

TYPES OF POTENTIAL DAMAGES ACCOMPANYING **TROPICAL** **CYCLONES**



CYCLONE

LOCAL TIDES

LOCAL COASTAL CONFIGURATION

STORM SURGE

WIND

RAIN

FLOODING OF COASTAL AREAS

EROSION OF BEACHES

LOSS OF SOIL FERTILITY FROM SALINE INTRUSIONS

DAMAGE TO STRUCTURES

LOSS OF POWER/COMMUNICATION

INJURIES & LOSS OF LIFE

DESTRUCTION OF CROPS, VEGETATION, LIVE-STOCK

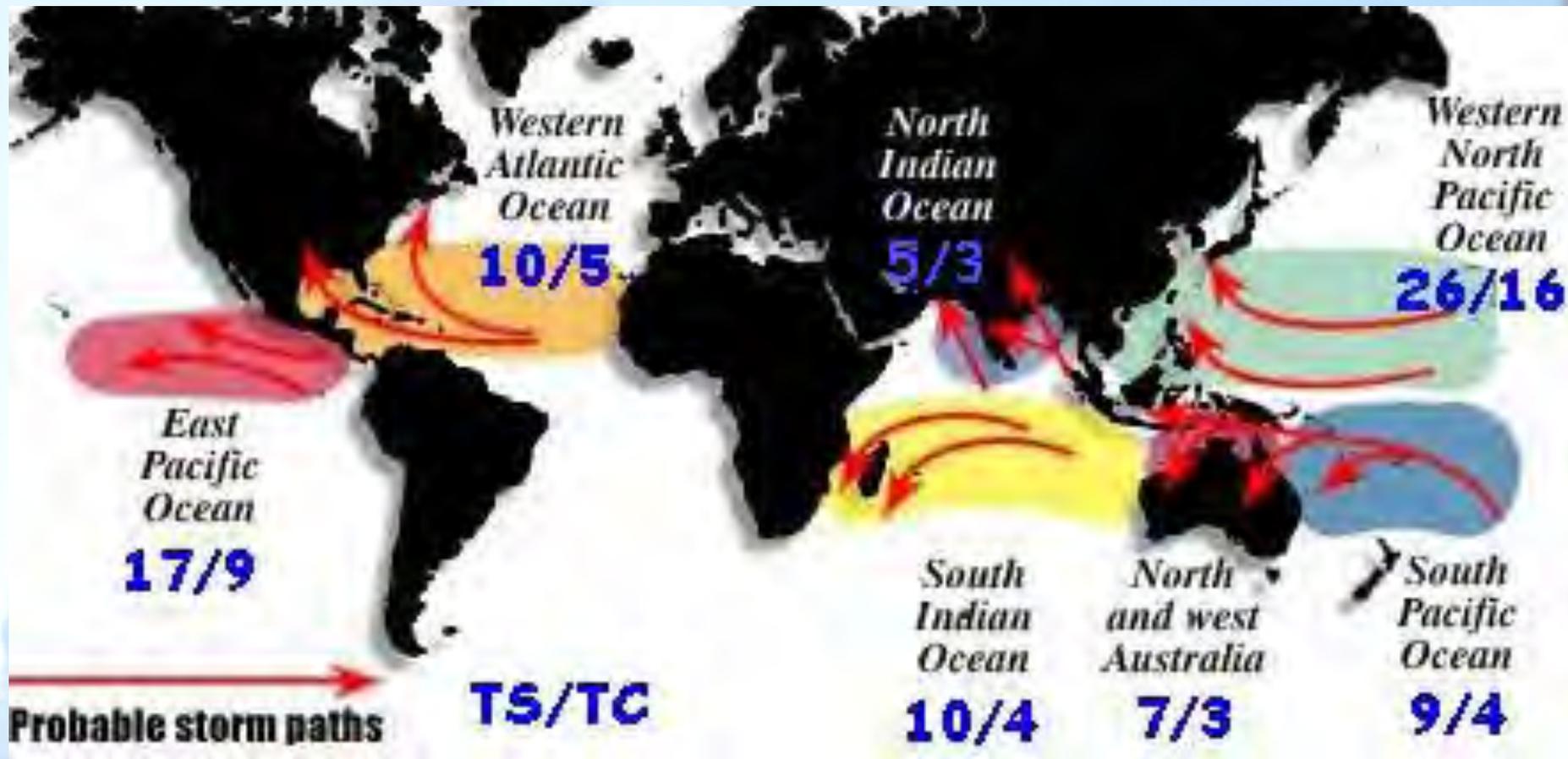
CONTAMINATION OF WATER SUPPLY SYSTEM

LAND SUBSIDENCE

FLOODING OF INLAND AREA



Climatology of tropical storms and cyclones



F. Roux, 2006

Average annual number (1970-2000) of tropical storms/cyclones over each ocean basin (average around the globe : 84 TS / 44 TC) and average track of the disturbances

