30 to 39 km	9 90 km and greater
4 40 to 49 km	/ undetermined
5 50 to 59 km	

**TABLE 4**

**T- Tendency of the eye, determined over the period since the last observation**

<b>Code Figure</b>	
0	Eye has first become visible since the last observation.
1	No significant change in the characteristics or size of the eye.
2	Eye has become smaller with no other significant change in characteristics.
3	Eye has become larger with no other significant change in characteristics.
4	Eye has become less distinct with no significant change in size.
5	Eye has become less distinct and decreased in size.
6	Eye has become less distinct and increased in size.
7	Eye has become more distinct with no significant change in size.
8	Eye has become more distinct and decreased in size.
9	Eye has become more distinct and increased in size.
/	Change in character and size of eye cannot be determined.

TABLE 5

**P- Period over which the movement of the storm centre has been determined**

7 During the preceding 3 hours  
8 During the preceding 6 hours  
9 During a period of more than 6 hours  
(to be reported whenever any radar echo is seen)

RAREP FFBB IIiiYYGGg CHARACTER (b1b1b1/r1r1r1 -----bnbnbn/rnrrrn) INTENSITY  
TENDENCY dsdsfsfs ALTD (bbb/HtHt/rrr)

NOTE: 1. Part B will normally be reported only at synoptic hours. In the case of any break in observations or rapid development, additional Part B messages may be transmitted as necessary.

2. Part A messages are to be prepared and transmitted as close to the observation time as possible. Part B can be transmitted separately, after Part A has been sent. When Part A and Part B are transmitted together, the code groups RAREP, IIii, YYGGg need not be included in Part B.

## **Character:**

EYE : An echo identified definitely as the eye wall of a tropical cyclone.  
SPRL BND : A continuous or broken curved line of echoes recognizable as a spiral band associated with a cyclonic system.

SQL LN : This pattern should normally have a length to width ratio of about 10 to 1 and length about 60 km or more.

**BRKN LN :** A broken line of echoes.

**SLD :** An area fully covered with echoes.

**BRKN :** An area 4/8 to 7/8 covered with echoes.

SCT : An area 1/8 to 4/8 covered with echoes.

WDLY SCT : An area less than 1/8 covered with echoes.

ISLTD : Isolated solid mass of echo.

ECHO ALDFT : Echo seen only at elevations higher than half the beam width.

**bbb :** Azimuth in three digits (degrees) of points on the periphery of an echo area.

rrr : Range (three digits) in units of kilometers.

**NOTE:**

- (1) The groups within the brackets ( ) may be reported as many times as necessary.
  - (2) In the case of line echoes, in spiral bands and eye wall, as many bbb/rrr points along the line as necessary may be given to define the shape of the line. The points should preferably be given along the line in the anticlockwise direction.
  - (3) In the case of areas, as many bbb/rrr points as necessary to define the shape may preferably be given in the anticlockwise order starting from the northernmost point. The first point should be repeated as the last point to indicate that it is a closed area.

**ANNEX III-A-4**

- (4) In any one RAREP message, the character of echoes will be reported in the order given in the group description above.
- (5) If an echo system with a distinct characteristic is partly or wholly embedded in another, the two systems should be reported in separate groups. For example, a SPRL BND, or BRKNLN (which may be distinguished as such by using the attenuator or isoecho system) embedded in a larger area of echoes will be reported as SPRL BND or BRKN LN in addition to the area reported separately.
- (6) The number of features or groups should be as few as possible, and should be just sufficient to convey an overall picture of the system.

**Intensity:**

<b>For radars having facility for quantitative measurement</b>			
<b>Code</b>	<b>dBZ</b>	<b>Approximate rainfall rate mm/hr</b>	<b>Other radars</b>
WK	23 to 32	less than 4	Qualitatively determined as
MDT	33 to 42	4 to 15	
in			
STG	43 to 52	16 to 63	Weather Radar
VRY STG	53 or more	64 and above	Manual

- NOTE: (1) The intensity of the strongest echo in the group is to be reported.  
 (2) The rainfall rates indicated are based on the relationship  $Z = 200R^{1.6}$  and may be taken only as a rough guide.  
 (3) Intensity is to be reported only of echoes within 200 km range

**Tendency:**

INCG	: Increasing
DCG	: Decreasing
NO CHG	: No change

In view of the difficulties in finding out the tendency of echoes of large areal extent as in a depression or cyclone, tendency should be reported only in case of isolated cells or groups of cells or a line mainly for aviation purposes. The radar meteorologist will take into consideration the change in height, area, length and intensity of echoes over a period of time in judging the tendency.

dsds : Direction in tens of degrees towards which the echo or group of echoes is moving.  
 fsfs : Speed in kmph of the echo or group of echoes.

**ANNEX III-A-5****Doppler Weather Radar (DWR):**

Doppler Weather Radars provide vital information on radial velocity within tropical cyclone which is not available in conventional radars. Conventional radar provides information on reflectivity and range only, whereas a DWR provides velocity and spectral width data along with various meteorological, hydrological and aviation products which are very useful for forecasters in estimating the storm's center, its intensity and predicting its future movement. The DWR generates these products through a variety of software algorithms.

**NOTE:** (1) In case of a group of echoes or of a line, only the overall movement of the group of echoes will be reported.

(2) The movement will be observed over a period of, say 30 to 60 minutes.

**ALTD:** Indicator for echo height information.

**HtHt:** Height of top of echo above mean sea level in kilometers.

**NOTE:** (1) Reports of heights should be restricted to a maximum range of 200 km from the station.

(2) In the case of echoes of large areas, the height group may be repeated as necessary for including a number of prominent echoes.

The radar meteorologist will have discretion to report any other special phenomena such as Bright Band and Anomalous Propagation in plain language at the end of the message.

Parts A and B both shall be used whenever the echo pattern observed is recognized as relating to tropical cyclone. Part B only will be used for reporting echoes other than connected with tropical cyclone.

In the IMD website these products are uploaded at 10 minutes interval when a cyclone comes within a coastal Radar range and could be used by member countries. The products available from DWR of IMD which are available in IMD website include MAX(Z) Product (MAX\_Z), Plan Position Indicator (PPI\_Z), Volume Velocity processing (VVP\_2), Plan Position Indicator (PPI\_V), Surface Rainfall Intensity (SRI\_150), Precipitation Accumulation (PAC) 24 hrs at 0300 UTC (HOURS\_24)

Typical example of the Hourly radar bulletin issued by DWR stations at Paradeep in association with SCS Dana, 2024 in India during the cyclone period is given below:

**DWR PARADEEP CYCLONE BULLETIN**

**Cyclone bulletin No.11**

**Cyclone: DANA**

**Time: 24/10/2024 19:30 IST**

<b>1.</b>	<b>Name of the Station</b>	<b>DWR PARADEEP</b>
<b>2.</b>	<b>Date &amp; Time of observation (UTC)</b>	<b>24/10/2024 1400 UTC</b>
<b>3.</b>	<b>Name of Cyclone</b>	<b>DANA</b>
<b>4.</b>	<b>Information about the Eye of the cyclone</b>	
	<b>a)Is the Eye Visible</b>	<b>Visible</b>
	<b>b)Shape of the Eye</b>	<b>Semicircle</b>
	<b>c)Diameter of the Eye (km)</b>	<b>21km (approx)</b>
	<b>d)Estimation of centre of the cyclone based on Eye/Spiral band observation</b>	<b>19.95N/87.23E/118.8deg/69.6km</b>
	<b>e)Echo top (20 dBZ level) of rain bearing clouds around the System within 100 km radius</b>	<b>17km</b>
	<b>f) Maximum radar reflectivity (dBZ) in eye wall and Spiral band region, its height (km) and position (azimuth and distance from the radar)</b>	<b>44.0dBZ/6.8km/125.3deg/75.6km</b>

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	<b>g) Maximum reflectivity at any other area (spiral/ streamers etc)</b>	41.50dBZ/5.7km/198.0deg/162.0km
	<b>h) Maximum radial velocity in observed (mps), its height (km) and its position (azimuth and distance from the Radar)</b>	-19.73dBZ/1.0km/105.8deg/73.9km
	<b>i) Maximum velocity in any other area (spiral / streamers / rain shields etc)</b>	30.74mps/0.8km/134.7deg/63.4km
<b>5.</b>	<b>Tendency of the Cyclone</b>	
	<b>a. Intensity(Increasing/Decreasing)</b>	<b>Sustaining</b>
	<b>b. Duration for which the information on movement pertains to</b>	<b>One hour</b>
	<b>c. Direction of Movement</b>	<b>NNW</b>
	<b>d. Estimated speed of Movement</b>	<b>11kmph(approx)</b>
<b>6.</b>	<b>Any other Significant Feature</b>	<b>N/A</b>
<b>7.</b>	<b>Confidence</b>	<b>GOOD</b>

