W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N
T E C H N I C A L D O C U M E N T

WMO/TD No. 84

TROPICAL CYCLONE
PROGRAMME
Report No. TCP-21

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

Edition 2023

SECRETARIAT OF THE WORLD METEOROLOGICAL ORGANIZATION
GENEVA SWITZERLAND

Chair, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix — Tel.: +41 (0) 22 730 84 03
P.O. Box 2300 — Fax: +41 (0) 22 730 80 40
CH-1211 Geneva 2, Switzerland — E-mail: publications@wmo.int

NOTE

The designations employed in WMO publications and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of WMO concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The mention of specific companies or products does not imply that they are endorsed or recommended by WMO in preference to others of a similar nature which are not mentioned or advertised.

The findings, interpretations and conclusions expressed in WMO publications with named authors are those of the authors alone and do not necessarily reflect those of WMO or its Members.

This publication has been issued without formal editing.

CONTENTS

CONTENTS

_____

C H A P T E R 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 ≥64 knots.

Low or low pressure area: An area enclosed by 1 closed isobar within 5^0 laltitude and longitude with minimum pressure inside and the associated maximum sustained wind speed is less than 17 knots (31 km/h).

Maximum sustained wind: **A**verage 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^{+}: 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# 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 5^0 laltitude & 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.

_____

+ 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 (WWMIWS), 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:

	Weather system	Maximum wind speed
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	Nisarga	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	Burevi	Burevi	Midhili	Midhili	Kaani	Kaani	Odi	Odi
Myanmar	Tauktae	Tau'Te	Michaung	Migjaum	Ngamann	Ngaman	Kyarthit	Kjathi
Oman	Yaas	Yass	Remal	Re-Mal	Sail	Sail	Naseem	Naseem
Pakistan	Gulab	Gul-Aab	Asna	As-Na	Sahab	Sa-Hab	Afshan	Af-Shan
Qatar	Shaheen	Shaheen	Dana	Dana	Lulu	Lulu	Mouj	Mouj
Saudi Arabia	Jawad	Jowad	Fengal	Feinjal	Ghazeer	Razeer	Asif	Aasif
Sri Lanka	Asani	Asani	Shakhti	Shakhti	Gigum	Gigum	Gagana	Gagana
Thailand	Sitrang	Si-Trang	Montha	Mon-Tha	Thianyot	Thian-Yot	Bulan	Bu-Lan
United Arab Emirates	Mandous	Man-Dous	Senyar	Sen-Yaar	Afoor	Aa-Foor	Nahhaam	Nah-Haam
Yemen	Mocha	Mokha	Ditwah	Ditwah	Diksam	Diksam	Sira	Sira

(contd.)

WMO/ESCAP Panel Member countries	Column 5		Column 6		Column 7		Column 8	
	Name	Pron'	Name	Pron'	Name	Pron'	Name	Pron'
Bangladesh	Barshon	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	Sapakyee	Zabagji	Wetwun	We'wum	Mwaihout	Mwei'hau	Kywe	Kjwe
Oman	Muzn	Muzn	Sadeem	Sadeem	Dima	Dima	Manjour	Manjour
Pakistan	Manahil	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	Verambha	Ve-Ram-Bha	Garjana	Garjana	Neeba	Neeba	Ninnada	Nin-Na-Da
Thailand	Phutala	Phu-Ta-La	Aiyara	Ai-Ya-Ra	Saming	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	Meghala	Meghla	Samiron	Somiron	Pratikul	Protikul	Sarobor	Soroboi	Mahanish	Mohanisha
India	Prabhanjan	Prabhanjan	Ghurni	Ghurni	Ambud	Ambud	Jaladhi	Jaladhi	Vega	Vega
Iran	Arsham	Arsham	Hengame	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	Ra Bab	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	Nakheel	Haboob	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	Athmad	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 2023 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 22nd April, 2018. The impact expected over the area of cyclogenesis was introduced from 07th 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%) alongwith 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 27th April 2023 is presented below.

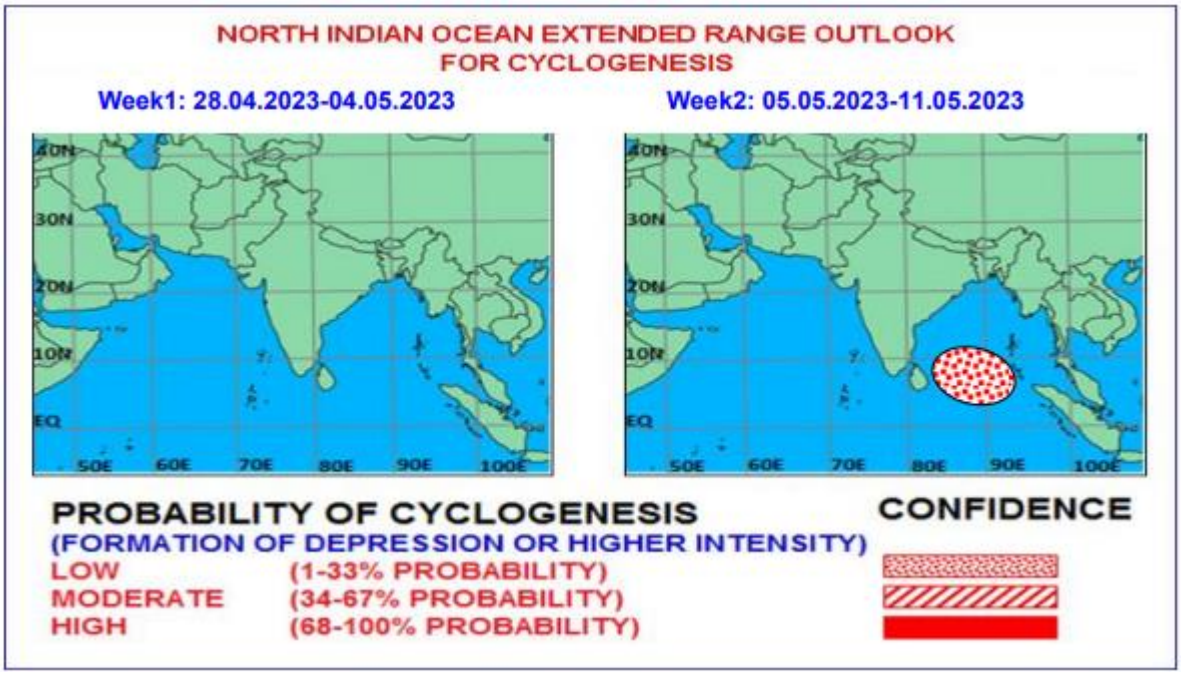


Fig.2.4.1 (a): Graphical Cyclogenesis over north Indian Ocean during next two weeks

I. Environmental features:

The Madden Julian Oscillation (MJO) Index is currently in Phase 1 with amplitude between 1 and 2. According to the dynamical forecasts by the model, the MJO will change the phase immediately at the start of week 1 and enter in phase 2. Thereafter, it will move across phases 2, 3 and 4 during later part of week 1, start of week 2 respectively with amplitude less than 1. During the later part of week 2 the MJO will be in phase 5. Hence, MJO will support enhancement of convective activity over the North Indian Ocean (NIO) during week 1 onwards but the genesis of cyclonic disturbances (CDs) is more favored during week 2. In the forecast, the amplitude of MJO in phase 3 and 4 is very close to 1 and not very much ideal for the enhanced intensification of CDs.

During first half week 1, easterly winds (1-3 mps) over Bay of Bengal (BoB) and East Equatorial Indian Ocean (EIO) whereas the very weak westerly is likely over central Arabian Sea (AS) and adjoining areas. The wind scenario is very likely to change during the later half of week 1 and weak (1-3 mps) westerly wind is likely to dominate over whole NIO.

The Kelvin waves are likely to become prominent over southern part of BoB & adjoining equatorial Indian Ocea and over north AS during week 1 with gradual propagation towards east. As the Kelvin waves is likely disappear over the region during week 2, the Equatorial Rossby Waves (ERW) is likely to appear over adjoining south Bay of Bengal (BoB) and adjoining East EIO. Considering collectively during week

1, zonal winds and all modes including MJO will support enhanced convection but chance of contribution towards any cyclogenesis over the region is less due to strong zonal shear. However, during first half of week 2, westerly winds, Equatorial Rossby Waves (ERW) and MJO have a possibility to overlap over south BoB and adjoining areas.

II. Model Guidance:

Various models including IMD GFS, NCUM, ECMWF, ECMM, NEPS and GEFS are not indicating any cyclogenesis over the region during next 7-10 days. Whereas NCEP-GFS and IMD GPP forecasts are indicating the formation of low pressure area during 2nd half of week 1 over southwest BoB and adjoining areas near Sri Lanka and Tamil Nadu coast.

IMD's Coupled Forecast System Version 2 (IMD CFS V2) indicating enhanced convection over south BoB during later part of week 1 but with no probability for cyclogenesis during week 1
and 2. Extended range forecast of ECMWF for tropical cyclone activity NIO region indicated very low (less than 20 %) probability of tropical storm over central and adjoining north BoB during 2nd half of week 2. The global tropics hazard outlook of CPC of NWS indicated probability of tropical cyclone hazard is more than 40% over south BoB during week 2.

(Legends: IMD GFS: India Meteorological Department Global Forecast System, NCUM: National Centre for Medium Range Weather Forecasting Centre Unified Model, European Centre for Medium Range Weather Forecasting, GPP: Genesis Potential Parameter, National Centre for Environment Prediction GFS, ECMM: ECMWF multi model, GEFS: GFS ensemble, NEPS: NCUM ensemble prediction system, CNCUM: Coupled NCUM, CPC: Climate Prediction Center, NWS: National Weather Service)

III. Inference:

Considering the environmental features and model guidance, it is inferred that no cyclogenesis (formation of depression) is likely over the North Indian Ocean region during week 1. There is likely low probability of cyclogenesis over south BoB and adjoining areas during week 2. Graphically shown in Fig. 1.

IV. Verification of forecast issued during last two weeks:

The forecast issued on 13th April, 2023 for week 2 (21.04.2023– 27.04.2023) indicated no cyclogenesis over the NIO region. The forecast issued on 20th April, 2023 for week 1 (21.04.2023– 27.04.2023) indicated no cyclogenesis over the NIO region. Thus, nil cyclogenesis was correctly predicted in two weeks forecast.

The realized rainfall during 21st April, 2023 – 26th April, 2023 from satellite-gauge merged data is presented in Fig.2.4.1 (b)

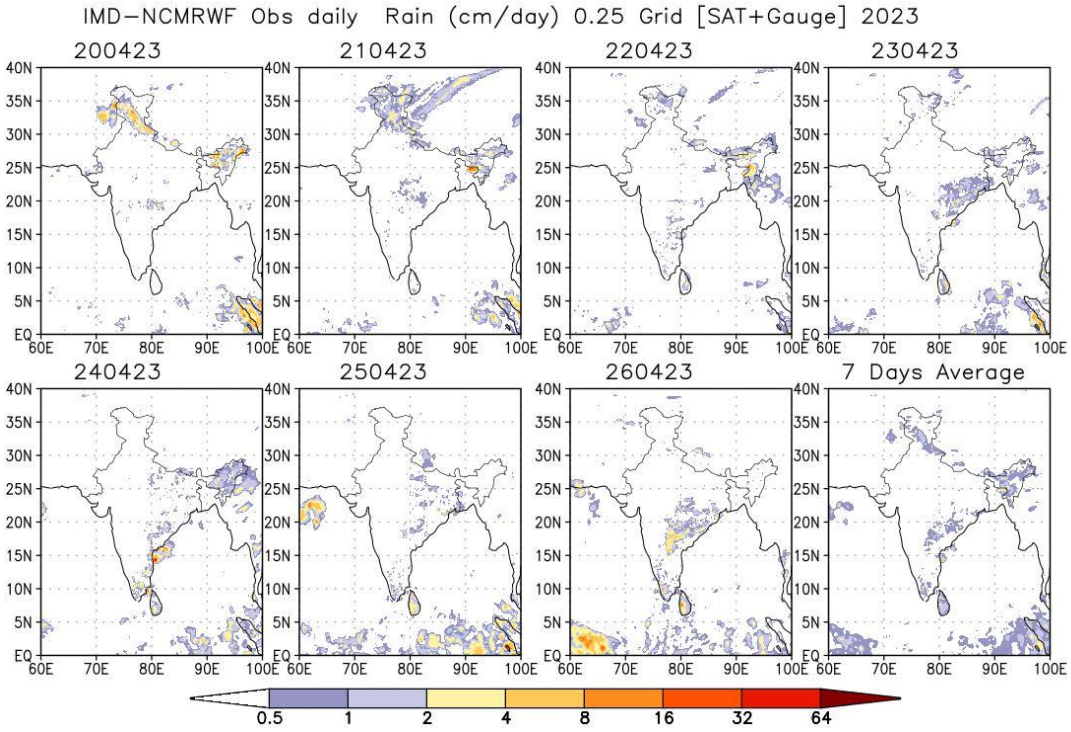


Fig.2.4.1 (b): Rain gauge and satellite merged rainfall plots during 20th – 26th April, 2023

Example 2: Extended Range Outlook issued on 4th May 2023 is presented below.

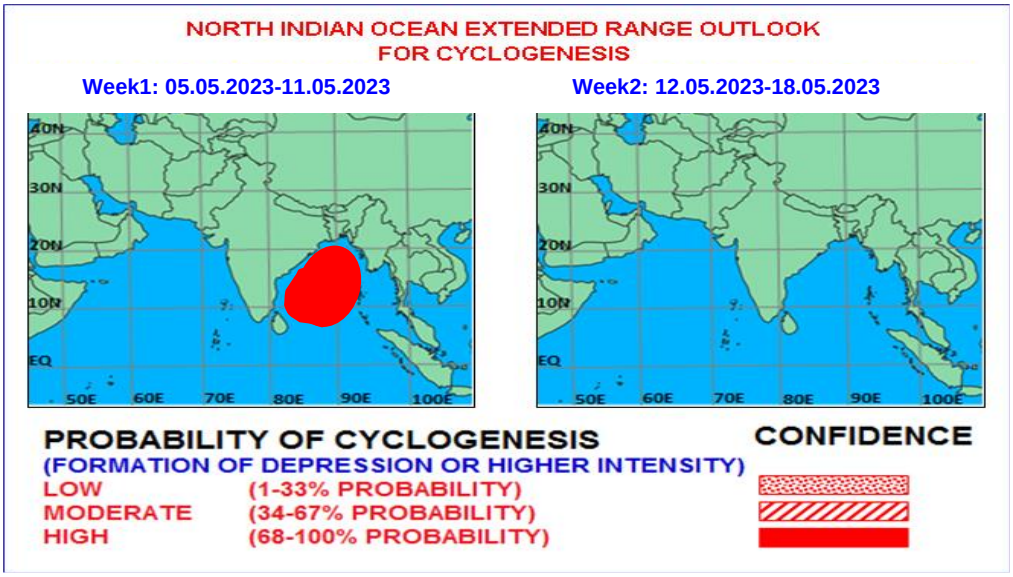


Fig. 2.4.1 :(c) Extended Range Outlook graphics indicating probability of cyclogenesis issued on 4th May 2023

I. Environmental features:

The Madden Julian Oscillation (MJO) Index is currently in Phase 5 with amplitude around 2. It would continue in same phase with increased amplitude during most part of week 1. Thereafter, it would move

eastwards and enter into phase 6. Hence, MJO will support enhancement of convective activity over the North Indian Ocean (NIO) during week 1. Easterly winds (1-3 mps) are likely to prevail over south Andaman Sea and south bay of Bengal (BoB) in the lower tropospheric levels during next 2 days. Thereafter, the westerly winds are

likely to prevail over the south BoB and south Andaman Sea with easterly winds over central & north BoB from 8th May onwards. Thus, the equatorial waves and MJO are likely to collectively contribute towards enhancement of convective activity and hence cyclogenesis over south BoB around 8th May onwards.

II. Model Guidance:

Various models including IMD GFS, NCUM, ECMWF, ECMM, NEPS and GEFS are indicating cyclogenesis over southeast BoB during middle of week 1 (around 8th May). All the models are indicating intensification of this system into a severe category storm. However, there is large variation among various models wrt the track of the system. GFS group of models and ECMWF are indicating northwestwards initially and then northwestwards movement towards Bangladesh and adjoining Myanmar coasts. However, NCUM group of models are indicating northwestwards movement of the system towards Tamil Nadu coast and re-emergence into the southeast & adjoining eastcentral Arabian Sea.

IMD's Coupled Forecast System Version 2 (IMD CFS V2) and NCMRWF coupled CNCUM are indicating potential zone for cyclogenesis during later half of week 1 over southeast BoB and first half of week 2 over central and adjoining northeast BoB. Extended range forecast of ECMWF for tropical cyclone activity NIO region also indicate likely cyclogenesis over south BoB during later part of week 1 (30-60% probability). Most of the ensemble members are indicating initial northwestwards movement followed by northeastwards recurvature towards Bangladesh-Myanmar coasts.

(Legends: IMD GFS: India Meteorological Department Global Forecast System, NCUM: National Centre for Medium Range Weather Forecasting Centre Unified Model, European Centre for Medium Range Weather Forecasting, GPP: Genesis Potential Parameter, National Centre for Environment Prediction GFS, ECMM: ECMWF multi model, GEFS: GFS ensemble, NEPS: NCUM ensemble prediction system, CNCUM: Coupled NCUM, CPC: Climate Prediction Center, NWS: National Weather Service)

III. Climatological Guidance

Fig. 2.4.2 (a) shows that during 1965-2020, about 214 cyclonic storms developed over the Bay of Bengal. May is the peak month wrt cyclonic activity during pre-monsoon season (March-May). Fig, 2.4.2 (b) shows the frequency of landfalling cyclones over various coastal states during 1965-2020. It shows that during pre-monsoon season, the frequency of landfalling cyclones is highest over Bangladesh followed by Myanmar, West Bengal, Odisha, Andhra Pradesh and Tamil Nadu.

(a)

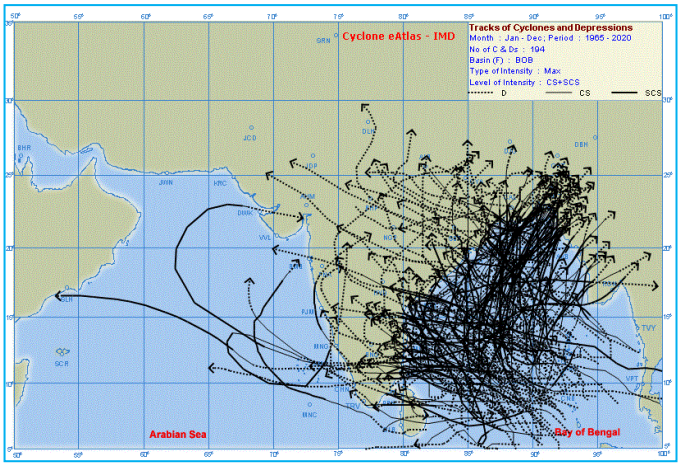


Fig.2.4.2: (a) Tracks of cyclonic storms over Bay of Bengal during 1961-2022

(b)

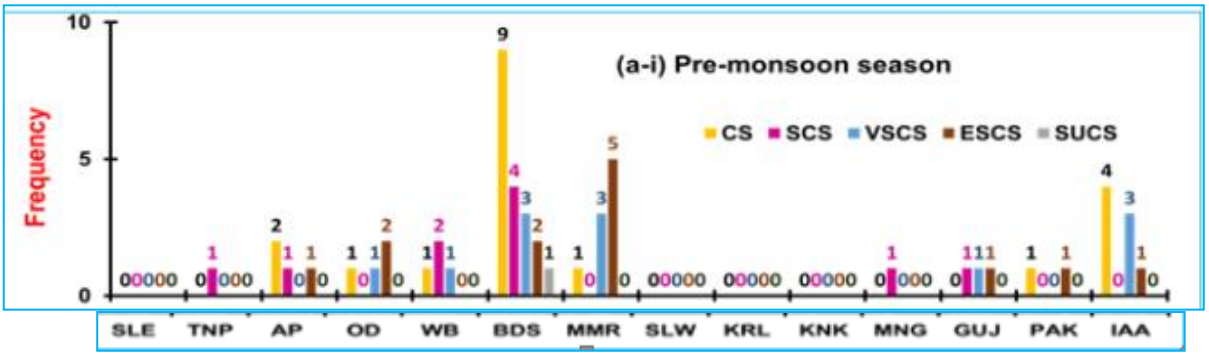


Fig.2.4.2: (b) Frequency of landfalling cyclones over various coastal states during 1965-2020

SLE: Sri Lanka East, TNP: Tamilnadu and Puducherry, AP: Andhra Pradesh, OD: Odisha, WB: West Bengal, BDS: Bangladesh, MMR: Myanmar, SLW: Sri Lanka West, KRL: Kerala, KNK: Karnataka, MNG: Maharashtra and Goa, GUJ: Gujarat, PAK: Pakistan, IAA: Iran, Arabia and Africa

Inference:

Considering all the above, there is high probability of cyclogenesis (formation of depression) over the Bay of Bengal region during later part of week 1 (Fig. 1).

IV. Verification of forecast issued during last two weeks:

The forecast issued on 21st April, 2023 for week 2 (28.04.2023– 04.05.2023) and 27th April, 2023 for week 1 (28.04.2023– 04.05.2023) indicated no cyclogenesis over the NIO region. Thus, nil cyclogenesis was correctly predicted in two weeks forecast.

The realized rainfall during 27th April, 2023 – 4th May, 2023 from satellite-gauge merged data is presented in Fig.2.4.3

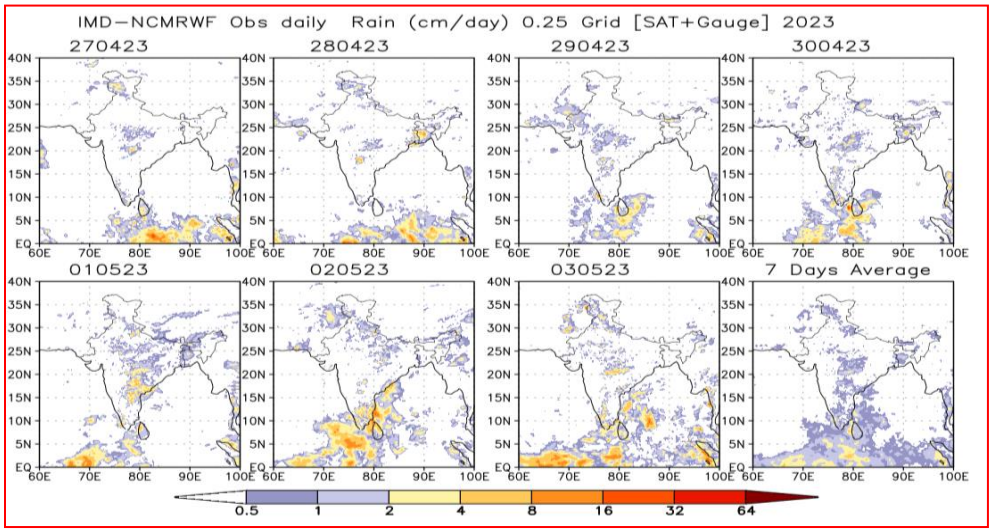


Fig.2.4.3: Rain gauge and satellite merged rainfall plots during 27th April– 4th May, 2023

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)

DEMS-RSMC TROPICAL CYCLONES NEW DELHI DATED 06.05.2023

TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND THE ARABIAN SEA) VALID FOR NEXT 120 HOURS ISSUED AT 0700 UTC OF 06.05.2023 BASED ON 0300 UTC OF 06.05.2023.

BAY OF BENGAL:

A CYCLONIC CIRCULATION HAS FORMED AND LAY OVER SOUTHEAST BAY OF BENGAL (BOB) AND NEIGHBOURHOOD EXTENDING UPTO MIDDLE TROPOSPHERIC LEVEL AT 0300 UTC OF TODAY THE 6TH MAY, 2023.

UNDER ITS INFLUENCE A LOW PRESSURE AREA IS LIKELY TO FORM OVER THE SAME REGION BY 8TH MAY, MORNING. IT IS LIKELY TO CONCENTRATE INTO A DEPRESSION OVER SOUTHEAST BOB AROUND 9TH MAY. THEREAFTER, IT IS LIKELY TO INTENSIFY INTO A CYCLONIC STORM WHILE MOVING NEARLY NORTHWARDS TOWARDS CENTRAL BOB. THE DETAILS OF ITS PATH AND INTENSIFICATION WILL BE PROVIDED AFTER THE FORMATION OF THE LOW PRESSURE AREA. THE SYSTEM IS UNDER CONSTANT WATCH AND BEING MONITORED REGULARLY.

SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH BAY OF BENGAL. SCATTERED LOW AND MEDIUM

CLOUDS WITH EMBEDDED MODERATE TO INTENSE CONVECTION LAY OVER WESTCENTRAL BAY OF BENGAL & SOUTH ANDAMAN SEA AND WEAK TO MODERATE CONVECTION LAY OVER NORTH & EASTCENTRAL BAY OF BENGAL AND NORTH ANDAMAN SEA.

PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 120 HRS:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
NIL	NIL	LOW	HIGH	HIGH

ARABIAN SEA:

SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER EXTREAM SOUTHWEST ARABIAN SEA AND ADJOINING SOMALIA COAST. SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED MODERATE TO INTENSE CONVECTION LAY OVER REST SOUTH ARABIAN SEA & COMORIN AREA AND ISOLATED WEAK TO MODERATE CONVECTION LAY OVER CENTRAL ARABIAN SEA.

PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 120 HRS:

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

REMARKS:

THE MADDEN JULIAN INDEX (MJO) CURRENTLY LIES IN PHASE 5 WITH AMPLITUDE MORE THAN 1. IT WILL CONTIBUE IN SAME PHASE DURING NEXT 4 DAYS. THUS, MJO PHASE IS HIGHLY CONDUCIVE FOR ENHANCED CONVECTION OVER THE BAY OF BENGAL (BOB) DURING NEXT 4-5 DAYS. EASTERLY WINDS (1-3 MPS) ARE LIKELY TO PREVAIL OVER SOUTH ANDAMAN SEA AND SOUTH BOB IN THE LOWER TROPOSPHERIC LEVELS DURING NEXT 2 DAYS. THEREAFTER, THE WESTERLY WINDS ARE LIKELY TO PREVAIL OVER THE SOUTH BOB AND SOUTH ANDAMAN SEA WITH EASTERLY WINDS OVER CENTRAL & NORTH BOB FROM 8^{TH} MAY ONWARDS. THUS, THE EQUATORIAL WAVES AND MJO ARE LIKELY TO COLLECTIVELY CONTRIBUTE TOWARDS ENHANCEMENT OF CONVECTIVE ACTIVITY AND HENCE CYCLOGENESIS OVER SOUTH BOB AROUND 9^{TH} MAY ONWARDS.

THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM^2 OVER MAJOR PARTS OF SOUTH ANDAMAN SEA & ADJOINING SOUTHEAST BOB AND CENTRAL BOB. IT IS INDICATING DECREASING TENDENCY ABOUT 60-70 KJ/CM^2 ALONG THE EAST COAST OF INDIA & ALONG MYANMAR COAST. SEA SURFACE TEMPERATURE (SST) IS AROUND 30-32°C OVER ENTIRE BOB. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR CYCLOGENESIS.

CONSIDERING THE ENVIRONMENTAL CONDITIONS, LOW LEVEL VORTICITY IS ABOUT $50\text{-}60x10^{-6}S^{-1}$ OVER SOUTHEAST BAY OF BENGAL WITH VERTICAL EXTENSION UPTO 500 HPA LEVELS. LOW LEVEL CONVERGENCE IS $20x10^{-5}S^{-1}$ OVER SOUTHEAST BOB AND UPPER LEVEL DIVERGENCE IS $20\text{-}30x10^{-5}S^{-1}$ OVER SOUTH BOB. THE UPPER TROPOSPHERIC RIDGE AT 200 HPA IS LOCATED NEAR 18.5N.

CONSIDERING THE MODEL GUIDANCE, THERE IS LARGE VARIATION AMONG VARIOUS MODELS WRT TIME OF GENESIS WITH IMD GFS INDICATING DEPRESSION AROUND 8^{TH}, NCEP GFS ON 9^{TH} & ECMWF ON 10^{TH}. THESE MODELS ARE INDICATING INTENSIFICATION OF THIS SYSTEM INTO A SEVERE CYCLONIC STORM. WRT TRACK, THERE IS LARGE VARIATION AMONG THESE MODELS WITH LANDFALL POINT VARYING FROM SOUTH TO NORTHEAST MYANMAR BETWEEN 13^{TH}-14^{TH} MAY. NCUM IS GIVING ABSOLUTELY DIFFERENT GUIDANCE. IT IS INDICATING NO SIGNIFICANT INTENSIFICATION OF THE SYSTEM AND WEST-NORTHWESTWARDS MOVEMENT TOWARDS TAMILNADU COAST & EMERGENCE INTO

SOUTHEAST ARABIAN SEA. CURRENT INFERENCE IS BASED ON SYNOPTIC ANALYSIS, ENVIRONMENTAL FEATURES AND GUIDANCE FROM GFS GROUP OF MODELS & ECMWF MODEL.

HENCE TO CONCLUDE, A LOW PRESSURE AREA IS LIKELY TO FORM OVER THE SOUTHEAST BAY OF BENGAL BY 8TH MAY, MORNING. IT IS LIKELY TO CONCENTRATE INTO A DEPRESSION OVER THE SAME REGION AROUND 9TH MAY. THEREAFTER, IT IS LIKELY TO INTENSIFY INTO A CYCLONIC STORM WHILE MOVING NEARLY NORTHWARDS TOWARDS CENTRAL BOB. THE DETAILS OF ITS PATH AND INTENSIFICATION WILL BE PROVIDED AFTER THE FORMATION OF THE LOW PRESSURE AREA. THE SYSTEM IS UNDER CONSTANT WATCH AND BEING MONITORED REGULARLY. HIGH PROBABILITY HAS BEEN ASSIGNED TO GENESIS (FORMATION OF DEPRESSION) OVER SOUTHEAST BAY OF BENGAL ON DAY 4 & 5 DURING 9TH-11TH MAY, 2023. THE SYSTEM IS UNDER CONSTANT SURVEILLANCE AND BEING MONITORED CONTINUOUSLY. THE DETAILS OF ITS PATH AND INTENSIFICATION WILL BE PROVIDED AFTER THE FORMATION OF LOW PRESSURE AREA.

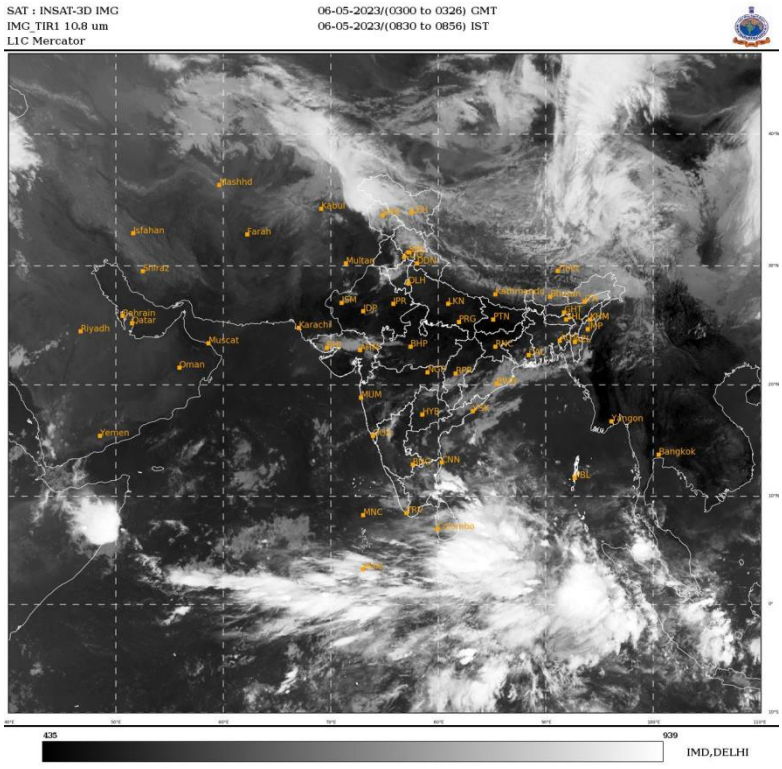


Fig. 2.4.4: Typical Satellite imagery based on 0300 UTC of 06th May, 2023

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 08.05.2023

TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND THE ARABIAN SEA) VALID FOR NEXT 120 HOURS ISSUED AT 0700 UTC OF 08.05.2023 BASED ON 0300 UTC OF 08.05.2023.

BAY OF BENGAL:

SUB: LOW PRESSURE AREA OVER SOUTHEAST BAY OF BENGAL & ADJOINING SOUTH ANDAMAN SEA

YESTERDAY'S CYCLONIC CIRCULATION OVER SOUTHEAST BAY OF BENGAL & ADJOINING SOUTH ANDAMAN SEA LAY AS A LOW PRESSURE AREA FORMED OVER SOUTHEAST BAY OF BENGAL AND ADJOINING SOUTH ANDAMAN SEA AT 0300 UTC OF TODAY, THE 8TH MAY 2023. IT IS LIKELY TO INTENSIFY INTO A DEPRESSION ON 9TH MAY OVER THE SAME REGION AND FURTHER INTO A CYCLONIC STORM OVER SOUTHEAST BAY OF BENGAL AND ADJOINING AREAS OF EAST CENTRAL BAY OF BENGAL AND ANDAMAN SEA ON 10TH MAY. IT IS LIKELY TO MOVE INITIALLY NORTH-NORTHWESTWARDS TOWARDS EASTCENTRAL BAY OF BENGAL TILL 11TH MAY. THEREAFTER, IT IS LIKELY TO RECURVE GRADUALLY AND MOVE NORTH-NORTHEASTWARDS TOWARDS BANGLADESH-MYANMAR COASTS.

LATEST SATELLITE IMAGERY INDICATES A LOW LEVEL CIRCULATION CENTRE OVER SOUTHEAST BAY OF BENGAL AND ADJOINING SOUTH ANDAMAN SEA. SCATTERED TO BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH BAY OF BENGAL AND SOUTH ANDAMAN SEA. SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED MODERATE TO INTENSE CONVECTION LAY OVER NORTH ANDAMAN SEA AND ISOLATED WEAK TO MODERATE CONVECTION LAY OVER NORTH AND CENTRAL BAY OF BENGAL. STRONG WINDS ARE SEEN IN THE EASTERN SECTOR AND SOUTHERN SECTOR. STRONGER WINDS IN THE SOUTHEREN SECTOR INDICATE INCREASED CROSS EQUATORIAL FLOW, WHICH WILL ALSO FAVOUR CYCLOGENESIS BY INCREASING VORTICITY AND CONVERGENCE OVER THE REGION. THESE FEATURES INDICATE LIKELY STRENGTHENING OF SYSTEM.

CONSIDERING THE SURFACE OBSERVATIONS, ASSOCIATED MAXIMUM SUSTAINED WIND SPEED IS 10-15 KTS. THE ESTIMATED CENTRAL PRESSURE OVER THE SYSTEM AREA IS 1006 HPA. THERE IS A FALLING TENDENCY OF MEAN SEA LEVEL PRESSURE OVER ANDAMAN & NICOBAR ISLANDS (1-2 HPA BELOW NORMAL).

PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 120 HRS:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
LOW	HIGH	HIGH	HIGH	HIGH

ARABIAN SEA:

SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER COMORIN AREA. SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED ISOLATED WEAK TO MODERATE CONVECTION LAY OVER CENTRAL & SOUTHEAST ARABIAN SEA & LAKSHADWEEP ISLAND AREAS.

PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 120 HRS:

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

REMARKS:

THE MADDEN JULIAN INDEX (MJO) CURRENTLY LIES IN PHASE 5 WITH AMPLITUDE MORE THAN 1. IT WILL CONTIBUE IN SAME PHASE DURING NEXT 3 DAYS. THUS, MJO PHASE IS HIGHLY CONDUCIVE FOR ENHANCED CONVECTION OVER THE BAY OF BENGAL (BOB) DURING NEXT 3-4 DAYS. EASTERLY WINDS (1-3 MPS) ARE LIKELY TO PREVAIL OVER SOUTH ANDAMAN SEA AND SOUTH BOB IN THE LOWER TROPOSPHERIC LEVELS ON 8^{TH}. THEREAFTER, THE WESTERLY WINDS ARE LIKELY TO PREVAIL OVER THE SOUTH BOB AND SOUTH ANDAMAN SEA WITH EASTERLY WINDS OVER CENTRAL & NORTH BOB FROM 9^{TH} MAY ONWARDS. THUS, THE EQUATORIAL WAVES AND MJO ARE LIKELY TO COLLECTIVELY CONTRIBUTE TOWARDS ENHANCEMENT OF CONVECTIVE ACTIVITY AND HENCE CYCLOGENESIS OVER SOUTH BOB AROUND 9^{TH} MAY ONWARDS.

THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM^2 OVER MAJOR PARTS OF SOUTH ANDAMAN SEA & ADJOINING SOUTHEAST BOB AND CENTRAL BOB. IT IS INDICATING DECREASING TENDENCY ABOUT 60-70 KJ/CM^2 ALONG THE EAST COAST OF INDIA & ALONG MYANMAR COAST. SEA SURFACE TEMPERATURE (SST) IS AROUND 30-32°C OVER ENTIRE BOB. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR CYCLOGENESIS.

CONSIDERING THE ENVIRONMENTAL CONDITIONS, THE LOW LEVEL VORTICITY AT 850 HPA HAS ORGANISED AND INCREASED TO $100x10^{-6}S^{-1}$ OVER SOUTH ANDAMAN SEA WITH VERTICAL EXTENSION UPTO 500 HPA LEVEL. LOW LEVEL CONVERGENCE HAS ORGANISED AND INCREASED FURTHER DURING PAST 24 HOURS AND IS AROUND 30 $x10^{-5}$ S^{-1} OVER SOUTH ANDAMAN SEA. UPPER LEVEL DIVERGENCE IS $20x10^{-5}S^{-1}$ OVER SOUTH ANDAMAN SEA AND ADJOINING SOUTHEAST BOB. EQUATORWARD OUTFLOW IS SEEN IN UPPER LEVELS. THE SEA

CONDITIONS AND ENVIRONMENTAL FEATURES INDICATE FAVOURABLE ENVIRONMENT FOR CYCLOGENESIS OVER THE REGION. THE UPPER TROPOSPHERIC RIDGE AT 500 HPA IS LOCATED NEAR 15.0N. THE RIDGE LOCATION INDICATES THAT THE SYSTEM WOULD MOVE INITIALLY NORTH-NORTHWESTWARDS AND THEN RECURVE GRADUALLY NORTH-NORTHEASTWARDS.

CONSIDERING THE MODEL GUIDANCE, IMD GFS IS INDICATING DEPRESSION ON 9^{TH} OVER SOUTHEAST & ADJOINING SOUTH ANDAMAN SEA WITH INTENSIFICATION INTO CYCLONIC STORM (CS) ON 10^{TH}. PEAK INTENSIFICATION IS INDICATED UPTO VERY SEVERE CYCLONIC STORM (VSCS) STAGE. IT IS INDICATING INITIAL NORTH-NORTHWESTWARDS MOVEMENT TILL 11^{TH} AND GRADUAL NORTH-NORTHEASTWARDS RECURVATURE THEREAFTER. LANDFALL IS INDICATED AROUND 14/0000 UTC OVER BANGLADESH-MYANMAR COASTS NEAR 21.3N/92.5E. ECMWF IS INDICATING DEPRESSION AROUND 10^{TH} MAY AND RAPID INTENSIFICATION INTO SEVERE CYCLONIC STORM ON 11^{TH} MAY. IT IS ALSO INDICATING INITIAL NORTH-NORTHWESTWARDS MOVEMENT TILL 11^{TH} AND NORTH-NORTHEASTWARDS RECURVATURE THEREAFTER. CROSSING IS INDICATED ON 15^{TH} OVER BANGLADESH-MYANMAR COASTS NEAR 23.3N/91.5E. IMD MME (IMD GFS & NCEP GFS BASED) IS INDICATING SIMILAR INTENSIFICATION AND MOVEMENT WITH CROSSING OVER MYANMAR COAST NEAR 16.2/94.2E.

CURRENT INFERENCE IS BASED UPON THE SYNOPTIC ANALYSIS, ENVIRONMENTAL FEATURES AND GUIDANCE FROM GFS GROUP, ECMWF AND IMD MME MODELS.

HENCE TO CONCLUDE, A DEPRESSION IS LIKELY TO FORM OVER SOUTHEAST BAY OF BENGAL AND ADJOINING SOUTH ANDAMAN SEA ON 9TH MAY. IT IS LIKELY TO FURTHER INTENSIFY INTO A CYCLONIC STORM OVER SOUTHEAST BAY OF BENGAL AND ADJOINING AREAS OF EASTCENTRAL BAY OF BENGAL AND ANDAMAN SEA ON 10TH MAY. IT IS LIKELY TO MOVE INITIALLY NORTH-NORTHWESTWARDS TOWARDS EASTCENTRAL BAY OF BENGAL TILL 11TH MAY. THEREAFTER, IT IS LIKELY TO RECURVE GRADUALLY AND MOVE NORTH-NORTHEASTWARDS TOWARDS BANGLADESH-MYANMAR COASTS.

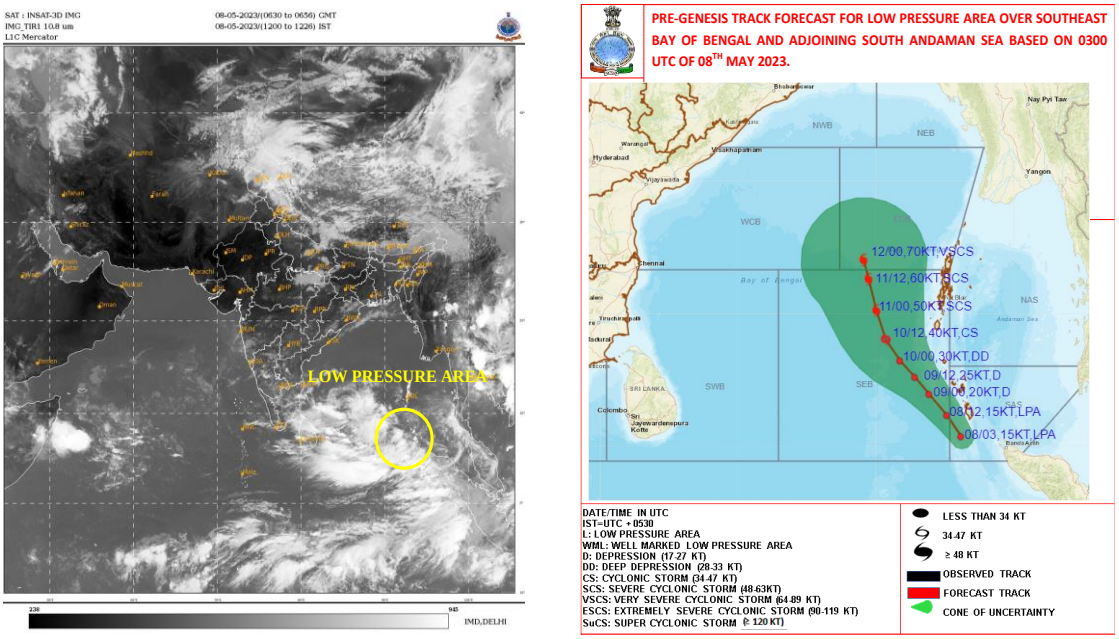


Fig. 2.4.5: (a) Typical Satellite imagery based on 0300 UTC of 8th May in association with LPA over Bay of Bengal (b) Observed and forecast track along with cone of uncertainty based on 0300 UTC of 8th May

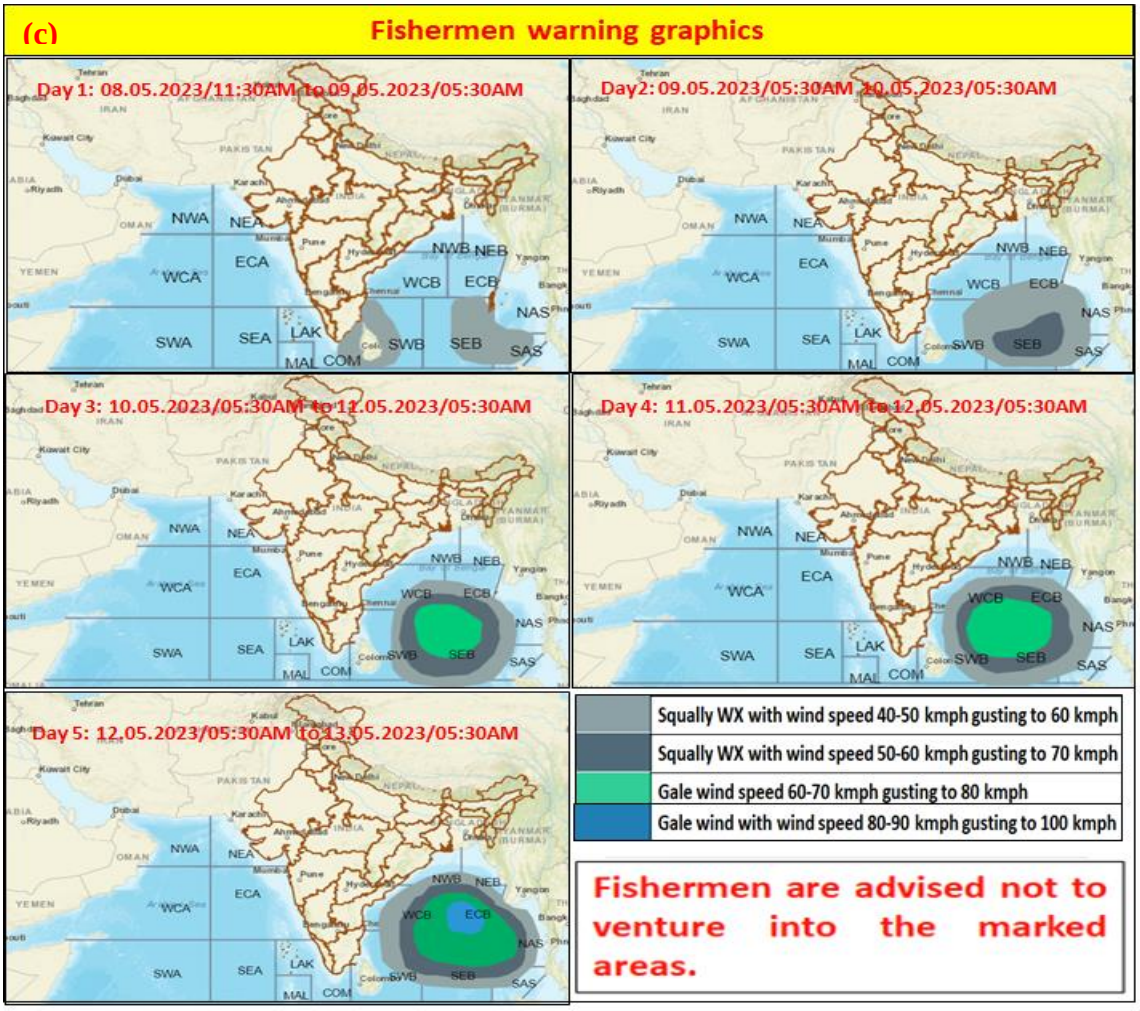


Fig. 2.4.5: (c) Fisherman warning graphics based on 0300 UTC of 8th May.

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 09.05.2023

TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND THE ARABIAN SEA) VALID FOR NEXT 120 HOURS ISSUED AT 0600 UTC OF 09.05.2023 BASED ON 0300 UTC OF 09.05.2023.

BAY OF BENGAL:

SUB: WELL MARKED LOW PRESSURE AREA OVER SOUTHEAST BAY OF BENGAL & ADJOINING SOUTH ANDAMAN SEA

YESTERDAY'S LOW PRESSURE AREA OVER SOUTHEAST BAY OF BENGAL AND ADJOINING SOUTH ANDAMAN SEA LAY AS A WELL MARKED LOW PRESSURE AREA OVER THE SAME REGION AT 0000 UTC AND IT PERSISTED OVER THE SAME REGION AT 0300 UTC OF TODAY, THE 9TH MAY 2023.

IT IS LIKELY TO INTENSIFY INTO A DEPRESSION BY TODAY EVENING OVER THE SAME REGION AND SUBSEQUENTLY INTO A CYCLONIC STORM OVER SOUTHEAST BAY OF BENGAL AND ADJOINING AREAS OF EASTCENTRAL BAY OF BENGAL AND ANDAMAN SEA ON 10TH MAY. IT IS LIKELY TO MOVE INITIALLY NORTH-NORTHWESTWARDS TOWARDS EASTCENTRAL BAY OF BENGAL TILL 11TH MAY. THEREAFTER, IT IS LIKELY TO RECURVE GRADUALLY AND MOVE NORTH-NORTHEASTWARDS TOWARDS BANGLADESH-MYANMAR COASTS.

LATEST SATELLITE IMAGERY INDICATES A LOW LEVEL CIRCULATION CENTRE OVER SOUTHEAST BAY OF BENGAL. INTENSITY OF THE SYSTEM IS CHARACTERISED AS T1.0. BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH BAY OF BENGAL AND ADJOINING EQUATORIAL INDIAN OCEAN BETWEEN LATITUDE 2.0N TO 13.0N & LONGITUDE 83.0E TO 93.0E. MINIMUM CLOUD TOP TEMPERATURE IS -93°C. INTENSE TO VERY INTENSE CONVECTION LAY TO THE WEST OF SYSTEM CENTRE.

ASCAT PASS AT 1514 UTC OF 8TH MAY IS INDICATING STRONGER WINDS IN THE SOUTHEREN SECTOR. WESTERLY WIND BURST OVER THE SOUTH BAY OF BENGAL IS SEEN, WHICH WILL FAVOUR CYCLOGENESIS BY INCREASING VORTICITY AND CONVERGENCE OVER THE REGION DURING NEXT 12 HOURS.

CONSIDERING THE SURFACE OBSERVATIONS, ASSOCIATED MAXIMUM SUSTAINED WIND SPEED IS 15-20 KTS. THE ESTIMATED CENTRAL PRESSURE OVER THE SYSTEM AREA IS 1004 HPA. THERE IS A FALLING TENDENCY OF MEAN SEA LEVEL PRESSURE OVER NICOBAR ISLANDS (1-2 HPA BELOW NORMAL).

PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 120 HRS:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS
HIGH	HIGH	HIGH	HIGH	HIGH

ARABIAN SEA:

SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE LAY OVER EASTCENTRAL ARABIAN SEA OFF MAHARASHTRA – KARNATAKA COASTS AND MODERATE TO INTENSE CONVECTION OVER SOUTH ARABIAN SEA & COMORIN AREA.

PROBABILITY OF CYCLOGENESIS (FORMATION OF DEPRESSION) DURING NEXT 120 HRS:

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

REMARKS:

INCREASED WESTERLY WINDS ARE LIKELY TO PREVAIL OVER THE SOUTH BOB AND SOUTH ANDAMAN SEA WITH EASTERLY WINDS OVER CENTRAL & NORTH BOB ON ALONGWITH MJO DURING NEXT 5-6 DAYS. THUS, THE ENHANCED WESTERLY WINDS AND MJO ARE LIKELY TO COLLECTIVELY CONTRIBUTE TOWARDS ENHANCEMENT OF CONVECTIVE ACTIVITY AND HENCE CYCLOGENESIS OVER SOUTHEAST & ADJOINING CENTRAL BOB DURING NEXT 4-5 DAYS.

THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM^2 OVER MAJOR PARTS OF SOUTH ANDAMAN SEA & ADJOINING SOUTHEAST BOB AND CENTRAL BOB. IT IS INDICATING DECREASING TENDENCY ABOUT 60-70 KJ/CM^2 ALONG THE EAST COAST OF INDIA & ALONG MYANMAR COAST. SEA SURFACE TEMPERATURE (SST) IS AROUND 30-32°C OVER ENTIRE BOB. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR CYCLOGENESIS.

CONSIDERING THE ENVIRONMENTAL CONDITIONS, THE LOW LEVEL VORTICITY AT 850 HPA HAS ORGANISED AND INCREASED TO 100x10^{-6}S^{-1} OVER SOUTHEAST BAY OF BENGAL TO THE WEST OF SYSTEM CENTRE. LOW LEVEL CONVERGENCE IS AROUND 20 x10^{-5} S^{-1} OVER SOUTHEAST BOB AND ANOTHER ZONE OVER SOUTHWEST BOB. UPPER LEVEL DIVERGENCE HAS INCREASED AND IS ABOUT 40x10^{-5}S^{-1} TO THE WEST OF SYSTEM CENTRE. GOOD POLEWARD OUFLOW IS SEEN. THE VERTICAL WIND IS LOW TO MODERATE (10-15 KNOTS) OVER THE SYSTEM AREA AND ALSO ALONG THE EXPECTED TRACK. THE SEA CONDITIONS AND ENVIRONMENTAL FEATURES INDICATE FAVOURABLE ENVIRONMENT FOR CYCLOGENESIS OVER THE REGION. THE UPPER TROPOSPHERIC RIDGE AT 500 HPA IS LOCATED NEAR 15.0N. THE RIDGE LOCATION INDICATES THAT THE SYSTEM WOULD MOVE INITIALLY NORTH-NORTHWESTWARDS AND THEN RECURVE GRADUALLY NORTH-NORTHEASTWARDS.

CONSIDERING THE MODEL GUIDANCE, MODELS LIKE IMD GFS, NCEP GFS, ECMWF AND IMD MME BASED ON THESE MODELS ARE INDICATING INITIAL NORTH-NORTHWESTWARDS MOVEMENT TILL 11TH MAY AND GRADUAL NORTH-NORTHEASTWARDS RECURVATURE THEREAFTER TOWARDS BANGLADESH-MYANMAR COASTS. TODAY, THERE IS CONSENSUS AMONG THESE MODELS 9IMD GFS: LANDFALL NEAR 22.0N/92.5 AROUND 14/12 UTC, ECMWF: 22.5N/91.7E AROUND 14/18 UTC AND IMD MME: 20.7N/92.5E AROUND 14/03 UTC).

CURRENT INFERENCE IS BASED UPON THE SYNOPTIC ANALYSIS, ENVIRONMENTAL FEATURES AND GUIDANCE FROM GFS GROUP, ECMWF AND IMD MME MODELS.
HENCE TO CONCLUDE, THE WELL MARKED LOW PRESSURE AREA OVER SOUTHEAST BAY OF BENGAL & ADJOINING SOUTH IS LIKELY TO INTENSIFY INTO A DEPRESSION BY TODAY EVENING OVER THE SAME REGION AND SUBSEQUENTLY INTO A CYCLONIC STORM OVER SOUTHEAST BAY OF BENGAL AND ADJOINING AREAS OF EASTCENTRAL BAY OF BENGAL AND ANDAMAN SEA ON 10TH MAY. IT IS LIKELY TO MOVE INITIALLY NORTH-NORTHWESTWARDS TOWARDS EASTCENTRAL BAY OF BENGAL TILL 11TH MAY. THEREAFTER, IT IS LIKELY TO

RECURVE GRADUALLY AND MOVE NORTH-NORTHEASTWARDS TOWARDS BANGLADESH-MYANMAR COASTS.

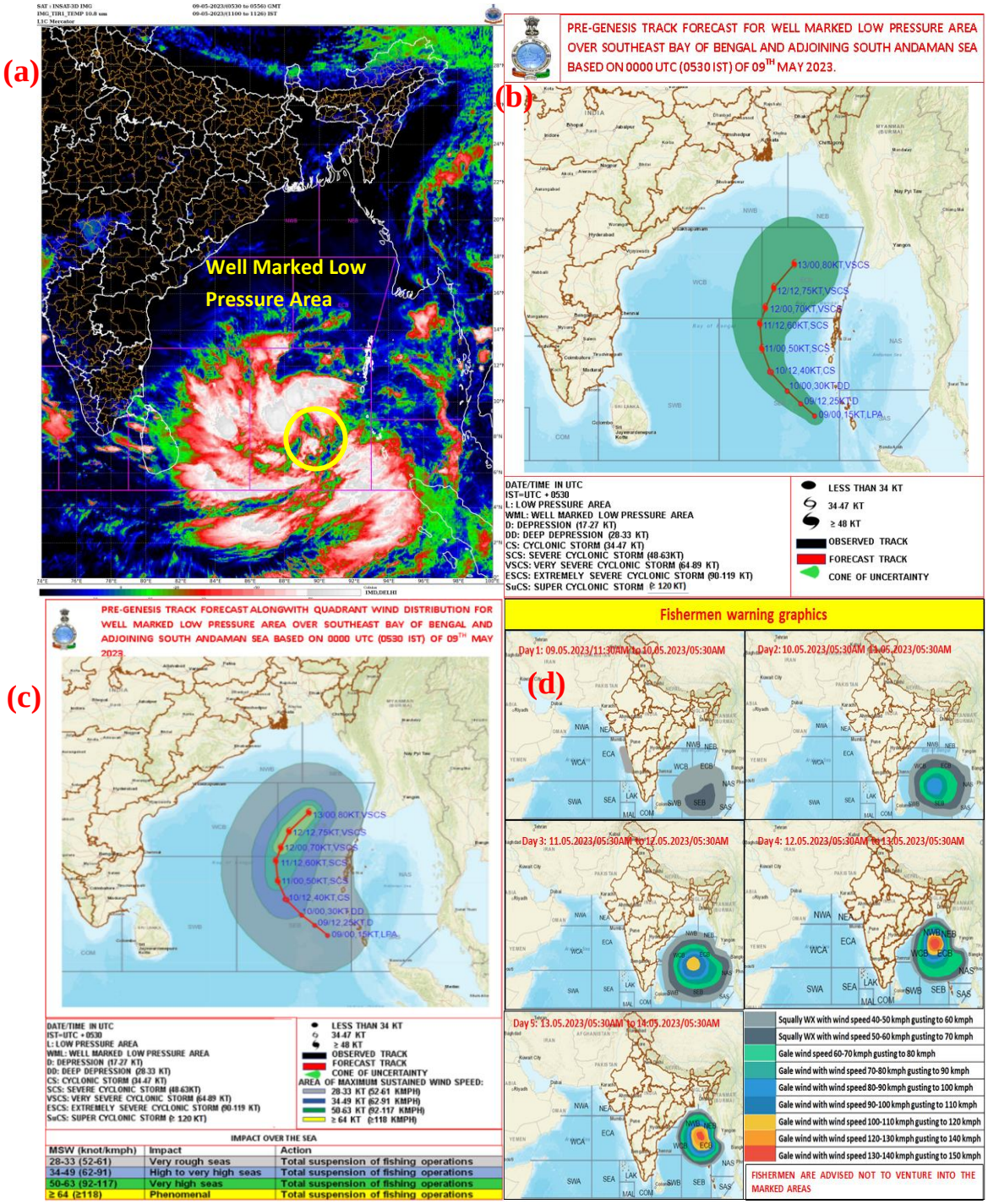


Fig. 2.4.6: (a) Typical Satellite imagery based on 0300 UTC of 9th May in association with WML over Bay of Bengal (b) Observed and forecast track alongwith with cone of uncertainty based on 0300 UTC of 9th May (c) Observed and forecast track alongwith with Quadrant wind distribution based on 0300 UTC of 9th May. (d) Fisherman warning graphics based on 0300 UTC of 9th May

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 SPECIAL TROPICAL WEATHER OUTLOOK

DEMS-RSMC TROPICAL CYCLONES NEW DELHI DATED 09.05.2023

SPECIAL TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND THE ARABIAN SEA) VALID FOR NEXT 120 HOURS ISSUED AT 1600 UTC OF 09.05.2023 BASED ON 1200 UTC OF 09.05.2023.

BAY OF BENGAL:

SUB: DEPRESSION OVER SOUTHEAST BAY OF BENGAL

THE WELL MARKED LOW PRESSURE AREA OVER SOUTHEAST BAY OF BENGAL AND ADJOINING SOUTH ANDAMAN SEA CONCENTRATED INTO A DEPRESSION AND LAY CENTERED AT 1200 UTC OF TODAY, THE 9TH MAY 2023 OVER SOUTHEAST BAY OF BENGAL NEAR LATITUDE 8.3°N AND LONGITUDE 89.5°E, ABOUT 510 KM SOUTHWEST OF PORT BLAIR, 1480 KM SOUTH-SOUTHWEST OF COX'S BAZAR (BANGLADESH) AND 1360 KM SOUTH-SOUTHWEST OF SITTWE (MYANMAR).

IT IS VERY LIKELY TO MOVE NORTH-NORTHWESTWARDS AND INTENSIFY GRADUALLY INTO A CYCLONIC STORM OVER THE SAME REGION AROUND 10TH MAY EVENING. CONTINUING TO MOVE NORTH-NORTHWESTWARDS, IT WILL GRADUALLY INTENSIFY FURTHER INTO A SEVERE CYCLONIC STORM BY 11TH MAY MORNING AND VERY SEVERE CYCLONIC STORM AROUND SAME EVENING OVER SOUTHEAST AND ADJOINING CENTRAL BAY OF BENGAL. THEREAFTER, IT IS LIKELY TO RECURVE GRADUALLY, MOVE NORTH-NORTHEASTWARDS AND CROSS SOUTHEAST BANGLADESH AND NORTH MYANMAR COASTS BETWEEN COX'S BAZAR (BANGLADESH) AND KYAUKPYU (MYANMAR) AROUND FORENOON OF 14TH MAY, 2023.

Forecast track and intensity are given below:

Date/Time (UTC)	POSITION LAT. ^{0}N/ LONG. ^{0}E	MAXIMUM SUSTAINED SURFACE WIND SPEED (KMPH)	CATEGORY OF CYCLONIC DISTURBANCE
09.05.23/1200	8.3/89.5	45-55 GUSTING TO 65	DEPRESSION
10.05.23/0000	9.3/88.5	50-60 GUSTING TO 70	DEEP DEPRESSION
10.05.23/1200	10.3/88.1	80-90 GUSTING TO 100	CYCLONIC STORM
11.05.23/0000	11.4/87.4	90-100 GUSTING TO 110	SEVERE CYCLONIC STORM
11.05.23/1200	12.7/87.3	110-120 GUSTING TO 130	VERY SEVERE CYCLONIC STORM
12.05.23/0000	13.5/87.4	130-140 GUSTING TO 155	VERY SEVERE CYCLONIC

			STORM
12.05.23/1200	14.6/88.0	140-150 GUSTING TO 165	VERY SEVERE CYCLONIC STORM
13.05.23/0000	16.0/89.2	135-145 GUSTING TO 160	VERY SEVERE CYCLONIC STORM
13.05.23/1200	17.6/90.6	130-140 GUSTING TO 155	VERY SEVERE CYCLONIC STORM
14.05.23/0000	19.7/92.0	110-120 GUSTING TO 130	VERY SEVERE CYCLONIC STORM
14.05.23/1200	21.8/93.2	65-75 GUSTING TO 85	CYCLONIC STORM

CONVECTION HAS FURTHER ORGANISED DURING LAST 6 HRS AND INTENSITY OF THE SYSTEM IS CHARACTERISED AS T1.5. ASSOCIATED BROKEN LOW/MED CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH BAY ADJ EQUTORIAL INDIAN OCEAN BET LAT 2.0N TO 13.0N LONG 83.0E TO 93.0E. MINIMUM CLOUD TOP TEMPERATURE (CTT) IS MINUS 93 DEG CELSIUS. INTENSE TO VERY INTENSE CONVECTION LAY TO THE NORTHWEST SECTOR OF THE SYSTEM CENTRE

THE MAXIMUM SUSTAINED SURFACE WIND SPEED IS 25 KNOTS GUSTING TO 35 KNOTS. THE ESTIMATED CENTRAL PRESSURE IS ABOUT 1002 HPA. SEA CONDITION IS ROUGH TO VERY ROUGH OVER SOUTHEAST BAY OF BENGAL AND ADJOINING SOUTH ANDAMAN SEA.

AT 1200 UTC, A SHIP NEAR 6°N/90°E REPORTED MEAN SEA LEVEL PRESSURE OF 1003.5HPA AND MAXIMUM SUSTAINED WIND SPEED OF 240^0/22 KTS. ANOTHER SHIP NEAR 6°N/93.5°E REPORTED MEAN SEA LEVEL PRESSURE OF 1006.7 HPA AND MAXIMUM SUSTAINED WIND SPEED OF 200^0/14 KTS. A BUOY NEAR 10.5°N/94.1°E REPORTED MEAN SEA LEVEL PRESSURE OF 1005.3HPA AND MAXIMUM SUSTAINED WIND SPEED OF 150^0/19 KTS

REMARKS:

INCREASED WESTERLY WINDS ARE LIKELY TO PREVAIL OVER THE SOUTH BOB AND SOUTH ANDAMAN SEA WITH EASTERLY WINDS OVER CENTRAL & NORTH BOB DURING ALONGWITH MJO DURING NEXT 3-4 DAYS. THUS, THE ENHANCED WESTERLY WINDS AND MJO ARE LIKELY TO COLLECTIVELY CONTRIBUTE TOWARDS ENHANCEMENT OF CONVECTIVE ACTIVITY AND FURTHER INTENSIFICATION OVER SOUTHEAST & ADJOINING CENTRAL BOB DURING NEXT 3-4 DAYS.

THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM^2 OVER MAJOR PARTS OF SOUTH ANDAMAN SEA & ADJOINING SOUTHEAST BOB AND CENTRAL BOB. IT IS INDICATING DECREASING TENDENCY ABOUT 60-70 KJ/CM^2 ALONG THE EAST COAST OF INDIA & ALONG MYANMAR COAST. SEA SURFACE TEMPERATURE (SST) IS AROUND 30-32°C OVER ENTIRE BOB. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR FURTHER INTENSIFICATION.

CONSIDERING THE ENVIRONMENTAL CONDITIONS, THE LOW LEVEL VORTICITY AT 850 HPA IS AROUND $100X10^{-6}S^{-1}$ OVER SOUTHEAST BAY OF BENGAL TO THE SOUTHEAST OF SYSTEM CENTRE. LOW LEVEL CONVERGENCE IS AROUND 20 $X10^{-5}$ S^{-1} OVER SOUTHEAST BOB TO THE SOUTH OF THE SYSTEM CENTER. UPPER LEVEL DIVERGENCE IS ABOUT $30X10^{-5}S^{-1}$ TO THE SOUTH OF SYSTEM CENTRE. GOOD POLEWARD AND EQUATOR-WARD OUFLOW ARE FAVOURABLE FOR FURTHER INTENSIFICATION OF THE SYSTEM. THE VERTICAL WIND IS LOW TO MODERATE (05-15 KNOTS) OVER THE SYSTEM AREA AND ALSO ALONG THE EXPECTED TRACK. THE SEA CONDITIONS AND ENVIRONMENTAL FEATURES INDICATE FAVOURABLE ENVIRONMENT FOR FURTHER INTENSIFICATION OVER THE REGION. THE UPPER TROPOSPHERIC RIDGE AT 500 HPA IS LOCATED NEAR 15.0N. THE RIDGE LOCATION INDICATES THAT THE SYSTEM WOULD MOVE INITIALLY NORTH-NORTHWESTWARDS AND THEN RECURVE GRADUALLY NORTH-NORTHEASTWARDS.

CONSIDERING THE MODEL GUIDANCE, MODELS LIKE IMD GFS, NCEP GFS, ECMWF AND IMD MME BASED ON THESE MODELS ARE INDICATING INITIAL NORTH-NORTHWESTWARDS

MOVEMENT TILL 11TH AND GRADUAL NORTH-NORTHEASTWARDS RECURVATURE THEREAFTER WITH CROSSING OVER SOUTHEAST BANGLADESH AND NORTH MYANMAR COASTS BETWEEN COX'S BAZAR (BANGLADESH) AND KYAUKPYU (MYANMAR) AROUND FORENOON OF 14TH MAY, 2023.

HENCE IT IS CONCLUDED THAT, THE DEPRESSION OVER SOUTHEAST BAY OF BENGAL IS VERY LIKELY TO MOVE NORTH-NORTHWESTWARDS AND INTENSIFY GRADUALLY INTO A CYCLONIC STORM OVER THE SAME REGION AROUND 10TH MAY EVENING. CONTINUING TO MOVE NORTH-NORTHWESTWARDS, IT WILL GRADUALLY INTENSIFY FURTHER INTO A SEVERE CYCLONIC STORM BY 11TH MAY MORNING AND VERY SEVERE CYCLONIC STORM AROUND SAME EVENING OVER SOUTHEAST AND ADJOINING CENTRAL BAY OF BENGAL. THEREAFTER, IT IS LIKELY TO RECURVE GRADUALLY, MOVE NORTH-NORTHEASTWARDS AND CROSS SOUTHEAST BANGLADESH AND NORTH MYANMAR COASTS BETWEEN COX'S BAZAR (BANGLADESH) AND KYAUKPYU (MYANMAR) AROUND FORENOON OF 14TH MAY, 2023.

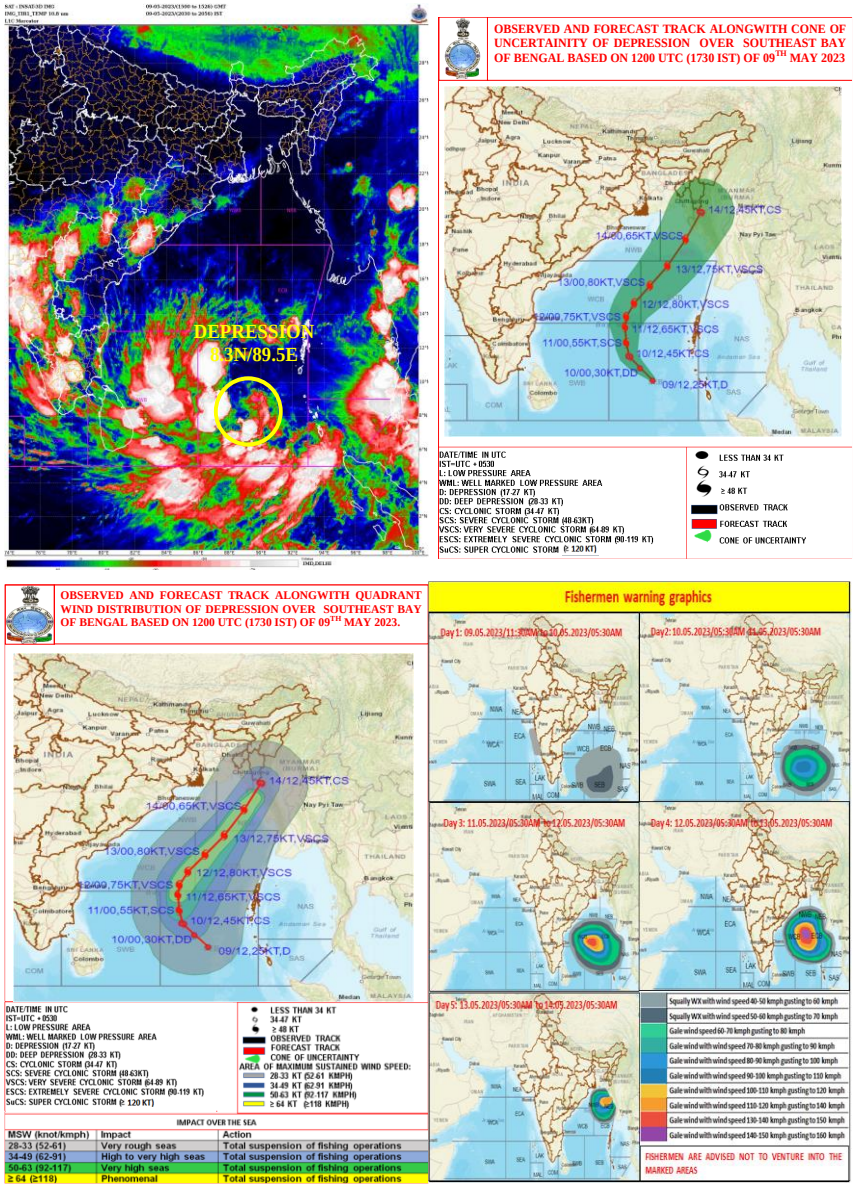


Fig. 2.4.7 (a) Typical Satellite imagery based on 1200 UTC of 9th May in association with Depression over Bay of Bengal (b) Observed and forecast track alongwith with cone of uncertainty based on 1200 UTC of 9th May (c) Observed and forecast track alongwith with Quadrant wind distribution based on 1200 UTC of 9th May. (d) Fisherman warning graphics based on 1200 UTC of 9th May

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

DEMS-RSMC TROPICAL CYCLONES NEW DELHI DATED 10.05.2023

SPECIAL TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND THE ARABIAN SEA) VALID FOR NEXT 120 HOURS ISSUED AT 0730 UTC OF 10.05.2023 BASED ON 0300 UTC OF 10.05.2023.