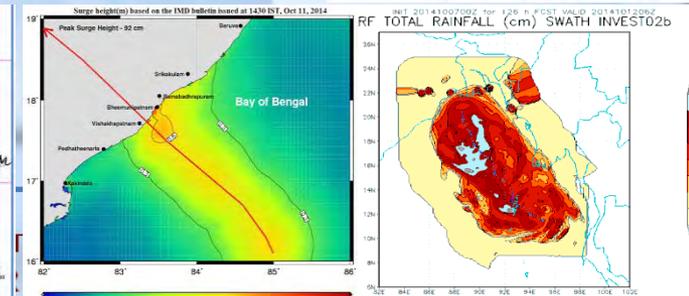
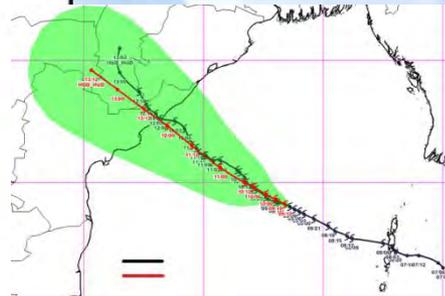
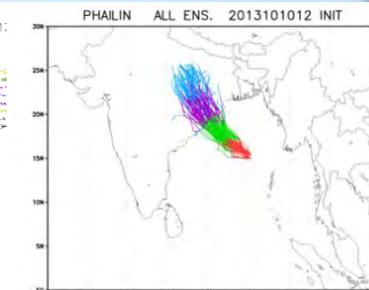
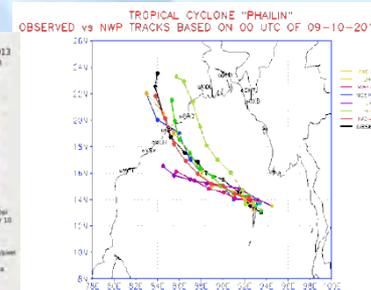
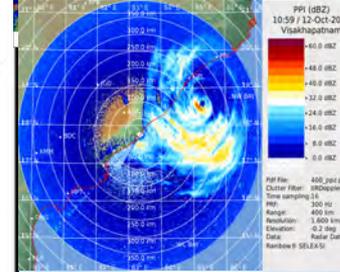
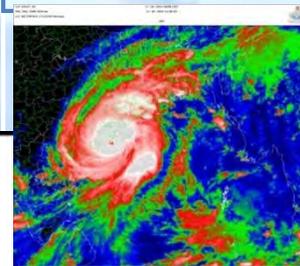
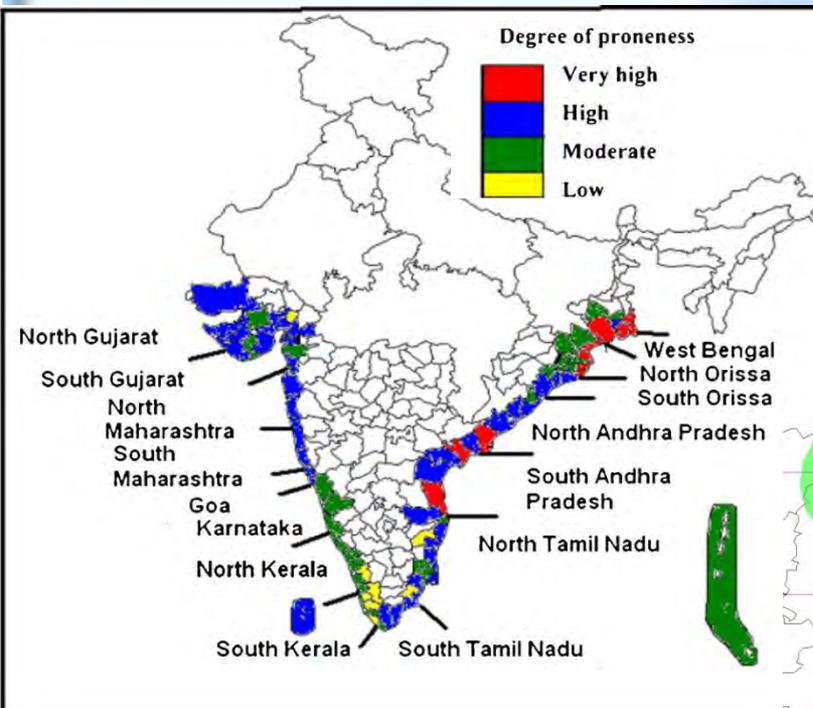
Cyclone Monitoring & Forecasting Process Accomplishments and Challenges

Cyclone Hazard Prone Districts

- ✓ Frequency of cyclone
- ✓ Frequency of severe cyclone
- ✓ Probable maximum Precipitation
- ✓ Wind strength
- ✓ Storm surge

About 4-5 cyclones develop over NIO, 2-3 become severe

- ❖ IMD is nodal agency for cyclone services
- ❖ Probabilistic Cyclogenesis Forecast upto 3days
- ❖ Track and intensity forecast upto 5 days in text and graphics
- ❖ Impact based heavy rainfall, wind and storm surge warning 5 days with advice for action



WMO/ESCAP Panel on Tropical Cyclones

Established in 1973

Members

Bangladesh

India (*RSMC,*)

Maldives

Myanmar

Oman

Pakistan

Sri Lanka

Thailand

Yemen,

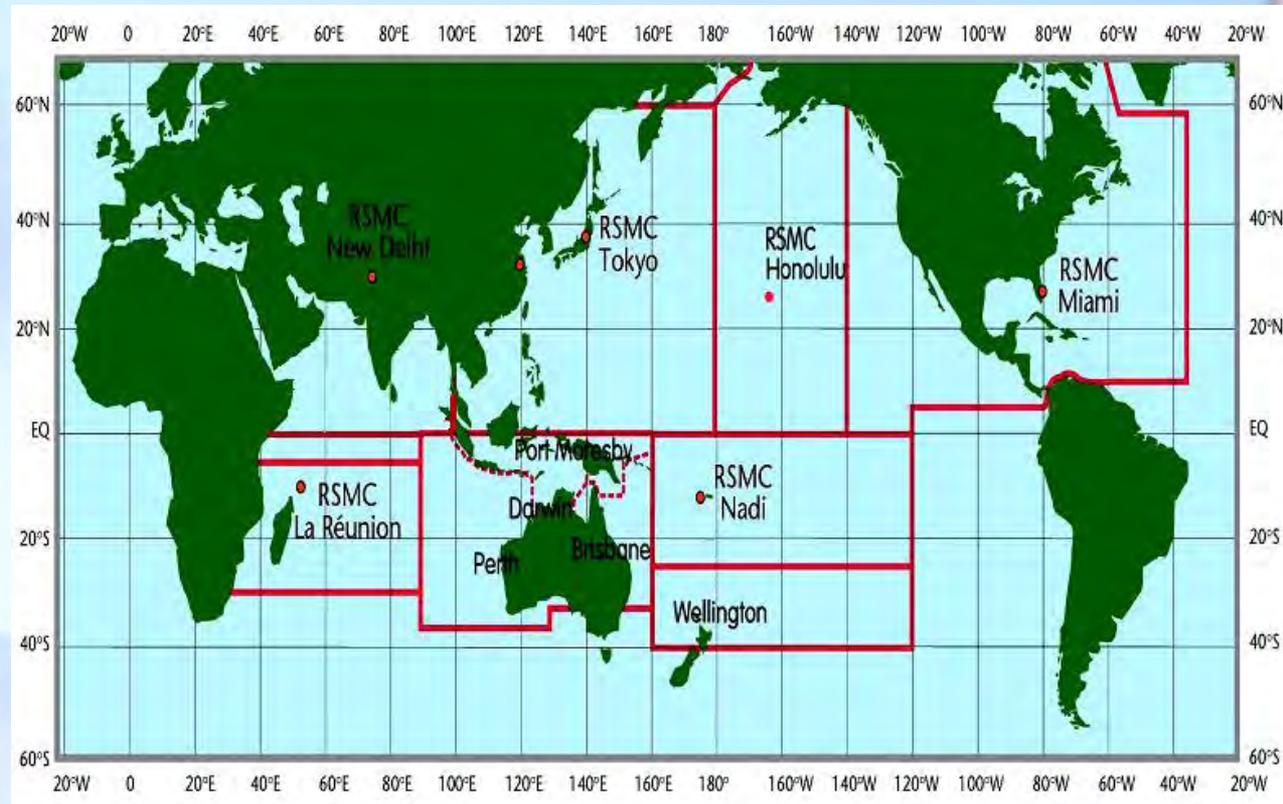
Joined This Year:

UAE,

Saudi Arabia,

Qatar,

Iran



CLASSIFICATION OF LOW PRESSURE SYSTEMS OVER THE NIO SINCE 2015

Low pressure system	T Number	Maximum sustained surface wind speed		
		knots	mps	kmph
Low (L)/ Well marked Low	LLC/T 1.0	< 17	< 9	< 31
Depression (D)	T 1.5	17-27	9-14	31-49
Deep depression	T 2.0	28-33	15-17	50-61
Cyclonic storm	T 2.5-3.0	34-47	18-24	62-88
Severe cyclonic storm	T 3.5	48-63	25-32	89-117
Very Severe cyclonic storm	T 4.0-4.5	64-89	33-46	118-166
Extremely Severe Cyclonic Storm	T 5.0-6.0	90-119	47-61	167-221
Super Cyclonic Storm	T 6.5 -8.0	120 and above	62 and above	222 and above

EXPECTED DAMAGE AND SUGGESTED ACTION

Intensity	Damage expected	Action Suggested
Deep Depression 50 – 61 kmph (28-33 knots)	Minor damage to loose and unsecured structures.	Fishermen advised not to venture into the open seas.
Cyclonic Storm 62 – 87 kmph (34-47 knots)	Damage to thatched huts. Breaking of tree branches causing minor damage to power and communication lines	Total suspension of fishing operations
Severe Cyclonic Storm 88-117 kmph (48-63 knots)	Extensive damage to thatched roofs and huts. Minor damage to power and communication lines due to uprooting of large avenue trees. Flooding of escape routes.	Total suspension of fishing operations. Coastal hutment dwellers to be moved to safer places. People in affected areas to remain indoors.



EXPECTED DAMAGE AND SUGGESTED ACTION

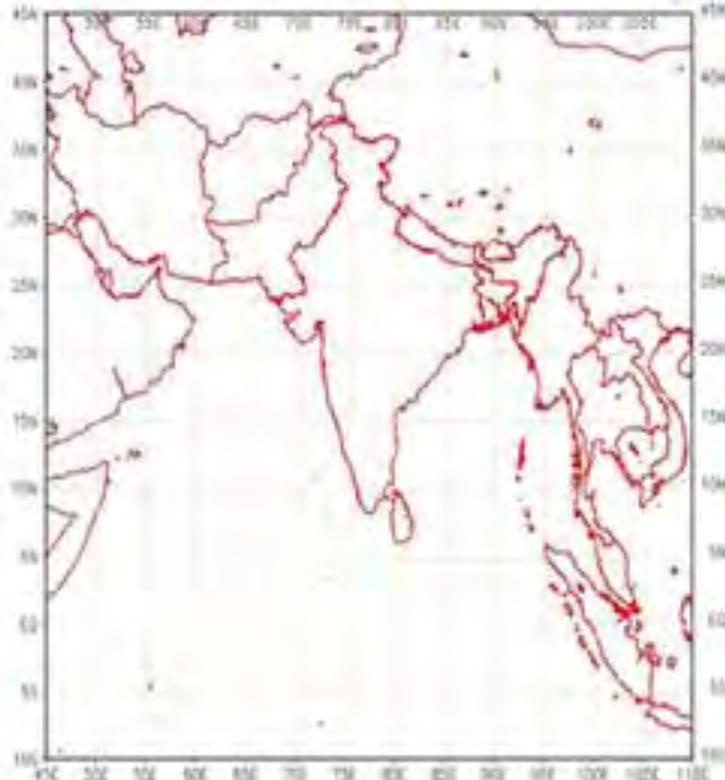
Intensity	Damage expected	Action Suggested
Very Severe Cyclonic Storm 118-166 kmph (64-89 knots)	Extensive damage to kutcha houses. Partial disruption of power and communication line. Minor disruption of rail and road traffic. Potential threat from flying debris. Flooding of escape routes.	Total suspension 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 167-221 kmph (90-119 knots)	Extensive damage to kutcha houses. Some damage to old buildings. Large-scale disruption of power and communication lines. Disruption of rail and road traffic due to extensive flooding. Potential threat from flying debris.	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 222 kmph and more (120 knots and more)	Extensive structural damage to residential and industrial buildings. Total disruption of communication and power supply. Extensive damage to bridges causing large-scale disruption of rail and road traffic. Large-scale flooding and inundation of sea water. Air full of flying debris.	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.