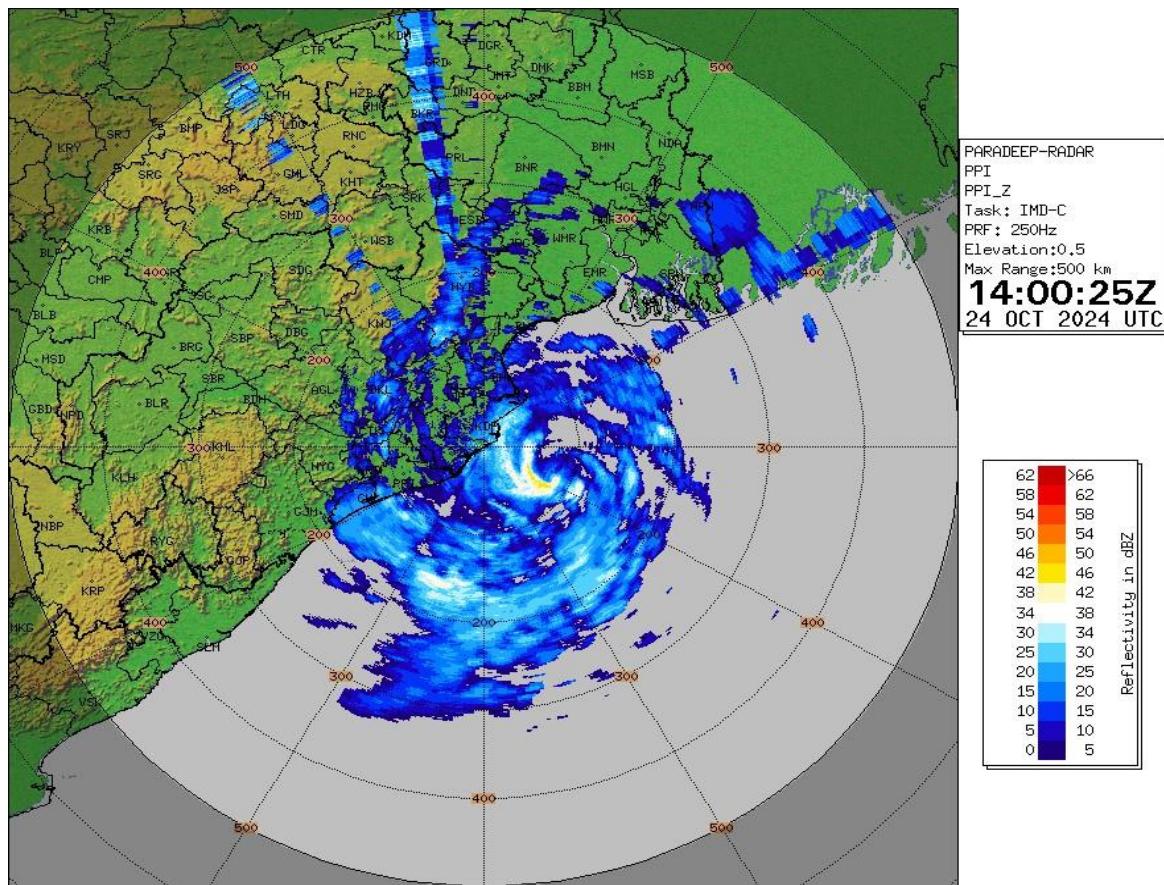
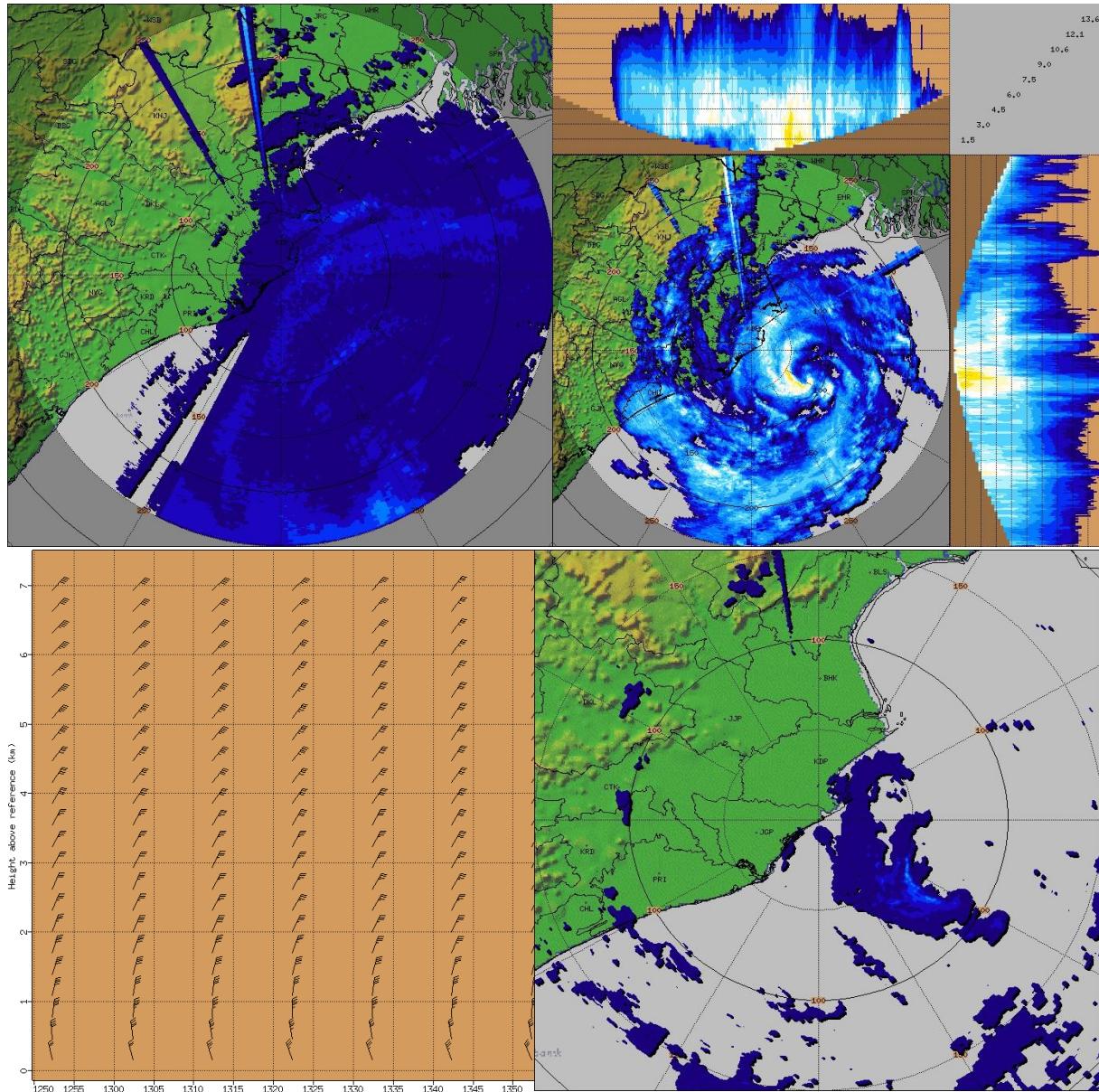


Fig 3.1(a): Radar Images issued at 0300 UTC of 24<sup>th</sup> October, 2024

### III-A-7



**Fig 3.1(b): Radar Images issued at 0300 UTC of 24<sup>th</sup> October, 2024**

**Satellite cloud imagery monitoring facilities in the Panel countries**  
**Bangladesh**

Bangladesh Meteorological Department (BMD) has the facilities of Himawari Satellite Receiving System of Japan. The satellite imageries of all of the available channels are updated on BMD website (<http://www.bmd.gov.bd>) regularly. With this system BMD is receiving images of Himawari 9. Satellite Images from 14 different channels have been received with 10 minutes intervals which is disseminated from Japanese communication satellite JC-SAT 2B. To analyze these satellite images SATAID data processing tool is used. BMD also has CMACast reception system. From this system BMD is receiving satellite images from Satellite FY-2D, FY-2E and FY-2F satellites. To analyze the images MICAPS data processing tool is used. Both of these reception systems are being used in operational weather forecasting.

Installation of the Receiving System of GK-2A (Korean Satellite) at BMD is under process and the available data will be utilized in operational forecasting.

**India**

At present IMD is receiving and processing meteorological data from two Indian geostationary Meteorological satellites namely INSAT-3D & INSAT-3DR. INSAT-3D launched on 26 July 2013 is positioned at 82°E and INSAT 3DR launched on 28th Aug 2016 is located at 74°E. INSAT-3D and INSAT-3DR have an advanced imager with six imagery channels {Visible (0.55-0.75 μm), Short wave Infra-Red (SWIR) (1.55-1.70 μm), Medium Infra-Red (MIR) (3.80-4.00 μm), Thermal Infra-Red-1(TIR-1) (10.2-11.3 μm), TIR-2 (11.5-12.5 μm), & WV (6.50-7.10 μm)} and a nineteen channel sounder (18 IR & 1 Visible) for derivation of atmospheric temperature and moisture profiles. Imager payload provides 1 km. resolution imagery in visible& SWR band, 4 km resolution in IR band and 8 km in WV band.

At Present about 48 nos. of satellite cloud images are taken daily from each of INSAT-3D and INSAT-3DR in a staggered mode so that effectively, after every fifteen minutes a new set of satellite cloud Images from imager become available to the forecasters and atmospheric profile of temperature and humidity from Sounder payload are obtained on hourly basis of Indian land region and one and half hourly basis of Indian ocean region from INSAT-3D and INSAT-3DR satellites. INSAT-3D Meteorological Data Processing System (IMDPS) is processing meteorological data from INSAT-3D and INSAT3-DR that supports all operational activities of the Satellite Meteorology Division on round the clock basis and all the processed data is archived. All the Cloud Imageries and derived products Data are transmitted to forecasting offices of the IMD through dedicated website as well as to the other users in India and foreign countries through FTP/GTS.

The following products derived from the satellite are useful for monitoring of tropical cyclones

1. Enhanced grey scale imagery of cyclone.
2. Enhanced coloured imagery of cyclone.
3. Outgoing Long wave Radiation (OLR) at pixel resolution
4. Rainfall Estimates
  - a. Hydro-Estimator (HE) at pixel resolution
  - b. INSAT Multispectral Rainfall Algorithm (IMSRA) at 0.1X0.1degree resolution
  - c. Three Hourly accumulated Quantitative Precipitation Estimation (QPE) at 1X1degree resolution
5. Sea Surface Temperature (SST) at pixel resolution
6. Upper Tropospheric Humidity (UTH)
7. Cloud Motion Vector (CMV)
8. Water Vapour Wind (WVW)
9. Visible/ Midinfrared wind
10. Wind derived products
  - a. Lower level Vorticity
  - b. Upper level Divergence.

### III-B-2

- c. Lower level convergence.
  - d. Vertical wind shear.
  - e. Wind shear tendency
11. Value added parameters from sounder products
- a. Layer Precipitable Water
  - b. Total Precipitable Water
  - c. Lifted Index
  - d. Dry Microburst Index
  - e. Maximum Vertical Theta-E Differential
  - f. Wind Index

At present Dvorak technique is used but manually applied. Recently efforts have been made for automation of this technique. Automated Dvorak technique version (8.2.1) is running in experimental mode at Satellite Application Unit, Satellite Meteorology Division. Satellite Application Unit is also using Microwave imageries operationally from NOAA, Metop's DMSP satellites for locating the tropical systems. Satellite Application Unit issues three hourly bulletins in general and hourly and half hourly bulletins in case of tropical cyclones and other severe weather events.

Real-time Analysis of Product and Information Dissemination (RAPID) is a web-based visualization and analysis tool developed jointly by IMD & ISRO for monitoring and analysis of satellite data of INSAT 3D and INSAT 3DR. A satellite based nowcast tool to predict IR1 BT is also available in RAPID. As RAPID is a geo-reference platform, it provides real time information on genesis, growth and decay along with its location and other geo-physical parameters to help forecasters to provide more objective nowcast. This tool can be accessed through IMD website at the link: <http://www.rapid.imd.gov.in/>

The online Web Archival System is developed at IMD for archiving the INSAT-3D and INSAT 3DR products & imageries. It is updated on real-time basis and at any instance of time last six-month imageries and products remain available. These are available to registered users through ftp.

