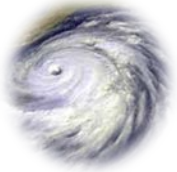

CYCLO-GENESIS PREDICTION OVER NORTH INDIAN OCEAN USING AN ENSEMBLE PREDICTION SYSTEM

PRESENTED BY,
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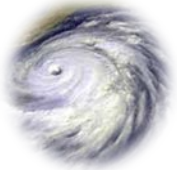
RF, IITM

Saranya G, Abhilash S, Sahai A K, Joseph S, Chattopadyay R.

Extended Range Prediction Group,
Indian Institute of Tropical Meteorology, Pune



Outline

- ✓ Introduction
- ✓ Model & Data sets
- ✓ Cases studies
- ✓ Results & Discussions
- ✓ Conclusions & Future Prospects

Almost 65 % of all observed tropical cyclones (TC) occur in between latitude 10° and 20° over **warm tropical oceans**.

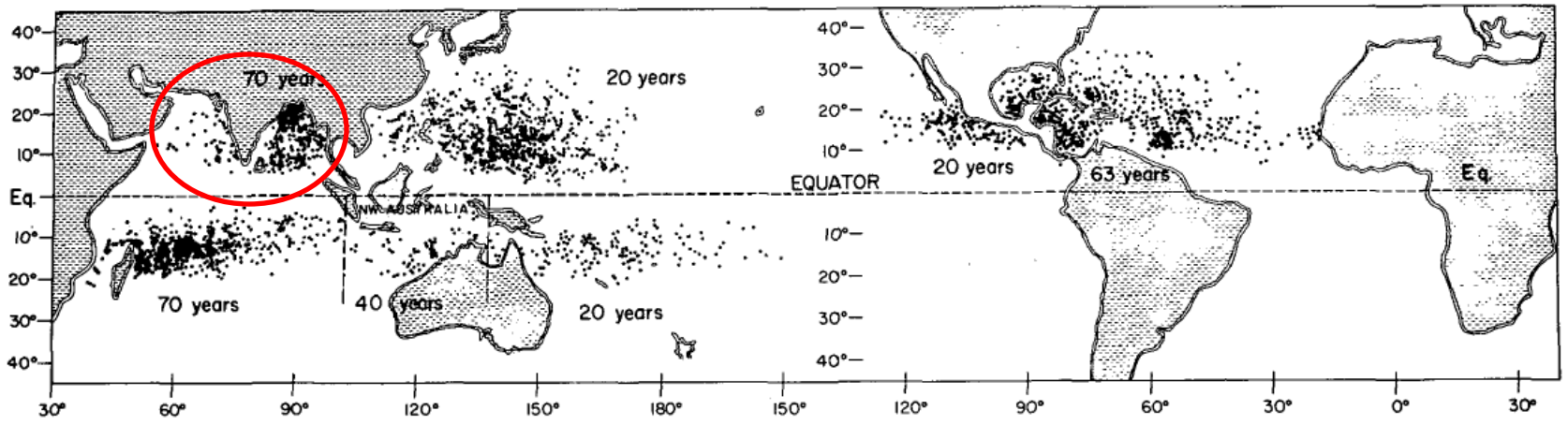
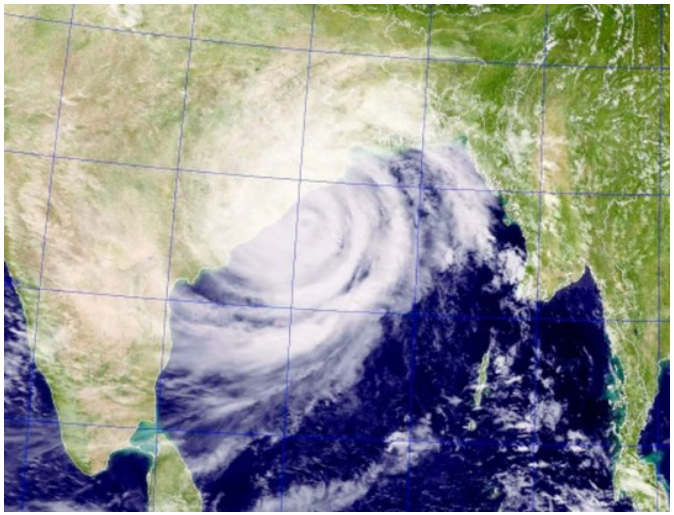


FIGURE 1.—Location points of first detection of disturbances which later became tropical storms.

Gray,1968, ***Global view of the origin of tropical disturbances and storms, MWR***



Cyclone Phailin , October 4-14,2013

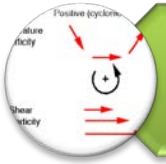
Courtesy, NASA

TC Frequency in North Indian Ocean (comprised of Arabian Sea and Bay of Bengal) : **only 13 % of global average**.

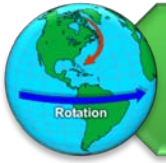
FEWER INTENSE STORMS with ADVERSE EFFECTS.

Six Cyclogenesis Potential Parameters : First Proposed by William M Gray (1968, 1975, 1979, 1981)

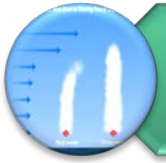
DYNAMIC



low-level relative vorticity



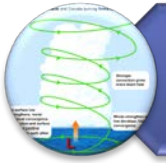
Coriolis parameter (at least a few degrees poleward of the equator)



weak vertical shear of the horizontal winds

THERMODYNAMIC

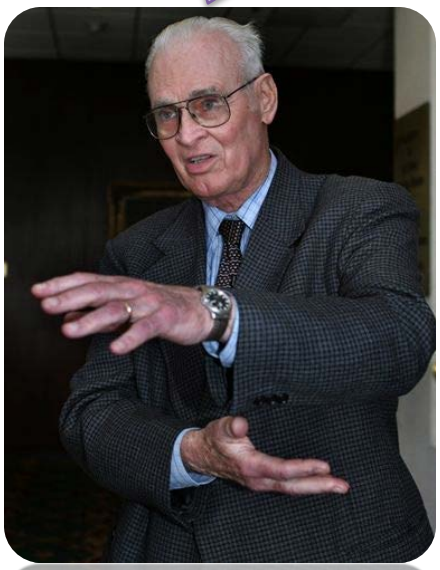
high SSTs exceeding 26°C and a deep thermocline



conditional instability through a deep atmospheric layer

large values of relative humidity in the lower and middle troposphere.

"In NIO, frequency of development is largest when the Eq. T. is displaced farthest from the Equator.'



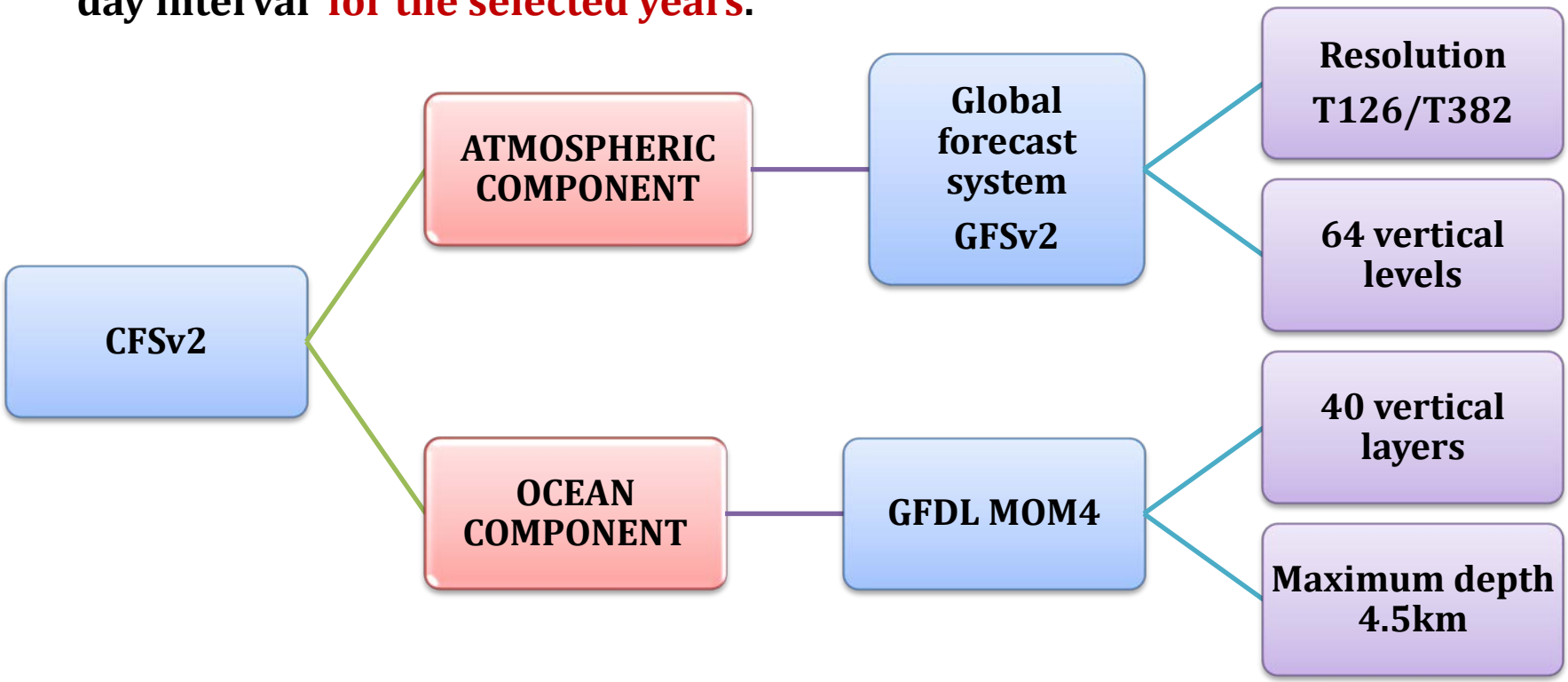
Kotal et. Al, 2007	Low-level relative vorticity (850), Vertical wind shear (s) between 200 and 850 hpa Middle tropospheric relative humidity, $M = \frac{[RH - 40]}{30}$ Middle tropospheric instability $I = (T_{850} - T_{500})\ ^{\circ}C$	$GPP = \frac{\xi_{850} \times M \times I}{S}$ if $\xi_{850} > 0, M > 0$ and $I > 0$ $= 0$ if $\xi_{850} \leq 0, M \leq 0$ or $I \leq 0$	• Well tested over NIO and region and IMD uses for official forecast • could capture almost 80% of developing and non-developing cases of cyclone genesis	• Some cases with GPP well above threshold didn't develop, may be due to proximity from land. • more case studies are required to calibrate threshold value

