Ensemble and MME Tools Used in IMD for Weather Forecasting

D. R. Pattanaik

IMD, New Delhi

Email : drpattanaik@gmail.com/dr.pattanaik@imd.gov.in

Ensemble Workshop, NCMRWF
20-22 January, 2021

भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT

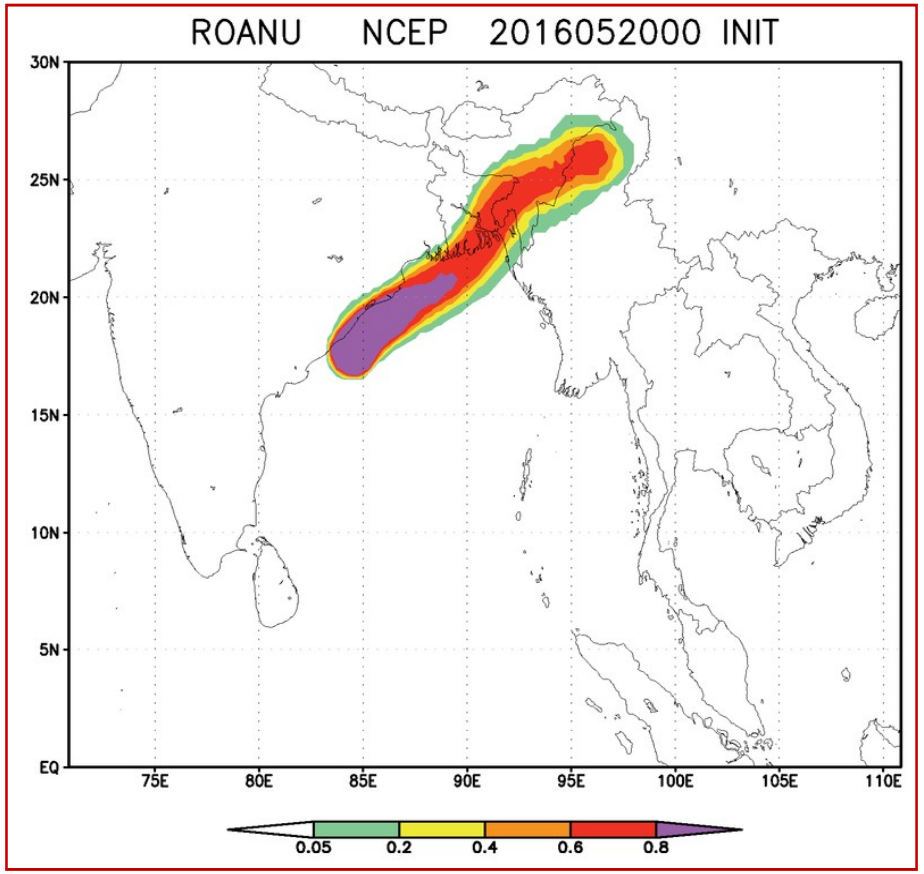
Layout of presentation

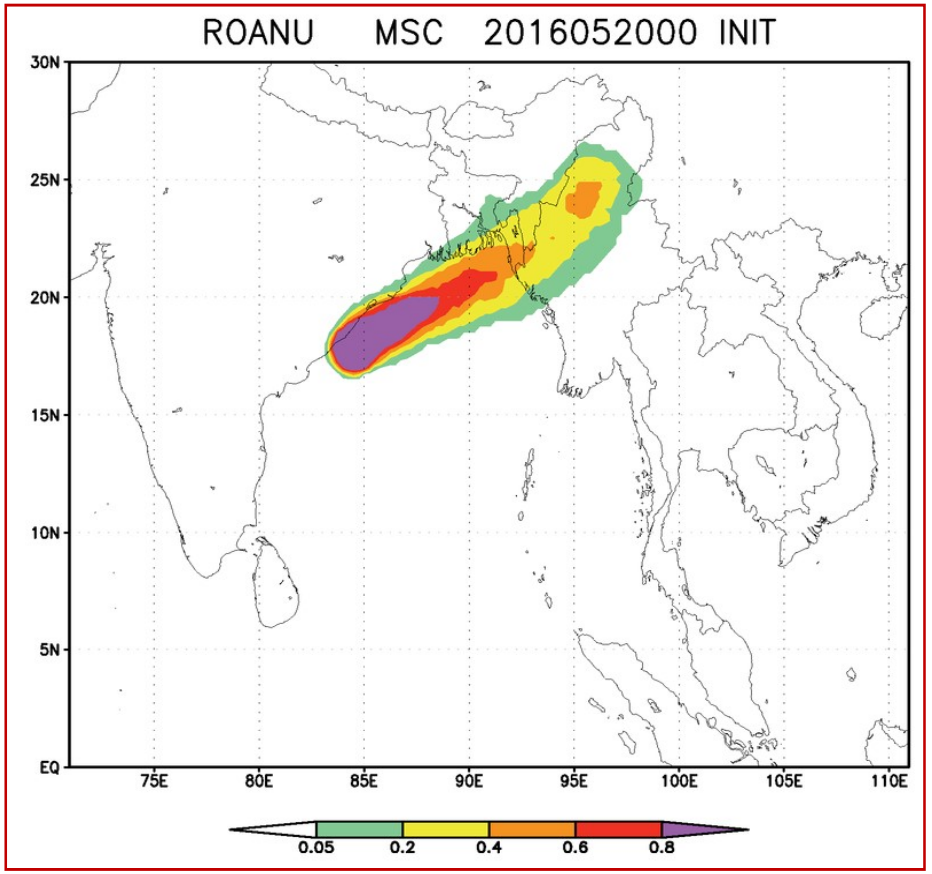
- IMD's operational Ensemble models
- *Other Ensembles & Multi-model ensembles products used by IMD for India and South Asian countries*
- Problems Areas