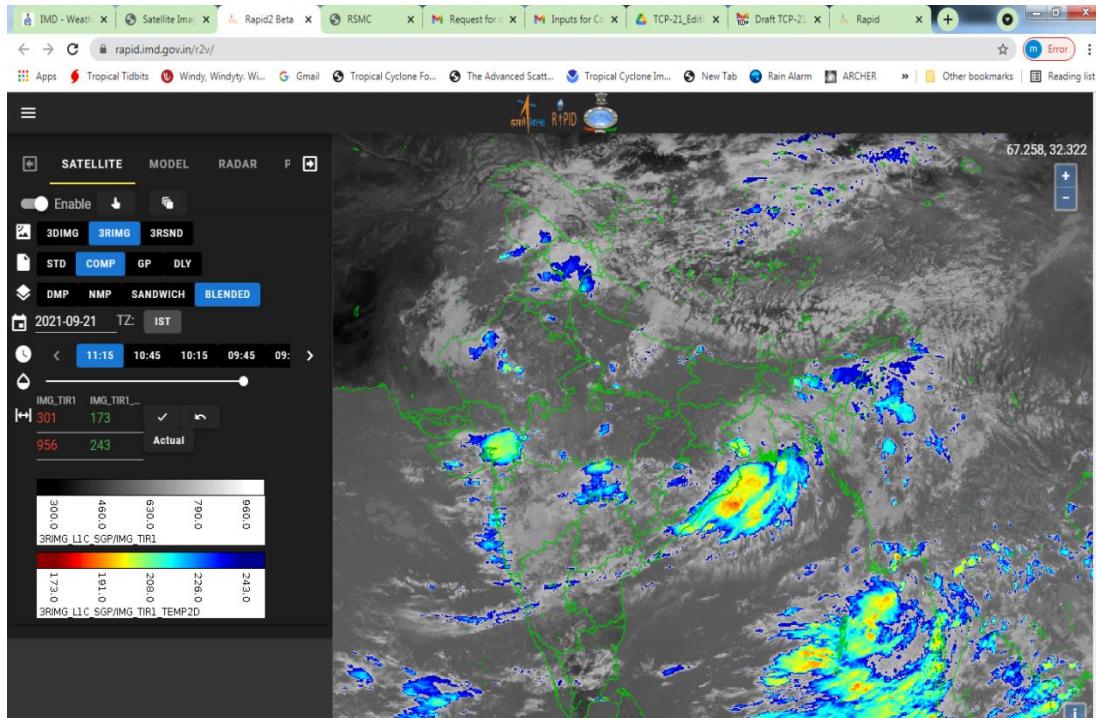


Fig.3.2: Image showing features available on RAPID Tool

#### 1.1.4.1 Lightning monitoring:

The occurrence of lightning in India is being monitored with the help of lightning detectors established by the Ministry of Earth Sciences and Indian Air Force. Currently, there are about 300 nos. of lightning detectors in the country. The area of lightning during preceding 10 min, 20 min and 30 min are superimposed with satellite and radar imageries. It helps in enhanced monitoring of thunderstorm and lightning activities and nowcasting of similar extreme events.

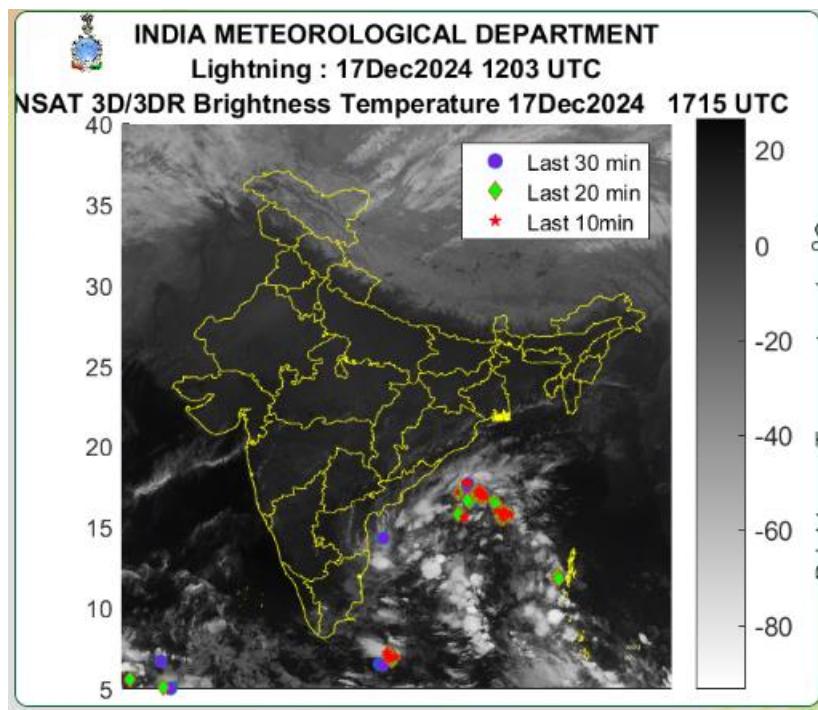


Fig.3.3: Lightning guidance at 1203 UTC of 17 December, 2024

#### 1.1.4.2. Meteosat-9: Products from MeteoSat 9 are also available IMD website at the link: <http://foreignsat.imd.gov.in>

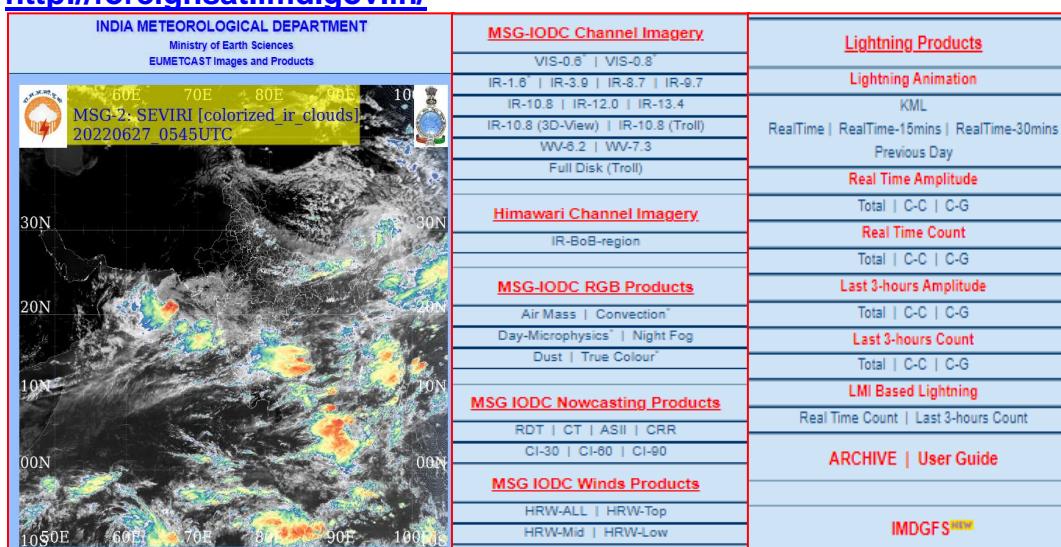


Fig.3.4: Meteo Sat-9 products

**Maldives**

Digital Meteorological Data Dissemination (DMDD) system donated by India Meteorological Department (IMD) receives WMO coded GTS data, half hourly cloud imagery from Satellite and Fax charts in LRIT/HRIT format transmitted by IMD and display on a high resolution color monitor. Images can be further enhanced using different image processing functions and can be focused more on the area of interest. This system has the capability to plot the received met data by values or contours on a specific image. With all these features it helps forecasters to do more precise predictions.

However, this system is facing signal loss therefore nothing has been received during 2012 and 2013.

The High Resolution Satellite Image Receiving System GEOSAT 500 has stopped functioning since 2010 due to expiring of service agreement with manufacture.

An integrated satellite receiving system generously donated by China Meteorological Agency was installed on 25 October 2012. This **CMACAST** system receives Satellite imageries from FY2E and FY2D series of Chinese geostationary satellites at an interval of 30 minutes. Surface synoptic data, Upper air sounding data, NWPs of ECMWF, T213: NWPs of CMA global model, NWP accumulation preci from Germany model and Japan model. Another component of this system is the application software MICAPS (meteorological data analyzing system) which enables to display satellite pictures, surface & upper air data and NWP products and overlay different products and analysis of various weather phenomena. This SYSTEM is satisfactorily operational.

**Myanmar**

The Department of Meteorology and Hydrology in Myanmar is receiving satellite imageries from Himawari Cast, CMA Cast ground reception system and also from US polar-orbiting satellites (NOAA series of the USA) by using internet.

An integrated satellite receiving system of Himawari Cast donated by Japan Meteorological Agency was upgrated on November 2015. This Himawari Cast system receives 14 channels and Himawari-8-9, NWP (JMA-GSM), Observation (SYNOP, TEMP, SHIP), Ocean Surface wind and MANAM.

An integrated satellite receiving system generously donated by China Meteorological Agency was installed on March 2012. This CMA Cast system receives Satellite imageries from FY2E and FY2D series of Chinese geostationary satellites at an interval of 30 minutes. Surface synoptic data, Upper air sounding data, NWPs of ECMWF, T213: NWPs of CMA global model, NWP accumulation precipitation from Germany model and Japan model. Another component of this system is the application software MICAPS (meteorological data analyzing system) which enables to display satellite pictures, surface & upper air data and NWP products and overlay different products and analysis of various weather phenomena.

**ANNEX III-B-3****Oman (Sultanate of Oman)**

The Meteorological Department has the following satellite ground receiving stations:

(i) METOSAT KU band at Muscat Airport and C band at Muscat Airport and Salalah Airport .

(ii) HRPT system at Muscat International Airport And Salalah Airport

All the above mentioned systems receive their data from the EUMETSAT Geostationary Satellite and NOAA Polar Orbiting Satellites.

Apart from generating cloud imagery, several products are derived from the satellite data. Some of these products are:

(i) Sounding based on TOVS [on experimental basis]

(ii) Sea surface temperature

(iii) Precipitation estimates

(iv) Cloud tops

(v) Fire detection [on experimental basis]

(vi) Pollution [on experimental basis]

(iv) Vegetation Index - NDVI [on experimental basis]

**Pakistan****Satellite Ground Stations operated by PMD**

1. HRPT at Islamabad and Quetta and

2. FY-2E/D (CMA cast-satellite receiving products, cloud imageries, winds and vorticity etc) at Islamabad and Karachi Airport.

3. Other satellite imageries available thru internet are accessed too.

**Qatar**

Qatar Meteorology Department receives Meteosat second generation satellite images on operational basis every 15 minutes which include visible, infrared, water vapor channels as well as HRV and various RGB satellite images.

**Sri Lanka**

Satellite imageries and products are received from HimawariCAST and CMACAST through the real time receiving systems .

METEOSAT-2SG/ INSAT imageries are accessed through Internet regularly

**Thailand**

The Meteorological Department in Thailand is receiving satellite imageries and products from Himawari 8, through HimawariCast receiving system, and FY-2 via internet.