An evaluation of the predictability of genesis potential of North Indian Ocean Tropical Cyclones by using Coupled Climate Models in a Multi-Model Framework .

- **Pre-genesis track forecasts are analyzed and compared for both developing and non-developing storms.**
- **Probability forecasts for genesis, intensity and track are developed based on the Genesis Potential Parameter (Kotal).**

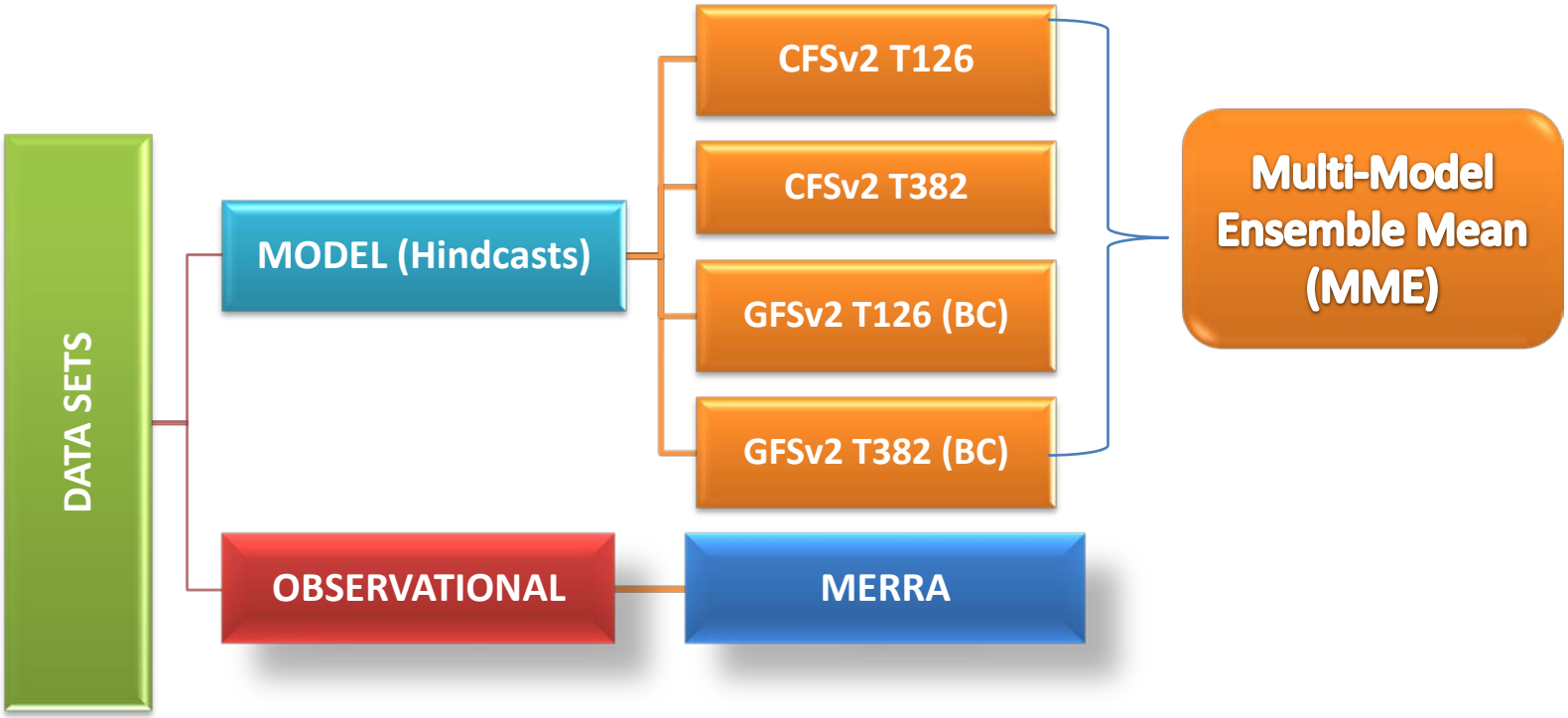
MODEL DESCRIPTION

- In this study, we have used NCEP CFSv2 along with its atmospheric component Global Forecast System (GFSv2) forced with bias corrected SST from CFSv2.
- Each atmospheric IC was perturbed to generate additional 10 ICs. Thus total 11 member model integrations each were done at two horizontal resolutions T126 (100x100 km) and T382 (38x38 km) in coupled mode (CFSv2) and atmospheric mode (GFSv2) forced with bias corrected SST from CFSv2 at every 5 day interval for the selected years.



DATA SETS

The scope of the study is limited to Pre-monsoon and Post-monsoon seasons. Area of interest is 0° - 30°N and 50°- 110°E (NIO).



- **MME hindcasts has been prepared using the CFS (T126 & T382) and GFSbc (T126 & T382) (each 11 members) .**

Abhilash et. al (2015): Journal of Applied Meteorology and Climatology, 54, July 2015, DOI:10.1175/JAMC-D-14-0200.1, 1569-1578

Case 1 : Extremely Severe Cyclonic storm Phailin

08/10/2013 - 14/10/2013, Bay of Bengal (12 N – 96 W)

Courtesy: NASA

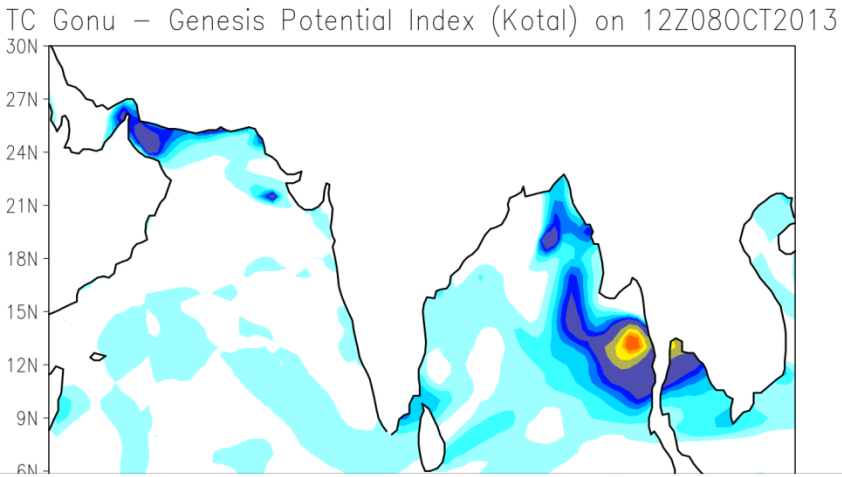
Initial Formation : First noted as a tropical depression on October 4, 2013 within the Gulf of Thailand