BAY OF BENGAL:

SUB: DEEP DEPRESSION OVER SOUTHEAST BAY OF BENGAL

THE DEEP DEPRESSION OVER SOUTHEAST BAY OF BENGAL MOVED NORTHWESTWARDS WITH A SPEED OF 07 KMPH DURING PAST 06 HOURS AND LAY CENTERED AT 0300 UTC OF TODAY, THE 10TH MAY 2023 OVER THE SAME REGION NEAR LATITUDE 8.8°N AND LONGITUDE 88.9°E, ABOUT 530 KM SOUTHWEST OF PORT BLAIR (43333), 1430 KM SOUTH OF COX'S BAZAR (BANGLADESH, 41992) AND 1320 KM SOUTH-SOUTHWEST OF SITTWE (MYANMAR, 48062).

IT IS VERY LIKELY TO MOVE NORTH-NORTHWESTWARDS AND INTENSIFY GRADUALLY INTO A CYCLONIC STORM OVER THE SAME REGION AROUND 1200 UTC. THEN CONTINUING TO MOVE NORTH-NORTHWESTWARDS, IT WILL GRADUALLY INTENSIFY FURTHER INTO A SEVERE CYCLONIC STORM BY 11TH MAY 0000 UTC AND VERY SEVERE CYCLONIC STORM AROUND 1800 UTC OF 11TH MAY OVER SOUTHEAST AND ADJOINING CENTRAL BAY OF BENGAL. THEREAFTER, IT IS LIKELY TO RECURVE GRADUALLY, MOVE NORTH-NORTHEASTWARDS FROM AROUND 12TH MAY 0000 UTC. IT IS LIKELY TO WEAKEN SLIGHTLY FROM AROUND 1200 UTC OF 13TH MAY AND CROSS SOUTHEAST BANGLADESH AND NORTH MYANMAR COASTS BETWEEN COX'S BAZAR (BANGLADESH) AND KYAUKPYU (MYANMAR) AROUND 0300-0600 UTC OF 14TH MAY, 2023 WITH MAXIMUM SUSTAINED WIND SPEED OF 110-120 KMPH GUSTING TO 130 KMPH.

Forecast track and intensity are given below:

Date/Time (UTC)	Position Lat. ^{0}N/ long. ^{0}E	Maximum sustained surface wind speed (Kmph)	Category of cyclonic disturbance
10.05.23/0300	8.8/88.9	50-60 GUSTING TO 70	DEEP DEPRESSION
10.05.23/0600	9.1/88.6	55-65 GUSTING TO 75	DEEP DEPRESSION
10.05.23/1200	9.7/88.1	60-70 GUSTING TO 80	CYCLONIC STORM
10.05.23/1800	10.3/87.7	70-80 GUSTING TO 90	CYCLONIC STORM
11.05.23/0000	11.0/87.6	90-100 GUSTING TO 110	SEVERE CYCLONIC STORM
11.05.23/1200	11.9/87.5	105-115 GUSTING TO 125	SEVERE CYCLONIC STORM
12.05.23/0000	13.1/87.6	125-135 GUSTING TO 150	VERY SEVERE CYCLONIC STORM
12.05.23/1200	14.3/88.2	130-140 GUSTING TO 155	VERY SEVERE CYCLONIC STORM
13.05.23/0000	15.8/89.3	140-150 GUSTING TO 165	VERY SEVERE CYCLONIC STORM
13.05.23/1200	17.9/90.8	130-140 GUSTING TO 155	VERY SEVERE CYCLONIC STORM
14.05.23/0000	20.0/92.2	120-130 GUSTING TO 140	VERY SEVERE CYCLONIC STORM
14.05.23/1200	22.1/93.5	55-65 GUSTING TO 75	DEEP DEPRESSION

THE CLOUD MASS ASSOCIATED WITH THE SYSTEM SHOWS FURTHER ORGANISATION. INTENSE CONVECTION IS SEEN IN THE WESTERN SECTOR AND ALSO IN THE NORTHEAST SECTOR.
BOTH POLLEWARD AND EQUATORWARD OUTFLOW IS INDICATED IN THE LATEST SATELLITE IMAGERY. INTENSITY OF THE SYSTEM IS CHARACTERISED AS T2.0. ASSOCIATED BROKEN LOW/MED CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER

SOUTH BAY OF BENGAL BETWEEN LATITUDE 5.0N TO 13.0N AND LONG 80.0E TO 93.0E. MINIMUM CLOUD TOP TEMPERATURE (CTT) IS MINUS 93 DEG CELSIUS.

THE MAXIMUM SUSTAINED SURFACE WIND SPEED IS 30 KNOTS GUSTING TO 40 KNOTS. THE ESTIMATED CENTRAL PRESSURE IS ABOUT 1000 HPA. SEA CONDITION IS ROUGH TO VERY ROUGH OVER SOUTHEAST BAY OF BENGAL AND ADJOINING SOUTH ANDAMAN SEA.

AT 0300 UTC, A BUOY NEAR 10.5°N/94.1°E REPORTED MEAN SEA LEVEL PRESSURE OF 1008.1 HPA AND MAXIMUM SUSTAINED WIND SPEED OF 150^0/23.3 KTS.

STORM SURGE GUIDANCE (GRAPHICS ATTACHED) FOR NORTH MYANMAR AND ADJOINING SOUTHEAST BANGLADESH COASTS:
STORM SURGE WITH HEIGHT OF ABOUT 1.5-2.0 M ABOVE THE ASTRONOMICAL TIDE IS LIKELY TO INUNDATE LOW LYING AREAS OF NORTH MYANMAR AND ADJOINING SOUTHEAST BANGLADESH COASTS DURING THE TIME OF LANDFALL.

REMARKS:
INCREASED WESTERLY WINDS ARE PREVAILING OVER THE SOUTH BOB AND SOUTH ANDAMAN SEA WITH EASTERLY WINDS OVER CENTRAL & NORTH BOB DURING ALONGWITH MJO IN PHASE 5. THUS, THE ENHANCED WESTERLY WINDS AND MJO ARE LIKELY TO COLLECTIVELY CONTRIBUTE TOWARDS ENHANCEMENT OF CONVECTIVE ACTIVITY AND FURTHER INTENSIFICATION OF THE SYSTEM DURING NEXT 3 DAYS.

THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM^2 OVER MAJOR PARTS OF SOUTHEAST AND CENTRAL BOB. IT IS INDICATING DECREASING TENDENCY ABOUT 60-70 KJ/CM^2 ALONG MYANMAR COAST. SEA SURFACE TEMPERATURE (SST) IS AROUND 30°C OVER SOUTHEAST BOB. IT IS SLIGHTLY HIGHER OVER EASTCENTRAL BOB AROUND 31°C AND LESS OFF MYANMAR COAST. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR FURTHER INTENSIFICATION OF SYSTEM OVER EASTCENTRAL BOB. TOTAL PRECIPITABLE WATER IMAGERY (TPW) INDICATES WARM MOIST AIR INCURSION INTO THE SYSTEM AREA FROM SOUTH.

CONSIDERING THE ENVIRONMENTAL CONDITIONS, THE LOW LEVEL VORTICITY AT 850 HPA IS AROUND 100X10-6S-1 TO THE EAST OF SYSTEM CENTRE. LOW LEVEL CONVERGENCE HAS INCREASED DURING PAST 6-HOURS AND IS AROUND 40 $X10^{-5}$ S^{-1} TO THE WEST OF THE SYSTEM CENTER. UPPER LEVEL DIVERGENCE IS ABOUT $30X10^{-5}S^{-1}$ TO THE SOUTHWEST & ANOTHER ZONE TO THE SOUTHEAST OF SYSTEM CENTRE. GOOD POLEWARD AND EQUATORWARD OUFLOW ARE FAVOURABLE FOR FURTHER INTENSIFICATION OF THE SYSTEM. THE VERTICAL WIND IS LOW TO MODERATE (15-20 KNOTS) OVER THE SYSTEM AREA AND IT IS DECREASING ALONG THE EXPECTED TRACK. THE SEA CONDITIONS AND ENVIRONMENTAL FEATURES INDICATE FAVOURABLE ENVIRONMENT FOR FURTHER INTENSIFICATION OVER THE REGION. THE SYSTEM IS LYING IN THE PERIPHERY OF UPPER TROPOSPHERIC RIDGE NEAR 15.0N IN ASSOCIATION WITH ANTI CYCLONIC CIRCULATION OVER ESATCENTRAL BOB. THE SYSTEM IS EXPECTED TO MOVE NORTH-NORTHWESTWARDS ALONG IT'S PERIPHERY. ONCE IT CROSSES. 15.0N, IT WILL GRADUALLY RECURVE NORTH-NORTHEASTWARDS, TOWARDS MYANMAR-BANGLADESH COASTS.

GUIDANCE FROM VARIOUS NUMERICAL MODELS INCLUDING IMD GFS, NCEP GFS, ECMWF, NCUM, UKMO AND IMD MME ARE NOW CONSISTENT WRT TRACK AND LANDFALL POINT. HOWEVER, THERE IS VARIATION AMONG VARIOUS MODELS WRT LANDFALL TIME AND INTENSITY OF THE SYSTEM. BUT, THERE IS CONSENSUS AMONG VARIOUS MODELS WRT SLIGHT WEAKENING OF THE SYSTEM BEFORE LANDFALL. IMD GFS IS INDICATING LANDFALL

AROUND 14/0600 UTC NEAR 20.1N/93.2E. ECMWF IS INDICATING CROSSING AROUND 14/0300 UTC NEAR 20.4N/92.7E. IMD MME IS INDICATING CROSSING AROUND 14/0300 UTC NEAR 20.0N/93.1E. PEAK INTENSITY BY VARIOUS MODELS IS VARYING BETWEEN 60 KT-110 KT. ACCORDINGLY, OPERATIONALLY THE PEAK INTENSITY HAS BEEN TAKEN AS 80 KTS BASED ON MME.

HENCE IT IS CONCLUDED THAT, THE DEEP DEPRESSION OVER SOUTHEAST BAY OF BENGAL IS VERY LIKELY TO MOVE NORTH-NORTHWESTWARDS AND INTENSIFY GRADUALLY

INTO A CYCLONIC STORM OVER THE SAME REGION AROUND 1200 UTC. THEN CONTINUING TO MOVE NORTH-NORTHWESTWARDS, IT WILL GRADUALLY INTENSIFY FURTHER INTO A SEVERE CYCLONIC STORM BY 11TH MAY 0000 UTC AND VERY SEVERE CYCLONIC STORM BY 11TH MAY, 1800 UTC OVER SOUTHEAST AND ADJOINING CENTRAL BAY OF BENGAL. THEREAFTER, IT IS LIKELY TO RECURVE GRADUALLY, MOVE NORTH-NORTHEASTWARDS FROM 12TH MAY, 0000 UTC. IT IS LIKELY TO WEAKEN SLIGHTLY FROM 13TH MAY, 1200 UTC AND CROSS SOUTHEAST BANGLADESH AND NORTH MYANMAR COASTS BETWEEN COX'S BAZAR (BANGLADESH) AND KYAUKPYU (MYANMAR) AROUND 0600 UTC OF 14TH MAY, 2023 WITH MAXIMUM SUSTAINED WIND SPEED OF 110-120 KMPH GUSTING TO 130 KMPH.

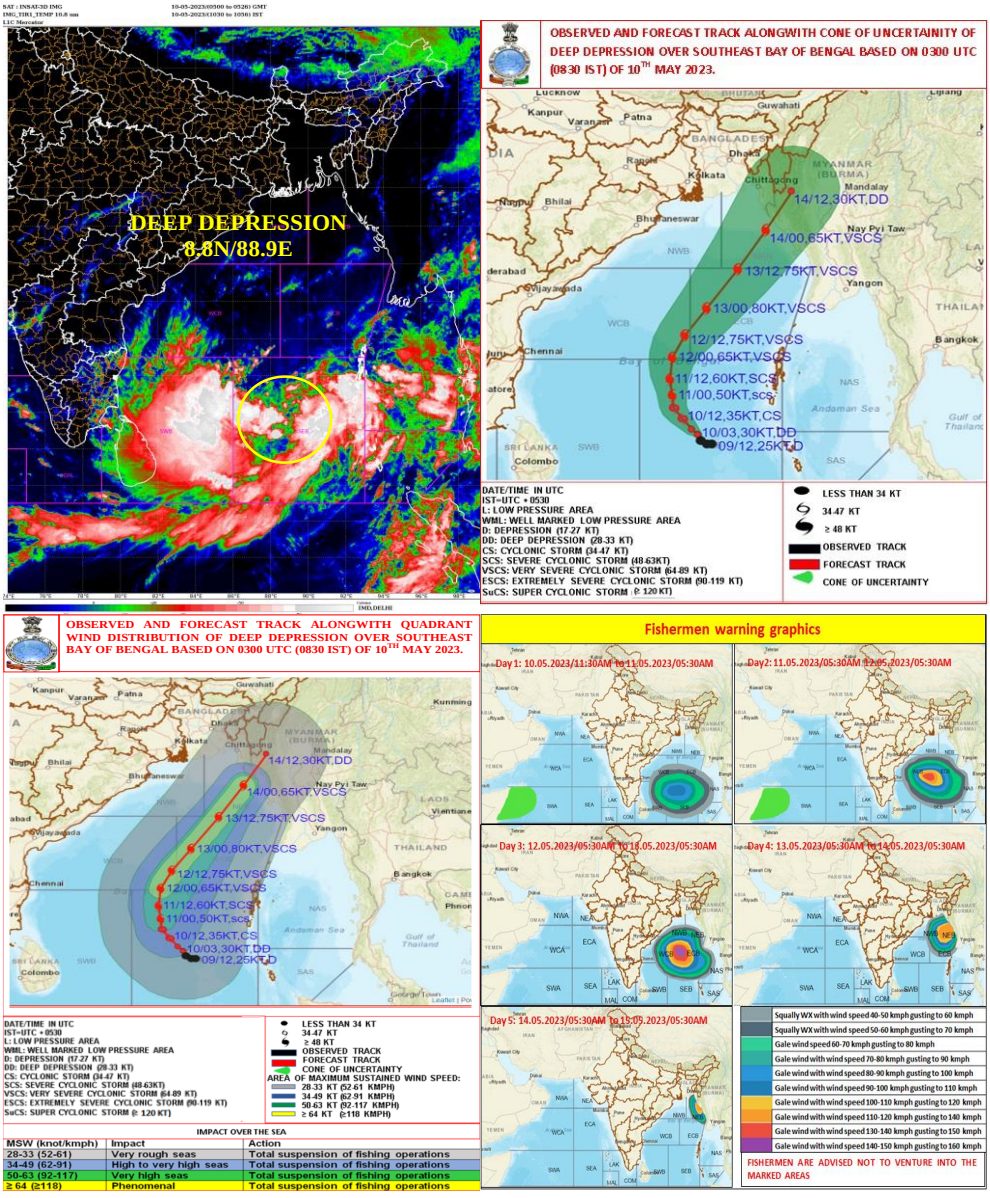


Fig. 2.4.8: (a) Typical Satellite imagery based on 0300 UTC of 10th May in association with Deep Depression over Bay of Bengal (b) Observed and forecast track alongwith with cone of uncertainty based on 0300 UTC of 10th May (c) Observed and forecast track alongwith with Quadrant wind distribution based on 0300 UTC of 10th May (d) Fisherman warning graphics based on 0300 UTC of 10th May

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 40^0E to 100^0E from 2018 onwards from long. 45° E to 100° E. Supplementary advisories may be issued as necessitated by circumstances, e.g., change in intensity or movement.

Tropical cyclone advisories will contain the information of tropical cyclone viz., name of the cyclone, the present location & intensity and past movement (past twelve hours) of the storm, and its forecast position, movement, intensity, maximum average surface wind speed with highest gust wind speed and sea conditions (in qualitative terms). These track and intensity forecasts are issued for +6, +12, +18, +24, +36, +48, +60, +72, +84, +96, +108 and +120 hrs. It also contains description of the convection as seen in satellite imageries and brief description of the diagnosis and prognosis of the system. The bulletin will contain the storm surge guidance based on IIT, Delhi Storm Surge prediction model in case of the cyclone landfalling over any member countries. Important information obtained from radar, synoptic, ship observations from the affected areas are also be reported in the advisory bulletin. Advisories are exchanged under appropriate headings for regional distribution by RTH, New Delhi on the GTS.

Example 6:

REGIONAL SPECIALISED METEOROLOGICAL CENTRE-TROPICAL CYCLONES, NEW DELHI TROPICAL CYCLONE ADVISORY NO. 2

DEMS-RSMC TROPICAL CYCLONES NEW DELHI DATED 11.05.2023

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. 2 FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND ARABIAN SEA) VALID FOR NEXT 120 HOURS ISSUED AT 0600 UTC OF 11.05.2023 BASED ON 0300 UTC OF 11.05.2023

SUBJECT: CYCLONIC STORM "MOCHA" PRONOUNCED AS "MOKHA" over SOUTHEAST BAY OF BENGAL

THE CYCLONIC STORM "MOCHA" PRONOUNCED AS "MOKHA" OVER SOUTHEAST BAY OF BENGAL MOVED NORTH-NORTHWESTWARDS WITH A SPEED OF 8 KMPH DURING PAST 06 HOURS, AND LAY CENTERED AT 0300 UTC OF 11TH MAY 2023 OVER THE SAME REGION NEAR LATITUDE 11.4°N AND LONGITUDE 88.0°E, ABOUT 510 KM WEST-SOUTHWEST OF PORT BLAIR (INDIA, 43333), 1190 KM SOUTH-SOUTHWEST OF COX'S BAZAR (BANGLADESH, 41992) AND 1100 KM SOUTH-SOUTHWEST OF SITTWE (MYANMAR, 48062).

IT IS VERY LIKELY TO MOVE NORTH-NORTHWESTWARDS AND GRADUALLY INTENSIFY INTO A SEVERE CYCLONIC STORM AROUND 1800 UTC OF TODAY, THE 11TH MAY. THEREAFTER, IT IS LIKELY TO RECURVE GRADUALLY, MOVE NORTH-NORTHEASTWARDS FROM 0000 UTC OF 12TH MAY AND INTENSIFY FURTHER INTO A VERY SEVERE CYCLONIC STORM AROUND 1200 UTC OF 12TH MAY EVENING OVER CENTRAL BAY OF BENGAL. IT WOULD REACH ITS PEAK INTENSITY AROUND 1200 UTC OF 13TH MAY. IT IS LIKELY TO CROSS SOUTHEAST BANGLADESH AND NORTH MYANMAR COASTS BETWEEN COX'S BAZAR (BANGLADESH, 41992) AND KYAUKPYU (MYANMAR, 48071), CLOSE TO SITTWE (MYANMAR) AROUND 0600 UTC OF 14TH MAY, 2023 WITH MAXIMUM SUSTAINED WIND SPEED OF 140-150 KMPH GUSTING TO 165 KMPH.

FORECAST TRACK AND INTENSITY ARE GIVEN BELOW:

DATE/TIME (UTC)	POSITION LAT. ^{0}N/ LONG. ^{0}E	MAXIMUM SUSTAINED SURFACE WIND SPEED (KMPH)	CATEGORY OF CYCLONIC DISTURBANCE
11.05.23/0300	11.4/88.0	65-75 gusting to 85	CYCLONIC STORM
11.05.23/0600	11.7/88.0	70-80 gusting to 90	CYCLONIC STORM
11.05.23/1200	12.2/87.9	80-90 gusting to 100	CYCLONIC STORM
11.05.23/1800	12.7/87.9	90-100 gusting to 110	SEVERE CYCLONIC STORM
12.05.23/0000	13.2/88.0	110-120 gusting to 130	SEVERE CYCLONIC STORM
12.05.23/1200	14.3/88.5	120-130 gusting to 145	VERY SEVERE CYCLONIC STORM
13.05.23/0000	15.8/89.3	130-140 gusting to 155	VERY SEVERE CYCLONIC STORM
13.05.23/1200	17.4/90.5	140-150 gusting to 165	VERY SEVERE CYCLONIC STORM
14.05.23/0000	19.0/91.8	140-150 gusting to 165	VERY SEVERE CYCLONIC STORM
14.05.23/1200	21.6/94.0	75-85 gusting to 95	CYCLONIC STORM

THE MAXIMUM SUSTAINED SURFACE WIND SPEED IS 35 KNOTS GUSTING TO 45 KNOTS. THE ESTIMATED CENTRAL PRESSURE IS ABOUT 996 HPA. SEA CONDITION IS VERY ROUGH TO HIGH OVER SOUTHEAST & ADJOINING EASTCENTRAL BAY OF BENGAL AND ADJOINING AREAS OF ANDAMAN SEA.

AS PER SATELLITE IMAGERY, INTENSITY IS T2.5. CLOUDS ASSOCIATED WITH THE SYSTEM ARE ORGANISED IN CURVED BAND PATTERN. INTENSE CONVECTION IS SEEN IN THE WESTERN SECTOR. ASSOCIATED BROKEN LOW/MED CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LAY OVER SOUTH BAY OF BENGAL BETWEEN LATITUDE 8.0N TO 14.5N AND LONG 83.0E TO 89.0E. MINIMUM CLOUD TOP TEMPERATURE (CTT) IS MINUS 93 DEG CELSIUS.

AT 0000 UTC, A BUOY NEAR 10.45°N/94.1°E REPORTED MEAN SEA LEVEL PRESSURE OF 1007 HPA AND MAXIMUM SUSTAINED WIND SPEED OF 160^0/17.5 KTS.

STORM SURGE GUIDANCE (GRAPHICS ATTACHED) FOR NORTH MYANMAR AND ADJOINING SOUTHEAST BANGLADESH COASTS:
STORM SURGE WITH HEIGHT OF ABOUT 2.0-2.5 M ABOVE THE ASTRONOMICAL TIDE IS LIKELY TO INUNDATE LOW LYING AREAS OF NORTH MYANMAR AND ADJOINING SOUTHEAST BANGLADESH COASTS DURING THE TIME OF LANDFALL.

REMARKS:

THE TROPICAL CYCLONE HEAT POTENTIAL (TCHP) IS MORE THAN 100 KJ/CM2 OVER MAJOR PARTS OF SOUTHEAST AND CENTRAL BAY OF BENGAL (BOB). IT IS INDICATING DECREASING TENDENCY ABOUT 60-70 KJ/CM2 ALONG MYANMAR COAST. SEA SURFACE TEMPERATURE (SST) IS AROUND 30°C OVER SOUTHEAST BOB. IT IS SLIGHTLY HIGHER OVER EASTCENTRAL BOB AROUND 31°C AND LESS OFF MYANMAR COAST. THE SEA CONDITIONS OVER BOB ARE ALSO CONDUCIVE FOR FURTHER INTENSIFICATION OF SYSTEM OVER EASTCENTRAL BOB. TOTAL PRECIPITABLE WATER IMAGERY (TPW) INDICATES WARM MOIST AIR INCURSION INTO THE SYSTEM AREA FROM SOUTH.

CONSIDERING THE ENVIRONMENTAL CONDITIONS, THE LOW LEVEL VORTICITY AT 850 HPA IS AROUND 200X10-6S-1 TO THE SOUTH OF THE SYSTEM CENTRE WITH VERTICAL EXTENSION UPTO 200 HPA LEVELS. LOW LEVEL CONVERGENCE IS AROUND 30 X10-5 S-1 TO THE SOUTH OF THE SYSTEM CENTER. UPPER LEVEL DIVERGENCE IS ABOUT 30X10-5S-1 TO THE SOUTHWEST AND ANOTHER ZONE TO THE NORTHEAST OF THE SYSTEM CENTER. THE VERTICAL WIND SHEAR IS LOW TO MODRATE (10-15 KNOTS) OVER THE SYSTEM AREA. STRONG POLEWARD AND EQUATORWARD OUTFLOW IS SEEN. HIGHER SEA SURFACE TEMPERATURE, POLEWARD & EQUATORWARD OUTFLOW AND MODERATE WIND ARE FAVOURABLE CONDITIONS FOR FURTHER INTENSIFICATION OF THE SYSTEM. THE SYSTEM IS LYING IN THE PERIPHERY OF UPPER TROPOSPHERIC RIDGE NEAR 15.0N IN ASSOCIATION WITH ANTI-CYCLONIC CIRCULATION OVER ESATCENTRAL BOB. THE SYSTEM IS EXPECTED TO MOVE NORTH-NORTHWESTWARDS ALONG IT'S PERIPHERY. ONCE IT CROSSES 15.0N, IT WILL GRADUALLY RECURVE NORTH-NORTHEASTWARDS, TOWARDS MYANMAR-BANGLADESH COASTS.

GUIDANCE FROM VARIOUS NUMERICAL MODELS INCLUDING IMD GFS, NCEP GFS, ECMWF, NCUM, UKMO AND IMD MME ARE NOW CONSISTENT WRT TRACK AND LANDFALL POINT. CURRENT MODEL GUIDANCE IS NOT INDICATING WEAKENING OF THE SYSTEM BEFORE LANDFALL. IMD GFS IS INDICATING LANDFALL AROUND 14/0600 UTC NEAR 20.0N/93.6E. ECMWF IS INDICATING LANDFALL AROUND 14/0900 UTC NEAR 20.5N/92.2E. IMD MME IS INDICATING LANDFALL AROUND 14/1000 UTC NEAR 20.2N/92.9E

IT IS CONCLUDED THAT, THE CYCLONIC STORM "MOCHA" PRONOUNCED AS "MOKHA" OVER SOUTHEAST BAY OF BENGAL IS VERY LIKELY TO MOVE NORTH-NORTHWESTWARDS AND GRADUALLY INTENSIFY INTO A SEVERE CYCLONIC STORM AROUND 1800 UTC OF TODAY, THE 11TH MAY. THEREAFTER, IT IS LIKELY TO RECURVE GRADUALLY, MOVE NORTH-NORTHEASTWARDS FROM 0000 UTC OF 12TH MAY AND INTENSIFY FURTHER INTO A VERY SEVERE CYCLONIC STORM AROUND 1200 UTC OF 12TH MAY EVENING OVER CENTRAL BAY OF BENGAL. IT WOULD REACH ITS PEAK INTENSITY AROUND 1200 UTC OF 13TH MAY. IT IS LIKELY TO CROSS SOUTHEAST BANGLADESH AND NORTH MYANMAR COASTS BETWEEN COX'S BAZAR (BANGLADESH, 41992) AND KYAUKPYU (MYANMAR, 48071), CLOSE TO SITTWE (MYANMAR) AROUND 0600 UTC OF 14TH MAY, 2023 WITH MAXIMUM SUSTAINED WIND SPEED OF 140-150 KMPH GUSTING TO 165 KMPH.

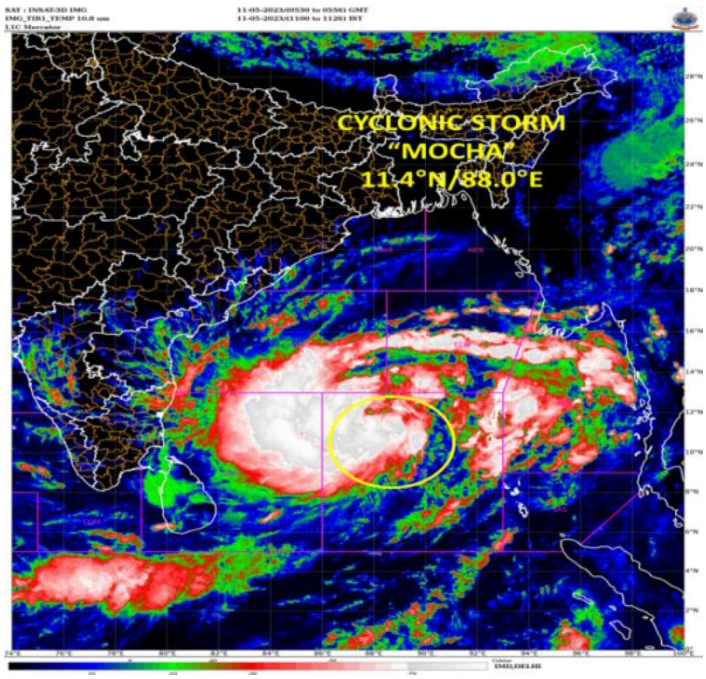


Fig. 2.4.9. (i) Typical Satellite imagery based on 0300 UTC of 11th May

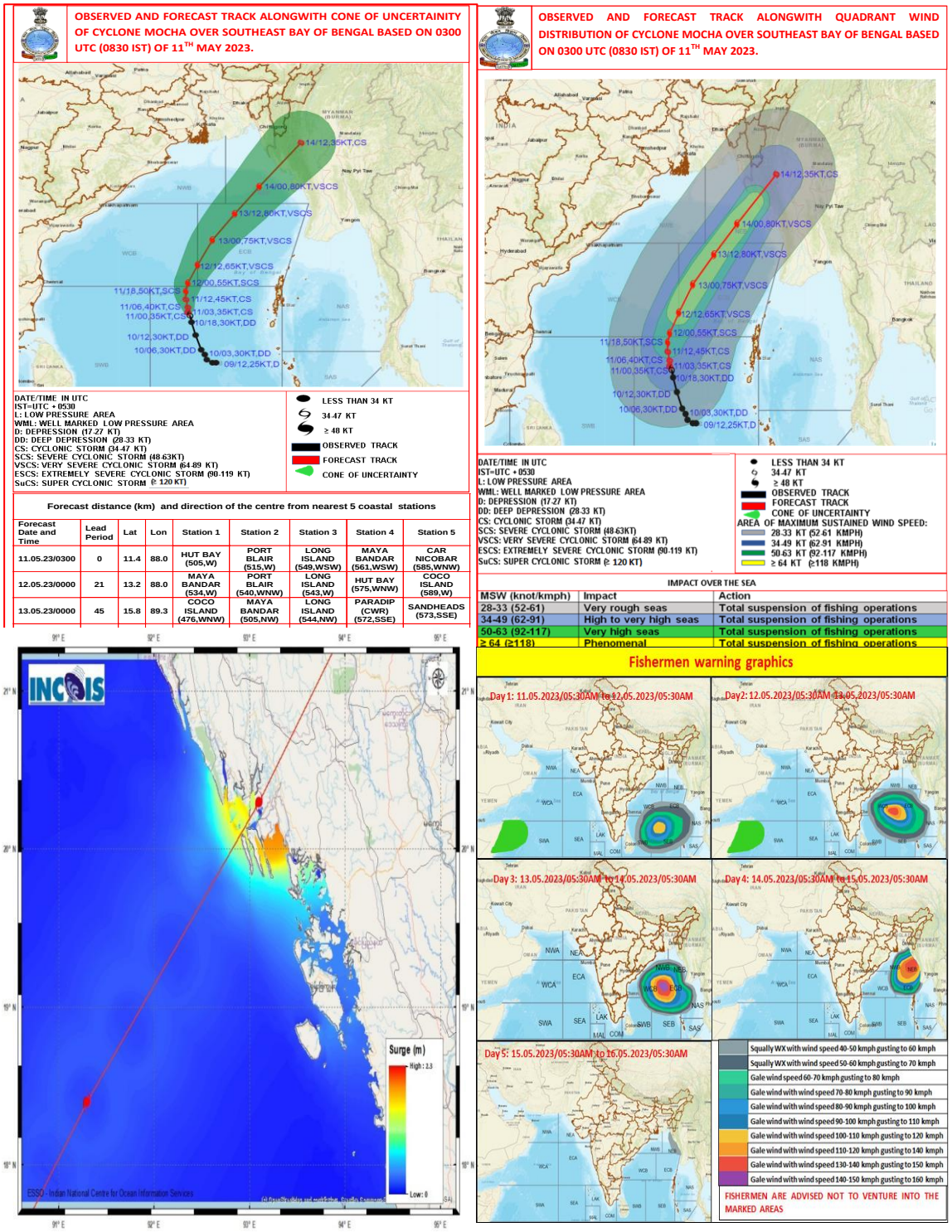


Fig. 2.4.9 (ii) : (a) Observed and forecast track alongwith with cone of uncertainty based on 0300 UTC of 11th May (b) Observed and forecast track alongwith with Quadrant wind distribution based on 0300 UTC of 11th May (c) Typical Storm Surge Warning Graphics (d) Fisherman warning graphics based on 0300 UTC of 11th May

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: Example hourly Bulletin issued during MOCHA on the day of landfall on 14th May:

***Special Hourly Message: 2**

Sub: Extremely Severe Cyclonic Storm "Mocha" (pronounced as "Mokha") is making landfall over Myanmar-Bangladesh coasts: Center lay just over the coastline at 1330 IST.

The **Extremely Severe Cyclonic Storm "Mocha"** (pronounced as **"Mokha")** overNortheast Bay of Bengal moved nearly north-northeastwards and lay centered at 1330 hours IST of today, the 14th May 2023 over Myanmar & southeast Bangladesh coastline near latitude 20.3°N and longitude 92.7°E, about 30 km northwest of Sittwe (Myanmar) and 145 km southeast of Cox's Bazar (Bangladesh).

It is crossing southeast Bangladesh and north Myanmar coasts between Cox's Bazar (Bangladesh) and Kyaukpyu (Myanmar), close to north of Sittwe (Myanmar) and landfall process will be completed during next 2 hours. The system is continuing the weakening trend and will weaken into a very severe cyclonic storm during next 6 hours.

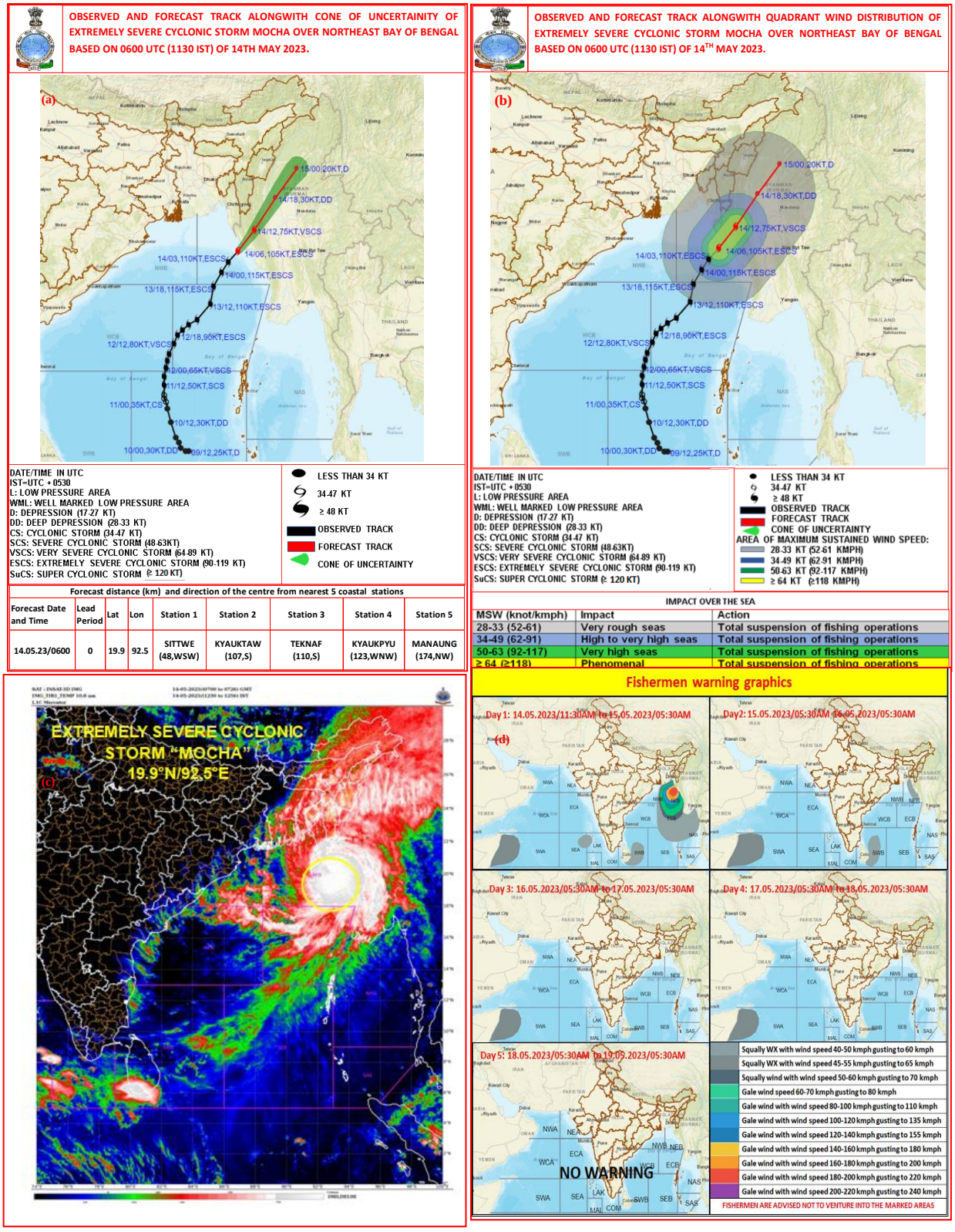


Fig. 2.4.10: a) Observed and forecast track alongwith with cone of uncertainty based on 0600 UTC of 14th May (b) Observed and forecast track alongwith with Quadrant wind distribution based on 0600 UTC of 14th May (c) Typical Satellite imagery association with Cyclonic Storm 'MOCHA' over Bay of Bengal (d) Fisherman warning graphics based on 0600 UTC of 14th May

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.II-9.**

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.**

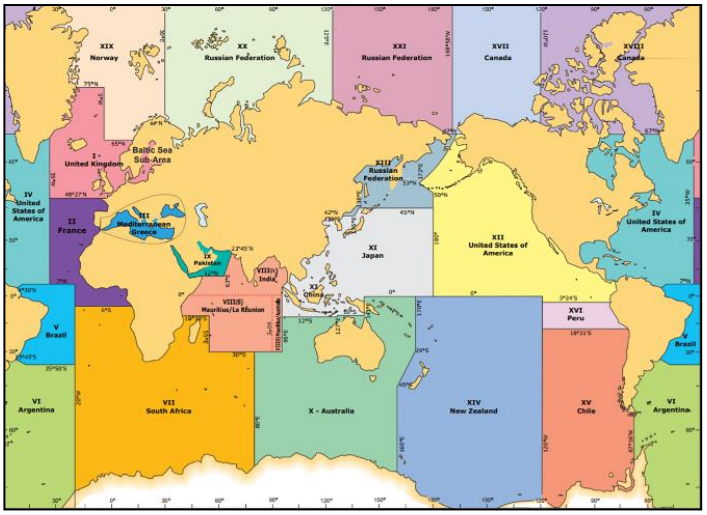


Fig. II-9: AREAS OF RESPONSIBILITY AND DESIGNATED NATIONAL METEOROLOGICAL SERVICES FOR THE ISSUE OF WARNINGS AND WEATHER AND SEA BULLETINS FOR THE WWMIWS

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

Station	Call sign of Coastal Radio Station	Area covered
Bangladesh, Chittagong	ASC	Bay of Bengal north of 18ºN Lat.
India, Mumbai		Arabian Sea north of Lat. 5ºN and east of Long. 60ºE excluding the area north of Lat. 20ºN and west of Long. 68ºE. The eastern boundary of the Arabian Sea for which these bulletins are issued by Mumbai is Long. 80ºE meridian excluding the Gulf of Mannar.
India, Kolkata		Bay of Bengal north of Lat. 5ºN except the area between the coastline on the east and the line drawn through the points 18ºN 94.5ºE, 18ºN 92ºE, 13.5ºN 92ºE, 13.5ºN 94ºE, 10ºN 94ºE, 10ºN 95ºE and 5ºN 95ºE. 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., 77.5ºE meridian).
India, Chennai		Bay of Bengal bulletins issued by ACWC Kolkata are being broadcast through Navtex, Chennai by Narrow Band Direct Printing (NBDP)
Myanmar, Yangon	XYR	Bay of Bengal except area west of Long. 92ºE and South of 10ºN Lat.
Oman (Sultanate of)	A4M	Muscat Coastal Radio Station
Pakistan, Karachi	ASK	Arabian Sea north of 20ºN, Gulf of Oman and Persian Gulf (12˚N-63˚E)
Sri Lanka, Colombo	4PB	Indian Ocean, Arabian Sea and Bay of Bengal from the equator to 10^{0}N between 60^{0}E and 95^{0}E. The area 5^{0}N to 10^{0}N between 60^{0}E and 95^{0}E is an overlap with India.
Thailand, Bangkok	HSA	Gulf of Thailand, west of southern Thailand, Strait of Malacca and South China Sea.
Qatar		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 informations:

(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 111330 IST
DATE/TIME OF ISSUE: 11-05-2023/0800 UTCGMDSS BULLETIN I 110900
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; THEEAST AFRICAN COAST SOUTH TO THE EQUATOR, THENCE TO 95 DEG E, TO 6 DEG N, THENCE NORTHEASTWARDS TO MYANMAR/THAILAND FRONTIER IN 10 DEG N 98 DEG 30'E AND NORTHWARDS COVERING ENTIRE BAY OF BENGAL.

VALID FROM 09 UTC OF 11TH MAY 2023 TO 00 UTC OF 13TH MAY 2023

PART-I STORM WARNING:

SUB: CYCLONIC STORM "MOCHA" PRONOUNCED AS "MOKHA" OVER SOUTHEAST BAY OF BENGAL.

THE CYCLONIC STORM "MOCHA" PRONOUNCED AS "MOKHA" OVER SOUTHEAST BAY OF BENGAL MOVED NORTH-NORTHWESTWARDS WITH A SPEED OF 8 KMPH DURING PAST 06 HOURS, AND LAY CENTERED AT 0300 UTC OF 11TH MAY 2023 OVER THE SAME REGION NEAR LATITUDE 11.4°N AND LONGITUDE 88.0°E, ABOUT 510 KM WEST-SOUTHWEST OF PORT BLAIR, 1190 KM SOUTH- SOUTHWEST OF COX'S BAZAR (BANGLADESH) AND 1100 KM SOUTH-SOUTHWEST OF SITTWE (MYANMAR).

IT IS VERY LIKELY TO MOVE NORTH-NORTHWESTWARDS AND GRADUALLY INTENSIFY INTO A SEVERE CYCLONIC STORM AROUND NIGHT OF TODAY, THE 11TH MAY. THEREAFTER, IT IS LIKELY TO RECURVE GRADUALLY, MOVE NORTH-NORTHEASTWARDS FROM 12TH MAY

MORNING AND INTENSIFY FURTHER INTO A VERY SEVERE CYCLONIC STORM AROUND 12TH MAY EVENING OVER CENTRAL BAY OF BENGAL. IT WOULD REACH ITS PEAK INTENSITY AROUND 13TH MAY EVENING. IT IS LIKELY TO CROSS SOUTHEAST BANGLADESH AND NORTH MYANMAR COASTS BETWEEN COX'S BAZAR (BANGLADESH) AND KYAUKPYU (MYANMAR), CLOSE TO SITTWE (MYANMAR) AROUND NOON OF 14TH MAY, 2023 WITH MAXIMUM SUSTAINED WIND SPEED OF 140-150 KMPH GUSTING TO 165 KMPH.

12 HRS VALID 2023/05/11 AT 15 UTC 12.5N / 87.9 E MAX WIND 50 KTS SEVERE CYCLONIC STORM (.)
24 HRS VALID 2023/05/12 AT 03 UTC 13.5 N / 88.2 E MAX WIND 65 KTS VERY SEVERE CYCLONIC STORM (.)

THE MAXIMUM SUSTAINED SURFACE WIND SPEED IS 35 KNOTS GUSTING TO 45 KNOTS. THE ESTIMATED CENTRAL PRESSURE IS ABOUT 996 HPA.

PART-II SYNOPTIC WEATHER SYSTEM AT 0300 UTC:

THE TROUGH FROM CYCLONIC CIRCULATION ASSOCIATED WITH THE CYCLONIC STORM "MOCHA" OVER SOUTHEAST BAY OF BENGAL TO SOUTH ANDHRA PRADESH COAST EXTENDING UPTO 5.8 KM ABOVE MEAN SEA LEVEL TILTING SOUTHWESTWARDS WITH HEIGHT PERSISTS.

ARB A1-FORECAST VALID FROM 09 UTC OF 11TH MAY 2023 TO 00 UTC OF 12TH MAY 2023
I)WIND DIRECTION AND SPEED:
1)W OF 68 DEG E: SW/W-LY 10/20 KTS BEC NW-LY 05/15 KTSTO THE E OF 58 DEG E.
2)REST AREA: SW-LY 10/25 KTS.

II) WEATHER:

1)E OF 60 DEG E: WIDESPREAD RA/TS.
2)REST AREA: ISOLATED RA/TS.

III) VISIBILITY:

1)E OF 60 DEG E: 3-2 NM.

2)REST AREA: 8-6 NM. IV)WAVE HEIGHT: 1.5-3.0 MTR.

ARB A1-FORECAST VALID FROM 00 UTC OF 12TH MAY 2023 TO 00 UTC OF 13TH MAY 2023
I) WIND DIRECTION AND SPEED: SW/W-LY 10/20 KTS BEC SW-LY 10/25 KTS TO THE E OF 70 DEG E.II)WEATHER: 1)E OF 60 DEG E: WIDESPREAD RA/TS.
2) REST AREA: ISOLATED RA/TS. III) VISIBILITY: 1) E OF 60 DEG E: 3-2 NM.2) REST AREA: 8-6 NM.
IV) WAVE HEIGHT: 0.5-3.0 MTR.

ARB A2-ARABIAN SEA:-23 DEG 45 MIN N 68 DEG E TO 12 DEG N 63 DEG ETO CAPE GARDAFUI TO N OF 10 DEG N (.)
ARB A2-FORECAST VALID FROM 09 UTC OF 11TH MAY 2023 TO 00 UTC OF 12TH MAY 2023
I)WIND DIRECTION AND SPEED: SW-LY 05/15 KTS BEC W/NW-LY 05/15 KTS TO THE E OF 64 DEG E.II)WEATHER: 1)S OF 14 DEG N TO THE E OF 61 DEG E: ISOLATED RA/TS.
2)REST AREA: FAIR.
III) VISIBILITY: 1)S OF 14 DEG N TO THE E OF 61 DEG E: 8-6 NM.2)REST AREA: 10-8 NM.
IV) WAVE HEIGHT: 0.5-1.5 MTR.
ARB A2-FORECAST VALID FROM 00 UTC OF 12TH MAY 2023 TO 00 UTC OF 13TH MAY 2023
I)WIND DIRECTION AND SPEED: SW-LY 10/20 KTS BEC W/NW-LY 10/15 KTS TO THE E OF 64 DEG E.
II)WEATHER: 1)S OF 14 DEG N: ISOLATED RA/TS.
2)REST AREA: FAIR.
III) VISIBILITY: 1)S OF 14 DEG N: 8-6 NM.2)REST AREA: 10-8 NM.

IV) WAVE HEIGHT: 0.5-1.5 MTR.

BOB A3-BAY OF BENGAL: EQUATOR TO 10 DEG N BETWEEN E OF 80 DEG E AND WEST OF 10DEG N/98 DEG 30 MIN E TO 6 DEG N/95 DEG E AND THENCE S-WARDS TO EQUATOR (.)
BOB A3-FORECAST VALID FROM 09 UTC OF 11TH MAY 2023 TO 00 UTC OF 12TH MAY 2023
1) WIND DIRECTION AND SPEED: 1)N OF 5 DEG N: CYCLONIC 40/50 KTS
2) REST AREA: SW-LY 15/25 KTS. II)WEATHER: FAIRLY WIDESPREAD RA/TS.III)VISIBILITY: 4-3 NM.IV)WAVE HEIGHT: 6.0-9.0 MTR.

BOB A3-FORECAST VALID FROM 00 UTC OF 12TH MAY 2023 TO 00 UTC OF 13TH MAY 2023
I)WIND DIRECTION AND SPEED: SW-LY 15/35 KTS.II)WEATHER: SCATTERED RA/TS.
III)VISIBILITY: 6-4 NM.
IV)WAVE HEIGHT: 6.0-9.0 MTR.

BOB: A4: BAY OF BENGAL N OF 10 DEG N AND E OF 80 DEG E (.)
BOB A4-FORECAST VALID FROM 09 UTC OF 11TH MAY 2023 TO 00 UTC OF 12TH MAY 2023
I) WIND DIRECTION AND SPEED: 1)S OF 18 DEG N: CYCLONIC 40/50 KTS.2)REST AREA: SE-LY 05/15 KTS.
II) WEATHER: 1)S OF 20 DEG N: WIDESPREAD RA/TS.2)REST AREA: ISOLATED RA/TS.
III) VISIBILITY: 1)S OF 20 DEG N: 3-2 NM.2)REST AREA: 8-6 NM.
IV) WAVE HEIGHT: 6.0-9.0 MTR.

BOB A4-FORECAST VALID FROM 00 UTC OF 12TH MAY 2023 TO 00 UTC OF 13TH MAY 2023
I) WIND DIRECTION AND SPEED: 1)S OF 18 DEG N: CYCLONIC 70/80 KTS.
2)N OF 18 DEG N: E/NE-LY 20/25 KTS.
II) WEATHER: 1)E OF 84 DEG E: WIDESPREAD RA/TS.2)REST AREA: FAIR.
III) VISIBILITY: 1)E OF 84 DEG E: 3-2 NM.2)REST AREA: 10-8 NM.
IV) WAVE HEIGHT: 14.0 MTR AND ABOVE.

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

NEXT FORECAST WILL BE ISSUED AT 11/1700 UTC
==========
TOO:-11/1330

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 10^0S & 35^0N and longitude 40^0E & 100^0E. The test messages in this regard were issued in November, 2023. The bulletin will be issued as and when request from the member country is received by RSMC (MER-SAR).

Typical example of Marine Emergency Response Bulletin

India Meteorological Department

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

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^{0}20′30″, 54^{0}20′23″
Last Known Time (LKT): 28/11/2023 0700 UTC
Object Type: Person in water (PIW)

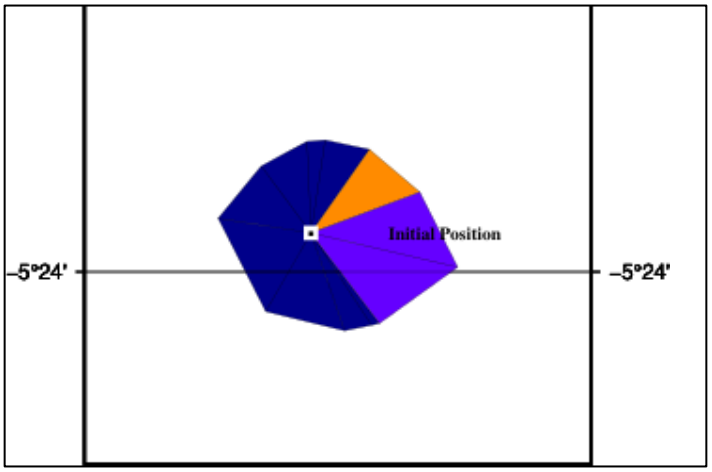
Probable drift areas information generated using the Search and AidRescue Tool (SARAT) to search for the lost object/person

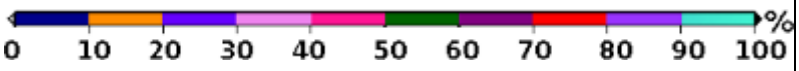
(From the Last Known Time to 48 hrs)

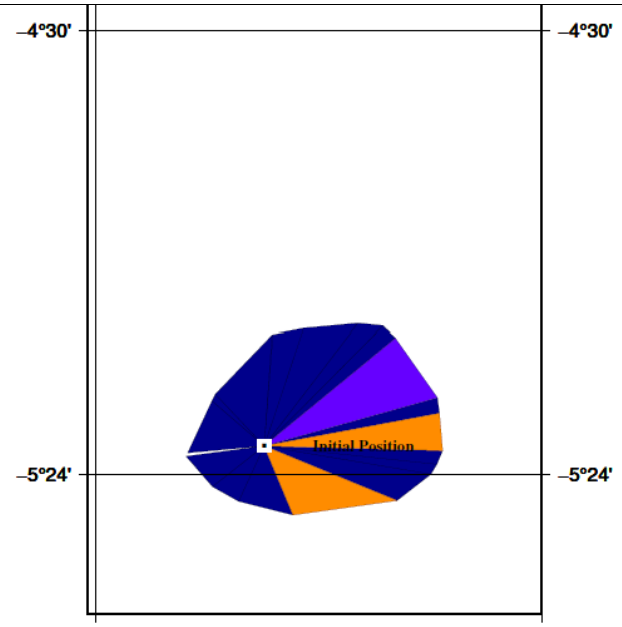
Last Known Position (LKP): 5^{0}20’30’’ S & 54^{0}20’23’’ E

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

Object Type: Person in water (PIW)

S.No.	Time afterLKT	Probability regions with coordinates
1	+ 6 Hours	

		REGION 1: Advised to search the triangular are bounded by the following lat. Lo Positions for finding the missing objects with 30 % probability. 1) 54 deg 20 min 24 sec, -5 deg 20 min 31 sec 2) 54 deg 26 min 34 sec, -5 deg 28 min 36 sec 3) 54 deg 30 min 10 sec, -5 deg 16 min 51 sec 4) 54 deg 33 min 34 sec, -5 deg 23 min 34 sec REGION 2: Advised to search the triangular are bounded by the following lat. Lo Positions for finding the missing objects with 20 % probability. 1) 54 deg 20 min 24 sec, -5 deg 20 min 31 sec 2) 54 deg 25 min 39 sec, -5 deg 13 min 8395385742188400 sec 3) 54 deg 30 min 10 sec, -5 deg 16 min 51 sec **Coordinates of the highest probable region(s):** **Link to SARAT advisory in PDF format:** https://sarat.incois.gov.in/sarat/data/pdf/bulletein-  5424.pdf
2	**+ 12 hours**	**Link to SARAT advisory in PDF format:** https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5426.pdf
3	**+ 18 hours**	**Link to SARAT advisory in PDF format:** https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5427.pdf
4	**+ 24 hours**	**Link to SARAT advisory in PDF format:** https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5428.pdf
5	**+ 30 hours**	**Link to SARAT advisory in PDF format:** https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5430.pdf
6	**+ 36 hours**	**Link to SARAT advisory in PDF format:** https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5431.pdf
7	**+ 42 hours**	**Link to SARAT advisory in PDF format:** https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5433.pdf

8	**+ 48 hours**	 REGION 1: Advised to search the triangular are bounded by the following lat. Lon. Positions for finding the missing objects with 30 % probability. 1) 54 deg 20 min 24 sec, -5 deg 20 min 31 sec 2) 54 deg 36 min 17 sec, -5 deg 7 min 25 sec 3) 54 deg 41 min 22 sec, -5 deg 14 min 38 sec REGION 2: Advised to search the triangular are bounded by the following lat. Lon. Positions for finding the missing objects with 20 % probability. 1) 54 deg 20 min 24 sec, -5 deg 20 min 31 sec 2) 54 deg 23 min 53 sec, -5 deg 28 min 55 sec 3) 54 deg 36 min 28 sec, -5 deg 27 min 10 sec 4) 54 deg 41 min 38 sec, -5 deg 16 min 32 sec 5) 54 deg 42 min 1 sec, -5 deg 21 min 4 sec

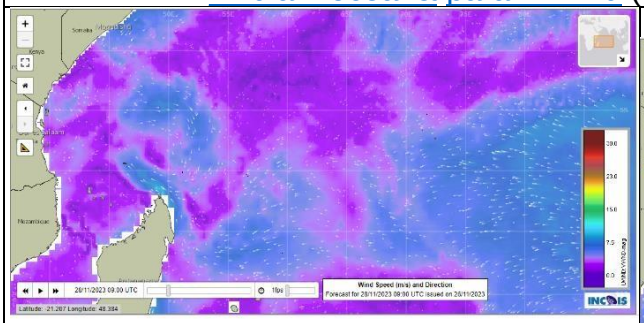
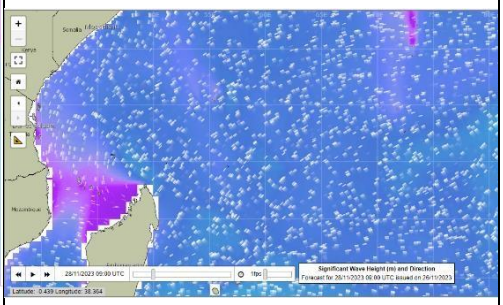
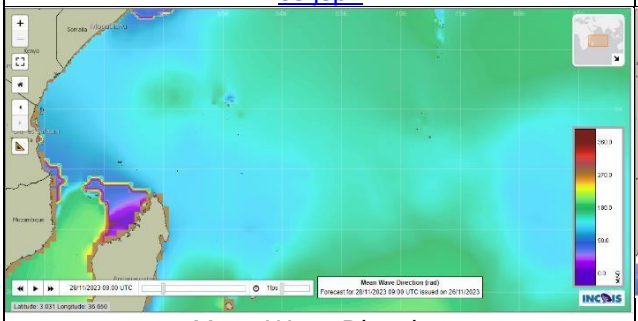
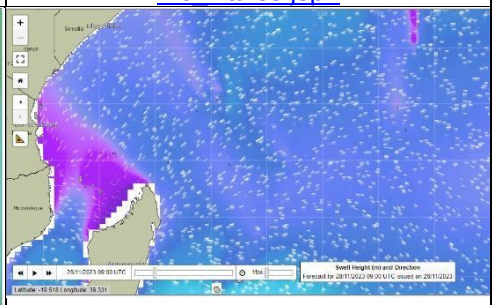
		Coordinates of the highest probable region(s): **Link to SARAT advisory in PDF format:** https://sarat.incois.gov.in/sarat/data/pdf/bulletein-5425.pdf

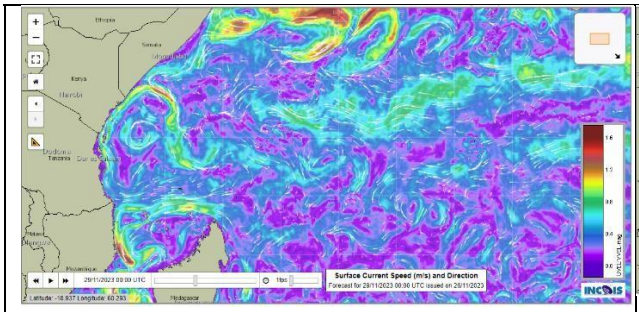
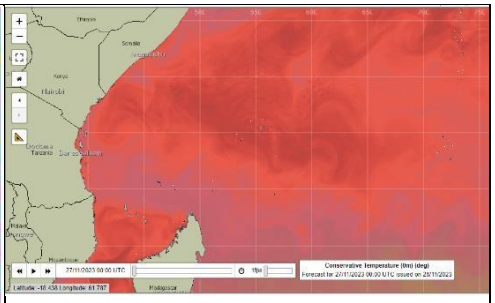
SAR Advisory:

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 thetriangular/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 conductedat 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

Graphical Products available at https://incois.gov.in/oceanservices/rsmc.jsp (Forecast at specific location and parameter can be obtained by clicking on interactive webmap) https://incois.gov.in/portal/osf/osfRegional.jsp?region=regional&area=northern_indian_ocean& param=wind (6 hourly animations)	
	
Wind Speed and Direction	**Significant Wave Height and Direction**
Animated Images:	Animated Images:
https://incois.gov.in/oceanservices/rsmc_waves.jsp#	https://incois.gov.in/oceanservices/rsmc_waves.jsp#
	
Mean Wave Direction	Swell Wave Height and Direction
Animated Images: https://incois.gov.in/oceanservices/rsmc_waves.jsp#	Animated Images: https://incois.gov.in/oceanservices/rsmc_waves.jsp#
Oceean Currents Speed and Direction	Sea Surface Temparature

	
https://incois.gov.in/oceanservices/rsmc_ocean.jsp (24 hourly in UTC) https://incois.gov.in/portal/osf/osfRegional.jsp?region=regional&area=northern_indian_ocean&param=s urfacecurrents (3 hourly in IST (UTC + 5.30)	https://incois.gov.in/oceanservices/rsmc_ocean.js p (24 hourly in UTC) https://incois.gov.in/portal/osf/osfRegional.jsp?region=regional&area=northern_indian_ocean&par am=sst (3 hourly in IST (UTC + 5.30)

The six-hourly animations of ocean stateII-41 forecast and SAR advisories are also available atINCOIS FTP server.

Server URL: ftpser.incois.gov.in
Path: /home1/incois/RSMC-MER/SAR/SAR-20231128-01

Username : incois
Password : incois@123

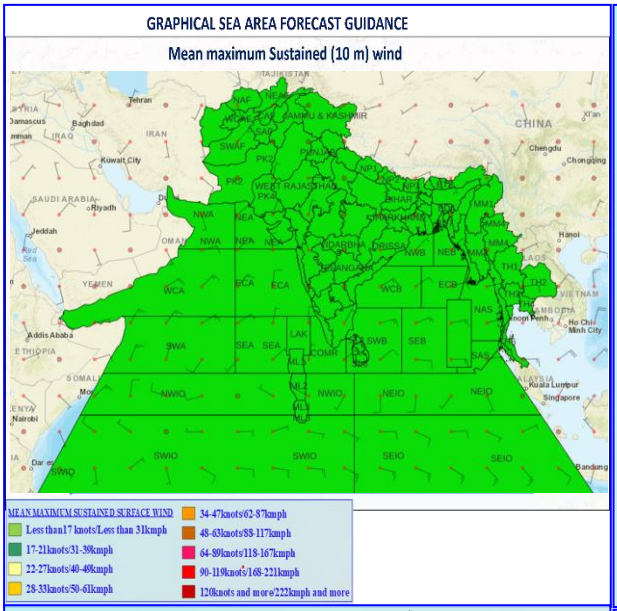
- **Significant Weather**: (Low Pressure system if any): No significant weather
- **Wind**: North-northeasterly to North-northwesterly/05-10 knots during 0600 UTC of 28th to 0600 UTC of 29th November. South-southwesterly to southeasterly/ 05-10 knots during 0600 UTC of 29th to 0600 UTC of 30th November.
- **Rainfall:** Light to moderate rainfall (0.5-3.0 mm) during next 48 hours.
- **Visibility:** Good to fair during next 48 hours.
- **Cloud Cover:** Mainly cloudy sky (6-8 oktas) during 0600 UTC of 28th November to 0600 UTC of 30th November.
- **Surface Relative Humidity:** It is likely to be 60-70% over the Area of concern during next 48 hours.

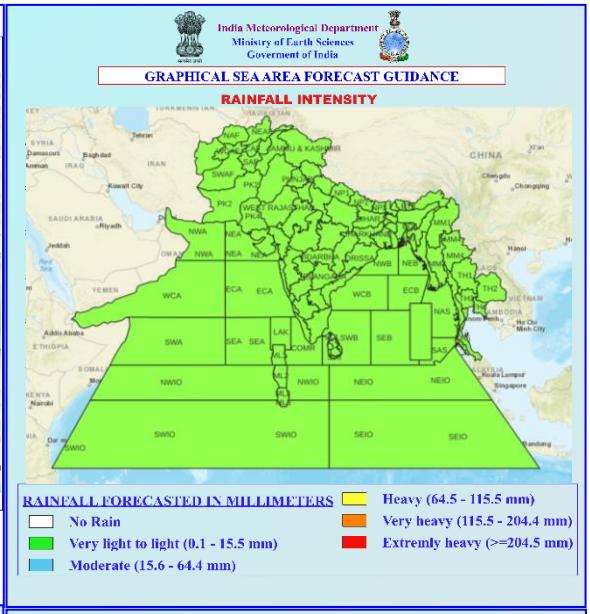
Location Specific MME based 6 hourly forecasts for the search region during next 48 hours based on 0600 UTC model run:
(Location : **-5^{0}20′30″, 54^{0}20′23″**)

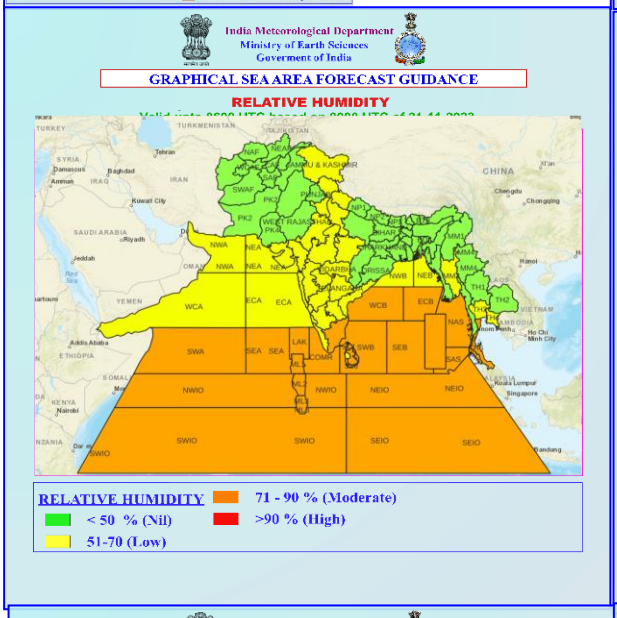
Hour	Rainfall (mm)	10m Wind speed (knots)	10m Wind Direction	2m Relative Humidity (%)	Total Cloud Cover (%)
6	0	6.0	NNE	70	100
12	0	4.0	NNW	67	100
18	0	2.0	NNW	67	100
24	0	2.5	N	68	100
30	3.0	3.5	ENE	70	100
36	0.1	2.5	SSW	69	100
42	0.0	2.0	S	70	100
48	0.0	2.0	SE	70	96

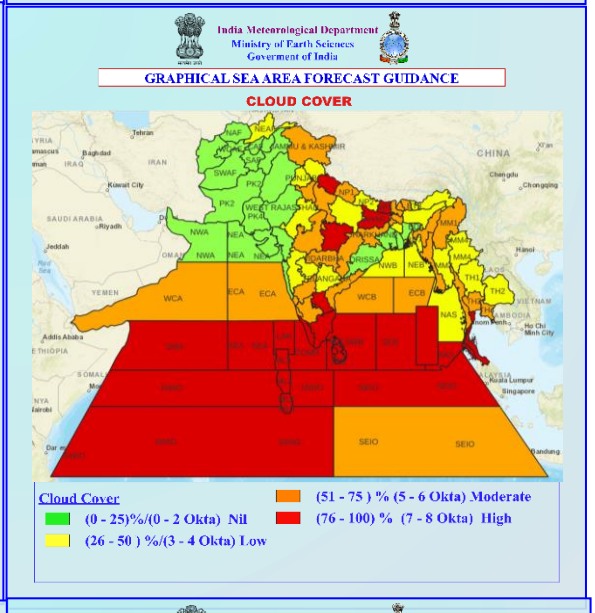
Annexure – I

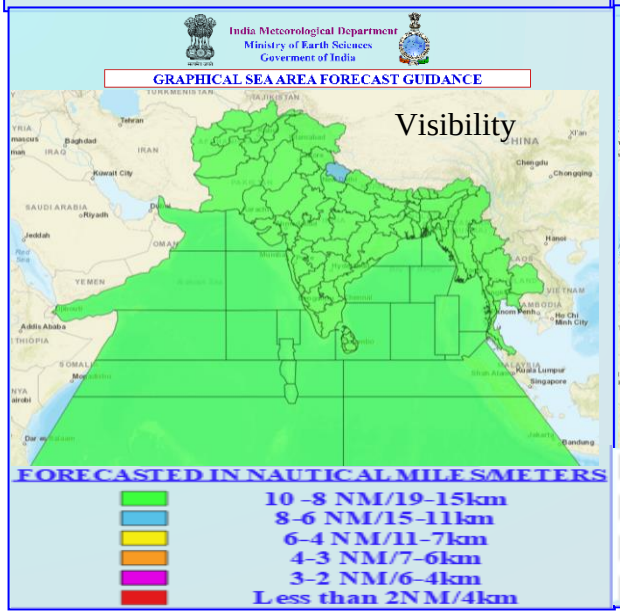
Multi Model Ensemble based Graphical Forecast for Weather State Parameters:

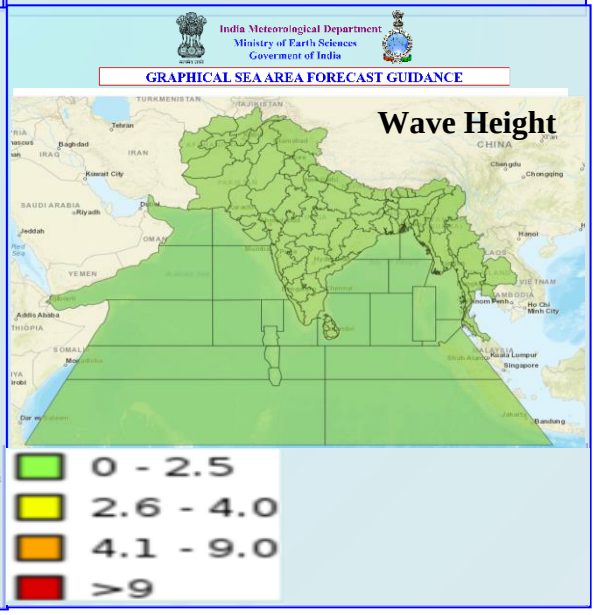












2.4.7 Warnings and advisories for Aviation

In accordance with the International Civil Aviation Organization (ICAO) Annex 3 — *Meteorological Service for International Air Navigational* 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 alongwith 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: 20230511/0600Z
TC: MOCHA
NR: 06
PSN: N1136 E08800
MOV: NNW06KT
INTST CHANGE: INTSF
C: 996HPA
MAX WIND: 45KT
FCST PSN+06HR: 11/1200Z N1212 E08754
FCST MAX WIND +06HRS: 50 KT
FCST PSN+12HR: 11/1800Z N1242 E08754
FCST MAX WIND +12HRS: 55 KT
FCST PSN+18HR: 12/0000Z N1312 E08800
FCST MAX WIND +18HRS: 65 KT
FCST PSN+24HR: 12/0600Z N1348 E08818
FCST MAX WIND +24HRS: 70 KT
RMK: NIL
NEXT MSG: 110523/1500Z
TOO: 111420HRS 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.II-10.