**UAE****Satellite cloud imagery monitoring facilities in NCM**

Satellite	Position (Longitude)	Orbit	channels	period
Eumetsat Met-11	0°	Geostationary	12	15 minutes
Eumetsat Met-8	41.5° E	Geostationary	12	3 hours
Himawari-8 (Japan)	140.7° East	Geostationary	1	10 minutes
GOES-15 USA west	135° W	Geostationary	1	3 hours
GOES-16 USA east	075° W	Geostationary	1	15 minutes
FY2E (China)	86.5° E	Geostationary	5	1 hour
FY2G (China)	105° E	Geostationary	5	1 hour

## CHAPTER IV

### TROPICAL CYCLONE FORECASTING

#### **4.1 Forecasting development and movement of tropical cyclones**

The final responsibility for analysis and forecasting of genesis, intensification and movement of tropical cyclones in the region will be with the National Meteorological Service of each of the Members. However, in addition to the exchange of observational data needed for analysis and forecasting, the following special arrangements for the exchange of processed products and advisories have been made.

- (i)     (a) Processed products will be provided by RSMC tropical cyclones, New Delhi. A list of output products broadcast from RSMC tropical cyclones, New Delhi for international purposes is given in Table IV1. A list of other products broadcast through facsimile from RSMC tropical cyclones, New Delhi for national purposes is given in Annex IV-A.  
       (b) RSMC tropical cyclones, New Delhi will issue a tropical weather outlook once daily throughout the year for the benefit of the Member countries. It is being transmitted on the GTS at 06 UTC. The outlook covering the Bay of Bengal and the Arabian Sea indicates possible development of tropical depressions over the sea. An additional outlook will be transmitted again over the GTS at 1700 UTC when a Depression is located and expected to intensify into a cyclonic storm.
- (ii)    In case there is a tropical cyclone in the Panel region, RSMC tropical cyclones, New Delhi will also issue the following:  
       (a) Tropical cyclone advisories, details of which have been given in earlier chapters.  
       (b) Tropical Cyclone Advisory Centre (TCAC) New Delhi will issue Tropical Cyclone Advisory bulletins for the international air navigation to Meteorological Watch Offices (MWOs) in area of responsibility at least for every six hours.
- (ii)    The satellite tropical disturbance summary issued from Washington will be exchanged through the GTS.
- (iii)   National Meteorological Services may like to use climatological charts of average vector motions for the track prediction. The track prediction based on climatological charts are usually most useful (minimum error) when tropical storms are to the south of subtropical anticyclones. Such charts for the region for each month and for each season are available in IMD and RSMC, New Delhi website in the form of cyclone Web Atlas.

#### **4.2 Prediction Models in operational use during the year 2024**

##### **4.2.1 Global Forecast System**

The Global Forecast System (GFS), adopted from National Centre for Environmental Prediction (NCEP) USA is operationally run at India Meteorological Department (IMD), New Delhi on Cray XC40 based High Power Computing Systems (HPCS). The IMD-GFS (T1534/L64) global model is run with ~12 km horizontal resolution and 64 hybrid sigma-pressure layers with Ensemble Kalman Filter (ENKF) based Grid Point Statistical Interpolation (GSI) scheme as the global data assimilation to generate 10 days forecast. The model is run four times in a day (00, 06, 12 and 18 UTC). The real-time outputs are made available to the national web site of IMD (<https://mausam.imd.gov.in/> under Short to Medium Range Model Guidance).

IMD also makes use of NWP products prepared by some other operational NWP Centers like, European Center for Medium Range Weather Forecasting (ECMWF), GFS (NCEP) USA, Japan Meteorological Agency (JMA), UK Meteorological Office (UKMO) model etc.

##### **4.2.2 Regional Forecast System**

IMD operationally runs regional models Weather Research Forecast Advance Research for Weather Forecasting (WRFARW) (v3.9) with regional GSI based data assimilation, and Atmosphere-

Ocean coupled Hurricane Weather Research and Forecast (HWRF) modelling system for short-range prediction during cyclone.

#### **4.2.2.1. Non-hydrostatic mesoscale modeling system WRF-ARW with regional GSI based Data Assimilation system**

The mesoscale Weather Research and Forecast WRF (version 3.9.1) with 3DVAR data assimilation is being operated daily twice to generate mesoscale analysis at 8 km horizontal resolution using IMD GFS-T574L64 analysis as first guess and forecasts as boundary condition. Using analysis and updated boundary conditions from the WRFDA, the WRF (ARW) is run for the forecast up to 3 days with 3 km and 45 Eta levels in the vertical 4 times a day at 06 hourly interval.

The model domain covers the area between lat. 5°S to 40°N long 50°E to 102°E covering India and neighboring south Asian countries. The model runs with its own regional data assimilation (Com GSI V3.7\_EnKF1.3).

#### **4.2.2.2 Hurricane WRF Model (HWRF)**

Since 2011, time to time the HWRF modelling system is developed and customized atmospheric and ocean models with other associated pre-processing and post-processing components are implemented in IMD under the framework of MoU between MoES and NOAA. The HWRF version H217 has been ported on the MHIR HPCS with horizontal resolution of 18 km for parent domain and 6km & 2 km for intermediate and innermost nested domains following the center of cyclonic storm. The model is running with 61 vertical levels with parent domain, intermediate and innermost domain covering area of 80ox80o, 24ox24o and 7ox7o respectively. The special feature modified for tropical cyclone forecasting includes vortex initialization and correction, GSI based regional data assimilation, coupler for two-way coupling between atmosphere and ocean components and fine-tuned physical parameterization schemes. This model is customized specifically to forecast the track, intensity and structure of tropical cyclones. The HWRF modelling system uses the dynamics and infrastructure from the NMM WRF modelling system. It uses physics that are proven to be better for the tropics. Also, at this time, it is an Ocean coupled model system with a Moving two-way interactive nest, and advanced data assimilation. IMD is operationally running ocean coupled HWRF models during Tropical Cyclone events with two ocean models viz. POM-TC and HYCOM. HYCOM initial conditions are provided through INCOIS whereas POM-TC is initialized based on climatology.

It is run 4 times a day in cyclic mode with GSI based (hybrid-EnVar) assimilation (80 members) with 6 hourly cycles in cycling mode with full physics configuration. The model is also configured with 2 different Ocean models i.e. Princeton Ocean Model (POM) and hybrid co-ordinate ocean model (HYCOM). The Unified Post-Processor (UPP) converts raw model outputs from all three domains into standard GRIB1/2 format. Moreover, GFDL tracker generates track and intensity information in a standard ATCF (Automated Tropical Cyclone Forecasting System) format processing all GRIB files with a specified time interval (3 or 6 hours) as per requirement.

The modeling system was fully operational and predicted all cyclones during the year 2021. Whenever any low-pressure system intensified and became depression over both sub-basins of North Indian Ocean, the cyclic run of the modelling system had been initiated. The model utilized ocean initial state from the ITOPSI (INCOIS Tendral Ocean Prediction System – Indian Ocean Model) during each cycle to initialize the HYCOM ocean component. All available observed data including conventional and satellite observations were assimilated into the regional GSI system to improve further the initial condition after the vortex initialization of the atmospheric first guess state of the model forecast from previous cycle (except first cycle).

The HWRF version H217 which was operational at EMC, NCEP USA has been ported on the MHIR HPCS with horizontal resolution of 18 km for parent domain and 6km & 2 km for intermediate and innermost

nested domains following the center of cyclonic storm. The model is running with 61 vertical levels with parent domain, intermediate and innermost domain covering area of  $80^{\circ}\text{N}$  $\times$  $80^{\circ}$ ,  $24^{\circ}\text{N}$  $\times$  $24^{\circ}$  and  $7^{\circ}\text{N}$  $\times$  $7^{\circ}$  respectively. The model also has state of the art features specially modified for tropical cyclone forecasting. The special feature includes vortex initialization and correction, GSI based regional data assimilation, coupler for two way coupling between atmosphere and ocean

#### **4.2.2.3. High Resolution Rapid Refresh Modeling System (HRRR)**

The High Resolution Rapid Refresh (HRRR) system based on Weather Research and Forecast (WRF-ARW) model with WRFDA (3DVAR-FGAT) data assimilation is operationalized in IMD in collaboration with Space Application Center (ISRO) from beginning of 2021. The HRRR is hourly updated atmospheric model with horizontal resolution of 2km. The model uses forecast of IMD-GFS (T1534L64) model as first guess and forecast as boundary during cold start and is then cycled providing hourly updates based on Radar Data assimilation. Using analysis and updated boundary conditions from the WRFDA, the HRRR is run to produce forecasts up to 12 hours and forecasts are made available after every two hours on NWP website of IMD.

The model is run in three different domains covering Indian mainland. The three domains are North-West domain, East & North-East domain and South-Peninsular domain. HRRR with hourly updates provide frequent and updated precipitation and reflectivity forecasts with respect to the TC's which could be very useful in planning effective and immediate disaster mitigation strategies in very short range.

#### **4.2.3. NWP based Objective Cyclone Prediction System (CPS)**

The method comprises of five forecast components, namely (a) Cyclone Genesis Potential Parameter (GPP), (b) Multi-Model Ensemble (MME) technique for cyclone track prediction, (c) Cyclone intensity prediction, (d) Rapid intensification and (e) Predicting decaying intensity after the landfall.

#### **4.2.4. Genesis Potential Parameter (GPP)**

A cyclone genesis parameter, termed the genesis potential parameter (GPP), for the North Indian Sea is developed (Kotal et al, 2009). The parameter is defined as the product of four variables, namely relative vorticity at 850 hPa, middle tropospheric relative humidity, middle tropospheric instability, and the inverse of vertical wind shear. The parameter is operationally used for distinction between non-developing and developing systems at their early development stages. The composite GPP value is found to be around three to five times greater for developing systems (T 3.0) than for non-developing systems. The analysis of the parameter at early development stage of a cyclonic storm found to provide a useful predictive signal for intensification of the system.

The grid point analysis and forecast of the genesis parameter up to seven days is also generated on real time. Higher value of the GPP over a region indicates higher potential of genesis over the region. Region with GPP value equal or greater than 30 is found to be high potential zone for cyclogenesis. The analysis of the parameter and its effectiveness during cyclonic disturbances in 2022-2024 affirm its usefulness as a predictive signal (4-5 days in advance) for cyclogenesis over the North Indian Ocean.