IMD Operational Ensemble Models

Temporal scales	Numerical NWP/Climate Models	Resolutions and Frequency of Update
Up to short range forecasting	• Hurricane Weather Research Forecast (HWRF) regional models	• 18x06x02 km (During cyclone)
Medium range forecast	• Global Ensemble Forecast System (GEFS) atmospheric model (20 members)	• 12 km (Run once a day) for 10 days
Extended range forecast (ERF)	• Climate Forecast System (CFS) coupled models (16 members)	• 38 km (Run once in a week) for 32 days
Seasonal forecast	• Climate Forecast System (CFS) coupled models (20 members)	• 38 km (Run once in a month) for 4 to 7 months

ENSEMBLE PRODUCT – 2 (TIGGE ENSEMBLE)



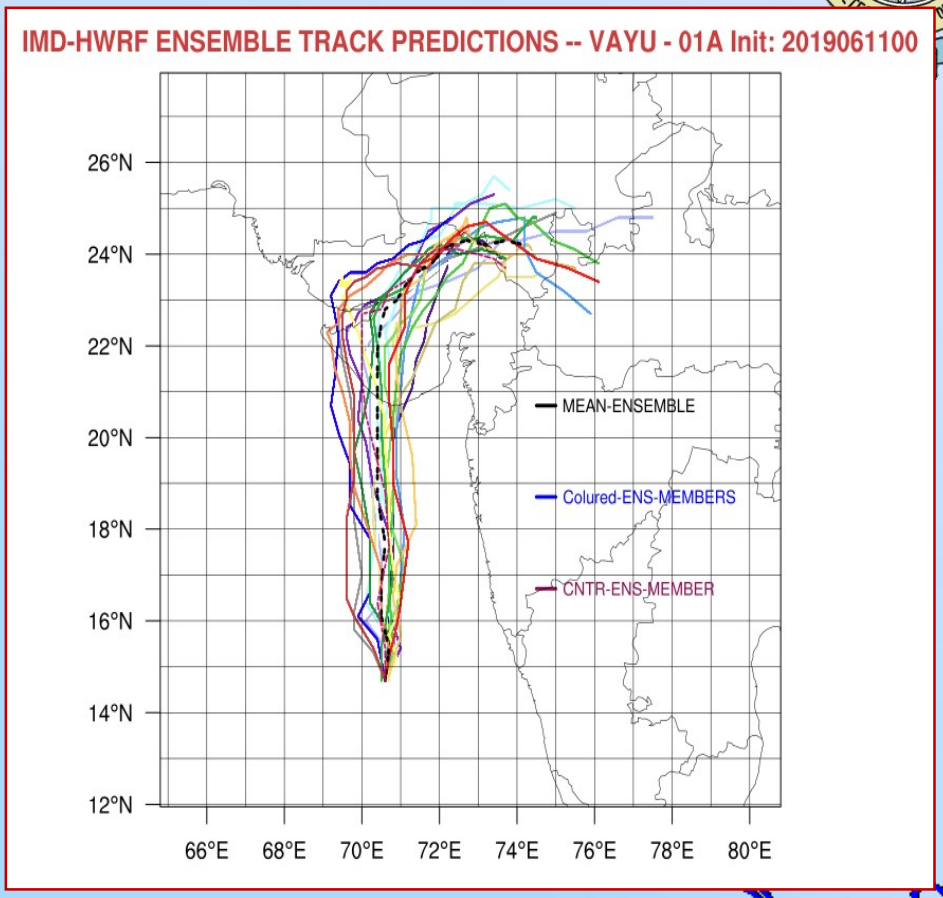


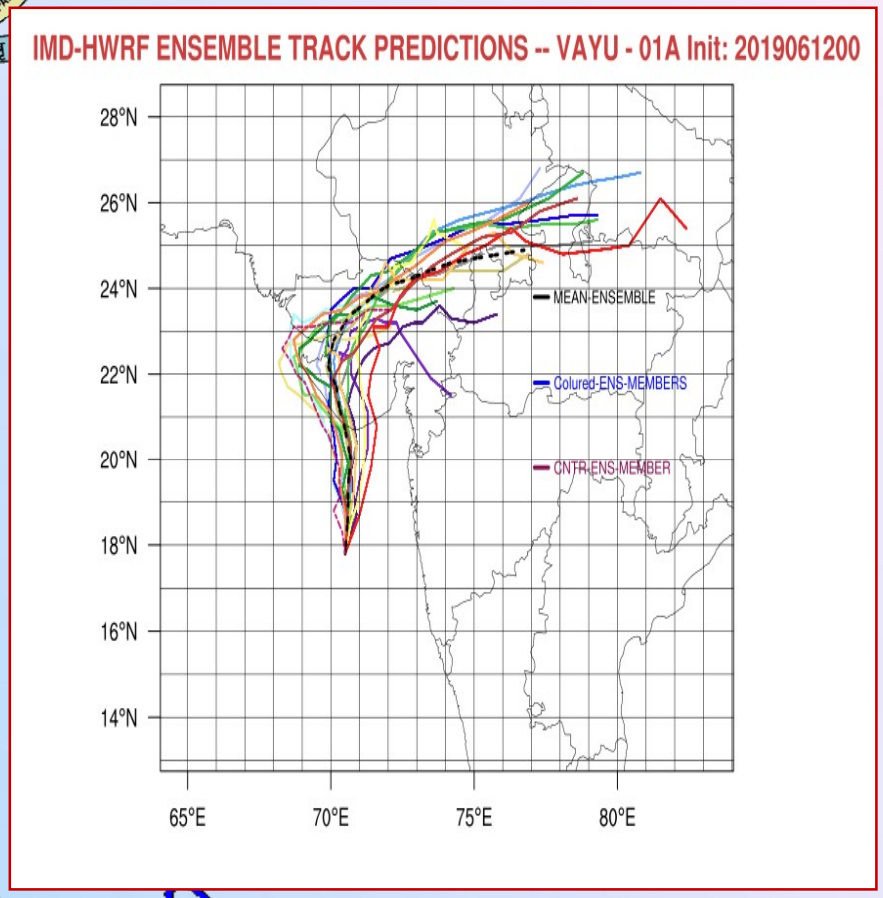
5–19% 20–39% 40–59% 60–79% 80–100%

Strike probability – the probability that the cyclone will pass within 120 km radius of a given location at any time during the next four days with each member having equal weight or represents Cone of Uncertainty (COU)

HWRF ENSEMBLE Experimental RUN for " VAYU"

- EXPERIMENTAL HWRF ENSEMBLE RUN WITH GEFS FORECAST FOR CS "VAYU".