EXTENDED RANGE FORECAST

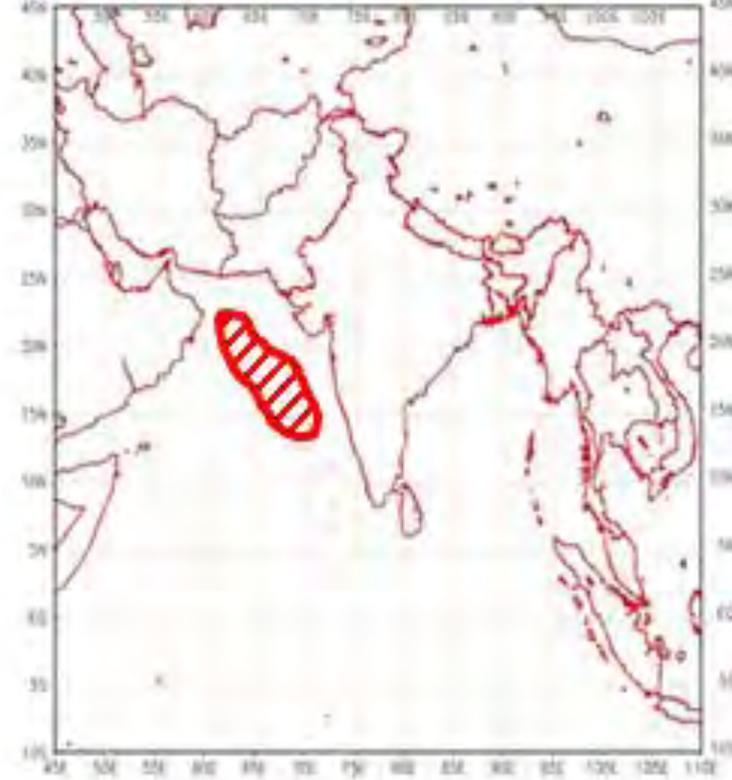
Implemented since 22 April 2018

NORTH INDIAN OCEAN EXTENDED RANGE OUTLOOK FOR CYCLOGENESIS

WEEK-1: VALIDITY 28.09.2018-04.10.2018



WEEK-2: VALIDITY 05.10.2018-11.10.2018



PROBABILITY OF CYCLOGENESIS
(FORMATION OF DEPRESSION OR HIGHER INTENSITY)

LOW (1-33% PROBABILITY)
MODERATE (34-67% PROBABILITY)
HIGH (68-100% PROBABILITY)

CONFIDENCE



GENESIS PROBABILITY : SHORT RANGE FORECAST

- SOP for Genesis Forecast
- Input :
- Observations (mainly satellite based) for synoptic and environmental conditions
- NWP models
- Dynamical statistical guidance
- The official forecast is based on a consensus forecast determined from NWP, synoptic, environmental, statistical and dynamical-statistical inputs.
- It provides probability of cyclogenesis during next 120 hrs based on the observations at 0300 UTC of everyday and issued at 0600 UTC.
- This probabilistic forecast is issued in terms of nil, low, fair, moderate and high probability corresponding to 0, 1-25, 26-50, 51-75 and 76-100% probability of occurrence.
- It commenced since 01 June 2014



TROPICAL WEATHER OUTLOOK



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

DEMS-RSMC TROPICAL CYCLONES NEW DELHI DATED 16.09.2018

TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND ARABIAN SEA) VALID FOR NEXT 120 HOURS ISSUED AT 0800 UTC OF 16.09.2018 BASED ON 0300 UTC OF 16.09.2018.

BAY OF BENGAL:

AS PER THE OBSERVATIONS BASED ON 0300 UTC OF TODAY, THE 16TH SEPTEMBER, 2018, THE CYCLONIC CIRCULATION OVER GULF OF MARTABAN & NEIGHBOURHOOD LAY OVER EASTCENTRAL BAY OF BENGAL & NEIGHBOURHOOD AND EXTENDED UPTO 5.8 KM ABOVE MEAN SEA LEVEL. **UNDER ITS INFLUENCE, A LOW PRESSURE AREA IS VERY LIKELY TO DEVELOP OVER CENTRAL & ADJOINING NORTH BAY OF BENGAL AROUND 18TH SEPTEMBER. IT IS LIKELY TO BECOME MORE MARKED SUBSEQUENTLY.**

BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION LIE OVER WESTCENTRAL BAY OF BENGAL.

BROKEN LOW AND MEDIUM CLOUDS WITH EMBEDDED MODERATE TO INTENSE CONVECTION LIE OVER NORTHWEST, EASTCENTRAL AND SOUTH BAY OF BENGAL, ANDAMAN SEA AND TENESSERIM COAST.

PROBABILITY OF CYCLOGENESIS DURING NEXT 120 HRS:

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

ARABIAN SEA:

SCATTERED LOW AND MEDIUM CLOUDS WITH EMBEDDED ISOLATED WEAK TO MODERATE CONVECTION LIE OVER SOUTHEAST ARABIAN SEA.

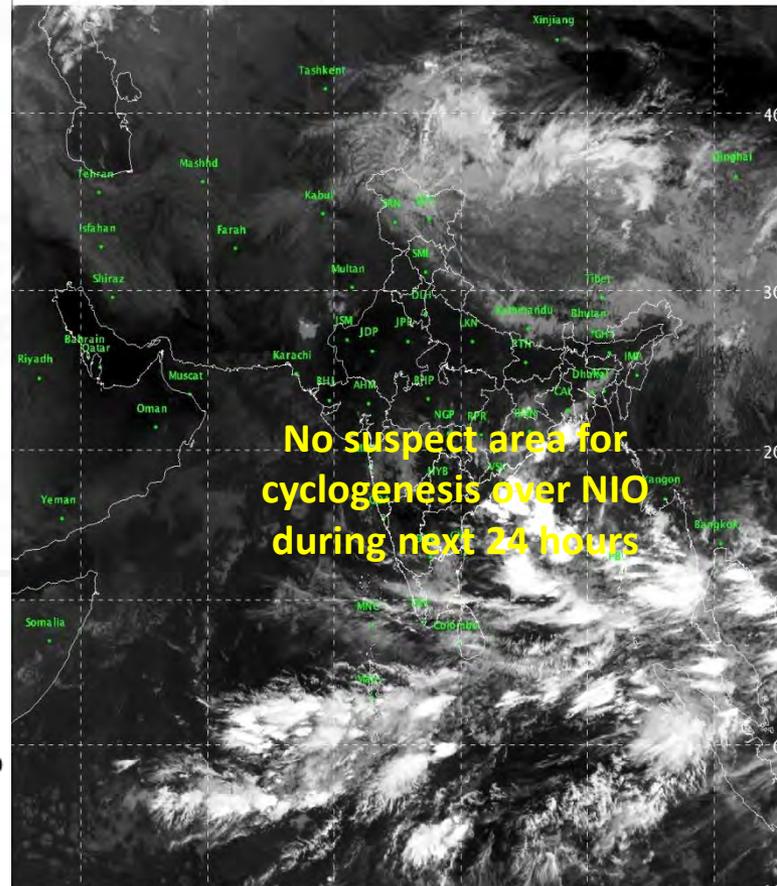
PROBABILITY OF CYCLOGENESIS DURING NEXT 72 HRS:

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

REMARKS: NIL

Implemented since 22 April 2018
Outlook valid for five days

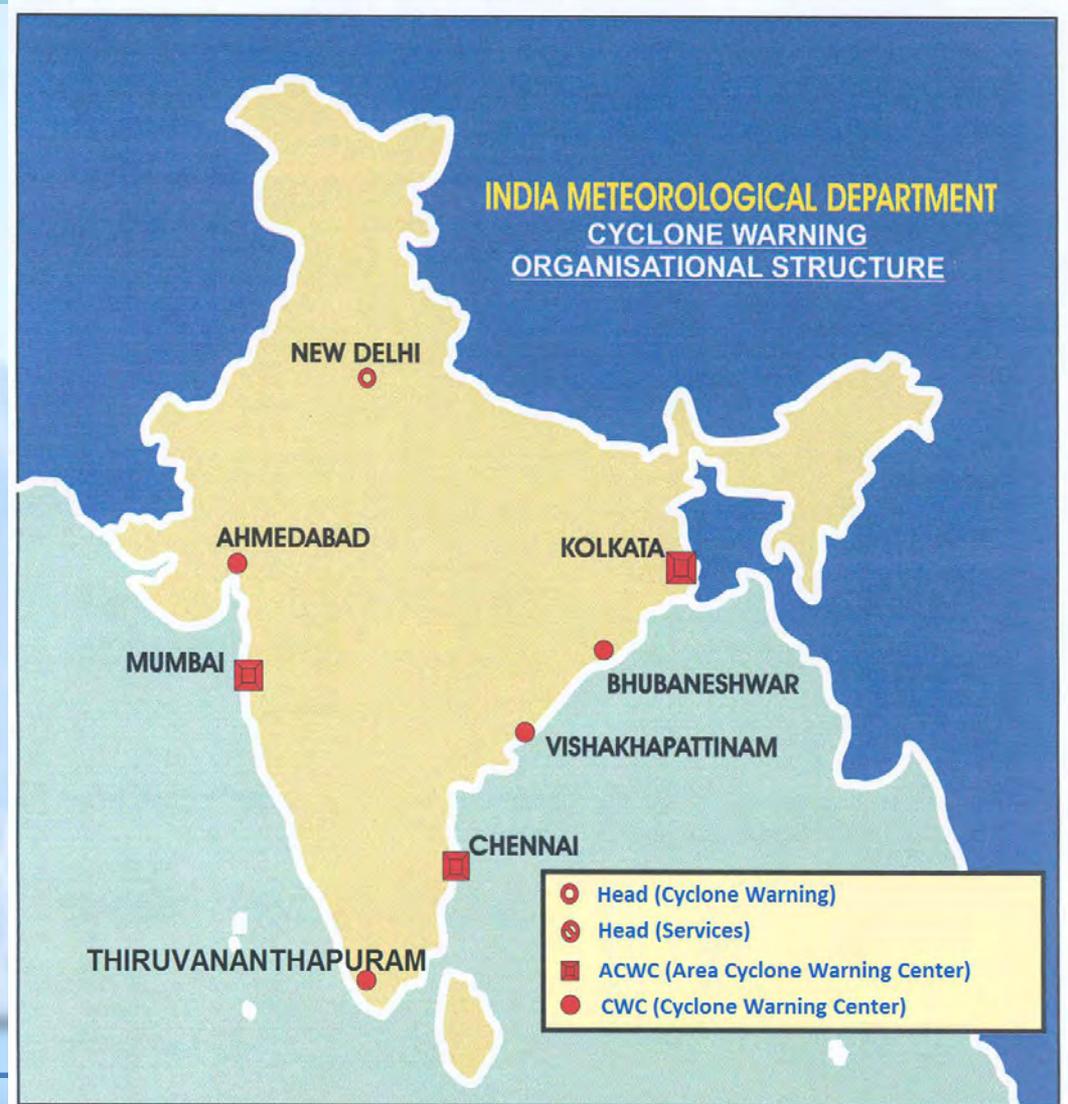
SAT :INSAT-3D IMG 16-09-2018/03:00 GMT
IMG_TIR1 10.8 um 16-09-2018/08:30 IST
LIC Mercator (LINEAR STRETCH: 1.0%)



Cyclones Warning Services

India Meteorological Department has the mandate to monitor and issue warnings regarding tropical cyclones over the north Indian ocean.

Cyclone Warning Centre
Thiruvananthapuram
operationalised w.e.f
01.10.2018



Cyclone Bulletins

- **Bulletin for India coast**
- **Tropical weather outlook : Once a day based on 0300 UTC observation**
- **Special Tropical Weather Outlook : Twice a day based on 0300 and 1200 UTC observation during depression stage**
- **Tropical Cyclone Advisories : Every three hourly during cyclone period**
- **Tropical Cyclone Advisories for Aviation as per the guidelines of ICAO every six hourly during cyclone period**
- **Quadrant winds (Structure Forecast)**



BULLETINS AND WARNINGS ISSUED for NATIONAL PURPOSE

❖ Four stage cyclone warning

- Sea area bulletin
- Coastal weather bulletin
- Bulletins for Indian navy
- Fisheries warnings
- Port warnings
- Aviation warning
- Bulletins for AIR/Doordarshan/ press
- CWDS bulletins
- Warnings for registered/designated users.
- Impact based forecast and warning using historical damage potential

- ❖ Pre-cyclone watch (Yellow) – Issued to Cabinet Secretary and Senior Officials indicating formation of a cyclonic disturbance – potential to intensify into a Tropical Cyclone and coastal belt to be affected.
- ❖ Cyclone Alert (Orange)- Issued at least 48 hrs in advance indicating expected adverse weather conditions.
- ❖ Cyclone warning (Red) – Issued at least 24 hrs in advance indicating latest position of Tropical Cyclone, intensity, time and point of landfall, storm surge height, type of damages expected and actions suggested.
- ❖ Post-Landfall Outlook- Issued about 12 hrs before landfall & till cyclone force winds prevail; District Collectors of interior districts besides the coastal areas are also informed.
- ❖ Finally a 'De-Warning' message is issued when the Tropical Cyclone weakens into Depression stage.