#### **4.2.5. Multi-model ensemble (MME) technique**

The multi model ensemble (MME) technique (Kotal and Roy Bhowmik, 2011) is based on a statistical linear regression approach. The predictors selected for the ensemble technique are forecasts latitude and longitude positions at 12-hour interval up to 120-hour of five operational NWP models. In the MME method, forecast latitude and longitude position of the member models are linearly regressed against the observed (track) latitude and longitude position for each forecast time at 12-hours intervals for the forecast up to 120-hour. The 12 hourly predicted cyclone tracks are then determined from the respective mean sea level pressure fields using a cyclone tracking software. Multiple linear regression technique is used to generate weights (regression coefficients) for each model for each forecast hour (12hr, 24hr, 36 hr, 48hr, 60hr, 72hr,

84hr, 96hr, 108hr and 120 hrs) based on the past data. These coefficients are then used as weights for the ensemble forecasts. 12-hourly forecast latitude (LATf) and longitude (LONf) positions are defined by multiple linear regression technique. A collective bias correction is applied in the MME by applying multiple linear regression based minimization principle for the member models GFS (IMD), GFS (NCEP), ECMWF, UKMO and JMA. ECMWF data are available at 24h intervals. Therefore, 12h, 36h, 60h, 84h, 108h forecast positions of ECMWF are computed based on linear interpolation. All these NWP products are routinely made available in real time on the IMD web site: [www.rsmcnewdelhi.imd.gov.in](http://www.rsmcnewdelhi.imd.gov.in).

With the latest version of different models & EPS as well as different tracker used for tracking the centre of TC in models, the IMD has developed another MME for track, intensity & landfall forecasts since 2021. It performs better than the individual models.

#### **4.2.6. Statistical Dynamical model for Cyclone Intensity Prediction (SCIP)**

A statistical-dynamical model (SCIP) (Kotal et al, 2008) has been implemented for real time forecasting of 12 hourly intensity up to 120 hours. The model parameters are derived based on model analysis fields of past cyclones. The parameters selected as predictors are: Initial storm intensity, Intensity changes during past 12 hours, Storm motion speed, Initial storm latitude position, Vertical wind shear averaged along the storm track, Vorticity at 850 hPa, Divergence at 200 hPa and Sea Surface Temperature (SST). For the real-time forecasting, model parameters are derived based on the forecast fields of IMD-GFS model. The method is found to be provided useful guidance for the operational cyclone forecasting.

The MME based all available NWP models on EPS is also developed by IMD since 2021 for intensity prediction.

#### **4.2.7. Rapid Intensification (RI) Index**

A rapid intensification index (RII) is developed for tropical cyclones over the Bay of Bengal (Kotal and Roy Bhowmik, 2013). The RII uses large-scale characteristics of tropical cyclones to estimate the probability of rapid intensification (RI) over the subsequent 24-h. The RI is defined as an increase of intensity 30 kt (15.4 ms<sup>-1</sup>) during 24-h. The RII technique is developed by combining threshold (index) values of the eight variables for which statistically significant differences are found between the RI and non-RI cases. The variables are: Storm latitude position, previous 12-h intensity change, initial storm intensity, vorticity at 850 hPa, divergence at 200 hPa, vertical wind shear, lower tropospheric relative humidity, and storm motion speed. The probability of RI is found to be increases from 0% to 100% when the total number of indices satisfied increases from zero to eight. The forecasts are made available in real time from 2013.

#### **4.2.8. Decay of Intensity after the landfall**

Tropical cyclones (TCs) are well known for their destructive potential and impact on human activities. The Super cyclone Odisha (1999) illustrated the need for the accurate prediction of inland effects of tropical cyclones. The super cyclone of Odisha maintained the intensity of cyclonic storm for about 30 hours after landfall. Because a dense population resides at or near the Indian coasts, the decay forecast has direct relevance to daily activities over a coastal zone (such as transportation, tourism, fishing, etc.) apart from disaster management. In view of this, the decay model (Roy Bhowmik et al. 2005) has been used for real time forecasting of decaying intensity (after landfall) of TCs.

#### **4.2.9.Tropical Cyclone Ensemble Forecast based on Global Models Ensemble (TIGGE) Data**

The THORPEX Interactive Grand Global Ensemble (TIGGE, Philippe Bougeault et al. 2010) is an implementation of ensemble forecasting for global weather forecasting and is part of THORPEX, an international research programme established in 2003 by the World Meteorological Organization (WMO) to accelerate improvements in the utility and accuracy of weather forecasts up to two weeks ahead. As part of WMO Program to provide a guidance of tropical cyclone (TC) forecasts in near real-time for the ESCAP/WMO Member Countries based on the TIGGE Cyclone XML (CXML) data, IMD implemented JMA supported software for real-time TC forecast over North Indian Ocean (NIO) in 2011. The Ensemble and

deterministic forecast products from ECMWF (50+1 Members), NCEP (20+1 Members), UKMO (23+1 Members) and MSC (20+1 Members) are available near real-time for NIO region for named TCs. These Products includes: Deterministic and Ensemble TC track forecasts, Strike Probability Maps, Strike probability of cities within the range of 120 kms 4 days in advance. The JMA provided software to prepare Web page to provide guidance of tropical cyclone forecasts in near real-time for the ESCAP/WMO committee Members. The forecast products are made available in real time.

Since 2021, IMD has also implemented IFS TC Tracker (available from ECMWF) for all available TIGGE models (9 in numbers). These 9 models are from Bureau of Meteorology, Australia (BoM), Environment and Climate Change Canada (ECCC), European Centre for Medium-Range Weather Forecasts (ECMWF), India Meteorological Department (IMD), Japan Meteorological Agency (JMA), Korea Meteorological Administration (KMA), Met Office - UK (UKMO), and National Centers for Environmental Prediction, USA (NCEP), and National Centre for Medium Range Weather Forecasting (NCMRWF) are nine International Institutes model outputs (contributing to the TIGGE) are chosen based on availability at the ECMWF-TIGGE web data portal <https://apps.ecmwf.int/datasets/data/tigge/levtype=sfc/type=cf/> as on December 2021.

#### **4.2.10. Global Ensemble Forecast System**

The Ministry of Earth Sciences (MoES) has commissioned two very high resolution (12 km grid scale) state-of-the-art global Ensemble Prediction Systems (EPS) for generating operational 10-days probabilistic forecasts of weather. The EPS involves the generation of multiple forecasts using slightly varying initial conditions. The forecast products from these two prediction systems are available at the following links (<http://nwp.imd.gov.in/gefspro.php>) and ([http://www.ncmrwf.gov.in/product\\_main.php](http://www.ncmrwf.gov.in/product_main.php)). The frameworks of the new EPSs are among the best weather prediction systems in the world at present. Very few forecasting centres in the world use this high resolution for short-medium range probabilistic weather forecasts.

##### **4.2.10.1. The Ensemble Mean and Spread**

The ensemble spread is a measure of the difference between the members and is represented by the standard deviation (SD) with respect to the ensemble mean (EM). On average, small (high) spread indicates a high (low) forecast accuracy.

- The ensemble spread is flow-dependent and varies for different parameters.
- It usually increases with the forecast range, but there can be cases when the spread is larger at shorter forecast ranges than at longer ranges. This might happen when the initial days are characterized by strong synoptic systems with complex structures but are followed by large-scale "fair weather" high pressure systems.

##### **4.2.10.2. Models run at NCMRWF**

Two global models are also run at NCMRWF, NGFS adapted from NCEP GFS and NCUM unified model adapted from UK Met Office. The observations assimilated at NCMRWF include various in-situ and remote sensing observations. In-situ observations includes measurements come from land weather stations, aircraft, radiosondes, ships and buoys. Satellite observation includes Infrared and microwave radiance measurements from Low Earth Orbiting (LEO) and Geostationary (GEO) satellites, Atmospheric Motion Vectors from LEO and GEO, ocean surface winds from scatterometers, GPS Radio Occultation measurements etc. Indian Doppler Weather Radar (DWR) observation are also assimilated in the NCMRWF NWP systems. NCUM-G (N1024/L70) model features a horizontal resolution of 12km and 70 vertical levels reaching upto an altitude of 80 km. It uses "ENDGame" dynamical core, which provides improved accuracy of the solution of primitive model equations and reduced damping. This was upgraded in June 2018 from the earlier model with a horizontal resolution of 17km. NCUM is a grid point model which has a Non-hydrostatic dynamics with a deep atmosphere suitable for all scales. It has semi-implicit time integration with 3D semi-Lagrangian advection, terrain following height coordinates and high order

advection. It features mass-flux for shallow convection with convective momentum transport, non-local mixing and entrainment for boundary layer. The new version of the NCUM has the model physics configuration of GA6.0 (Global Atmosphere version 6.0) and a land surface model configuration of GL 6.0 which is based on JULES land surface scheme(Walters et al., 2017). This helps in producing finer details in the simulations of synoptic scale systems such as cyclones, fronts, troughs and jet stream winds. ENDGame also increases variability in the tropics, which leads to an improved representation of tropical cyclones and other tropical phenomena (Walters et al., 2017). Hybrid 4D-Var data assimilation system prepares initial condition for NCUM. The advantage of the Hybrid 4D-Var is that it uses a blended background error, blend of “climatological” r and day-to-day varying flow dependent background error derived from the 22-member ensemble forecasts at NCMRWF. The hybrid approach is scientifically attractive because it elegantly combines the benefits of ensemble data assimilation with the known benefits of 4D-Var within a single data assimilation system.

NCUM-R is a regional model having a horizontal grid resolution of ~4km with 80 vertical levels reaching up to 38.5 km height. NCUM-R uses the high-resolution analysis prepared by regional 4D-Var system. In addition to most of the in-situ and satellite observation types used in the global NCUM, Indian DWR observations of radial wind and rainfall intensity estimates are also used in the regional NCUM DA system. The model domain of NCUM-R spans entire south Asia covering Bay of Bengal and part of Arabian Sea (5 N-40 N, 65-100 E).

NCMRWF Ensemble Prediction System (NEPS-G) is a global medium range probabilistic forecasting system adapted from UK MET Office. The configuration consists of four cycles of assimilation corresponding to 00Z, 06Z, 12Z & 18Z and 10-day forecasts are made using the 00Z initial condition. The operational NCMRWF Ensemble Prediction System (NEPS) has 22 ensemble members. The horizontal resolution of NEPS is ~12km. The NCUM model analysis is used as the initial condition for the control model forecast. The perturbations are generated by Ensemble Transform Kalman Filter (ETKF) method which are added to the global deterministic analysis to create 22 perturbed initial conditions. These are used for generating ensemble member forecasts. One control and 11 perturbed ensemble members run from initial condition of 00UTC of current day and 11 more perturbed members run from 12 UTC of previous day to give 23 members (11 + 11 + 1 control) ensemble forecasts up to 10 days lead time. More details about NEPS-G are available in Mamgain et al. (2018). The new 12-km NEPS-G is the highest resolution for Ensemble forecasting.