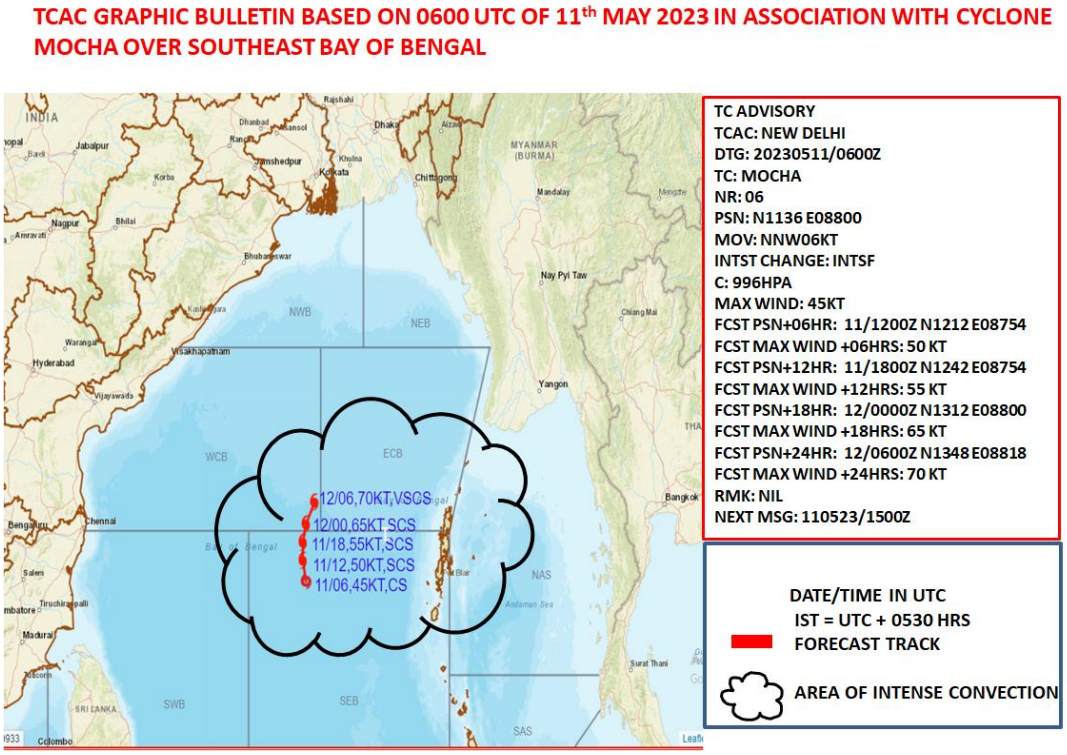


Fig II-9: Typical graphical TCAC bulletin during CS MOCHA

(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
MOCHA
202305091200 08.3 089.5 025 O
202305091800 08.3 089.3 025 O
202305100000 08.5 089.0 030 O
202305100300 08.8 088.9 030 O
202305100600 09.1 088.7 030 O
202305101200 10.0 088.4 030 O
202305101800 10.8 088.2 030 O
202305110000 11.2 088.1 035 O
202305110300 11.4 088.0 035 O
202305110600 11.6 088.0 045 O
202305111200 12.2 087.7 050 F
202305111800 12.7 087.9 055 F
202305120000 13.2 088.0 065 F
202305120600 13.8 088.3 065 F

2.4.8 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.

2.4.9 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 0300 UTC OF 11th May, 2023

STORM SURGE GUIDANCE (GRAPHICS ATTACHED) FOR NORTH MYANMAR AND ADJOINING SOUTHEAST BANGLADESH COASTS:

Storm surge with height of about 2.0-2.5 m above the astronomical tide is likely to inundate low lying areas of north Myanmar and adjoining southeast Bangladesh coasts during the time of landfall.

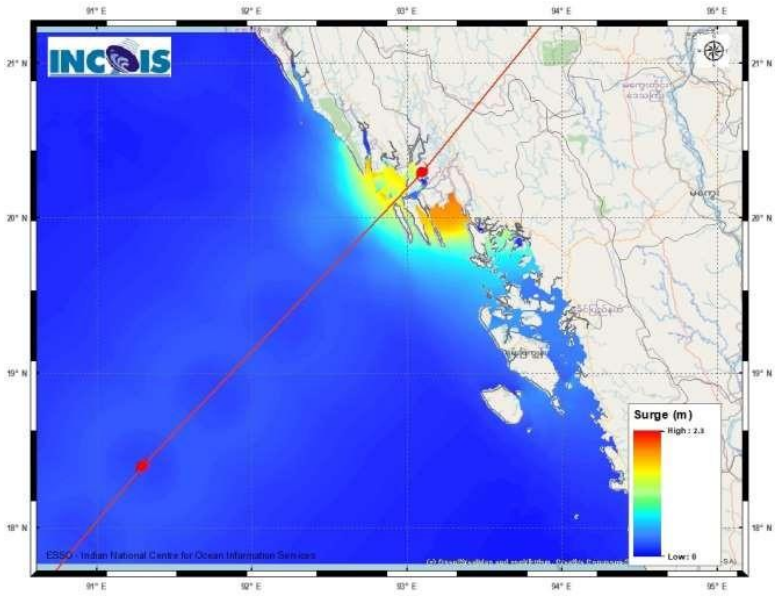


Fig.II-10 Storm Surge guidance based on 0300 UTC of 11th in association with MOCHA

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://ddgmui.imd.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. II-12.

2.5.1 Cone of uncertainty:

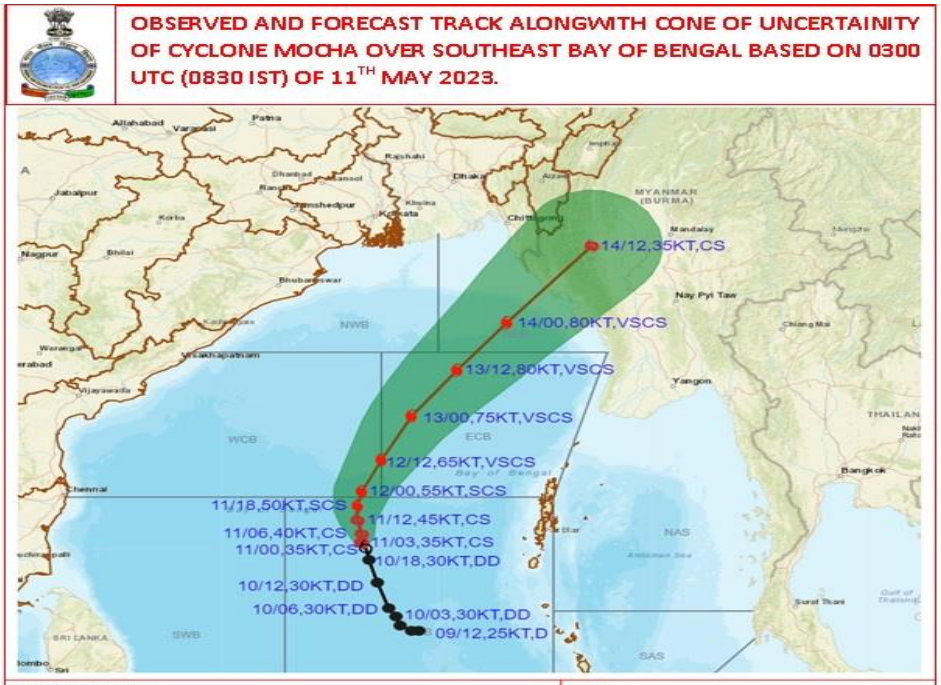
The cone of uncertainty in the forecast was introduced with effect from the cyclone, 'WARD' during December, 2009 for the lead time 72 hours at an interval of 12 hrs. It was further revised with effect from cyclone 'VIYARU' during May, 2013 and extended upto 120 hrs for the

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



Forecast distance (km) and direction of the centre from nearest 5 coastal stations

Forecast Date and Time	Lead Period	Lat	Lon	Station 1	Station 2	Station 3	Station 4	Station 5
11.05.23/0300	0	11.4	88.0	HUT BAY (505,W)	PORT BLAIR (515,W)	LONG ISLAND (549,WSW)	MAYA BANDAR (561,W SW)	CAR NICOBAR (585,WNW)
12.05.23/0000	21	13.2	88.0	MAYA BANDAR (534,W)	PORT BLAIR (540,WNW)	LONG ISLAND (543,W)	HUT BAY (575,WNW)	COCO ISLAND (589,W)
13.05.23/0000	45	15.8	89.3	COCO ISLAND (476,WNW)	MAYA BANDAR (505,NW)	LONG ISLAND (544,NW)	PARADIP (CWR) (572,SSE)	SANDHEADS (573,SSE)
14.05.23/0000	69	19	91.8	SITTWE (170,SW)	KYAUKPYU (190,WSW)	MANAUNG (204,W)	TEKNAF (214,SSW)	KYAUKTAW (224,SSW)

Fig.II-11 Observed and forecast track based on 0300 UTC of 11th in association with CS MOCHA

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 was 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.II-13. 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.

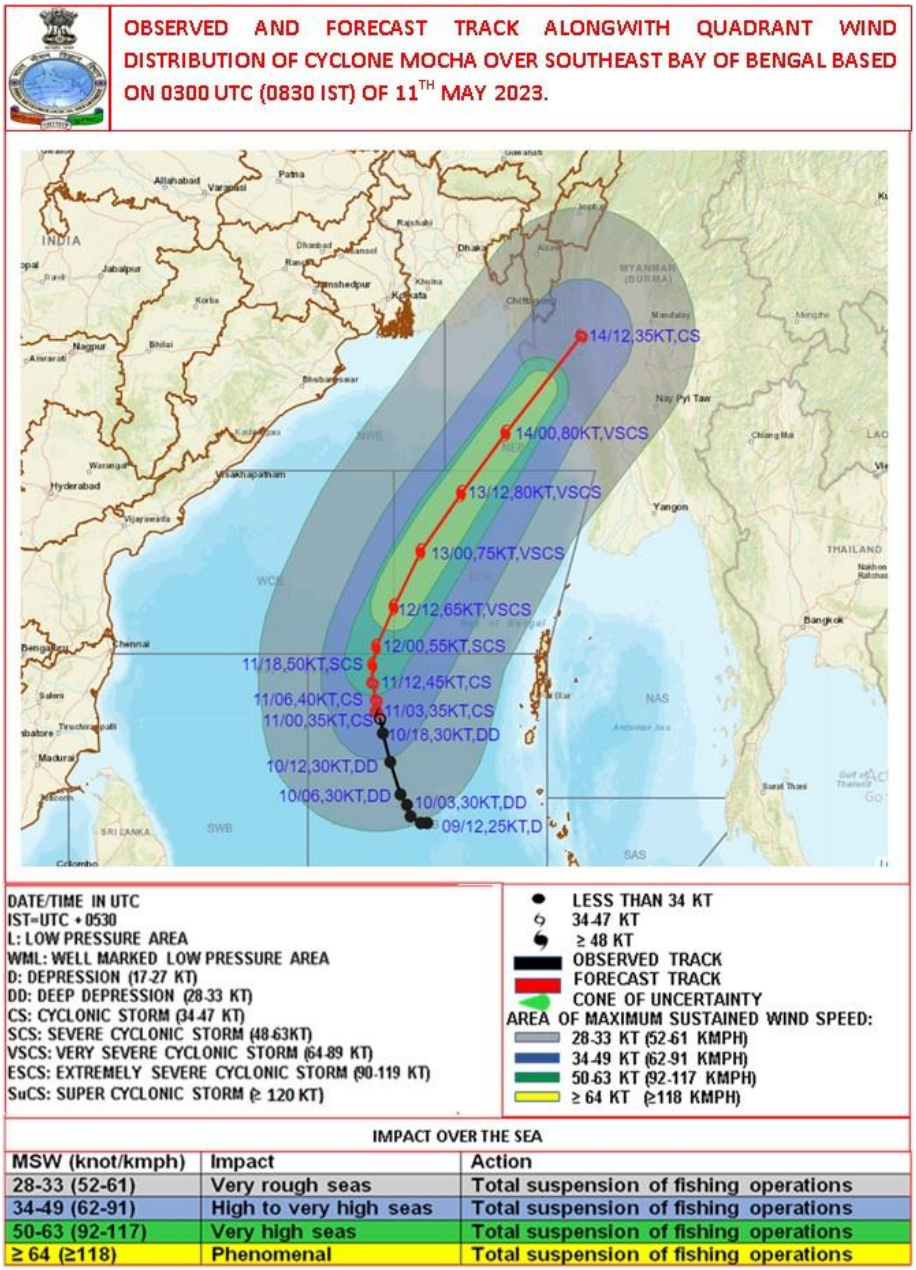


Fig.II-12: A typical example of observed track and forecast area of maximum sustained wind in association based on 0300 UTC of 11th in association with CS MOCHA

(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. II.14 in association with ESCS MOCHA

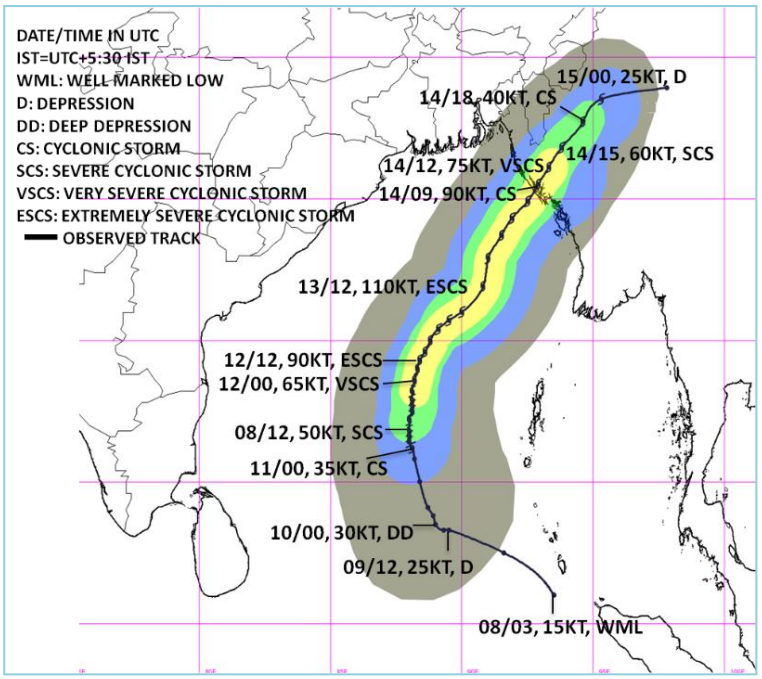


Fig. II.13: Estimated maximum sustained wind speed in association with ESCS MOCHA during 9th-14th May

(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. II.14 in association with ESCS Mocha.

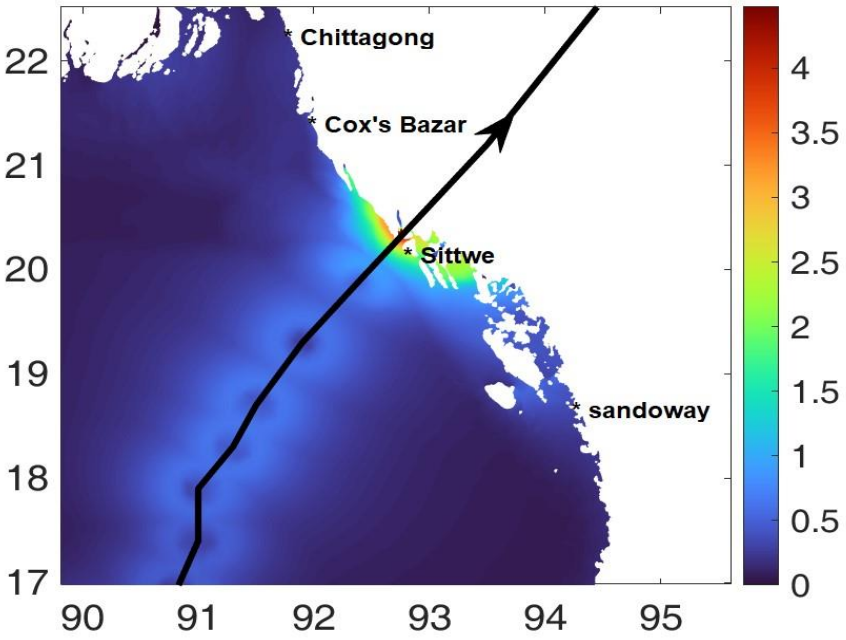


Fig. II.14: Estimated storm surge in association with ESCS Mocha during landfall

(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 MOCHA OVER BAY OF BENGAL ON 0600 UTC OF 11-05-2023 FOR WHICH FORECAST IS PREPARED:
PRESENT DATE AND TIME: **110600**
PRESENT POSITION: **11.6°N/88°E**
POSITION ACCURATE TO 20 KM
PRESENT MOVEMENT (DDD/FF) PAST SIX HOURS: 346/04KT
PRESENT WIND DISTRIBUTION:
MAX SUSTAINED WINDS: 45 KT, GUSTS 55 KT
RADIUS OF MAXIMUM WIND **40 NM**
WINDS VARY IN EACH QUADRANT
RADII ARE LARGEST RADII EXPECTED ANYWHERE IN THE QUADRANT
WIND RADII VALID OVER OPEN WATER ONLY
RADIUS OF 027KT WINDS:
210 NM NORTHEAST QUADRANT
160 NM SOUTHEAST QUADRANT
200 NM SOUTHWEST QUADRANT
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:
100 NM NORTHEAST QUADRANT
80 NM SOUTHEAST QUADRANT
80 NM SOUTHWEST QUADRANT
60 NM NORTHWEST QUADRANT

FORECASTS:
06 HRS, VALID AT:
111200Z 12.2°N/87.9°E
MAX SUSTAINED WINDS: 50 KT, GUSTS 60 KT
RADIUS OF 027KT WINDS:
210 NM NORTHEAST QUADRANT
160 NM SOUTHEAST QUADRANT
200 NM SOUTHWEST QUADRANT
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:
100 NM NORTHEAST QUADRANT
80 NM SOUTHEAST QUADRANT
80 NM SOUTHWEST QUADRANT
60 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:
65 NM NORTHEAST QUADRANT
50 NM SOUTHEAST QUADRANT
50 NM SOUTHWEST QUADRANT
45 NM NORTHWEST QUADRANT
12 HRS, VALID AT:
111800Z 12.7°N/87.9°E
MAX SUSTAINED WINDS: 55 KT, GUSTS 65 KT
RADIUS OF 027KT WINDS:
210 NM NORTHEAST QUADRANT
160 NM SOUTHEAST QUADRANT

200 NM SOUTHWEST QUADRANT
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:
110 NM NORTHEAST QUADRANT
90 NM SOUTHEAST QUADRANT
90 NM SOUTHWEST QUADRANT
70 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:
65 NM NORTHEAST QUADRANT
50 NM SOUTHEAST QUADRANT
50 NM SOUTHWEST QUADRANT
45 NM NORTHWEST QUADRANT

18 HRS, VALID AT:
120000Z 13.2°N/88°E
MAX SUSTAINED WINDS: 65 KT, GUSTS 75 KT
RADIUS OF 027KT WINDS:
210 NM NORTHEAST QUADRANT
160 NM SOUTHEAST QUADRANT
200 NM SOUTHWEST QUADRANT
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:
110 NM NORTHEAST QUADRANT
90 NM SOUTHEAST QUADRANT
90 NM SOUTHWEST QUADRANT
70 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:
65 NM NORTHEAST QUADRANT
50 NM SOUTHEAST QUADRANT
50 NM SOUTHWEST QUADRANT
45 NM NORTHWEST QUADRANT

RADIUS OF 064KT WINDS:
45 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
30 NM SOUTHWEST QUADRANT
30 NM NORTHWEST QUADRANT

24 HRS, VALID AT:
120600Z 13.8°N/88.3°E
MAX SUSTAINED WINDS: 70 KT, GUSTS 80 KT
RADIUS OF 027KT WINDS:
210 NM NORTHEAST QUADRANT
160 NM SOUTHEAST QUADRANT
200 NM SOUTHWEST QUADRANT
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:
110 NM NORTHEAST QUADRANT
90 NM SOUTHEAST QUADRANT
90 NM SOUTHWEST QUADRANT
70 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:
65 NM NORTHEAST QUADRANT
50 NM SOUTHEAST QUADRANT

50 NM SOUTHWEST QUADRANT
45 NM NORTHWEST QUADRANT

RADIUS OF 064KT WINDS:
45 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
30 NM SOUTHWEST QUADRANT
30 NM NORTHWEST QUADRANT

36 HRS, VALID AT:
131800Z 15°N/88.9°E
MAX SUSTAINED WINDS: 75 KT, GUSTS 85 KT
RADIUS OF 027KT WINDS:
210 NM NORTHEAST QUADRANT
160 NM SOUTHEAST QUADRANT
200 NM SOUTHWEST QUADRANT
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:
120 NM NORTHEAST QUADRANT
90 NM SOUTHEAST QUADRANT
90 NM SOUTHWEST QUADRANT
80 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:
65 NM NORTHEAST QUADRANT
50 NM SOUTHEAST QUADRANT
50 NM SOUTHWEST QUADRANT
45 NM NORTHWEST QUADRANT

RADIUS OF 064KT WINDS:
45 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
30 NM SOUTHWEST QUADRANT
30 NM NORTHWEST QUADRANT

48 HRS, VALID AT:
130600Z 16.6°N/89.9°E
MAX SUSTAINED WINDS: 80 KT, GUSTS 90 KT
RADIUS OF 027KT WINDS:
210 NM NORTHEAST QUADRANT
160 NM SOUTHEAST QUADRANT
200 NM SOUTHWEST QUADRANT
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:
120 NM NORTHEAST QUADRANT
90 NM SOUTHEAST QUADRANT
90 NM SOUTHWEST QUADRANT
80 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:
65 NM NORTHEAST QUADRANT
50 NM SOUTHEAST QUADRANT
50 NM SOUTHWEST QUADRANT
45 NM NORTHWEST QUADRANT

RADIUS OF 064KT WINDS:

45 NM NORTHEAST QUADRANT

40 NM SOUTHEAST QUADRANT
30 NM SOUTHWEST QUADRANT
30 NM NORTHWEST QUADRANT

60 HRS, VALID AT:
131800Z 18.3°N/91.2°E
MAX SUSTAINED WINDS: 85 KT, GUSTS 95 KT
RADIUS OF 027KT WINDS:
210 NM NORTHEAST QUADRANT
160 NM SOUTHEAST QUADRANT
200 NM SOUTHWEST QUADRANT
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:
120 NM NORTHEAST QUADRANT
90 NM SOUTHEAST QUADRANT
90 NM SOUTHWEST QUADRANT
80 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:
65 NM NORTHEAST QUADRANT
50 NM SOUTHEAST QUADRANT
50 NM SOUTHWEST QUADRANT
45 NM NORTHWEST QUADRANT

RADIUS OF 064KT WINDS:
45 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
30 NM SOUTHWEST QUADRANT
30 NM NORTHWEST QUADRANT

72 HRS, VALID AT:
140600Z 20.1°N/92.7°E
MAX SUSTAINED WINDS: 85 KT, GUSTS 95 KT
RADIUS OF 027KT WINDS:
210 NM NORTHEAST QUADRANT
160 NM SOUTHEAST QUADRANT
200 NM SOUTHWEST QUADRANT
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:
120 NM NORTHEAST QUADRANT
90 NM SOUTHEAST QUADRANT
90 NM SOUTHWEST QUADRANT
80 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:
65 NM NORTHEAST QUADRANT
50 NM SOUTHEAST QUADRANT
50 NM SOUTHWEST QUADRANT
45 NM NORTHWEST QUADRANT

RADIUS OF 064KT WINDS:
35 NM NORTHEAST QUADRANT
30 NM SOUTHEAST QUADRANT
20 NM SOUTHWEST QUADRANT
20 NM NORTHWEST QUADRANT

84 HRS, VALID AT:
141800Z 22.3°N/94.5°E

MAX SUSTAINED WINDS: 50 KT, GUSTS 60 KT
RADIUS OF 027KT WINDS:
210 NM NORTHEAST QUADRANT
160 NM SOUTHEAST QUADRANT
200 NM SOUTHWEST QUADRANT
150 NM NORTHWEST QUADRANT

RADIUS OF 034KT WINDS:
110 NM NORTHEAST QUADRANT
90 NM SOUTHEAST QUADRANT
90 NM SOUTHWEST QUADRANT
70 NM NORTHWEST QUADRANT

RADIUS OF 050KT WINDS:
65 NM NORTHEAST QUADRANT
50 NM SOUTHEAST QUADRANT
50 NM SOUTHWEST QUADRANT
45 NM NORTHWEST QUADRANT

96 HRS, VALID AT:
150600Z 24.5°N/96.4°E
MAX SUSTAINED WINDS: 25 KT, GUSTS 35 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	MOCHA
integer tcv_century	2-digit century id (19 or 20)	20
integer tcv_yymmdd	Date of observation	230511
integer tcv_hhmm	Time of observation (UTC)	**0600**
integer tcv_lat	Storm Lat (X10), always >0	116 (for 11.6^0 latitude)
character*1 tcv_latns	'N' or 'S'	N
integer tcv_lon	Storm Lon (*10), always >0	**0880** (for 88.0^0 longitude)
character*1 tcv_lonew	'E' or 'W'	E
integer tcv_stdir	Storm motion vector (in degree)	**346** (Past six hours) (north-northwestwards)
integer tcv_stspd	Speed of storm movement (m/sX10)	020 (Past six hours Reported in 3 digits)
integer tcv_pcen	Min central pressure (mb)	0996 (Reported in 4 digits)
integer tcv_penv	outermost closed isobar(mb)	1003 (Reported in 4 digits)
integer tcv_penvrad	rad outermost closed isobar(km)	0350 (Reported in 4 digits) (300 km)
integer tcv_vmax	max sfc wind speed (m/s)	022 (Reported in 3 digits)
integer tcv_vmaxrad	rad of max sfc wind spd (km)	035 (Reported in 4 digits**)** (half of average of radius of MSW)
integer tcv_r15ne	NE rad of 34 knots winds (km)	0185 (Reported in 4 digits)
integer tcv_r15se	SE rad of 34 knots winds (km)	0148 (Reported in 4 digits)
integer tcv_r15sw	SW rad of 34 knots winds (km)	0148 (Reported in 4 digits)
integer tcv_r15nw	NW rad of 34 knots winds (km)	0111 (Reported in 4 digits)
character*1 tcv_depth	Storm depth (S,M,D,X)	D

	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	

Example:

IMD 01B MOCHA 20230511 0600 116N 0880E 346 020 0996 1003 0350 022 035 0185 0148 0148 0111 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 ≥28 knots, ≥34 knots, ≥50 knots, ≥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 2023 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.	:	**ARB/21/2023**
CYCLONE / DISTURBANCE NAME	:	BIPARJOY
ISSUED ON	:	10 JUNE 2023
BASED ON	:	0830 IST
CURRENT LOCATION OF CYCLONIC DISTURBANCE	:	LATITUDE 16.7°N AND LONGITUDE 67.4°E
GEOGRAPHIC REFERENCE	:	Eastcentral Arabian sea
CENTRAL PRESSURE	:	976 HPA
DIRECTION AND SPEED OF MOVEMENT DURING PAST 6 HOURS	:	Nearly northwards with a speed of 7 kmph
SYNOPSIS	:	The very severe cyclonic storm "Biparjoy" (pronounced as "Biporjoy") over eastcentral Arabian Sea moved nearly northwards with a speed of 7 kmph during past 6-hours and lay centered at 0830 hours IST of today, the 10th June, 2023 over the same region near latitude 16.7°N and longitude 67.4°E, about 700 km west-northwest of Goa, 620 km west-southwest of Mumbai, 600 km south-southwest of Porbandar and 910 km south of Karachi. It is very likely to intensify further and move north-northeastwards gradually during next 24 hours. Then it would move gradually north-northwestwards during subsequent 3 days.

Table 1: GENERAL forecast in association with cyclonic disturbance over the Arabian Sea based on 0830 hrs IST of 10th June,2023

FORECAST HOUR	DATE/ TIME (IST)	POSITION		FORECAST INTENSITY CATEGORY	FORECAST MOVEMENT		FORECAST WIND(KT)		UNCERTAINTY IN FORECAST		SIGNIFICANT WAVE HEIGHT(M)	STATE OF SEA
		LAT (°N)	LONG (°E)		SPEED (KMPH)	DIRECTION	MSW	GUST	PATH (NM)	INTENSITY (KT)		
0	10.06.23/ 0830	16.7	67.4	VSCS			75	85	10	15	>14.0	Phenomenal
3	10.06.23/ 1130	17.0	67.5	VSCS	12	NNE	80	90	10	15	>14.0	Phenomenal
9	10.06.23/ 1730	17.4	67.6	VSCS	8	NNE	80	90	20	15	>14.0	Phenomenal
15	10.06.23/ 2330	17.8	67.7	VSCS	8	NNE	85	95	30	15	>14.0	Phenomenal
21	11.06.23/ 0530	18.1	67.8	VSCS	6	NNE	85	95	40	15	>14.0	Phenomenal
33	11.06.23/ 1730	18.8	67.8	VSCS	6	N	80	90	50	15	>14.0	Phenomenal
45	12.06.23/ 0530	19.5	67.7	VSCS	7	N	80	90	65	15	>14.0	Phenomenal
57	12.06.23/ 1730	20.1	67.6	VSCS	6	N	75	85	80	15	>14.0	Phenomenal
69	13.06.23/ 0530	20.7	67.4	VSCS	6	NNW	75	85	90	15	>14.0	Phenomenal
81	13.06.23/ 1730	21.3	67.2	VSCS	6	NNW	70	80	105	15	>14.0	Phenomenal
93	14.06.23/ 0530	22.0	67.0	VSCS	7	NNW	65	75	125	10	>14.0	Phenomenal
105	14.06.23/ 1730	22.6	66.9	SCS	6	N	60	70	140	10	9.0-14.0	Very High
117	15.06.23/ 0530	23.2	66.8	SCS	6	N	55	65	155	10	9.0-14.0	Very High

Table 2: Wind forecast with radii of influence in association with cyclonic disturbance over the Arabian Sea based on 0830 hrs IST of 10th June,2023

FORECAST HOUR	DATE/ TIME (IST)	POSITION		FORECAST INTENSITY CATEGORY	WIND(KT)		RADII OF INFLUENCE (NM)															
							R28				R34				R20				R64			
		LAT (°N)	LONG (°E)		MSW	GUST	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE
0	10.06.23/ 0830	16.7	67.4	VSCS	75	85	110	110	115	115	85	85	95	95	50	50	55	55	25	25	30	30
3	10.06.23/ 1130	17.0	67.5	VSCS	80	90	110	110	115	115	85	85	95	95	50	50	55	55	25	25	30	30
9	10.06.23/ 1730	17.4	67.6	VSCS	80	90	110	110	115	115	85	85	95	95	50	50	55	55	25	25	30	30
15	10.06.23/ 2330	17.8	67.7	VSCS	85	95	120	120	125	125	90	90	100	100	55	55	60	60	25	25	30	30
21	11.06.23/ 0530	18.1	67.8	VSCS	85	95	120	120	125	125	90	90	100	100	55	55	60	60	25	25	30	30
33	11.06.23/ 1730	18.8	67.8	VSCS	80	90	110	110	115	115	85	85	95	95	50	50	55	55	25	25	30	30
45	12.06.23/ 0530	19.5	67.7	VSCS	80	90	110	110	115	115	85	85	95	95	50	50	55	55	25	25	30	30
57	12.06.23/ 1730	20.1	67.6	VSCS	75	85	110	110	115	115	85	85	95	95	50	50	55	55	25	25	30	30
69	13.06.23/ 0530	20.7	67.4	VSCS	75	85	110	110	115	115	85	85	95	95	50	50	55	55	25	25	30	30
81	13.06.23/ 1730	21.3	67.2	VSCS	70	80	110	110	115	115	85	85	95	95	50	50	55	55	25	25	30	30
93	14.06.23/ 0530	22.0	67.0	VSCS	65	75	110	110	115	115	85	85	95	95	50	50	55	55	25	25	30	30
105	14.06.23/ 1730	22.6	66.9	SCS	60	70	110	110	115	115	90	90	100	100	50	50	55	55				
117	15.06.23/ 0530	23.2	66.8	SCS	55	65	110	110	115	115	90	90	100	100	50	50	55	55				

TABLE 4: CYCLONIC DISTURBANCE FORECAST FOR ARABIAN SEA & MAJOR AREAS OF E&P OPERATIONS BASED ON 0830 hrs IST of 10th June,2023

Sl	DESCRIPTION Name(Lat°N /Long°E)	LOCATION		CURRENT LOCATION FROM CENTRE OF CYCLONIC DISTURABANCE		FORECAST PARAMETERS WHEN THE INSTALLATION WOULD BE NEAREST TO THE CYCLONE PATH							
		LAT (°N)	LON (°E)	DISTANCE (NM)	DIRECTION	DATE/ TIME(IST) OF OCCURRENCE	DISTANCE OF RIG FROM PATH	DIRECTION OF RIG FROM PATH	UNCERTAINITY IN DISTANCE OVER PATH(NM)	MSW OVER RIG(KTS)	UNCERTAINITY IN MSW OVER RIG(KT)	SIGNIFICANT WAVE HEIGHT	STATE OF SEA
Arabian Sea													
1.	Lakshadweep Area (LAK)-1 (8.75/75.67)	16.7	67.4	680	SE	10.06.23/0830	680	SE	10	<27	5	<4	Rough
2.	Lakshadweep Area (LAK)-2 (11.00/72.75)	16.7	67.4	463	SE	10.06.23/0830	463	SE	10	<27	5	<4	Rough
3.	Eastcentral Arabian Sea (ECA)-1 (15.33/72.75)	16.7	67.4	319	ESE	10.06.23/0830	319	ESE	10	<27	5	<4	Rough
4.	Eastcentral Arabian Sea (ECA)-2 (18.75/71.33)	16.7	67.4	256	ENE	11.06.23/1430	200	E	50	<27	5	<4	Rough
5.	Northeast Arabian Sea (NEA) (20.50/70.00)	16.7	67.4	272	NNE	12.06.23/1730	137	E	80	<27	5	<4	Rough
MAJOR E&P AREA IN THE Arabian Sea													
6.	Ratna Field (ECA) (18.15/72.30)	16.7	67.4	294	ENE	11.06.23/0530	257	E	40	<27	5	<4	Rough
7.	Neelam & Heera Field (ECA) (18.67/72.30)	16.7	67.4	304	ENE	11.06.23/1130	256	E	45	<27	5	<4	Rough
8.	Bassein Field (ECA) (19.22/72.00)	16.7	67.4	303	ENE	11.06.23/1730	239	E	50	<27	5	<4	Rough
9.	Mumbaai High Field (ECA) (19.40/71.30)	16.7	67.4	275	NE	11.06.23/1730	202	E	50	<27	5	<4	Rough
10.	Tapti Field (ECA) (20.60/72.20)	16.7	67.4	360	NE	12.06.23/1430	260	E	80	<27	5	<4	Rough
11.	Kutchh Area (NEA) (22.33/68.00)	16.7	67.4	340	N	14.06.23/0830	57	E	130	49	10	6-10	High
B-80 Block in the western offshore Mumbai													
12.	B-80(A) (19.05,71.18)	16.7	67.4	258	ENE	11.06.23/1730	192	E	50	<27	5	<4	Rough
13.	B-80(B) (19.05,71.79)	16.7	67.4	287	ENE	11.06.23/1730	227	E	50	<27	5	<4	Rough
14.	B-80(C) (18.98,71.79)	16.7	67.4	286	ENE	11.06.23/1430	227	E	50	<27	5	<4	Rough
15.	B-80(D) (18.98,71.72)	16.7	67.4	282	ENE	11.06.23/1730	223	E	50	<27	5	<4	Rough

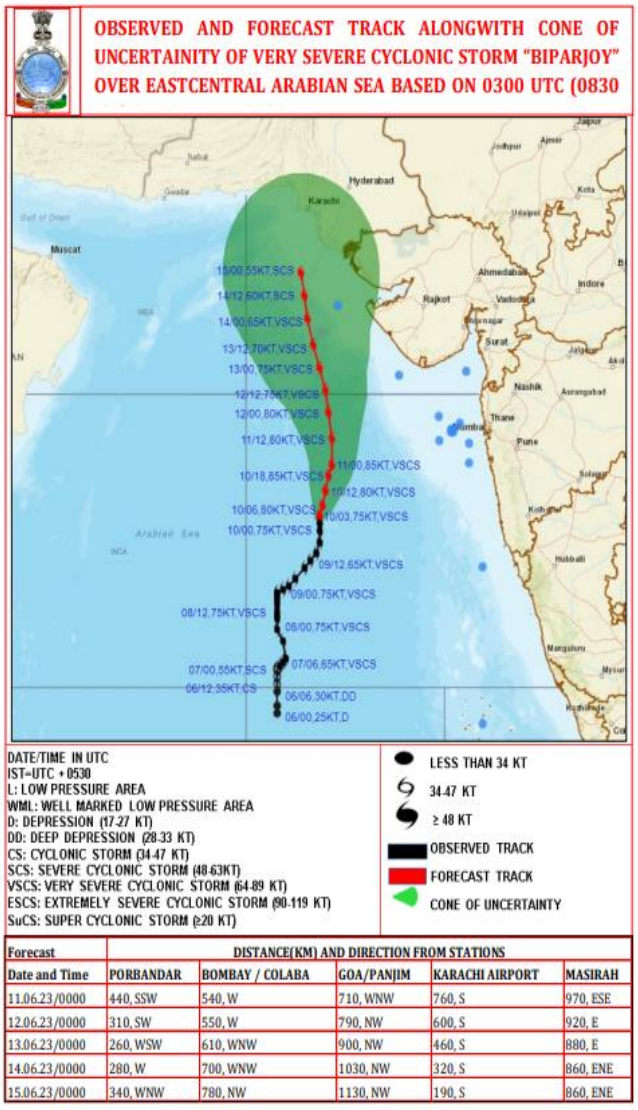
Color Code for generating impact based forecast:

ZONE	PARAMETERS
GREEN	NORMAL SITUATION, NO FORECAST OF CYCLONE
YELLOW	(1) A TROPICAL CYCLONE FORECAST: THE STORM CENTRE WITHIN 800 NM FROM LOCATION AND (2) THE FORECAST TRACK IS FORECAST TO BE WITHIN 300 NM FROM LOCATION
ORANGE	(1) A TROPICAL CYCLONE FORECAST: 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) A TROPICAL CYCLONE FORECAST: 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

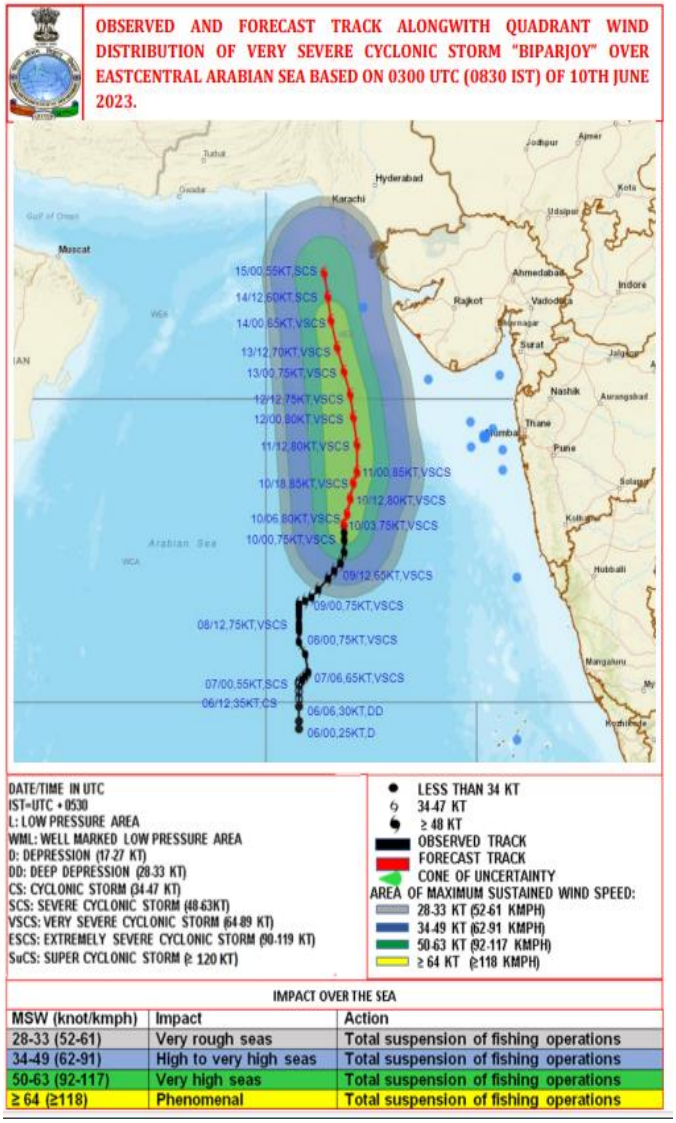
Notes:

(1) Under each zone, all three parameters are to be fulfilled to declare the rig under that zone

(2) The distance from Forecast Track in Sl No.2 of each zone is the minimum distance of the rig from the track/path when it is passing through;i.e., when it is closest to the rig



Forecast	DISTANCE(KM) AND DIRECTION FROM STATIONS				
Date and Time	PORBANDAR	BOMBAY / COLABA	GOA/PANJIM	KARACHI AIRPORT	MASIRAH
11.06.23/0000	440, SSW	540, W	710, WNW	760, S	970, ESE
12.06.23/0000	310, SW	550, W	790, NW	600, S	920, E
13.06.23/0000	260, WSW	610, WNW	900, NW	460, S	880, E
14.06.23/0000	280, W	700, WNW	1030, NW	320, S	860, ENE
15.06.23/0000	340, WNW	780, NW	1130, NW	190, S	860, ENE



IMPACT OVER THE SEA

MSW (knot/kmph)	Impact	Action
28-33 (52-61)	Very rough seas	Total suspension of fishing operations
34-49 (62-91)	High to very high seas	Total suspension of fishing operations
50-63 (92-117)	Very high seas	Total suspension of fishing operations
≥ 64 (≥118)	Phenomenal	Total suspension of fishing operations

Fig. II.15: Observed and forecast track along with Cone of uncertainty and Quadrant wind distribution of Very Severe Cyclonic storm "BIPARJOY".

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)

Country	**Type of Disturbance**	**Corresponding Wind Speed**
Bangladesh	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)
India	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
Maldives	Low pressure area	Less than 17 knots
	Depression	17- 27 knots
	Deep Depression	28 -33 knots
	Cyclonic storm	34 -47knots
	Severe cyclonic storm	48 -63knots
	Very severe cyclonic storm	64 -119knots
	Super cyclonic storm	120 knots and above
Myanmar	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
Oman (Sultanate of Oman)		
	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
Pakistan	Depression	22- 27knots
	Deep Depression	28- 33knots
	Cyclonic storm	34 -47knots
	Severe cyclonic storm	48- 63knots
	Very severe cyclonic storm	64- 119 knots
	Super cyclonic storm	120 knots or more
Qatar	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
Sri Lanka	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 (≥ 222 km/h)
Thailand	Tropical depression	27 - 33 knots
	Tropical Cyclones	34 knots and more
UAE	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
Yemen	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
WMO Classification	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

ANNEX II-B-1

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.

ANNEX II-B-2

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.
(vii) Approximate time of commencement of gale winds (speed more than 51 km/ h).
(viii) Storm surge height in feet and areas likely to be inundated.
(ix) 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^{o} 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 require 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 Tramsmission (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

ANNEX II-C-1

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 24^0 N 68^0 E, 20^0 N 68^0 E, 20^0 N 60^0 E, 5^0 N 60^0 E, 5^0 N 95^0 E, 10^0 N 95^0 E, 10^0 N 94^0 E, 13^0 30'N 94^0 E, 13^0 30'N 92^0 E, 18^0 N 92^0 E and 18^0 N 94^0 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 WWMIWS, 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.

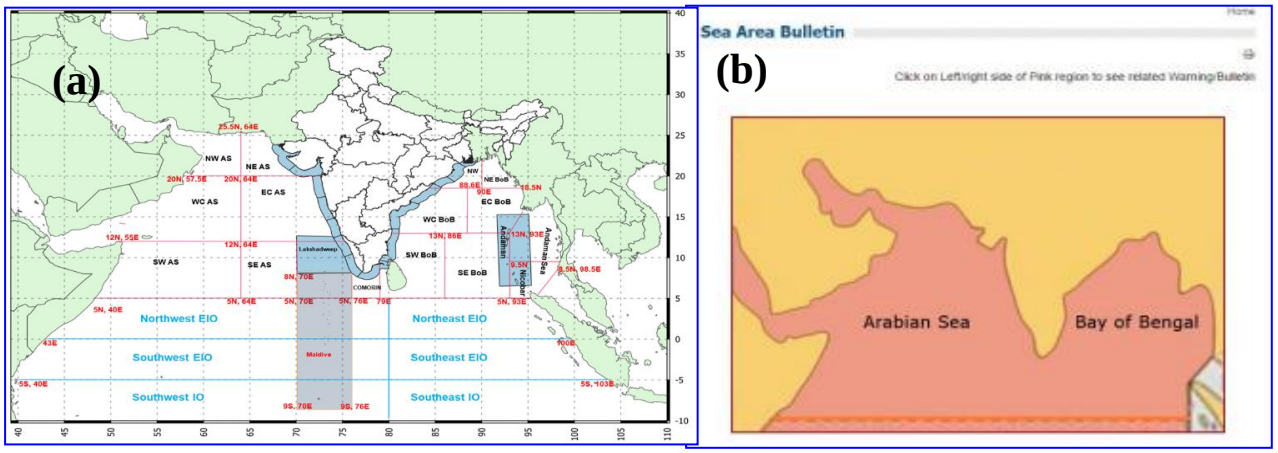


Fig II-C-1. (a): The exact area of responsibility of RSMC New Delhi and (b) areal coverage as indicated on RSMC website for sea area bulletin

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 - Friday 12/05/2023

From :: Area Cyclone Warning Center Kolkata(Alipore Weather office)

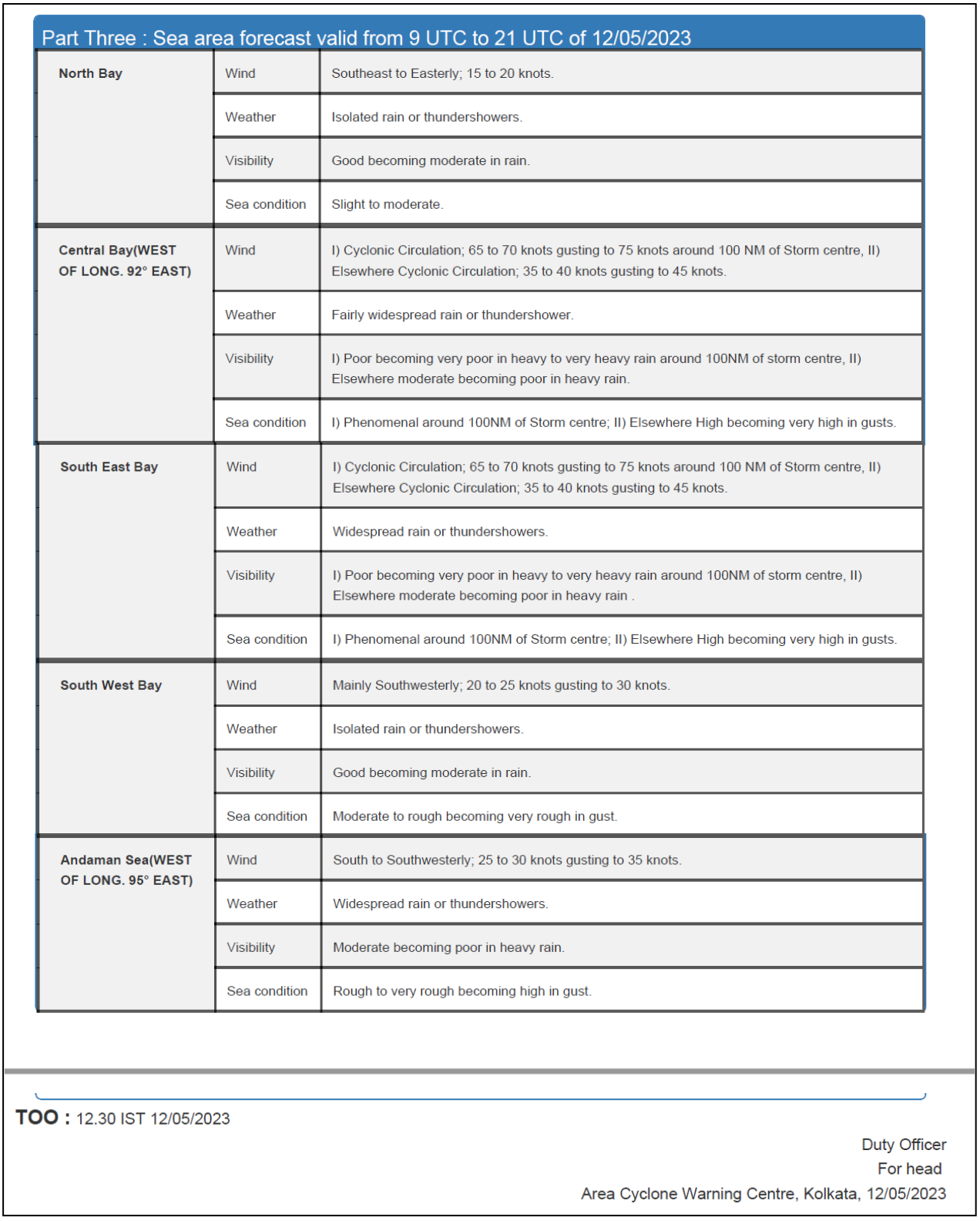
To :: Portblair Radio , Kolkata Port Wireless

Part One

TTT Very Severe Cyclone Warning Bay of Bengal 120300UTC

Part Two

The Very Severe Cyclonic Storm "Mocha" (pronounced as "Mokha") over Central and adjoining Southeast Bay of Bengal moved north-northeastwards with a speed of 13 kmph during past 06 hours and lay centered at 0830 hours IST of today, the 12th May 2023 over the same region near latitude 13.6°N and longitude 88.2°E, about 530 km west-northwest of Port Blair, 950 km south-southwest of Cox's Bazar (Bangladesh) and 870 km south-southwest of Sittwe (Myanmar). It is very likely to move northnortheastwards and intensify further over Eastcentral Bay of Bengal. It is likely to cross southeast Bangladesh and north Myanmar coasts between Cox's Bazar (Bangladesh) and Kyaukpyu (Myanmar), close to Sittwe (Myanmar) around noon of 14th May, 2023 as a Very Severe Cyclonic Storm with maximum sustained wind speed of 150-160 kmph gusting to 175 kmph. Weather seasonal over rest Bay of Bengal and Andaman Sea.



Part Three : Sea area forecast valid from 9 UTC to 21 UTC of 12/05/2023

North Bay	Wind	Southeast to Easterly; 15 to 20 knots.
	Weather	Isolated rain or thundershowers.
	Visibility	Good becoming moderate in rain.
	Sea condition	Slight to moderate.
Central Bay(WEST OF LONG. 92° EAST)	Wind	I) Cyclonic Circulation; 65 to 70 knots gusting to 75 knots around 100 NM of Storm centre, II) Elsewhere Cyclonic Circulation; 35 to 40 knots gusting to 45 knots.
	Weather	Fairly widespread rain or thundershower.
	Visibility	I) Poor becoming very poor in heavy to very heavy rain around 100NM of storm centre, II) Elsewhere moderate becoming poor in heavy rain.
	Sea condition	I) Phenomenal around 100NM of Storm centre; II) Elsewhere High becoming very high in gusts.
South East Bay	Wind	I) Cyclonic Circulation; 65 to 70 knots gusting to 75 knots around 100 NM of Storm centre, II) Elsewhere Cyclonic Circulation; 35 to 40 knots gusting to 45 knots.
	Weather	Widespread rain or thundershowers.
	Visibility	I) Poor becoming very poor in heavy to very heavy rain around 100NM of storm centre, II) Elsewhere moderate becoming poor in heavy rain .
	Sea condition	I) Phenomenal around 100NM of Storm centre; II) Elsewhere High becoming very high in gusts.
South West Bay	Wind	Mainly Southwesterly; 20 to 25 knots gusting to 30 knots.
	Weather	Isolated rain or thundershowers.
	Visibility	Good becoming moderate in rain.
	Sea condition	Moderate to rough becoming very rough in gust.
Andaman Sea(WEST OF LONG. 95° EAST)	Wind	South to Southwesterly; 25 to 30 knots gusting to 35 knots.
	Weather	Widespread rain or thundershowers.
	Visibility	Moderate becoming poor in heavy rain.
	Sea condition	Rough to very rough becoming high in gust.

TOO : 12.30 IST 12/05/2023

Duty Officer
For head
Area Cyclone Warning Centre, Kolkata, 12/05/2023

Fig. II-C-2: Sample Sea Area bulletin for Arabian Sea at 0900UTC of 12th May 2023

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. (To be updated)

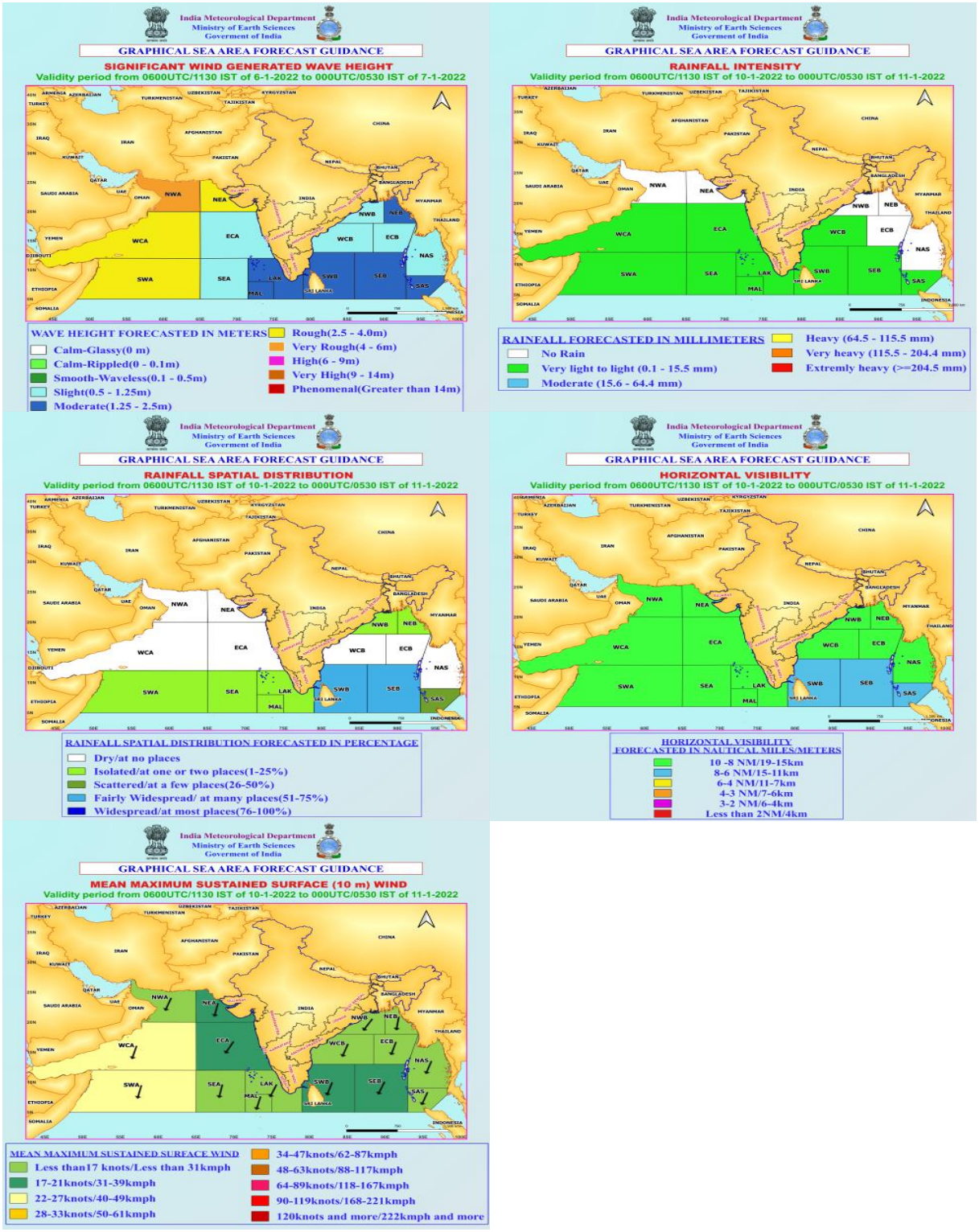


Fig. II-C-3: Sample Sea Area bulletin on QGIS based on multi model ensemble guidance

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 though 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). Areal coverage for coastal weather bulletin is shown in Fig. II C-4. Sample bulletin is placed at Fig. II-C-5.

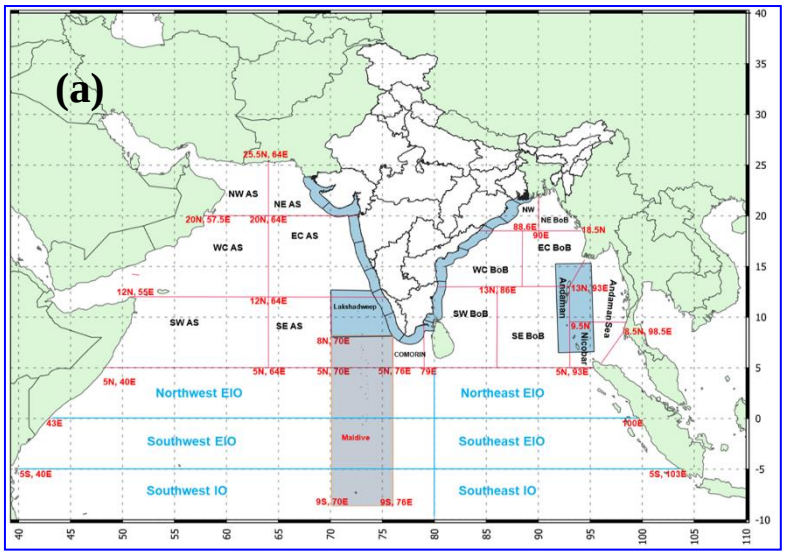
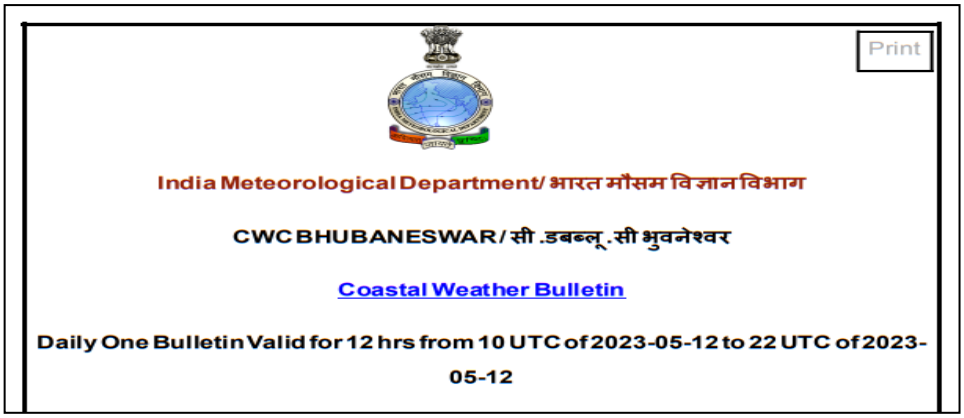


Fig. II-C-4: Sample areal coverage for coastal Weather bulletin along the coast of India



Synoptic Situation	The Very Severe Cyclonic Storm "Mocha" (pronounced as "Mokha") over Central and adjoining Southeast Bay of Bengal moved nearly northwards with a speed of 13 kmph during past 06 hours and lay centered at 0830 hours IST of today, the 12th May 2023 over the same region near latitude 13.6°N and longitude 88.2°E, about 530 km west-northwest of Port Blair, 950 km south-southwest of Cox'sBazar (Bangladesh) and 870 km south-southwest of Sittwe (Myanmar). It is very likely to move north-northeastwards and intensify further over Eastcentral Bay ofBengal. It is very likely to cross southeast Bangladesh and north Myanmar coasts between Cox's Bazar (Bangladesh) and Kyaukpyu (Myanmar), close to Sittwe (Myanmar) around noon of 14th May, 2023 as a Very Severe Cyclonic Storm with maximum sustained wind speed of 150-160 kmph gusting to 175 kmph.

North Odisha coast

Wind	East South-Easterly, 10 - 15 Knots
Weather	Isolated Rain/ Thunderstorm
Visibility	Good EXCEPT IN RA/TS.
Sea Condition	Smooth to Slight
Port Signal	Keep Hoisted Distant Warning Signal No-2 (DW-2) at all ports of Odisha.

South Odisha coast

Wind	East South-Easterly, 10 - 15 Knots
Weather	Isolated Rain/ Thunderstorm
Visibility	Good EXCEPT IN RA/TS.
Sea Condition	Smooth to Slight
Port Signal	Keep Hoisted Distant Warning Signal No-2 (DW-2) at all ports of Odisha.

Time of Issue	14:21 IST of 2023-05-12

Fig. II-C-5: Sample Coastal Weather bulletin issued by ACWC Mumbai at 0600 UTC of 10th May 2022

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--6. 9 (To be updated)

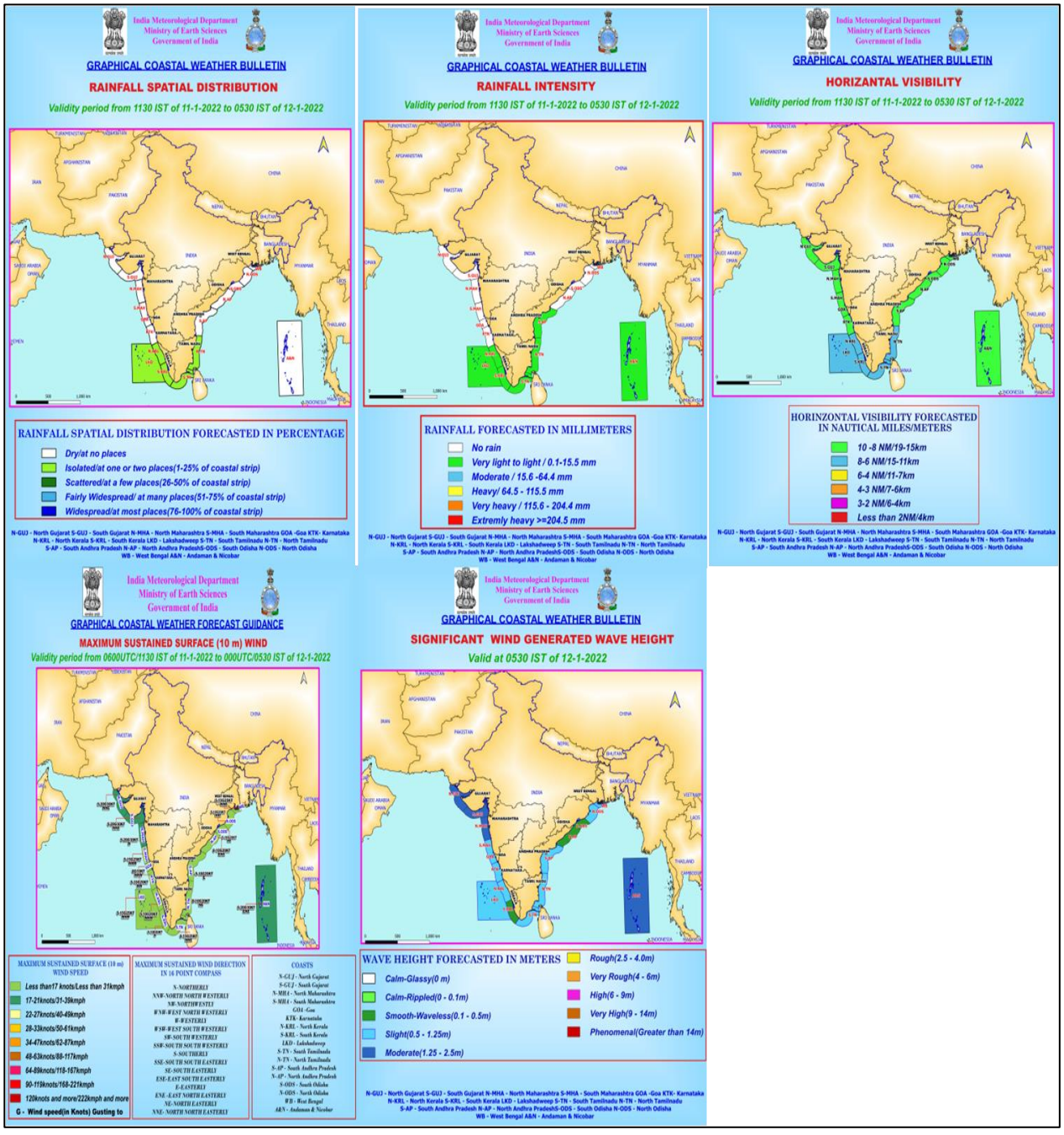


Fig. II-C-6: Sample Coastal area bulletin on QGIS based on multi model ensemble guidance

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). 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)

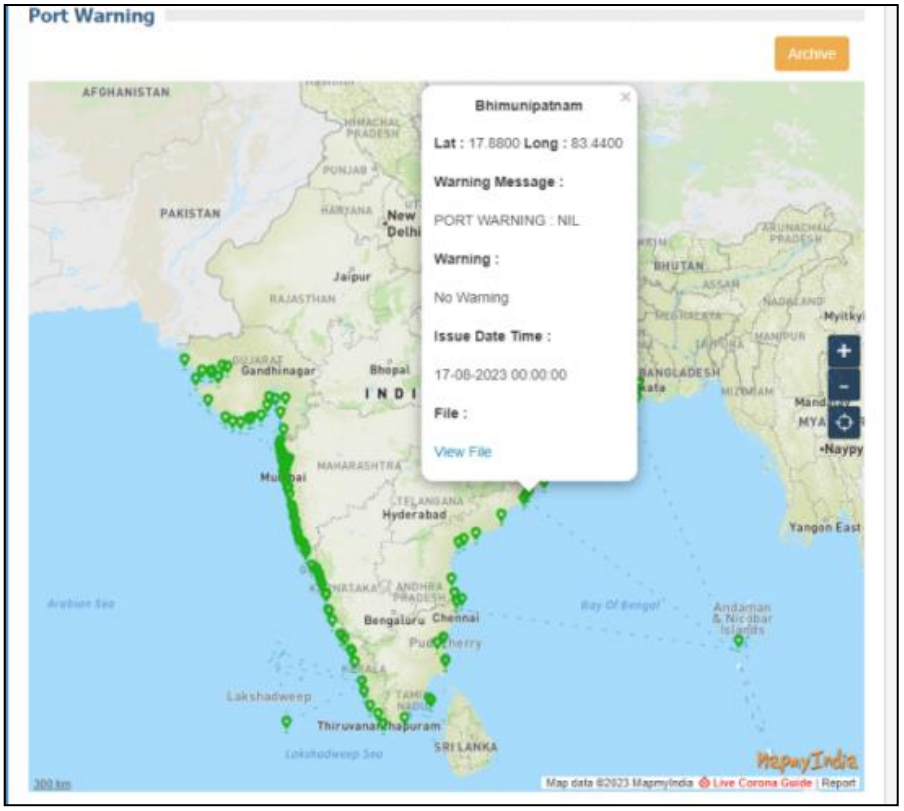


Fig. II-C-7(a): Sample Port Warning bulletin available at RSMC New Delhi website

INDIA METEOROLOGICAL DEPARTMENT
CYCLONE WARNING CENTRE
BHUBANESWAR

Port Warning for all ports in Odisha

Date: 12.05.2023 **Time: 2100 Hours IST.**

Sub: Very Severe Cyclonic storm "Mocha" (pronounced as "Mokha") over Central Bay of Bengal

The **Very *Severe Cyclonic Storm* "Mocha"** (pronounced as **"Mokha")** over Central Bay of Bengal moved nearly north-northeastwards with a speed of 12 kmph during past 06 hours and lay centered at 1730 hours IST of today, the 12th May 2023 over the same region near latitude 14.6°N and longitude 88.6°E, about 550 km northwest of Port Blair, 730 km south-southwest of Cox's Bazar (Bangladesh) and 760 km southwest of Sittwe (Myanmar).

It is very likely to move north-northeastwards and intensify further into an Extremely Severe Cyclonic Storm over Eastcentral Bay of Bengal during night of today, the 12th May 2023. It is likely to cross southeast Bangladesh and north Myanmar coasts between Cox's Bazar (Bangladesh) and Kyaukpyu (Myanmar), close to Sittwe (Myanmar) around noon of 14th May, 2023 as a ***Very Severe Cyclonic Storm with maximum sustained wind speed of 150-160 kmph gusting to 175 kmph.***

Advice for Hoisting Port Warning Signals :
Keep Hoisted Distant Warning Signal No-2 (DW-2) at all ports of Odisha.

Fig. II-C-7(b): Sample Port Warning bulletin issued by CWC BHUBANESWAR based on 2100 UTC of 12th May 2023 in association with VSCS Mocha

ANNEX II-C-4

Fisherman Warnings

Warnings for fisherman and fishery officals 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 alongwith probability of exceedance of maximum sustained winds speed (MSW) of 25 knots & more since 28th July, 2022. Sample areal coverage is presented in Fig. II-C-8. Fishermen warning graphics bulletin issued during cyclone Asani on 10th May is presented in Fig. II-C-9. Sample graphics showing fishermen warning area based on MME and graphics showing probability of exceedance of MSW≥25 knots is presented in Fig. II-C-10 and II-C-11.

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

Sample graphics showing fishermen warning area based on MME and graphics showing probability of exceedance of MSW≥25 knots is presented in Fig. II-C-09 and II-C-10.