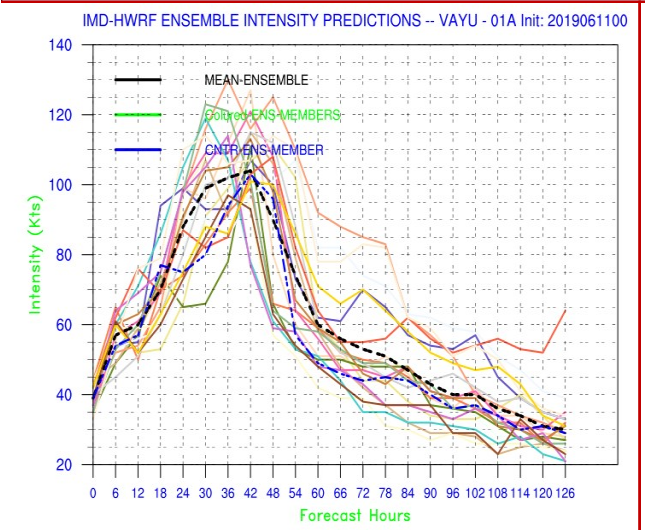


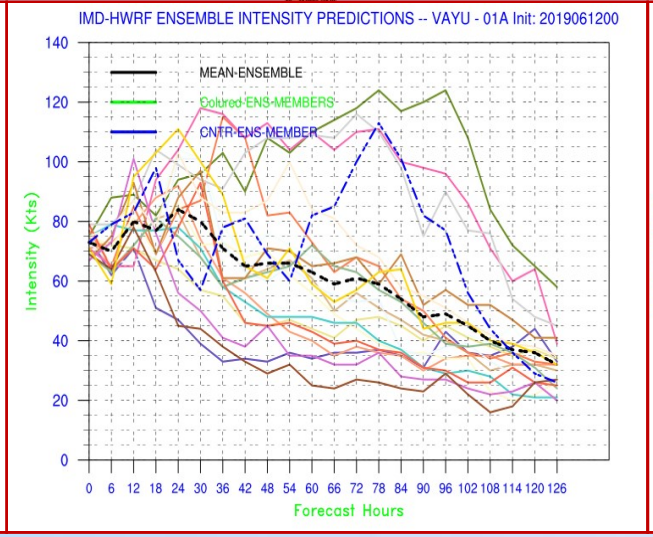


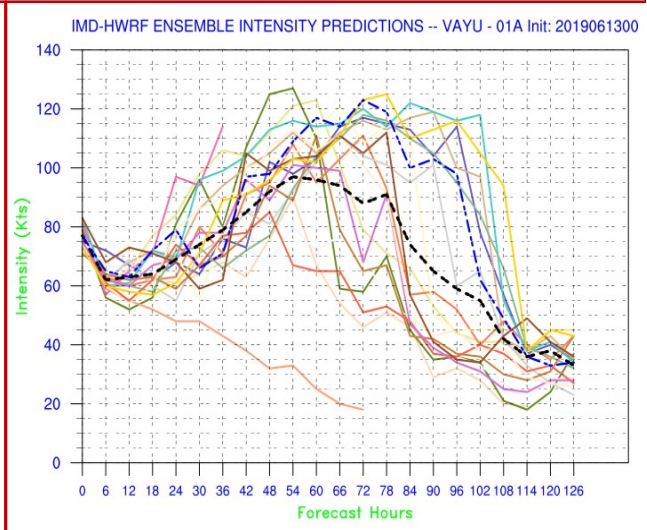
भारत मौसम विज्ञान विभाग

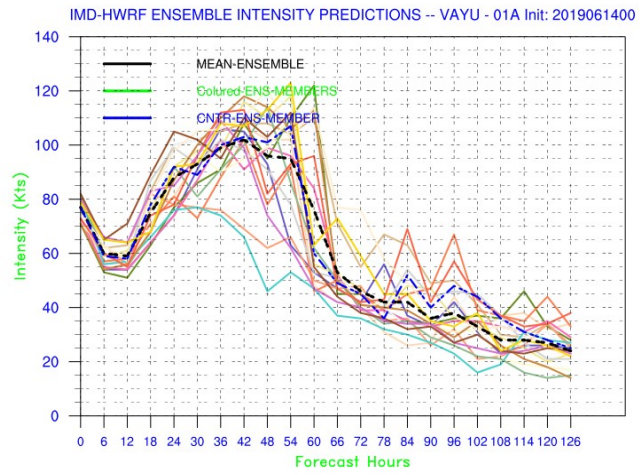
INDIA METEOROLOGICAL DEPARTMENT

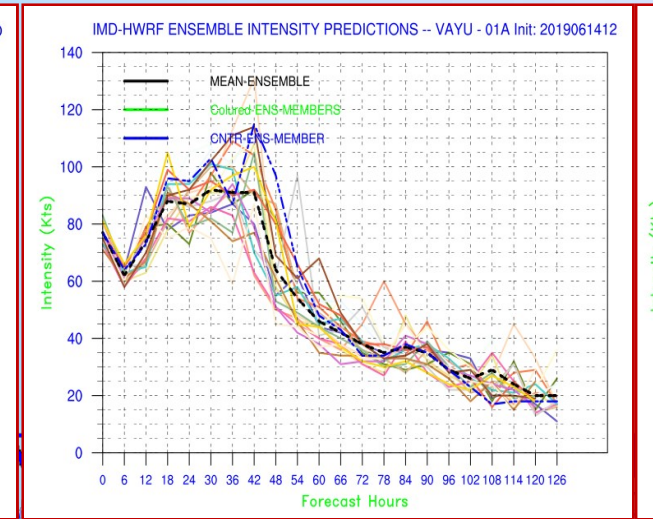
HWRF ENSEMBLE "VAYU" INTENSITY PREDICTION