Genesis & Movement: west-northwest into an improving environment for further development and gained cyclonic strength on 09OCT2013

Landfall : moved northwestward made landfall on 12OCT2013, near Gopalpur in Odisha coast at around 2130 IST as VSCS

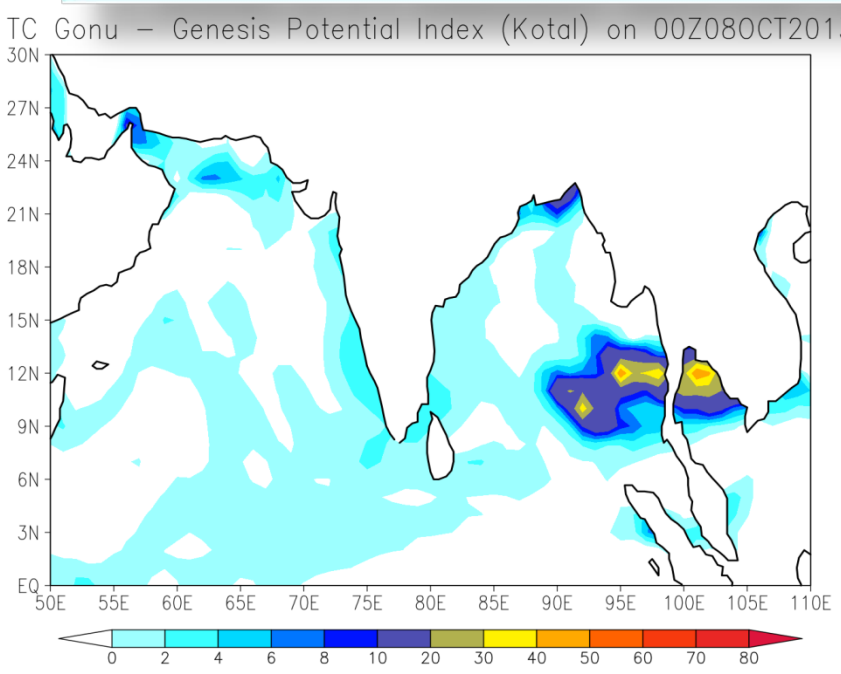
Genesis Potential Index (Kotal et. Al) 8 October 2013

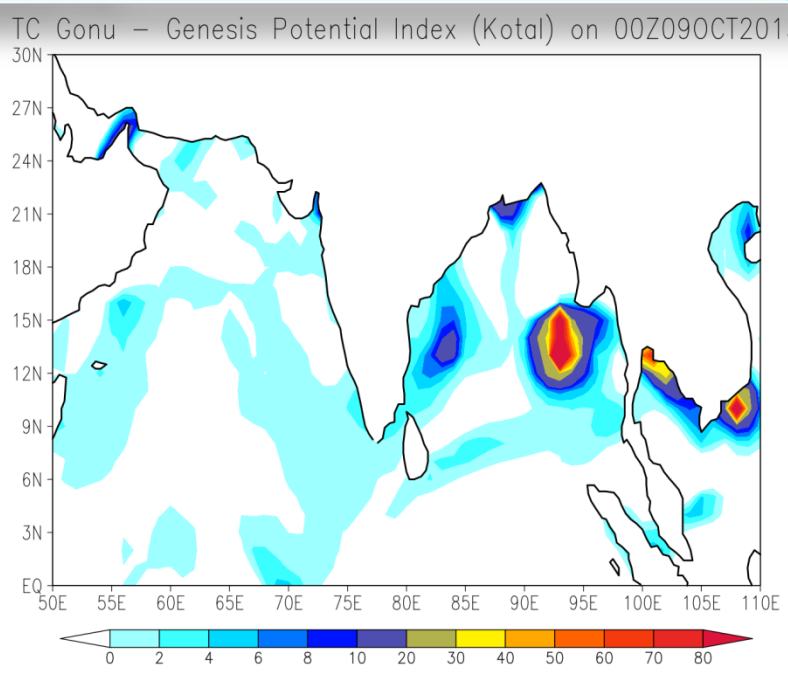
OBSERVED GPI



Genesis Location (IMD) : 12 N – 96 W

- **MME FORECASTS AT BOTH PENTADS COULD CAPTURE HIGH GPI VALUES NEAR THE OBSERVED GENESIS LOCATION.**
- **THERE IS AN UNDERESTIMATION OF INTENSITY.**



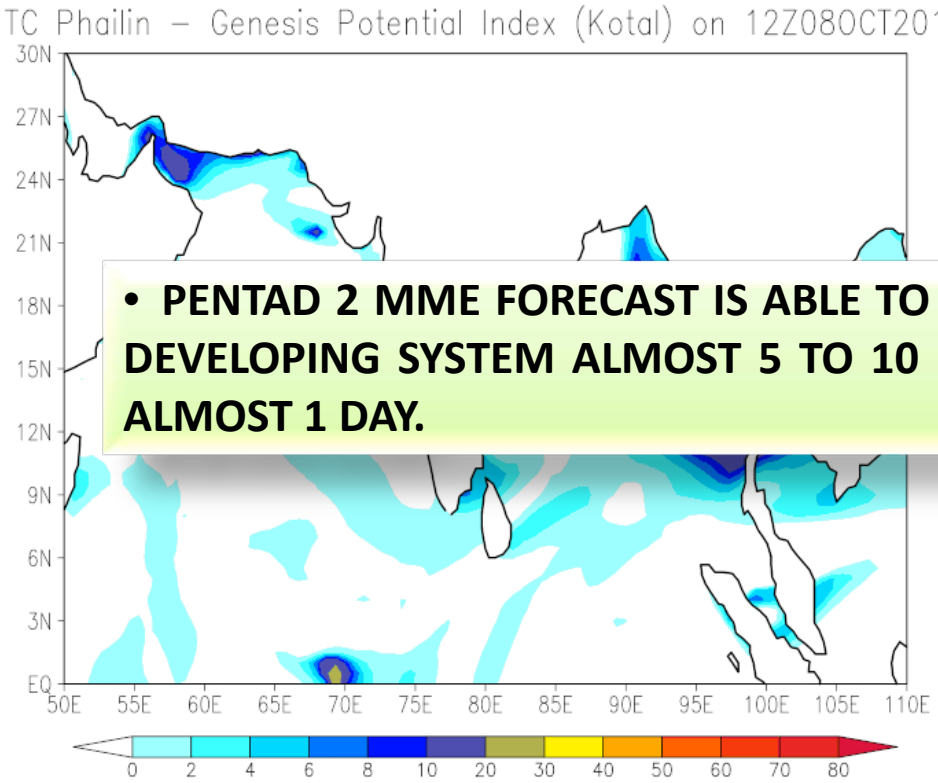


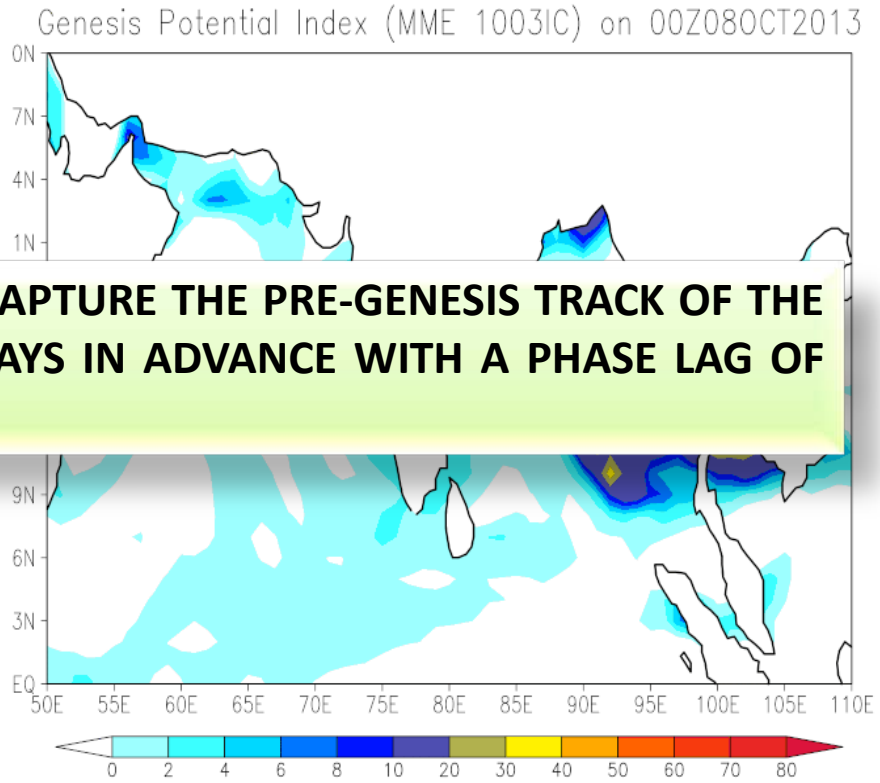
Pre-Genesis track from 3rd October Initial Conditions (8 – 14 October, 2013)