The Coupled Ocean Atmosphere Model at NCMRWF (CNCUM) uses the Nucleus European Modelling of Ocean (NEMO) based global ocean analysis and forecast system at 0.25x0.25degree resolution is used to compute the upper ocean heat content up to 26°C isotherm depth called as Tropical Cyclone Heat Potential (TCHP). It is important oceanic parameter which affects the intensity of the TCs. At NCMRWF, it is produced in real time using the global ocean forecast system up to 10 days using the ocean only model and up to 15 days using the coupled atmosphere-ocean model for monitoring the upper ocean and also for research purpose mainly for Tropical Cyclone (TC) study. Further, the NEMO based temperature and salinity forecast from the Extended Range Prediction (ERP) is also used to compute the TCHP up to 4 week periods.

#### **4.2.10.3. Models run at IITM Pune**

Since 2018, Global Ensemble Forecast System (GEFS) T1534 (~12 km) is used for operational short-range probabilistic weather forecast system including cyclone prediction at IITM. It is based on Global Forecast System (GFS v14.1) which is a part of the ‘Operational Model’ developed at NCEP, USA in 2018. This is a spectral model with semi lagrangian dynamics and semi implicit time scheme. It has a horizontal resolution of 12.5 km. The total number of 21 Ensembles (20 perturbed forecasts + 1 control forecast) constitutes the ensemble system. These 20 ensembles analysis are generated by Ensemble Kalman Filter (EnKF) method from the forecast perturbation of the previous cycles four times a day (00, 06, 12 and 18 UTC) at all 64 model vertical levels. These analysis perturbations are added to the reconfigured analysis

obtained from the hybrid four-dimensional Ensemble variational data assimilation system (GDAS-Hybrid4DEnsVar) as part of the suite. The 243-hour forecast of GEFS is routinely generated based on 00UTC and 12UTC initial conditions which include a control forecast starting from GDAS assimilation and 20 (20 perturbations) ensemble members with each perturbed initial conditions.

#### **4.2.10.4. Probabilistic forecasts of quantitative precipitation**

- In these charts, the probability that 24-hour precipitation amounts over a 2.5x2.5 lat-long grid box will exceed certain threshold values is given. The forecast probability is estimated directly from the 20-member global ensemble.
- At each grid point the number of ensemble members having a 24-hour precipitation amount within a specified range (e.g. 1-2cm, 2-5cm etc) is counted (M) and the probability is expressed as  $100*(M/20)$ .

#### **4.3 Storm surge forecasting**

Storm surge forecasting is the responsibility of the National Meteorological Services. However, storm surge guidance is issued and incorporated in the Tropical Cyclone Advisory bulletin by RSMC- New Delhi based on IIT, Delhi Storm Surge prediction model and INCOIS Advanced Circulation model (AdCirc).

#### **4.4 Coastal inundation forecasting**

The coastal inundation forecast by RSMC, New Delhi commenced from 2013 experimentally with cyclone Phailin. This forecast is provided to disaster managers. It is mainly based on coastal inundation model run by Indian National Centre for Ocean Information Services (INCOIS) Hyderabad. This is ADCIRC model is adapted from USA. This forecast guidance is also provided all member countries.

#### **4.5 Seasonal Prediction of cyclonic disturbances**

Seasonal prediction of cyclonic disturbances is being issued experimentally for the post monsoon season (Oct.-Dec.) since 2014. This contains information about the frequency of cyclonic disturbances (depression and above) over the Bay of Bengal and number of cyclonic disturbance days over the north Indian Ocean. However, it has not been operationalised considering the large inter-annual & intra-seasonal variability and less number of cases over north Indian Ocean region.

**Processed products updated and uploaded on IMD's website ([www.internal.imd.gov.in](http://www.internal.imd.gov.in)) on real time basis by RSMC –Tropical Cyclones New Delhi for national/international purposes.**

#### **(A) WEATHER CHARTS**

<b>Model</b>	<b>Products</b>
GFS (T1534)	Analysis and forecast up to 240 hrs
WRF-VAR (ARW) Analysis 9 km	Analysis and forecast up to 72 hrs
WRF-VAR (ARW) Analysis 3 km	Analysis and forecast up to 72 hrs
Extended Range Forecast	Temperature anomaly and mean rainfall forecast up to four weeks
Other products	Weekly Upper Level Mean Winds Weekly Upper Level Wind Anomalies Monthly Upper Level Mean Winds Monthly Upper Level Wind Anomalies
HWRF	Analyses and forecasts upto five days
EPS	Forecast Track and strike probability upto five days
GEFS (T1534)	Analysis and forecast up to 192 hrs
NCMRWF : GEFS	EPS products, forecast track and strike probability upto five days.
NCUM	Analysis and forecast up to 240 hrs.
NCUM-EPS	Analysis and forecast up to 240 hrs.

**(B) DOPPLER RADAR PRODUCTS**

- MAX(Z) Product (MAX\_Z)
- Plan Position Indicator (PPI\_Z)
- Volume Velocity processing (VVP\_2)
- Plan Position Indicator (PPI\_V)
- Surface Rainfall Intensity (SRI\_150)
- Precipitation Accumulation (PAC) 24 hrs at 0300 UTC (HOURS\_24)

**(C) INSAT IMAGES & INSAT PRODUCTS****❖ INSAT IMAGES****(a) FULL DISC**

- Visible Channel
- Infra-red Channel
- Colour Composite
- Water Vapour Channel

**(b) SECTOR**

- Visible Channel
- Infra-red Channel
- Colour Composite
- Water Vapour Channel
- Enhanced IR Channel
- Enhanced Visible Channel

**(c) NORTH WEST SECTOR**

- Visible Channel
- Infra-red Channel
- Colour Composite
- Water Vapour Channel

**(d) NORTH EAST SECTOR**

- Visible Channel
- Infra-red Channel
- Colour Composite
- Water Vapour Channel

**(e) CYCLONE SPECIFIC IMAGES**

- Enhanced grey scale imag
- Enhanced colour image

**(ii) PRODUCTS**

- Daily Average WVBT image from INSAT-3D
- Daily Average IR1BT image from INSAT-3D
- Cloud Motion Vectors (CMV)
- Water Vapour Winds (WVW)
- Visible/Mid-Infrared Winds (VISW/ MIRW)
- Cloud Top Temperature Image
- Cloud Top Temperature Image( Below -40°C )
- G.P.S. Precipitable Water Data
- Upper Tropospheric Humidity ( UTH )
- Map of Daily UTH
- Map of Weekly UTH
- Sea Surface Temperature ( SST )
- Map of Weekly SST
- Map of Daily SST
- Outgoing Long wave Radiation (OLR)

- Map of Daily Mean OLR
- Map of Weekly Mean OLR
- Map of Monthly Mean OLR
- Quantitative Precipitation Estimate (QPE), HE & IMSRA
- Map of Daily QPE, HE & IMSRA
- Map of Weekly QPE, HE & IMSRA
- Map of Monthly QPE, HE & IMSRA
- ❖ SCATSAT-1 Imageries and Products

**NOAA METOP IMAGES (Microwave channel) SCAT SAT IMAGES**

## CHAPTER V

### COMMUNICATIONS

#### **5.1 General**

The basic communication network for the exchange of data, forecast, warnings and observations will be the Global Telecommunication System (GTS). Tropical cyclone advisories and warnings (SIGMETs) for aviation shall be transmitted by means of the Aeronautical Fixed Service (AFS), according to the provision of ICAO Annex 3/ WMO No. 49, Technical Regulations [C.3.1], and ICAO ASIA/PAC and MID ANP FASIDs.

Tropical cyclone warnings for shipping (WWMIWS) shall be transmitted by agreed means of the GMDSS, according to the provision of the Manual on Marine Meteorological Services (WMO No. 558). The METAREA Coordinator is responsible for ensuring warnings are disseminated on the appropriate GMDSS communication channel. The list of METAREA Coordinators is available from WMO No.9, Volume D, Information for Shipping.

[http://www.wmo.int/pages/prog/www/ois/Operational\\_Information/VolumeD/GMDSS/Focal\\_Points/GM\\_DSS/fp.pdf](http://www.wmo.int/pages/prog/www/ois/Operational_Information/VolumeD/GMDSS/Focal_Points/GM_DSS/fp.pdf)

Processed products of RSMC tropical cyclones, New Delhi are distributed in chart form through Satellite broadcast as well as through ftp server on Internet.

In the GTS a regional arrangement exists for the exchange of raw and processed data, forecasts, warnings and addressed messages. Normally message-switching computers in GTS transmit the data on a first in-first out basis. However, priority can be assigned to certain messages on the basis of abbreviated headings. Such messages are given preference over other messages in transmission on the circuits.

The messages for which high priorities are to be assigned are:

- (i) all radar observations in cyclonic storm situations;
- (ii) composite ships' surface and upper-air observations from the tropical cyclone field;
- (iii) tropical cyclone warnings;
- (iv) tropical weather outlook;
- (v) tropical cyclone advisories; and
- (vi) satellite bulletins from RSMC tropical cyclones, New Delhi.

To exchange these messages on priority basis among the Panel countries the abbreviated headings as decided in consultation with RTH New Delhi will be used.

#### **5.2 Procedures to be followed**

WMO headings.

Station location indicators.

International block and station index numbers will be used to send surface and upper-air observations.

##### ***5.2.1 Tropical cyclone warning headings***

The headings used for the exchange of tropical cyclone warnings by the Panel countries are given in Table V1. Member countries will request RTH New Delhi to assign priority to these headings if not already provided.

##### ***5.2.2 Telecommunication headings for the exchange of radar observations***

The telecommunication headings used for the exchange of radar observations are listed in Table V2.

##### ***5.2.3 Telecommunication headings for the exchange of other messages***

The telecommunication headings (which will be the priority headings) for the exchange of tropical weather outlook, tropical storm advisories and satellite bulletins as decided in consultation with the RTH New Delhi are listed in Table V3.

#### **5.2.4 Telecommunication headings for the exchange of tropical cyclone advisories and warnings for aviation**

The telecommunication headings for the exchange of tropical cyclone advisories and warnings for aviation are given in Table V4.

#### **5.3 Existing GTS circuits among the Panel countries**

1. New Delhi -Bangkok	64 Kbps leased line TCP/IP WMO FTP and 150 Mbps IPVPN TCP/IP WMO Socket circuit over internet.
2 New Delhi- Colombo (Sri Lanka)	2 Mbps TCP/IP WMO Socket circuit over internet.
3. New Delhi- Dhaka (Bangladesh)	200 Mbps IPVPN TCP/IP WMO Socket circuit over Internet.
4. New Delhi- Karachi (Pakistan)	64 kbps leased line TCP/IP Socket circuit and 150 Mbps IPVPN TCP/IP WMO FTP circuit over internet.
5. New Delhi –Malé (Maldives)	150 Mbps TCP/IP WMO Socket circuit over internet
6. New Delhi -Myanmar	150 Mbps IPVPN TCP/IP WMO Socket circuit over internet.
7. New Delhi -Muscat	150 Mbps TCP/IP WMO Socket circuit over internet.
8. New Delhi.-Jeddah	150 Mbps TCP/IP WMO FTP circuit over internet.
9. New Delhi – Yemen	No direct connectivity.
10. Bangkok – NayPyiTaw (Myanmar)	20 Mbps IPVPN TCP/IP WMO FTP circuit over Internet
11. Bangkok - Jeddah	1 Mbps MPLS TCP/IP WMO FTP Circuit and 20 Mbps TCP/IP WMO FTP circuit over internet.