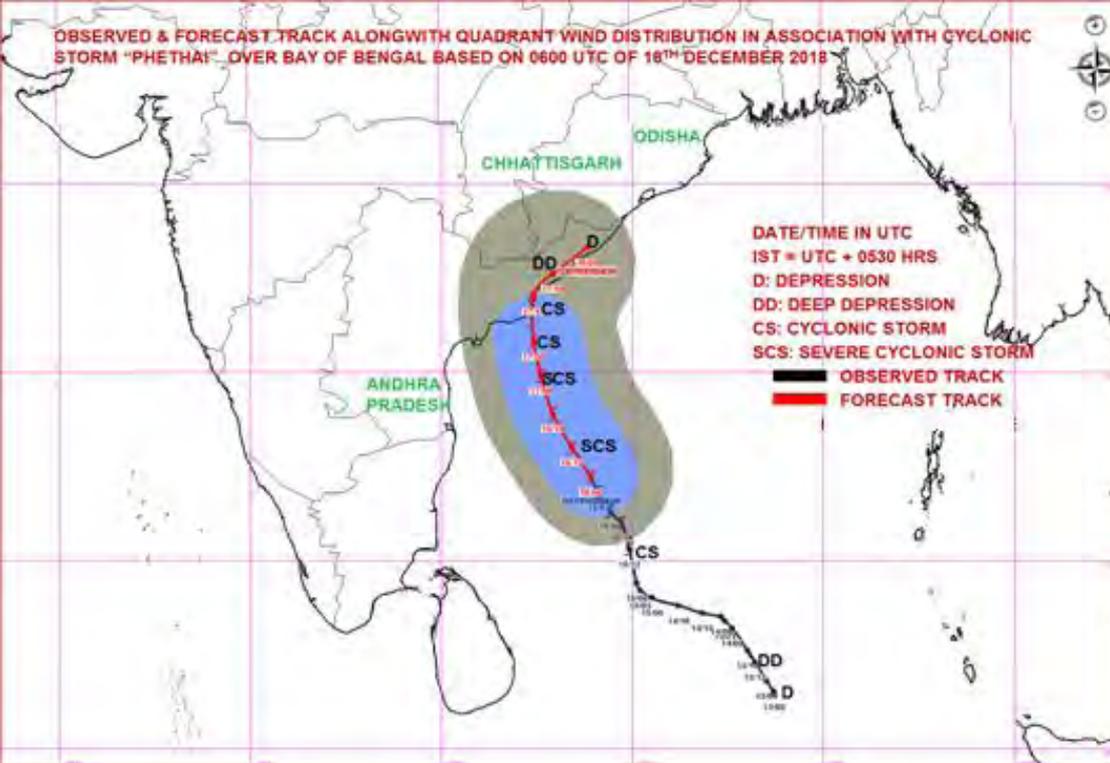


Different colour codes as mentioned below are being used since post monsoon season of 2006 for the different stages of the cyclone warning bulletins as desired by the National Disaster Management.

Stage of warning	Colour code
Cyclone Alert	Yellow
Cyclone Warning	Orange
Post landfall out look	Red



OBSERVED & FORECAST TRACK ALONGWITH QUADRANT WIND DISTRIBUTION IN ASSOCIATION WITH CYCLONIC STORM "PHETHAI" OVER BAY OF BENGAL BASED ON 0600 UTC OF 18TH DECEMBER 2018



Impact Based Forecast

MSW (knot) /kmph	Impact	Action
28-33 (51-62)	<ul style="list-style-type: none"> • Some breaches in Kutcha road due to flooding. • Minor damage to loose/unsecured structures/kutcha embankments. Minor damage to banana trees/coastal agriculture/ripe paddy crops due to salt spray. • Very rough seas. Sea waves about 4-6 m high. 	Fishermen advised not to venture into the open seas.
34-49 (63-91)	<ul style="list-style-type: none"> • Major damage to thatched huts/kutcha roads. Minor damage to Pucca roads. • Minor damage to power/communication lines due to breaking of branches. • Some damage to paddy crops/banana/papaya trees/orchards • High to very high sea waves(6-9 m) • Sea water inundation in low lying areas after erosion of Kutcha embankments. 	Total suspension of fishing operations.

Advances in Warning Dissemination Mechanism

- ❖ Telephone, Tele-fax
- ❖ Mobile Phones (SMS) through IMD severe weather network, Agromet Network, INCOIS network.
- ❖ VHF/HFRT/Police Wireless
- ❖ Satellite based cyclone warning dissemination System
- ❖ Aeronautical Fixed Terminal Network
- ❖ Global telecommunication system (GTS) : (International Telecom centres)
- ❖ NAVTEX
- ❖ Internet (e-mail), ftp
- ❖ Websites, Dedicated website for cyclone (rsmcnewdelhi.imd.gov.in)
- ❖ Radio/TV, News Paper network (AM, FM, Community Radio, Private TV) : Prasar Bharati and private broadcasters
- ❖ GAMES and NAVIK

HOME PAGE OF RSMC WEBSITE

- IMD has launched a website exclusively for RSMC, New Delhi.
- The data, forecast and products will be available to all the countries of the region through this website.

The screenshot displays the homepage of the Regional Specialized Meteorological Centre for Tropical Cyclones Over North Indian Ocean. The page features a navigation menu with the following items: Home, RSMC, CWD, Cyclone Awareness, Publications, Tools And Data, Forecast Verification, Archive, Climatology, and Contact. A central satellite map of the North Indian Ocean is shown with the text "There is no cyclone:" above it. The map includes labels for various cities and regions such as QATAR, MUHAR, KARACHI, JSM, PPR, BOM, AGHT, RPR, BAN, HYD, VIZAG, MYANMAR, BANGKOK, MNC, COLMBO, and MALE. The page also includes a search bar, a WMO logo, and a "Quick Links" section with the following items: Top News, Press Release, Feedback, All India Weather Forecast, NWP, Satellite, Imagery, Bulletin, OceanSat-2, Radar, Imagery, Bulletin, FDP Cyclone, and SWEP. The browser address bar shows the URL "http://www.rsmcnewdelhi.imd.gov.in/index.php?lang=en". The system tray at the bottom indicates the time as 13:31 on 21-01-2014.