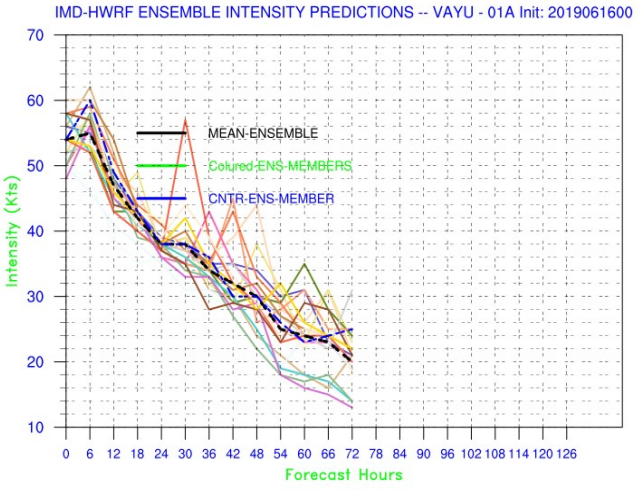








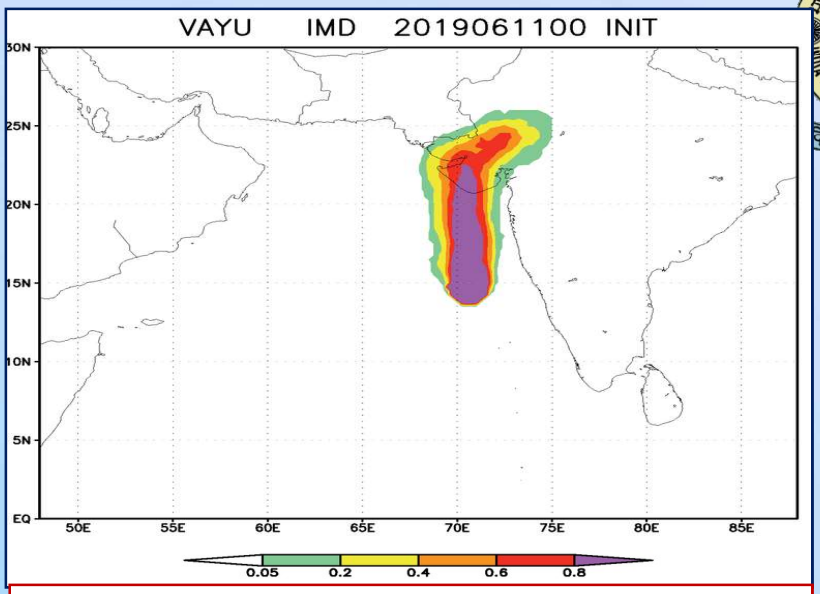


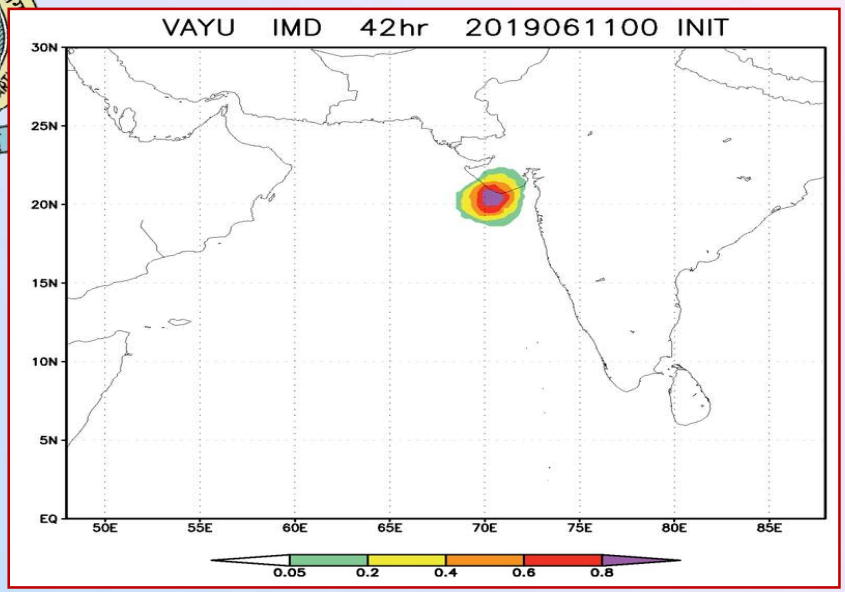


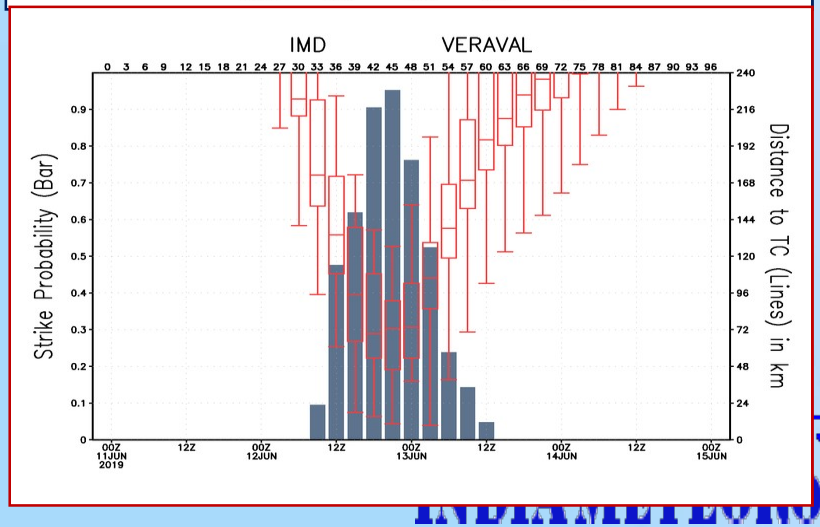
INDIA METEOROLOGICAL DEPARTMENT

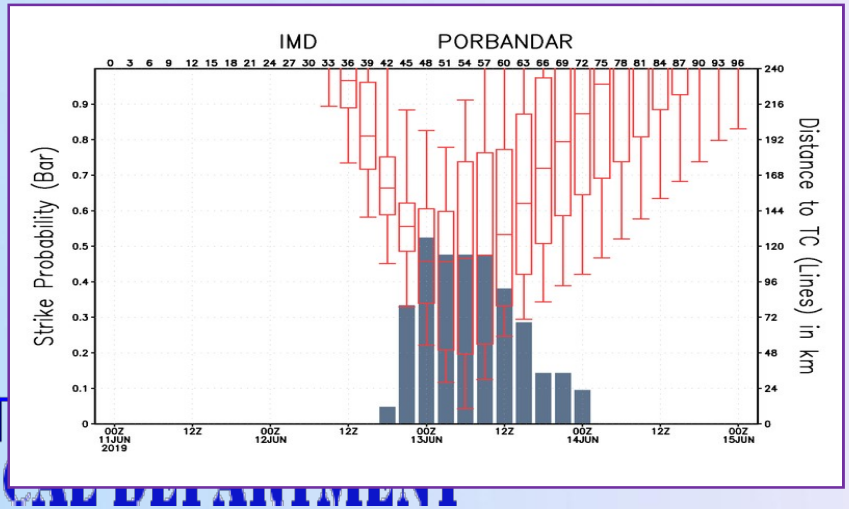
IMD-HWRF ENSEMBLE RUN UTILIZATION THROUGH "TIGGE – EPS PORTAL