#### **5.4 List of important telephone numbers and addresses connected with tropical cyclone warnings in the Panel countries**

A list containing addresses of the tropical cyclone warning centres of the Panel countries, together with their telephone numbers, is given in Annex V-A.

India Meteorological Department is hosting its own website [www.internal.imd.gov.in](http://www.internal.imd.gov.in) and [www.rsmcnewdelhi.imd.gov.in](http://www.rsmcnewdelhi.imd.gov.in) which also provides information pertaining to WX Charts, Forecasts, Warnings, Satellite Imageries, Hydrological and Seismological and other weather related topics are updated on regular basis.

Regional Meteorological Centres located at Delhi, Chennai, Nagpur, Kolkata, Guwahati and Mumbai are hosting their own websites.

**TABLE V-1  
ABBREVIATED HEADINGS FOR EXCHANGE OF  
TROPICAL CYCLONE WARNINGS FOR THE HIGH SEAS**

<u>Country</u>	<u>GTS Abbreviated Headings</u>	<u>Priority</u>
1. Bangladesh	WTBW20 VGDC	Highest
2. India	WTIN20 DEMS	Highest
3. Iran		
4. Maldives	WTMV20 VRMM	Highest
5. Myanmar	WTBM20 and WOBM20 VBRR	Highest
6. Oman (Sultanate of Oman)	WTOM20 and WSOM20 OOMS	Highest
7. Pakistan	WWPK20 OPKC	Highest
8. Qatar	FQQT20(with Pakistan Met Service)	Highest
9. Saudi Arabia		

10.	Sri Lanka	WTSB40 VCCC	Highest
11.	Thailand	WTTH20 VTBB	Highest
12.	United Arab Emirates		
13.	Yemen	WTYE20 OYSN	Highest

**TABLE V-2**  
**Communication headings for the exchange of radar observations**

	<u>Country</u>	<u>Abbreviated heading</u>
1.	Bangladesh	SDBW20 VGDC
2.	India	Since conventional radar has been replaced by DWR, there is no message communication on GTS.
3.	Iran	.
4.	Maldives	SDMV20 VRMM
5.	Myanmar	SDBM20 VBRR
6.	Oman	
7.	Pakistan	SDPK20 OPKC SDPK40 OPKC
8.	Qatar	
9.	Saudi Arabia	
10.	Sri Lanka	SDSB20 VCCC
11.	Thailand	SDTH20 VTBB
12.	United Arab Emirates	
13.	Yemen	

**TABLE V-3**

**GTS headings for the exchange of tropical weather outlook, tropical storm advisory and satellite bulletin**

<u>Country</u>	<u>Abbreviated heading</u>
	<u>Tropical weather outlook</u>
Bangladesh	WWBW20 VGDC,
India	WTIN20 DEMS
Pakistan	WWPK20 OPKC

<u>Tropical storm advisory</u>
BMAA01 VGDC
BMAA01 VBRR
BMAA01 OPKC
BMAA01 VCCC
BMAA01 VTBB
BMAA01 VRMM
BMAA01 OOMS
BMAA01 OYSN
BMAA01 OIII
BMAA01 OTBD
BMAA01 OEJD
BMAA01 OMAA

Satellite bulletins generated by RTH, New Delhi

TCIN20 DEMS (Sat bulletins based on INSAT pictures) - For International  
TCIN50 DEMS (Sat bulletins based on INSAT pictures)

TCIN51 DEMS (Intense precipitation advisory bulletins For National  
 ATIN50 DEMS (For all CDRs during cyclone period)

**TABLE V-4**

WMO headings for the exchange of Tropical Cyclone Advisories for aviation and SIGMETs

I. *TC Advisories*

	Country	Abbreviated heading	Area
1.	India	FKIN21 VIDP FKIN20 VIDP	Bay of Bengal Arabian Sea

II. *SIGMETs for tropical cyclones*

	Country	Abbreviated heading	Originating center
1.	Bangladesh	WCBWxx VGHS	Dhaka
2.	India	WCINxx VECC WCINxx VOMM WCINxx VABB	Kolkata Chennai Mumbai
3.	Iran	WSIR31	Tehran
4.	Maldives	WCMV31 VRMM	Malé
5.	Myanmar	WCBM31 VYYY	Yangon
6.	Oman (Sultanate of Oman)	WCOMxx OOMS	Muscat
7.	Pakistan	WCPKxx OPKC	Karachi
8.	Sri Lanka	WCSB31 VCCC	Colombo
9.	Thailand	WCTH31 VTBB	Bangkok
10.	Yemen	WCYE31OYSN	SANAA
10.	Iran	WSIR31	Tehran

**Notes:** Yemen

1. *TCAC New Delhi shall send the TC advisories to the MWOs through AFTN. In addition to the MWOs listed above, the advisories sent to all MWOs in the area of responsibility of TCAC New Delhi according to ICAO ASIA/PAC and MID Regions FASIDs.*
2. *TCAC New Delhi send the TC advisories to Singapore OPMET Data Bank – AFTN address WSSSYMYX.*
3. *The MWOs listed above sends their SIGMETs for tropical cyclones through AFTN to the MWOs responsible for the adjacent FIRs and to Singapore OPMET Data Bank – AFTN address WSSSYMYX.*

## ANNEX V-A-1

**LIST OF IMPORTANT ADDRESSES AND TELEPHONE NUMBERS CONNECTED  
WITH TROPICAL CYCLONE WARNINGS IN THE PANEL COUNTRIES**

<b>Country Name</b>	<b>Name of contact person</b>	<b>Contact details</b>
<b><u>Bangladesh</u></b>	Dr. Md. Shadekul Alam Director, BMD Bangladesh Meteorological Department Meteorological, E-24 Agargaon, Dhaka- 1207 Dhaka-1207	Phone: Off:(880) 2-41025705, (880) 2-41025726 Res: (880) 2-58152019 E-mail:info@bmd.gov.bd, shadekul@gmail.com FAX: 88 02 41025726, 41025873 Home page: <a href="http://www.bmd.gov.bd">http://www.bmd.gov.bd</a>
	Kawsar Parvin Deputy Director Storm Warning Centre Dhaka	Phone: Off: (880) 2-9114388 Res: (880) 2-9126806 Cell: 01743783969 Fax: (880) 2-58152019 <a href="mailto:swc@bmd.gov.bd">swc@bmd.gov.bd</a>
	Duty Forecasting Officer Storm Warning Centre Dhaka	Phone: (880) 2-9141437 (880) 2-9135742 (880) 2-9111015 (880) 2-9112439 Fax: (880) 2-58152019 <a href="mailto:swc@bmd.gov.bd">swc@bmd.gov.bd</a>
<b><u>India</u></b>	Dr. Mrutyunjay Mohapatra Director General of Meteorology India Meteorological Department (IMD) Mausam Bhavan, Lodi Road New Delhi-11003	Phone: Off: (91) 11-24611842 Res: (91) 11-24122236 Mob: (91) 8826354400 Fax (91) 11-24611792 F-mail: <a href="mailto:mohapatraimd@gmail.com">mohapatraimd@gmail.com</a> Home page: <a href="http://www.imd.gov.in">http://www.imd.gov.in</a>
<b><u>Iran</u></b>	Dr. Sahar Tajbakhsh Mosalman Deputy Minister of Roads and Urban Development President of the I.R. of Iran Meteorological Organisation and PR of Islamic Republic of Iran with WMO	Tel: +9821 660 700 38 Email: <a href="mailto:affairs.int@gmail.com">affairs.int@gmail.com</a>  FAX: +9821 660 700005
	Dr. Behzad Layeghi Head of the Deputy for Development, Forecasting and Crisis Management of Weather Hazards	<a href="tel:+989123692364">Tel:+989123692364</a> Email:layeghi2001@yahoo.com
	Dr. Martha Abbasi Head of the Marine Meteorology Strategic Group	<a href="tel:+989120754990">Tel:+989120754990</a> Email:marthaabbasi@yahoo.com
<b><u>Maldives</u></b>	Abdulla Wahid, Director General Meteorology  Mr. Ali Sareef Deputy Director General,	

	<p>Maldives Meteorological Service, Hulhule' 22000, Maldives.</p> <p>Duty Forecaster, National Meteorological Centre</p>	<p>Phone: Off: (960) 332 3084 332 3302 Mobile: (960) 7771828 Email: <a href="mailto:shareef@meteorology.gov.mv">shareef@meteorology.gov.mv</a></p> <p>Phone: Off: (960) 332 3084 Mobile: (960) 796 7171 Email: <a href="mailto:metmdv@gmail.com">metmdv@gmail.com</a></p>
<b><u>Myanmar</u></b>	Dr. Kyaw Moe Oo Director-General Department of Meteorology and Hydrology, Building No. 5, Ministry of Transport and Communications, Nay Pyi Taw	<p>Phone: Off: (95) 67 3411031 (95) 67 3411525 (95) 67 3411422 (95) 67 3411446</p> <p>(95) 67 3411527 Res: (95) 67 3403404 Fax: (95) 67 3411449 (95) 67 3411254 (95) 67 3411250 (95) 67 3411526</p> <p>Mobile: (95) 9 250954636 Email: <a href="mailto:dq.dmh1@gmail.com">dq.dmh1@gmail.com</a> <a href="mailto:dq.dmh@mptmail.net.mm">dq.dmh@mptmail.net.mm</a></p> <p>Web page: <a href="http://www.moezala.gov.mm">www.moezala.gov.mm</a> <a href="http://www.dmh.gov.mm">www.dmh.gov.mm</a> <a href="http://Whatsapp number: (95) 925094636">Whatsapp number: (95) 925094636</a></p>
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	Islamabad – 44000, Pakistan	
	Mr. Abdul Qayoom Bhutto Director Marine Meteorology – Tropical Cyclone Warning Centre (TCWC), Meteorological Complex, University Road, Karachi – 75270, Pakistan	Tel: + (92) 21-99261434, Cell: + (92) 333-7271894 Fax: + (92) 21-99261405, 99261407 Email: <a href="mailto:aq_1961@yahoo.com">aq_1961@yahoo.com</a> Website: <a href="http://www.pmd.gov.pk">http://www.pmd.gov.pk</a>
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	Mr Mohammad Al-Kubaisi Head of Forecasting and Analysis Section	Email: <a href="mailto:Mohammad.Alkubaisi@caa.gov.qa">Mohammad.Alkubaisi@caa.gov.qa</a>
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<b><u>Saudi Arabia</u></b>	Mr. Ayman S Ghulam, Ph D Vice President of Meteorological Affairs General Authority of Meteorology & Environmental Protection Kingdom of Saudi Arabia	Phone: 966 12 653 6000 FAX: 966 12 651 1424 Email: <a href="mailto:dms@pme.gov.sa">dms@pme.gov.sa</a>

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## C H A P T E R VI

### MONITORING AND QUALITY CONTROL OF DATA

#### **6.1 Monitoring of data**

It will be the responsibility of the National Meteorological Services to monitor the data, advisories and forecasts received by them in accordance with the specified arrangements. Each tropical cyclone warning centre will review from time to time the inflow of data to the centre and also the transmission to neighbouring services of the messages they are responsible for sending out.