Pre-cyclone Exercise: (Telecommunication)

1. Communications

(1) Head of ACWC/CWC contacts General Manager-Telephones, General Manager-Maintenance and Senior officials in-charge of telephone/telefax/mobile/internet systems at their respective stations and ensure that :

a) Communication links at ACWC/CWC (Telephone/ Telefax/ mobile/ internet/ IVRS etc) are maintained in good working condition.

b) They are requested to designate local DOT officers to serve as liaison officers to ensure quick service.

(2) Computer and Telefax machines

Computers and Telefax machines at stations are maintained in good working condition. Essential spare parts requisitioned well in time

(3) **Police W/T:** Any action required in connection with the issue of warnings through Police W/T is completed.



Publicity and Broadcast of Warnings

1 Through posters and films

ACWCs/CWCs writes to State Government officials concerned for giving publicity in coastal districts about cyclones through cyclone posters and exhibition of the film on cyclones.

2 Radio and TV Talks

Talks on radio and TV is arranged by the ACWCs and CWCs on the hazards of cyclones and precautionary measures to be taken before, during and after the storms. The system of warnings are explained.

3 All India Radio

Station Directors of AIR station in the concerned State(s) are alerted about the broadcasts of cyclone warnings through AIR and to ensure that stations keep extended watch for broadcast of additional weather bulletins whenever required. They are requested to include storm warning bulletins in their Vividh Bharati broadcasts and FM Channel also at frequent interval as these have popular appeal.

4 Newspapers

Proper liaison is established with local newspapers for prompt publication of latest warnings.

(Pre-cyclone exercise)

- **Meeting with the Chief Secretaries of the Maritime States ACWCs/CWCs/MCs connected with storm warning work :**

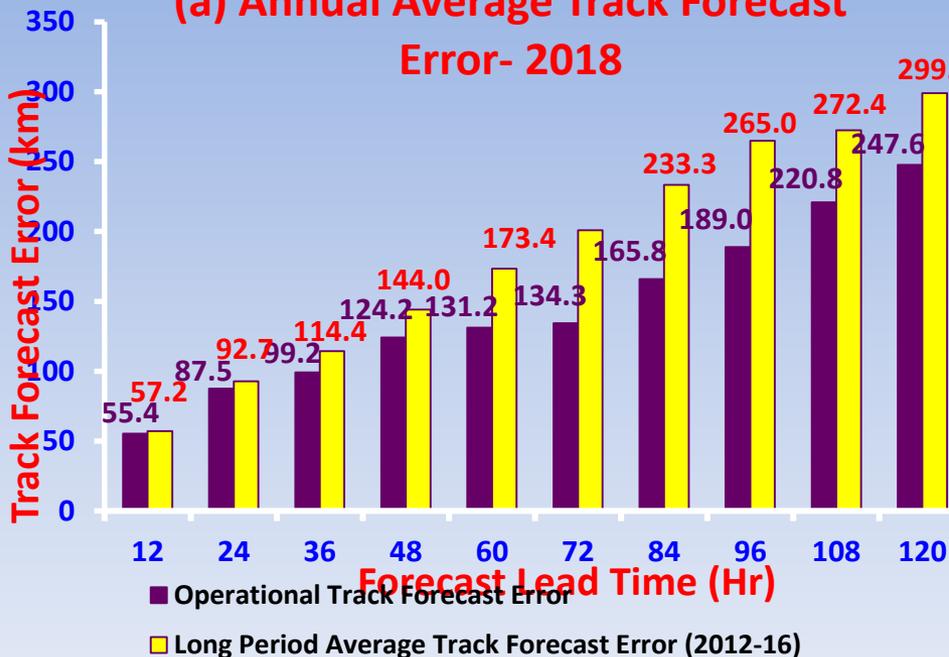
Every year to apprise them of our storm warning service.