IMD-HWRF-ENSEMBLE

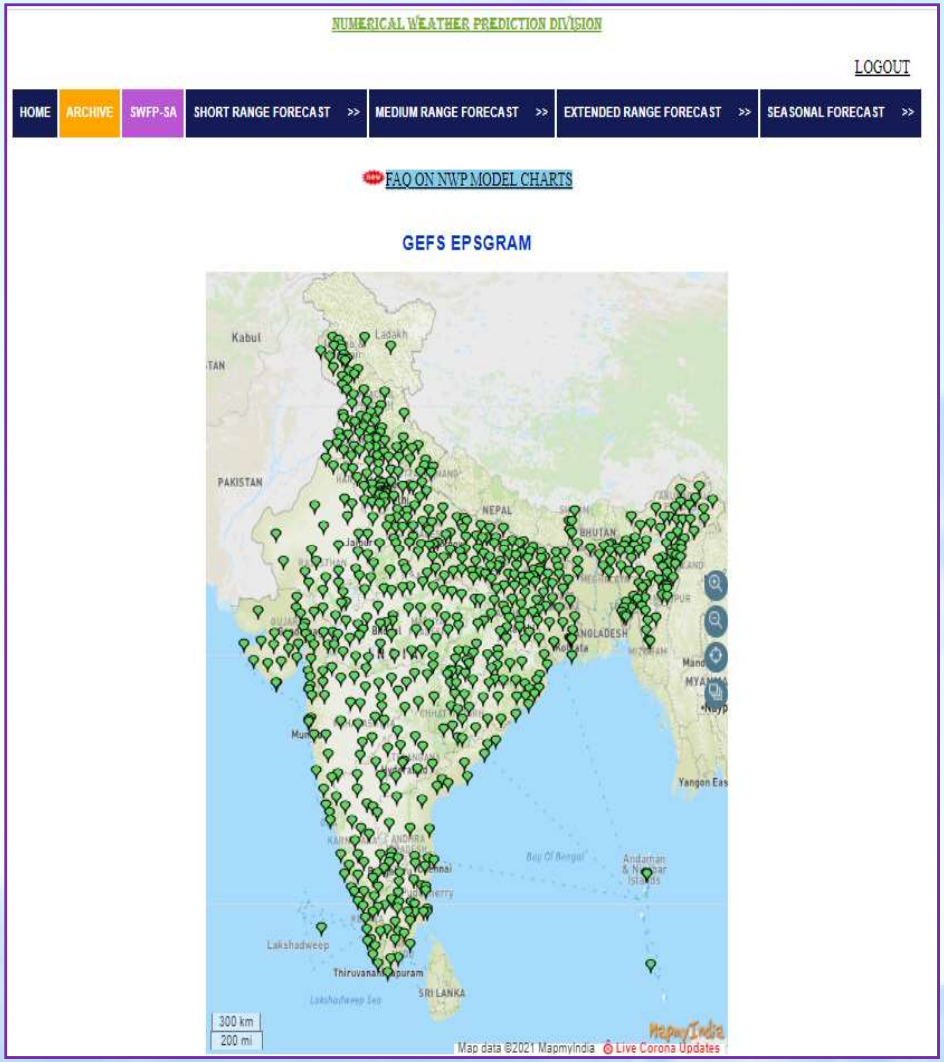


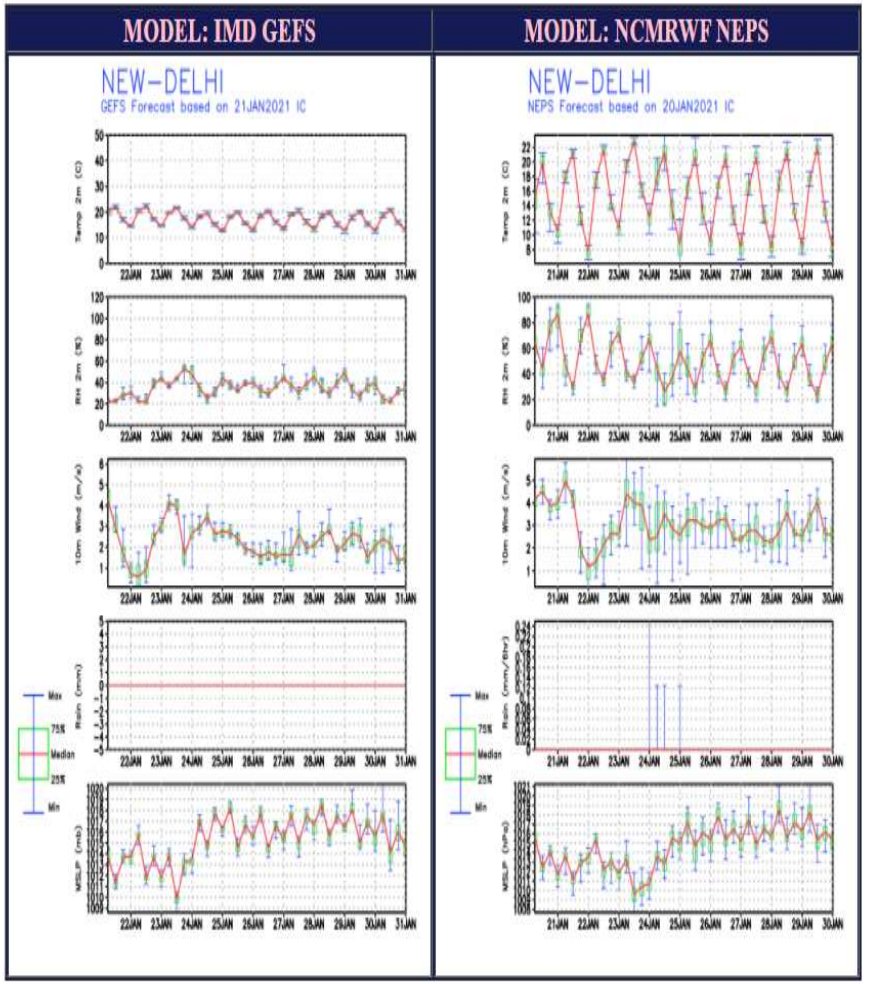


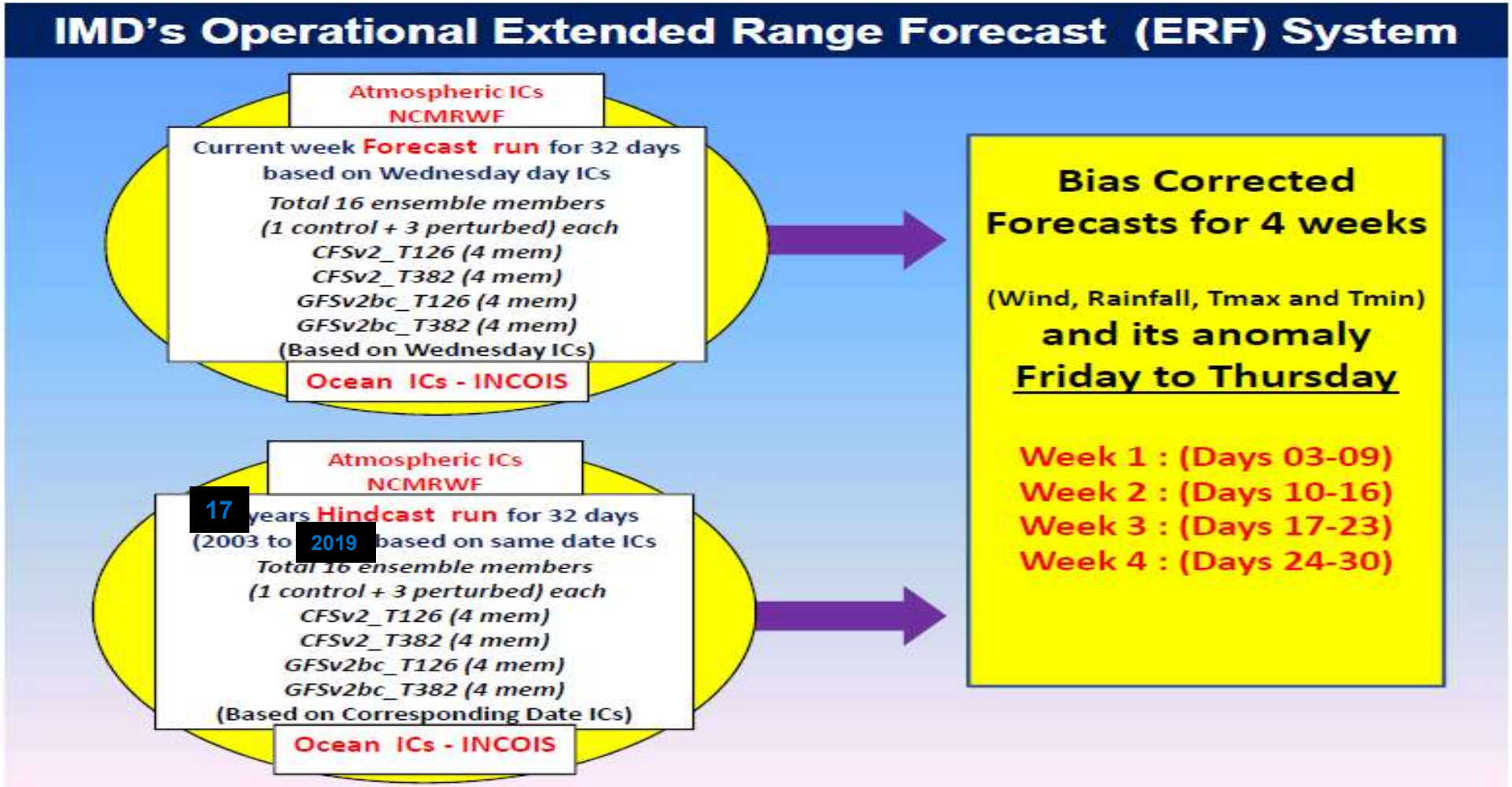




GEFS & NEPS PRODUCTS