To be sure of reception of important data in the case of cyclonic storm situations, cyclone warning centres of the Member countries will transmit addressed messages to RSMC tropical cyclones, New Delhi four times a day which will include important surface, upper-air and ships' observations.

The National Meteorological Services will inform RSMC tropical cyclones, New Delhi of any shortcomings in the flow of data (raw and processed) and also indicate any requirements over and above those already agreed upon for tropical cyclone warning purposes.

#### **6.2 Quality control**

National Meteorological Services will make extra efforts to make sure that all observational data passed on GTS, particularly during disturbed weather, have been checked for errors and that corrections are made if needed. They will impress upon their observing stations the need for accuracy of data, particularly in tropical cyclone situations and the difficulties that may be caused in the decision process by an incorrectly recorded or transmitted observation.

In case of doubt as to the correctness of any observation or part thereof, an addressed message will be sent to the national service and to RSMC tropical cyclones, New Delhi requesting confirmation.

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## C H A P T E R VII

### ARCHIVAL OF DATA

#### **7.1 Necessity for data archival**

In view of the development of computer facilities in the region, it is expected that the research efforts on tropical cyclones will substantially increase. In addition to dynamic modeling of tropical cyclones on the new generation computer being acquired by national authorities, it is expected that the synoptic oriented investigations and research as well as verification programmes will be undertaken in the region.

It is, therefore, necessary to create data sets as detailed and as complete as possible for all the future cyclones.

#### **7.2 Tropical cyclone data on landfall**

There is a dearth of information on actual conditions of tropical cyclones and an endeavor is therefore required to be made to utilize whatever information is obtained to the maximum extent possible. In particular, the Panel countries are interested in verifying forecast and estimated conditions against the actual. Panel countries will take appropriate steps to ensure that after a tropical cyclone makes a landfall all the available data pertaining to that tropical cyclone are collected and archived. Data on the actual condition of winds, storm surge, surface pressure and rainfall from stations near the point of landfall will be sent to RSMC tropical cyclones, New Delhi. If the landfall is in a country other than India, its meteorological service will send a brief summary of information to RSMC tropical cyclones, New Delhi for inclusion in the RSMC New Delhi tropical cyclone report. In the case of a tropical cyclone making a landfall on the coast of a country, which is not a member of the Panel, RSMC Tropical Cyclones, New Delhi will collect the information for inclusion in the RSMC, New Delhi tropical cyclones report.

#### **7.3 Role of RSMC-tropical cyclones, New Delhi in data archival**

For each tropical cyclone occurrence in the area, initially RSMC tropical cyclones New Delhi will compile the following data sets:

- (i) Daily synoptic charts covering the area  $45^{\circ}$  N to  $30^{\circ}$  S and  $30^{\circ}$  E to  $120^{\circ}$  E for the surface and upper-air charts for the levels 700, 500 and 200 hPa for 00 UTC and 12 UTC.
- (ii) All upper-air data from stations within 15 degrees of the tropical cyclone field.
- (iii) The tracks of tropical cyclones for the Panel regions prepared by the India Meteorological Department.
- (i) An e-Atlas on Cyclones and Depressions (C&D's) having many salient features as generation of Tracks, several types of C&D's statistics have been developed and also circulated to Panel Member countries for their use.
- (ii) The online version of e-Atlas is available at IMD Website at Cyclone Page under the URL: [www.rmcchennaieatlas.tn.nic.in](http://www.rmcchennaieatlas.tn.nic.in).
- (iii) All the annual reports on cyclonic disturbances are available for the period of 1990 onwards in the RSMC, New Delhi website.
- (iv) Bulletins of cyclonic storms since 2011 are available on RSMC website

For the purpose of making these archives the National Meteorological Services will supply New Delhi with relevant information requested by RSMC tropical cyclones, New Delhi. On request by a Panel country, the RSMC tropical cyclones, New Delhi will make arrangements to supply these data sets to the Panel Member concerned on a copying cost basis. In accordance with the directive of the WMO Executive Council (ECXLV), Geneva, July 1993) an international format for the archiving of tropical cyclone data is to be used by all RSMCs with activity specialization in tropical cyclones. The Tropical Cyclone Programme (TCP) office of the WMO Secretariat has the responsibility for the maintenance of the format, including assignment of the source codes to appropriate organizations, and authorizing additions and changes.

In the international format given below, the Dvorak T number (Position 3536) and Dvorak CI number (position 3738) will be the ones determined at the centre submitting the data, in the case of the Panel on Tropical Cyclones, by RSMC New Delhi.

Complete historic data in the format given in Annex VII-A will be made available for research applications. RSMC New Delhi will provide such data, to the Director of the National Climatic Data Centre (NCDC), USA in this format through WMO.

## ANNEX VII-A-1

**GLOBAL TROPICAL CYCLONE TRACK AND INTENSITY DATA SET REPORT FORMAT****Position Content**

1-9

Cyclone identification code composed by 2 digit numbers in order within the cyclone season, area code and year code. 01 SWI2000 shows the 1st system observed in Southwest Indian Ocean basin during the 2000/2001 season. Area codes are as follows:

ARB = Arabian Sea

ATL = Atlantic Ocean

AUB = Australian Region (Brisbane)

AUD = Australian Region (Darwin)

AUP = Australian Region (Perth)

BOB = Bay of Bengal

CNP = Central North Pacific Ocean

ENP = Eastern North Pacific Ocean

ZEA = New Zealand Region

SWI = Southwest Indian Ocean

SWP = Southwest Pacific Ocean

WNP = Western North Pacific Ocean and South China Sea

10-19 Storm Name

20-23 Year

24-25 Month (0112)

26-27 Day (0131)

28-29 Hour-universal times (at least every 6 hourly position 00Z, 06Z, 12Z and 18Z)

30 Latitude indicator:

1 =North latitude;

2=South latitude

31-33 Latitude (degrees and tenths)

34-35 Check sum (sum of all digits in the latitude)

36 Longitude indicator:

1 =West longitude;

2=East longitude

37-40 Longitude (degrees and tenths)

41-42 Check sum (sum of all digits in the longitude)

43 position confidence\*

1 = good (&lt;30nm; &lt;55km)

2 = fair (3060nm; 55-110km)

3 = poor (&gt;60nm; &gt;110km)

9 = unknown

Note\* Confidence in the center position: Degree of confidence in the center position of a tropical cyclone expressed as the radius of the smallest circle within which the center may be located by the analysis. "position good" implies a radius of less than 30 nm, 55 km; "position fair", a radius of 30 to 60 nm, 55 to 110km; and "position poor", radius of greater than 60 nm, 110km.

44-45 Dvorak T number (99 for no report)

46-47 Dvorak CI number (99 for no report)

48-50 Maximum average wind speed (whole values) (999 for no report).

51 Units 1 =kt, 2=m/s, 3=km per hour.

52-53 Time interval for averaging wind speed (minutes for measured or derived wind speed, 99 if unknown or estimated).

54-56 Maximum Wind Gust (999 for no report)

57 Gust Period (seconds, 9 for unknown)

58 Quality code for wind reports:

1 =Aircraft or Dropsonde observation

2=Over water observation (e.g. buoy)

	3=Over land observation
	4=Dvorak estimate
	5=Other
59-62	Central pressure (nearest hectoPascal) (9999 if unknown or unavailable)
63	Quality code for pressure report (same code as for winds)
64	Units of length: 1 =nm, 2=km
65-67	Radius of maximum winds (999 for no report)
68	Quality code for RMW:
	1 =Aircraft observation
	2=Radar with well defined eye
	3=Satellite with well defined eye
	4=Radar or satellite, poorly defined eye
	5=Other estimate
69-71	Threshold value for wind speed (gale force preferred, 999 for no report)
72-75	Radius in Sector 1: 315 45
76-79	Radius in Sector 2: 45 135
80-83	Radius in Sector 3: 135 225
84-87	Radius in Sector 4: 225 315
88	Quality code for wind threshold
	1=Aircraft observations
	2=Surface observations
	3=Estimate from outer closed isobar
	4=Other estimate
89-91	Second threshold value for wind speed (999 for no report)
92-95	Radius in Sector 1: 315 45
96-99	Radius in Sector 2: 45 135
100-103	Radius in Sector 3: 135 225
104-107	Radius in Sector 4: 225 315
108	Quality code for wind threshold (code as for row 88)
109-10	Cyclone type:
	01 = tropics; disturbance ( no closed isobars)
	02= <34 knot winds, <17m/s winds and at least one closed isobar
	03= 34-63 knots, 17 32m/s
	04= >63 knots, >32m/s
	05= extra tropical
	06= dissipating
	07= subtropical cyclone (non frontal, low pressure system that comprises I initially baroclinic circulation developing over subtropical water)
	08= overland
	09= unknown
111-112	Source code (2digit code to represent the country or organization that provided the data to NCDC USA.
	WMO Secretariat is authorized to assign number to additional participating centers, organizations)
01	RSMC Miami Hurricane Center
02	RSMC Tokyo Typhoon Center
03	RSMC Tropical Cyclones New Delhi
04	RSMC La Reunion Tropical Cyclone Centre
05	Australian Bureau of Meteorology
06	Meteorological Service of New Zealand Ltd.
07	RSMC Nandi Tropical Cyclone Centre
08**	Joint Typhoon Warning Center, Honolulu
09**	Madagascar Meteorological Service
10 **	Mauritius Meteorological Service
11 **	Meteorological Service, New Caledonia
12	Central Pacific Hurricane Center, Honolulu

Note\*\*: no longer used

Headings 1-19 Cyclone identification code and name;  
20-29 Date time group;  
30-43 Best track positions;  
44-110 Intensity, Size and Type;  
111-112 Source code.