OBSERVED GPI

MME

P2 lead time : 5 – 10 days





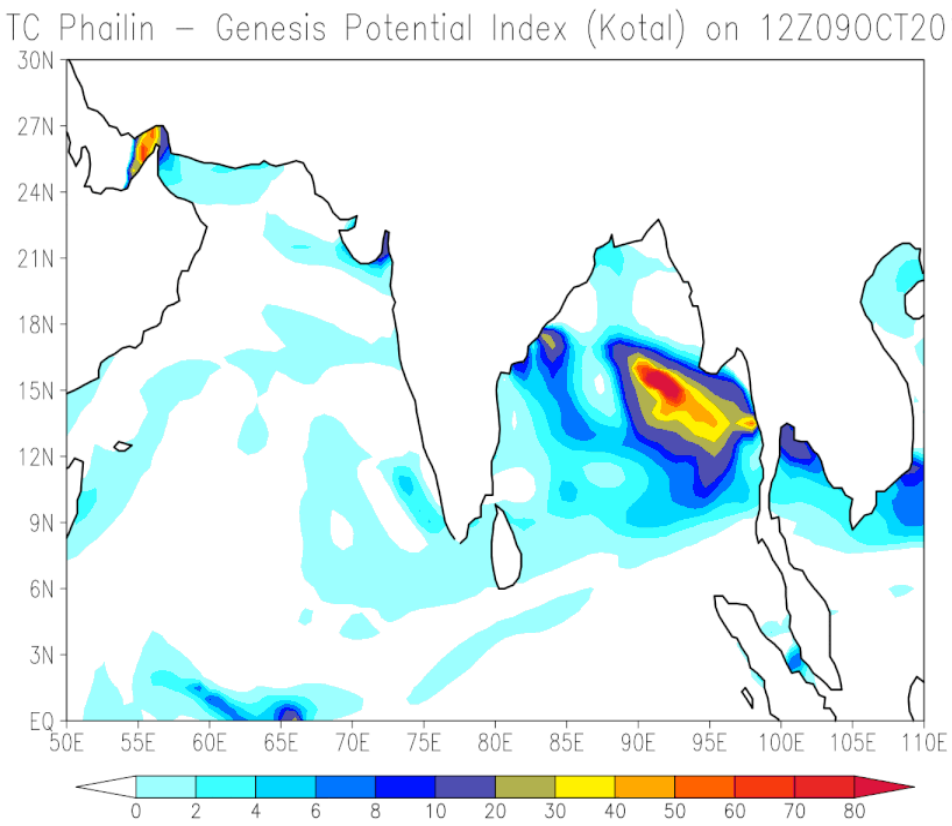
- **PENTAD 2 MME FORECAST IS ABLE TO CAPTURE THE PRE-GENESIS TRACK OF THE DEVELOPING SYSTEM ALMOST 5 TO 10 DAYS IN ADVANCE WITH A PHASE LAG OF ALMOST 1 DAY.**

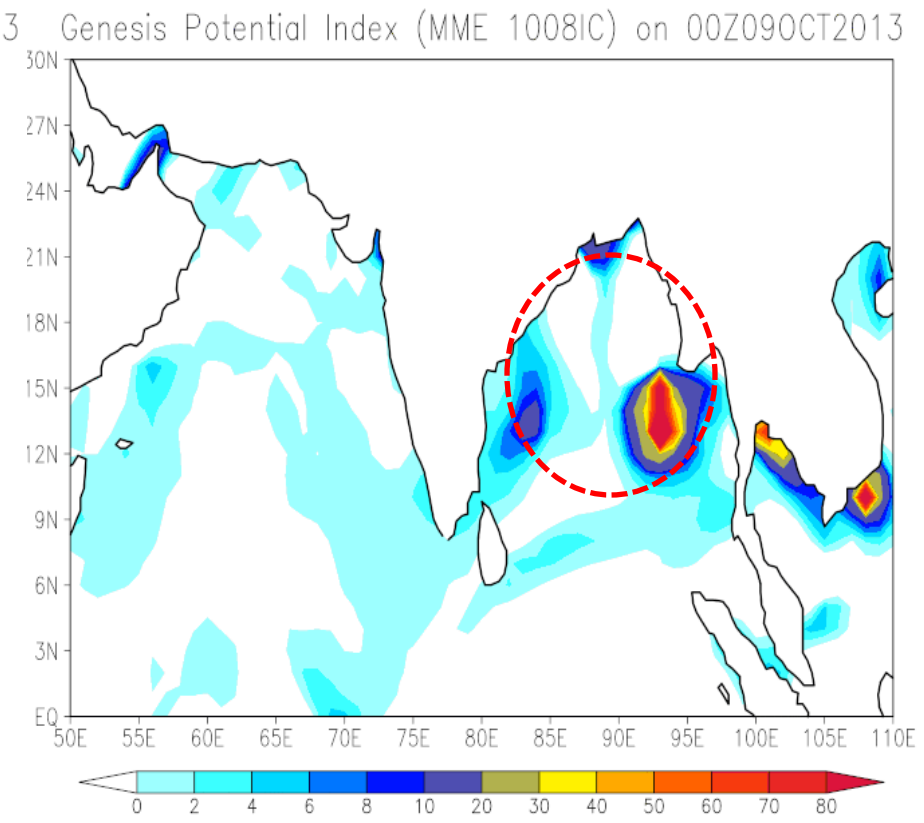
Movement from nearest Initial Conditions (8th October)
(9 – 14 October, 2013)