Springer Link

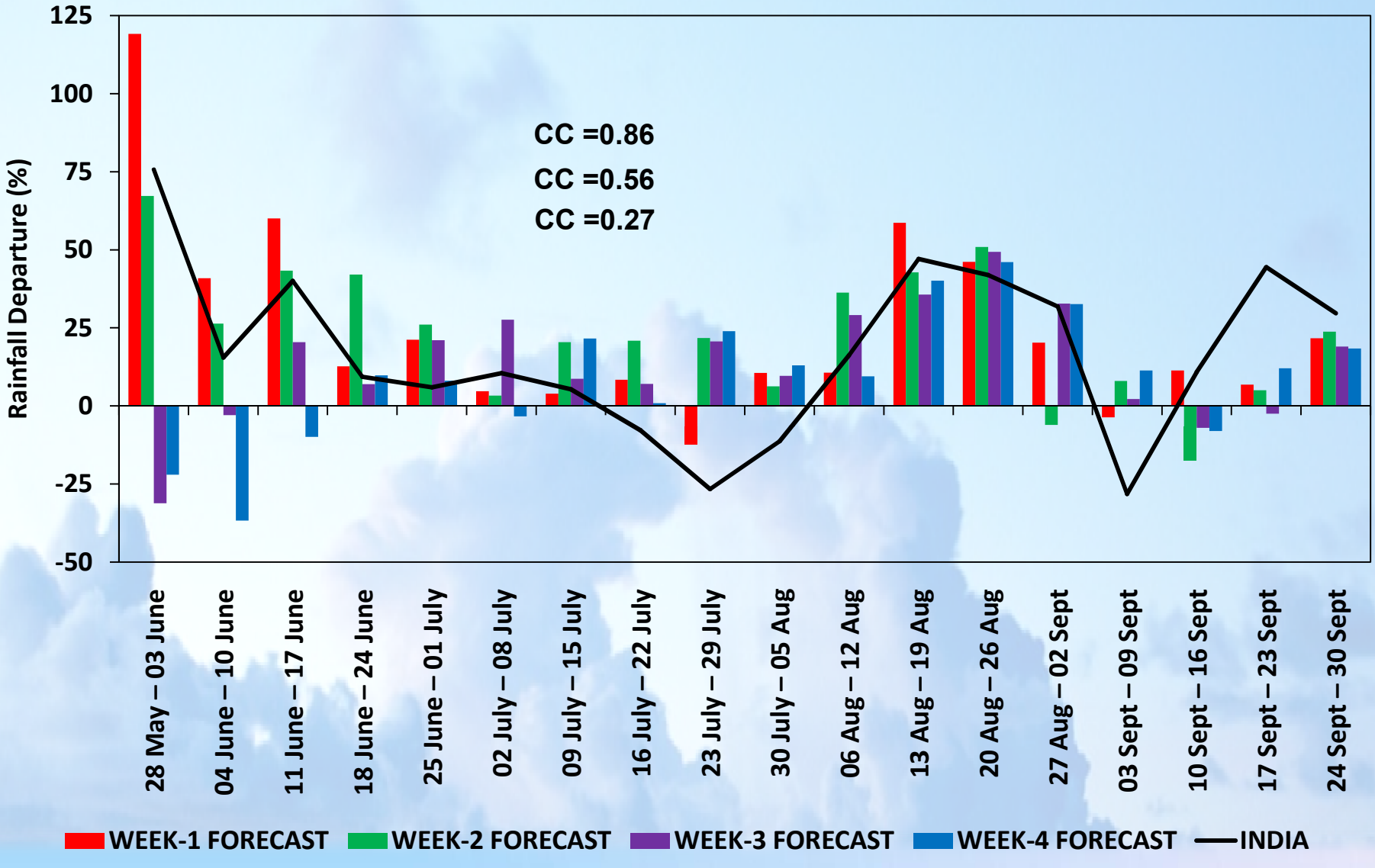
Published: 25 May 2020

Active-Break Transitions of Monsoons Over India as Predicted by Coupled Model Ensembles