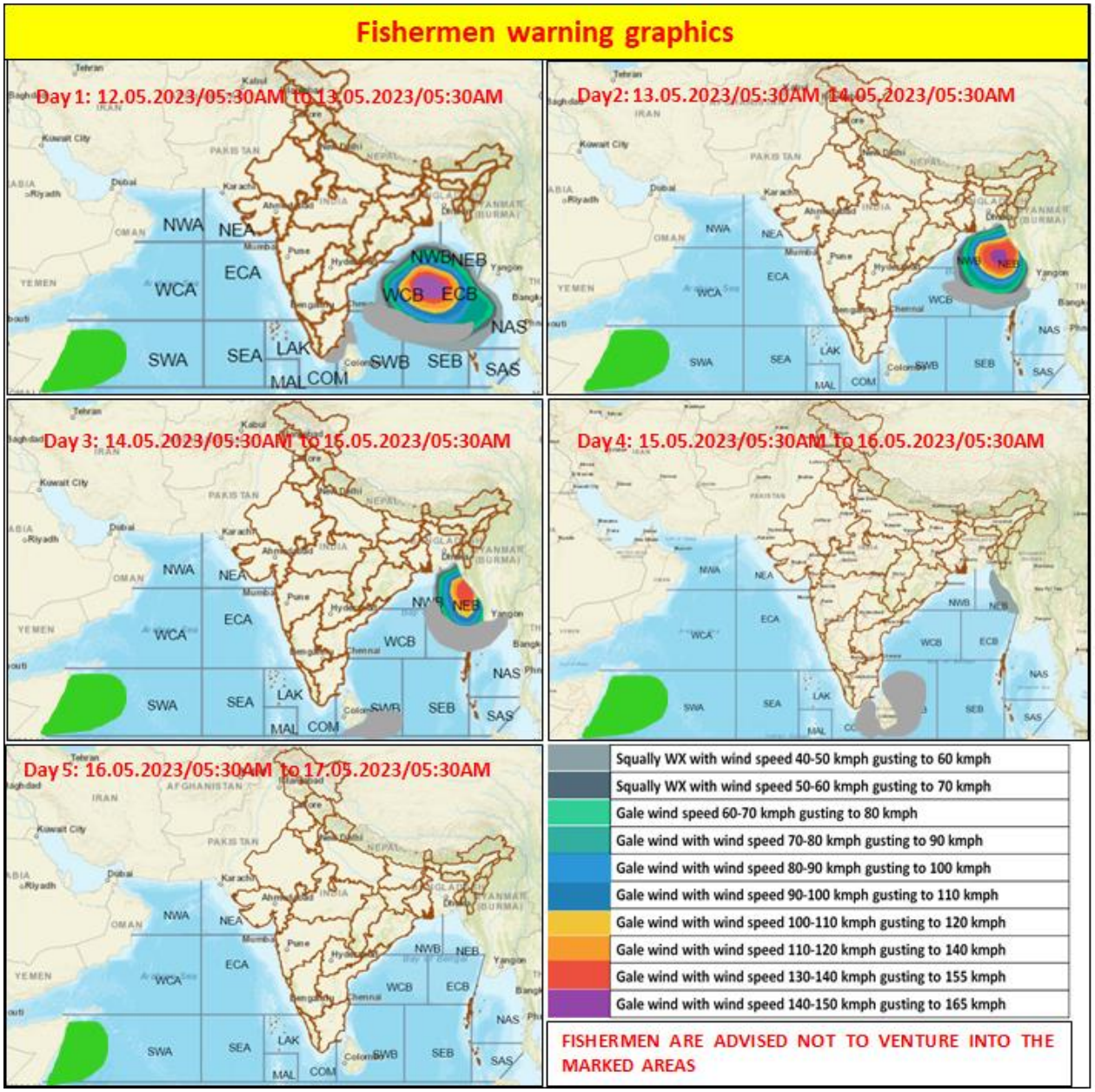


Fig.II-C-10: Sample graphics showing fishermen warning area based on MME issued on 12th May

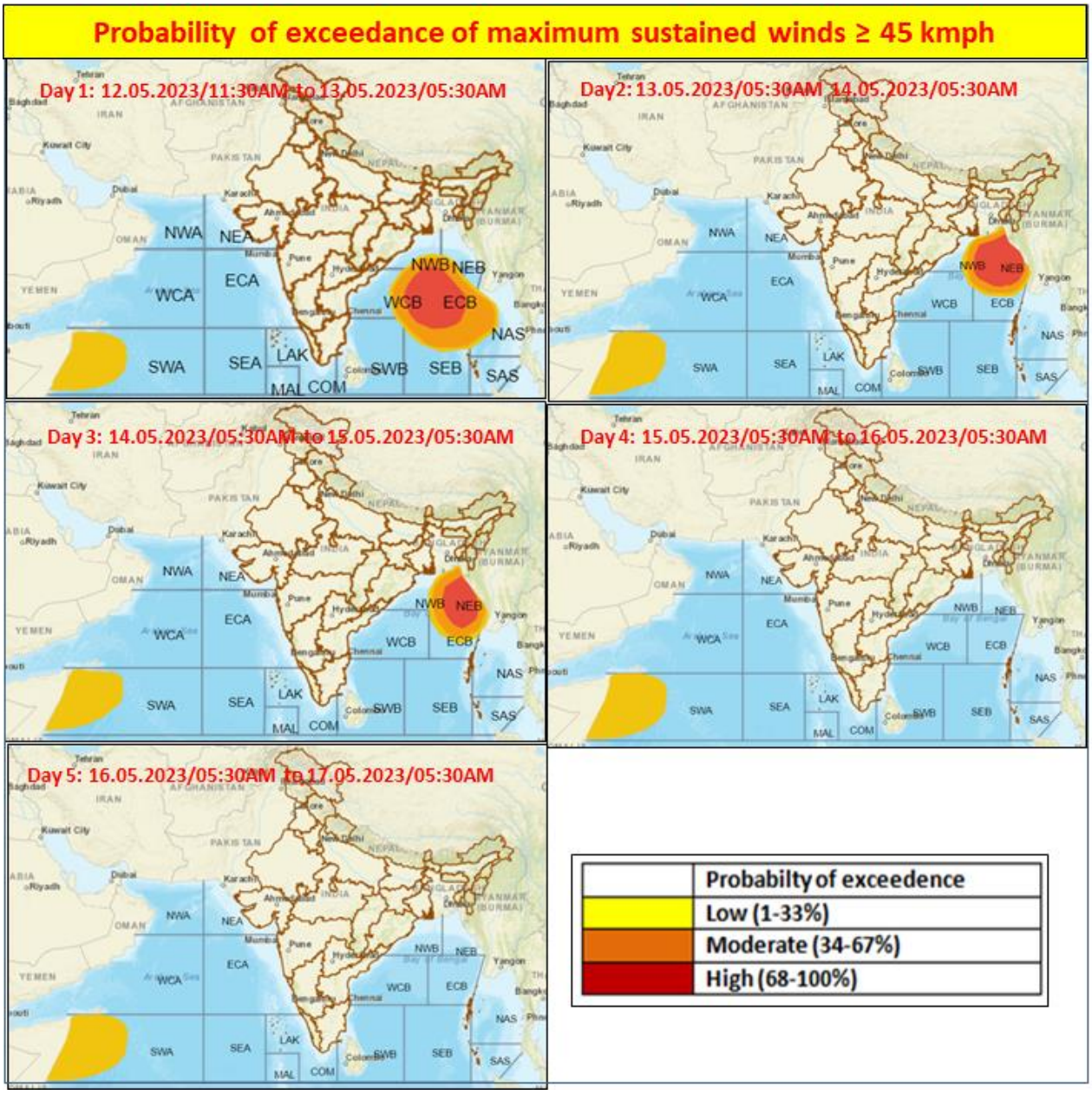


Fig.II-C-11: Sample graphics showing probability of exceedance of in areas having MSW≥45 kmph issued on 12th May

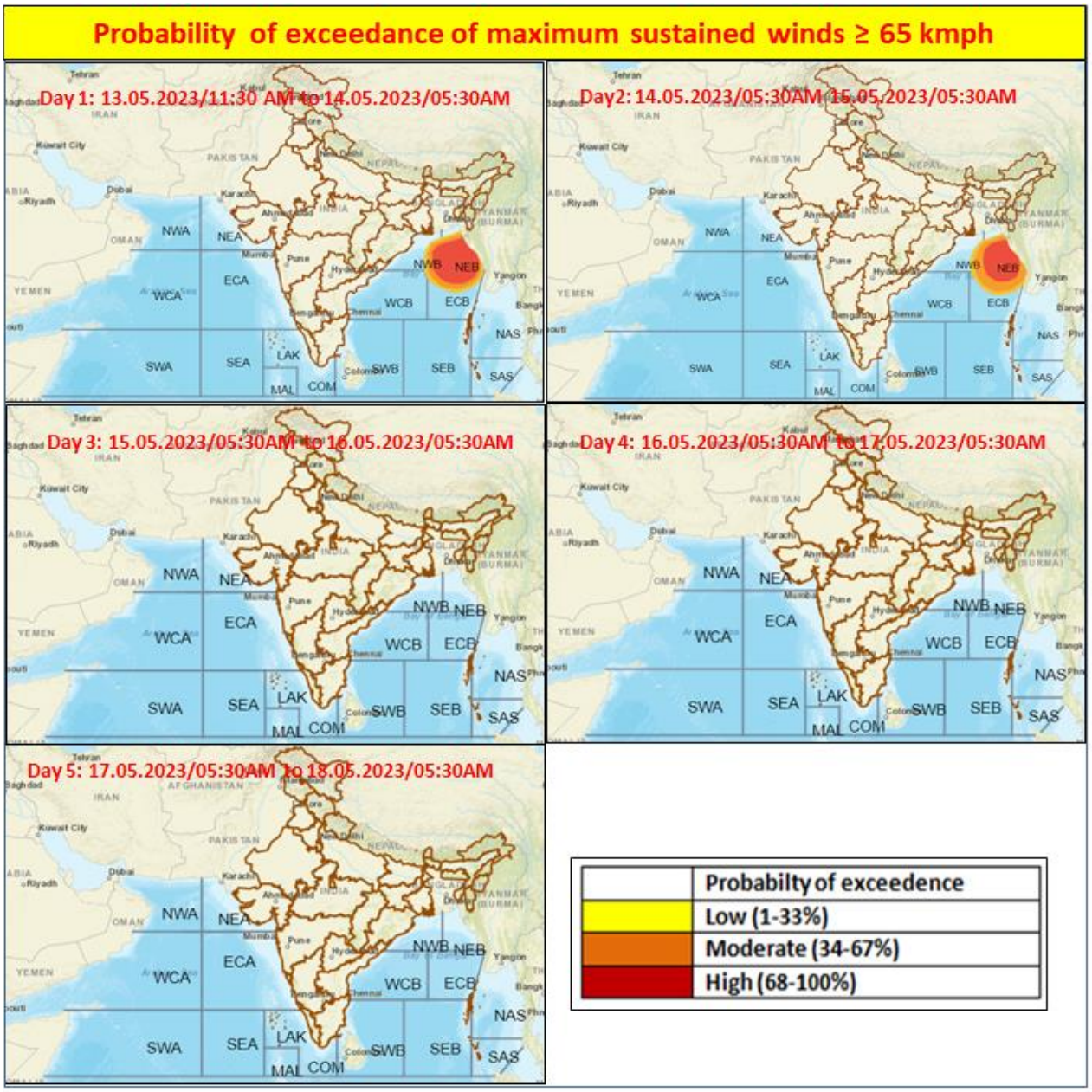


Fig.II-C-12: Sample graphics showing probability of exceedance of in areas having MSW≥65 kmph issued on 12th May

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

ANNEX II-C-6

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

Category/ T.No/ Wind Speed	Structures	Communication & Power	Road /Rail	Agriculture	Marine Interests	Coastal Zone	Overall Damage Category	Suggested Actions
Deep Depression T 2.0 52 – 61 kmph (28-33 knots)	Minor damage to loose / unsecured structures		Some breaches in Kutcha road due to flooding.	Minor damage to Banana trees and near coastal agriculture due to salt spray. Damage to ripe paddy crops.	Very rough seas. Sea waves about 4-6 m high.	Minor damage to Kutcha embankments.	Minor	Fishermen advised not to venture into the open seas.
Cyclonic Storm T 2.5-T 3.0 62 – 87 kmph (34-47 knots)	Damage to thatched huts.	Minor damage to power and communication lines due to breaking of branches.	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 waves about 6-9 m high.	Sea water inundation in low lying areas after erosion of Kutcha embankments.	Minor to moderate.	Total suspension of fishing operations.
Severe Cyclonic Storm T 3.5 88-117 kmph (48-63 knots)	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 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.	Phenomenal seas with wave height 9-14 m. Movement in motor boats unsafe.	Major damage to coastal crops. Storm surge upto 1.5 m (area specific) causing damage to embankments/ salt pans. Inundation upto 5 km in specific areas.	Moderate	Total suspension of fishing operations. Coastal hutment dwellers to be moved to safer places. People in affected areas to remain indoors.
Very Severe Cyclonic Storm T 4.0- T 4.5 118-166 kmph (64-89 knots)	Total destruction of thatched houses/ extensive damage to kutcha houses. Some damage to pucca houses. Potential threat from flying objects.	Bending/ uprooting of power and communication poles.	Major damage to Kutcha and and Pucca roads. Flooding of escape routes. Minor disruption of railways, overhead powerlines and signalling 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 kutcha houses, some damage to old badly managed Pucca structures. Potential 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. Diversion 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.

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).
(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). 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 Kutcha 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-13

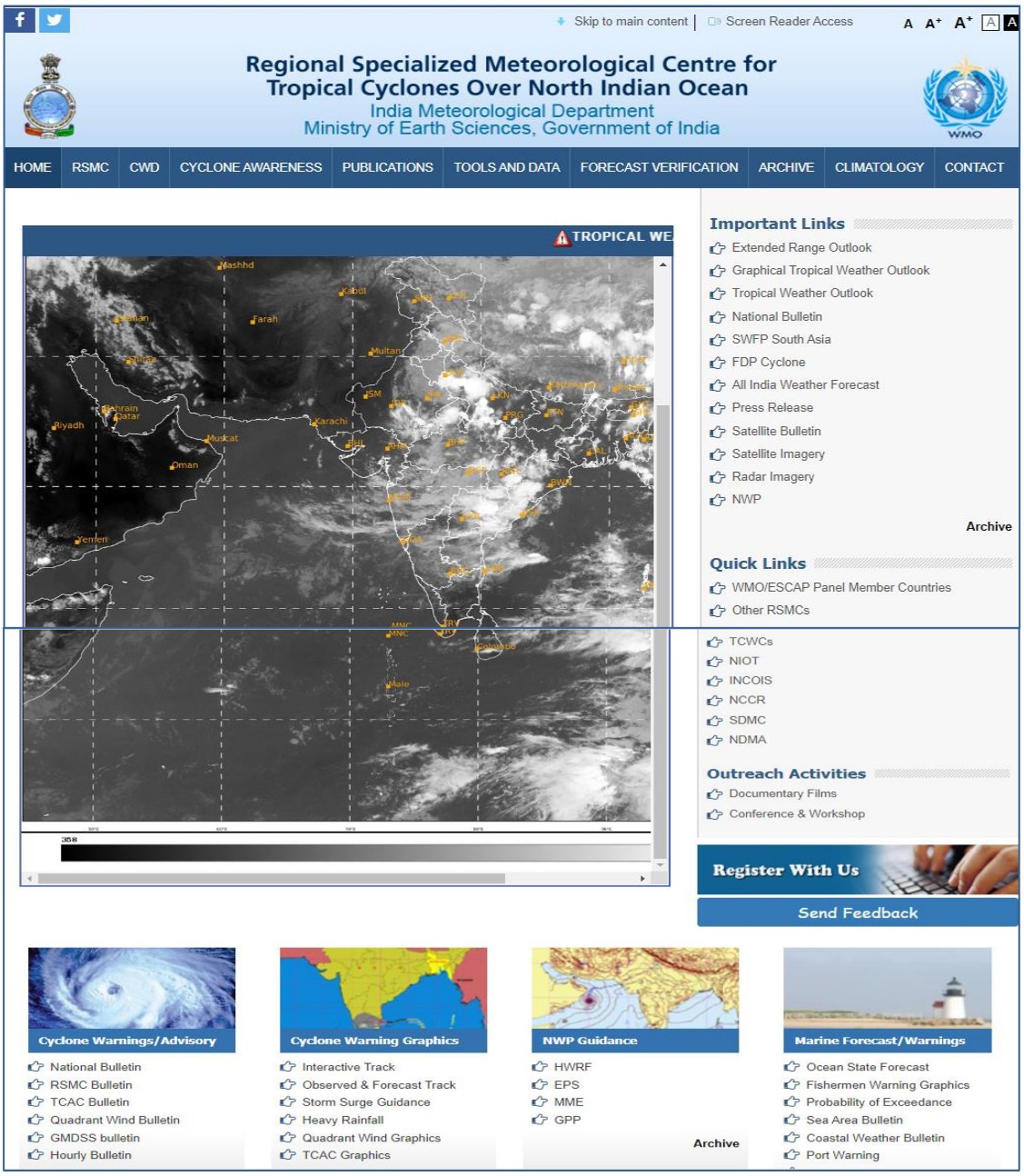


Fig.II-C-13: RSMC Website

ANNEX II-D-1

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
Facsimile

ANNEX II-D-2

Alert and Warning criteria

Alert Level		Description	Action
1	WHITE	- Mean wind speed is expected or prevailed between 23 – 30 mph. - Rainfall of more than 50 mm is expected to occur within 24 hours. - High tidal waves are expected.	Weather Information, but no immediate threat.
2	YELLOW	- Mean wind speed is expected or prevailed between 30 – 40 mph. - Torrential rain is expected and if heavy rain occurred for more than 2 hours. - A severe thunderstorm is expected or experienced. - Tropical Cyclone is formed within effective areas of Maldives. - Significant tidal or swell waves expected or experienced.	Concern authorities and people living in the area to be on alert & be ready to take action. Travel by sea not advisable.
3	RED	-Flash flood is expected. -A tropical Cyclone is tracked to move closer or cross Maldives islands. -Destructive tidal or swell waves or storm surge is expected or observed.	Evacuation of population from threatened areas to safer places. Prohibition of sea transportation.
4	GREEN	The condition has improved.	Cancel warning

ANNEX II-E-1

Cyclone warning system in Myanmar

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
7. Single Side Band Transceiver (SSB)
8. DMH Facebook

ANNEX II-E-2

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.

ANNEX II-F-1

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 Civil Defense (NCCD).

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 imagesfrom 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

ANNEX II-G-1

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^{o}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 (PDMAs) 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

ANNEX II-G-2

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^{o} N). Coverage is shown in Fig. II-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 are:

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
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.

ANNEX II-H-1

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 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 under standing

Signal No.	Colour	Description	Action required
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	Green  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, Minstry of Health, Highways etc.

Specific users

- Coastal fishing
- Shipping
- Port and Habours
- 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 10^0 N between 60^0 E and 95^0 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

ANNEX II-I-1

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 capabailties 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 under standing

Signal No	Colours	Description	Action Required
1	white 	Potential area of possibility to development of vortex /disturbance /	Information only, Vessels at sea to be vigilant and avoid the area, Listen to media
2	Yellow 	Cyclone has formed in the vicinity, heavy rain with strong winds, rough seas (30-40 kts, 55-75kmph)	Stay away from beach/sea, vessels in danger/be inside building/ Be ready to leave weak buildings and low lying areas (flood prone areas), secure your home valuables
3	Red 	Cyclone is expected to cross land, Very heavy rain/very strong winds (v>50kts,100kmph)	Evacuate to predesignated areas
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 10^0 N between 60^0 E and 95^0 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

ANNEX II-J-1

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.	**To high seas** 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. **(every 3 hours)**
		To coastal stations and ports By : Telephone, Facsimile, Email, SMS, Social Media (Facebook, Line), Thailand Radios/ and Thailand TVs, TMD Mobile Application, TMD Radio, TMD Website : www.tmd.go.th, http://www.metalarm.tmd.go.th **(every 6 hours)**
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	**To high seas** 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. **(every 3 hours)**
		To coastal stations and ports By : Telephone, Facsimile, Email, SMS, Social Media (Facebook, Line), Thailand Radios/ and Thailand TVs, TMD Mobile Application, TMD Radio, TMD Website : www.tmd.go.th, http://www.metalarm.tmd.go.th **(every 6 hours)** Port warning signals used in Thailand Ports are given in Attachment to Annex II-I.
		To government agencies concerned namely : • Department of Disaster Prevention and Mitigation (DDPM) • Port Authority of Thailand (PAT) • Marine Department (MD) • National Disaster Warning Center (NDWC) • Governors of risk provinces **To specific users (aviation, fishery, etc.), media and general public** By : Telephone, Facsimile, Email, SMS, Social Media (Facebook, Line), Thailand Radios/ and Thailand TVs, TMD Mobile Application, TMD Radio, TMD Website : www.tmd.go.th, http://www.metalarm.tmd.go.th **(every 6 hours)**
Tropical Cyclones (34 knots and more)	Comprehensive Warning/ Advisory will be issued every 3 hours containing : (i) Issuing number (ii) Date and time	**To high seas** 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. **(every 3 hours)**

	(iii) Name of storm (iv) Classification by intensity (v) Position of the tropical storm (vi) Central pressure (vii) Movement the direction and speed (viii) Wind direction and maximum wind near the centre (ix) Destination from a coastal point	**To coastal stations and ports** By : Telephone, Facsimile, Email, SMS, Social Media (Facebook, Line), Thailand Radios/ and Thailand TVs, TMD Mobile Application, TMD Radio, TMD Website : www.tmd.go.th, http://www.metalarm.tmd.go.th **(every 3 hours)** Port warning signals used in Thailand Ports are given in Attachment to Annex II-I.
		To government agencies concerned namely : • Department of Disaster Prevention and Mitigation (DDPM) • Port Authority of Thailand (PAT) • Marine Department (MD) • National Disaster Warning Center (NDWC) • Governors of risk provinces **To specific users (aviation, fishery, etc.), media and general public** By : Telephone, Facsimile, Email, SMS, Social Media (Facebook, Line), Thailand Radios/ and Thailand TVs, TMD Mobile Application, TMD Radio, TMD Website : www.tmd.go.th, http://www.metalarm.tmd.go.th **(every 3 hours)**

ANNEX II-K-1

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 are 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- SMStext messages.
6- Media (Local radio channels, local TV channels, local press).

Day Signals*		Specifications	Night Signals*	Remarks

Bangladesh (8.XI.1976)

Signals Meant for Maritime Ports

16a	I.	Distant Cautionary Signal Number One 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.	Distant Warning Signal Number Two A storm has formed (cyclonic storm with surface winds 62-88 kmph. (34-47 knots)	2b	
3a	III.	Local Cautionary Signal Number Three 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.	Local Warning Signal Number Four 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))	4b	
17a	V.	Danger Signal Number Five 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	16b	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.

Attachment to ANNEX II-B-2

Day Signals*	Specifications	Night Signals*	Remarks

Bangladesh - continued

18a	VI.	Danger Signal Number Six	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.	Danger Signal Number Seven	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.	Great Danger Signal Number Eight	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.	Great Danger Signal Number Nine	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)		)	

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

Day Signals*	Specifications	Night Signals*	Remarks
	Bangladesh - continued		
22a	X. Great Danger Signal Number Ten 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. Failure of Communications 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) Cautionary Signal Number One	5b	
	The area is threatened by squally winds of transient nature (Nor'wester squalls) of wind speed not exceeding 60 km/h (32 knots).		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 likelt 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) Danger Signal Number Three	2b	
	A storm (wind speed of 62-88 km/h or more) is likely to strike the area soon (All vessel will seek shelter immediately).		

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

Day Signals*	Specifications	Night Signals*	Remarks

Bangladesh - continued

10a	(IV) Great Danger Signal Number Four 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 CYCLOGENESIS:

India Meteorological Department
Ministry of Earth Sciences
Mausam Bhawan, Lodhi Road, New Delhi-110003

Issued on 01.06.2023

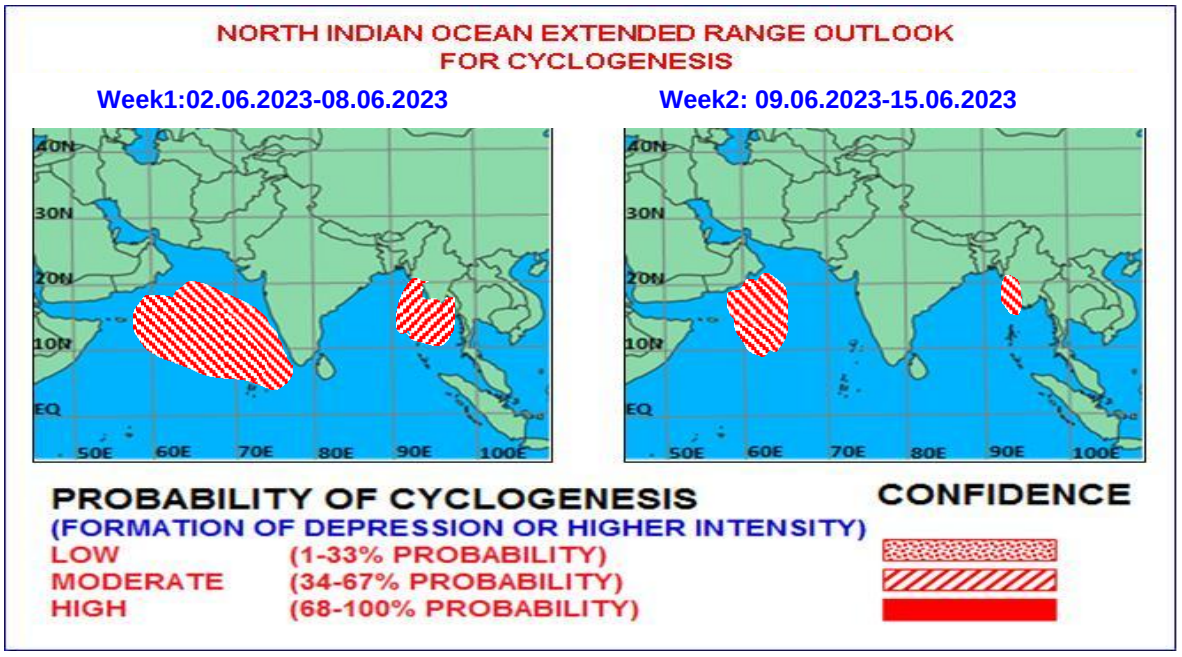


Fig.1: Graphical Cyclogenesis over north Indian Ocean during next two weeks

I. Environmental features:

The Madden Julian Oscillation (MJO) Index is currently in Phase 1 with amplitude less than 1. It would continue in same phase during first half of week 1. Thereafter, it would move across phase 2 during later part of week 1. During week 2, it would move across phases 3 and 4 with amplitude reaching close to 1 at the end of week 2. Hence, MJO is likely to support the enhancement of convective activity and cyclogenesis over the Bay of Bengal (BoB) and Arabian Sea (AS) from middle of week 1. From middle of week 1 onwards, westerly winds (1-3 mps) along with Equatorial Rossby Waves (ERW) are likely to prevail over south Arabian Sea till middle of week 2 and similarly over the eastcentral Bay of Bengal and North Andaman Sea area during later part of week 1. Therefore, westerly winds (1-3 mps) along with ERW and Kelwin Waves and MJO waves are likely to contribute towards cyclogenesis over south Arabian Sea and also over eastcentral BoB & North Andaman Sea during later part of week 1 and sustenance to convective activity over the region.

II. Model Guidance:

(a) Bay of Bengal:

Various deterministic models including ECMWF, NCUM and NEPS are indicating cyclogenesis (formation of depression) over North Andaman Sea & adjoining eastcentral BoB during later part of week 1. However, IMD GFS is not indicating any cyclogenesis over the BoB during the entire forecast period. Probabilistic model ECMM is indicating cyclogenesis over eastcentral & adjoining North

Andaman Sea during later part of week1. IMD's coupled forecast model CFS (V2) is also indicating low (20-30%) probability of cyclogenesis over eastcentral & adjoining North Andaman Sea off Myanmar coast during week 1. CNCUM is indicating cyclonic circulation over North Andaman Sea and adjoining eastcentral BoB during later part of week 1.

Arabian Sea: Various deterministic models including ECMWF, IMD GFS, NCEP GFS and NCUM are indicating cyclogenesis over Arabian Sea during later part of week 1. However, there is large variation among various models with respect to area and time of genesis and subsequent movement. Probabilistic model ECMM is indicating cyclogenesis over southeast AS during later part of week 1, with most of the member models are indicating movement towards westcentral AS during first half of week 2. IMD's coupled forecast model CFS (V2) is also indicating moderate (50-60%) probability of cyclogenesis over south AS during week 1 and (30-40%) probability of cyclogenesis over westcentral AS during week 2. CNCUM is also indicating cyclonic circulation over central AS.

(Legends: IMD GFS: India Meteorological Department Global Forecast System, NCUM: National Centre for Medium Range Weather Forecasting Centre Unified Model, European Centre for Medium Range Weather Forecasting, GPP: Genesis Potential Parameter, National Centre for Environment Prediction GFS, ECMM: ECMWF multi model, GEFS: GFS ensemble, NEPS: NCUM ensemble prediction system, CNCUM: Coupled NCUM, CPC:Climate Prediction Center, NWS: National Weather Service)

III. Inference:

Considering various environmental features and model guidance, following inferencesare drawn:

(i) there is moderate probability of cyclogenesis (formation of depression) over North Andaman Sea and adjoining eastcentral Bay of Bengal during later part of week 1 and start of week 2.

(ii) there is moderate probability of cyclogenesis over southeast Arabian Sea during later part of week 1.

IV. Verification of forecast issued during last two weeks:

The forecast issued on 18th May, 2023 for week 2 (26.05.2023– 01.06.2023) indicated no cyclogenesis during week 2. The forecast issued on 25th May for week 2 (26.05.2023– 01.06.2023) indicated likely formation of cyclonic circulation around 29th May with low probability of cyclogenesis (formation of depression) during end of week 1 or beginning of week 2. Actually, a cyclonic circulation formed over North Andaman Sea and adjoining eastcentral BoB on 30th May. Thus, likely formation of cyclonic circulation could be well captured.

The realized rainfall during 25th May, 2023 – 31st May, 2023 from satellite-gaugemerged data is presented in Fig.2

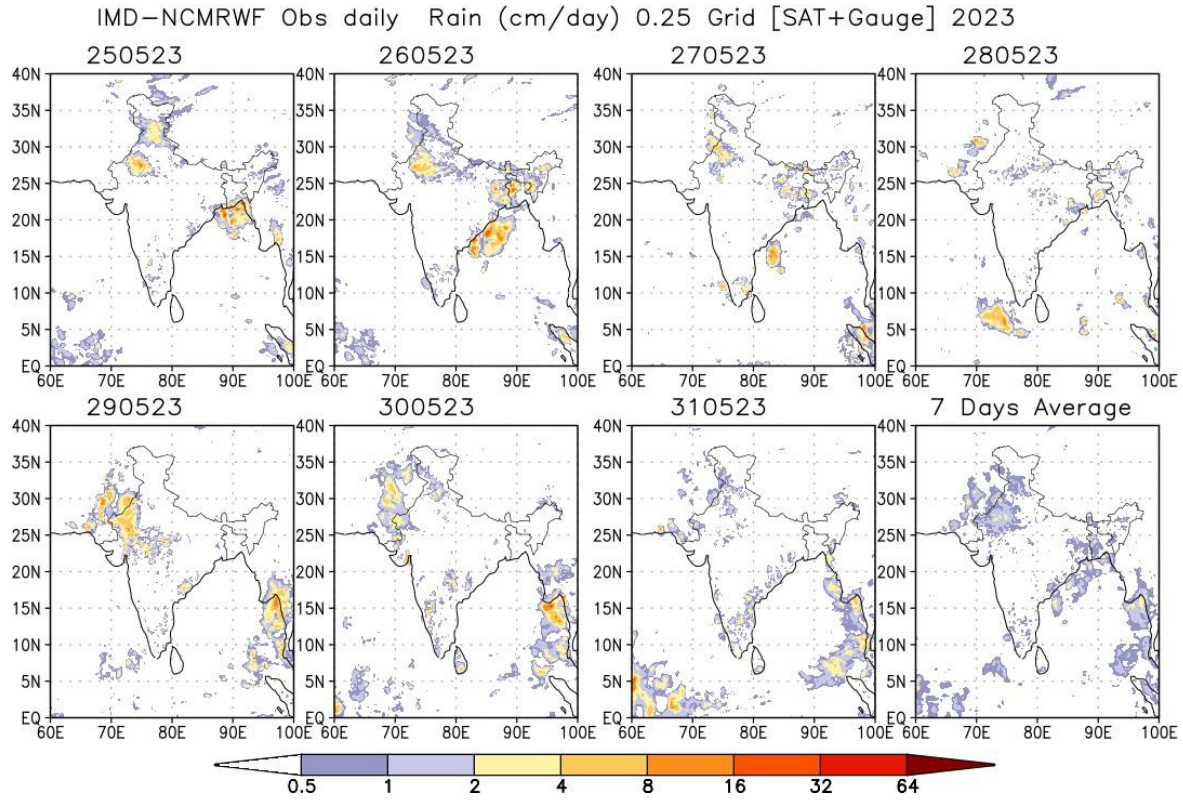


Fig.2: Rain gauge and satellite merged rainfall plots during 17th May– 23rd May, 2023

Next update: 08.06.2023

Examples-1 (Special Message in association with Low Pressure Area)

India Meteorological Department
(Ministry of Earth Sciences)

SPECIAL BULLETIN NO. 1

TIME OF ISSUE:1545 HOURS IST **DATED: 08.05.2023**
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, ANDAMAN & NICOBAR ISLANDS (FAX NO. 03192- 232656)
CHIEF SECRETARY, GOVT. WEST BENGAL (FAX NO. 033-22144328)
CHIEF SECRETARY, GOVT. OF ODISHA (FAX NO. 0674 -2536660)
CHIEF SECRETARY, GOVT. OF ANDHRA PRADESH (FAX NO. 0863-2441029, 08645-246600)
CHIEF SECRETARY, GOVT. OF TAMIL NADU (FAX NO. 044-25672304)
CHIEF SECRETARY, GOVT. OF PUDUCHERRY (FAX NO. 0413-2337575, 2334145)
Sub: Low pressure area over southeast Bay of Bengal and adjoining south Andaman Sea

A low pressure area has formed over Southeast Bay of Bengal and adjoining South Andaman Sea at 0830 hrs IST of today, the 8th May 2023. It is likely to intensify into a depression on 9th May over the same region and further into a cyclonic storm over southeast Bay of Bengal and adjoining areas of eastcentral Bay of Bengal and Andaman Sea on 10th May. It is likely to move initially north-northwestwards till 11th May. Thereafter, it is likely to recurve gradually and move north-northeastwards towards Bangladesh-Myanmar coasts.

Warnings:

(i) Rainfall (warning graphics enclosed)

- Light/moderate rainfall at most places with isolated heavy rainfall very likely over Nicobar Islands on 08th.
- Rainfall at many places with isolated heavy to very heavy rainfall is likely over Andaman & Nicobar Islands on 9th May.
- Rainfall at most places with heavy to very heavy rainfall with extremely heavy rainfall at isolated places is likely over Andaman & Nicobar Islands during 10th to 11th May.
- Rainfall at most places with heavy to very heavy rainfall at isolated places is likely over Andaman Islands on 12th May and isolated heavy rainfall over Nicobar Islands.

(ii) Wind warning:

- Squally weather with wind speed reaching 40-50 kmph gusting to 60 kmph is likely to prevail over southeast Bay of Bengal, Andaman & Nicobar Islands and adjoining Andaman Sea on 8th May.
- Squally wind speed reaching 50-60 kmph gusting to 70 kmph is likely over southeast Bay of Bengal, Andaman & Nicobar Islands and adjoining Andaman Sea on 9th May.
- Gale wind speed reaching 60-70 kmph gusting to 80 kmph is likely over southeast and adjoining eastcentral Bay of Bengal, Andaman & Nicobar Islands and adjoining Andaman Sea on 10th & 11th May.
- Gale wind speed reaching 80-90 kmph gusting to 100 kmph is likely over eastcentral Bay of Bengal and 60-70 kmph gusting to 80 kmph over Andaman Sea and Andaman Islands on 12th May.

(iii) Sea condition

- Sea condition is likely to be rough over southeast Bay of Bengal and adjoining south Andaman Sea on 8th May and very rough from 9th May onwards. It is likely to be very rough to high over southeast and adjoining eastcentral Bay of Bengal and Andaman Sea from 10th May onwards till 11th May. It is likely to be high to very high over eastcentral Bay of Bengal and very rough to high adjoining southeast Bay of Bengal and Andaman Sea from 12th May.

(iv) Fishermen Warning (warning graphics enclosed)

- Fishermen, small ships, boats and trawlers are advised not to venture into southeast Bay of Bengal and adjoining areas of Andaman Sea from 8th May onwards and into southeast & adjoining central Bay of Bengal and Andaman Sea from 9th May onwards.
- Those who are over southeast Bay of Bengal and adjoining south Andaman Sea are advised to return to safer places by today, the 8th May and those over eastcentral Bay of Bengal and north Andaman Sea are advised to return by 9th May.

(v) Advisory

- Regulation of tourism and offshore activities and shipping near Andaman and Nicobar Islands during 8th - 12th May and
- Regulation of shipping activity over the sea areas of southeast & central Bay of Bengal and Andaman Sea during 8th -12th May.

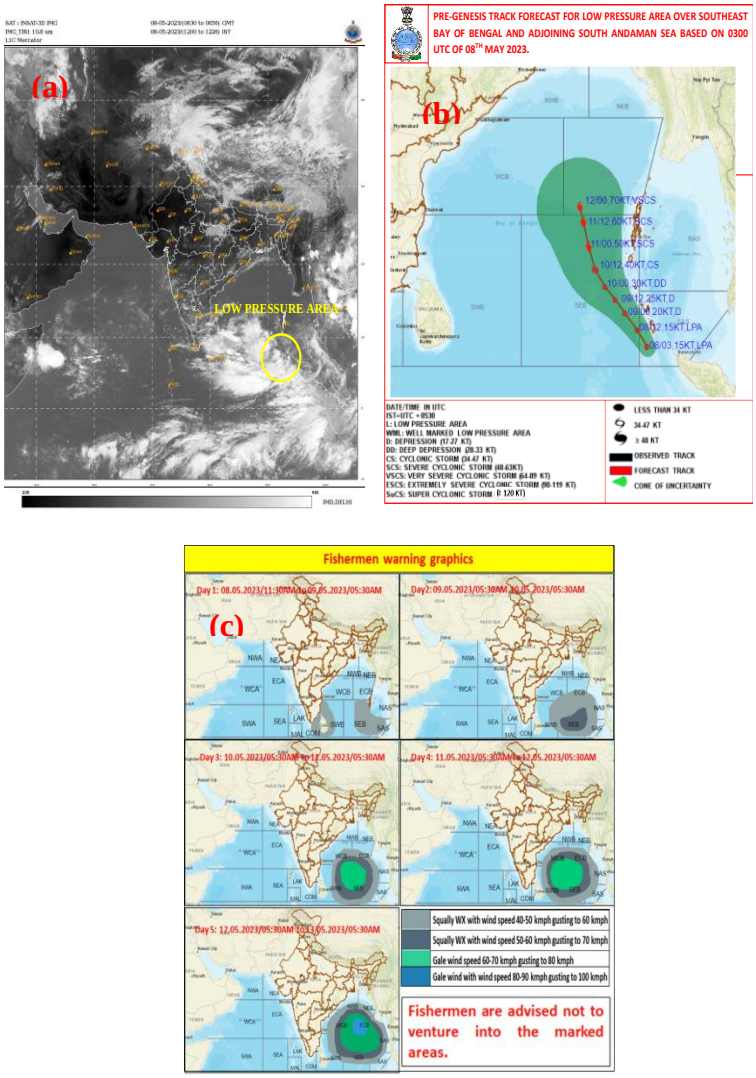


Fig. II-7: (a) Typical Satellite imagery based on 0300 UTC of 08th May in association with SCS ASANI over Bay of Bengal (b) Observed and forecast track alongwith with cone of uncertainty based on 0300 UTC of 08th May (c) Fisherman warning graphics based on 0300 UTC of 08th May

Examples-2 (Special Message in association with Well Marked Low Pressure Area)

India Meteorological Department
(Ministry of Earth Sciences)

SPECIAL BULLETIN NO. 2

TIME OF ISSUE:1230 HOURS IST **DATED: 09.05.2023**
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, ANDAMAN & NICOBAR ISLANDS (FAX NO. 03192- 232656)
CHIEF SECRETARY, GOVT. WEST BENGAL (FAX NO. 033-22144328)
CHIEF SECRETARY, GOVT. OF ODISHA (FAX NO. 0674 -2536660)
CHIEF SECRETARY, GOVT. OF ANDHRA PRADESH (FAX NO. 0863-2441029, 08645-246600)
CHIEF SECRETARY, GOVT. OF TAMIL NADU (FAX NO. 044-25672304)
CHIEF SECRETARY, GOVT. OF PUDUCHERRY (FAX NO. 0413-2337575, 2334145)

Sub: Well Marked Low pressure area over southeast Bay of Bengal and adjoining south Andaman Sea
The low pressure area over Southeast Bay of Bengal and adjoining South Andaman Sea has become Well Marked Low pressure Area over the same region at 0530 hours IST of today, the 9th May 2023. It is very likely to intensify into a depression by today evening over the same region and subsequently into a cyclonic storm over southeast Bay of Bengal and adjoining areas of eastcentral Bay of Bengal and Andaman Sea on 10th May. It is likely to move initially north-northwestwards till 11th May. Thereafter, it is likely to recurve gradually and move north-northeastwards towards Bangladesh-Myanmar coasts.

Warnings:

(i) Rainfall (warning graphics enclosed)

- **Andaman & Nicobar Islands:** Rainfall at most places with
  Heavy to very heavy rainfall at isolated places is likely during 9th to 11th May.
  Heavy rainfall at isolated places over Andaman Islands is likely on 12th May.

(ii) Wind warning:

- **Andaman & Nicobar Islands:**
  Squally wind speed reaching 45-55 kmph gusting to 65 kmph prevails on 9th May
  Squally wind speed reaching 50-60 kmph gusting to 70 kmph is very likely from evening of 9th May and 55-65 kmph gusting to 75 kmph on 10th & 11th May.

- **Andaman Sea:**
  Squally wind speed reaching 45-55 kmph gusting to 65 kmph prevails on 9th May.
  Squally wind speed reaching 50-60 kmph gusting to 70 kmph is very likely by morning of 10th May and 55-65 kmph gusting to 75 kmph is likely on 11th May.

- **Southeast Bay of Bengal:**
  Squally wind speed reaching 45-55 kmph gusting to 65 kmph prevails on 9th May.
  Squally wind speed reaching 50-60 kmph gusting to 70 kmph is very likely from morning of 10th May.
  Gale wind speed reaching 70-80 kmph gusting to 90 kmph from 11th May morning becoming 80-90 kmph gusting to 100 kmph on 12th May.
  Squally wind speed reaching 50-60 kmph gusting to 70 kmph is very 13th May.

- **Eastcentral Bay of Bengal:**
  Squally weather with wind speed reaching 40-50 kmph gusting to 60 kmph is very likely on 9th May and 50-60 kmph gusting to 70 kmph on 10th May.
  Gale wind speed reaching 60-70 kmph gusting to 80 kmph from evening of 10th May.
  Gale wind speed reaching 80-100 kmph gusting to 120 kmph on 11th May becoming 130-140 kmph gusting to 150 kmph during 12th & 13th May.

- **Westcentral Bay of Bengal:**
  Squally weather with wind speed reaching 40-50 kmph gusting to 60 kmph is very likely on 9th May and 50-60 kmph gusting to 70 kmph on 10th May.
  Gale wind speed reaching 60-70 kmph gusting to 80 kmph becoming 80-90 kmph gusting to 100 kmph on 11th May.
  Gale wind speed reaching 100-110 kmph gusting to 120 kmph during 12th & 13th May.

(iii) Sea condition

- **Andaman Sea:**
  Rough to very rough over south Andaman Sea prevails on 9th May
  Very rough to high over Andaman Sea during 10th & 11th May.
  Very rough to very rough over north Andaman Sea during 12th and 13th May.

- **Southeast Bay of Bengal:**
  Rough to very rough prevails on 9th May.
  Very rough to high during 10th and 11th May.
  High to very high during on 12th May.

- **Eastcentral Bay of Bengal:**
  Rough to very rough prevails on 9th May.
  High to very high during10th & 11th May.
  Very High to phenomenal during 12th & 13th May.

- **Westcentral Bay of Bengal:**
  Rough to very rough on 9th May.
  High to very high during10th & 11th May.
  High to Very High during 12th & 13th May.

(iv) Fishermen Warning (warning graphics enclosed)

- Fishermen, small ships, boats and trawlers are advised not to venture into southeast and central Bay of Bengal and Andaman Sea from 9th May onwards.
- Those over central Bay of Bengal and north Andaman Sea are advised to return by today, the 9th May.

(v) Advisory

- Regulation of tourism and offshore activities and shipping near Andaman and Nicobar Islands during 9th - 12th May and
- Regulation of shipping activity over the sea areas of southeast & central Bay of Bengal and Andaman Sea during 9th -13th May.

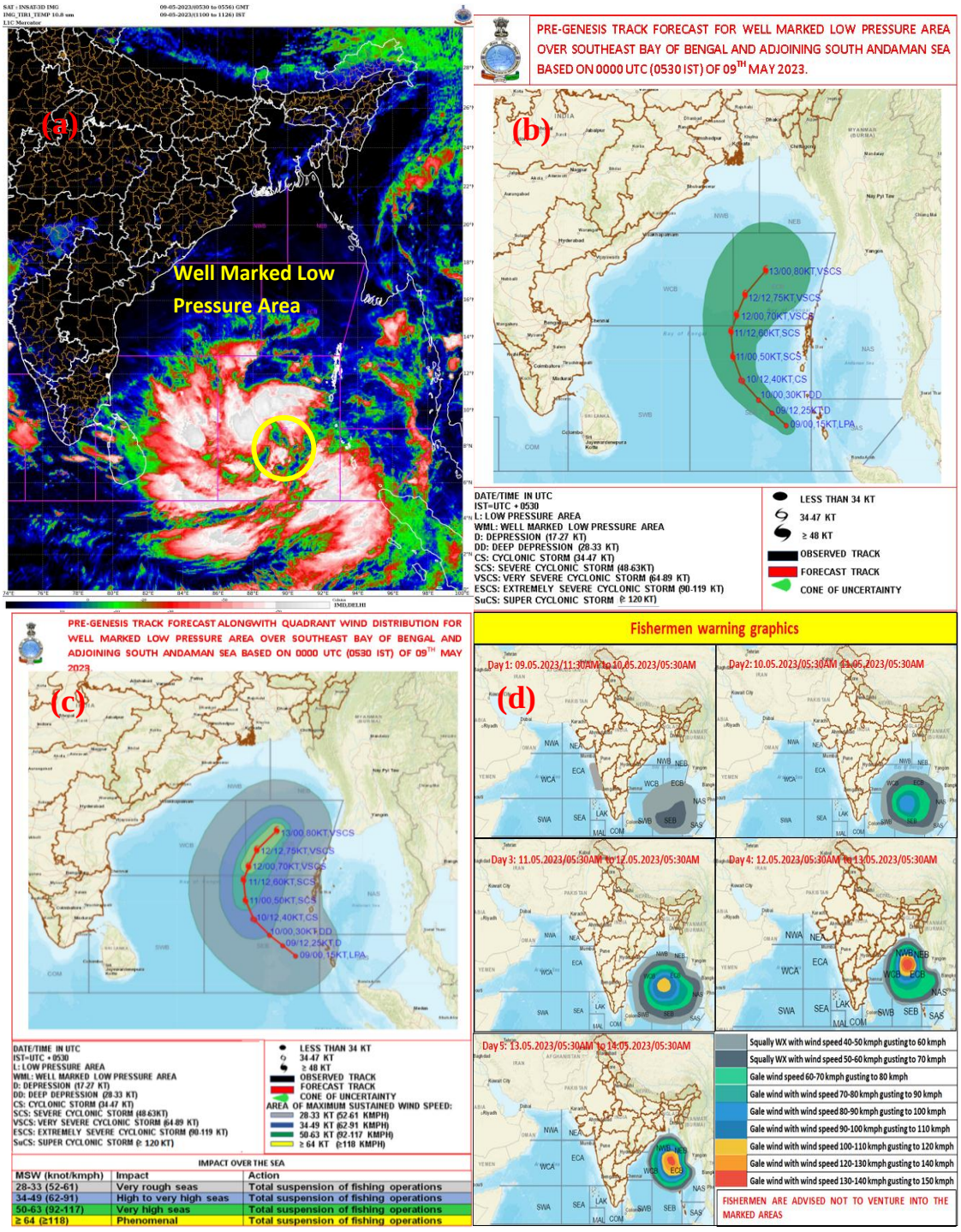


Fig. 2.4.6: (a) Typical Satellite imagery based on 0300 UTC of 9th May in association with WML over Bay of Bengal (b) Observed and forecast track alongwith with cone of uncertainty based on 0300 UTC of 9th May (c) Observed and forecast track alongwith with Quadrant wind distribution based on 0300 UTC of 9th May. (d) Fisherman warning graphics based on 0300 UTC of 9th May

Examples-3 (National Bulletin in association with Depression)

India Meteorological Department
(Ministry of Earth Sciences)

BULLETIN NO. 1 (ARB/01/2023)

TIME OF ISSUE:1030 HOURS IST **DATED: 06.06.2023**
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, KERALA (FAX NO. 0471-2327176)
ADMINISTRATOR, LAKSHADWEEP ISLANDS (FAX NO. 0413-262184)
CHIEF SECRETARY, TAMILNADU (FAX NO. 044-25672304)
CHIEF SECRETARY, GOA (FAX NO. 0832-2415201)
CHIEF SECRETARY, KARNATAKA (FAX NO. 080-22258913)
CHIEF SECRETARY, MAHARASHTRA (FAX NO. 022- 22028594)
CHIEF SECRETARY, GUJARAT (FAX NO. 079-23250305)
CHIEF SECRETARY, DAMAN & DIU (FAX NO. 0260-2230775)
CHIEF SECRETARY, DADRA & NAGAR HAVELI (FAX NO. 0260-2645466)

Sub: Depression has formed over Southeast Arabian Sea

Latest observations indicate that a depression has formed over southeast Arabian Sea and lay centered at 0530 hours IST of today, the 06th June, 2023 near latitude 11.3°N and longitude 66.0°E, about 920 km west-southwest of Goa, 1120 km south-southwest of Mumbai, 1160 km south of Porbander and 1520 km south of Karachi.

It is likely to move nearly northwards and intensify into a cyclonic storm over Eastcentral Arabian Sea & adjoining southeast during next 24 hours.

Forecast track and intensity are given below:

Date/Time(IST)	Position (Lat. ^{0}N/ long. ^{0}E	Maximum sustained surface wind speed (Kmph)	Category of cyclonic disturbance
06.06.23/0530	11.3/66.0	45-55 gusting to 65	Depression
06.06.23/1730	11.6/65.9	55-65 gusting to 75	Deep Depression
07.06.23/0530	12.0/65.8	60-70 gusting to 80	Cyclonic Storm
07.06.23/1730	12.7/65.7	70-80 gusting to 90	Cyclonic Storm
08.06.23/0530	13.2/65.6	80-90 gusting to 100	Cyclonic Storm
08.06.23/1730	13.9/65.5	90-100 gusting to 110	Severe Cyclonic Storm

09.06.23/0530	14.4/65.4	95-105 gusting to 115	Severe Cyclonic Storm
09.06.23/1730	15.1/65.3	105-110 gusting to 125	Severe Cyclonic Storm
10.06.23/0530	15.7/65.2	115-125 gusting to 140	Severe Cyclonic Storm
10.06.23/1730	16.4/65.1	115-125 gusting to 140	Very Severe Cyclonic Storm
11.06.23/0530	17.3/65.0	125-135 gusting to 150	Very Severe Cyclonic Storm

(i) Wind warning:

6th June: Squally wind speed reaching 45-55 kmph gusting to 65 kmph is prevailing over southeast & adjoining east central Arabian Sea and it is likely to become Gale wind speed reaching 60-70 kmph gusting to 80 kmph from night of today over Eastcentral Arabian Sea & adjoining southeast Arabian Sea.

Squally wind speed reaching 35-45 kmph gusting to 55 kmph is likely over adjoining areas of southwest & westcentral Arabian Sea and along & off Kerala-Karnataka-Goa coasts, Lakshadweep-Maldives areas.

7th June: Gale wind speed reaching 65-75 kmph gusting to 85 kmph is likely to prevail over eastcentral Arabian Sea and adjoining areas of southeast Arabian. It is likely to become 80-90 kmph gusting to 100kmph from night of 7th June over the same area

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of westcentral & south Arabian Sea and along & off north Kerala-Karnataka-Goa coasts.

8th June: Gale wind speed reaching 80-90 kmph gusting to 100 kmph is likely to prevail over east central Arabian Sea and adjoining areas of westcentral & south Arabian and it is likely to become 90-100 kmph gusting to 110kmph from night of 8th June over the same area.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely along & off Karnataka-Goa-Maharashtra coasts.

9th June: Gale wind speed reaching 95-105 kmph gusting to 115 kmph is likely to prevail over eastcentral & adjoining westcentral Arabian Sea and it is likely to become 115-125 kmph gusting to 140kmph from night of 9th June over the same area. Squally wind speed reaching 50-60 kmph gusting to 70 kmph is likely over adjoining areas of South Arabian Sea.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely along & off Karnataka-Goa- Maharashtra coasts.

10th June: Gale wind speed reaching 115-125 kmph gusting to 140 kmph is likely to prevail over eastcentral & adjoining areas of westcentral Arabian Sea.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of south Arabian Sea and along & off north Karnataka-Goa-Maharashtra coasts.

(iii) Sea condition

6th June: Sea condition is likely to be rough to very rough over southeast & adjoining eastcentral Arabian Sea and it is likely to become very rough to high from night of today over Eastcentral Arabian Sea & adjoining south Arabian Sea. Sea condition is likely to be rough over adjoining areas of southwest Arabian Sea, along & off Kerala-Karnataka-Goa coasts, Lakshadweep-Maldives areas.

7th June:

Sea condition is likely to be high over eastcentral Arabian Sea and adjoining southeast Arabian and it is likely to become high to very high from night of 7th June over the same area.Sea condition is likely to be rough over south Arabian Sea, along & off north Kerala-Karnataka- Goa coasts, Lakshadweep-Maldives areas.

8th June:

Sea condition is likely to be high to very high over eastcentral & adjoining westcentral Arabian Sea and adjoining south Arabian and it is likely to become very high from night of 8th June over Eastcentral & adjoining southeast Arabian Sea. Sea condition is likely to be rough over southwest Arabian Sea, along & off Karnataka-Goa- Maharashtra coasts.

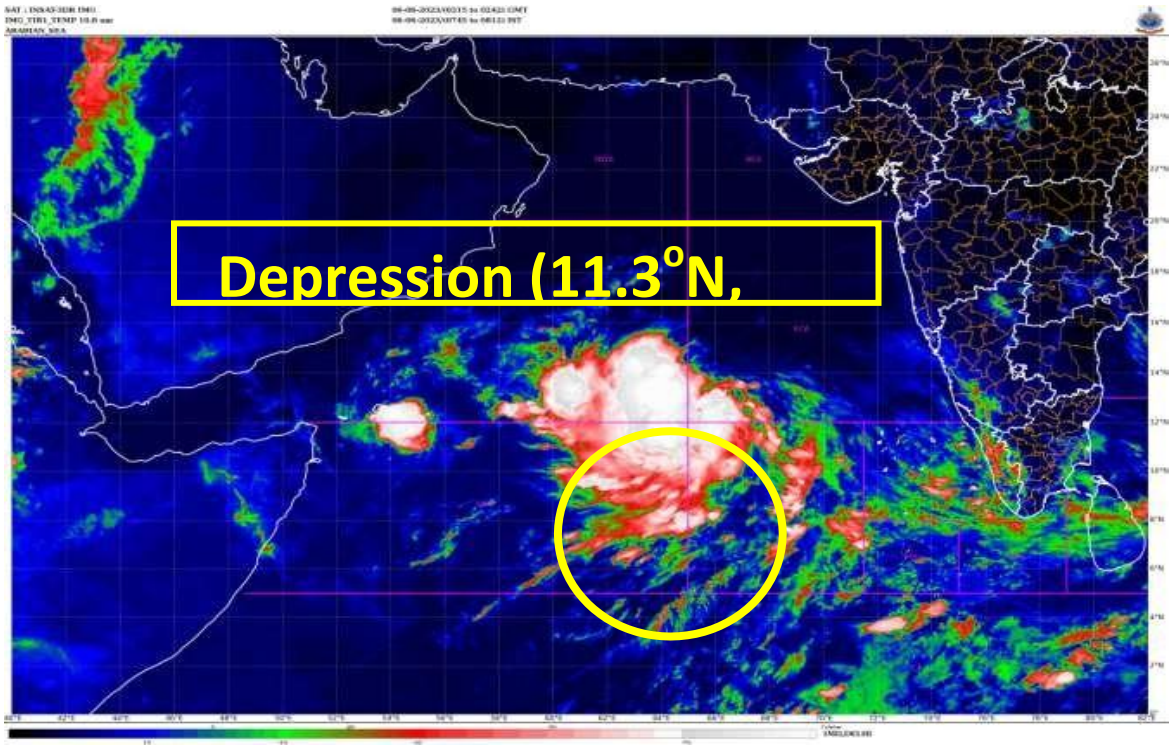
9th June: Sea condition is likely to be very high to phenomenal over eastcentral & adjoining westcentral Arabian Sea and it is likely to become phenomenal from night of 9th June over the same area. Sea condition is likely to be rough over adjoining areas of South Arabian Sea and along & off Karnataka-Goa- Maharashtra coasts.

10th June: Sea condition is likely to be very high to phenomenal over eastcentral & adjoining westcentral Arabian Sea and it is likely to become phenomenal from night of 9th June over the same area. Sea condition is likely to be rough over adjoining areas of South Arabian Sea and along & off Karnataka-Goa- Maharashtra coasts.

(iv) Fishermen Warning

Fishermen are advised not to venture into:

(i) Southeast and adjoining central & southwest Arabian Sea on 6th June
(ii) Eastcentral and adjoining areas of westcentral & south Arabian Sea during 7th-9th June
(iii) Eastcentral and adjoining areas of westcentral Arabian Sea on 10th June.
(iv) Along & off along & off Kerala-Karnataka coasts, Lakshadweep-Maldives areas during 6th & 7th and along & off Konkan-Goa- Maharashtra coasts during 8th-10th June.
(v) Those out at sea are advised to return to coast by today afternoon.



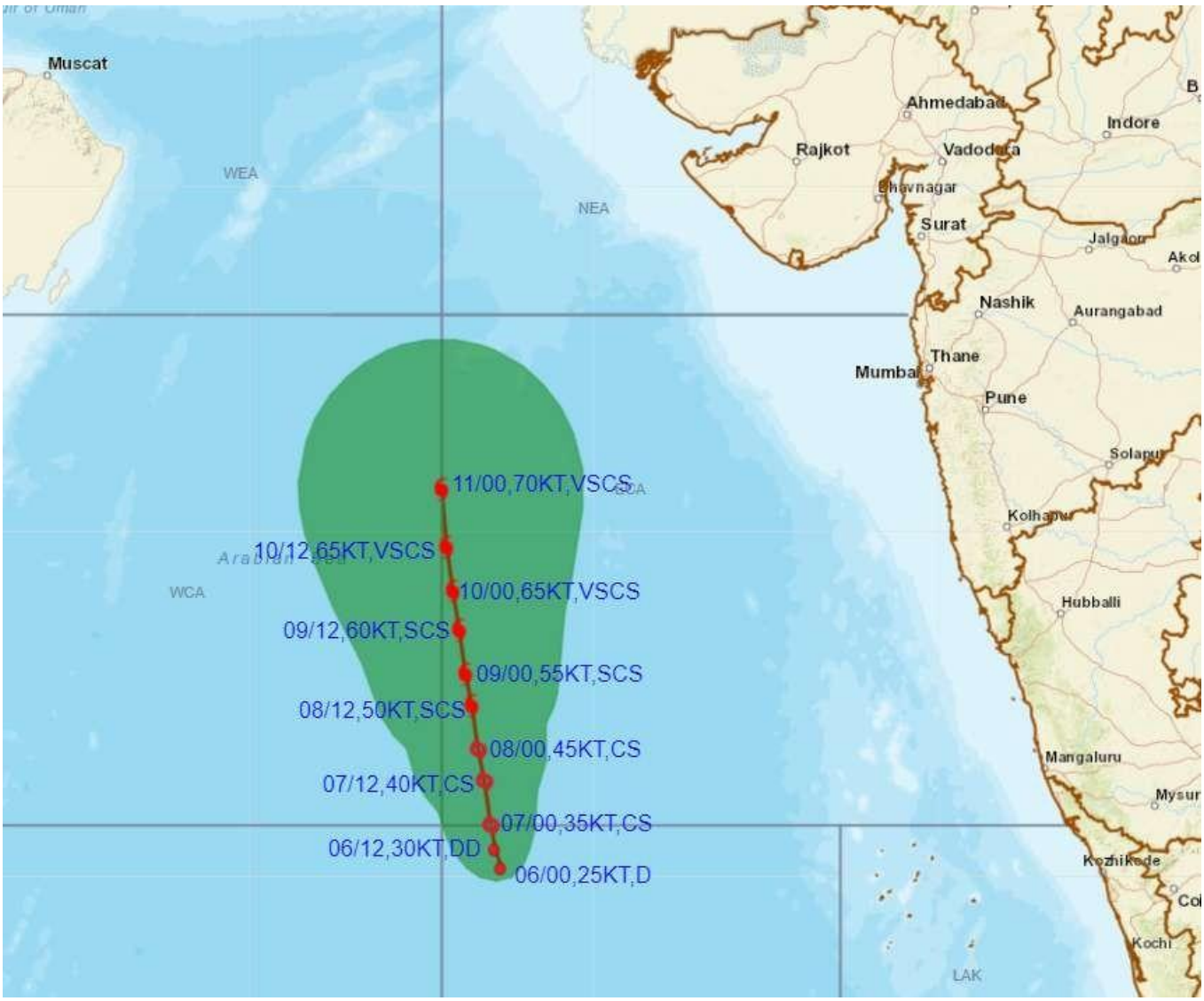
The system is under continuous surveillance and the next message will be issued at 1130 hours IST of today, the 6TH June, 2022.

(R K Jenamani)
Scientist G, Cyclone Warning, New Delhi

Copy to: ACWC Kolkata/ ACWC Chennai/ CWC Bhubaneswar/CWCVisakhapatnam/CWC Ahmedabad/ MO Port Blair/MC Raipur/MC Bhopal/MC Hyderabad/RMC Nagpur

LEGEND: **Heavy Rainfall**: 64.5 to 115.5mm, **Very Heavy Rainfall**: 115.6 to 204.4mm **Most Places**: more than 76% of total stations, **Isolated Places**: Less than 25% of total

OBSERVED AND FORECAST TRACK ALONGWITH CONE OF UNCERTAINITY OF DEPRRESSION OVER SOUTHEAST ARABIAN SEA BASED ON 0000 UTC (0530 IST) OF 06TH JUNE 2023.



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 (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY

Examples-4 (National Bulletin in association with Deep Depression)

India Meteorological Department
(Ministry of Earth Sciences)

BULLETIN NO. 3 (ARB/01/2023)

TIME OF ISSUE:1500 HOURS IST **DATED: 06.06.2023**
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, KERALA (FAX NO. 0471-2327176)
ADMINISTRATOR, LAKSHADWEEP ISLANDS (FAX NO. 0413-262184)
CHIEF SECRETARY, TAMILNADU (FAX NO. 044-25672304)
CHIEF SECRETARY, GOA (FAX NO. 0832-2415201)
CHIEF SECRETARY, KARNATAKA (FAX NO. 080-22258913)
CHIEF SECRETARY, MAHARASHTRA (FAX NO. 022- 22028594)
CHIEF SECRETARY, GUJARAT (FAX NO. 079-23250305)
CHIEF SECRETARY, DAMAN & DIU (FAX NO. 0260-2230775)
CHIEF SECRETARY, DADRA & NAGAR HAVELI (FAX NO. 0260-2645466)

Sub: Deep depression over Southeast and adjoining Eastcentral Arabian Sea

The depression over southeast Arabian Sea moved nearly northwards with a speed of 13 kmph during last 6 hours, intensified into a deep depression and lay centered at 1130 hours IST of today, the 06th June, 2023 over southeast and adjoining eastcentral Arabian Sea near latitude 11.9°N and longitude 66.0°E, about 930 km west-southwest of Goa, 1060 km southwest of Mumbai, 1150 km south-southwest of Porbandar and 1450 km south of Karachi.

It is likely to move nearly northwards and intensify into a cyclonic storm over Eastcentral Arabian Sea & adjoining southeast during next 6 hours.

Forecast track and intensity are given below:

Date/Time(IST)	Position (Lat. ^{0}N/ long. ^{0}E	Maximum sustained surface wind speed (Kmph)	Category of cyclonic disturbance
06.06.23/1130	11.9/66.0	50-60 gusting to 70	Deep Depression
06.06.23/2330	12.4/66.0	60-70 gusting to 80	Cyclonic Storm
07.06.23/1130	13.0/65.9	70-80 gusting to 90	Cyclonic Storm
07.06.23/2330	13.6/65.8	80-90 gusting to 100	Cyclonic Storm

08.06.23/1130	14.2/65.7	90-100 gusting to 110	Severe Cyclonic Storm
08.06.23/2330	14.8/65.6	95-105 gusting to 115	Severe Cyclonic Storm
09.06.23/1130	15.4/65.5	105-115 gusting to 125	Severe Cyclonic Storm
09.06.23/2330	16.1/65.4	115-125 gusting to 140	Very Severe Cyclonic Storm
10.06.23/1130	16.9/65.2	125-135 gusting to 150	Very Severe Cyclonic Storm
10.06.23/2330	17.8/65.0	135-145 gusting to 160	Very Severe Cyclonic Storm
11.06.23/0530	18.7/64.8	145-155 gusting to 170	Very Severe Cyclonic Storm

(i) Wind warning:

6th June: Squally wind speed reaching 50-60 kmph gusting to 70 kmph is prevailing over southeast & adjoining eastcentral Arabian Sea and it is likely to become Gale wind speed reaching 60-70 kmph gusting to 80 kmph from evening of today over Eastcentral Arabian Sea and adjoining areas of westcentral & southeast Arabian Sea.

Squally wind speed reaching 35-45 kmph gusting to 55 kmph is likely over adjoining areas of southwest & westcentral Arabian Sea and along & off Kerala-Karnataka-Goa coasts, Lakshadweep-Maldives areas.

7th June: Gale wind speed reaching 70-80 kmph gusting to 90 kmph is likely to prevail over eastcentral Arabian Sea and adjoining areas of westcentral & southeast Arabian Sea. It is likely to become 80-90 kmph gusting to 100 kmph from evening of 7th June over the same area

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of westcentral & south Arabian Sea and along & off north Kerala-Karnataka-Goa coasts.

8th June: Gale wind speed reaching 90-100 kmph gusting to 110 kmph is likely to prevail over eastcentral Arabian Sea and adjoining areas of westcentral & south Arabian and it is likely to become 95-105 kmph gusting to 115 kmph from evening of 8th June over the same area.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely along & off Karnataka- Goa-Maharashtra coasts.

9th June: Gale wind speed reaching 105-115 kmph gusting to 125 kmph is likely to prevail over central Arabian Sea and it is likely to become 125-135 kmph gusting to 150 kmph from evening of 9th June over the same area. Squally wind speed reaching 50-60 kmph gusting to 70 kmph is likely over adjoining areas of South Arabian Sea.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely along & off Karnataka- Goa-Maharashtra coasts.

10th June: Gale wind speed reaching 125-135 kmph gusting to 150 kmph is likely to prevail over central Arabian Sea. Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of south Arabian Sea and along & off north Karnataka-Goa-Maharashtra coasts.

(iii) Sea condition

6th June: Sea condition is likely to be very rough over southeast & adjoining eastcentral Arabian Sea and it is likely to become high to very high from evening of today over Eastcentral Arabian Sea and adjoining westcentral & south Arabian Sea.

Sea condition is likely to be rough over adjoining areas of southwest Arabian Sea, along & off Kerala-Karnataka-Goa coasts, Lakshadweep-Maldives areas.

7th June: Sea condition is likely to be high over eastcentral Arabian Sea and adjoining westcentral & southeast Arabian and it is likely to become high to very high from evening of 7th June over the same area.

Sea condition is likely to be rough over south Arabian Sea, along & off north Kerala-Karnataka-Goa coasts, Lakshadweep-Maldives areas.

8th June:
Sea condition is likely to be high to very high over central Arabian Sea and adjoining south Arabian and it is likely to become very high from evening of 8th June over central & adjoining southeast Arabian Sea. Sea condition is likely to be rough over southwest Arabian Sea, along & off Karnataka-Goa-Maharashtra coasts.

9th June: Sea condition is likely to be very high to phenomenal over central Arabian Sea and it is likely to become phenomenal from evening of 9th June over the same area. Sea condition is likely to be rough over adjoining areas of South Arabian Sea and along & off Karnataka-Goa- Maharashtra coasts.

10th June: Sea condition is likely to be phenomenal over central Arabian Sea. Sea condition is likely to be rough over adjoining areas of north & South Arabian Sea and along & off Karnataka-Goa- Maharashtra coasts.

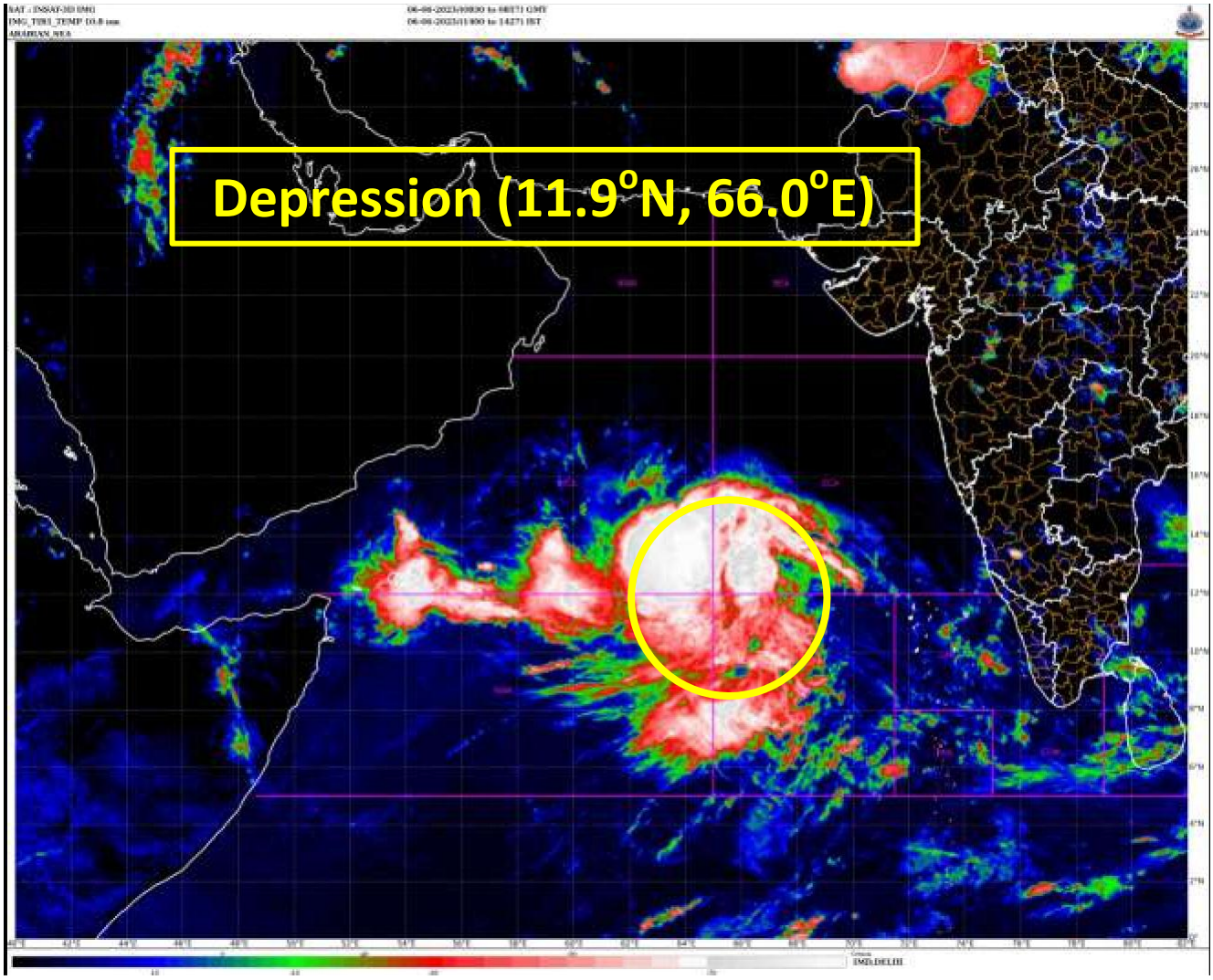
(iv) Fishermen Warning (Graphics Attached)
Fishermen are advised not to venture into:

(i) Southeast and adjoining central & southwest Arabian Sea on 6th June
(ii) Eastcentral and adjoining areas of westcentral & south Arabian Sea during 7th-9th June
(iii) Eastcentral and adjoining areas of westcentral Arabian Sea on 10th June.
(iv) Along & off along & off Kerala-Karnataka coasts, Lakshadweep-Maldives areas during 6th and 7th and along & off Konkan-Goa- Maharashtra coasts during 8th-10th June.
(v) Those out at sea are advised to return to coast by today afternoon.