OBSERVED GPI

MME

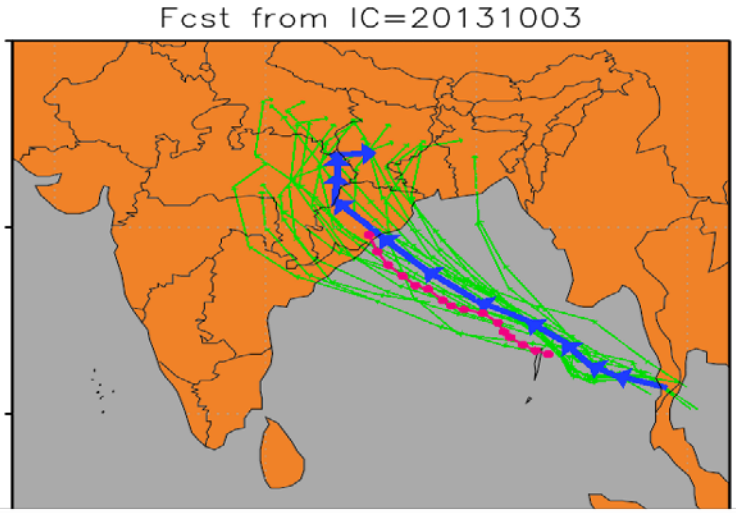
From P1 lead
Time : 1 to 6 days

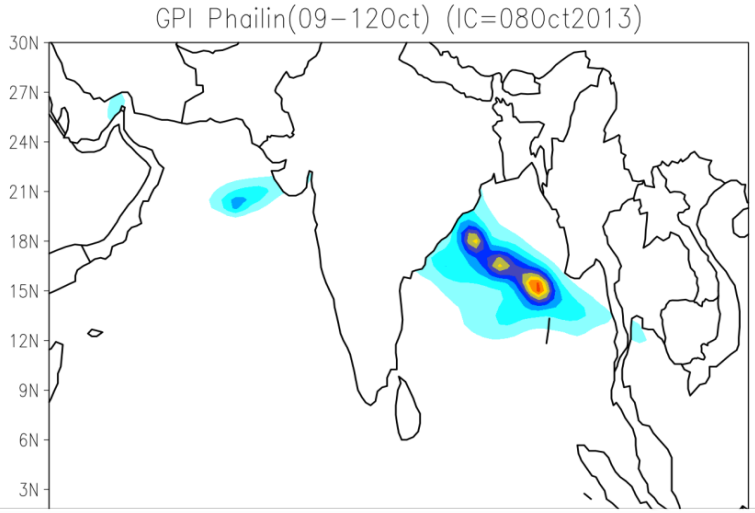




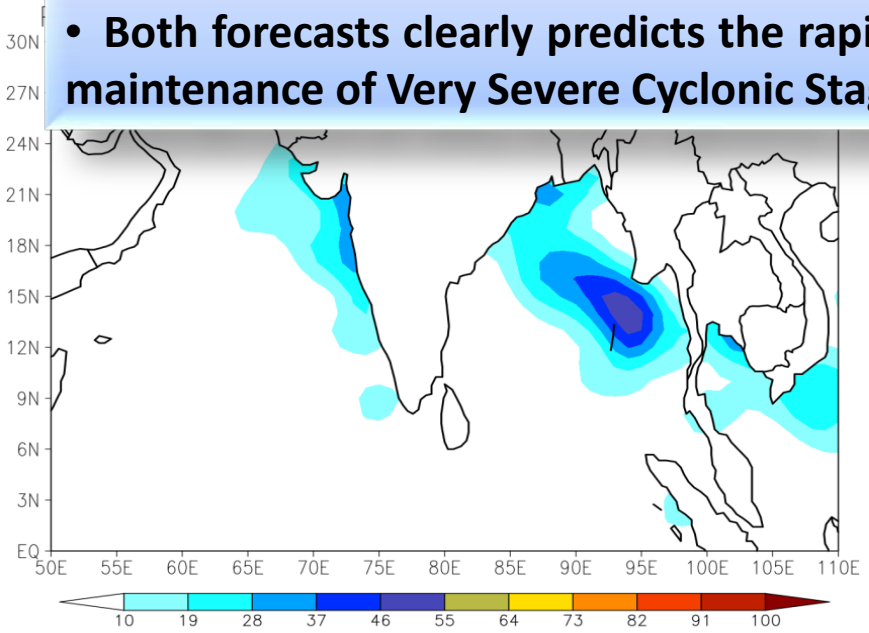
Probability Prediction of Phailin (08-12 October, 2013)

OBS.
MME
ENS

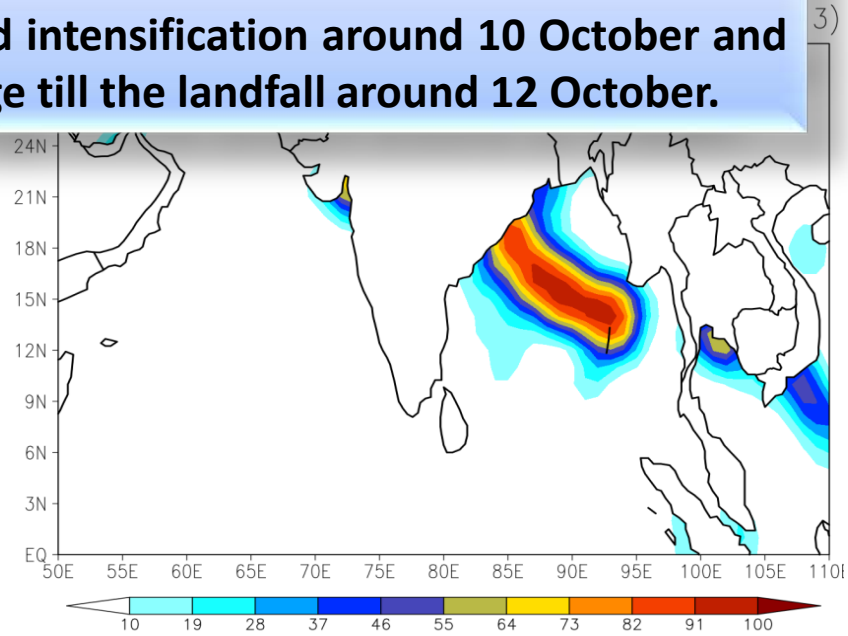




- MME forecasts at both pentads are able to capture the probability of genesis, northwestward movement and development of the storm.
- Both forecasts clearly predicts the rapid intensification around 10 October and maintenance of Very Severe Cyclonic Stage till the landfall around 12 October.



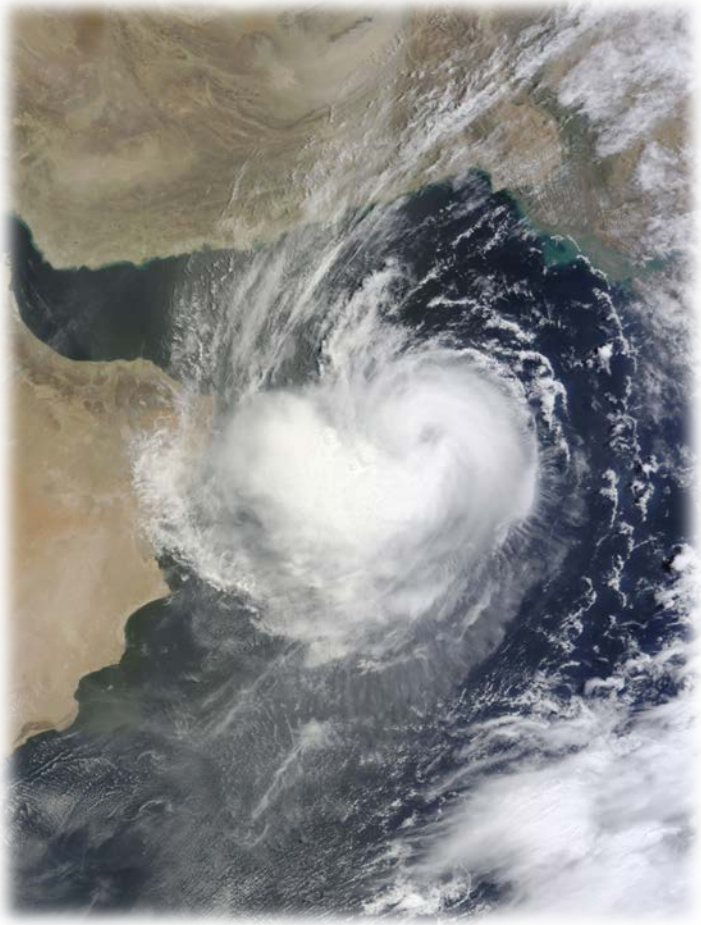
Probability (%) (GPI>15)



Probability (%) (GPI>15)

Case 2 : Cyclonic storm Ashobaa

06/06/2015-12/06/2015, Arabian Sea (15.5N, 68.5E)



Courtesy: NASA

Genesis : Influence of ongoing onset of southwest monsoon, a low pressure area formed over AS on June 6

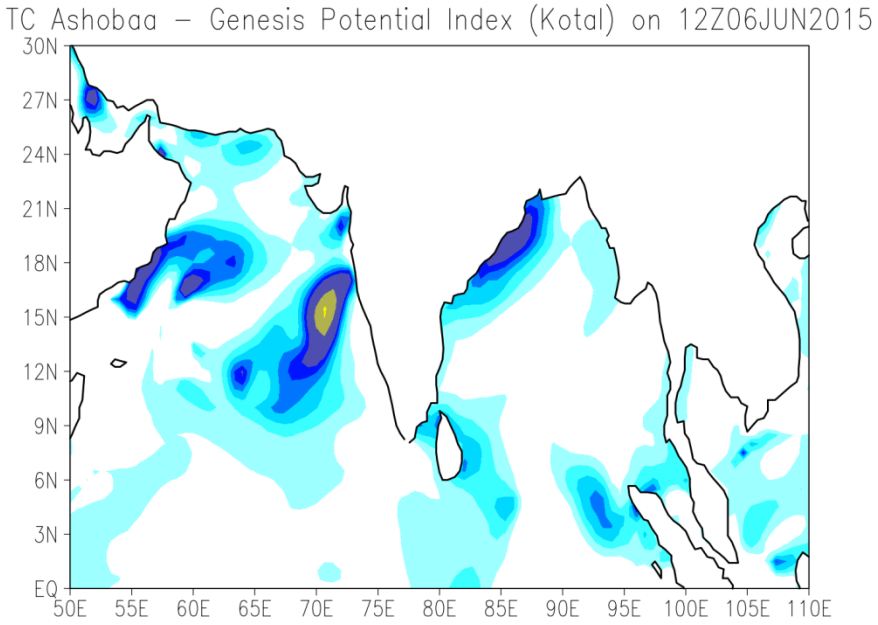
Movement and Development : On June 8, IMD upgraded the storm to a cyclonic storm tracking northwest. Further moved westwards and weakened due to moderate to high wind shear and land interaction

Landfall : On 12 June, Ashobaa hit eastern Oman coast and dissipated.