D. R. Pattanaik ✉, A. K. Sahai, R. Phani Muralikrishna, Raju Mandal & Avijit Dey

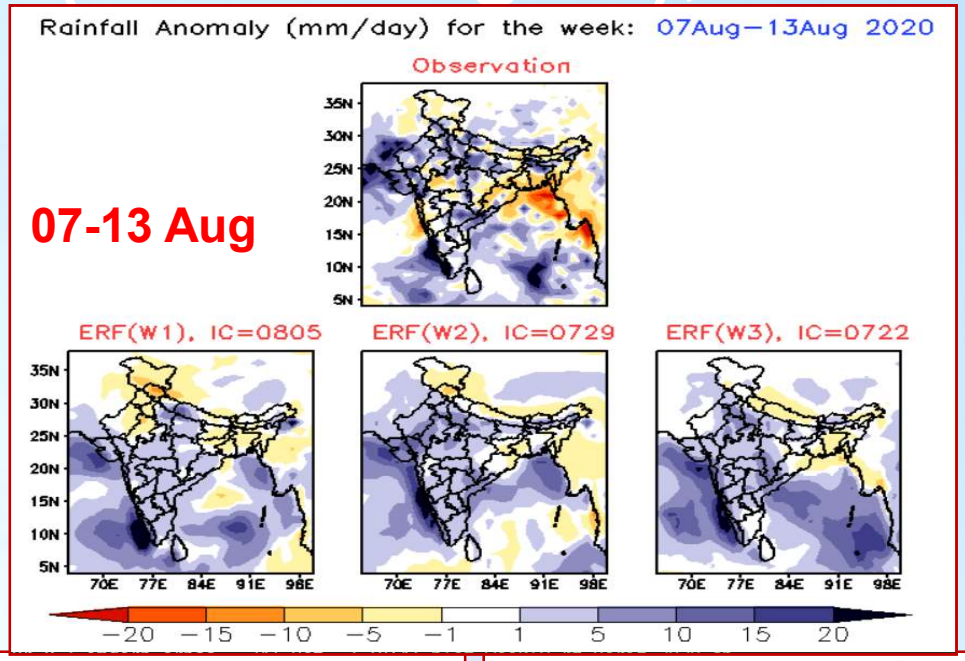
Pure and Applied Geophysics **177**, 4391–4422(2020) | Cite this article