- Meeting whenever a new incumbent takes office.
- Users workshop

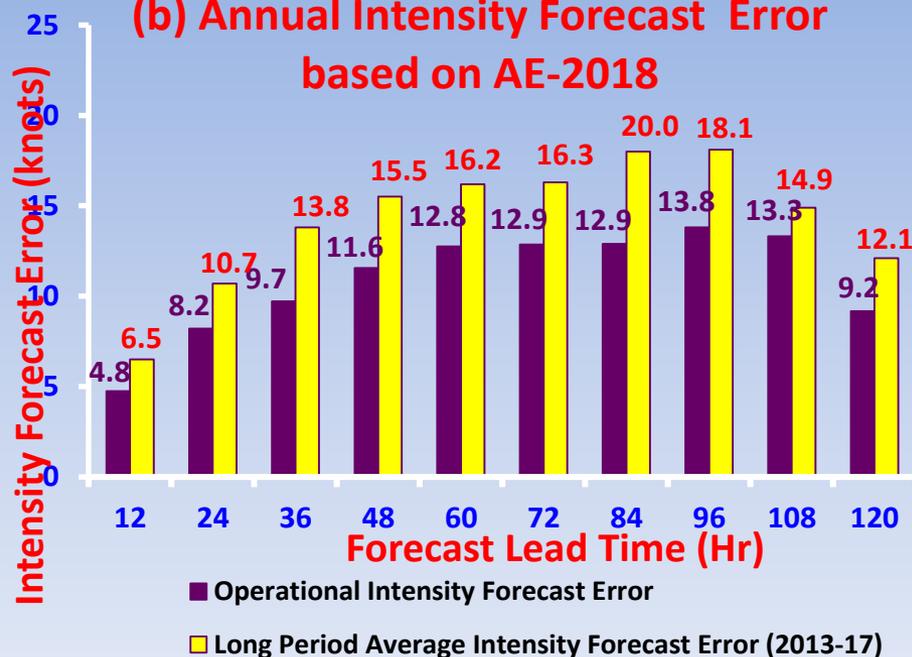


Cyclone Forecast: Accomplishments and Challenges

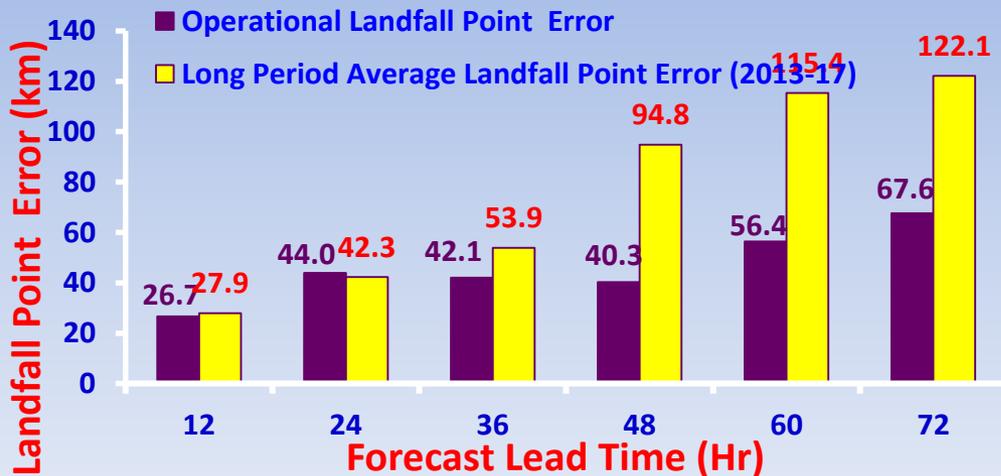
(a) Annual Average Track Forecast Error- 2018



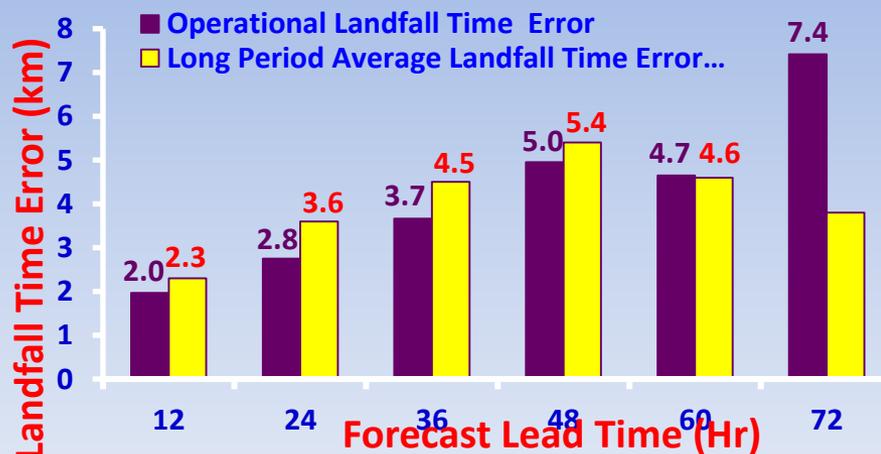
(b) Annual Intensity Forecast Error based on AE-2018



(c) Annual Average Landfall Point Error- 2018



(d) Annual Average Landfall Time Error- 2018



EXTENDED RANGE FORECAST OF CYCLOGENESIS

Introduced since 22 April 2018

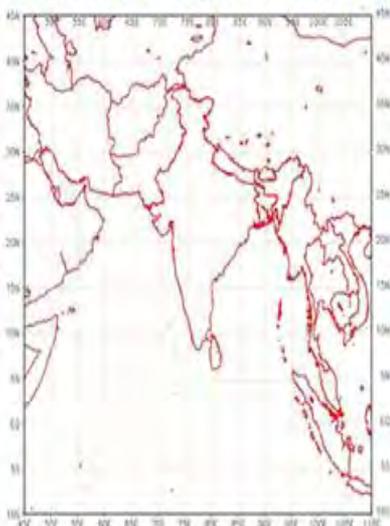
Issued on 27-Sep

Issued on 04-Oct

NORTH INDIAN OCEAN EXTENDED RANGE OUTLOOK FOR CYCLOGENESIS

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WEEK-2: VALIDITY 05.10.2018-11.10.2018



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(FORMATION OF DEPRESSION OR HIGHER INTENSITY)

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- HIGH (68-100% PROBABILITY)

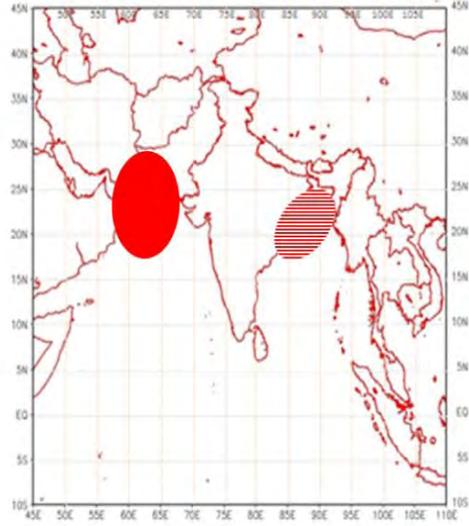
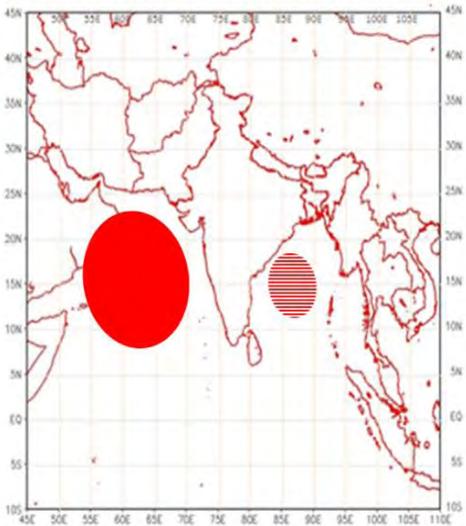
CONFIDENCE



NORTH INDIAN OCEAN EXTENDED RANGE OUTLOOK FOR CYCLOGENESIS

WEEK-1: VALIDITY 05.10.2018-11.10.2018

WEEK-2: VALIDITY 12.10.2018-18.10.2018



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(FORMATION OF DEPRESSION OR HIGHER INTENSITY)

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- HIGH (68-100% PROBABILITY)

CONFIDENCE



Extended range forecast issued on 27-Sep and 4-Oct. for Cyclogenesis of Titli and Luban