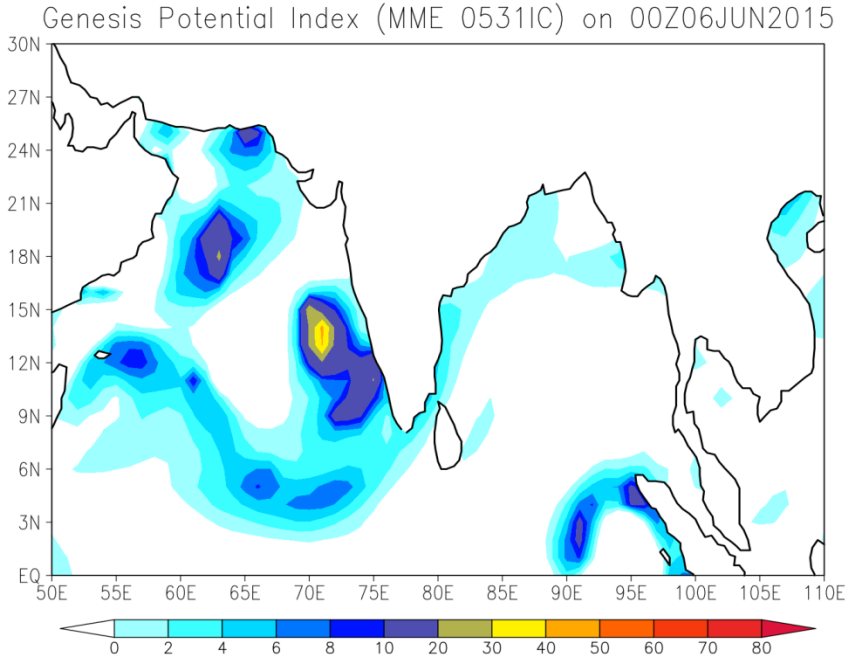
Genesis Potential Index (Kotal et. Al) 6 June 2015

Genesis Location (IMD) : 15.5N, 68.5E

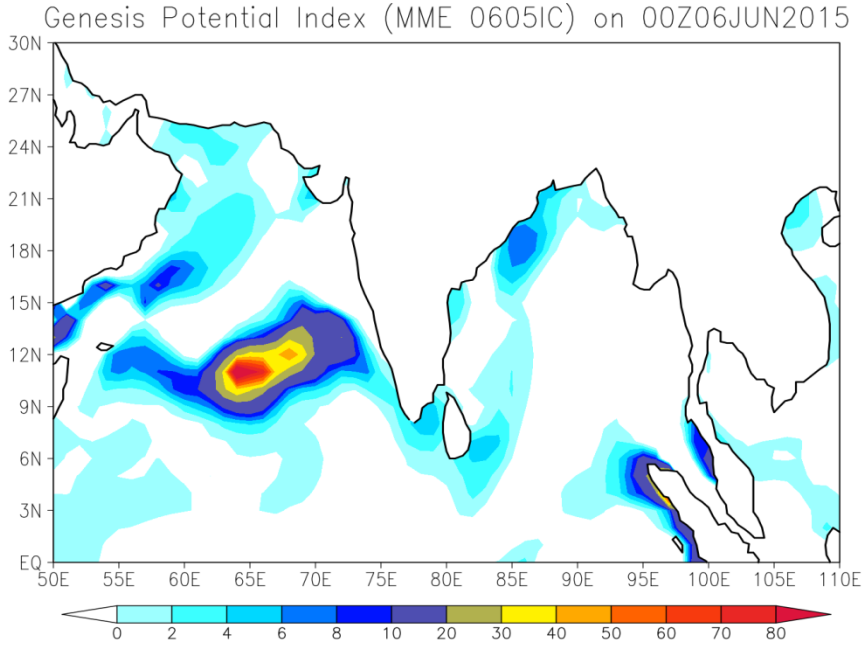
OBSERVED GPI



MME 0531IC

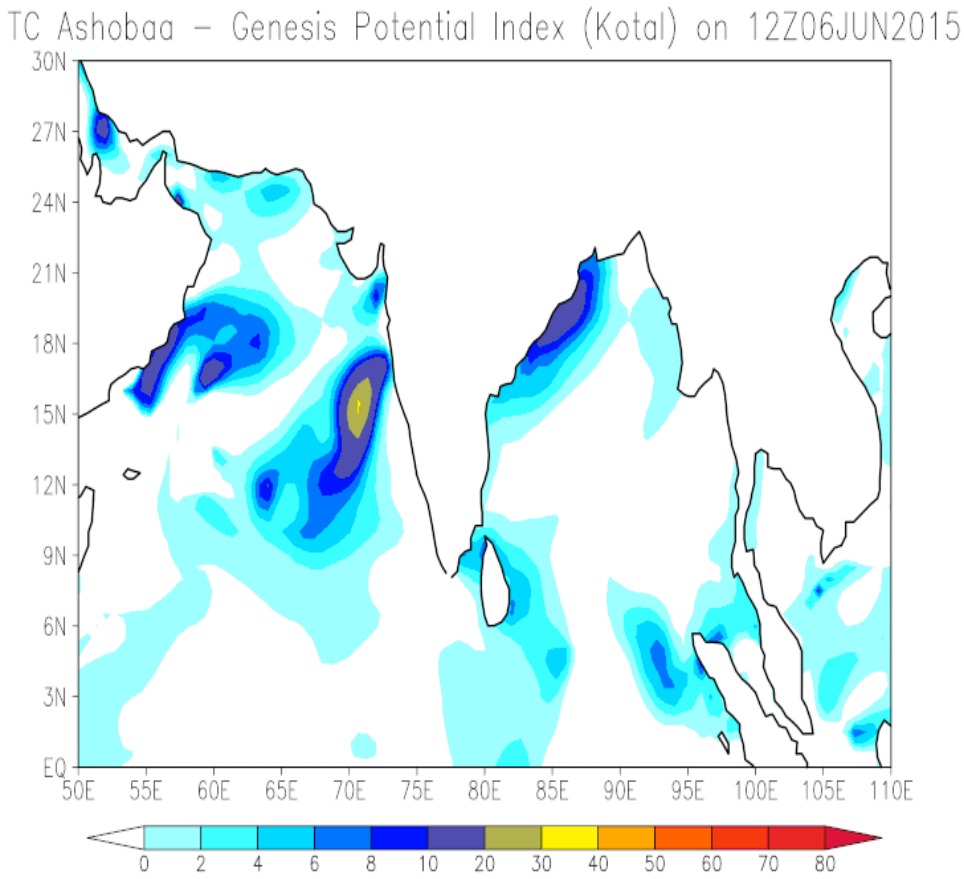


MME 0605IC



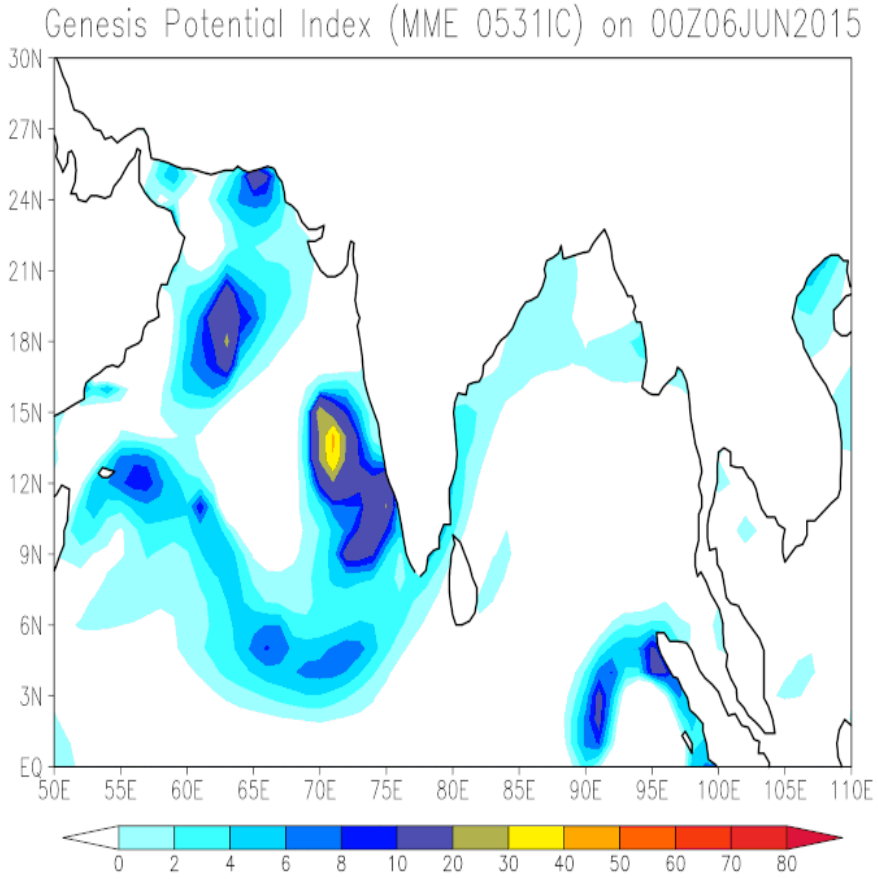
Pre-Genesis track forecast from 31st May Initial Conditions (6 – 12 June 2015)