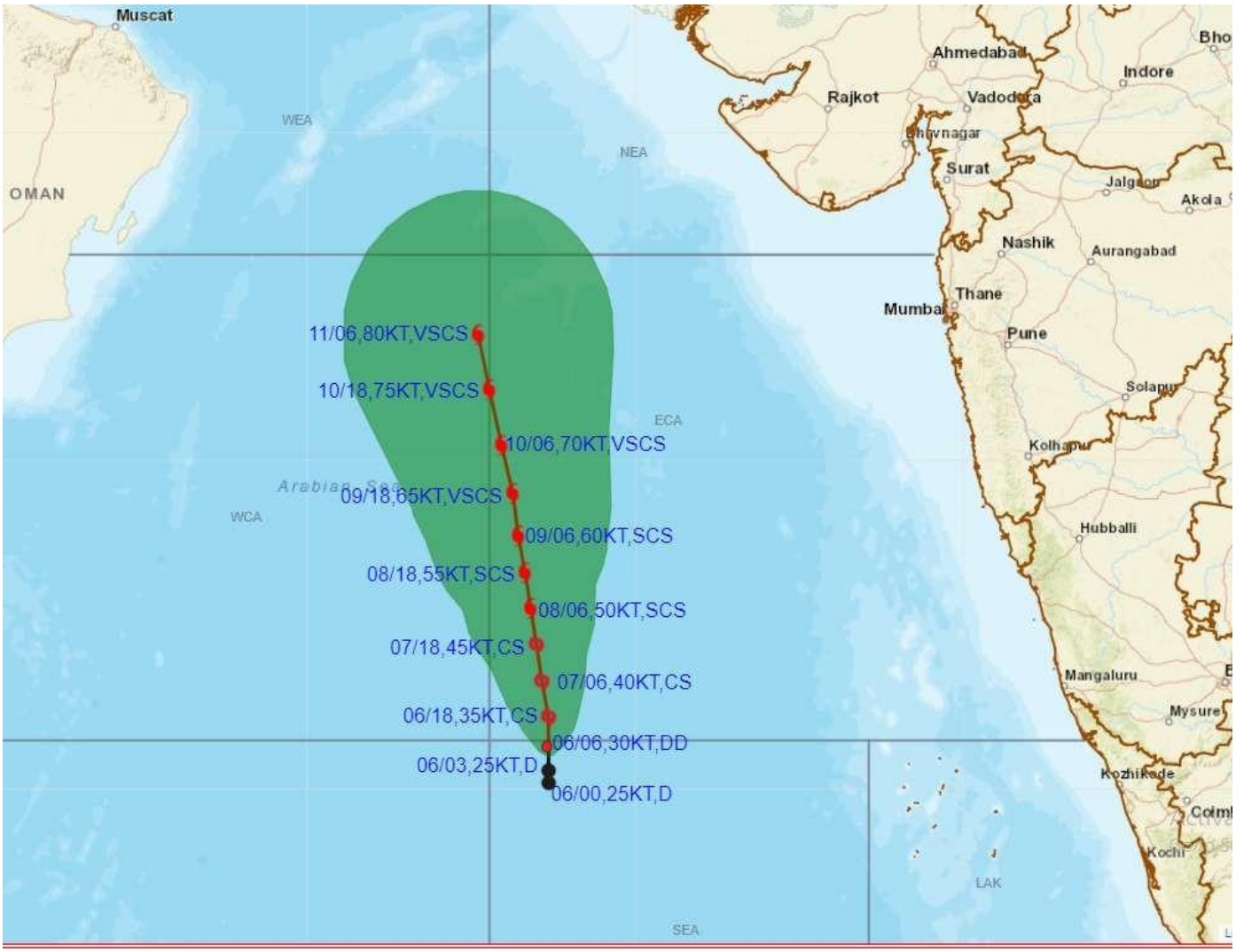
The system is under continuous surveillance and the next message will be issued at 2030 hours IST of today, the 6TH June, 2022.

Copy to: ACWC Kolkata/ ACWC Chennai/ CWC Bhubaneswar/CWCVisakhapatnam/CWC Ahmedabad/ MO Port Blair/MC Raipur/MC Bhopal/MC Hyderabad/RMC Nagpur

LEGEND: **Heavy Rainfall**: 64.5 to 115.5mm, **Very Heavy Rainfall**: 115.6 to 204.4mm **Most Places**: more than 76% of total stations, **Isolated Places**: Less than 25% of total


Depression (11.9°N, 66.0°E)

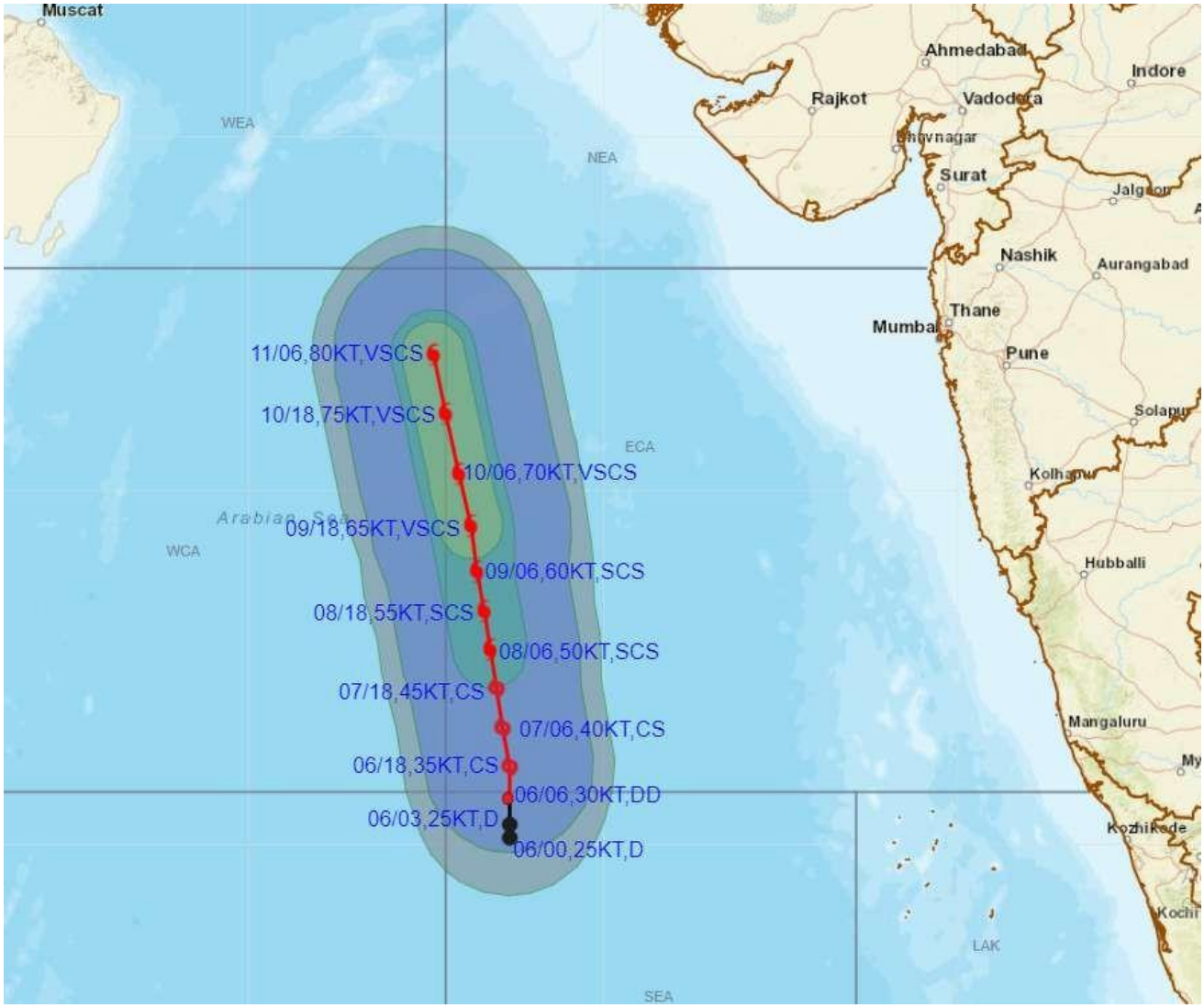
OBSERVED AND FORECAST TRACK ALONGWITH CONE OF UNCERTAINITY OF DEEP DEPRRESSION OVER SOUTHEAST AND ADJOINING EASTCENTRAL ARABIAN SEA BASED ON 0600 UTC (1130 IST) OF 06TH JUNE 2023.



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 (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY

OBSERVED AND FORECAST TRACK ALONGWITH QUADRANT WIND DISTRIBUTION OF DEEP DEPRESSION OVER SOUTHEAST AND ADJOINING EASTCENTRAL ARABIAN SEA BASED ON 0600 UTC (1130 IST) OF 06TH JUNE 2023.

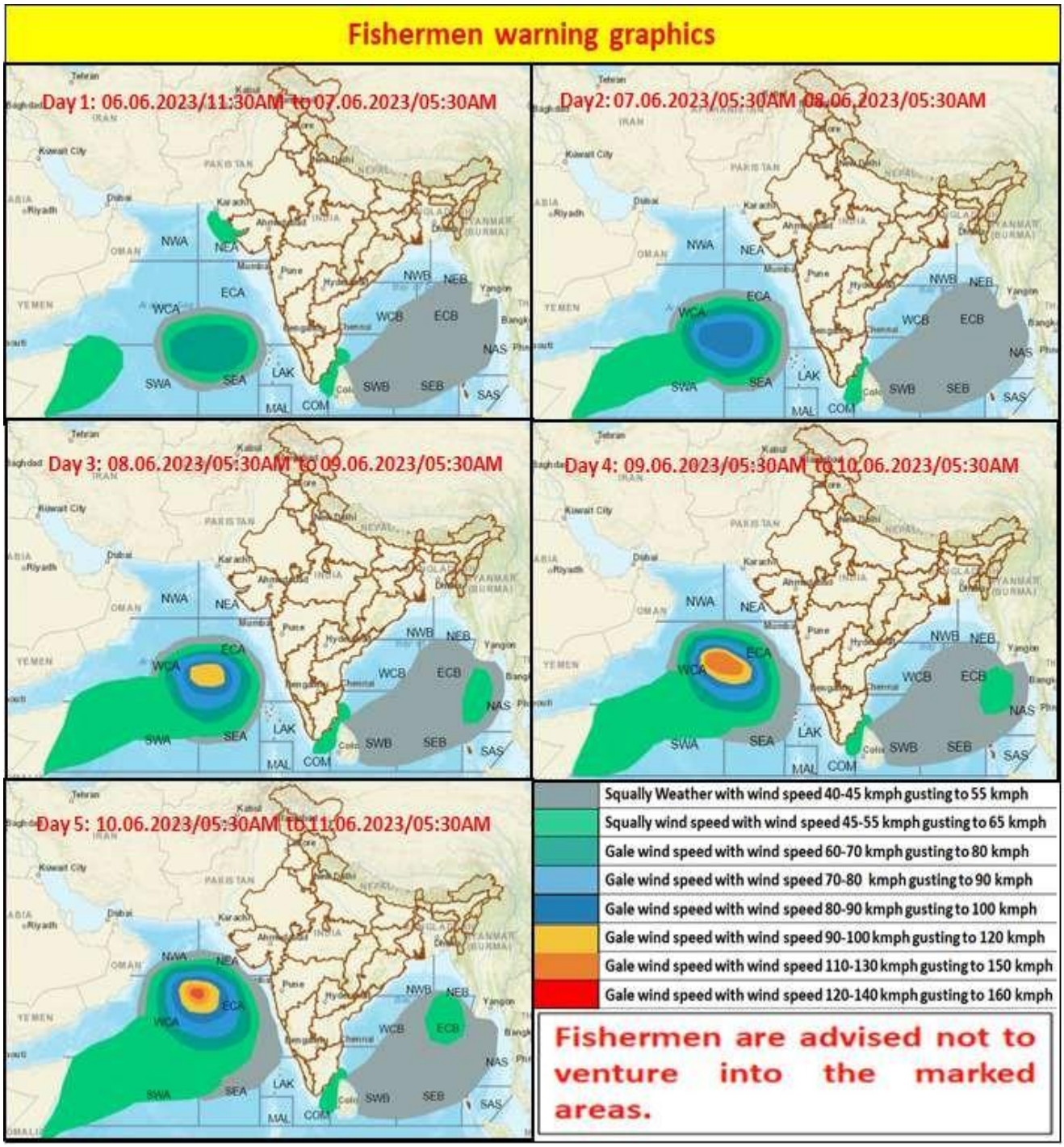


DATE/TIME IN UTC
IST=UTC + 0530
L: LOW PRESSURE AREA
WML: WELL MARKED LOW PRESSURE AREA
D: DEPRESSION (17-27 KT)
DD: DEEP DEPRESSION (28-33 KT)
CS: CYCLONIC STORM (34-47 KT)
SCS: SEVERE CYCLONIC STORM (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY
AREA OF MAXIMUM SUSTAINED WIND SPEED:
28-33 KT (52-61 KMPH)
34-49 KT (62-91 KMPH)
50-63 KT (92-117 KMPH)
≥ 64 KT (≥118 KMPH)

IMPACT OVER THE SEA

MSW (knot/kmph)	Impact	Action
28-33 (52-61)	Very rough seas	Total suspension of fishing operations
34-49 (62-91)	High to very high seas	Total suspension of fishing operations
50-63 (92-117)	Very high seas	Total suspension of fishing operations
≥ 64 (≥118)	Phenomenal	Total suspension of fishing operations


Fishermen warning graphics
Day 1: 06.06.2023/11:30AM to 07.06.2023/05:30AM
Day2: 07.06.2023/05:30AM 08.06.2023/05:30AM
Day 3: 08.06.2023/05:30AM to 09.06.2023/05:30AM
Day 4: 09.06.2023/05:30AM to 10.06.2023/05:30AM
Day 5: 10.06.2023/05:30AM to 11.06.2023/05:30AM
NWA
NEA
ECA
WCA
WCB
ECB
NWB
NEB
NAS
SWA
SEA
LAK
MAL
COM
SWB
SEB
SAS
Squally Weather with wind speed 40-45 kmph gusting to 55 kmph
Squally wind speed with wind speed 45-55 kmph gusting to 65 kmph
Gale wind speed with wind speed 60-70 kmph gusting to 80 kmph
Gale wind speed with wind speed 70-80 kmph gusting to 90 kmph
Gale wind speed with wind speed 80-90 kmph gusting to 100 kmph
Gale wind speed with wind speed 90-100 kmph gusting to 120 kmph
Gale wind speed with wind speed 110-130 kmph gusting to 150 kmph
Gale wind speed with wind speed 120-140 kmph gusting to 160 kmph
Fishermen are advised not to venture into the marked areas.

Examples-5 (National Bulletin in association with Cyclonic Storm "BIPARJOY")

India Meteorological Department
(Ministry of Earth Sciences)

BULLETIN NO. 4 (ARB/01/2023)

TIME OF ISSUE:2030 HOURS IST DATED: 06.06.2023
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, KERALA (FAX NO. 0471-2327176)
ADMINISTRATOR, LAKSHADWEEP ISLANDS (FAX NO. 0413-262184)
CHIEF SECRETARY, TAMILNADU (FAX NO. 044-25672304)
CHIEF SECRETARY, GOA (FAX NO. 0832-2415201)
CHIEF SECRETARY, KARNATAKA (FAX NO. 080-22258913)
CHIEF SECRETARY, MAHARASHTRA (FAX NO. 022- 22028594)
CHIEF SECRETARY, GUJARAT (FAX NO. 079-23250305)
CHIEF SECRETARY, DAMAN & DIU (FAX NO. 0260-2230775)
CHIEF SECRETARY, DADRA & NAGAR HAVELI (FAX NO. 0260-2645466)

Sub: Deep depression intensified into the Cyclonic Storm "Biparjoy" (pronounced as "Biporjoy") over eastcentral and adjoining southeast Arabian Sea

The deep depression over southeast and adjoining eastcentral Arabian Sea moved nearly northwards with a speed of 4 kmph during last 6 hours, intensified into a cyclonic storm **"Biparjoy" (pronounced as "Biporjoy")** and lay centered at 1730 hours IST of today, the 06th June, 2023 over eastcentral and adjoining southeast Arabian Sea near latitude 12.1°N and longitude 66.0°E, about 920 km west-southwest of Goa, 1050 km southwest of Mumbai, 1130 km south-southwest of Porbandar and 1430 km south of Karachi.

It is likely to move nearly northwards and intensify gradually into a severe cyclonic storm over eastcentral Arabian Sea during next 24 hours.

Forecast track and intensity are given below:

Date/Time(IST)	Position (Lat. ^{0}N/ long. ^{0}E	Maximum sustained surface wind speed (Kmph)	Category of cyclonic disturbance
06.06.23/1730	12.1/66.0	60-70 gusting to 80	Cyclonic Storm
06.06.23/2330	12.4/66.0	70-80 gusting to 90	Cyclonic Storm
07.06.23/0530	12.7/66.0	80-90 gusting to 100	Cyclonic Storm
07.06.23/1130	13.0/66.0	90-100 gusting to 110	Severe Cyclonic Storm
07.06.23/1730	13.3/65.9	95-105 gusting to 115	Severe Cyclonic Storm
08.06.23/0530	13.9/65.8	105-115 gusting to 125	Severe Cyclonic Storm
08.06.23/1730	14.5/65.7	115-125 gusting to 140	Very Severe Cyclonic Storm
09.06.23/0530	15.1/65.6	125-135 gusting to 150	Very Severe Cyclonic Storm
09.06.23/1730	15.8/65.5	135-145 gusting to 160	Very Severe Cyclonic Storm
10.06.23/0530	16.5/65.3	145-155 gusting to 170	Very Severe Cyclonic Storm
10.06.23/1730	17.4/65.1	145-155 gusting to 170	Very Severe Cyclonic Storm
11.06.23/0530	18.3/64.9	145-155 gusting to 170	Very Severe Cyclonic Storm
11.06.23/1730	19.2/64.7	135-145 gusting to 160	Very Severe Cyclonic Storm

(i) Wind warning:

6th June: Gale wind speed reaching 60-70 kmph gusting to 70 kmph is prevailing over eastcentral & adjoining southeast Arabian Sea and it is likely to become Gale wind speed reaching 70-80 kmph gusting to 90 kmph from night of today over Eastcentral Arabian Sea and adjoining areas of westcentral & southeast Arabian Sea.

Squally wind speed reaching 35-45 kmph gusting to 55 kmph is likely over adjoining areas of southwest & westcentral Arabian Sea and along & off Kerala-Karnataka-Goa coasts, Lakshadweep-Maldives areas.

7th June: Gale wind speed reaching 80-90 kmph gusting to 100 kmph is likely to prevail over eastcentral Arabian Sea and adjoining areas of westcentral & southeast Arabian Sea. It is likely to become 95-105 kmph gusting to 115 kmph from evening of 7th June over the same area.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of westcentral & south Arabian Sea and along & off north Kerala-Karnataka-Goa coasts.

8th June: Gale wind speed reaching 105-115 kmph gusting to 125 kmph is likely to prevail over eastcentral Arabian Sea and adjoining areas of westcentral & south Arabian and it is likely to become 115-125 kmph gusting to 140 kmph from evening of 8th June over the same area.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely along & off Karnataka-Goa-Maharashtra coasts.

9th June: Gale wind speed reaching 125-135 kmph gusting to 150 kmph is likely to prevail over central Arabian Sea and it is likely to become 135-145 kmph gusting to 160 kmph from evening of 9th June over the same area. Squally wind speed reaching 50-60 kmph gusting to 70 kmph is likely over adjoining areas of South Arabian Sea.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely along & off Karnataka-Goa- Maharashtra coasts.

10th June: Gale wind speed reaching 145-155 kmph gusting to 170 kmph is likely to prevail over central Arabian Sea.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of south Arabian Sea and along & off north Karnataka-Goa-Maharashtra coasts.

(iii) Sea condition

6th June: High Sea condition is prevailing over southeast & adjoining eastcentral Arabian Sea and it is likely to become high to very high from night of today over Eastcentral Arabian Sea and adjoining westcentral & south Arabian Sea.

Sea condition is likely to be rough over adjoining areas of southwest Arabian Sea, along & off Kerala-Karnataka-Goa coasts, Lakshadweep-Maldives areas.

7th June: Sea condition is likely to be high to very high over eastcentral Arabian Sea and adjoining westcentral & southeast Arabian. Sea condition is likely to be rough to very rough over south Arabian Sea, along & off north Kerala-Karnataka-Goa coasts, Lakshadweep-Maldives areas.

8th June:
Sea condition is likely to be very high to phenomenal over central Arabian Sea and adjoining south Arabian and it is likely to become phenomenal from evening of 8th June over the same region.

Sea condition is likely to be rough to very rough over south Arabian Sea, along & off Karnataka-Goa-Maharashtra coasts.

9th June: Sea condition is likely to be phenomenal over central Arabian Sea. Sea condition is likely to be rough to very rough over adjoining areas of South Arabian Sea and along & off Karnataka-Goa- Maharashtra coasts.

10th June: Sea condition is likely to be phenomenal over central Arabian Sea. Sea condition is likely to be rough to very rough over adjoining areas of north & South Arabian Sea and along & off Karnataka-Goa- Maharashtra coasts.

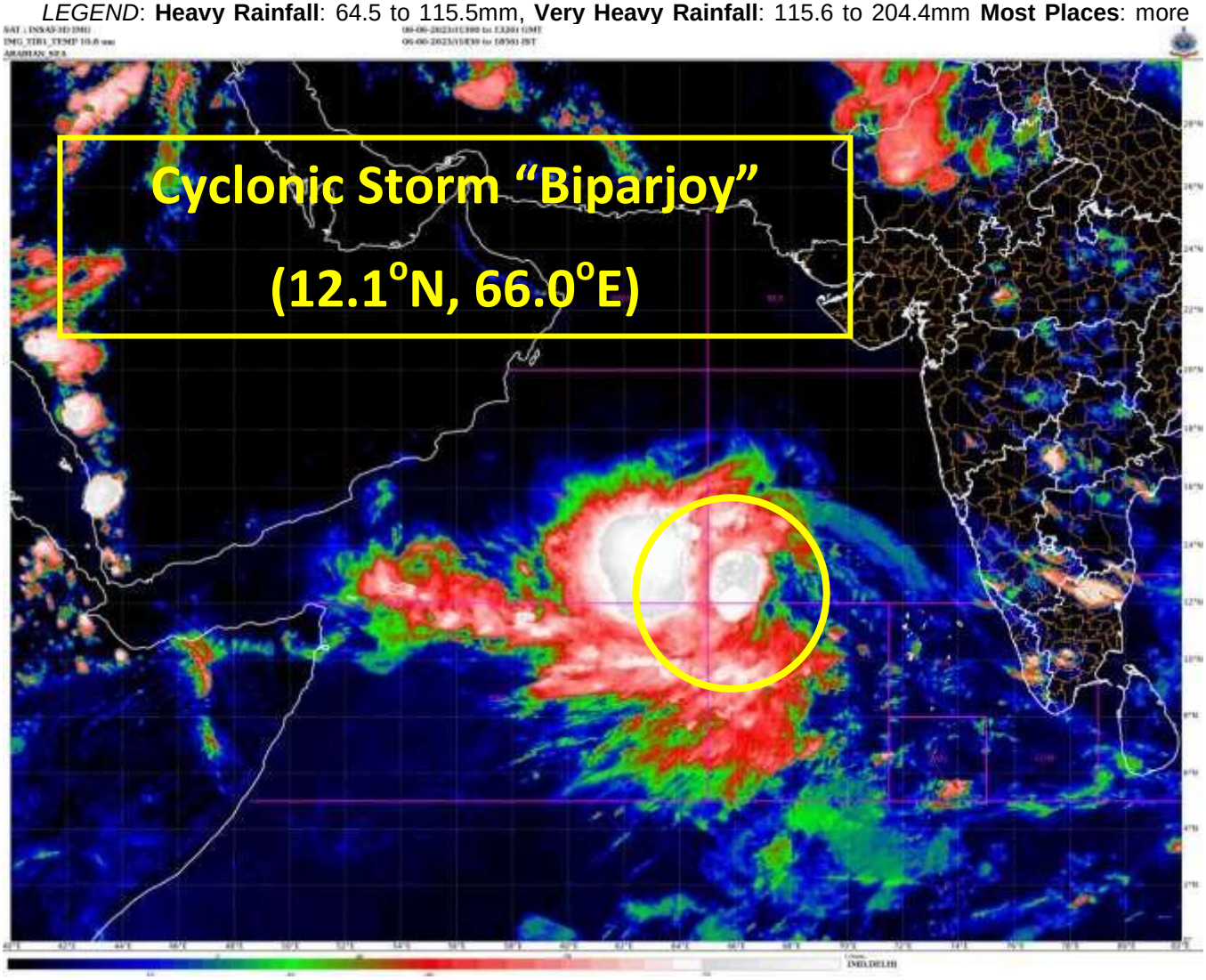
(iv) Fishermen Warning (Graphics Attached)
Fishermen are advised not to venture into:

(i) Southeast and adjoining central & southwest Arabian Sea on 6th June
(ii) Central and adjoining areas of south Arabian Sea during 7th-9th June
(iii) Central and adjoining areas of north & south Arabian Sea on 10th June.

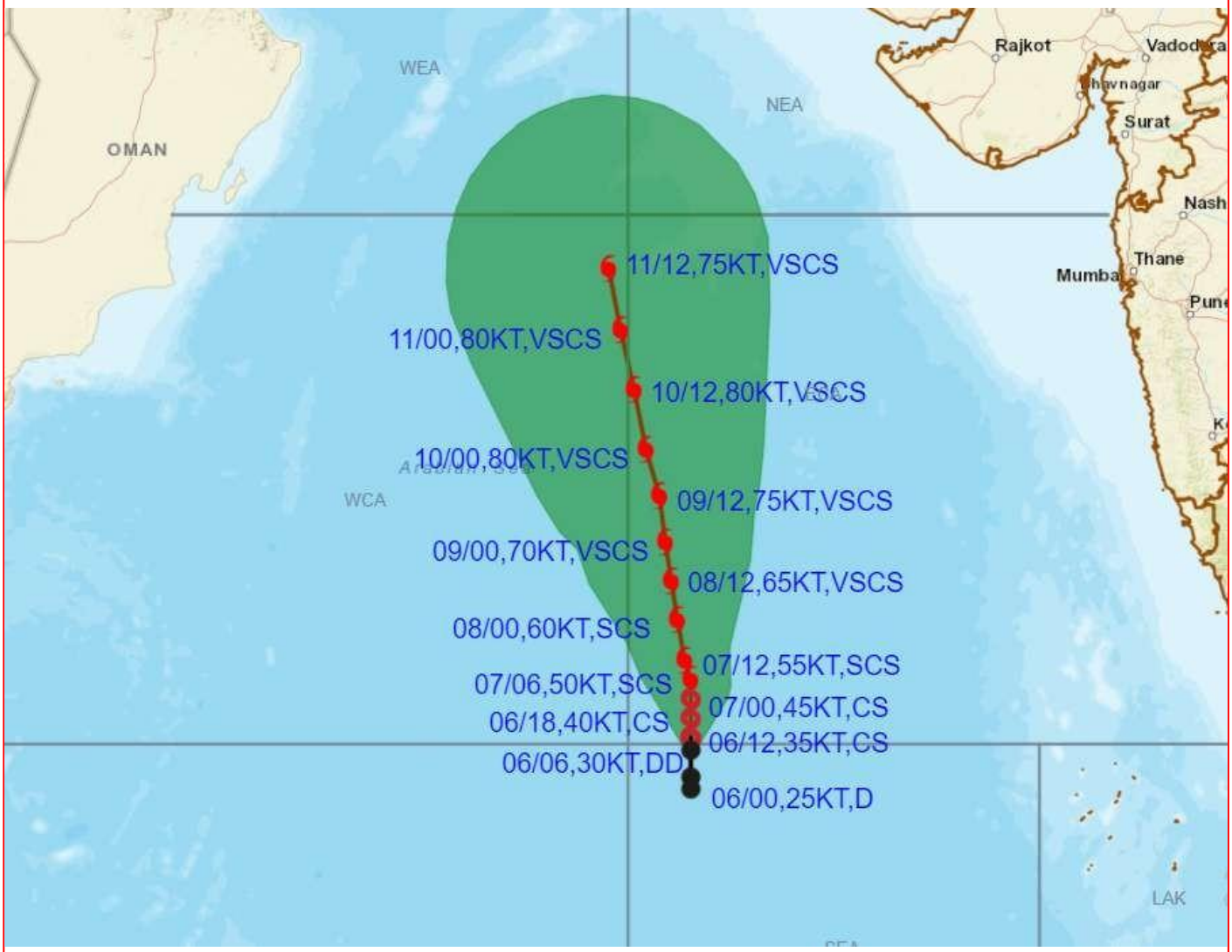
(iv) Along & off along & off Kerala-Karnataka coasts, Lakshadweep-Maldives areas during 6th and 7th and along & off Konkan-Goa- Maharashtra coasts during 8th-10th June.
(v) Those out at sea are advised to return to coast.

The system is under continuous surveillance and the next message will be issued at 2330 hours IST of today, the 6th June, 2022.
Copy to: ACWC Kolkata/ ACWC Chennai/ CWC Bhubaneswar/CWCVisakhapatnam/CWC Ahmedabad/ MO Port Blair/MC Raipur/MC Bhopal/MC Hyderabad/RMC Nagpur

LEGEND: **Heavy Rainfall**: 64.5 to 115.5mm, **Very Heavy Rainfall**: 115.6 to 204.4mm **Most Places**: more



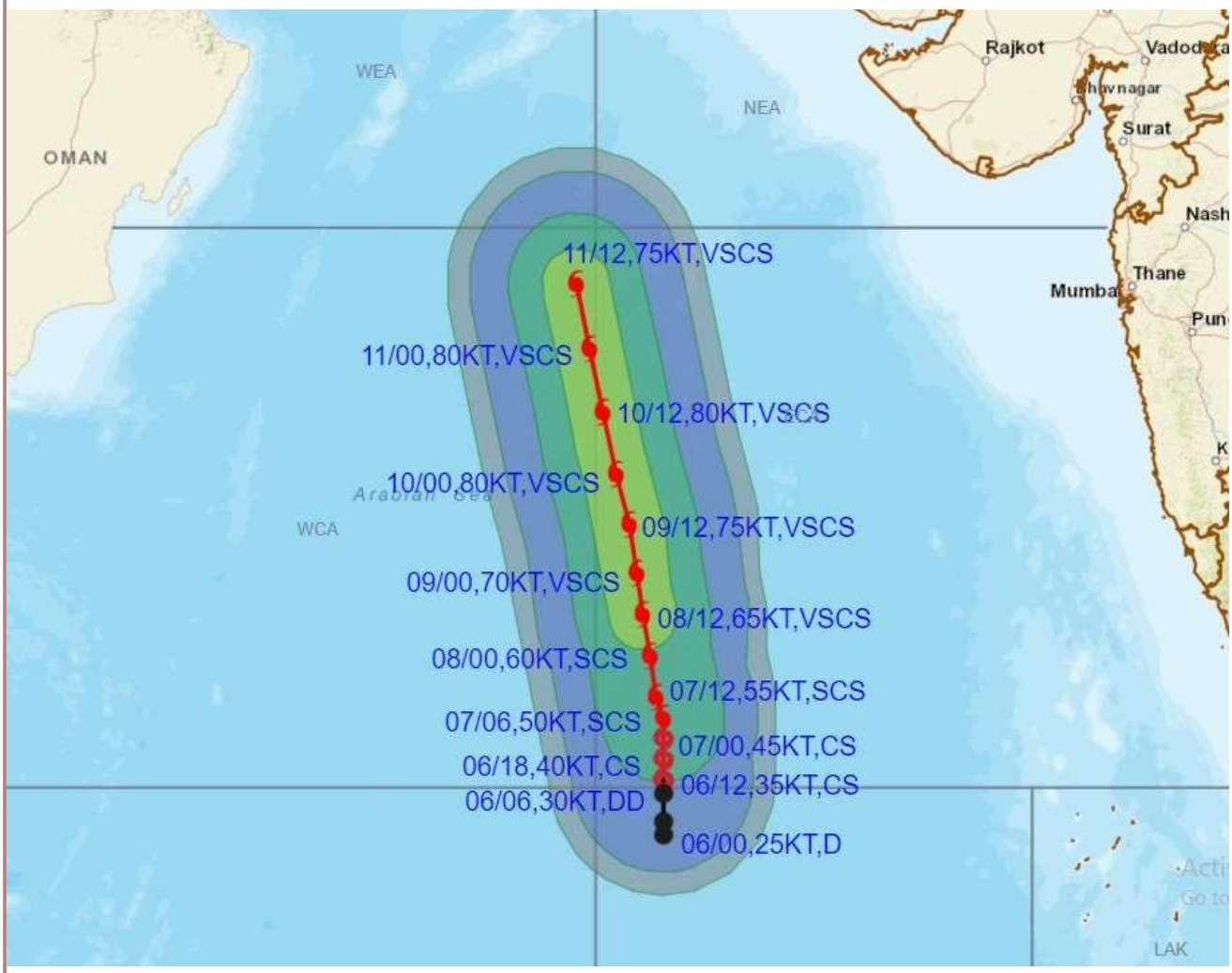
OBSERVED AND FORECAST TRACK ALONGWITH CONE OF UNCERTAINITY OF CYCLONIC STORM "BIPARJOY" OVER EASTCENTRAL AND ADJOINING SOUTHEAST ARABIAN SEA BASED ON 1200 UTC (1730 IST) OF 06TH JUNE 2023.



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 (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY

OBSERVED AND FORECAST TRACK ALONGWITH QUADRANT WIND DISTRIBUTION OF CYCLONIC STORM "BIPARJOY" OVER EASTCENTRAL AND ADJOINING SOUTHEAST ARABIAN SEA BASED ON 1200 UTC (1730 IST) OF 06TH JUNE 2023.



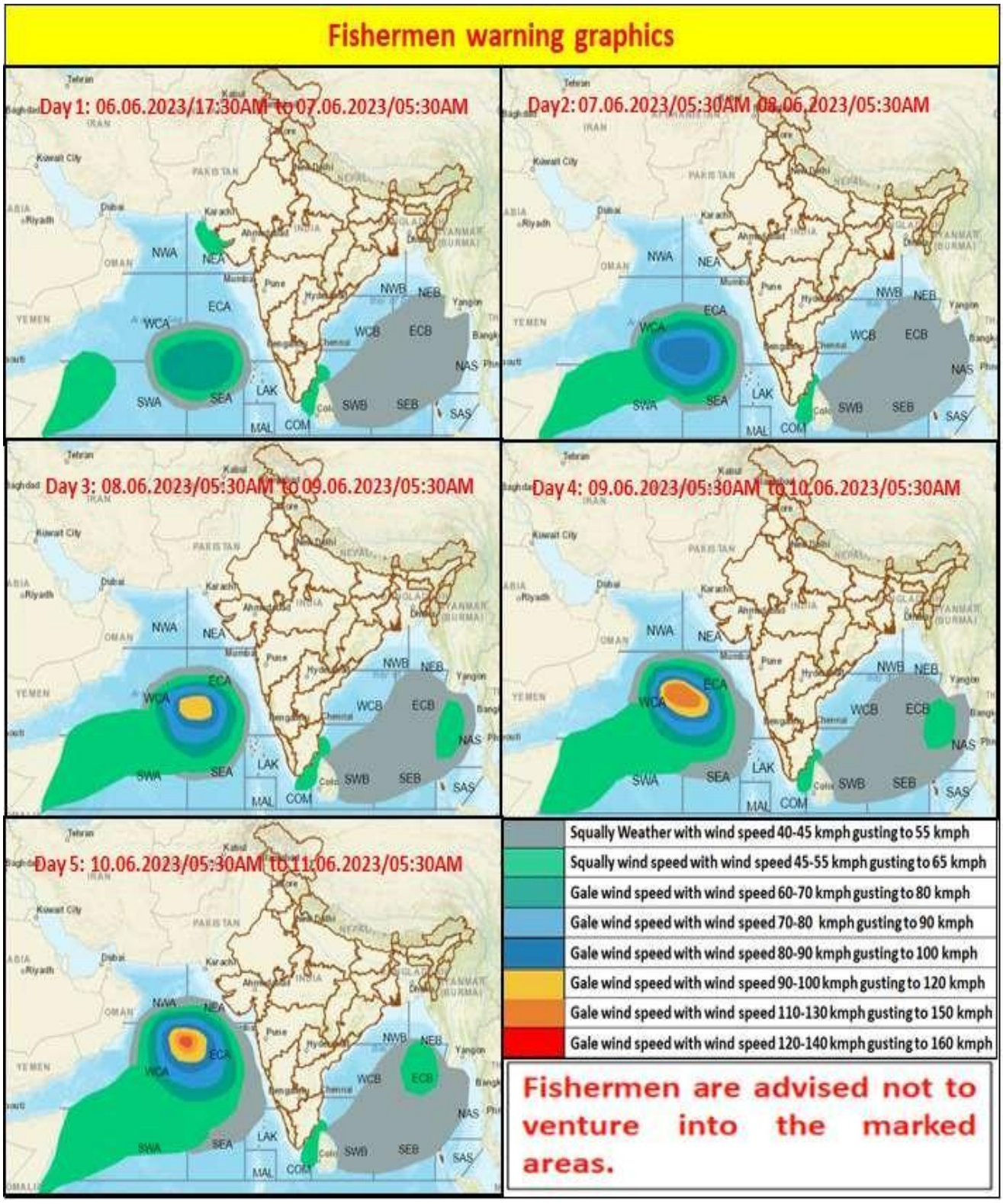
DATE/TIME IN UTC
IST=UTC + 0530
L: LOW PRESSURE AREA
WML: WELL MARKED LOW PRESSURE AREA
D: DEPRESSION (17-27 KT)
DD: DEEP DEPRESSION (28-33 KT)
CS: CYCLONIC STORM (34-47 KT)
SCS: SEVERE CYCLONIC STORM (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

- LESS THAN 34 KT
- 34-47 KT
- ≥ 48 KT
- OBSERVED TRACK
- FORECAST TRACK
- CONE OF UNCERTAINTY

AREA OF MAXIMUM SUSTAINED WIND SPEED:
- 28-33 KT (52-61 KMPH)
- 34-49 KT (62-91 KMPH)
- 50-63 KT (92-117 KMPH)
- ≥ 64 KT (≥118 KMPH)

IMPACT OVER THE SEA

MSW (knot/kmph)	Impact	Action
28-33 (52-61)	Very rough seas	Total suspension of fishing operations
34-49 (62-91)	High to very high seas	Total suspension of fishing operations
50-63 (92-117)	Very high seas	Total suspension of fishing operations
≥ 64 (≥118)	Phenomenal	Total suspension of fishing operations


Fishermen warning graphics
Day 1: 06.06.2023/17:30AM to 07.06.2023/05:30AM
Day2: 07.06.2023/05:30AM 08.06.2023/05:30AM
Day 3: 08.06.2023/05:30AM to 09.06.2023/05:30AM
Day 4: 09.06.2023/05:30AM to 10.06.2023/05:30AM
Day 5: 10.06.2023/05:30AM to 11.06.2023/05:30AM
NWA
NEA
ECA
WCA
NWB
NEB
WCB
ECB
NAS
SWA
SEA
LAK
SWB
SEB
SAS
MAL
COM
Squally Weather with wind speed 40-45 kmph gusting to 55 kmph
Squally wind speed with wind speed 45-55 kmph gusting to 65 kmph
Gale wind speed with wind speed 60-70 kmph gusting to 80 kmph
Gale wind speed with wind speed 70-80 kmph gusting to 90 kmph
Gale wind speed with wind speed 80-90 kmph gusting to 100 kmph
Gale wind speed with wind speed 90-100 kmph gusting to 120 kmph
Gale wind speed with wind speed 110-130 kmph gusting to 150 kmph
Gale wind speed with wind speed 120-140 kmph gusting to 160 kmph
Fishermen are advised not to venture into the marked areas.

Examples-6 (National Bulletin in association with Severe Cyclonic Storm "BIPARJOY")

India Meteorological Department
(Ministry of Earth Sciences)

BULLETIN NO. 8 (ARB/01/2023)

TIME OF ISSUE: 0900 HOURS IST DATED: 07.06.2023
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, KERALA (FAX NO. 0471-2327176)
ADMINISTRATOR, LAKSHADWEEP ISLANDS (FAX NO. 0413-262184)
CHIEF SECRETARY, TAMILNADU (FAX NO. 044-25672304)
CHIEF SECRETARY, GOA (FAX NO. 0832-2415201)
CHIEF SECRETARY, KARNATAKA (FAX NO. 080-22258913)
CHIEF SECRETARY, MAHARASHTRA (FAX NO. 022- 22028594)
CHIEF SECRETARY, GUJARAT (FAX NO. 079-23250305)
CHIEF SECRETARY, DAMAN & DIU (FAX NO. 0260-2230775)
CHIEF SECRETARY, DADRA & NAGAR HAVELI (FAX NO. 0260-2645466)

Sub: Cyclonic Storm "Biparjoy" (pronounced as "Biporjoy") intensified into a Severe Cyclonic Storm over eastcentral and adjoining southeast Arabian Sea

The cyclonic storm **"Biparjoy" (pronounced as "Biporjoy")** over eastcentral and adjoining southeast Arabian Sea moved nearly northwards with a speed of 2 kmph during last 6 hours, intensified into a severe cyclonic storm and lay centered at 0530 hours IST of 07th June, 2023 over the same region near latitude 12.6°N and longitude 66.1 °E, about 890 km west-southwest of Goa, 1000 km southwest of Mumbai, 1070 km south-southwest of Porbandar and 1370 km south of Karachi.

It is likely to move nearly northwards during next 24 hours and intensify into a very severe cyclonic storm. It would then move north-northwestwards during subsequent 3 days.

Forecast track and intensity are given below:

Date/Time(IST)	Position (Lat. ^{0}N/ long. ^{0}E	Maximum sustained surface wind speed (Kmph)	Category of cyclonic disturbance
07.06.23/0530	12.6/66.1	95-105 gusting to 115	Severe Cyclonic Storm
07.06.23/1130	12.8/66.2	105-115 gusting to 125	Severe Cyclonic Storm
07.06.23/1730	13.0/66.3	115-125 gusting to 140	Very Severe Cyclonic Storm
07.06.23/2330	13.3/66.3	125-135 gusting to 150	Very Severe Cyclonic Storm
08.06.23/0530	13.9/66.2	130-140 gusting to 155	Very Severe Cyclonic Storm
08.06.23/1730	14.5/66.0	135-145 gusting to 160	Very Severe Cyclonic Storm
09.06.23/0530	15.1/65.8	135-145 gusting to 160	Very Severe Cyclonic Storm
09.06.23/1730	15.8/65.5	145-155 gusting to 170	Very Severe Cyclonic Storm
10.06.23/0530	16.5/65.2	145-155 gusting to 170	Very Severe Cyclonic Storm
10.06.23/1730	17.4/64.8	145-155 gusting to 170	Very Severe Cyclonic Storm
11.06.23/0530	18.3/64.4	135-145 gusting to 160	Very Severe Cyclonic Storm
11.06.23/1730	19.2/64.0	130-140 gusting to 155	Very Severe Cyclonic Storm
12.06.23/0530	19.8/63.7	125-135 gusting to 150	Very Severe Cyclonic Storm

(i) Wind warning:

7th June: Gale wind speed reaching 95-105 kmph gusting to 115 kmph is prevailing over eastcentral Arabian Sea and adjoining areas of westcentral & southeast Arabian Sea. It is likely to increase and become 125-135 kmph gusting to 155 kmph during night of 7th June over the same area.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of westcentral & south Arabian Sea and along & off north Kerala-Karnataka-Goa coasts.

8th June: Gale wind speed reaching 130-140 kmph gusting to 155 kmph is likely to prevail over eastcentral Arabian Sea and adjoining areas of westcentral & south Arabian and it is likely to increase and become 135-145 kmph gusting to 160 kmph from evening of 8th June over the same area.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely along & off Karnataka-Goa-Maharashtra coasts.

9th June: Gale wind speed reaching 135-145 kmph gusting to 160 kmph is likely to prevail over central Arabian Sea and it is likely to increase and become 145-155 kmph gusting to 170 kmph from evening of 9th June over the same area. Squally wind speed reaching 50-60 kmph gusting to 70 kmph is likely over adjoining areas of South Arabian Sea.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely along & off Karnataka-Goa- Maharashtra coasts.

10th June: Gale wind speed reaching 145-155 kmph gusting to 170 kmph is likely to prevail over central Arabian Sea.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of south Arabian Sea and along & off north Karnataka-Goa-Maharashtra coasts.

11th June: Gale wind speed reaching 135-145 kmph gusting to 160 kmph is likely to prevail over central & adjoining north Arabian Sea.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of eastcentral Arabian Sea and along & off Goa-Maharashtra coasts, northeast Arabian Sea and along & off Gujarat coasts.

(iii) Sea condition

7th June: Very high Sea condition is likely to prevail over eastcentral Arabian Sea and adjoining westcentral & southeast Arabian. Sea condition is likely to be rough to very rough over south Arabian Sea, along & off north Kerala-Karnataka-Goa coasts, Lakshadweep-Maldives areas.

8th June:
Sea condition is likely to be very high to phenomenal over central Arabian Sea and adjoining south Arabian and it is likely to become phenomenal from evening of 8th June over the same region.

Sea condition is likely to be rough to very rough over south Arabian Sea, along & off Karnataka-Goa-Maharashtra coasts.

9th June: Sea condition is likely to be phenomenal over central Arabian Sea. Sea condition is likely to be rough to very rough over adjoining areas of South Arabian Sea and along & off Karnataka-Goa- Maharashtra coasts.

10th June: Sea condition is likely to be phenomenal over central Arabian Sea. Sea condition is likely to be rough to very rough over adjoining areas of north & South Arabian Sea and along & off Karnataka-Goa- Maharashtra coasts.

11th June: Sea condition is likely to be phenomenal to very high over central & adjoining north Arabian Sea. Sea condition is likely to be rough to very rough over adjoining areas of eastcentral Arabian Sea and along & off Goa-Maharashtra coasts, northeast Arabian Sea and along & off Gujarat coasts.

(iv) Fishermen Warning

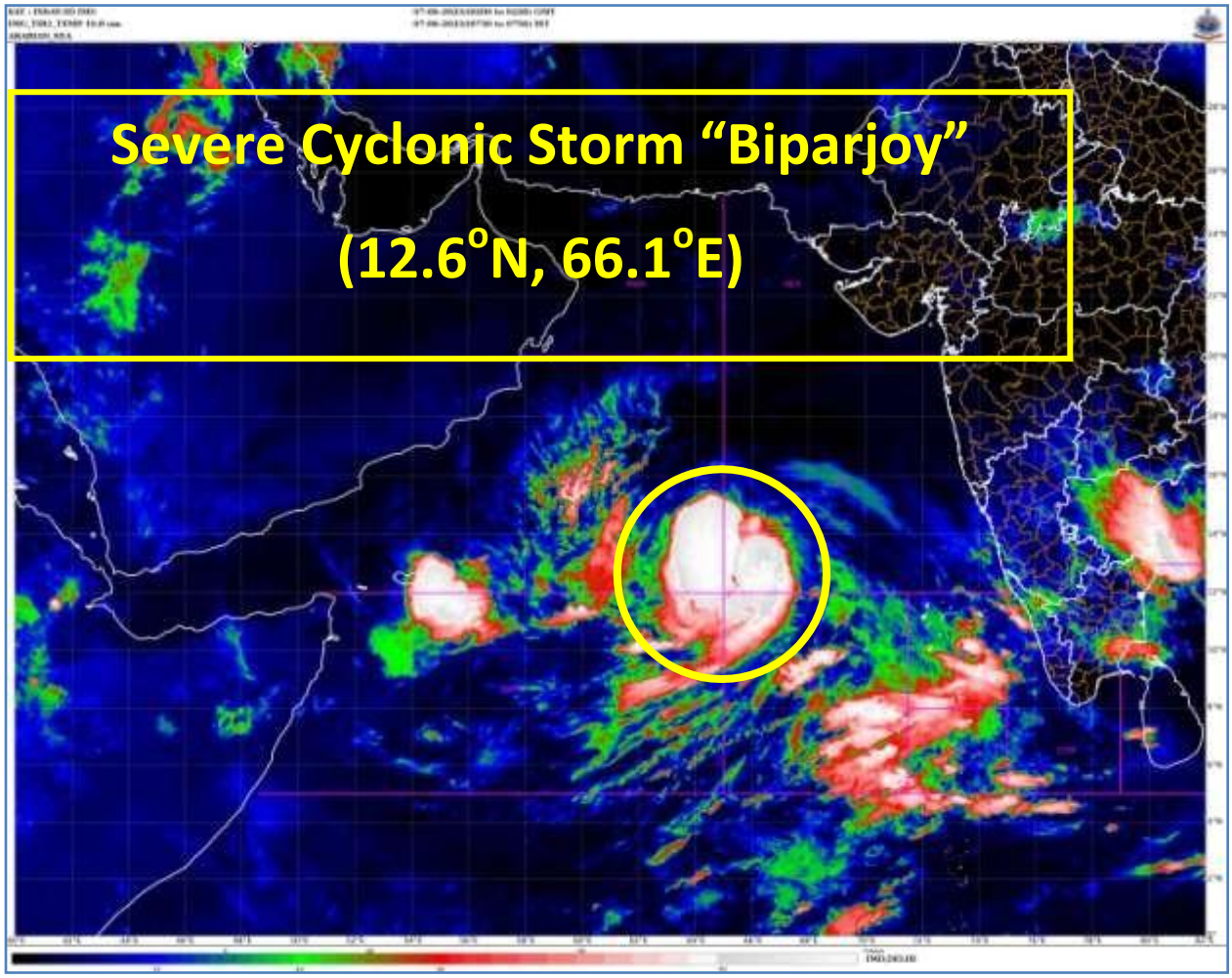
Fishermen are advised not to venture into:

(i) Central Arabian Sea till 12th June.
(ii) North Arabian Sea on 12th June.
(iii) Adjoining areas south Arabian Sea till 8th June.
Along & off along & off Kerala-Karnataka coasts, Lakshadweep-Maldives areas during 6th and
(iv) 7th, along & off Konkan-Goa- Maharashtra coasts during 8th-12th and along & off Gujaratcoast on 11th & 12th June.
(v) Those out at sea are advised to return to coast.

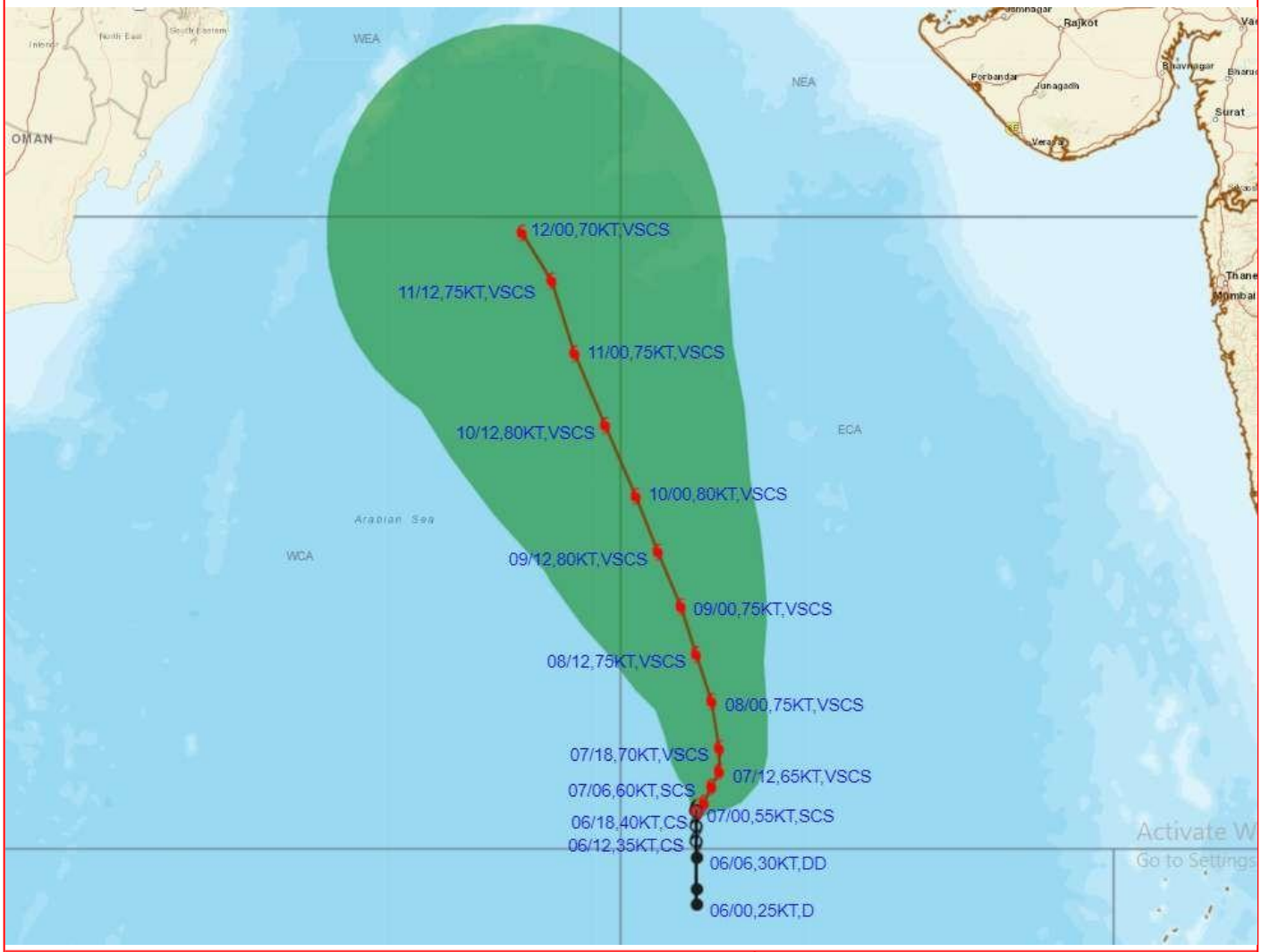
The system is under continuous surveillance and the next message will be issued at 1130 hours IST of today, the 7th June, 2023.

Copy to: ACWC Kolkata/ ACWC Chennai/ CWC Bhubaneswar/CWCVisakhapatnam/CWC Ahmedabad/ MO Port Blair/MC Raipur/MC Bhopal/MC Hyderabad/RMC Nagpur

LEGEND: **Heavy Rainfall**: 64.5 to 115.5mm, **Very Heavy Rainfall**: 115.6 to 204.4mm **Most Places**: more than 76% of total stations, **Isolated Places**: Less than 25% of total



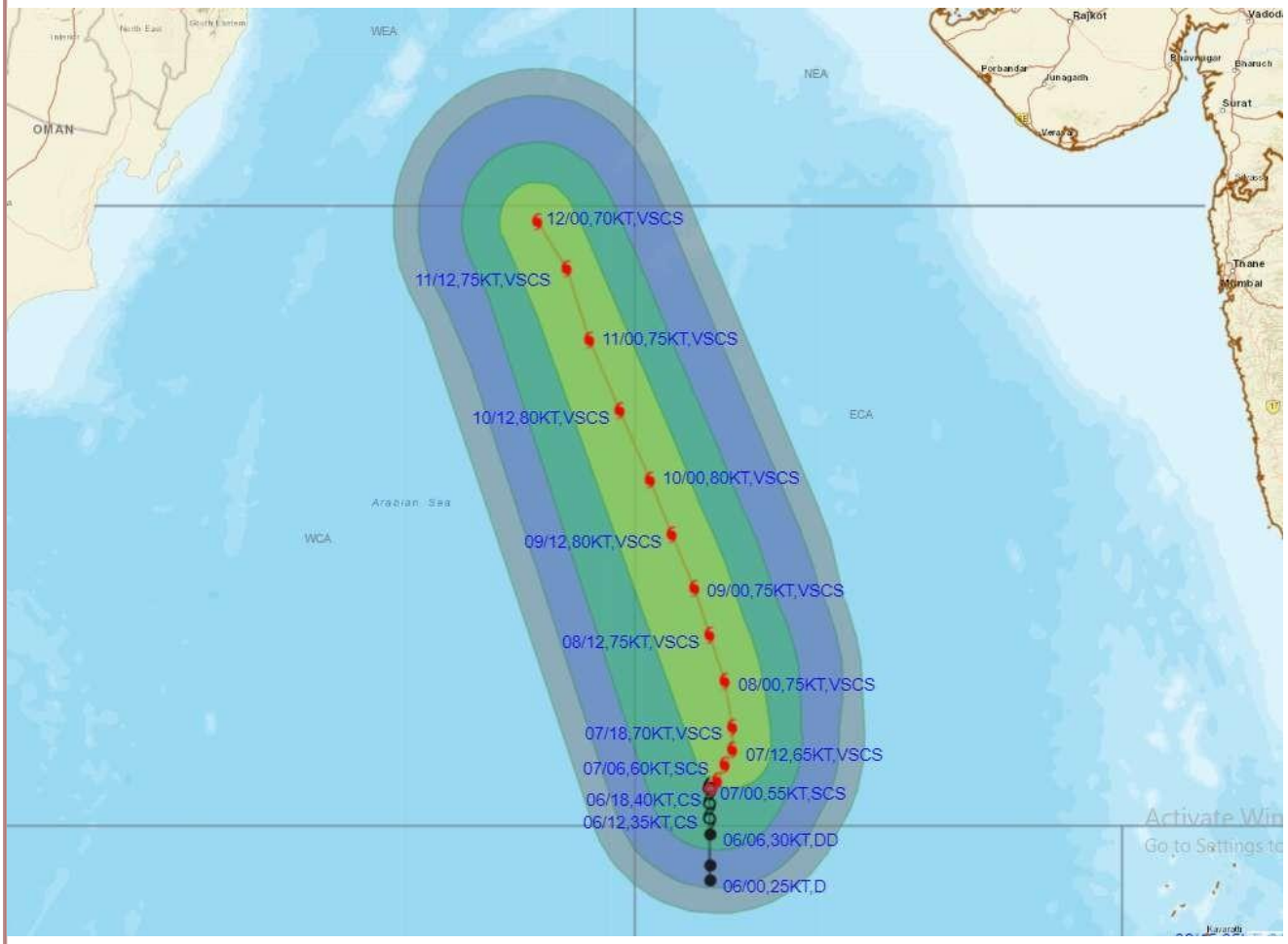
OBSERVED AND FORECAST TRACK ALONGWITH CONE OF UNCERTAINITY OF SEVERE CYCLONIC STORM "BIPARJOY" OVER EASTCENTRAL AND ADJOINING SOUTHEAST ARABIAN SEA BASED ON 0000 UTC (0530 IST) OF 07TH JUNE 2023.



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 (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY

OBSERVED AND FORECAST TRACK ALONGWITH QUADRANT WIND DISTRIBUTION OF SEVERE CYCLONIC STORM "BIPARJOY" OVER EASTCENTRAL AND ADJOINING SOUTHEAST ARABIAN SEA BASED ON 0000 UTC (0530 IST) OF 07TH JUNE 2023.



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 (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY
AREA OF MAXIMUM SUSTAINED WIND SPEED:
28-33 KT (52-61 KMPH)
34-49 KT (62-91 KMPH)
50-63 KT (92-117 KMPH)
≥ 64 KT (≥118 KMPH)

IMPACT OVER THE SEA

MSW (knot/kmph)	Impact	Action
28-33 (52-61)	Very rough seas	Total suspension of fishing operations
34-49 (62-91)	High to very high seas	Total suspension of fishing operations
50-63 (92-117)	Very high seas	Total suspension of fishing operations
≥ 64 (≥118)	Phenomenal	Total suspension of fishing operations

Examples-7 (National Bulletin in association with Very Severe Cyclonic Storm "BIPARJOY")

India Meteorological Department
(Ministry of Earth Sciences)

BULLETIN NO. 10 (ARB/01/2023)

TIME OF ISSUE: 1515 HOURS IST DATED: 07.06.2023
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, KERALA (FAX NO. 0471-2327176)
ADMINISTRATOR, LAKSHADWEEP ISLANDS (FAX NO. 0413-262184)
CHIEF SECRETARY, TAMILNADU (FAX NO. 044-25672304)
CHIEF SECRETARY, GOA (FAX NO. 0832-2415201)
CHIEF SECRETARY, KARNATAKA (FAX NO. 080-22258913)
CHIEF SECRETARY, MAHARASHTRA (FAX NO. 022- 22028594)
CHIEF SECRETARY, GUJARAT (FAX NO. 079-23250305)
CHIEF SECRETARY, DAMAN & DIU (FAX NO. 0260-2230775)
CHIEF SECRETARY, DADRA & NAGAR HAVELI (FAX NO. 0260-2645466)

Sub: Severe Cyclonic Storm "Biparjoy" (pronounced as "Biporjoy") intensified into a Very Severe Cyclonic Storm over eastcentral and adjoining southeast Arabian Sea

The severe cyclonic storm **"Biparjoy" (pronounced as "Biporjoy")** over eastcentral and adjoining southeast Arabian Sea moved nearly north-northeastwards with a speed of 5 kmph during last 6 hours, intensified into a very severe cyclonic storm and lay centered at 1130 hours IST of today, the 07th June, 2023 over the same region near latitude 12.8°N and longitude 66.3

°E, about 860 km west-southwest of Goa, 970 km southwest of Mumbai, 1050 km south- southwest of Porbandar and 1350 km south of Karachi.

It would move nearly northwards during next 24 hours and then north-northwestwards during subsequent 3 days.

Forecast track and intensity are given below:

Date/Time(IST)	Position (Lat. ^{0}N/ long. ^{0}E)	Maximum sustained surface wind speed (Kmph)	Category of cyclonic disturbance
07.06.23/1130	12.8/66.3	115-125 gusting to 140	Very Severe Cyclonic Storm
07.06.23/1730	13.0/66.4	120-130 gusting to 145	Very Severe Cyclonic Storm
07.06.23/2330	13.3/66.3	125-135 gusting to 150	Very Severe Cyclonic Storm
08.06.23/0530	13.7/66.2	130-140 gusting to 155	Very Severe Cyclonic Storm
08.06.23/1130	14.0/66.1	135-145 gusting to 160	Very Severe Cyclonic Storm
08.06.23/2330	14.6/65.9	135-145 gusting to 160	Very Severe Cyclonic Storm
09.06.23/1130	15.3/65.6	145-155 gusting to 170	Very Severe Cyclonic Storm
09.06.23/2330	16.0/65.2	145-155 gusting to 170	Very Severe Cyclonic Storm
10.06.23/1130	16.7/64.8	145-155 gusting to 170	Very Severe Cyclonic Storm
10.06.23/2330	17.4/64.4	135-145 gusting to 160	Very Severe Cyclonic Storm
11.06.23/1130	18.2/64.0	130-140 gusting to 155	Very Severe Cyclonic Storm
11.06.23/2330	18.9/63.6	125-135 gusting to 150	Very Severe Cyclonic Storm
12.06.23/1130	19.5/63.1	120-130 gusting to 145	Very Severe Cyclonic Storm

(i) Wind warning:

7th June: Gale wind speed reaching 115-125 kmph gusting to 140 kmph is prevailing over eastcentral Arabian Sea and adjoining areas of westcentral & southeast Arabian Sea. It is likely to increase and become 125-135 kmph gusting to 150 kmph during night of 7th June over the same area.

Squally weather with wind speed reaching 35-45 kmph gusting to 55 kmph is likely over adjoining areas of south Arabian Sea and along & off north Kerala-Karnataka-Goa coasts.

8th June: Gale wind speed reaching 130-140 kmph gusting to 155 kmph is likely to prevail over eastcentral Arabian Sea and adjoining areas of westcentral & south Arabian and it is likely to increase and become 135-145 kmph gusting to 160 kmph during night of 8th June over the same area.

Squally weather with wind speed reaching 35-45 kmph gusting to 55 kmph is likely along & off Karnataka-Goa-Maharashtra coasts.

9th June: Gale wind speed reaching 145-155 kmph gusting to 170 kmph is likely to prevail over central Arabian Sea.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of South Arabian Sea. Squally weather with wind speed reaching 35-45 kmph gusting to 55 kmph is likely along & off Karnataka-Goa-Maharashtra coasts.

10th June: Gale wind speed reaching 145-155 kmph gusting to 170 kmph is likely to prevail over central Arabian Sea.

Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of north Arabian Sea. Squally weather with wind speed reaching 35-45 kmph gusting to 55 kmph is likely along & off Karnataka-Goa-Maharashtra coasts.

11th June: Gale wind speed reaching 130-140 kmph gusting to 155 kmph is likely to prevail over central & adjoining north Arabian Sea.

Squally weather with wind speed reaching 35-45 kmph gusting to 55 kmph is likely along & off Maharashtra-Gujarat coasts.

12th June: Gale wind speed reaching 120-130 kmph gusting to 145 kmph is likely to prevail over central & adjoining northwest Arabian Sea.

Squally weather with wind speed reaching 35-45 kmph gusting to 55 kmph is likely along & off Maharashtra-Gujarat coasts.

(iii) Sea condition

7th June: Phenomenal Sea condition is likely to prevail over eastcentral Arabian Sea and adjoining westcentral & southeast Arabian. Sea condition is likely to be rough to very rough over south Arabian Sea and along & off north Kerala-Karnataka-Goa coasts.

8th June:
Sea condition is likely to be phenomenal over central Arabian Sea and adjoining south Arabian Sea. Sea condition is likely to be rough over Arabian Sea along & off Karnataka-Goa- Maharashtra coasts.

9th June: Sea condition is likely to be phenomenal over central Arabian Sea. Sea condition is likely to be rough over adjoining areas of Arabian Sea and along & off Karnataka-Goa- Maharashtra coasts.

10th June: Sea condition is likely to be phenomenal over central Arabian Sea. Sea condition is likely to be rough over adjoining areas of north Arabian Sea and along & off Karnataka-Goa-Maharashtra coasts.

11th June: Sea condition is likely to be phenomenal to very high over central & adjoining north Arabian Sea. Sea condition is likely to be rough to very rough over adjoining areas of northeast Arabian Sea and rough along & off Maharashtra-Gujarat coasts.

12th June: Sea condition is likely to be phenomenal over central & adjoining northwest Arabian Sea. Sea condition is likely to be rough to very rough over adjoining areas of northeast Arabian Sea and rough along & off Maharashtra-Gujarat coasts.

(iv) Fishermen Warning (Graphics Attached)

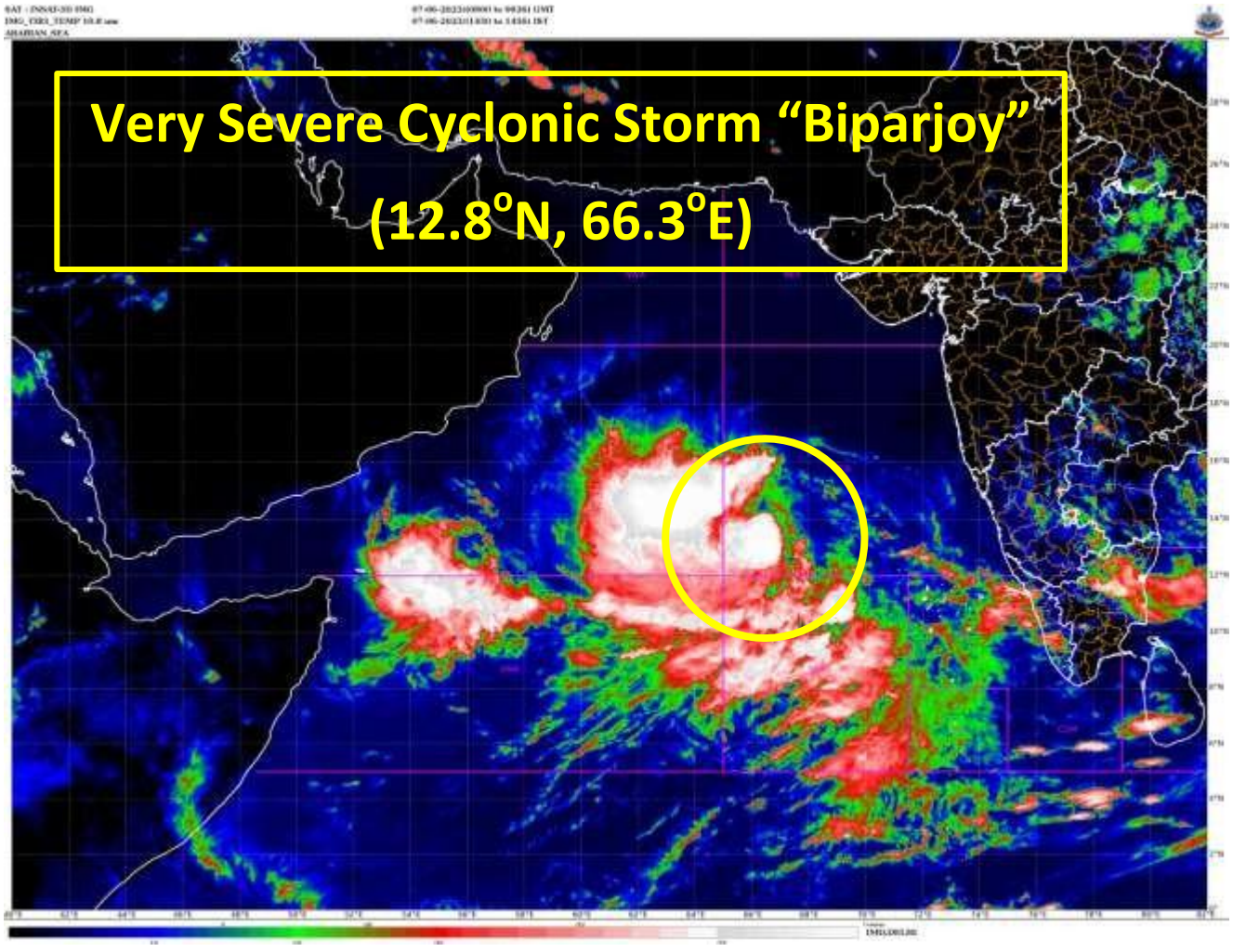
- Total suspension of fishing operations over
  - eastcentral and adjoining westcentral & south Arabian Sea till 12th June.
  - westcentral and adjoining northwest Arabian Sea during 12-14th June

- Fishermen are advised not to venture into:
  - Central Arabian Sea till 13th June.
  - Adjoining areas of north Arabian Sea during 12th -13th June.
  - Adjoining areas of south Arabian Sea till 7th June.
- Those out at sea are advised to return to coast.

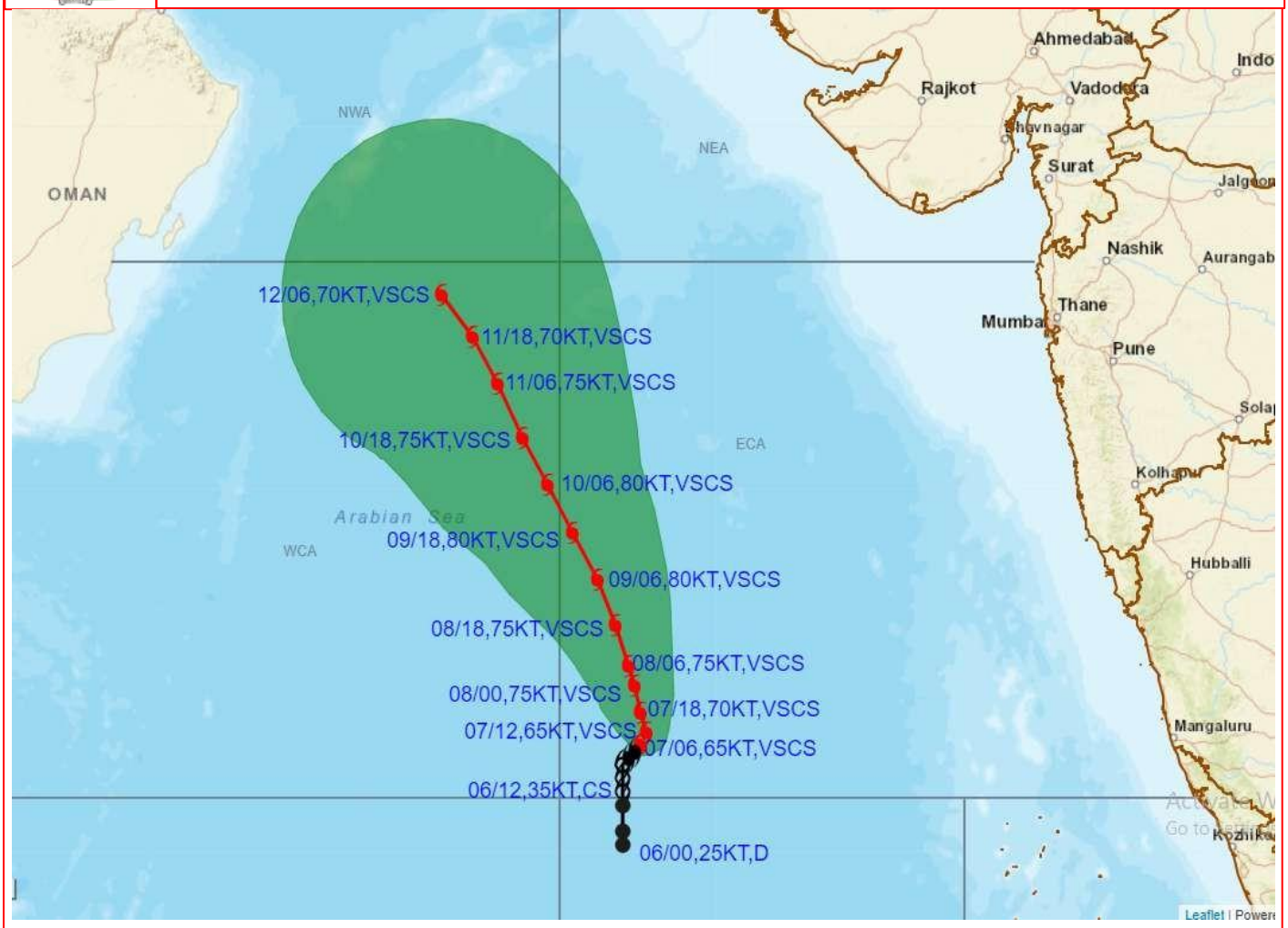
The system is under continuous surveillance and the next message will be issued at 1730 hours IST of today, the 7th June, 2023.