OBS



MME

From P2 lead IC: 0531IC

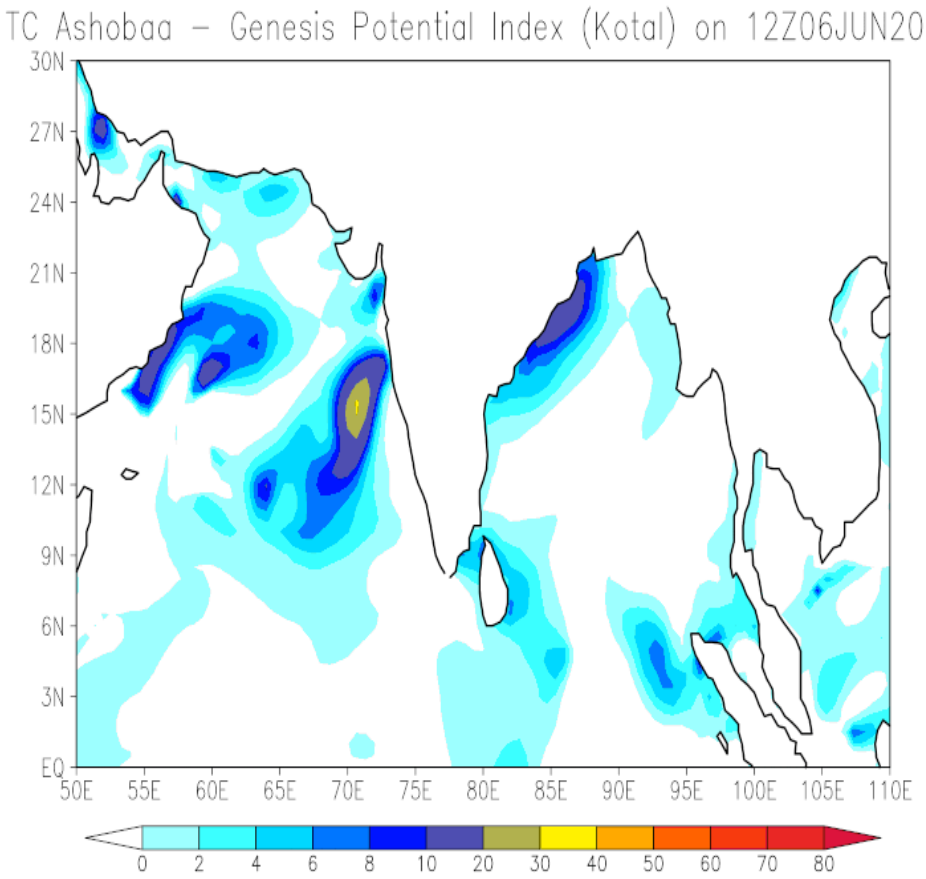


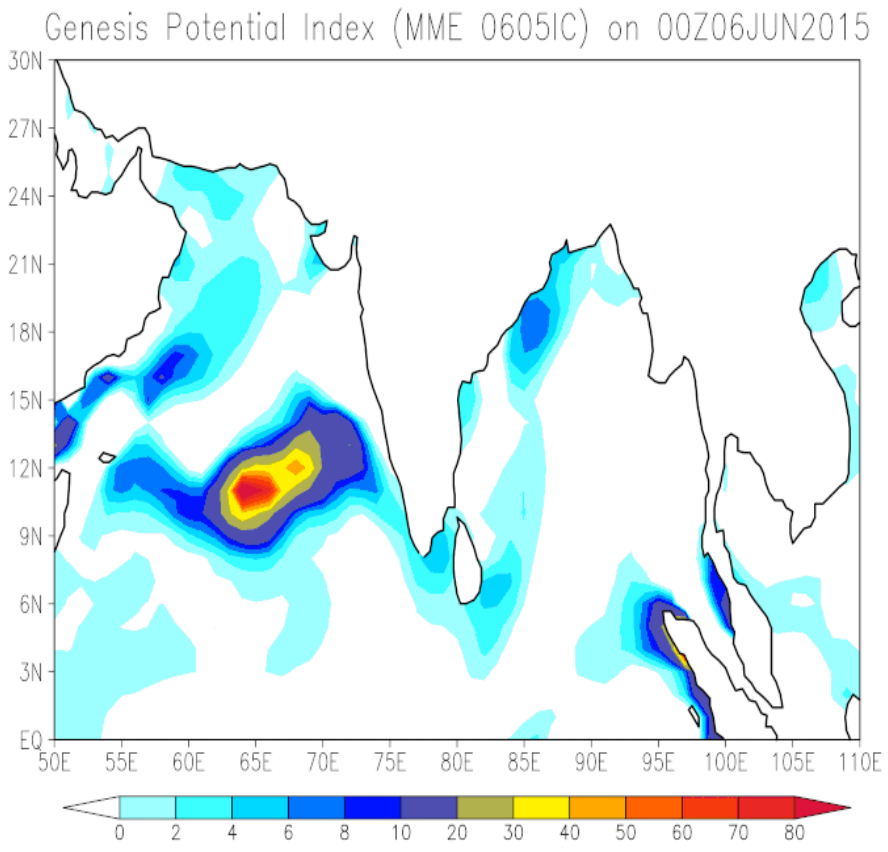
Movement from nearest initial condition
(6 - 12 June, 2015)

OBS

MME

From P1 lead
IC: 0605IC





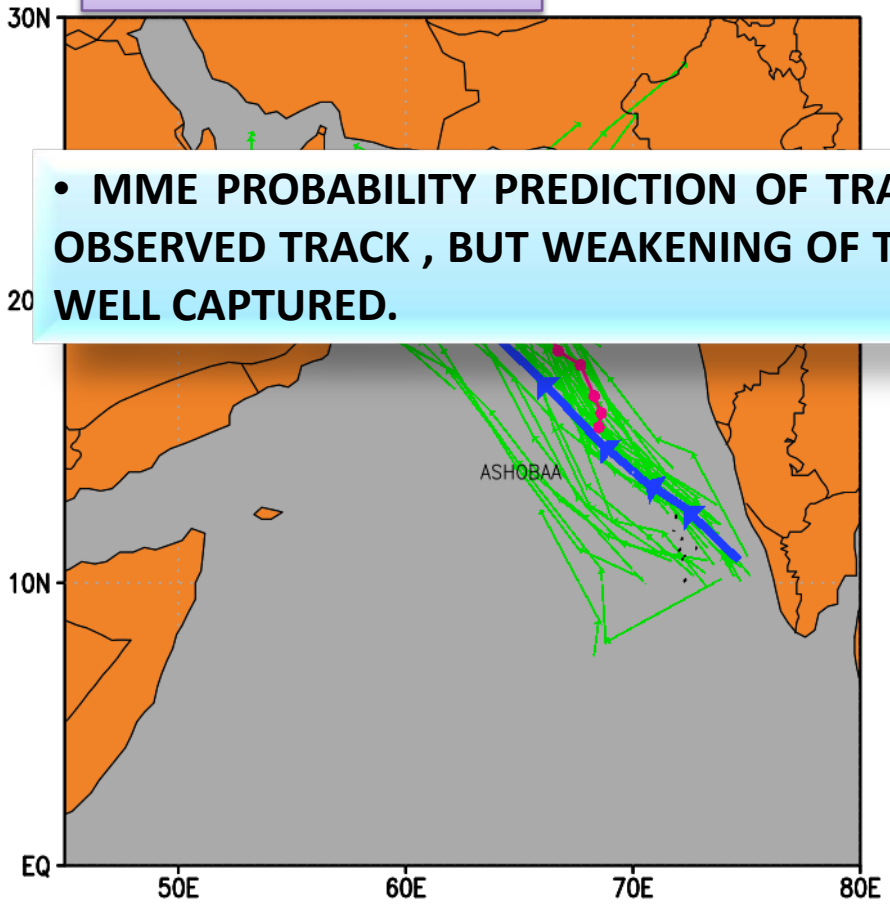
Probability Prediction of ASHOBAA (06-12 June, 2015)