Copy to: ACWC Kolkata/ ACWC Chennai/ CWC Bhubaneswar/CWCVisakhapatnam/CWC Ahmedabad/ MO Port Blair/MC Raipur/MC Bhopal/MC Hyderabad/RMC Nagpur

LEGEND: **Heavy Rainfall**: 64.5 to 115.5mm, **Very Heavy Rainfall**: 115.6 to 204.4mm **Most Places**: more than 76% of total stations, **Isolated Places**: Less than 25% of total



OBSERVED AND FORECAST TRACK ALONGWITH CONE OF UNCERTAINITY OF VERY SEVERE CYCLONIC STORM "BIPARJOY" OVER EASTCENTRAL AND ADJOINING SOUTHEAST ARABIAN SEA BASED ON 0600 UTC (1130 IST) OF 07TH JUNE 2023

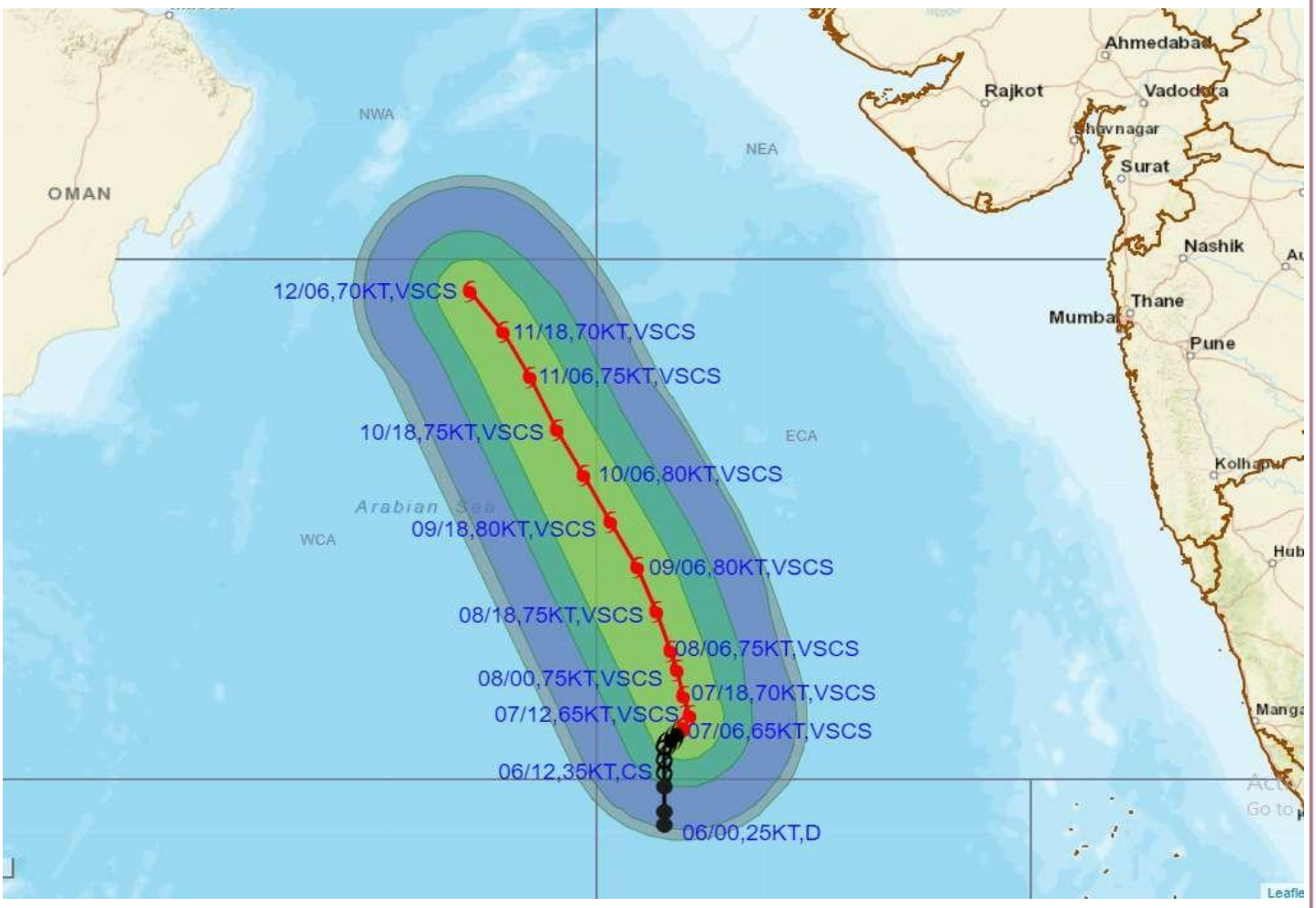


DATE/TIME IN UTC
IST=UTC + 0530
L: LOW PRESSURE AREA
WML: WELL MARKED LOW PRESSURE AREA
D: DEPRESSION (17-27 KT)
DD: DEEP DEPRESSION (28-33 KT)
CS: CYCLONIC STORM (34-47 KT)
SCS: SEVERE CYCLONIC STORM (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY

STATIONS	DISTANCE(KM) AND DIRECTION FROM STATIONS		
	08.06.23/0600	09.06.23/0600	10.06.23/0600
PORBANDAR	930, SSW	820, SSW	750, SW
BOMBAY / COLABA	900, SW	870, WSW	880, WSW
GOA/PANJIM	850, W	890, W	970, W
KARACHI AIRPORT	1210, S	1080, S	940, SSW
MASIRAH	1060, SE	920, SE	760, SE

OBSERVED AND FORECAST TRACK ALONGWITH QUADRANT WIND DISTRIBUTION OF VERY SEVERE CYCLONIC STORM "BIPARJOY" OVER EASTCENTRAL AND ADJOINING SOUTHEAST ARABIAN SEA BASED ON 0600 UTC (1130 IST) OF 07TH JUNE 2023

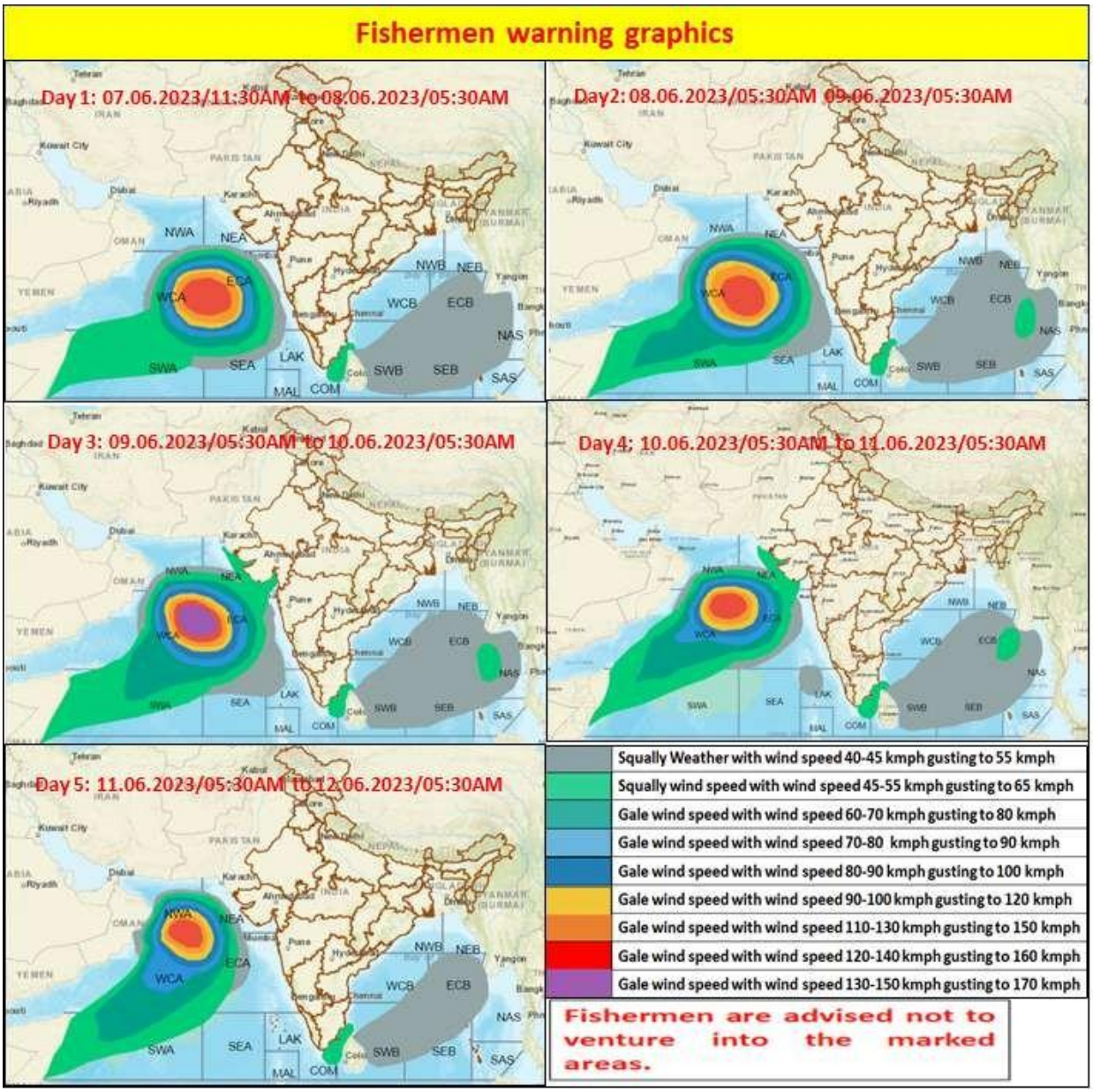


DATE/TIME IN UTC
IST=UTC + 0530
L: LOW PRESSURE AREA
WML: WELL MARKED LOW PRESSURE AREA
D: DEPRESSION (17-27 KT)
DD: DEEP DEPRESSION (28-33 KT)
CS: CYCLONIC STORM (34-47 KT)
SCS: SEVERE CYCLONIC STORM (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY
AREA OF MAXIMUM SUSTAINED WIND SPEED:
28-33 KT (52-61 KMPH)
34-49 KT (62-91 KMPH)
50-63 KT (92-117 KMPH)
≥ 64 KT (≥118 KMPH)

IMPACT OVER THE SEA

MSW (knot/kmph)	Impact	Action
28-33 (52-61)	Very rough seas	Total suspension of fishing operations
34-49 (62-91)	High to very high seas	Total suspension of fishing operations
50-63 (92-117)	Very high seas	Total suspension of fishing operations
≥ 64 (≥118)	Phenomenal	Total suspension of fishing operations


Fishermen warning graphics
Day 1: 07.06.2023/11:30AM to 08.06.2023/05:30AM
Day2: 08.06.2023/05:30AM 09.06.2023/05:30AM
Day 3: 09.06.2023/05:30AM to 10.06.2023/05:30AM
Day 4: 10.06.2023/05:30AM to 11.06.2023/05:30AM
Day 5: 11.06.2023/05:30AM to 12.06.2023/05:30AM
NWA
NEA
ECA
WCA
NWB
NEB
WCB
ECB
NAS
SWA
SEA
LAK
MAL
COM
SWB
SEB
SAS
Squally Weather with wind speed 40-45 kmph gusting to 55 kmph
Squally wind speed with wind speed 45-55 kmph gusting to 65 kmph
Gale wind speed with wind speed 60-70 kmph gusting to 80 kmph
Gale wind speed with wind speed 70-80 kmph gusting to 90 kmph
Gale wind speed with wind speed 80-90 kmph gusting to 100 kmph
Gale wind speed with wind speed 90-100 kmph gusting to 120 kmph
Gale wind speed with wind speed 110-130 kmph gusting to 150 kmph
Gale wind speed with wind speed 120-140 kmph gusting to 160 kmph
Gale wind speed with wind speed 130-150 kmph gusting to 170 kmph
Fishermen are advised not to venture into the marked areas.

Examples-8 (National Bulletin in association with Extremely Severe Cyclonic Storm "BIPARJOY")

India Meteorological Department
(Ministry of Earth Sciences)

BULLETIN NO. 40 (ARB/01/2023)

TIME OF ISSUE: 0945 HOURS IST **DATED: 11.06.2023**

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, KERALA (FAX NO. 0471-2327176)
ADMINISTRATOR, LAKSHADWEEP ISLANDS (FAX NO. 0413-262184)
CHIEF SECRETARY, TAMILNADU (FAX NO. 044-25672304)
CHIEF SECRETARY, GOA (FAX NO. 0832-2415201)
CHIEF SECRETARY, KARNATAKA (FAX NO. 080-22258913)
CHIEF SECRETARY, MAHARASHTRA (FAX NO. 022- 22028594)
CHIEF SECRETARY, GUJARAT (FAX NO. 079-23250305)
CHIEF SECRETARY, DAMAN & DIU (FAX NO. 0260-2230775)
CHIEF SECRETARY, DADRA & NAGAR HAVELI (FAX NO. 0260-2645466)

Sub: Very Severe Cyclonic Storm "Biparjoy" (pronounced as "Biporjoy") intensified into an Extremely Severe Cyclonic Storm over eastcentral Arabian Sea: Cyclone Alert for Saurashtra & Kutch Coasts (Yellow Message)

The very severe cyclonic storm "Biparjoy" (pronounced as "Biporjoy") over eastcentral Arabian Sea moved north-northeastwards with a speed of 9 kmph during past 6-hours, intensified into an Extremely Severe Cyclonic Storm and lay centered at 0530 hours IST of today, the 11th June, 2023 over the same region near latitude 17.9°N and longitude 67.4°E, about 580 km west-southwest of Mumbai, 480 km south-southwest of Porbandar, 530 km south-southwest of Devbhumi Dwarka, 610 km south-southwest of Naliya and 780 km south of Karachi (Pakistan).

It is very likely to move nearly northward till 14th morning, then move north-northeastwards and cross Saurashtra & Kutch and adjoining Pakistan coasts between Mandvi (Gujarat) and Karachi (Pakistan) around noon of 15th June as a very severe cyclonic storm with maximum sustained wind speed of 125-135 kmph gusting to 150 kmph.

Forecast track and intensity are given below:

Date/Time(IST)	Position (Lat. ^{0}N/ long. ^{0}E)	Maximum sustained surfac wind speed (Kmph)	Category of cyclonic disturbance
11.06.23/0530	17.9/67.4	160-170 Gusting To 190	Extremely Severe Cyclonic Storm
11.06.23/1130	18.3/67.5	165-175 Gusting To 195	Extremely Severe Cyclonic Storm
11.06.23/1730	18.6/67.6	165-175 Gusting To 195	Extremely Severe Cyclonic Storm
11.06.23/2330	18.9/67.7	160-170 Gusting To 190	Extremely Severe Cyclonic Storm
12.06.23/0530	19.2/67.7	155-165 Gusting To 185	Very Severe Cyclonic Storm
12.06.23/1730	19.8/67.5	150-160 Gusting To 180	Very Severe Cyclonic Storm
13.06.23/0530	20.5/67.3	145-155 Gusting To 175	Very Severe Cyclonic Storm
13.06.23/1730	21.2/67.3	140-150 Gusting To 165	Very Severe Cyclonic Storm
14.06.23/0530	21.8/67.4	135-145 Gusting To 160	Very Severe Cyclonic Storm
14.06.23/1730	22.3/67.7	130-140 Gusting To 155	Very Severe Cyclonic Storm
15.06.23/0530	22.9/68.2	125-135 Gusting To 150	Very Severe Cyclonic Storm
15.06.23/1730	23.7/69.1	100-110 Gusting To 120	Severe Cyclonic Storm
16.06.23/0530	24.3/70.1	55-65 Gusting To 75	Deep Depression

(i) Heavy Rainfall warning for Gujarat (Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts):

- Light to moderate rainfall at most places with heavy to very heavy rainfall at isolated places very likely over Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts of Saurashtra & Kutch on 14th June.
- The intensity of rainfall would increase with heavy to very heavy rainfall at a few places and extremely heavy falls at isolated places very likely over Kutch, Devbhumi Dwarka & Jamnagar and heavy to very heavy rainfall at a few places over Porbandar, Rajkot, Morbi & Junagarh districts of Gujarat on 15th June.
- Isolated heavy rainfall is very likely over remaining districts of Saurashtra and north Gujarat region on 15th June.

(ii) Wind warning:

11th June: Gale wind speed reaching 160-175 kmph gusting to 195 kmph is prevailing over eastcentral and adjoining westcentral & northeast Arabian Sea.

12th June: Gale wind speed reaching 150-165 kmph gusting to 185 kmph is likely to prevail over northeast and adjoining central Arabian Sea.

13th June: Gale wind speed reaching 145-155 kmph gusting to 170 kmph is likely to prevail over northeast and adjoining central Arabian Sea. Gale wind speed reaching 80-90 kmph gusting to 100 kmph over adjoining areas of northwest Arabian Sea.

14th June: Gale wind speed reaching 135-145 kmph gusting to 160 kmph is likely to prevail over northeast Arabian Sea. Gale wind speed reaching 70-80 kmph gusting to 90 kmph over adjoining areas of central & northwest Arabian Sea.

15th June: Gale wind speed reaching 125-135 kmph gusting to 150 kmph is likely to prevail over northeast Arabian Sea and likely to decrease becoming 100-110 kmph gusting to 125 kmph from evening over the region. Squally wind speed reaching 50-60 kmph gusting to 70 kmph is likely over adjoining areas of central Arabian Sea.

Wind warning along & off Saurashtra & Kutch coasts (Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts) including Gulf of Kutch:

- Squally wind speed reaching 40-50 kmph gusting to 60 kmph on 11th June, 45-55 kmph gusting to 65 kmph during 12th and becoming 50-60 kmph gusting to 70 kmph from 13th to evening of 14th June.
- Gale wind speed reaching 65-75 kmph gusting to 85 kmph very likely to prevail from 14th June evening and becoming 120-130 kmph gusting to 145 kmph from 15th morning for subsequent 12 hours.
- Squally wind speed reaching 55-65 kmph gusting to 75 kmph very likely to prevail along & off remaining districts Saurashtra coast on 14th & 15th June.

(iii) Sea condition

11th June: Sea condition is likely to be phenomenal over eastcentral and adjoining westcentral & northeast Arabian Sea.

12th June: Sea condition is likely to be phenomenal over northeast and adjoining central Arabian Sea.

13th June: Sea condition is likely to be phenomenal over northeast and adjoining northwest & central Arabian Sea

14th June: Sea condition is likely to be phenomenal to very high over northeast and adjoining northwest Arabian Sea and high to very rough sea condition is likely over adjoining areas of central Arabian Sea.

15th June: Sea condition is likely to be very high to phenomenal over northeast and very rough to high over adjoining northwest Arabian Sea and very rough to rough sea condition over adjoining areas of central Arabian Sea.

Along & off Saurashtra & Kutch coasts:

Sea conditions likely to be rough to very rough till 14th evening and high to phenomenal thereafter till 15th June noon and improve thereafter.

(iv) Storm Surge Warning (Kutch, Devbhumi Dwarka, Porbandar, Jamnagar and Morbi districts)

Storm surge of about 2 m above the astronomical tide is likely to inundate the low lying areas of above districts during the time of landfall.

(v) Damage expected over Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Morbi & Junagarh & Rajkot districts of Gujarat on 15th June:

- Total destruction of thatched houses/ extensive damage to kutcha houses. Some damage to Pucca houses. Potential threat from flying objects.
- Bending/ uprooting of power and communication poles.

- Major damage to Kutcha and Pucca roads. Flooding of escape routes. Minor disruption of railways, overhead power lines and signalling systems.
- Widespread damage to standing crops, plantations, orchards, falling of green coconuts and tearing of palm fronds. Blowing down of bushy trees like mango.

- Small boats, country crafts may get detached from moorings.
- Visibility severely affected.

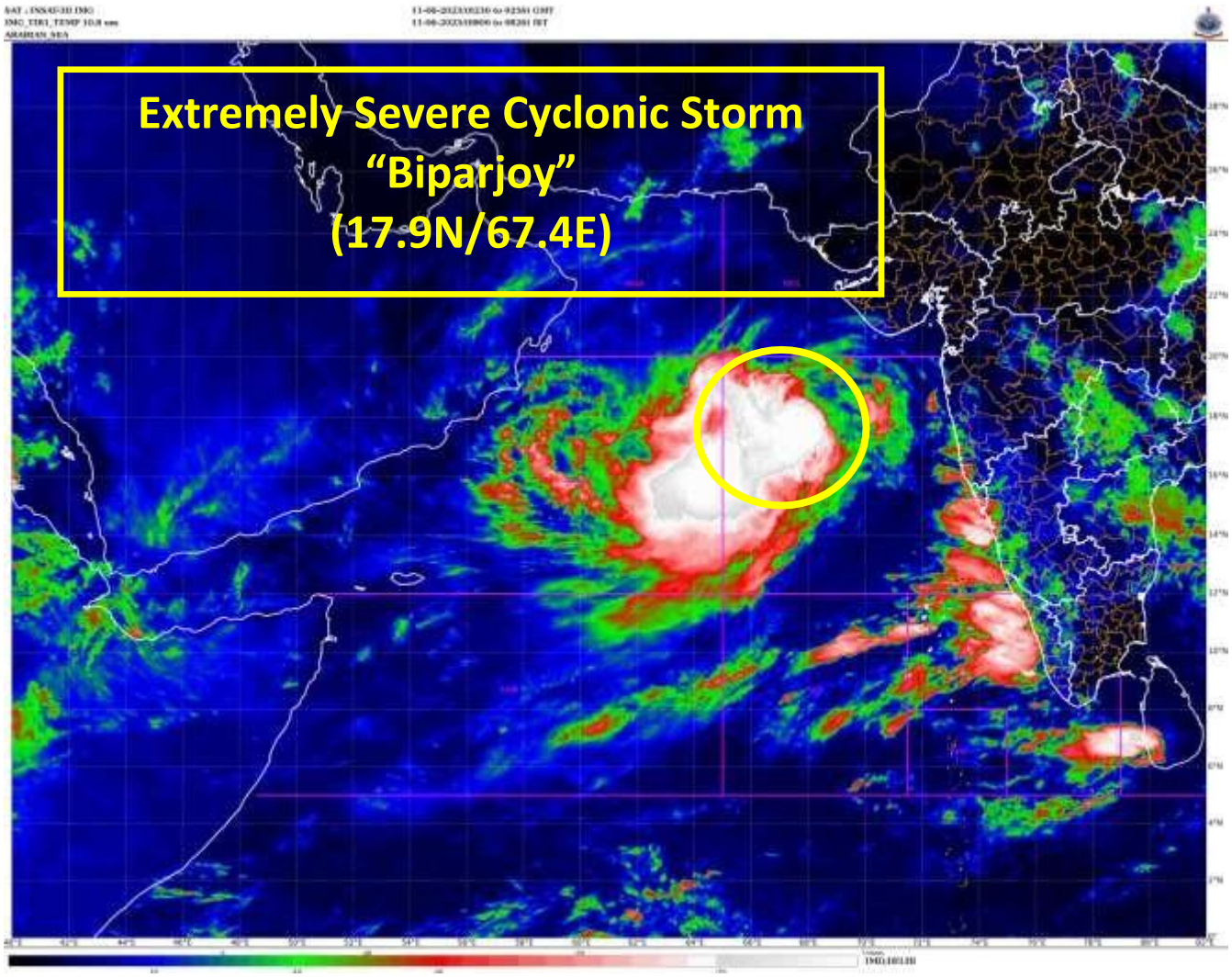
(vi) Fishermen Warning & Action Suggested (Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts) and for Offshore & Onshore Industries (Graphics Attached):

- Total suspension of fishing operations over
  - eastcentral and adjoining westcentral Arabian Sea till 15th June.
  - north and adjoining central Arabian Sea during 12th -15th June
- Fishermen are advised not to venture into:
  - Central Arabian Sea till 15th June.
  - North Arabian Sea during 12th -15th June.
- Those out at sea are advised to return to coast.
- Judicious regulation of offshore and onshore activities.
- Mobilise evacuation from coastal areas.
- Judicious regulation of rail and road traffic.
- People in affected areas to remain indoors.
- Movement in motor boats and small ships all & off these coasts to be avoided.

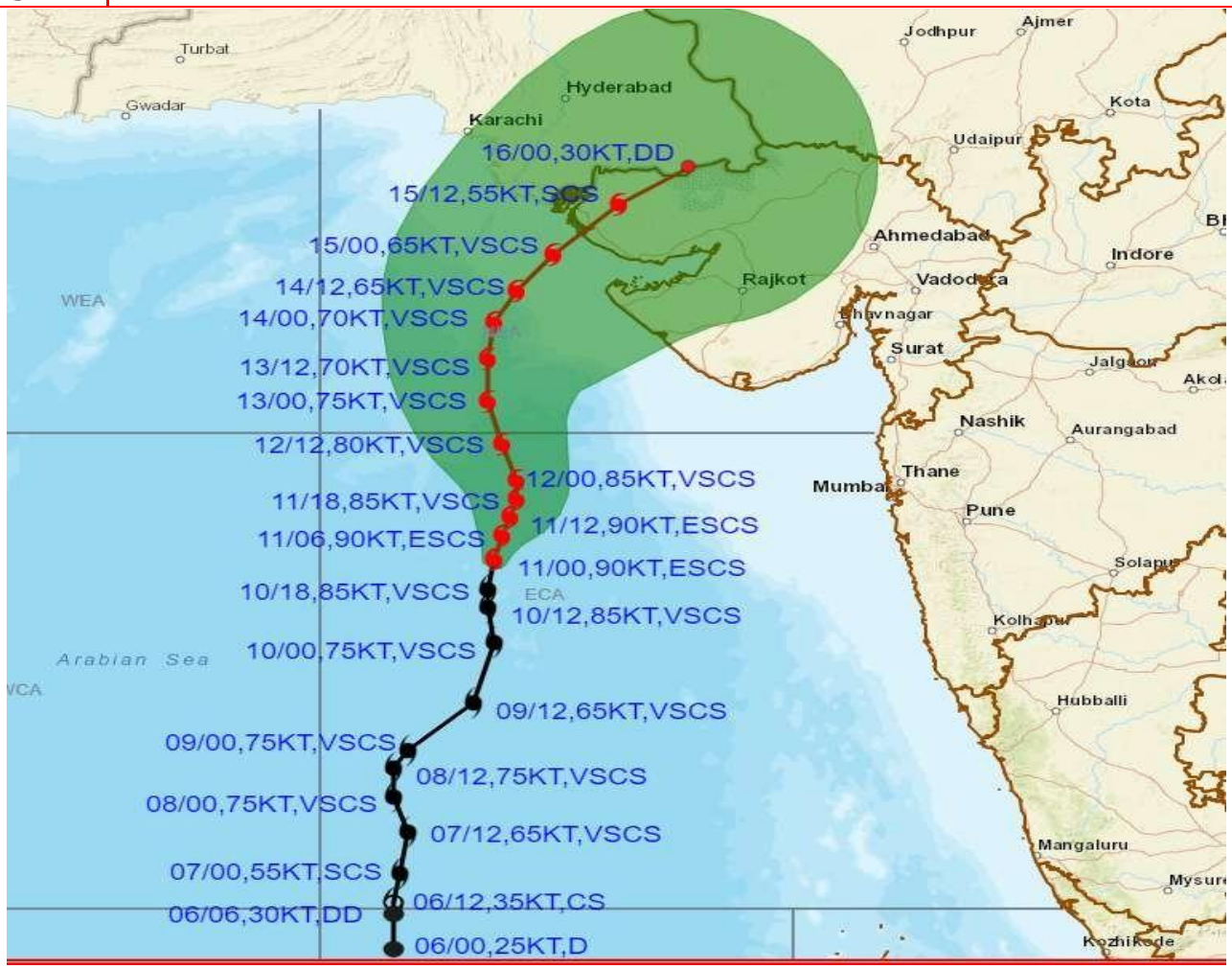
The systems are under continuous surveillance and the next message will be issued at 1130 hours IST of 11th June, 2023.

Copy to: ACWC Kolkata/ ACWC Chennai/ CWC Bhubaneswar/CWCVisakhapatnam/CWC Ahmedabad/ MO Port Blair/MC Raipur/MC Bhopal/MC Hyderabad/RMC Nagpur

LEGEND: **Heavy Rainfall**: 64.5 to 115.5mm, **Very Heavy Rainfall**: 115.6 to 204.4mm **Most Places**: more than 76% of total stations, **Isolated Places**: Less than 25% of total


Extremely Severe Cyclonic Storm
"Biparjoy"
(17.9N/67.4E)

OBSERVED AND FORECAST TRACK ALONGWITH CONE OF UNCERTAINITY OF EXTREMELY SEVERE CYCLONIC STORM "BIPARJOY" OVER EASTCENTRAL ARABIAN SEA BASED ON 0000 UTC (0530 IST) OF 11TH JUNE 2023.

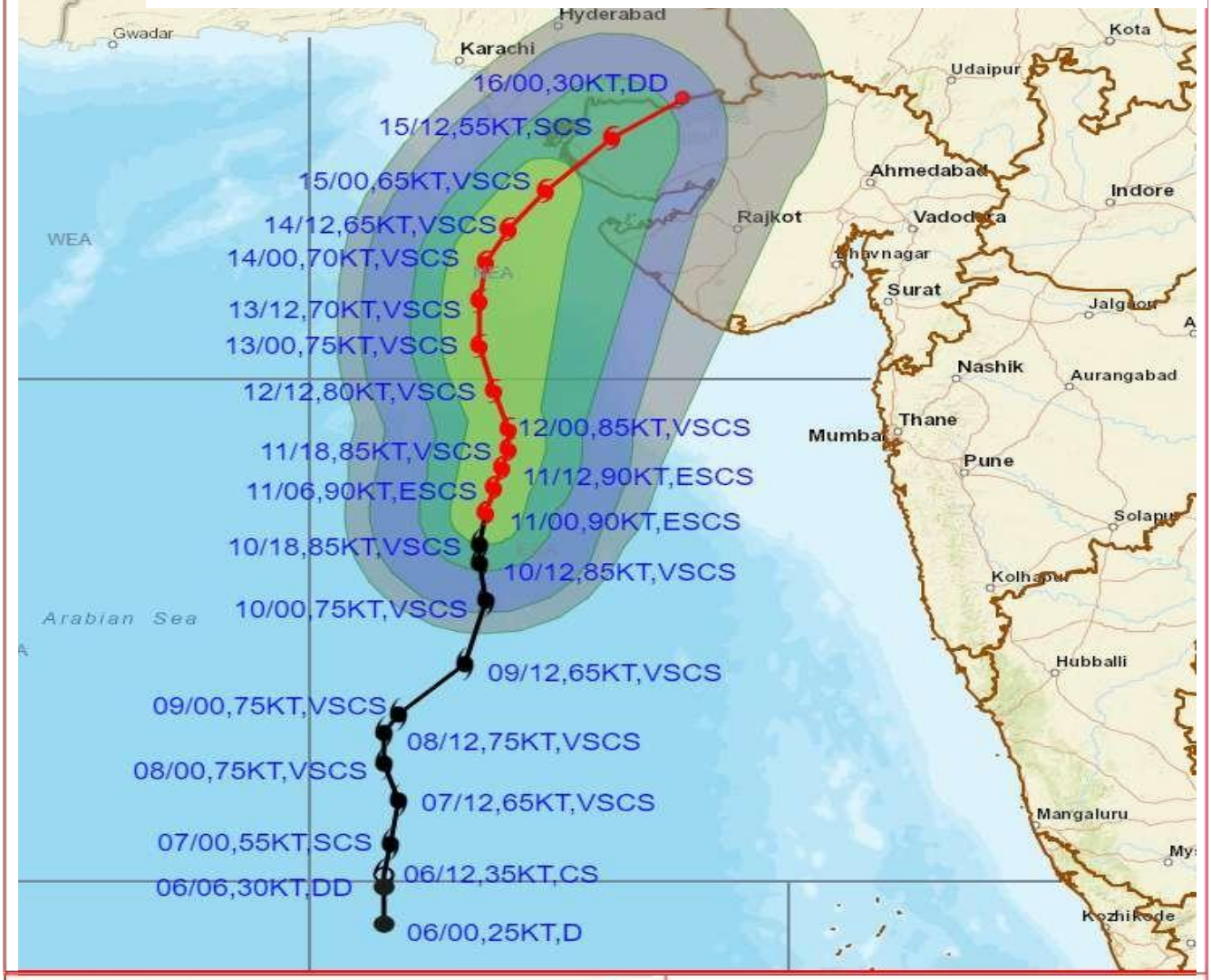


DATE/TIME IN UTC
IST=UTC + 0530
L: LOW PRESSURE AREA
WML: WELL MARKED LOW PRESSURE AREA
D: DEPRESSION (17-27 KT)
DD: DEEP DEPRESSION (28-33 KT)
CS: CYCLONIC STORM (34-47 KT)
SCS: SEVERE CYCLONIC STORM (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY

STATIONS	DISTANCE(KM) AND DIRECTION FROM STATIONS				
	12.06.23/0000	13.06.23/0000	14.06.23/0000	15.06.23/0000	16.06.23/000
PORBANDAR	340, SW	270, WSW	230, W	210, NW	290, N
BOMBAY / COLABA	540, W	610, WNW	660, WNW	660, NW	660, NNW
GOA/PANJIM	780, WNW	890, NW	980, NW	1020, NW	1050, NNW
KARACHI AIRPORT	630, S	490, S	340, S	250, SSE	300, ESE
DWARKA	380, SSW	270, SW	180, WSW	110, WNW	230, NNE

OBSERVED AND FORECAST TRACK ALONGWITH QUADRANT WIND DISTRIBUTION OF EXTREMELY SEVERE CYCLONIC STORM "BIPARJOY" OVER EASTCENTRAL ARABIAN SEA BASED ON 0000 UTC (0530 IST) OF 11TH JUNE 2023.



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 (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

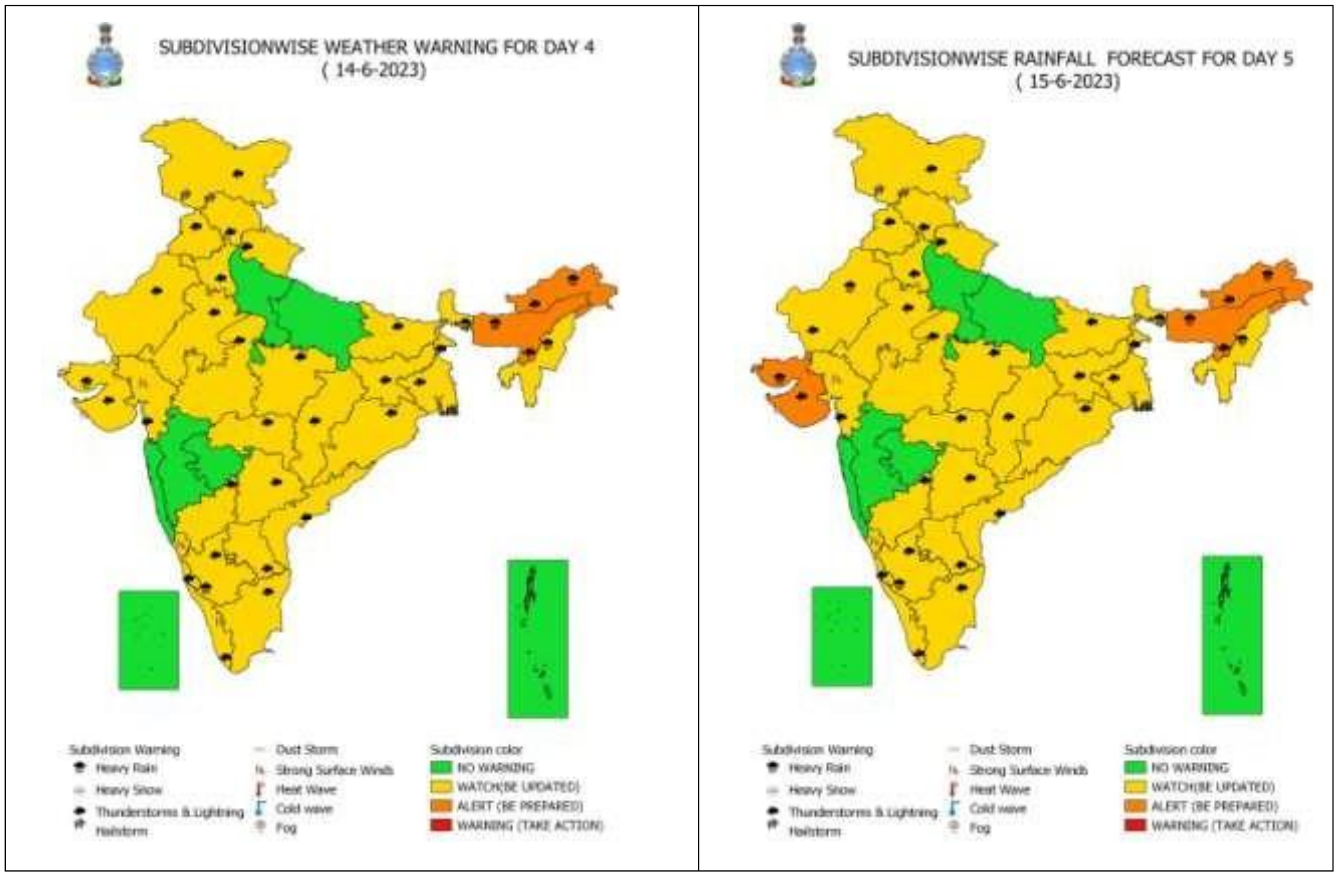
- LESS THAN 34 KT
- 34-47 KT
- ≥ 48 KT
- OBSERVED TRACK
- FORECAST TRACK
- CONE OF UNCERTAINTY

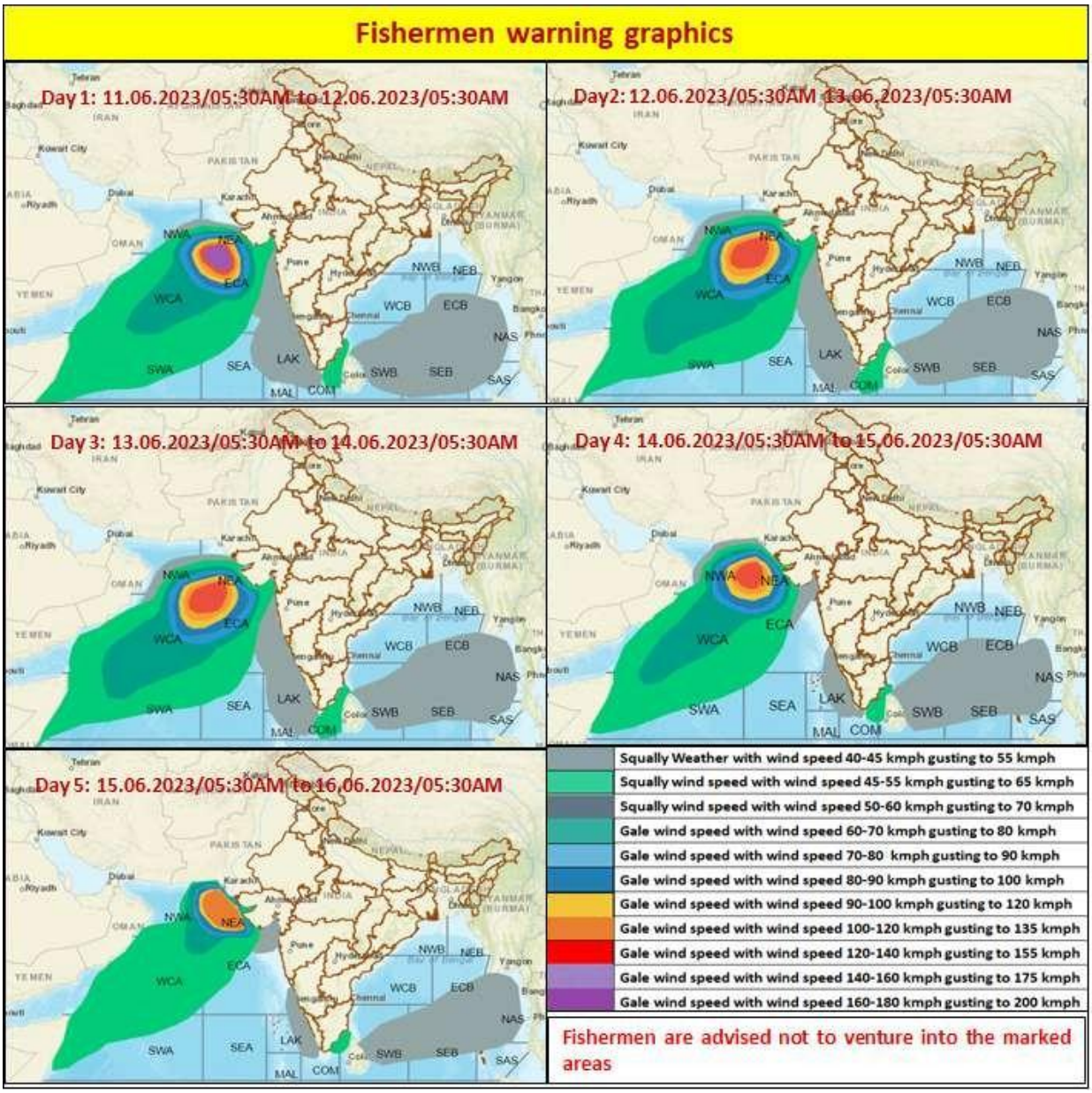
AREA OF MAXIMUM SUSTAINED WIND SPEED:
- 28-33 KT (52-61 KMPH)
- 34-49 KT (62-91 KMPH)
- 50-63 KT (92-117 KMPH)
- ≥ 64 KT (≥118 KMPH)

IMPACT OVER THE SEA

MSW (knot/kmph)	Impact	Action
28-33 (52-61)	Very rough seas	Total suspension of fishing operations
34-49 (62-91)	High to very high seas	Total suspension of fishing operations
50-63 (92-117)	Very high seas	Total suspension of fishing operations
≥ 64 (≥118)	Phenomenal	Total suspension of fishing operations

Heavy Rainfall Warning for 14th & 15th June 2023




Fishermen warning graphics
Day 1: 11.06.2023/05:30AM to 12.06.2023/05:30AM
Day2: 12.06.2023/05:30AM 13.06.2023/05:30AM
Day 3: 13.06.2023/05:30AM to 14.06.2023/05:30AM
Day 4: 14.06.2023/05:30AM to 15.06.2023/05:30AM
Day 5: 15.06.2023/05:30AM to 16.06.2023/05:30AM
Squally Weather with wind speed 40-45 kmph gusting to 55 kmph
Squally wind speed with wind speed 45-55 kmph gusting to 65 kmph
Squally wind speed with wind speed 50-60 kmph gusting to 70 kmph
Gale wind speed with wind speed 60-70 kmph gusting to 80 kmph
Gale wind speed with wind speed 70-80 kmph gusting to 90 kmph
Gale wind speed with wind speed 80-90 kmph gusting to 100 kmph
Gale wind speed with wind speed 90-100 kmph gusting to 120 kmph
Gale wind speed with wind speed 100-120 kmph gusting to 135 kmph
Gale wind speed with wind speed 120-140 kmph gusting to 155 kmph
Gale wind speed with wind speed 140-160 kmph gusting to 175 kmph
Gale wind speed with wind speed 160-180 kmph gusting to 200 kmph
Fishermen are advised not to venture into the marked areas

Examples-9 (National Bulletin in association with Landfall of Severe Cyclonic Storm "BIPARJOY")

India Meteorological Department (Ministry of Earth Sciences)

BULLETIN NO. 79 (ARB/01/2023)

TIME OF ISSUE: 0345 HOURS IST **DATED: 17.06.2023**

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, KERALA (FAX NO. 0471-2327176)
ADMINISTRATOR, LAKSHADWEEP ISLANDS (FAX NO. 0413-262184)
CHIEF SECRETARY, TAMILNADU (FAX NO. 044-25672304)
CHIEF SECRETARY, GOA (FAX NO. 0832-2415201)
CHIEF SECRETARY, KARNATAKA (FAX NO. 080-22258913)
CHIEF SECRETARY, MAHARASHTRA (FAX NO. 022- 22028594)
CHIEF SECRETARY, GUJARAT (FAX NO. 079-23250305)
CHIEF SECRETARY, DAMAN & DIU (FAX NO. 0260-2230775)
CHIEF SECRETARY, DADRA & NAGAR HAVELI (FAX NO. 0260-2645466)

Sub: Severe Cyclonic Storm "Biparjoy" (pronounced as "Biporjoy") over Saurashtra & Kutch

The Severe Cyclonic Storm "Biparjoy" (pronounced as "Biporjoy") over Saurashtra & Kutch moved northeastwards with a speed of 13 kmph during past 6-hours and lay centered at 0230 hours IST of 16th June, 2023 over the same region near latitude 23.5°N and longitude 68.9°E, about 40 km northeast of Jakhau Port (Gujarat) and 30 km north of Naliya. It is very likely to move nearly northeastwards across north Gujarat and weaken gradually into a cyclonic storm over Saurashtra & Kutch by early morning of 16th June and subsequently into a depression over south Rajasthan by evening of the same day.

Forecast track and intensity are given below:

Date/Time(IST)	Position (Lat. ^{0}N/ long. ^{0}E)	Maximum sustained surfac wind speed (Kmph)	Category of cyclonic disturbance
16.06.23/0230	23.5/68.9	90-100 Gusting To 110	Severe Cyclonic Storm
16.06.23/0530	23.8/69.4	75-85 Gusting To 95	Cyclonic Storm
16.06.23/1130	24.3/70.2	50-60 Gusting To 70	Deep Depression
16.06.23/1730	25.0/71.2	35-45 Gusting To 55	Depression

(i) Heavy Rainfall warning:

- Light to moderate rainfall at most places with heavy to extremely heavy rainfall at isolated places very likely over Saurashtra & Kutch, north Gujarat region and south Rajasthan on 16th and over southeast Rajasthan & adjoining North Gujarat region on 17th June.

(ii) Wind warning:

Northeast Arabian Sea: Gale wind speed reaching 90-100 kmph gusting to 110 kmph prevailing over the region likely to decrease gradually and becoming squally wind speed reaching 50-60 kmph gusting to 70 kmph by 16th June morning.

Eastcentral Arabian Sea: Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely to prevail till noon of 16th June.

Wind warning along & off Saurashtra & Kutch coasts (Kachchh, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts) including Gulf of Kutch:

- Gale wind speed reaching 90-100 kmph gusting to 110 kmph is prevailing along & off Kachchh, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts. It would decrease gradually becoming 75-85 kmph gusting to 95 kmph over Kachchh and adjoining districts of Saurashtra & Kutch by 16th early morning and squally wind speed reaching 45-55 kmph gusting to 65 kmph by 16th June noon.
- Squally wind speed reaching 50-60 kmph gusting to 70 kmph very likely to prevail along & off remaining districts of Saurashtra coast till 16th June morning and decrease thereafter.

Wind Warning for South Rajasthan

- Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over South Rajasthan during 16th noon to evening and 35-45 kmph gusting to 55 kmph till 17th June morning.

(iii) Sea condition

Prevailing very high to high sea condition over northeast Arabian Sea would improve gradually and become rough by 16th June noon.

Along & off Saurashtra& Kutch coasts:

Very high to high Sea condition prevailing over the region is likely to become very rough to rough by 16th June noon and improve thereafter.

(iv) Damage expected over Kachchh, Devbhumi Dwarka, Porbandar, Jamnagar, Morbi & Junagarh & Rajkot districts of Gujarat during next 3 hours:

- 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 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.
- Major damage to coastal crops.
- Damage to embankments/ salt pans.

(v) Fishermen Warning & Action Suggested (Kachchh, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts) and for Offshore & Onshore Industries till 16th June noon: (Graphics Attached)

- Total suspension of fishing operations over northeast and adjoining eastcentral Arabian Sea till 16th June morning.
- Judicious regulation of offshore and onshore activities.

- Ports along the west coast of India may take necessary precautions.
- Naval base operations may maintain necessary precautions.
- Movement in motor boats unsafe.
- Judicious regulation of rail and road traffic.
- Tourism activities may be regulated over these areas.
- People in affected areas to remain indoors.

(vi) Post Landfall Outlook for interior districts of Saurashtra and north Gujarat region (Districts apart from those mentioned under warning above):

After the landfall the system is very likely to move northeastwards, across north Gujarat and weaken gradually. It is likely to maintain the intensity of Cyclonic Storm till the morning of 16th June and thereafter it will weaken gradually into a Depression over south Rajasthan by evening of the same day.

Light to moderate rainfall at most places with heavy to extremely heavy rainfall at isolated places very likely over Banaskantha and Patan; heavy to very heavy at isolated places over Kachchh, Morbi, Mehsana and Sabarkantha of north Gujarat and isolated heavy rainfall over remaining districts on 16th June.

Light to moderate rainfall at most places with heavy to very heavy rainfall at isolated places likely over Banaskantha and Sabarkantha on 17th June.

Damage expected over interior districts of Saurashtra and north Gujarat region (Districts apart from those mentioned under warning):

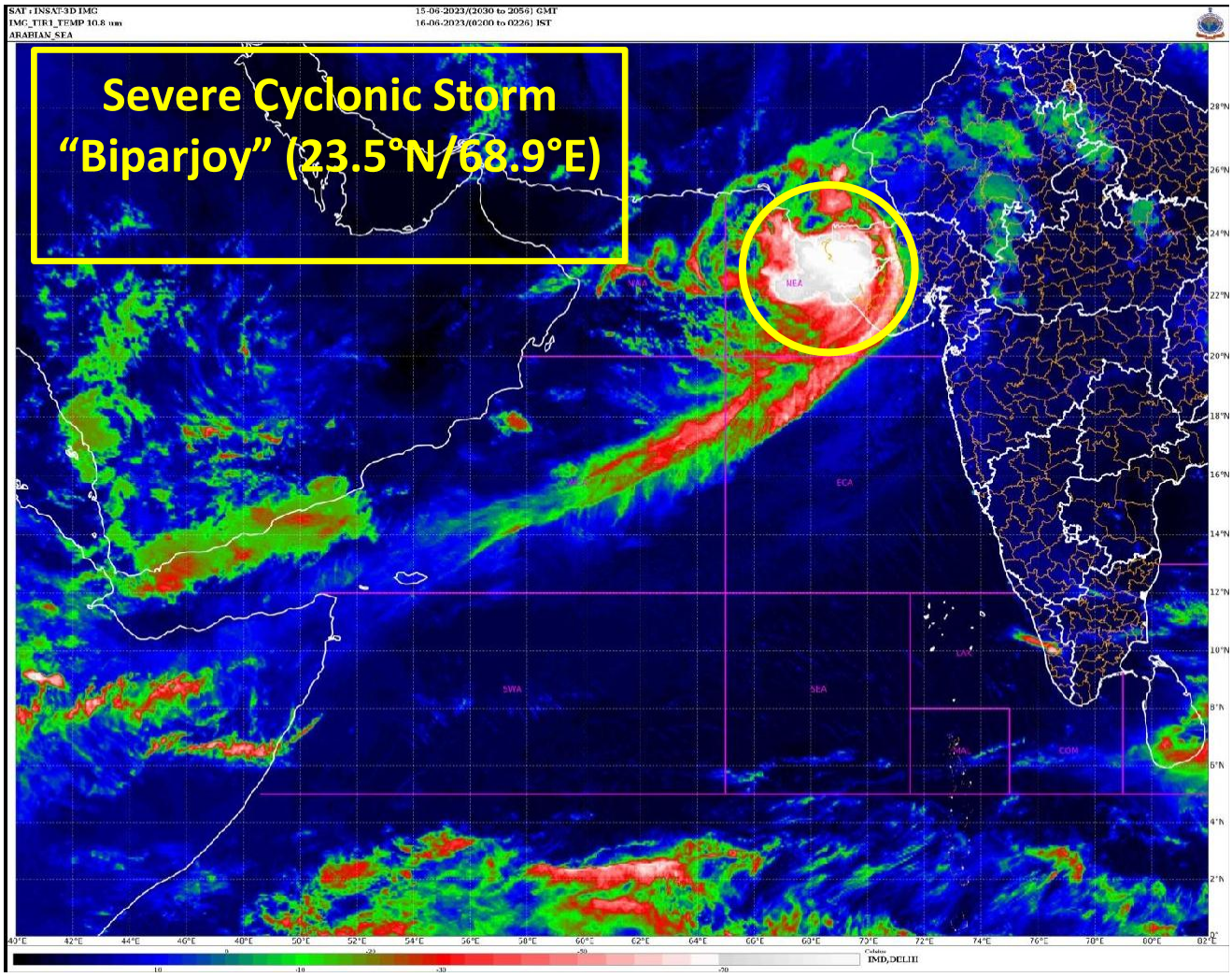
(i) Damage to Kutcha and minor damage to Pucca roads. (ii) Water logging and flooding in low lying areas (iii) Breaking of tree branches, uprooting of small tree and damage to

orchards. People in affected areas are advised to remain indoors.

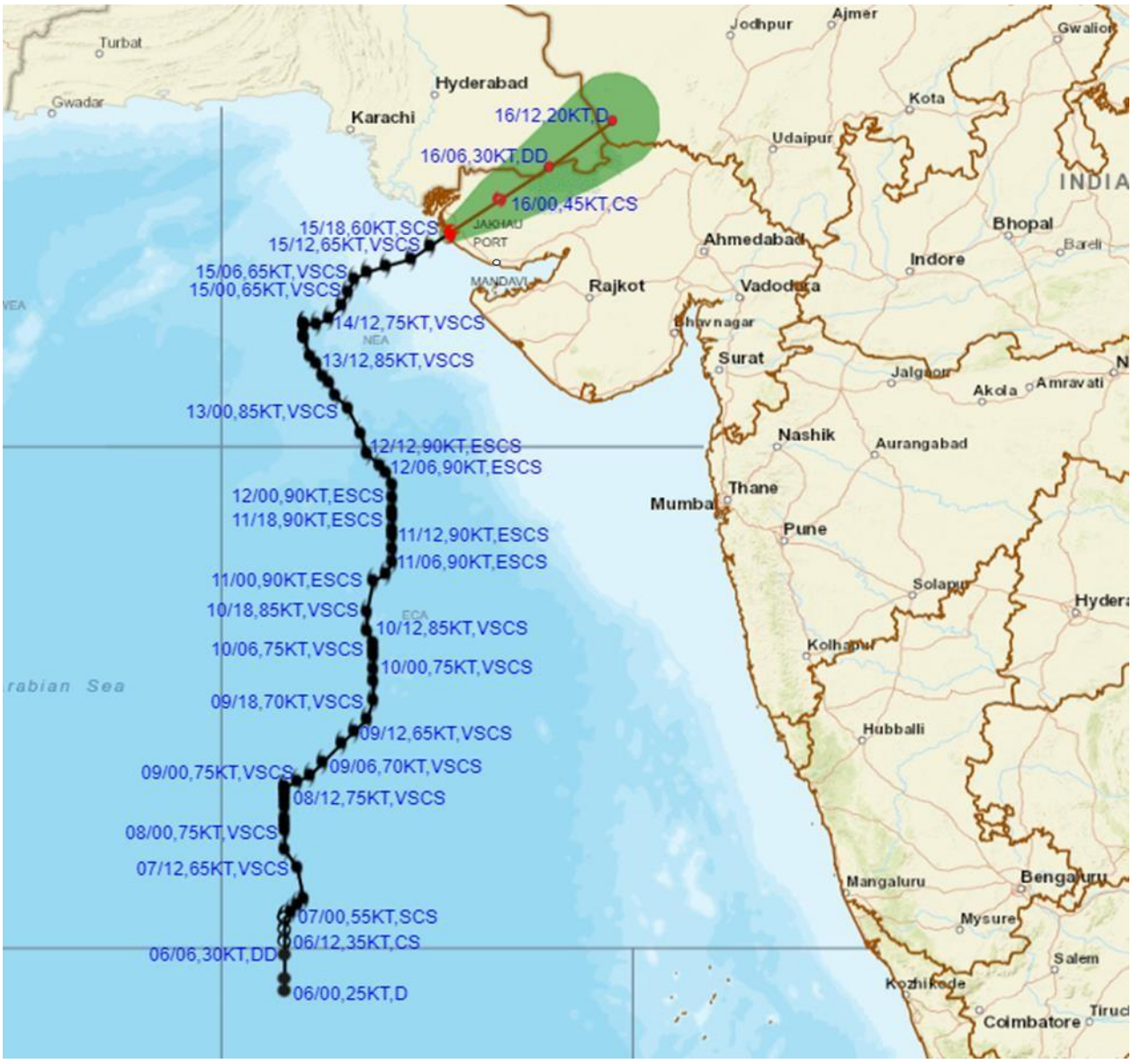
The system is under continuous surveillance and the next message will be issued at 0830 hours IST of today, the 16th June, 2023.

Copy to: ACWC Kolkata/ ACWC Chennai/ CWC Bhubaneswar/CWC Visakhapatnam/CWC Ahmedabad/ MO Port Blair/MC Raipur/MC Bhopal/MC Hyderabad/RMC Nagpur

LEGEND: **Heavy Rainfall**: 64.5 to 115.5mm, **Very Heavy Rainfall**: 115.6 to 204.4mm **Most Places**: more than 76% of total stations, **Isolated Places**: Less than 25% of total


SAT : INSAT-3D IMG
IMG_TIR1_TEMP 10.8 mm
ARABIAN_SEA
15-06-2023/(2030 to 2056) GMT
16-06-2023/(0200 to 0226) IST
Severe Cyclonic Storm
"Biparjoy" (23.5°N/68.9°E)
NEA
ECA
SWA
SEA
IMD,DELHI

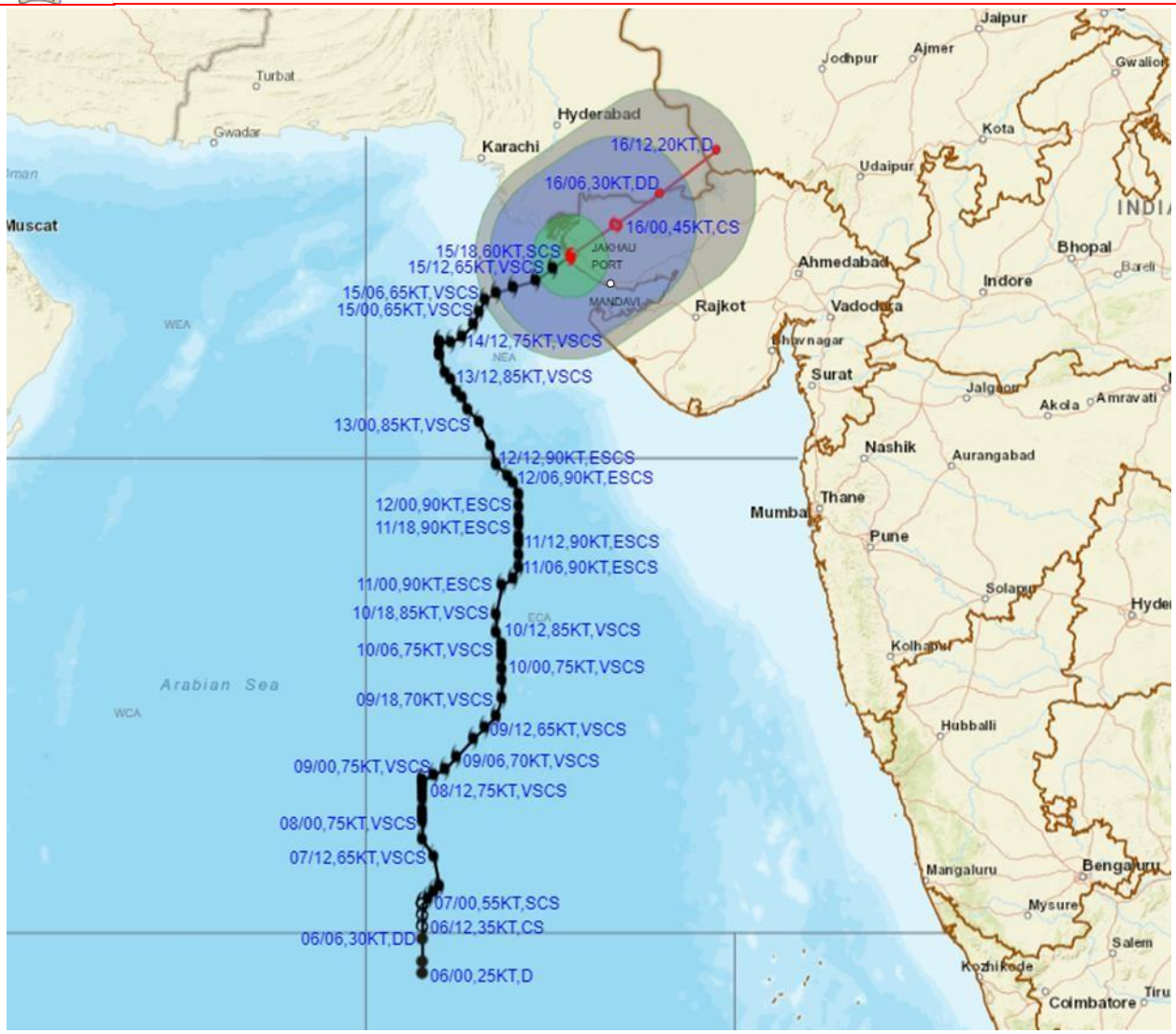
OBSERVED AND FORECAST TRACK ALONGWITH CONE OF UNCERTAINITY OF SEVERE CYCLONIC STORM "BIPARJOY" OVER SAURASHTRA & KUTCH BASED ON 1800 UTC (2330 IST) OF 15TH JUNE 2023.



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 (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY

OBSERVED AND FORECAST TRACK ALONGWITH QUADRANT WIND DISTRIBUTION OF SEVERE CYCLONIC STORM "BIPARJOY" OVER SAURASHTRA & KUTCH BASED ON 1800 UTC (2330 IST) OF 15TH JUNE 2023.