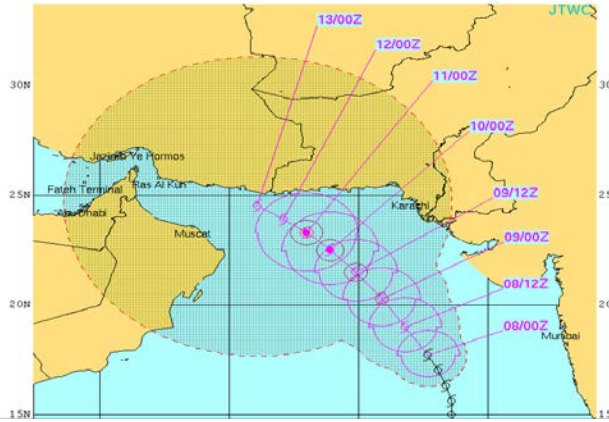
OBSERVED TRACK

MME

ENSEMBLES

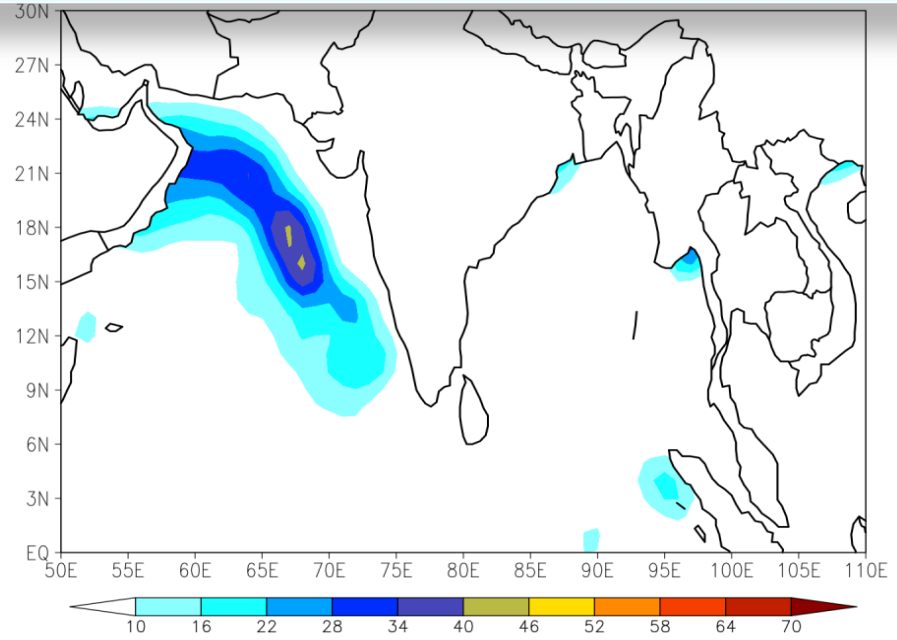
Track from 31st MAY IC





JTWC TRACK FORECAST

- **MME PROBABILITY PREDICTION OF TRACK USING 31ST MAY IC IS TO THE SOUTH OF OBSERVED TRACK , BUT WEAKENING OF THE SYSTEM AS IT PROPAGATES NORTHWEST IS WELL CAPTURED.**



Conclusions and Future Prospects...

- Genesis Forecasts derived from MME even at Pentad 2 lead time is able to capture the probable location of formation of the storms.

- Pre-genesis track forecasts could capture the track and movement of the systems (10-12 days and 5-7 days) well in advance. But GPI values were slightly underestimated for Pentad 2 leads where as overestimated for nearest ICs with a phase lag of almost 1 day.

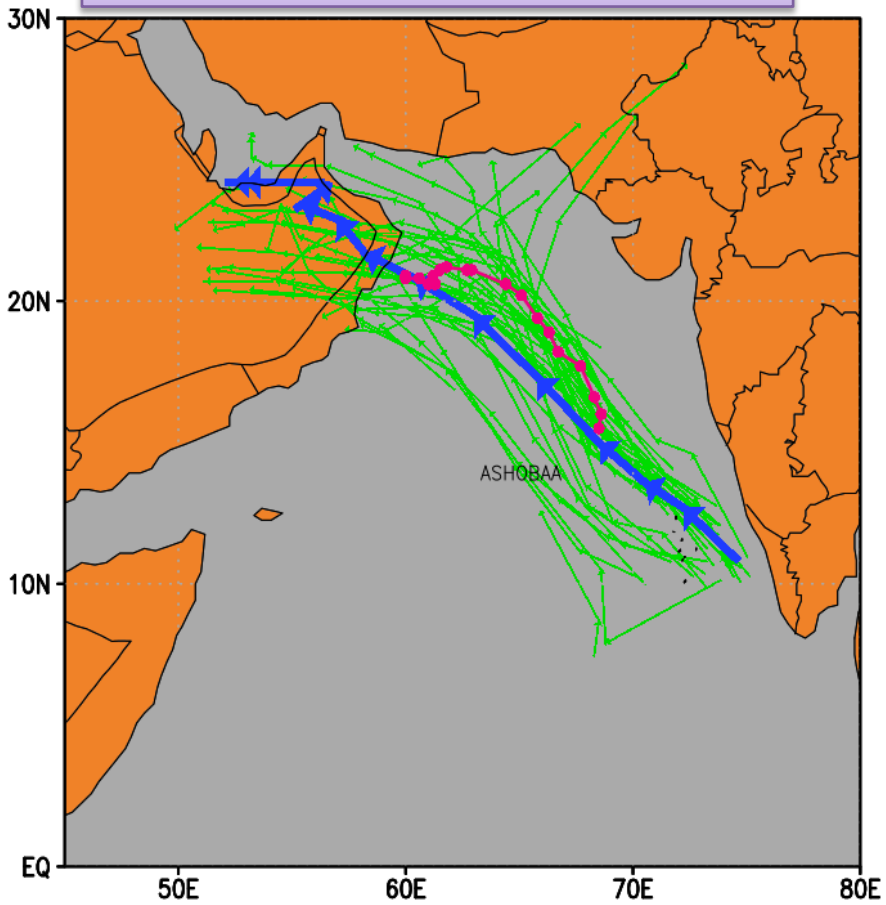
- Probability prediction implemented is capable of predicting both developing and non-developing cases of storms.

- The phase lag in the propagation and track error will be reduced by applying 4-point space time correction of ensemble members guided by the leading signal.

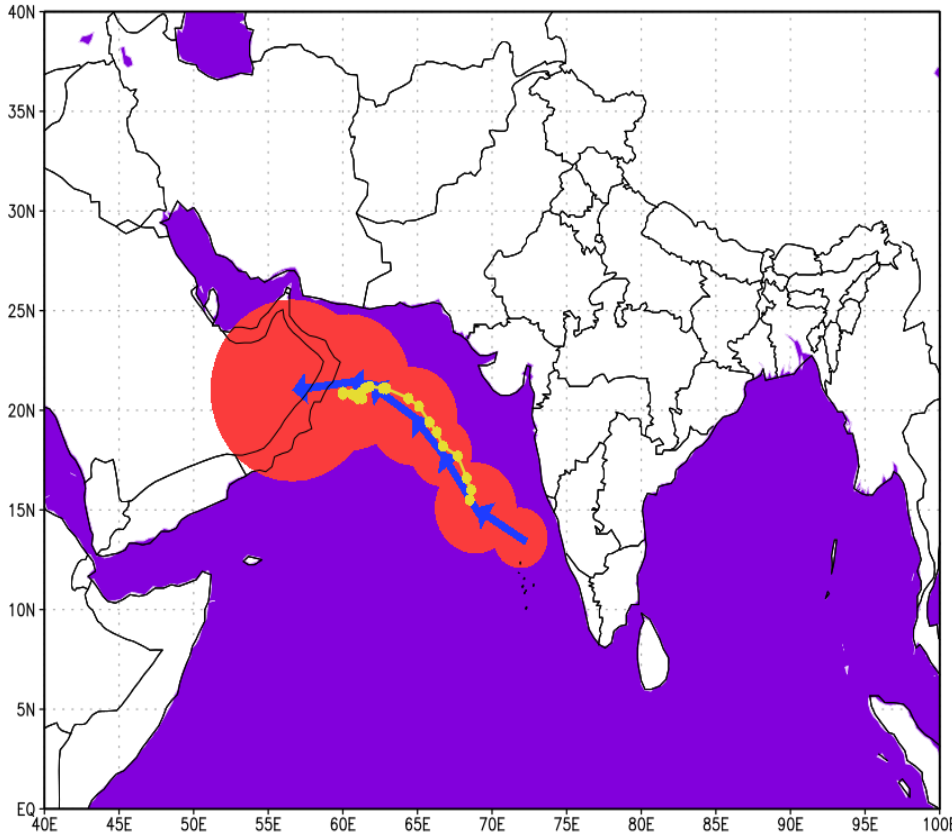
Application of correction of Ensembles Guided by Leading Signal

Track Prediction :
ASHOBAA during Onset Phase

Uncorrected Track from IC=20150531



Corrected Track from IC=20150531



(Ongoing Work)


Thank You. .