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 (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

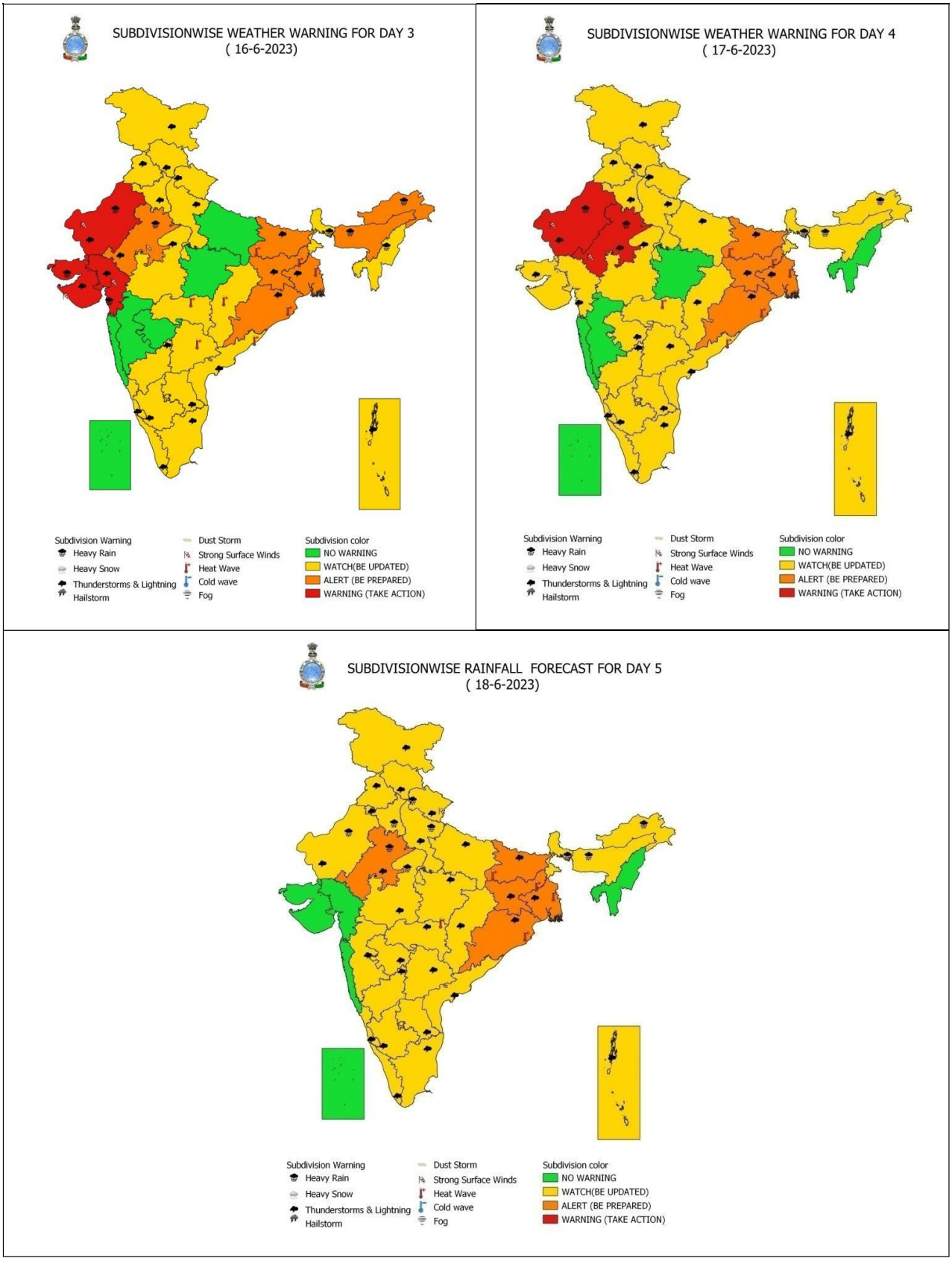
- LESS THAN 34 KT
- 34-47 KT
- ≥ 48 KT
- OBSERVED TRACK
- FORECAST TRACK
- CONE OF UNCERTAINTY

AREA OF MAXIMUM SUSTAINED WIND SPEED:
- 28-33 KT (52-61 KMPH)
- 34-49 KT (62-91 KMPH)
- 50-63 KT (92-117 KMPH)
- ≥ 64 KT (≥118 KMPH)

IMPACT OVER THE SEA

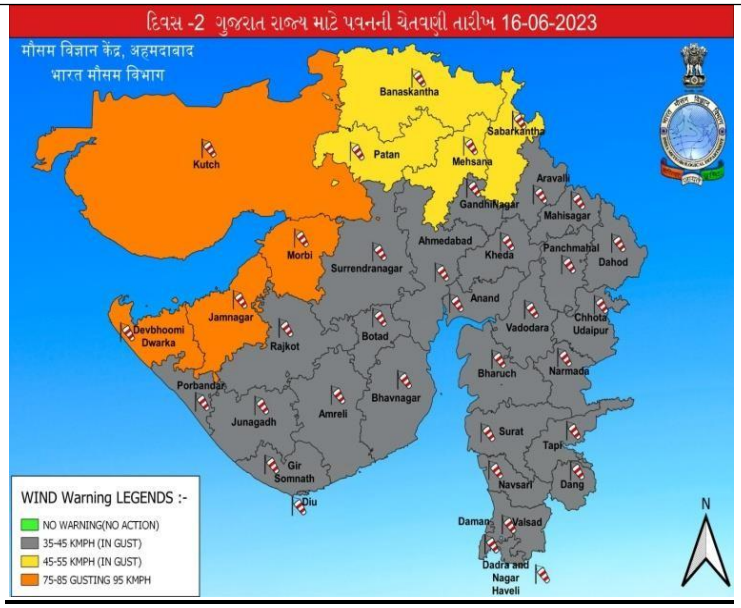
MSW (knot/kmph)	Impact	Action
28-33 (52-61)	Very rough seas	Total suspension of fishing operations
34-49 (62-91)	High to very high seas	Total suspension of fishing operations
50-63 (92-117)	Very high seas	Total suspension of fishing operations
≥ 64 (≥118)	Phenomenal	Total suspension of fishing operations

All India Heavy Rainfall Warning for 16th to 18th June 2023

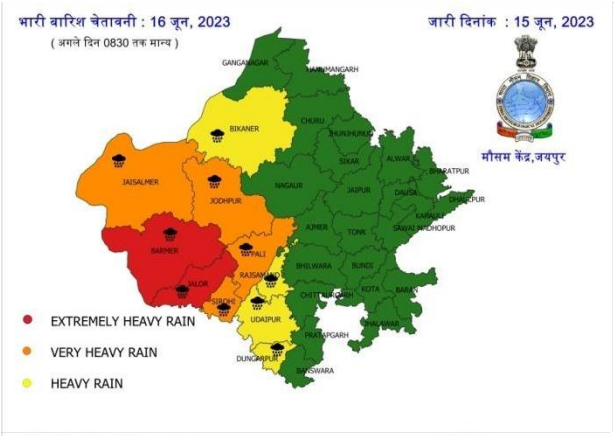


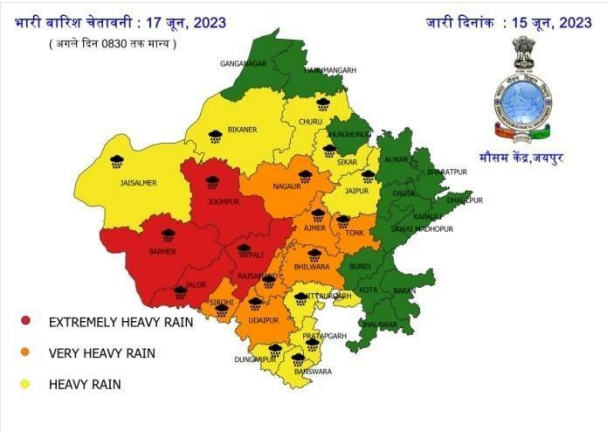
District-wise Heavy Rainfall Warning Maps for 16th to 17th June

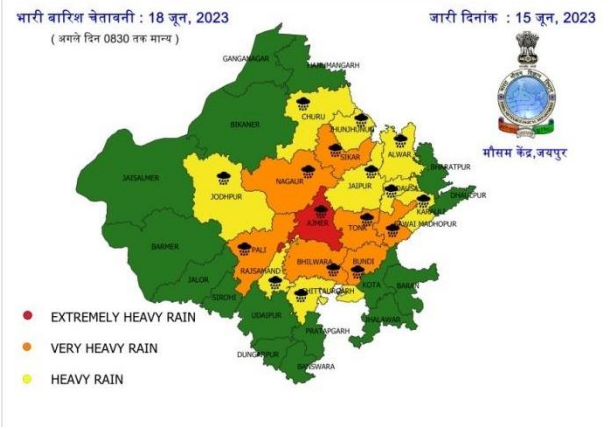
District-wise Wind Warning Maps for 16th June

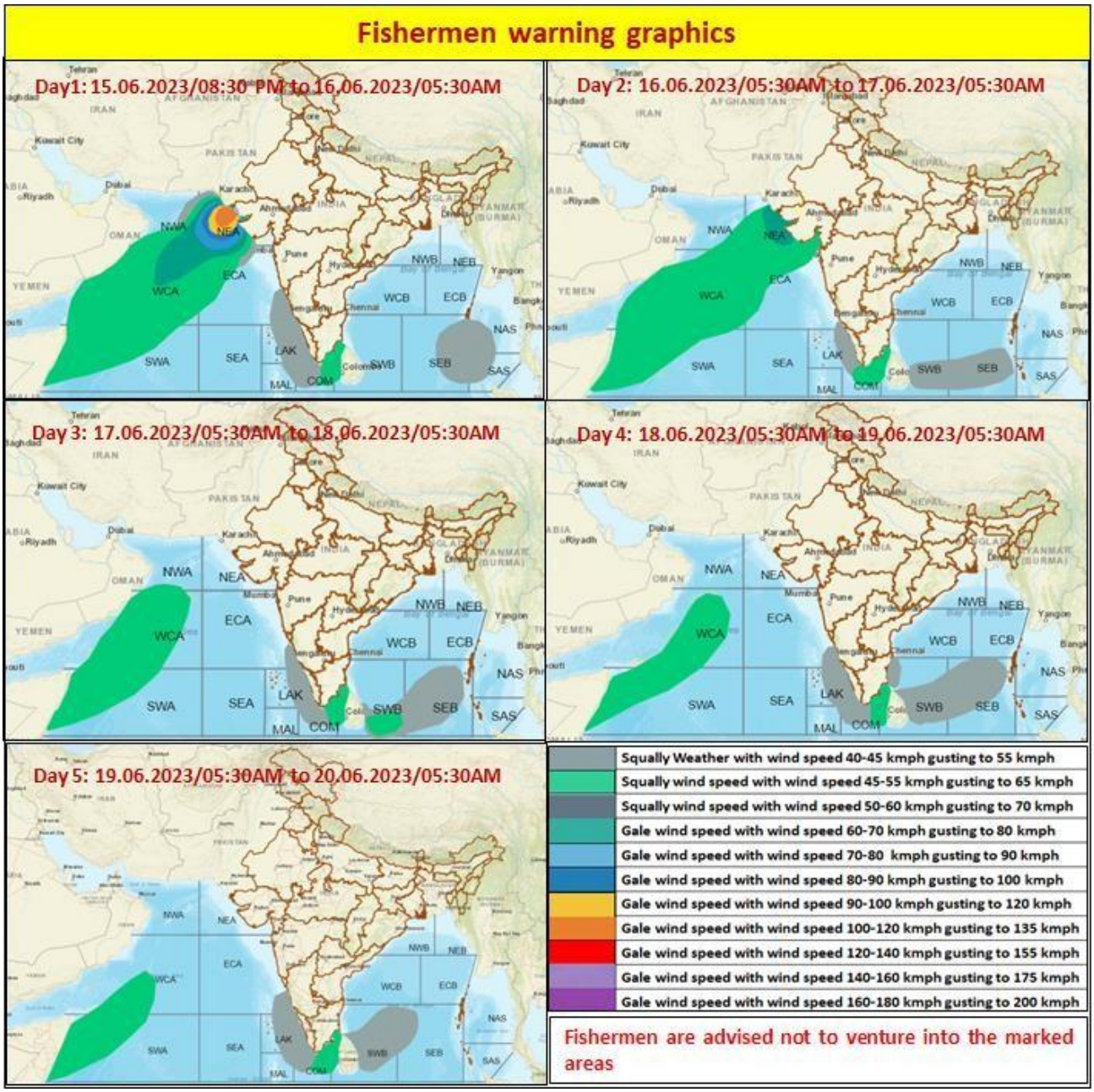


District-wise Heavy Rainfall Warning Maps for 16th, 17th and 18th June for Rajasthan

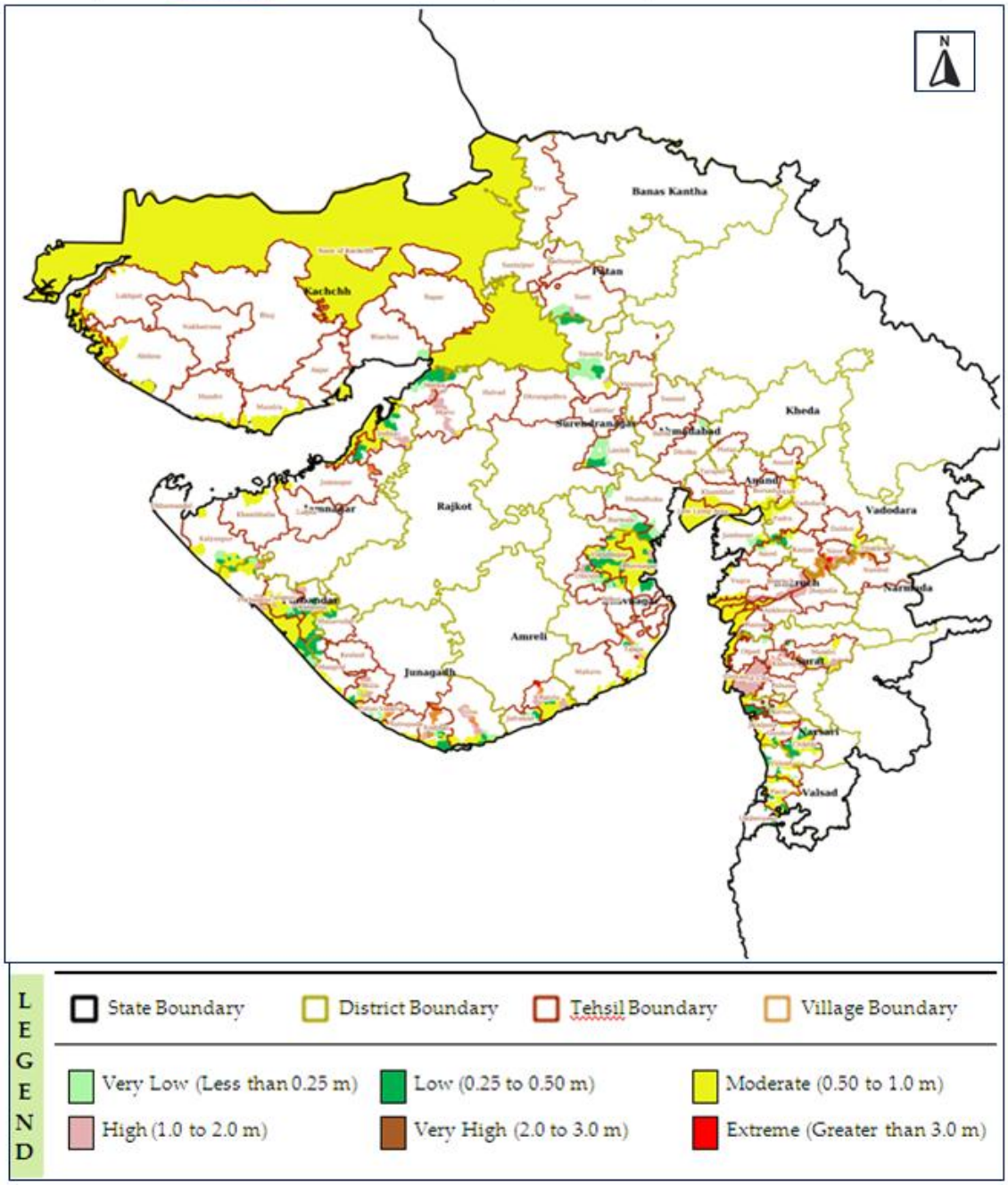







Fishermen warning graphics
Day1: 15.06.2023/08:30 PM to 16.06.2023/05:30AM
Day 2: 16.06.2023/05:30AM to 17.06.2023/05:30AM
Day 3: 17.06.2023/05:30AM to 18.06.2023/05:30AM
Day 4: 18.06.2023/05:30AM to 19.06.2023/05:30AM
Day 5: 19.06.2023/05:30AM to 20.06.2023/05:30AM
Squally Weather with wind speed 40-45 kmph gusting to 55 kmph
Squally wind speed with wind speed 45-55 kmph gusting to 65 kmph
Squally wind speed with wind speed 50-60 kmph gusting to 70 kmph
Gale wind speed with wind speed 60-70 kmph gusting to 80 kmph
Gale wind speed with wind speed 70-80 kmph gusting to 90 kmph
Gale wind speed with wind speed 80-90 kmph gusting to 100 kmph
Gale wind speed with wind speed 90-100 kmph gusting to 120 kmph
Gale wind speed with wind speed 100-120 kmph gusting to 135 kmph
Gale wind speed with wind speed 120-140 kmph gusting to 155 kmph
Gale wind speed with wind speed 140-160 kmph gusting to 175 kmph
Gale wind speed with wind speed 160-180 kmph gusting to 200 kmph
Fishermen are advised not to venture into the marked areas

Cyclone Biparjoy Flood Hazard Map (Tehsil-wise) on 15th June – Flood Depth



Examples-10 (National Bulletin in association with Severe Cyclonic Storm "BIPARJOY") (Orange message)

India Meteorological Department (Ministry of Earth Sciences)

BULLETIN NO.53 (ARB/01/2023)
TIME OF ISSUE: 2300 HOURS IST DATED:12.06.203
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)
PSTO HON'BLE MINISTER FOR S&T AND EARTH SCIENCES (FAXNO.23316745) SECRETARY, MOES (FAXNO.24629777)
H.Q. (INTEGRATED DEFENCE STAFF AND CDS) (FAX NO. 23005137/23005147) DIRECTOR GENERAL, DOORDARSHAN (23385843)
DIRECTOR GENERAL, AIR 23421105, (23421219) PIBMOES (FAX NO. 23389042) UNI (FAXNO. 23355841) D.G. NATIONAL DISASTER RESPONSE FORCE (NDRF) (FAX NO. 26105912, 2436 3260) DIRECTOR, PUNCTUALITY, INDIAN RAILWAYS (FAX NO. 23388503)
CHIEF SECRETARY, KERALA (FAX NO. 0471-2327176) ADMINISTRATOR, LAKSHADWEEP ISLANDS (FAX NO. 0413-262184) CHIEF SECRETARY, TAMIL NADU (FAXNO.044-25672304)
CHIEF SECRETARY, GOA (FAXNO.0832-2415201)
CHIEF SECRETARY, KARNATAKA (FAX NO. 080 - 22258913)
CHIEF SECRETARY, MAHARASHTRA (FAX NO. 022- 22028594)
CHIEF SECRETARY, GUJARAT (FAXNO.079-23250305)
CHIEF SECRETARY, DAMAN& DIU (FAXNO.0260-2230775)
CHIEF SECRETARY, DADRA & NAGAR HAVELI (FAXNO. 0260-2645466)

Sub: Extremely Severe Cyclonic Storm "Biparjoy" (pronounced as "Biporjoy") over Northeast and adjoining Eastcentral Arabian Sea: Cyclone Warning for Saurashtra & Kutch Coasts (OrangeMessage)

The extremely severe cyclonic storm "Biparjoy" (pronounced as "Biporjoy") over eastcentral and adjoining northeast Arabian Sea moved nearly northwestwards with a speed of 08 kmph during past 6-hours and lay centered at 2030 hours IST of today, the12th June, 2023 over Northeast and adjoining Eastcentral Arabian Sea near latitude20.0°N and longitude 67.2°E, about 320 km southwest of Porbandar, 330 km southwest of Devbhumi Dwarka, 390 km south-southwest of Jakhau Port, 400 km south – southwest of Naliya and 540 km south of Karachi(Pakistan).

It is very likely to move nearly northwards till14th morning,then move north-northeastwards and cross Saurashtra & Kutch and adjoining Pakistan coasts between Mandvi (Gujarat) and Karachi (Pakistan) near Jakhau Port (Gujarat) by evening of 15thJune as a very severe cyclonic storm with maximum sustained wind speed of 125-135kmphgustingto150kmph.

Forecast track and intensity are given below:

Date/Time(IST)	Position (Lat.^{0}N/long.^{0}E)	Maximum sustained surface Wind speed(Kmph)	Category of cyclonic disturbance
12.06.23/2030	20.0/67.2	160-170GustingTo 190	Extremely Severe Cyclonic Storm
12.06.23/2330	20.1/67.1	155-165GustingTo 185	Very Severe Cyclonic Storm
13.06.23/0530	20.4/67.0	150-160GustingTo 180	Very Severe Cyclonic Storm
13.06.23/1130	24.8/67.1	145-155GustingTo 170	Very Severe Cyclonic Storm
13.06.23/1730	21.2/67.2	140-150GustingTo 165	Very Severe Cyclonic Storm
14.06.23/0530	21.8/67.4	135-145GustingTo 160	Very Severe Cyclonic Storm
14.06.23/1730	22.4/67.7	130-140GustingTo 155	Very Severe Cyclonic Storm
15.06.23/0530	23.0/68.1	125-135GustingTo 150	Very Severe Cyclonic Storm
15.06.23/1730	23.5/68.7	90-100GustingTo110	Severe Cyclonic Storm
16.06.23/0530	24.0/69.4	50-60GustingTo 70	Deep Depression
16.06.23/1730	24.5/70.3	30-40GustingTo 50	Well-Marked Low Pressure Area

(i) Heavy Rainfall warning for Gujarat (Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts):

- Light to moderate rainfall at many places in coastal districts of Saurashtra & Kutch with isolated heavy rainfall on13thJune.
- Light to moderate rainfall at most places with heavy to very heavy rainfall at isolated places very likely over Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districtsof Saurashtra& Kutch on 14thJune.
- The intensity of rainfall would increase with heavy to very heavy rainfall at a few places and extremely heavy falls at isolated places very likely over Kutch, Devbhumi Dwarka & Jamnagar and heavy to very heavy rainfall at a few places over Porbandar, Rajkot, Morbi &Junagarh districts of Gujarat on 15thJune.
- Isolated heavy rainfall is very likely over remaining districts of Saurashtra and north Gujarat region on15thJune. Light to moderate rainfall at most places with heavy to very heavy rainfall at isolated places very likely over north Gujarat and adjoining south Rajasthan on 16thJune.

(ii) Wind warning:

12thJune: Gale wind speed reaching 160-170 kmph gusting to 190 kmph is likely to prevail over northeast and adjoining eastcentral Arabian Sea. Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of west central Arabian Sea.

13th June: Gale wind speed reaching 150-160 kmph gusting to 180 kmph is likely to prevail over northeast Arabian Sea and becoming 140-150 kmph gusting to 165 kmph from evening. Gale wind speed reaching 80-90 kmph gusting to 100 kmph is likely to prevail over adjoining areas of eastcentral Arabian Sea. Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of northwest Arabian Sea.

14th June: Gale wind speed reaching 135-145 kmph gusting to 160 kmph is likely to prevail over northeast Arabian Sea. Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of eastcentral Arabian Sea.

15th June: Gale wind speed reaching 125-135 kmph gusting to 150 kmph is likely to prevail over northeast Arabian Sea and likely to decrease becoming 90-100 kmph gusting to 110 kmph from evening. Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of eastcentral Arabian Sea.

16th June: Squally wind speed reaching 40-50 kmph gusting to 60 kmph is likely over adjoining areas of eastcentral Arabian Sea till evening.

Wind warning along & off Saurashtra & Kutch coasts (Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts) including Gulf of Kutch:

- Squally wind speed reaching 45-55 kmph gusting to 65 kmph is very likely on 12th, becoming 50-60 kmph gusting to 70kmph from 13thmorningto 14thJunemorning.
- It would increase becoming Gale wind speed reaching 65-75 kmph gusting to 85 kmph from14th June morning along & off Porbandar &Devbhoomi Dwarka district coasts. It would become 125-135 kmph gusting to 150 kmph from 15th morning for subsequent 12 hours along& off Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts. Thereafter it would decrease gradually becoming 45-55 kmph gusting to 65 kmph over north Gujarat and adjoining south Rajasthan from 16th morning to evening.
- Squally wind speed reaching 55-65 kmph gusting to 75 kmph very likely to prevail along & off remaining districts Saurashtra coast on 14th& 15th June and 30-40 kmph gusting to 50kmph during16th morning to evening.

(iii) Sea condition

12thJune: Sea condition is likely to be phenomenal over northeast and adjoining east central Arabian Sea and rough over adjoining westcentral Arabian Sea.

13thJune: Sea condition is likely to be phenomenal over northeast and adjoining eastcentral Arabian Sea and rough over adjoining northwest Arabian Sea

14th June: Sea condition is likely to be phenomenal over northeast Arabian Sea and rough to very rough sea condition is likely over adjoining areas of east central Arabian Sea.

15th June: Sea condition is likely to be phenomenal to high over northeast Arabian Sea and very rough to rough over adjoining eastcentral Arabian Sea till 15th June evening and improve thereafter.

Along & off Saurashtra & Kutch coasts:

Sea condition is likely to be rough to very rough till 14th morning and high to phenomenal thereafter till15thJune evening and would improve thereafter.

(iv) Storm Surge Warning (Kutch, Devbhumi Dwarka, Porbandar, Jamnagarh and Morbi districts)

Storm surge of about 2 -3 m above the astronomical tide is likely to inundate the low lying areas of above districts during the time of landfall. The

astronomical tides along these districts could be upto 3-6 meters in different places.

(v) Damage expected over Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Morbi & Junagarh &Rajkot districts of Gujarat on15th June:

- Total destruction of thatched houses/ extensive damage to kutcha houses. Some damage to Pucca houses.
- Potential threat from flying objects.
- Bending/ uprooting of power and communication poles.

Major damage to Kutcha and Pucca roads. Flooding of escape routes. Disruption of

- railways, overhead power lines and signaling systems.
- Wide spread damage to standing crops, plantations, orchards, falling of green coconut sand tearing of palm fronds. Blowing down of bushy trees like mango.
- Small boats, country crafts may get detached from moorings.
- Visibility severely affected due to salt spray.

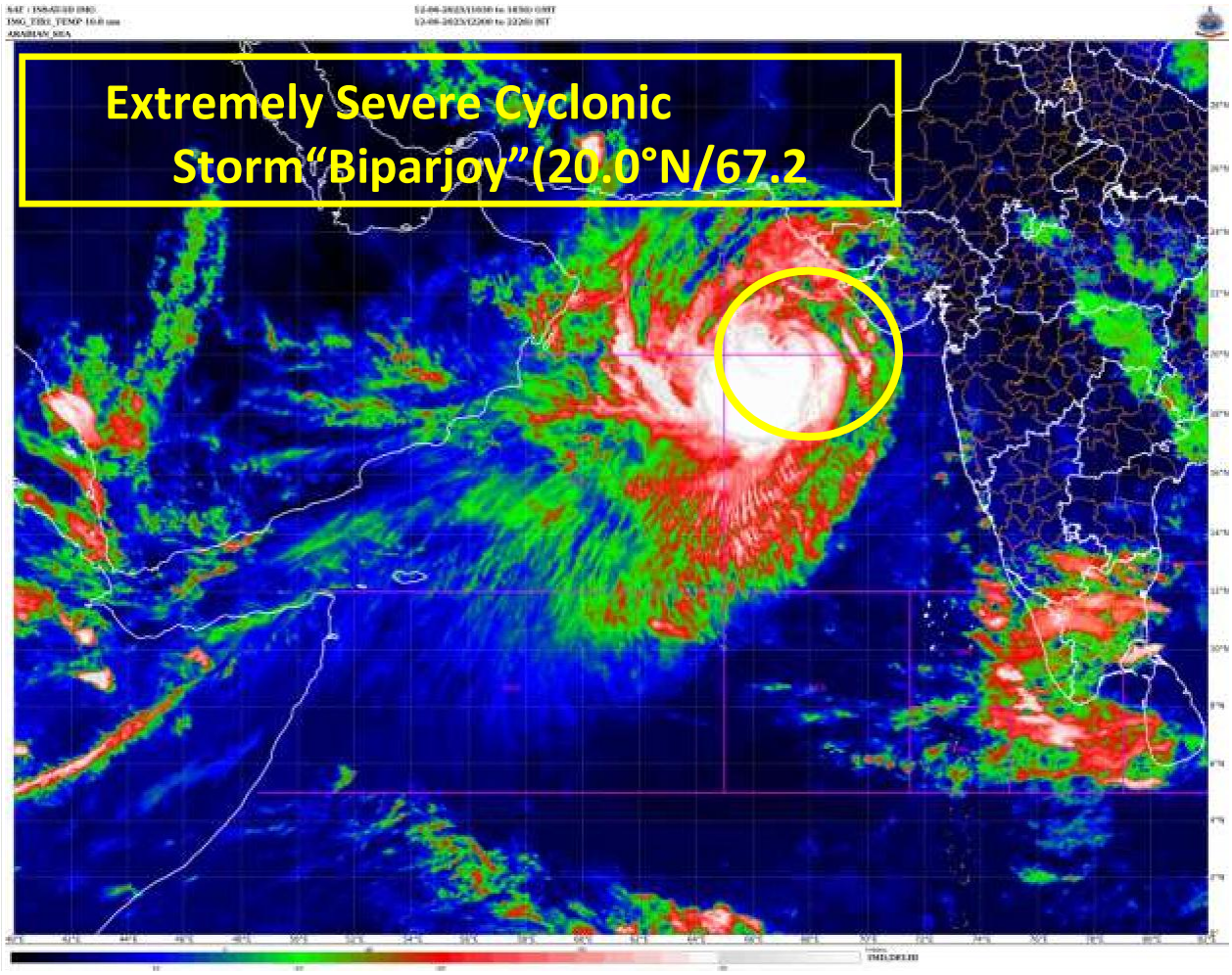
(vi) Fishermen Warning & Action Suggested (Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts) and for Offshore & Onshore Industries (GraphicsAttached):

- Total suspension of fishing operations over
  - Eastcentral and adjoining Westcentral Arabian Sea till15th June.
  - Northeast Arabian Seaduring12th-15th June
- Those out at sea are advised to return to coast.
- Judicious regulation of offshore and onshore activities.
- Ports along the west coast of India may take necessary precautions.
- Naval base operations may maintain necessary precautions.
- Movement in motor boat sand small ship sall & off these coasts to be avoided.
- Mobilise evacuation from coastal areas of Saurashtra and Kutch (Kutch, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbidistricts).
- Judicious regulation of rail and road traffic.
- People in affected areas to remain indoors.
- Tourism activities may be restricted over the sea areas.
- Preparatory actions before the cyclones.

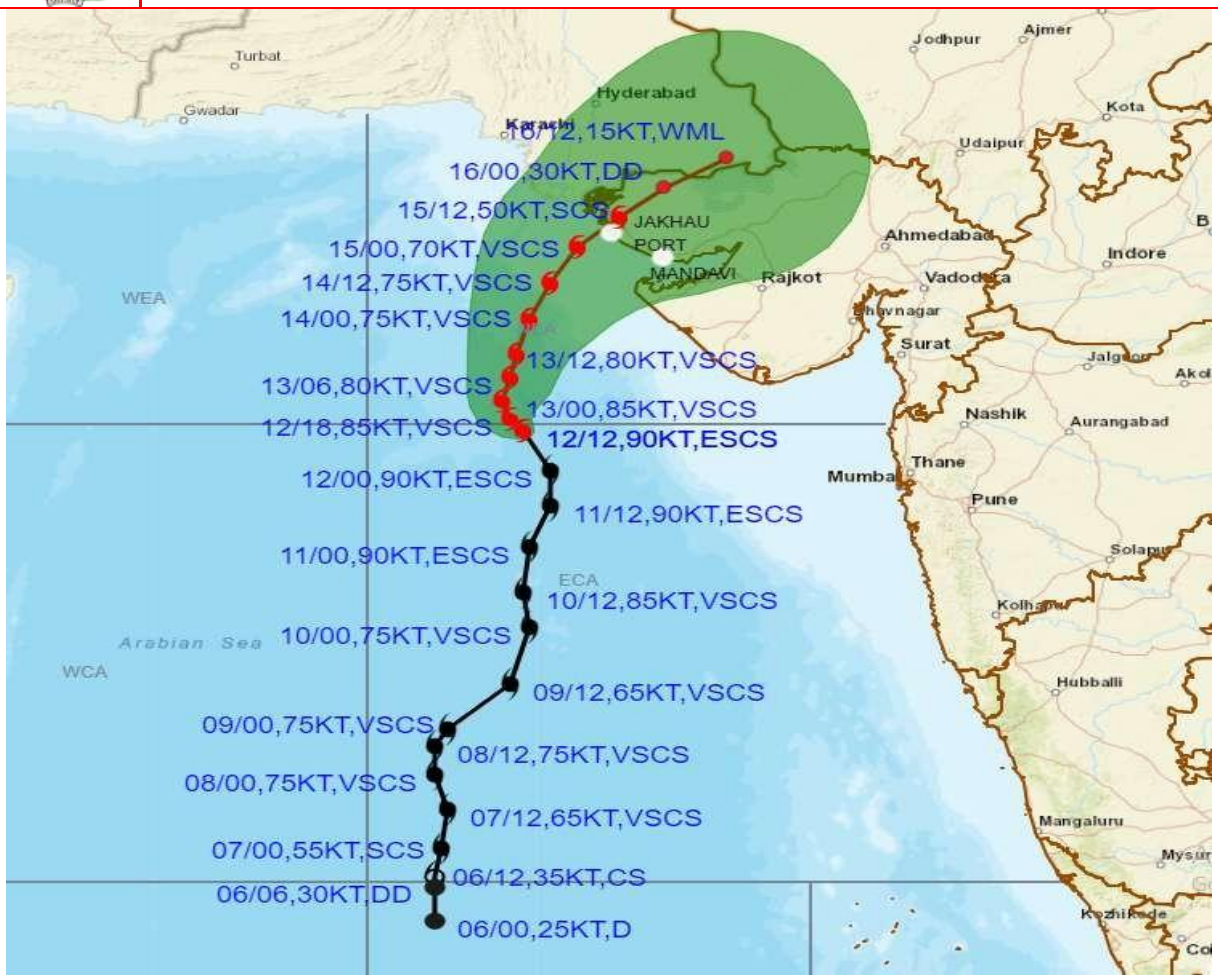
The system is under continuous surveillance and the next message will be issued at 0230 hours IST of tomorrow, the 13th June, 2023.

Copyto:ACWCKolkata/ACWCChennai/CWCBhubaneswar/CWCVisakhapatnam/CWCAhmedabad/MOPortBlair/MC Raipur/MCBhopal/MC Hyderabad/RMCNagpur

LEGEND:**HeavyRainfall**:64.5to115.5mm,**VeryHeavyRainfall**:115.6to204.4mm**MostPlaces**:morethan 76%oftotalstations,**IsolatedPlaces**: Less than25%oftotal


Extremely Severe Cyclonic
Storm“Biparjoy”(20.0°N/67.2

OBSERVED AND FORECAST TRACK ALONGWITH CONE OF UNCERTAINITY OF EXTREMELYSEVERE CYCLONIC STORM "BIPARJOY" OVER EASTCENTRAL AND ADJOINING NORTHEASTARABIANSEABASED ON1200UTC(1730IST)OF12TH JUNE2023.

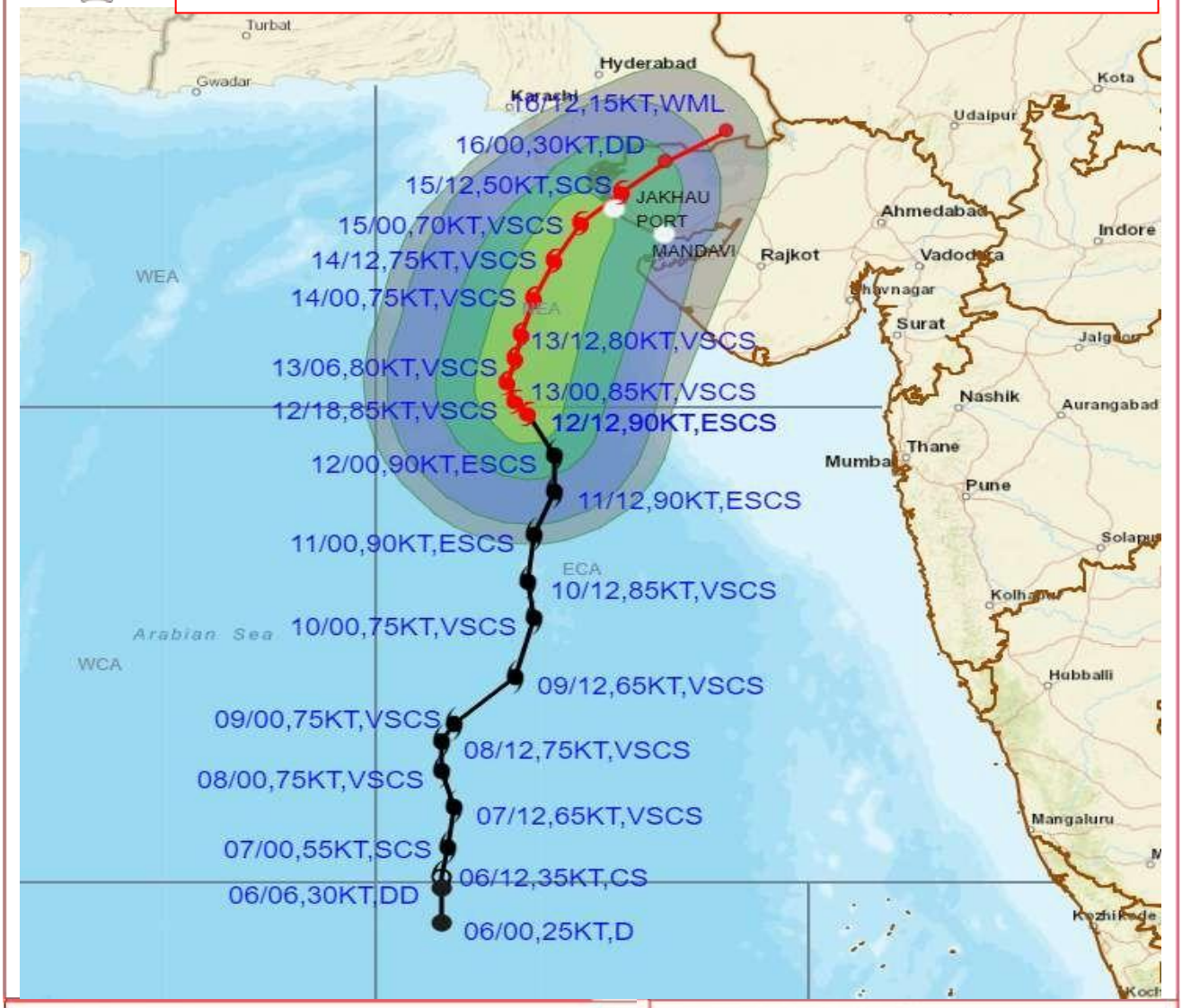


DATE/TIME IN UTC
IST=UTC + 0530
L: LOW PRESSURE AREA
WML: WELL MARKED LOW PRESSURE AREA
D: DEPRESSION (17-27 KT)
DD: DEEP DEPRESSION (28-33 KT)
CS: CYCLONIC STORM (34-47 KT)
SCS: SEVERE CYCLONIC STORM (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY

STATIONS	DISTANCE(KM)ANDDIRECTIONFROMSTATIONS				
	13.06.23/1200	14.06.23/1200	15.06.23/1200	16.06.23/1200	
PORBANDAR	260,W	220,WNW	230,NNW	320,NNE	
DWARKA	230,SW	140,W	140,NNW	270,NNE	
JAKHAUPORT	260,SSW	130,SW	40,NNE	220,NE	
NALIYA	280,SW	150,SW	40,NNW	200,NE	
KARACHI	410,S	280,SSE	230,SE	320,E	

OBSERVED AND FORECAST TRACK ALONGWITH QUADRANT WIND DISTRIBUTION OFEXTREMELY SEVERE CYCLONIC STORM "BIPARJOY" OVER EASTCENTRAL AND ADJOININGNORTHEASTARABIAN SEABASEDON1200UTC(1730IST)OF12TH JUNE2023.



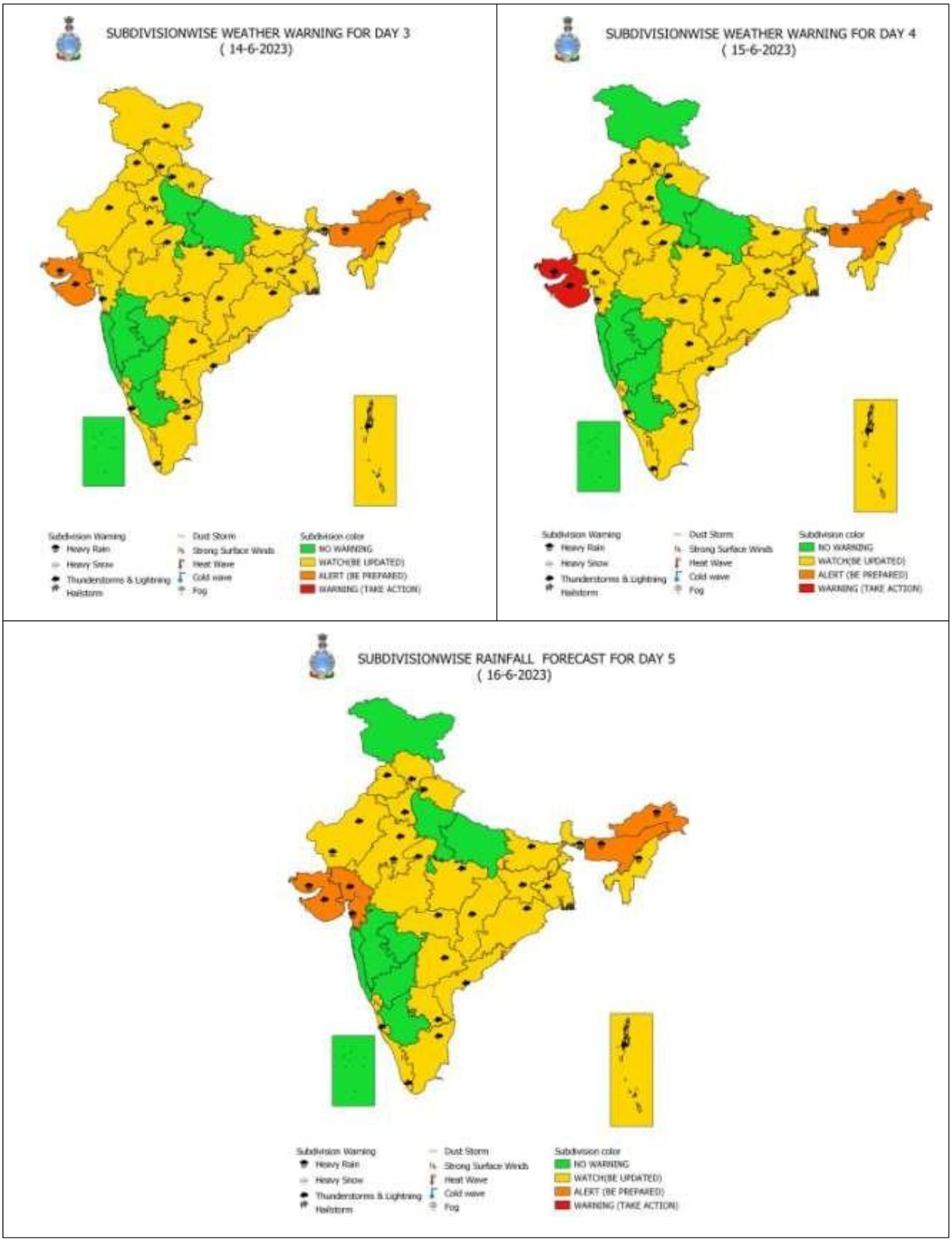
DATE/TIME IN UTC
IST=UTC + 0530
L: LOW PRESSURE AREA
WML: WELL MARKED LOW PRESSURE AREA
D: DEPRESSION (17-27 KT)
DD: DEEP DEPRESSION (28-33 KT)
CS: CYCLONIC STORM (34-47 KT)
SCS: SEVERE CYCLONIC STORM (48-63KT)
VSCS: VERY SEVERE CYCLONIC STORM (64-89 KT)
ESCS: EXTREMELY SEVERE CYCLONIC STORM (90-119 KT)
SuCS: SUPER CYCLONIC STORM (≥ 120 KT)

LESS THAN 34 KT
34-47 KT
≥ 48 KT
OBSERVED TRACK
FORECAST TRACK
CONE OF UNCERTAINTY
AREA OF MAXIMUM SUSTAINED WIND SPEED:
28-33 KT (52-61 KMPH)
34-49 KT (62-91 KMPH)
50-63 KT (92-117 KMPH)
≥ 64 KT (≥118 KMPH)

IMPACT OVER THE SEA

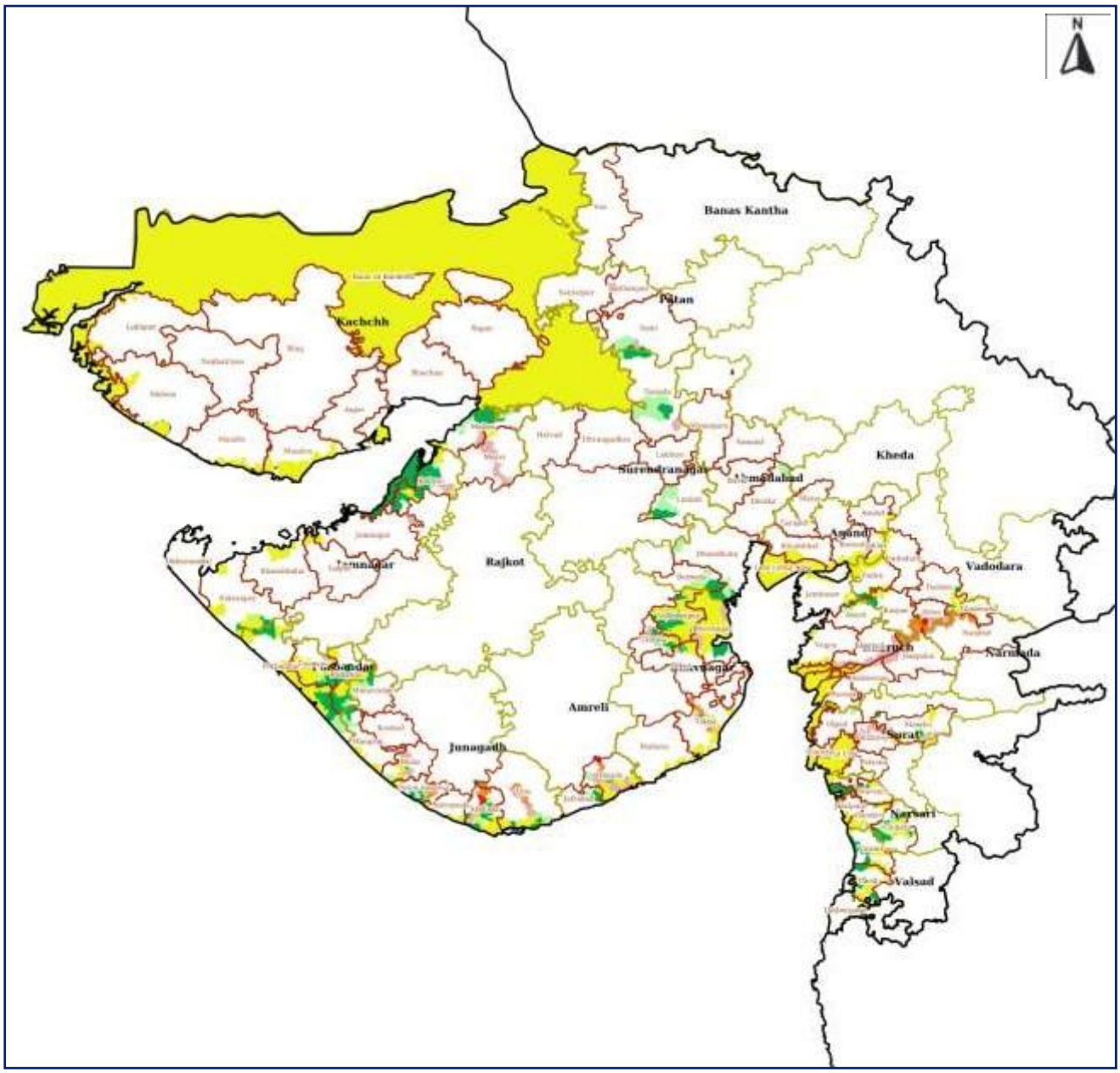
MSW (knot/kmph)	Impact	Action
28-33 (52-61)	Very rough seas	Total suspension of fishing operations
34-49 (62-91)	High to very high seas	Total suspension of fishing operations
50-63 (92-117)	Very high seas	Total suspension of fishing operations
≥ 64 (≥118)	Phenomenal	Total suspension of fishing operations

Heavy Rainfall Warning for 14th to 16th June 2023



District- wise Heavy Rainfall Warning Maps for 15th to 17th June

Hazard Map –Flood Depth for Cyclone Biparjoy Flood



LEGEND

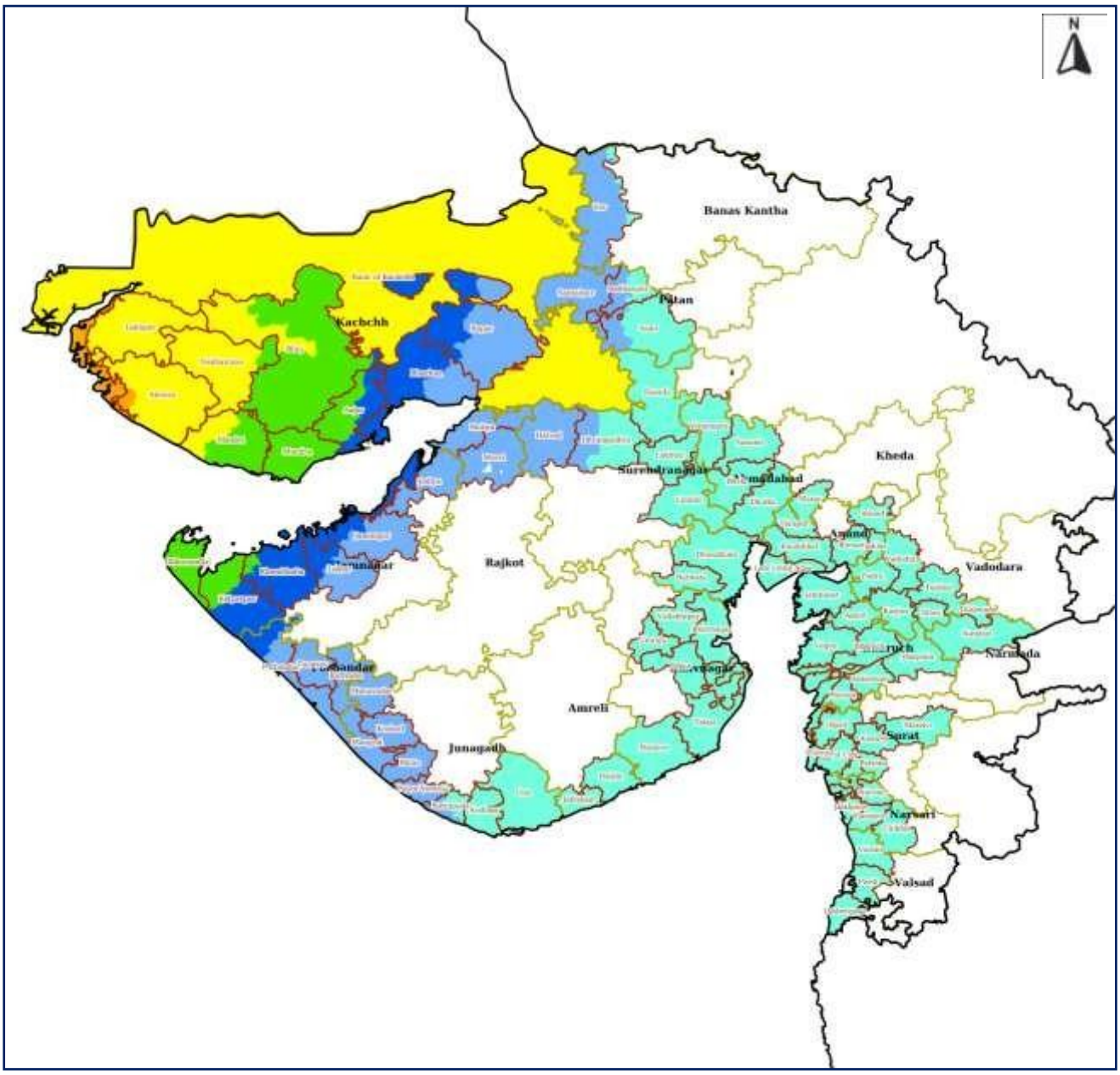
State Boundary | District Boundary | Tehsil Boundary | Village Boundary

Very Low (Less than 0.25 m) | Low (0.25 to 0.50 m) | Moderate (0.50 to 1.0 m)

High (1.0 to 2.0 m) | Very High (2.0 to 3.0 m) | Extreme (Greater than 3.0 m)

District-wise Wind Warning Maps for 12th to16th June

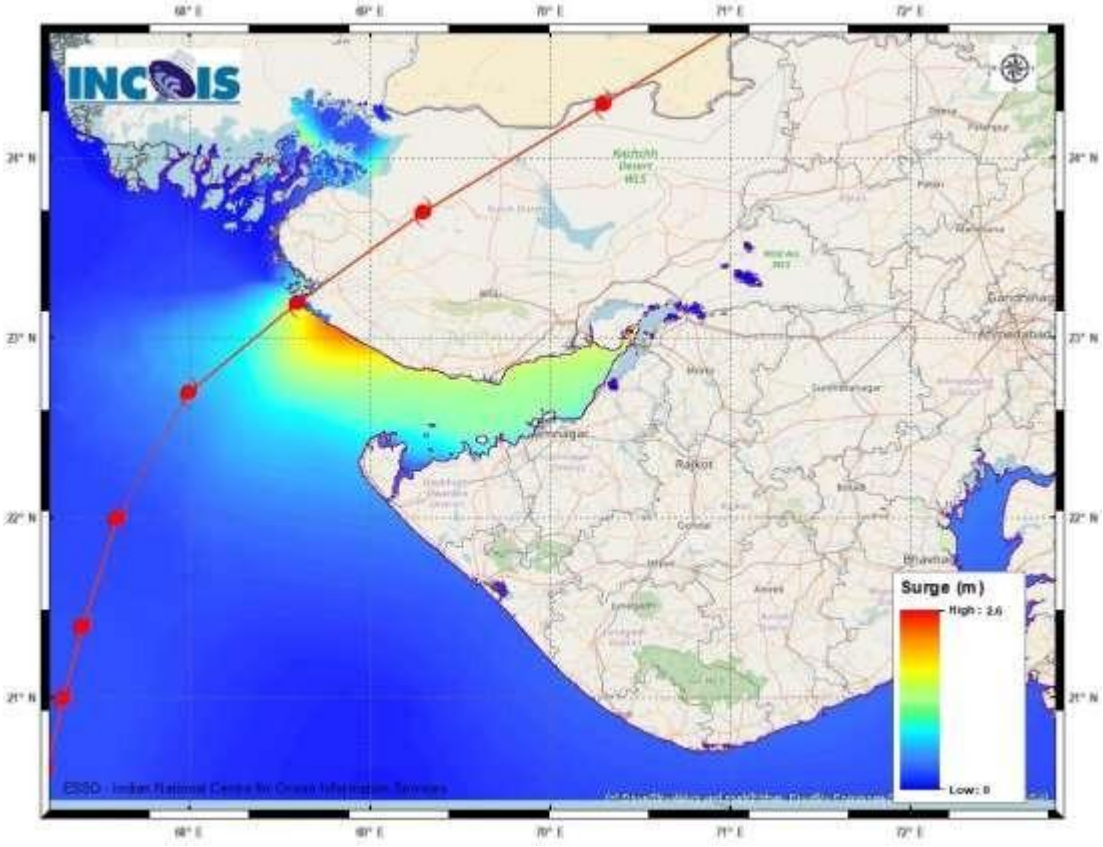
Hazard Map –Wind Speeds for Cyclone Biparjoy Wind



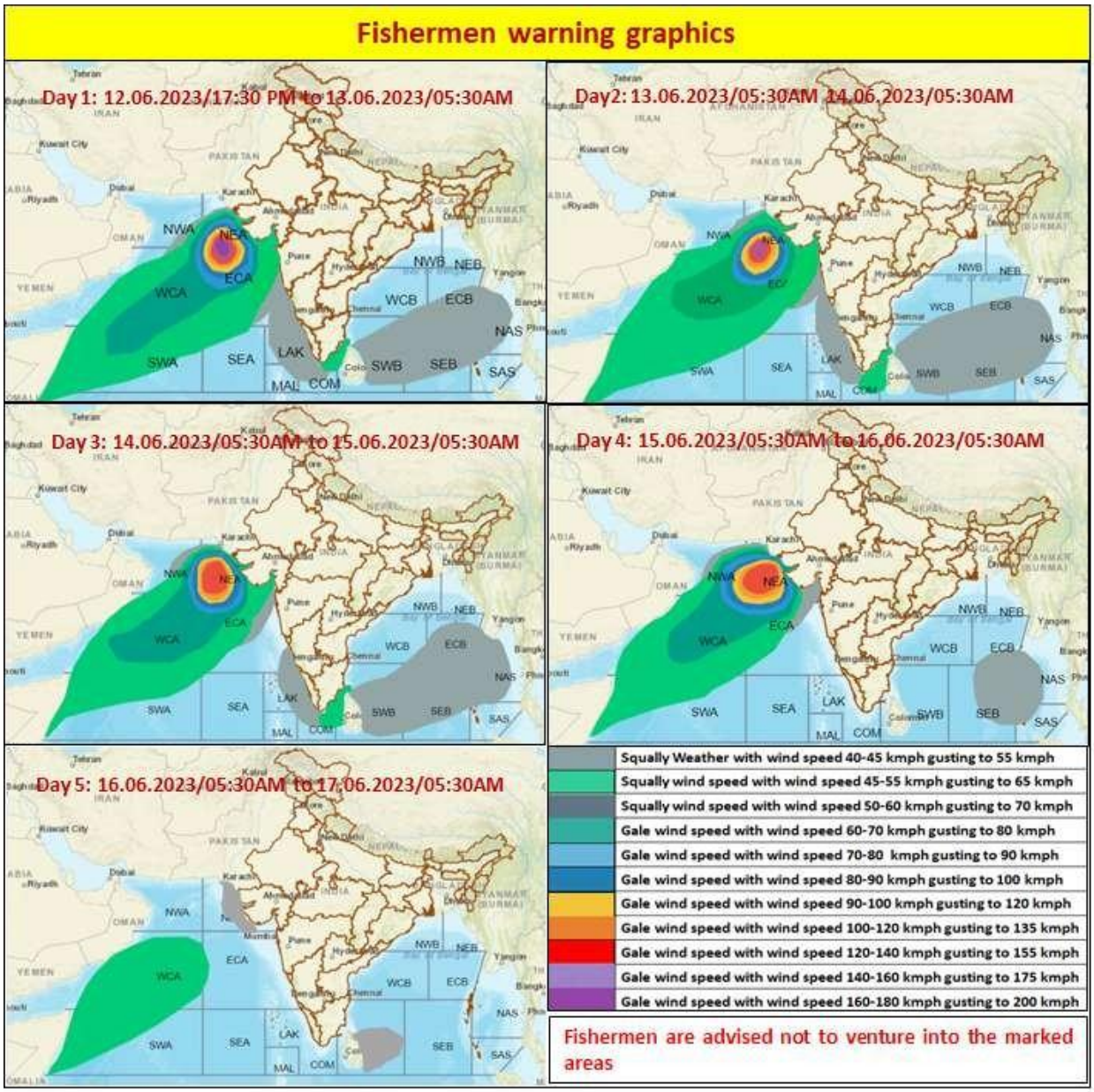
LEGEND

- State Boundary
- District Boundary
- Tehsil Boundary
- Village Boundary
- Wind Speed (Less than 31 Km/h)
- Wind Speed (31 - 49 Km/h)
- Wind Speed (49 - 61 Km/h)
- Wind Speed (61 - 88 Km/h)
- Wind Speed (88 - 117 Km/h)
- Wind Speed (117- 166 Km/h)
- Wind Speed (166 - 221 Km/h)
- Wind Speed (Greater than 221 Km/h)

Storm Surge Warning Map based on Forecast Track



AstronomicalTideon15th June2023		
Station	Time(IST)	Height(m)
Porbandar	09:37	2.61
Navlakhi	13:38	7.54
OKHA	11:36	3.74
DEENDAYALPORT (KANDLA)	13:02	6.79


Fishermen warning graphics
Day 1: 12.06.2023/17:30 PM to 13.06.2023/05:30AM
Day2: 13.06.2023/05:30AM 14.06.2023/05:30AM
Day 3: 14.06.2023/05:30AM to 15.06.2023/05:30AM
Day 4: 15.06.2023/05:30AM to 16.06.2023/05:30AM
Day 5: 16.06.2023/05:30AM to 17.06.2023/05:30AM
NWA
NEA
ECA
WCA
SWA
SEA
LAK
MAL
COM
NWB
NEB
WCB
ECB
SWB
SEB
NAS
SAS
Squally Weather with wind speed 40-45 kmph gusting to 55 kmph
Squally wind speed with wind speed 45-55 kmph gusting to 65 kmph
Squally wind speed with wind speed 50-60 kmph gusting to 70 kmph
Gale wind speed with wind speed 60-70 kmph gusting to 80 kmph
Gale wind speed with wind speed 70-80 kmph gusting to 90 kmph
Gale wind speed with wind speed 80-90 kmph gusting to 100 kmph
Gale wind speed with wind speed 90-100 kmph gusting to 120 kmph
Gale wind speed with wind speed 100-120 kmph gusting to 135 kmph
Gale wind speed with wind speed 120-140 kmph gusting to 155 kmph
Gale wind speed with wind speed 140-160 kmph gusting to 175 kmph
Gale wind speed with wind speed 160-180 kmph gusting to 200 kmph
Fishermen are advised not to venture into the marked areas

Examples-11 (National Bulletin in association with Severe Cyclonic Storm "BIPARJOY") (Red message)

India Meteorological Department
(Ministry of Earth Sciences)

BULLETIN NO. 64 (ARB/01/2023)

TIME OF ISSUE: 0850 HOURS IST **DATED: 14.06.2023**

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, KERALA (FAX NO. 0471-2327176)
ADMINISTRATOR, LAKSHADWEEP ISLANDS (FAX NO. 0413-262184)
CHIEF SECRETARY, TAMILNADU (FAX NO. 044-25672304)
CHIEF SECRETARY, GOA (FAX NO. 0832-2415201)
CHIEF SECRETARY, KARNATAKA (FAX NO. 080-22258913)
CHIEF SECRETARY, MAHARASHTRA (FAX NO. 022- 22028594)
CHIEF SECRETARY, GUJARAT (FAX NO. 079-23250305)
CHIEF SECRETARY, DAMAN & DIU (FAX NO. 0260-2230775)
CHIEF SECRETARY, DADRA & NAGAR HAVELI (FAX NO. 0260-2645466)

Sub: Very Severe Cyclonic Storm "Biparjoy" (pronounced as "Biporjoy") over Northeast Arabian Sea: Cyclone Warning for Saurashtra & Kutch Coasts (Red Message)

The Very Severe Cyclonic Storm "Biparjoy" (pronounced as "Biporjoy") over Northeast Arabian Sea moved nearly northwards with a speed of 3 kmph during past 6-hours and lay centered at 0530 hours IST of today, the 14th June, 2023 over the same region near latitude 21.9°N and longitude 66.3°E, about 280 km west-southwest of Jakhau Port (Gujarat), 290 km west-southwest of Devbhumi Dwarka, 300 km west-southwest of Naliya, 350 km west-northwest of Porbandar, and 340 km south-southwest of Karachi (Pakistan)

It is very likely to move nearly northeastwards and cross Saurashtra& Kutch and adjoining Pakistan coasts between Mandvi (Gujarat) and Karachi (Pakistan) near Jakhau Port (Gujarat)

by evening of 15thJune as a very severe cyclonic storm with maximum sustained wind speed of 125-135 kmph gusting to 150 kmph.

Forecast track and intensity are given below:

Date/Time(IST)	osition at. ^{0}N/ long. ^{0}E)	aximum sustained surface ind speed (Kmph)	Category of cyclonic disturbance
14.06.23/0530	21.9/66.3	145-155 Gusting To 170	Very Severe Cyclonic Storm
14.06.23/1130	22.1/66.5	145-155 Gusting To 170	Very Severe Cyclonic Storm
14.06.23/1730	22.4/66.8	140-150 Gusting To 165	Very Severe Cyclonic Storm
14.06.23/2330	22.7/67.2	135-145 Gusting To 160	Very Severe Cyclonic Storm
15.06.23/0530	23.0/67.7	130-140 Gusting To 155	Very Severe Cyclonic Storm
15.06.23/1730	23.5/68.5	125-135 Gusting To 150	Very Severe Cyclonic Storm
16.06.23/0530	24.2/69.7	90-100 Gusting To 110	Severe Cyclonic Storm
16.06.23/1730	24.8/71.1	50-60 Gusting To 70	Deep Depression
17.06.23/0530	25.1/72.4	25-35 Gusting To 45	Well Marked Low Pressure Area

(i) Heavy Rainfall warning:

- Light to moderate rainfall at most places with heavy to extremely heavy rainfall at isolated places very likely over Kachchh, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts of Saurashtra & Kutch on 14thJune.
- The intensity of rainfall would increase with heavy to very heavy rainfall at a few places and extremely heavy falls at isolated places very likely over Kachchh, Devbhumi Dwarka & Jamnagar and heavy to very heavy rainfall at a few places over Porbandar, Rajkot, Morbi & Junagarh districts of Gujarat and Isolated heavy to very heavy rainfall is very likely over remaining districts of Saurashtra and north Gujarat region on 15th June.
- Light to moderate rainfall at most places with heavy to extremely heavy rainfall at isolated places very likely over north Gujarat and adjoining south Rajasthan on 16thand southeast Rajasthan & adjoining North Gujarat region on 17thJune.

(ii) Wind warning:

Northeast Arabian Sea: Gale wind speed reaching 145-155 kmph gusting to 170 kmph prevailing over the region likely to decrease becoming 125-135 kmph gusting 150 kmph during 15th morning to evening. It would weaken gradually further more thereafter becoming 45-55 kmph gusting to 65 kmph by 16th morning.

Eastcentral Arabian Sea: Gale wind speed reaching 60-70 kmph gusting to 80 kmph is prevailing and would become 40-50 kmph gusting to 60 kmph from 15th morning for subsequent 12 hours.

Wind warning along & off Saurashtra & Kutch coasts (Kachchh, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts) including Gulf of Kutch:

- Gale wind speed reaching 65-75 kmph gusting to 85 kmph will prevail along & off Porbandar &Devbhoomi Dwarka district coasts from forenoon of today, the 14th June.
- It would gradually increase becominggale wind speed reaching 125-135 kmph gusting to 150 kmph during 15thforenoonto night along & offKachchh, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts. Thereafter, it would decrease gradually becoming 85-95 kmph gusting to 105 kmph over Kachchh and adjoining districts of Saurashtra & Kutch by 16thearly morning and squally wind speed reaching 50-60 kmph gusting to 70 kmph by 16thafternoon.
- Squally wind speed reaching 55-65 kmph gusting to 75 kmph very likely to prevail along & off remaining districts of Saurashtra coast on 14th & 15th June.

Wind Warning for South Rajasthan

- Squally wind speed reaching 45-55 kmph gusting to 65 kmph is likely over South Rajasthan during 16th noon to evening and 35-45 kmph gusting to 55kmph till mid-night of 16th June.

(iii) Sea condition

Sea condition will be phenomenal over northeast Arabian Sea till 15th evening and rough to very rough over adjoining eastcentral Arabian Sea during the same period.

Along & off Saurashtra& Kutch coasts:

Sea condition is likely to be very rough till 14thevening and high to phenomenal thereafter till 15th June evening and would improve thereafter.

(iv) Storm Surge Warning (Kachchh, Devbhumi Dwarka, Porbandar, Jamnagarh and Morbi districts)

Storm surge of about 2 -3 m above the astronomical tide is likely to inundate the low lying areas of above districts during the time of landfall. The astronomical tides along these districts could be upto 3-6 meters in different places.

(v) Damage expected over Kachchh, Devbhumi Dwarka, Porbandar, Jamnagar, Morbi & Junagarh & Rajkot districts of Gujarat on 15th June:

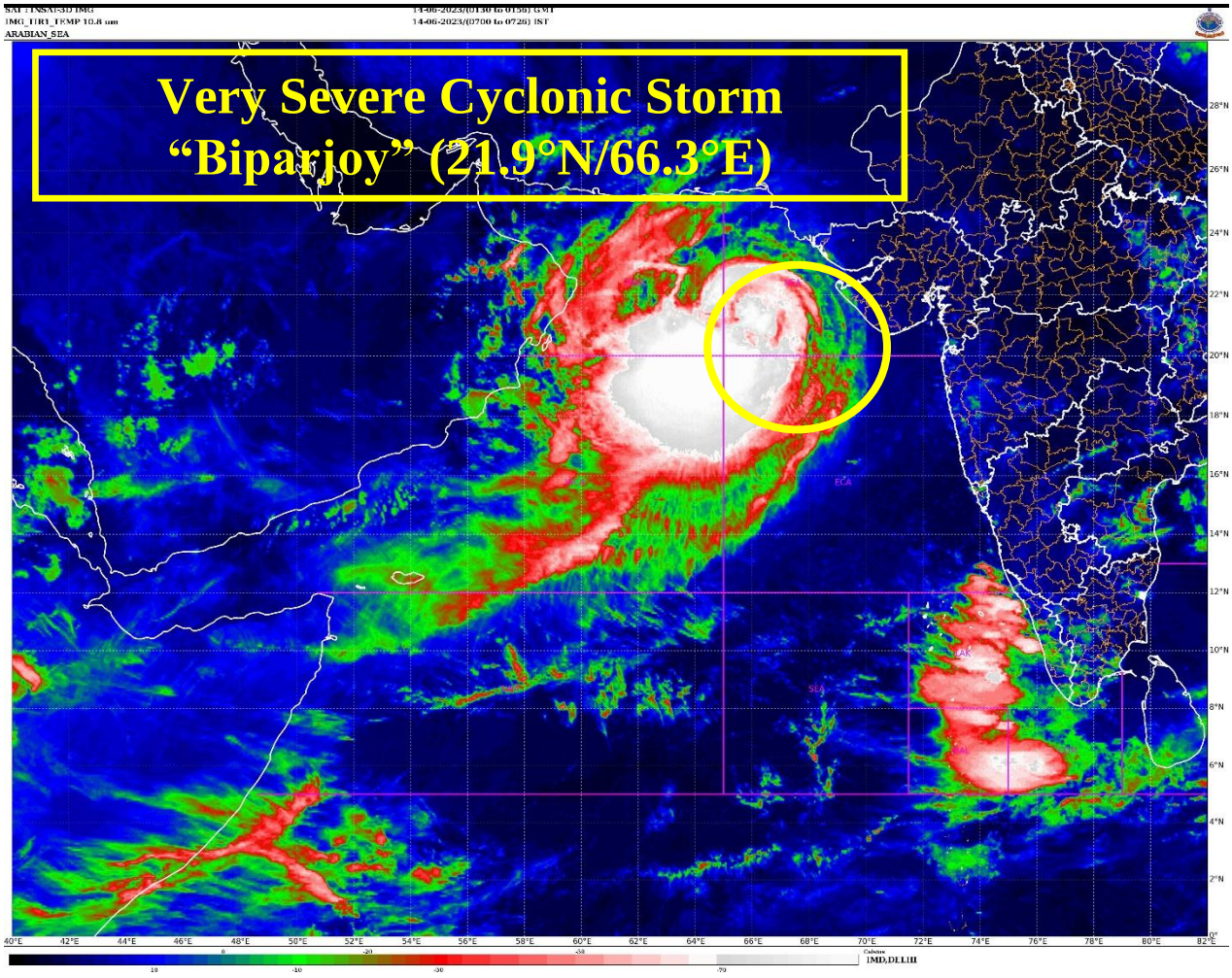
- Total destruction of thatched houses/ extensive damage to kutcha houses. Some damage to Pucca houses.
- Potential threat from flying objects.
- Bending/ uprooting of power and communication poles.
- Major damage to Kutcha and Pucca roads. Flooding of escape routes. Disruption of railways, overhead power lines and signalling systems.
- Widespread damage to standing crops, plantations, orchards, falling of green coconuts and tearing of palm fronds. Blowing down of bushy trees like mango.
- Small boats, country crafts may get detached from moorings.
- Visibility severely affected due to salt spray.

(vi) Fishermen Warning & Action Suggested (Kachchh, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts) and for Offshore & Onshore Industries (Graphics Attached):

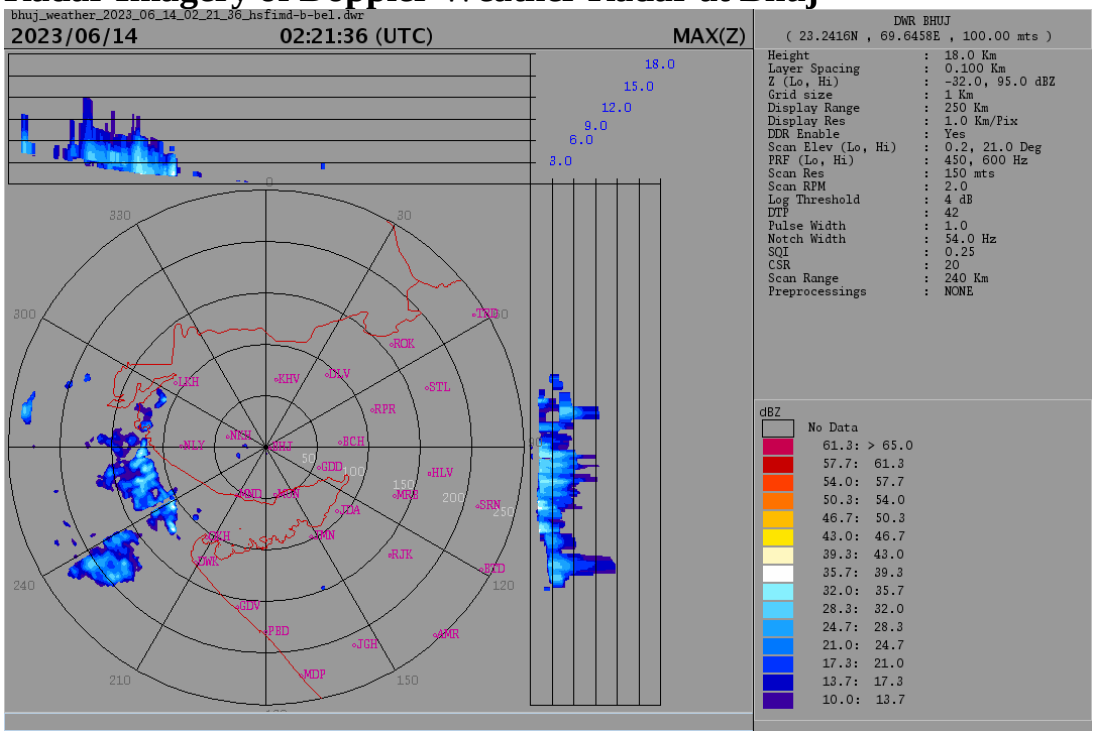
- Total suspension of fishing operations over eastcentral and adjoining Westcentral Arabian Sea till 15th June and over northeast Arabian Sea during 14th -15th June
- Those out at sea are advised to return to coast.
- Judicious regulation of offshore and onshore activities.
- Ports along the west coast of India may take necessary precautions.
- Naval base operations may maintain necessary precautions.
- Movement in motor boats and small ships all & off these coasts to be avoided.
- Mobilise evacuation from coastal areas of Saurashtra and Kutch (Kachchh, Devbhumi Dwarka, Porbandar, Jamnagar, Rajkot, Junagarh and Morbi districts).
- Judicious regulation of rail and road traffic.
- People in affected areas to remain indoors.
- Tourism activities may be restricted over these areas.
- Preparatory actions before the cyclones.

The system is under continuous surveillance and the next message will be issued at 1130 hours IST of today, the 14th June, 2023.

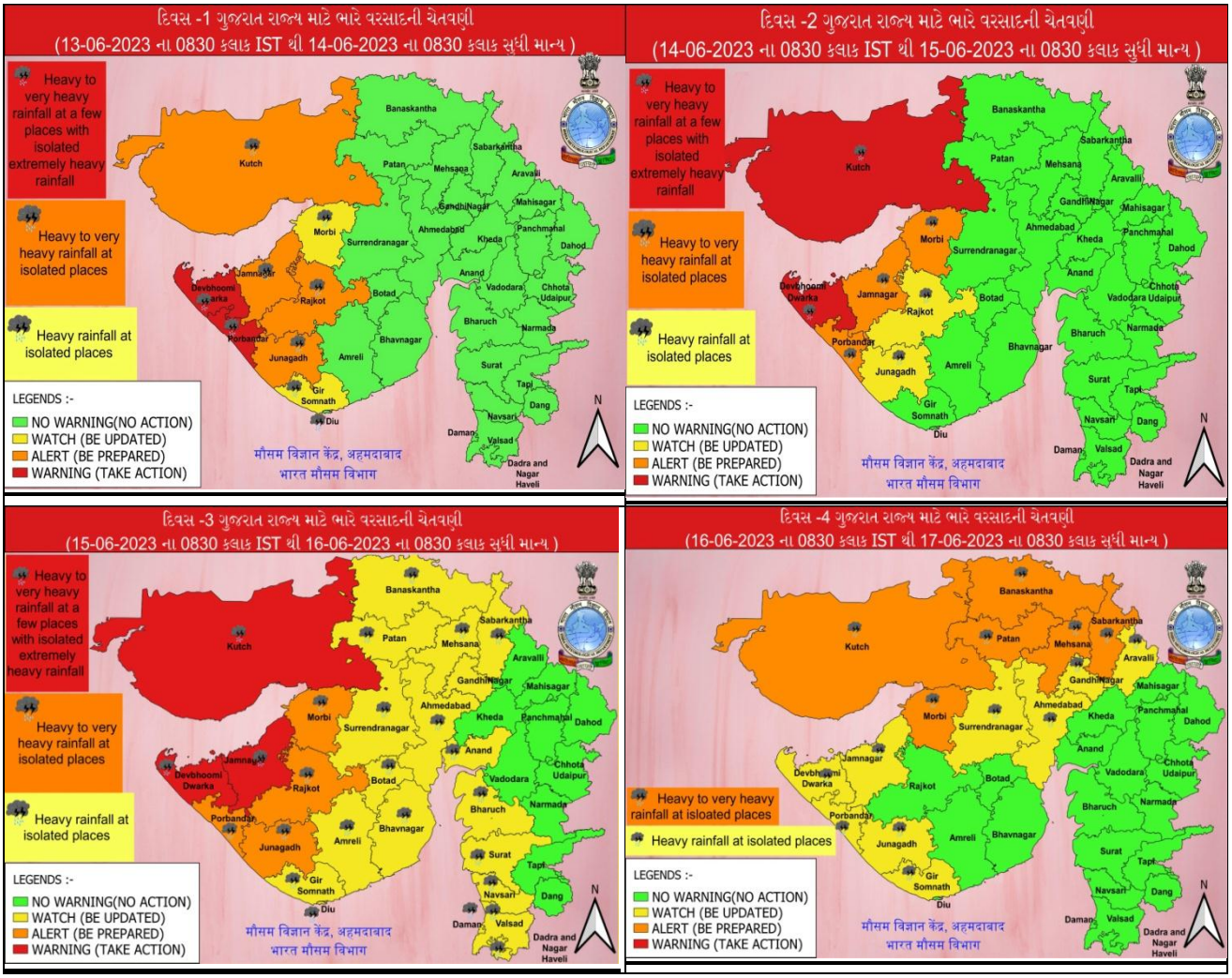
Copy to: ACWC Kolkata/ ACWC Chennai/ CWC Bhubaneswar/CWC Visakhapatnam/CWC Ahmedabad/ MO Port Blair/MC Raipur/MC Bhopal/MC Hyderabad/RMC Nagpur
LEGEND: **Heavy Rainfall**: 64.5 to 115.5mm, **Very Heavy Rainfall**: 115.6 to 204.4mm **Most Places**: more than 76% of total stations, **Isolated Places**: Less than 25% of total


SAT : INSAT-3D IMG
IMG_TIR1_EMP 10.8 um
ARABIAN_SEA
13-06-2023/(0130 to 0156) GMT
14-06-2023/(0700 to 0726) IST
Very Severe Cyclonic Storm
"Biparjoy" (21.9°N/66.3°E)
IMD,DELHI

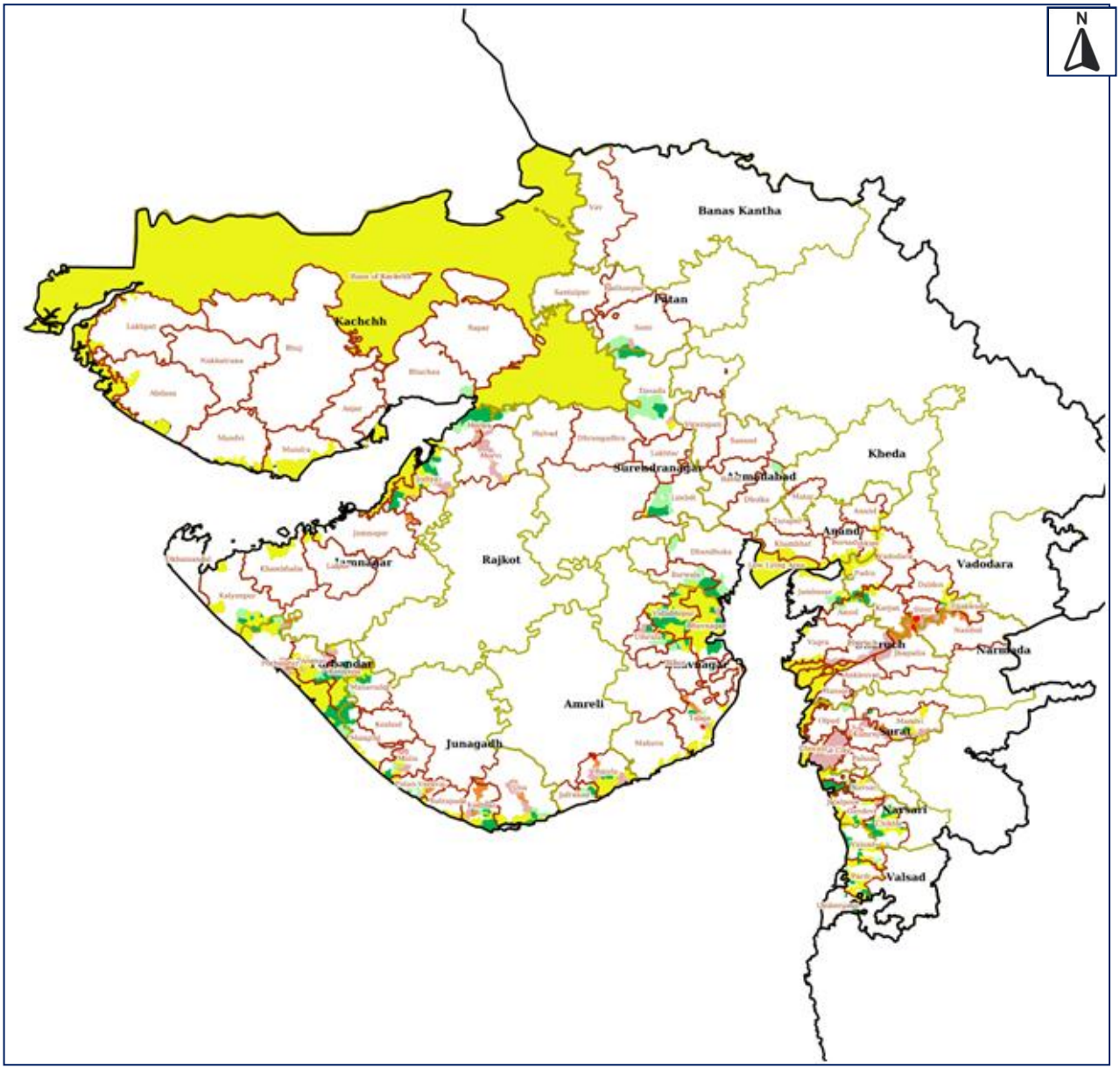
Radar Imagery of Doppler Weather Radar at Bhuj



District-wise Heavy Rainfall Warning Maps for 14th to 16th June



Cyclone Biparjoy Flood Hazard Map (Tehsil-wise) on 15th June–Flood Depth



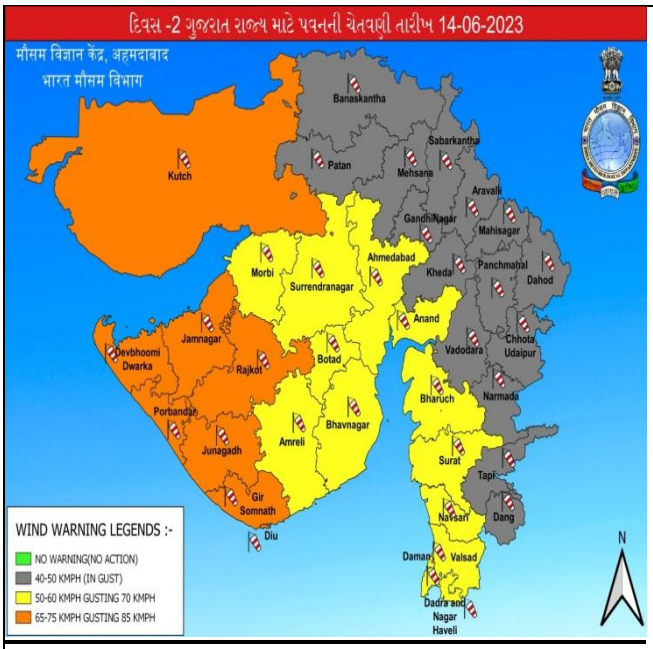
LEGEND

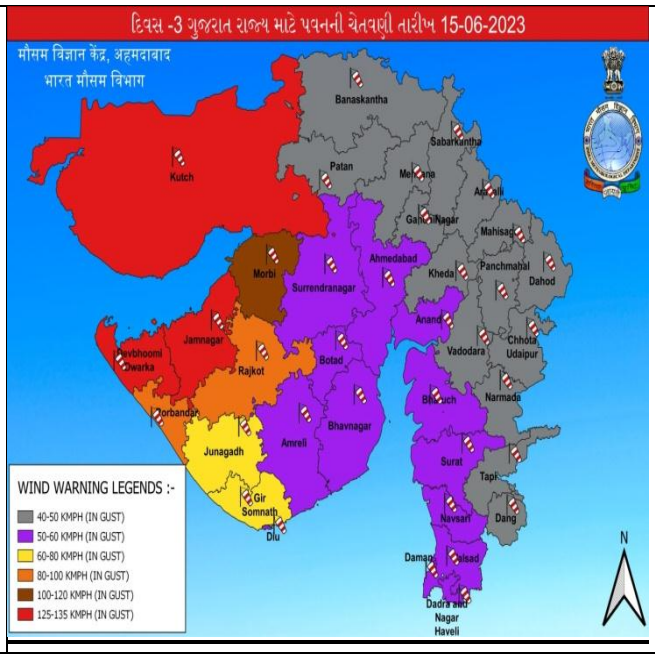
State Boundary | District Boundary | Tehsil Boundary | Village Boundary

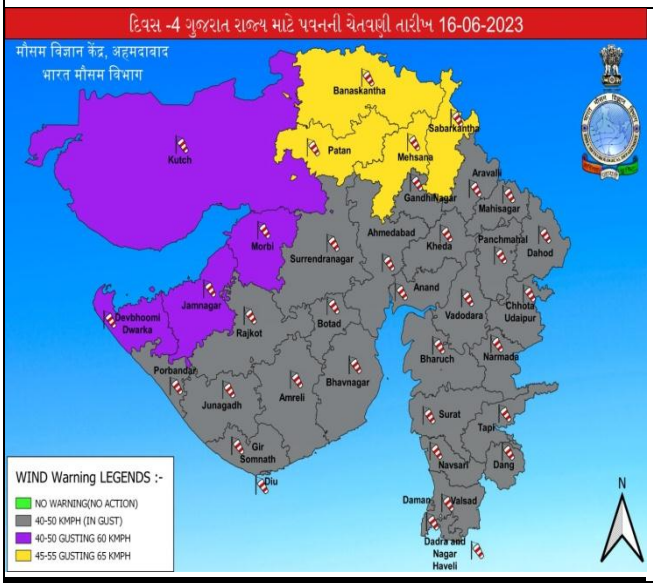
Very Low (Less than 0.25 m) | Low (0.25 to 0.50 m) | Moderate (0.50 to 1.0 m)

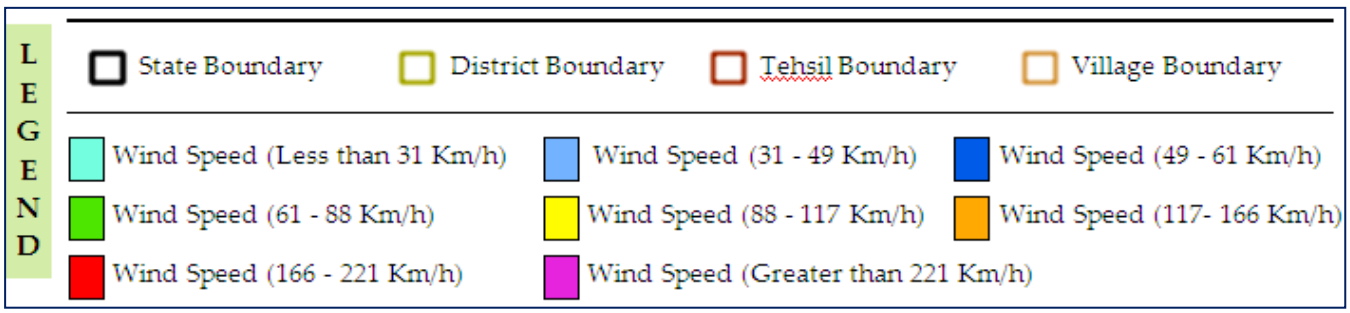
High (1.0 to 2.0 m) | Very High (2.0 to 3.0 m) | Extreme (Greater than 3.0 m)

District-wise Wind Warning Maps for 14th to 16th June

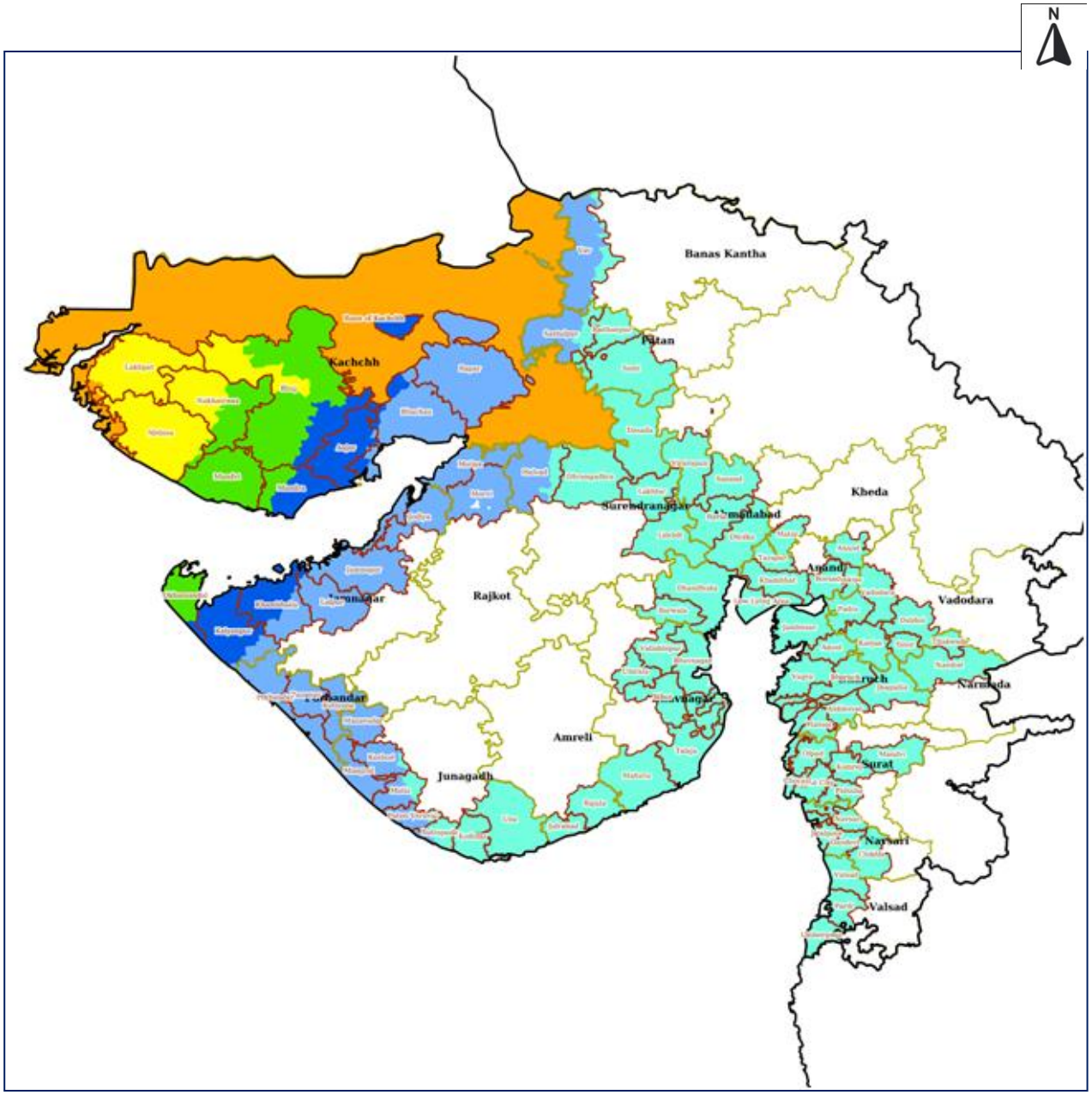




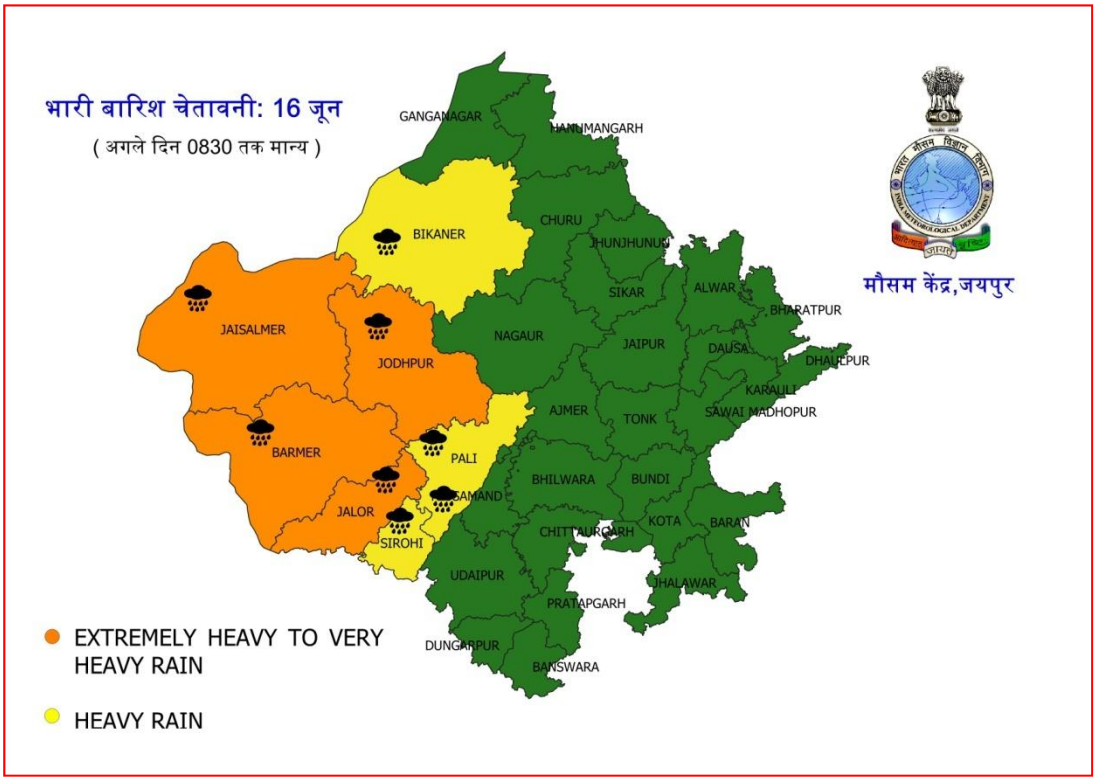




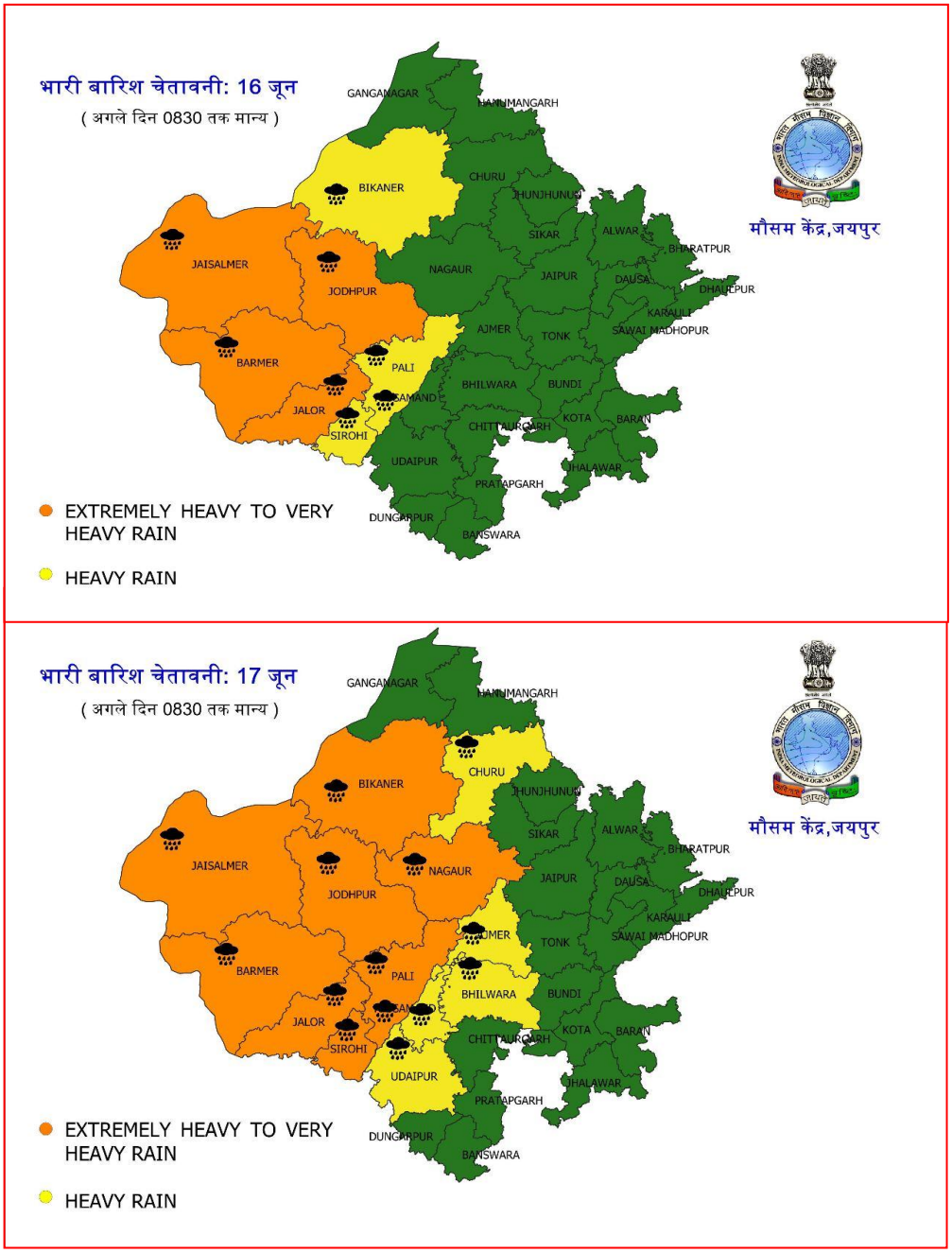
Cyclone Biparjoy Wind Hazard Map (Tehsil-wise) on 15th June - Wind Speeds



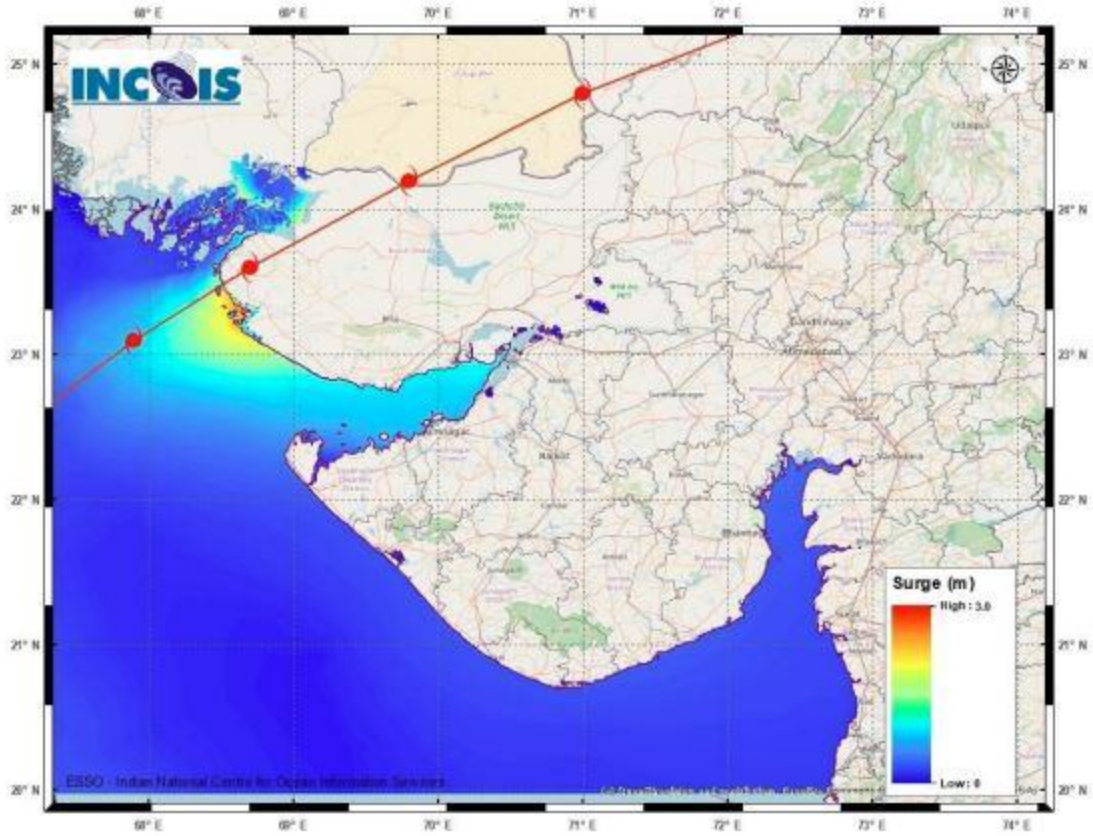
District-wise Heavy Rainfall Warning Maps for 16th June for Rajasthan



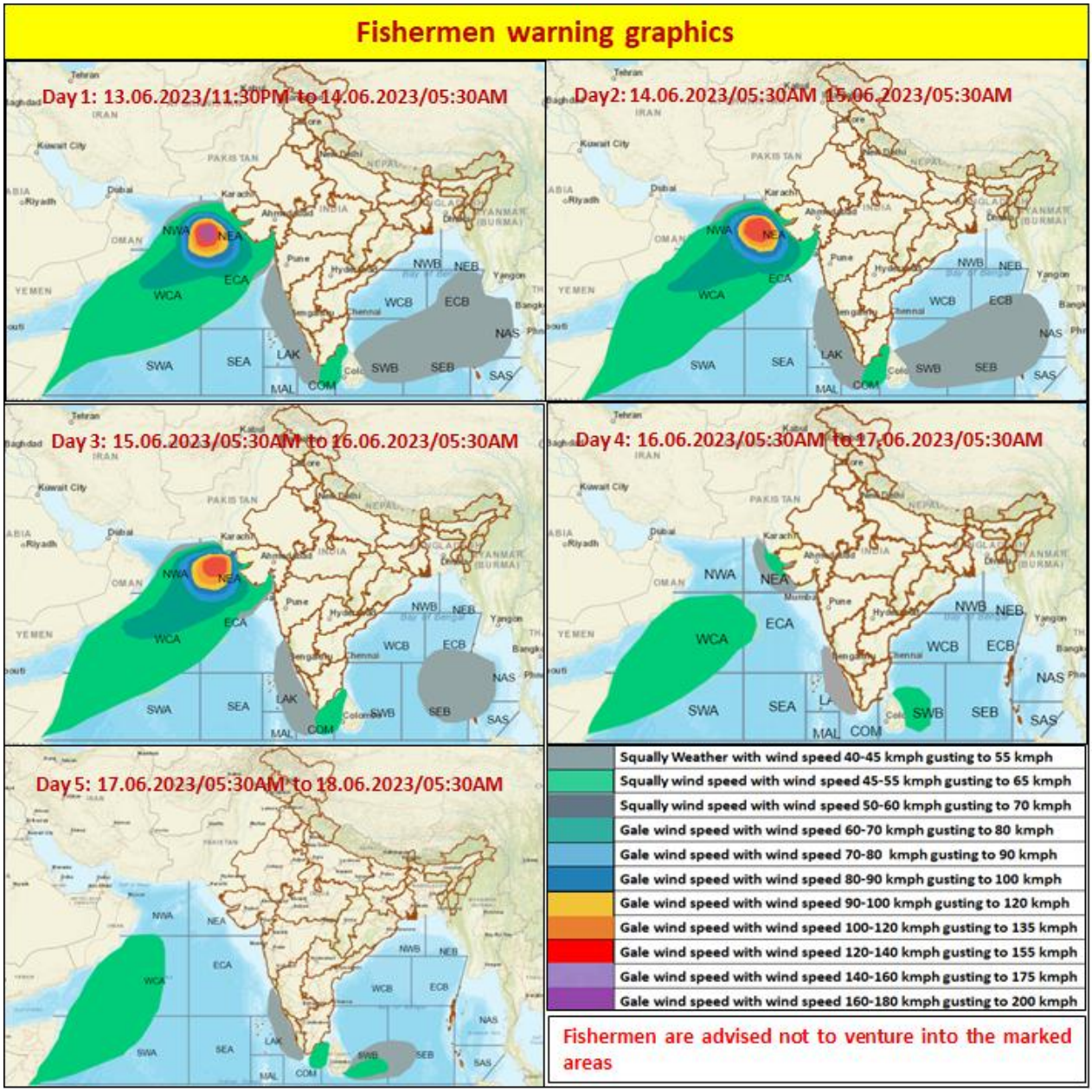
District-wise Wind Warning Maps on 16th and 17th June for Rajasthan



Storm Surge Warning Map based on Forecast Track



Astronomical Tide on 15th June 2023		
Station	Time (IST)	Height (m)
Porbandar	09:37	2.61
Navlakhi	13:38	7.54
OKHA	11:36	3.74
DEENDAYAL PORT (KANDLA)	13:02	6.79


Fishermen warning graphics
Day 1: 13.06.2023/11:30PM to 14.06.2023/05:30AM
Day2: 14.06.2023/05:30AM 15.06.2023/05:30AM
Day 3: 15.06.2023/05:30AM to 16.06.2023/05:30AM
Day 4: 16.06.2023/05:30AM to 17.06.2023/05:30AM
Day 5: 17.06.2023/05:30AM to 18.06.2023/05:30AM
Squally Weather with wind speed 40-45 kmph gusting to 55 kmph
Squally wind speed with wind speed 45-55 kmph gusting to 65 kmph
Squally wind speed with wind speed 50-60 kmph gusting to 70 kmph
Gale wind speed with wind speed 60-70 kmph gusting to 80 kmph
Gale wind speed with wind speed 70-80 kmph gusting to 90 kmph
Gale wind speed with wind speed 80-90 kmph gusting to 100 kmph
Gale wind speed with wind speed 90-100 kmph gusting to 120 kmph
Gale wind speed with wind speed 100-120 kmph gusting to 135 kmph
Gale wind speed with wind speed 120-140 kmph gusting to 155 kmph
Gale wind speed with wind speed 140-160 kmph gusting to 175 kmph
Gale wind speed with wind speed 160-180 kmph gusting to 200 kmph
Fishermen are advised not to venture into the marked areas

1. State / Central Govt. Officials / Vital installations / Registered User Cyclone Alert/ Cyclone Warning Bulletin No.

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:

(iv) Likely impacts and actions: Depending on intensity of the storm as per IMD Monograph on "Damage Potential of Tropical Cyclones"

Attachment to Annex II-C1

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 WITHSTATE GOVERNMENT OFFICIALS AND DISASTER MANAGEMENT AGENCIES.

Attachment to ANNEX II-C3

India Port warnings largely used

Day Signals*		Specifications	Night Signals*	Remarks
16a	I.	Distant Cautionary Signal Number One 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.	Distant Warning Signal Number Two A storm has formed (cyclonic storm with surface winds 63-87 km/h. (34-47 knots))	2b	
3a*	III.	Local Cautionary Signal Number Three 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.	Local Warning Signal Number Four 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.	Danger Signal Number Five 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.	Danger signal number Six 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.	Danger signal number Seven 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.	Great Danger Signal number Eight 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

Attachment to ANNEX II-C2-2

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	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 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.

Day Signals*	Specifications	Night Signals*	Remarks
Myanmar (21.II.1977)			
		General System	
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

Attachment to ANNEX II-F-2

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

Pakistan- (10.VI.1984) **Port warnings largely used**

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
Attachment to ANNEX II-G-2

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 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 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 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
Signals indicating the intensity of storms			
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
Signals indicating the locality of storms			
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

C H A P T E R 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

Name of Station		Surface						Radiowind/Radiosonde												
1	2	3													4					
		00	03	06	09	12	15	18	21	00	06	12	18	00	12					
41240	KHASAB			X	X	X	X	X	X	X	X	X	X							
242	DIBA*			X	X	X	X	X	X	X	X	X	X	X	X					
244	BURAIMI		X	X	X	X	X	X	X	X	X	X	X							
246	SOHAR MAJIS		X	X	X	X	X	X	X	X	X									
253	RUSTAQ		X	X	X	X	X	X	X	X	X	X	X							
254	SAIQ			.	X	X	X	X												
255	NIZWA*				X	X	X													
256	MUSCAT INT. AIRPORT		X	X	X	X	X													
257	SAMAIL			X	X	X	X	X	X	X	X	X	X							
258	MINA SULTAN QABOOS		X	X	X	X	X													
262	FAHUD			X	X	X	X	X	X	X	X	X	X	X	X					
263	BAHLA			X	X	X	X	X	X	X	X	X	X	X	X					
264	ADAM			X	X	X	X	X	X	X	X	X	X	X	X					
265	IBRA			X	X	X	X	X	X	X	X	X	X	X	X					
267	QALHAT			X	X	X	X	X	X	X	X	X	X	X						
268	SUR			X	X	X	X	X	X	X	X	X	X	X	X					
275	QARN ALAM		X	X	X	X	X	X	X	X	X	X	X							
288	MASIRAH			X	X	X	X	X	X	X	X	X	X	X						
304	MARMUL			X	X	X	X	X	X	X	X	X	X	X						
312	MINA SALALAH		X	X	X	X	X	X	X	X	X									
314	THUMRAIT		X	X	X	X	X	X	X	X	X	X								
315	QAIROON HAIRITI		X	X	X	X	X	X	X											
316	SALALAH			X	X	X	X	X	X	X	X	X	X	X						
515	DROSH			X	X	X	X	X	X	X	X	X	X	X						
530	PESHAWAR		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
560	PARACHINAR		X	X	X	X	X	X	X	X	X	X								

571	ISLAMABAD AIRPORT			X	X	X	X	X	X	X	X								
594	SARGODHA					X	X	X	X	X	X	X	X	X	X	X	X	X	
598	JHELUM						X	X	X	X	X	X	X	X	X	X	X		
620	ZHOB							X	X	X	X	X	X	X	X				
624	DERA ISMAIL KHAN			X	X	X	X	X	X	X	X	X	X	X	X				
641	LAHORE CITY				X	X	X	X	X	X	X	X	X	X	X	X			
660	QUETTA AIRPORT			X	X	X	X	X	X	X	X								
675	MULTAN						X	X	X	X	X	X	X	X	X	X	X	X	X
685	BAR KHAN						X	X	X	X	X	X	X	X	X	X	X		
710	NOKKUNDI					X	X	X	X	X	X	X	X						
712	DAL BANDIN					X	X	X	X	X	X	X	X	X	X	X	X		
715	JACOBABAD					X	X	X	X	X	X	X	X	X	X	X	X		
718	KHANPUR						X	X	X	X	X	X	X	X					
739	PANJGUR						X	X	X	X	X	X	X	X					X
744	KHUZDAR						X	X	X	X	X	X	X	X	X	X	X		
749	NAWABSHAH					X	X	X	X	X	X	X	X	X	X	X			
756	JIWANI							X	X	X	X	X	X	X	X	X	X	X	
757	GWADAR						X	X	X	X	X	X	X	X					
759	PASNI							X	X	X	X	X	X	X	X	X	X	X (Pilot winds)	
764	HYDERABAD					X	X	X	X	X	X	X	X	X	X	X	X		
768	CHHOR						X	X	X	X	X	X	X	X	X	X	X	X	
780	KARACHI AIRPORT			X	X	X	X	X	X	X	X	X	X	X	X		X		

TABLE III-1: LIST OF IMPLEMENTED REGIONAL BASIC SYNOPTIC NETWORK STATIONS

	Name of station	Surface								Radiowind				Radiosonde	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
41859	RANGPUR	x	x	x	X	x	x	x	x	x	x	x	x		
41883	BOGRA	x	x	x	X	x	x	x	x	x	x	x	x	x	.
41886	MYMENSINGH	x	x	x	X	x	x	x	x						
41891	SYLHET	x	x	x	x	x	x	x	x	x	x	x	x	x	.
41907	ISHURDI	x	x	x	x	x	x	x	x	x	x	x	x		
41923	DHAKA	x	x	x	x	x	x	x	x	x	x	x	x	x	x
41936	JESSORE	x	x	x	x	x	x	x	x	x	x	x	x		
41943	FENI	x	x	x	x	x	x	x	x	x	x	x	x		
41950	BARISHAL	x	x	x	x	x	x	x	x	x	x	x	x		
41953	MAIJDI COURT	x	x	x	x	x	x	x	x						
41963	HATIYA	x	x	x	x	x	x	x	x						
41964	SANDWIP	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						
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		

Name of station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
42027	SRINAGAR	X	X	X	X	X	X	X	X	X	X		X	X	X
42071	AMRITSAR	X	X	X	X	X	X	X	X	X	X				
42101	PATIALA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42111	DEHRADUN	X	X	X	X	X	X	X	X						
42131	HISSAR	X	X	X	X	X	X	X	X						
42165	BIKANER	X	X	X	X	X	X	X	X						
42182	NEW DELHI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42189	BAREILLY	X	X	X	X	X	X	X	X						
42260	AGRA	X	X	X	X	X	X	X	X						
42309	NORTH LAKHIMPUR		X	X	X	X	X								
42314	DIBRUGARH/MOHANBARI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42328	JAISALMER	X	X	X	X	X	X	X	X						
42339	JODHPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42348	JAIPUR/SANGANER	X	X	X	X	X	X	X	X	X		X			
42361	GWALIOR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42369	LUCKNOW/AMAUSI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42379	GORAKHPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42397	SILIGURI	X	X	X	X	X	X	X	X						
42410	GUWAHATI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42415	TEZPUR	X	X	X	X	X	X	X	X						
42452	KOTA AERODROME	X	X	X	X	X	X	X	X						
42475	ALLAHABAD/ BAMHRAULI	X	X	X	X	X	X	X	X						
42492	PATNA	X	X	X	X	X	X	X	X					X	X
42559	GUNA	X	X	X	X	X	X	X	X						
42571	SATNA	X	X	X	X	X	X	X	X						
42587	DALTONGANJ		X	X	X	X									
42591	GAYA	X	X	X	X	X	X	X	X	X		X	X		
42623	IMPHAL TULIHAL	X	X	X	X	X	X	X	X	X	X	X	X		
42634	BHUJ-RUDRAMATA	X	X	X	X	X	X	X	X						
42779	PENDRA	X	X	X	X	X	X	X	X						
42798	JAMSHEDPUR	X	X	X	X	X	X	X	X	X		X			
42809	KOLKATA / DUMDUM	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
42875	RAIPUR	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					
42895	BALASORE	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
42977	SANDHEADS		X			X									

Name of Station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
43003	MUMBAI (SANTACRUZ)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43014	AURANGABAD CHIKALTHANA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
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/ WALTAIR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
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						
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						
43213	KURNOOL	X	X	X	X	X	X	X	X						
43226	HONAVAR	X	X	X	X	X	X	X	X						
43233	CHITRADURGA	X	X	X	X	X	X	X	X						
43237	ANANTAPUR	X	X	X	X	X	X	X	X						
43245	NELLORE	X	X	X	X	X	X	X	X						
43279	CHENNAI/MEENAMBAKKAM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43284	MANGALORE/BAJPE	X	X	X	X	X	X	X	X						
43285	MANGALORE/PANAMBUR	X	X	X	X		X	X							
43295	BANGALORE	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42830	PORBANDAR	X	X	X	X	X	X	X	X						
43049	GOPALPUR	X	X	X	X	X	X	X	X	X		X	X		
43221	ONGOLE	X	X	X	X	X	X	X	X						
43348	ADIRAMPATTINAM	X			X										

Name of Station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
43311	AMINI DIVI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43314	KOZHIKODE	X	X	X	X	X	X	X	X						
43321	COIMBATORE/PEELAMEDU	X	X	X	X	X	X	X	X						
43329	CUDDALORE	X	X	X	X	X	X	X	X						
43333	PORT BLAIR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43344	TIRUCHIRAPALLI	X	X	X	X	X	X	X	X						
43346	KARAIKAL	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43353	KOCHI WILLINGTON	X	X	X	X	X	X	X	X					X	X
43369	MINICOY	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43371	THIRUVANANTHAPURAM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43418	TRINCOMALEE	X	X	X	X	X	X	X	X	X	X	X			
43421	ANURADHAPURA	X	X	X	X	X	X	X	X						
43424	PUTTALAM	X	X	X	X	X	X	X	X						
43436	BATTICALOA	X	X	X	X	X	X	X	X						
43450	KATUNAYAKE	X	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	HANIMADHOO	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	KADEHDHOO	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	X	X	X	X	X									
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	X	X	X	X	X									
48037	MONYWA	X	X	X	X	X									
48039	SAGAING	X	X	X	X	X									
48040	HSIPAW	X	X	X	X	X									
48042	MANDALAY	X	X	X	X	X		X							
48043	PYINOOLWIN	X	X	X	X	X									
48045	MINDAT	X	X	X	X	X									
48047	MYINGYAN	X	X	-	-	X									
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									

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 DhabBateen 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		
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	
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	
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		
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
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		
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		
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		
41951	BHOLA	x	x	x	x	x	x	x	x						
41953	MAIJDI 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	RAMGATI	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		
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						
AD04 (ARB)	X	X		X	X	X	X	X						
AD05 (ARB)	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						
BD07 (BOB)	X	X	X	X	X	X	X	X						
BD08 (BOB)	X	X	X	X	X	X	X	X						
BD10 (BOB)	X	X		X	X	X	X	X						
BD11 (BOB)	X	X	X	X	X	X	X	X						
BD12 (BOB)	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

Country		Station	N	E	Type	Op. Since
Bangladesh	41992	Cox's Bazar	21º20'	92º17'	Doppler	1970
	41984	Khepupara	21º59'	90º14'	Doppler	1982
	41923	Dhaka	23º46'	90º23'	10 cm	1970
	41859	Rangpur	25º44'	89º14'	10 cm	1999
		Moulvibazar	24º29'8"	91º46'30"	Doppler	2009
India	42807	Kolkata	22º33'	88º20'	10 cm	1973
					DWR	2002
	42976	Paradip	20º15'	86º39'	10 cm	1973
					DWR	
	43049	Gopalpur	19º15'	84º53'	10 cm	2017
					DWR	
	43149	Visakhapatnam	17º44'	83º20'	10 cm	1970
					DWR	2006
	43185	Machilipatnam	16º10'	81º08'	10 cm	1981
					DWR	2004
	----	Sriharikota	13º39'	80º13'	10 cm	2004
					DWR	
	43278	Chennai	13º04'	80º16'	10 cm	1973
			DWR		2002	
	43346	Karaikal	10º54'	79º50'	10 cm	1989
					DWR	2016
	43353	Kochi	09º55'	76º15'	10 cm	1987
					DWR	2016
	43371	Thiruvananthapuram	08º31'	76º51'	05 cm	2017
					DWR	
	43192	Goa	15º29'	73º49'	10 cm	2002
					DWR	2016
	43057	Mumbai	18º54'	72º48'	10 cm	1989
					DWR	2016
	42634	Bhuj	23º14'	69º38'	10 cm	1987
					DWR	2016
Maldives	43555	Male	04º09'	73º11'	10 cm(DWR)	2008
Myanmar	48071	Kyaukpyu	19º17'	93º31'	Doppler	2015
	48097	Yangon	16º52'	96º09'	Doppler	2016
	48042	Mandalay	21º47'	96º02'	Doppler	2018
Pakistan	41780	Karachi	24º54'	67º08'	5.6 cm	1991
Thailand	48455	Bangkok	13º 55'	100º36'	10 cm (DWR)	1992
	48475	Hau Hin	12º35'	99º57'	10 cm (DWR)	1995
	48517	Chumphon	10º29'	99º11'	5.6 cm (DWR)	2008
	48551	Surat Thani	09º08'	99º9'	10 cm (DWR)	1993
	48565	Phuket	08º08'	98º19'	5.6 cm (DWR)	2006
	48569	HAT Yai	06º56'	100º23'	5.6 cm (DWR)	2004
	48563	Krabi	08º06'	98º58'	5.6 cm (DWR)	2006
48568	Songkhla	07º26'	100º27'	5.6 cm (DWR)		2011
48583	Narathiwat		06º25'	101º45'	5.6 cm (DWR) (Dual.Pol.)	2014

ANNEX III-A-1

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 Pdsdsfsfs
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 SPIRAL : Either the word "EYE" or the word "SPIRAL" will be reported, 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 pdsdsfsfs 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.

ANNEX III-A-2

TABLE 1

Confidence of Fix (C)

Code Figure	Category	Radar echo pattern	Likely accuracy about
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

Shape of eye and length of arc of eyewall seen (S)

Code Figure	Length of arc	Shape
0	-------	Ill-defined
1	Less than 180^0	{ Shape other than
2	More than 180^0	{ circular or elliptical
3	Closed	{
4	Less than 180^0	{
5	More than 180^0	{ Elliptical
6	Closed	{
7	Less than 180^0	{
8	More than 180^0	{ Circular
9	Closed	{

TABLE 3

D- Diameter or length of major axis of the eye of the tropical cyclone

Code Figure		Code Figure	
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

Code Figure	
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.

ANNEX III-A-3

TABLE 5

P- Period over which the movement of the storm centre has been determined

Code Figure	Period
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 IIiiiYYGGg CHARACTER (b1b1b1/r1r1r1 ----------bnbnbn/rnrnrn) 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, IIiii, 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.

(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:

	For radars having facility for quantitative measurement		
Code	**dBZ**	**Approximate rainfall rate mm/hr**	**Other radars**
WK	23 to 32	less than 4	Qualitatively
MDT	33 to 42	4 to 15	determined as 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 avaible 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 Chennai in association with SCS Mandous, 2022 in India during the cyclone period is given below:

DWR CHENNAI CYCLONE BULLETIN

CYCLONE BULLETIN NO: 6 CYCLONE: MANDOUS TIME: 1945 IST

1.	Name of the station	DWR CHENNAI
2.	Date and Time of Observation (UTC)	2022-12-09 / 1400UTC
3.	Name of the Cyclone	MANDOUS
4.	Information about the eye of the Cyclone	Open
	a. Is the Eye Visible	partial
	b. Shape of the Eye	---
	c. Diameter of the Eye(km)	---
	d. Estimation of centre of the cyclone based on Eye/spiral band observation	11.9193N, 80.99033E
	e. Echo top (height 20 dBZ level) of rain bearing clouds around the cyclone within 100 Km radius (km)	5.7 km
	f. Maximum radar reflectivity (dBZ) & rainfall rate (mm/h) in the eye wall/spiral band region, its height (km) and position (azimuth and distance from the radar)	34.0 dBZ 1km, [127.7deg, 82.7km]
	g. Maximum reflectivity at any other area (spiral/ streamers etc)	30.0dBZ 4.3km [160.1deg, 31.4km]
	h. Maximum radial velocity in eye wall/spiral band region (mps), its height (km) and its position (azimuth and distance from the Radar)	27.3 m/s 1 km [70.3deg 61.6km]
	i. Maximum velocity in any other area (spiral / streamers / rain shields etc)	28.44 m/s 1km [191.2 deg, 170.5m]
5.	Tendency of the Cyclone	
	a. Intensity(Increasing/Decreasing)	Stable
	b. Duration for which the information on movement pertains to	1 hr
	c. Direction of Movement	N-Wrly
	d. Estimated speed of Movement	10kmph
6.	Any other Significant Feature	Not well organized, height of clouds lesser, Reflectivity values lesser
7.	Confidence	fair

ANNEX III-B-1

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 utiled 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.
    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.

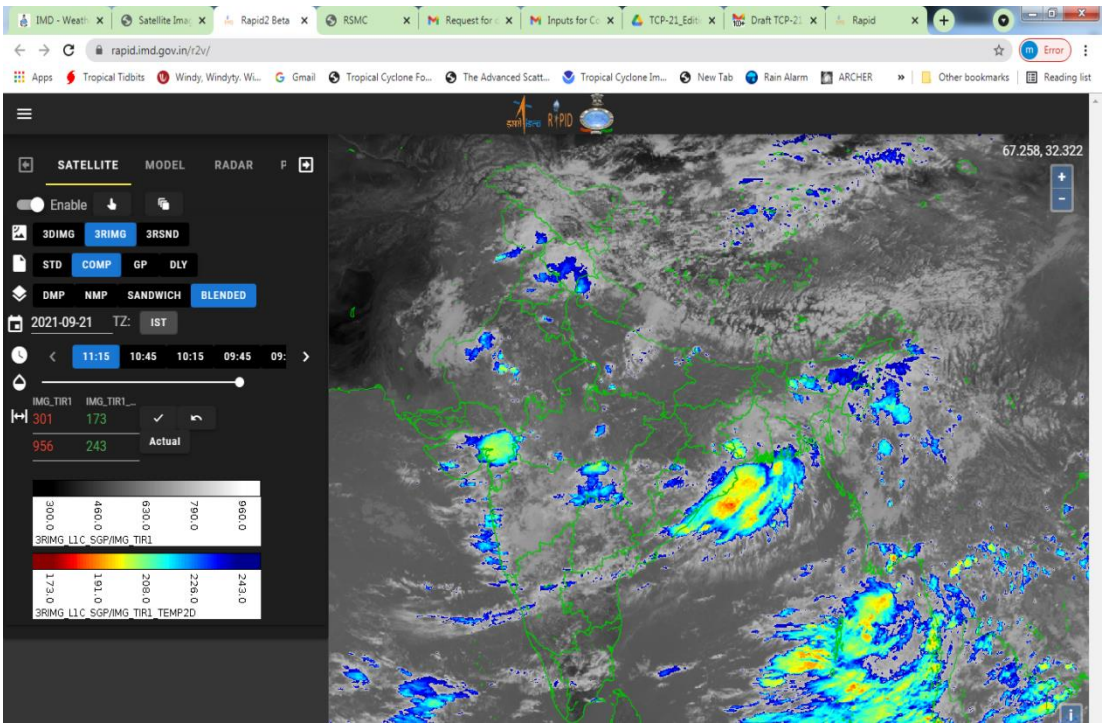


Fig.III-B-1: Image showing features available on RAPID Tool

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.

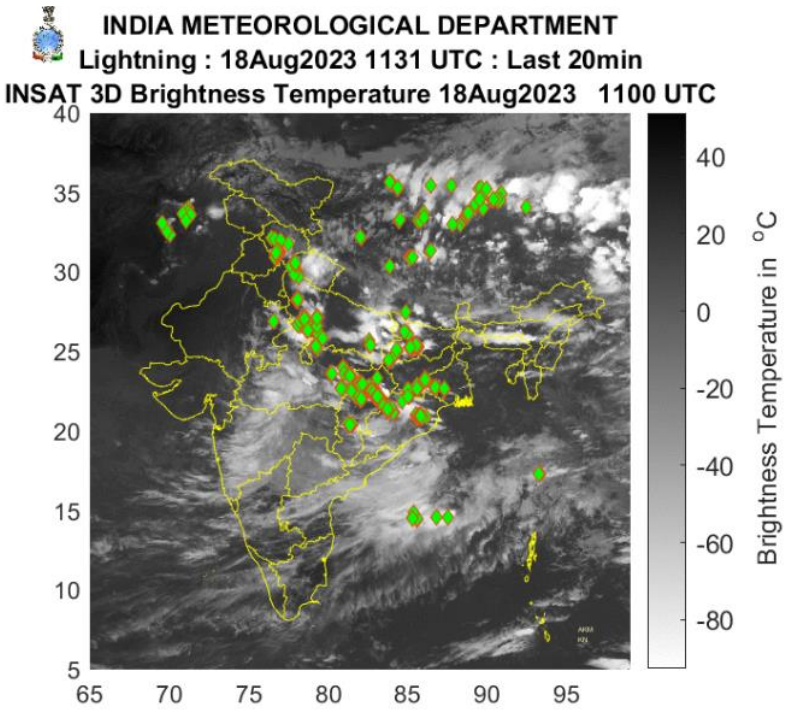


Fig.III-B-2: Lightning guidance at 1235 UTC of 22 September, 2022

1.1.4.2. Meteosat-9: Products from MeteoSat 9 are also available IMD website at the link: http://foreignsat.imd.gov.in/

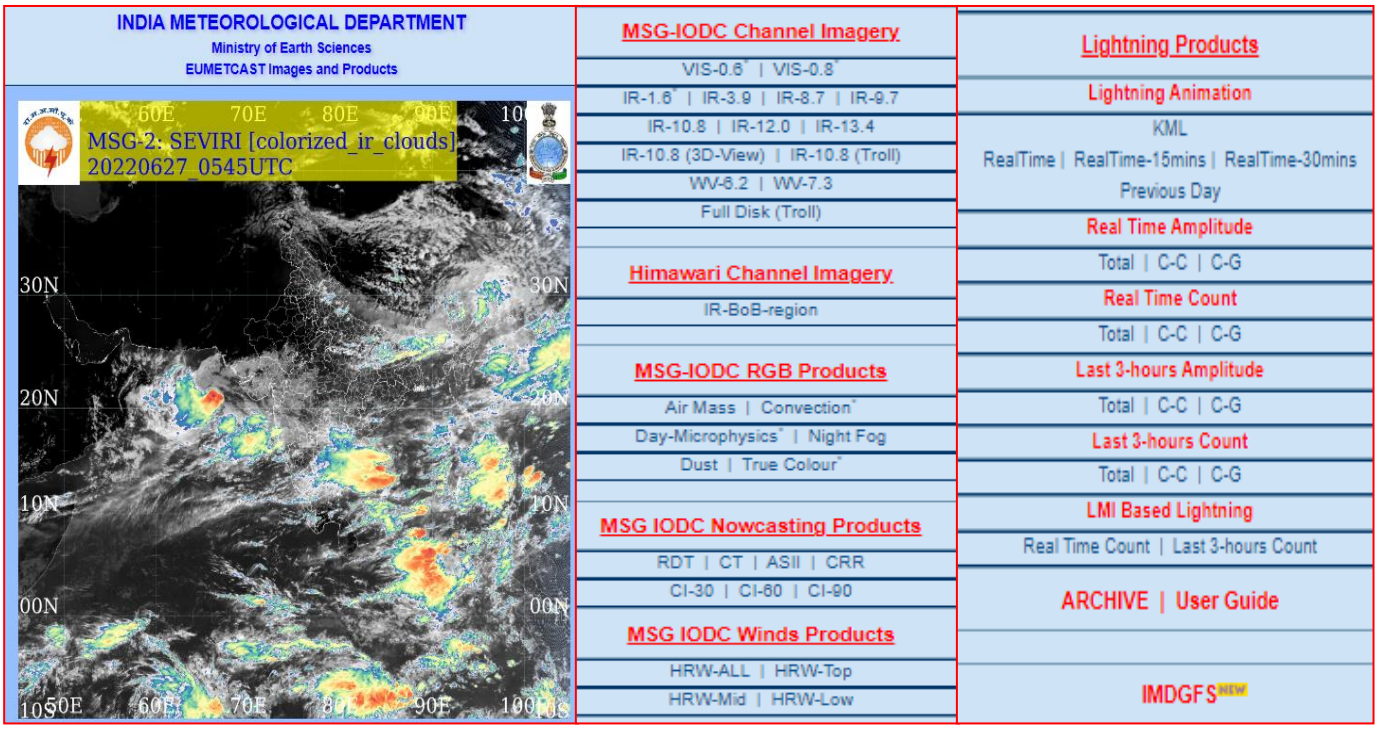


Fig.III-B-3 : Meteo Sat-9 products

ANNEX III-B-3

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-4

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

C H A P T E R 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 2021

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. 5ºS to 40ºN long 50ºE to 102ºE covering India and neighbouring 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) coverts 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^ox80^o, 24^ox24^o and 7^ox7^o 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 2022-2023 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.

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-1) 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. Theforecast 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). 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 Spread3

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) on real time basis by RSMC –Tropical Cyclones New Delhi for national/international purposes.

(A) WEATHER CHARTS

Model	Products
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^{o}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

C H A P T E R 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/ WMONo. 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/GMDSS/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.

5.5 India Meteorological Department is hosting its own website www.internal.imd.gov.in and 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.

5.6 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

	Country	GTS Abbreviated Headings	Priority
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

	Country	Abbreviated heading
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

Country	Abbreviated heading	
	Tropical weather outlook	Tropical storm advisory
		BMAA01 VGDC
Bangladesh	WWBW20 VGDC,	BMAA01 VBRR
India	WTIN20 DEMS	BMAA01 OPKC
Pakistan	WWPK20 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	Abbrevaited heading	Area
1.	India	FKIN21 VIDP FKIN20 VIDP	Bay of Bengal Arabian Sea

II. SIGMETs for tropical cyclones

	Country	Abbrevaited heading	Originating center
1.	Bangladesh	WCBWxx VGHS	Dhaka
2.	India	WCINxx VECC WCINxx VOMM WCINxx VABB	Kolkata Chennai Mumbai
3.	Maldives	WCMV31 VRMM	Malé
4.	Myanmar	WCBMxx VYYY	Yangon
5.	Oman (Sultanate of Oman)	WCOMxx OOMS	Muscat
6.	Pakistan	WCPKxx OPKC	Karachi
7.	Sri Lanka	WCSB31 VCCC	Colombo
8.	Thailand	WCTH31 VTBB	Bangkok
9.	Yemen	WCYE31OYSN	SANAA

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.*

V-7

ANNEX V-A-1

LIST OF IMPORTANT ADDRESSES AND TELEPHONE NUMBERS CONNECTED WITH TROPICAL CYCLONE WARNINGS IN THE PANEL COUNTRIES

Country Name	Name of contact person	Contact details
Bangladesh	Md. Azizur Rahman Director, BMD Bangladesh Meteorological Department Meteorological, E-24 Agargaon, Dhaka-1207 Dhaka-1207	Phone: Off:(880) 2-9135742, (880) 2-9123838 Cell: (880) 2-9827598 Res: (880) 2-58152019 E-mail:info@bmd.gov.bd, sifat_ar@yahoo.com FAX: 88 02 8152019, 48113333 Home page: http://www.bmd.gov.bd
	Kawsar Parvin Deputy Director Storm Warning Centre Dhaka	Phone: Off: (880) 2-9114388 Res: (880) 2-9126806 Cell: 01743783969 Fax: (880) 2-58152019 swc@bmd.gov.bd
	Duty Forecasting Officer Storm Warning Centre Dhaka	Phone: (880) 2-9141437 (880) 2-9135742 (880) 2-9111015 (880) 2-9112439 Fax: (880) 2-58152019 swc@bmd.gov.bd
India	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: mohapatraimd@gmail.com Home page: http://www.imd.gov.in
Iran	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: affairs.int@gmail.com FAX: +9821 660 700005
	Mohammed Nather Al-Din (Contact person for Bulletins through Whatsapp)	Cell : +699543444694
	Mohammed Ahmad Al-Kably (Contact person for Bulletins through Whatsapp)	Cell :+966549999069
Maldives	Mr. Ali Sareef Deputy Director General, Maldives Meteorological Service, Hulhule' 22000, Maldives.	Phone: Off: (960) 332 3084 332 3302 Mobile: (960) 7771828 Email: shareef@meteorology.gov.mv
	Duty Forecaster,	Phone: Off: (960) 332 3084 Mobile: (960) 796 7171

	National Meteorological Centre	Email: metmdv@gmail.com
Myanmar	Dr. Kyaw Moe Oo Director-General Department of Meteorology and Hydrology, Building No. 5 Nay Pyi Taw	Phone: Off: (95) 67 3411031 (95) 67 3411525 (95) 67 3411422 (95) 67 3411446 (95) 67 3411527 Res: (95) 67 3403404 Fax: (95) 67 3411449 (95) 67 3411254 (95) 67 3411250 (95) 67 3411526 Mobile: (95) 9 250954638 Email: dg.dmh1@gmail.com dg.dmh@mptmail.net.mm Web page: www.moezala.gov.mm www.dmh.gov.mm
Oman	Dr. Mr. Abdullah Rashid Nasser Alkhadouri, Director General of Meteorology Public Authority for Civil Aviation P.O. Box 1, P.C. 111 Muscat	Phone : 00968 24354555 Cell : 00968 99433726 Fax : 00968 24354504 Email : a.alkhadouri@met.gov.om
	Mr. Badar Alrumhi Director of Forecasting & Early Warninig Centre	Phone: 00968 24354610 (office) +968 24354660 (24hrs) Cell : 00968 99327811 Fax : 00968 24348501,502 (24 hours) Email: b.alrumhi@met.gov.om
	Mr. Khalid Alwahaib Chief of General Forecasting & EWS	Phone: 00968 24354655 (office) +968 24354660 (24hrs) Fax : 00968 24348501,502 (24 hours) Email: k.alwahaibi@met.gov.om
Pakistan	Mr. Sahibzad Khan Director General Pakistan Meteorological Department Headquarters Office, Sector H-8/2, Islamabad – 44000, Pakistan	Tel: + (92) 51-9250367, Cell: + (92) 333-7271894 Email: pakmet_islamabad@yahoo.com Website: http://www.pmd.gov.pk
	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: aq_1961@yahoo.com Website: http://www.pmd.gov.pk

	Dr. Muhammed Hanif Director Marine Meteorology –Tropical Cyclone Warning Centre (TCWC), Meteorological Complex, University Road, Karachi – 75270, Pakistan	Tel/Fax: + (92) 21-99261434, Cell: + (92) 334-5635796 Email: hanifwxc@hotmail.com
	Duty Forecasting Officer / Meteorologist, Main Analysis Centre Meteorological Complex, University Road, Karachi – 75270, Pakistan	Tel: + (92) 21-99261417 + (92) 21 99238958 (24 Hours) Fax. +(92) 21-99261405 Website: http://www.pmd.gov.pk
Qatar	Mr Abdullah AlMannai Director of Qatar Meteorology Department and Permanent Representative of Qatar with WMO	Email: Abdulla.Almannai@caa.gov.qa
	Mr Mohammad Al-Kubaisi Head of Forecasting and Analysis Section	Email: Mohammad.Alkubaisi@caa.gov.qa
	Mr Khalid Al-Jahwari Meteorology Expert Qatar Meteorology Department	Email: Khalid.Aljahwari@caa.gov.qa Website: www.qweather.gov.qa
Saudi Arabia	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: dms@pme.gov.sa
	Mohammed Nather Al-Din(Contact person for Bulletins through Whatsapp)	Cell : +699543444694
	Mohammed Ahmad Al-Kably(Contact person for Bulletins through Whatsapp)	Cell : +966549999069

Sri Lanka	Mr. Athula Kumara Karunanayake Director-General of Meteorology Department of Meteorology Bauddhaloka Mawatha	Phone: Off: (94) 11-2694104 Cell: 94773050535 Fax (94) 11-2698311 E-mail: athu1970@yahoo.com Homepage:http://www.meteo.gov.lk E-mail: meteo@sltnet.lk
	Director, Weather Forecasting and Decision Support Dr. Shiromani Jayawardena, Director National Meteorological Center, Colombo	Phone off: (94) 11-2691443 Cell : 94714398874 Fax (94) 11-2691443 E-mail: shirojaya2000@yahoo.com
	Mr. M. M. P. Mendis Deputy Director, NMC, Colombo	Phone/Fax (94) 11-2682661 E-mail: merilmdi@yahoo.com
	Duty Meteorologist, NMC, Colombo	Phone (94) 11-2686686 E-mail: metnmc@gmail.com
	Duty Meteorologist, Met office International Airport, Katunayake	Phone (94) 11-2252721 E-mail: meteo.kia@gmail.com Fax: (94) 11-2252319
	Duty Meteorologist, Met office International Airport, Mattala	Phone (94) 47-2031488 (47) Fax: (94) 47-2031489 (47) E-mail: met.mattala@gmail.com
Thailand	Dr. Chomparee Chompurat Director-General Thai Meteorological Department 4353 Sukumvit Road Bang-Na, Bangkok 10260	Phone : (66) 2-399 1425 Fax : (66) 2-399 1426 Cell : (66) 844888388 E-mail : tmd_inter@tmd.mail.go.th Home page: http://www.tmd.go.th
	Ms. Chalalai Jamphon Director, Weather Forecast Division Thai Meteorological Department 4353-Sukumvit Road Bang-Na Bangkok-10260 THAILAND	Phone : (66) 2-398 9801 Fax : (66) 2-399 4001(24hours) E-mail : chalaij@yahoo.com tmd_inter@tmd.mail.go.th Homepage : http://www.tmd.go.th Whatsapp No. :+66 818448807
	Mr. Chaichan Sitthiworanun Director, Central Weather Forecast Sub-Division, Weather Forecast Division Thai Meteorological Department 4353-Sukumvit Road Bang-Na	Phone : (66) 2-398 9830 Fax : (66) 2-399 9836 (66) 2-399 9816(24hours) E-mail : tttoon11@gmail.com Homepage : http://www.tmd.go.th Whatsapp No. :+66 619783691

	Bangkok-10260 THAILAND	
United Arab Emirates	Mr. Abdulla Ahmed Al Mandous , Executive Director, National Centre for Meteorology and Seismology, Abu Dhabi, Post Box No. 4815, United Arab Emirates	Phone: +971 2222 7777, Fax. : +971 2666 1575 Website : www.qweather.gov.qa
Yemen	Mr. Mohammed S. Hamid Alzuraiqi PR of Yemen with WMO Assistant Deputy Chairman for Meteorology, Civil Avaition & Meteorology Authority, Yemen Meteorological Service (CAMA/YMS) Republic of Yemen	Phone: + 967 1 419771 Cell:+ 967-777228636 Fax: + 967 1 419770 Email: yms@yms.gov.ye Home page:http://www.yms.gov.ye
	Mr. Rashed Al Areqi Director, Public Weather Service Yemen Meteorological Service Republic of Yemen	Phone: + 967736021713 FAX: + 967 1 419770 Email: rash_areqi@yahoo.com

ANNEX V-A-6

Focal Points of the Forecast Center (in accordance to Para. 9.5 of PTC -36th final report)

Country	Name of Contact person	Contact Details
Bangladesh	Kawsar Parvin Deputy Director Storm Warning Centre Dhaka	Phone Off: (880) 2-9114388 Res: (880) 2-9126806 Fax: (880) 2-58152019 E-mail: kawsarpervin@yahoo.com, swc@bmd.gov.bd
India	Dr. D.R Pattanaik Scientist-F and Head RSMC, New Delhi	Phone: Off (91)11-24344482, Mob: (91) -9868554029 E-mail: cwdhq2008@gmail.com drpattanaik@gmail.com
	Duty Officer	Phone:(91)-11-24631913 (24 hrs)
	Dr. Ananda Kumar Das Scientist-F and Head Cyclone Warning Division	Phone: Off: (91)11-24652484, (91)11-24631913 Mob: (91) 9868126275 E-mail : cwdhq2008@gmail.com akuda.imd@gmail.com
	Duty Officer	Phone: (91) 11-24631913 (24 hrs)
	Mrs. Monica Sharma Scientist-D	Phone: Off: (91)11-43824304 (91) 11-24631913 Mob : (91)-9990389494 E-mail: cyclonewarningdivision@gmail.com moniimd@gmail.com
	Duty Officer	Phone: (91) 11-24631913 (24 hrs)
Iran	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: affairs.int@gmail.com FAX: +9821 660 700005
	Mohammed Nather Al-Din (Contact person for Bulletins through Whatsapp)	Whatsapp Number : +699543444694
	Mohammed Ahmad Al-Kably (Contact person for Bulletins through Whatsapp)	Whatsapp Number:+966549999069
Maldives	Ali SHAREEF Deputy Director General, Maldives Meteorological Service,Hulhule' 22000,Maldives.	Phone: Off: (960) 332 6200 Fax: (960) 332 0021, 334 1797 Res: (960) 332 2829 Mobile: (960) 7771828 Email: shareef@meteorology.gov.mv
	Ahmed Rasheed Meteorologist Maldives Meteorological Service,Hulhule' 22000,Maldives.	Phone: Off: (960) 332 3084 Fax: (960) 332 0021 , 3315509 Mobile: (960) 7768565 Email: rasheed@meteorology.gov.mv
	Duty Forecaster Meteorological Watch Office National Meteorological Centre	Phone: Off: (960) 332 3084 Fax: (960) 331 5509, Mobile: (960) 796 7171 Email: metmdv@gmail.com
Myanmar	Dr. Tin Mar Htay	Phone: Off: (95) 67 3 411526

	Department of Meteorology and Hydrology Office No. (5) Ministry of Transport Nay Pyi Taw, Myanmar	Fax: (95) 67 3411527 Mobile: (95) 9 250954664 Email: tmarhtay@gmail.com
Sultanate of Oman	Mr. Khalid Alwahaibi Chief of General Forecasting & EWS Directorate General of Meteorology Public Authority for Civil Aviation P.O.BOX 1, P. C. 111 Muscat	Phone: 00968 24354655 (Office: +968 24354660 (24hrs) Fax: 00968 24348501,502 (24 hrs) Email : k.alwahaibi@met.gov.om
Pakistan	Mr. Abdul Qayoom Bhutto Director Marine Meteorology- Tropical Cyclone Warning Centre,Meteorological Complex, University Road **Karachi-75270, Pakistan**	Tel : +(92) 21 - 99261434 Fax: + (92)-21- 99261405 Cell: +(92) 333-7271894 Email: aq_1961@yahoo.com
	Mr. Muhammad Hanif Director, National Weather Forecasting Centre, Pakistan Meteorological Department, Head quarters Office, Sector H-8/2, **Islamabad- 44000, Pakistan**	Tel: +92-51-9250595 +92-51-9250363-4 (24 Hours) Fax: +92-51-9250368, Cell: +92-0334 5635796 Email: hanifwxc@hotmail.com PMD website: http://www.pmd.gov.pk
Qatar	Gulf Marine Center	Phone: (+974)44480405 (+974)40102239 Email: Met.Media@caa.gov.qa
Saudi Arabia	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: dms@pme.gov.sa
	Mohammed Nather Al-Din(Contact person for Bulletins through Whatsapp)	WhatsApp number : +699543444694
	Mohammed Ahmad Al-Kably(Contact person for Bulletins through Whatsapp)	WhatsApp number : +966549999069
Sri Lanka	Mr. A. K. Karunanayake Director General Department of Meteorology COLOMBO 7, SRI LANKA	Phone/Fax NO. (94)11-2694104 Email: athu1970@yahoo.com
	Mr. M. M. P. Mends Deputy Director National Meteorological Centre Department of Meteorology COLOMBO 7, SRI LANKA	Phone No.: (94)11-2682661 Fax No.: (94)11-2698311 Email: merilmdi@yahoo.com
	Duty Meteorologist National Meteorological Centre Department of Meteorology COLOMBO 7, SRI LANKA	Phone No. (94)11-2684746/ (94)11-2686686 Fax No.: (94)11-2691443 E-mail: metnmc@gmail.com
Thailand	Ms. Chalalai Jamphon Director,Weather Forecast Division	Phone:(66)2-3989801 Fax : (66) 2-399 4001 E-mail: chalalaij@yahoo.com

	Thai Meteorological Department 4353 Sukumvit Road Bang-Na Bangkok 10260 THAILAND	tmd_inter@tmd.mail.go.th Homepage: http://www.tmd.go.th Whatsapp No. :+66 818448807
	Mr. Chaichan Sitthiworanun Director, Central Weather Forecast Sub-Division, Weather Forecast Division Thai Meteorological Department 4353-Sukumvit Road Bang-Na Bangkok-10260 THAILAND	Phone : (66) 2-398 9830 Fax : (66) 2-399 9836 (66) 2-399 9816(24hours) E-mail : tttoon11@gmail.com Homepage : http://www.tmd.go.th Whatsapp No. :+66 619783691
United Arab Emirates	Majed Naser Alshkeili Head of Marine Forecast Section National Center of Meteorology (NCM) Ministry of Presidential Affairs (MOPA) P.O Box 4815 | Abu Dhabi | United Arab Emirates	Tel + 971 2 2227330 Fax + 971 2 6661575 Mob + 971 50 6620028 Email: malsheikili@ncms.ae Website | www.ncm.ae
Yemen	Mr. Mohammed S. Hamid Alzuraiqi PR of Yemen with WMO Assistant Deputy Chairman for Meteorology, Civil Avaition & Meteorology Authority, Yemen Meteorological Service (CAMA/YMS) Republic of Yemen	Phone: + 967 1 419771 Cell:+ 967-777228636 Fax: + 967 1 419770 Email: yms@yms.gov.ye Home page:http://www.yms.gov.ye
	Mr.Rashed Al Areqi Director, Public Weather Service Yemen Meteorological Service Republic of Yemen	Phone: + 967736021713 FAX: + 967 1 419770 Email: rash_areqi@yahoo.com
WMO Secretariat	**WMO Tropical Cyclone programme (TCP)** Mr Taoyong Peng, Chief Tropical Cyclone Programme Division WDS Department, WMO, Geneva	Tel.+(41 22) 730 8145 Fax : +(41 22) 730 8021 Cell 1 : 41798911594 Cell 2 : 41792929469 E-Mail: tpeng@wmo.int

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.

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 45^0 N to 30^0 S and 30^0 E to 120^0 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.
(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 (<30nm; <55km)
2 = fair (3060nm; 55-110km)
3 = poor (>60nm; >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.