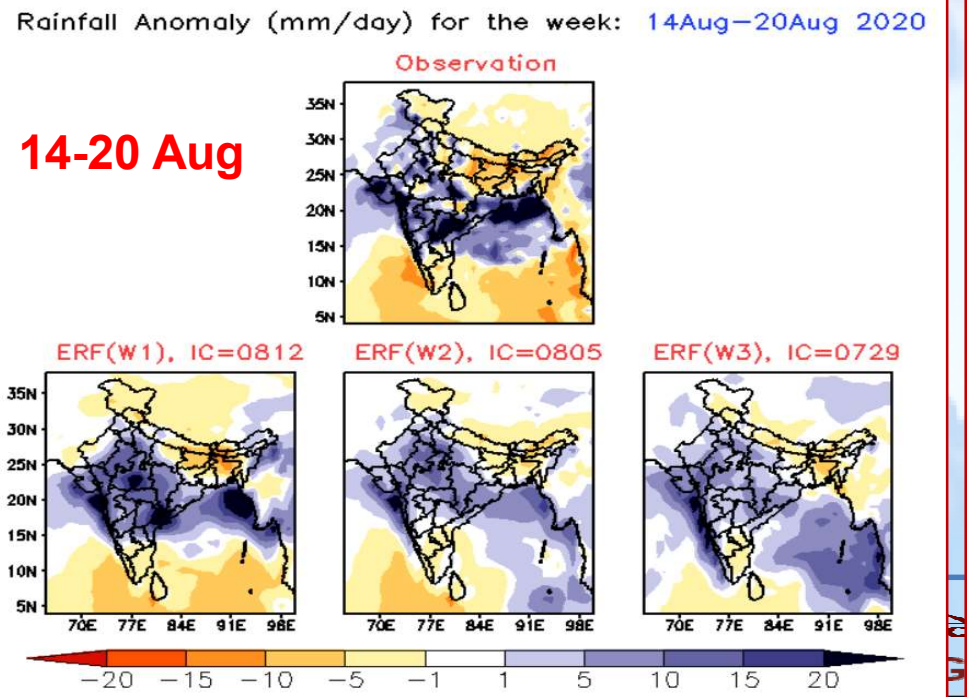
4 Week Forecast over the 18 Week Period for All India

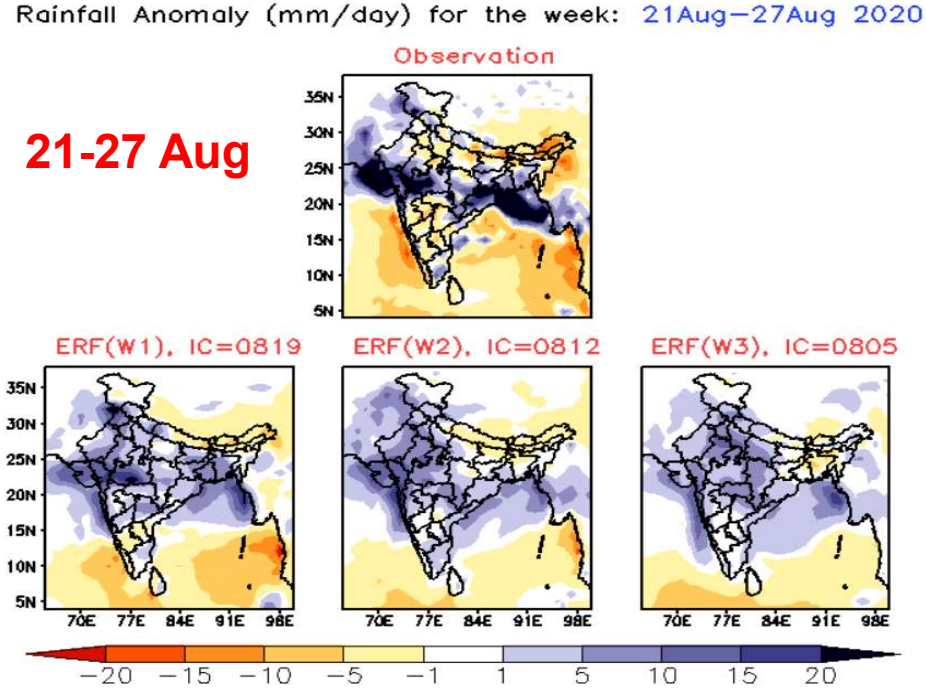


भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT

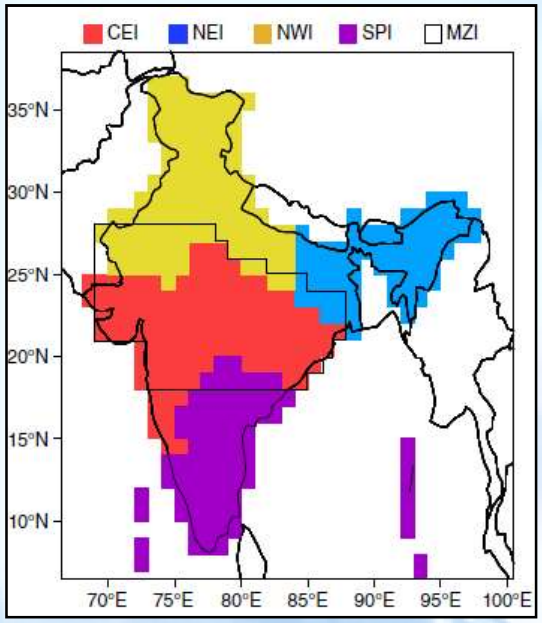
Verification (Active August); 07-27 Aug, 2020

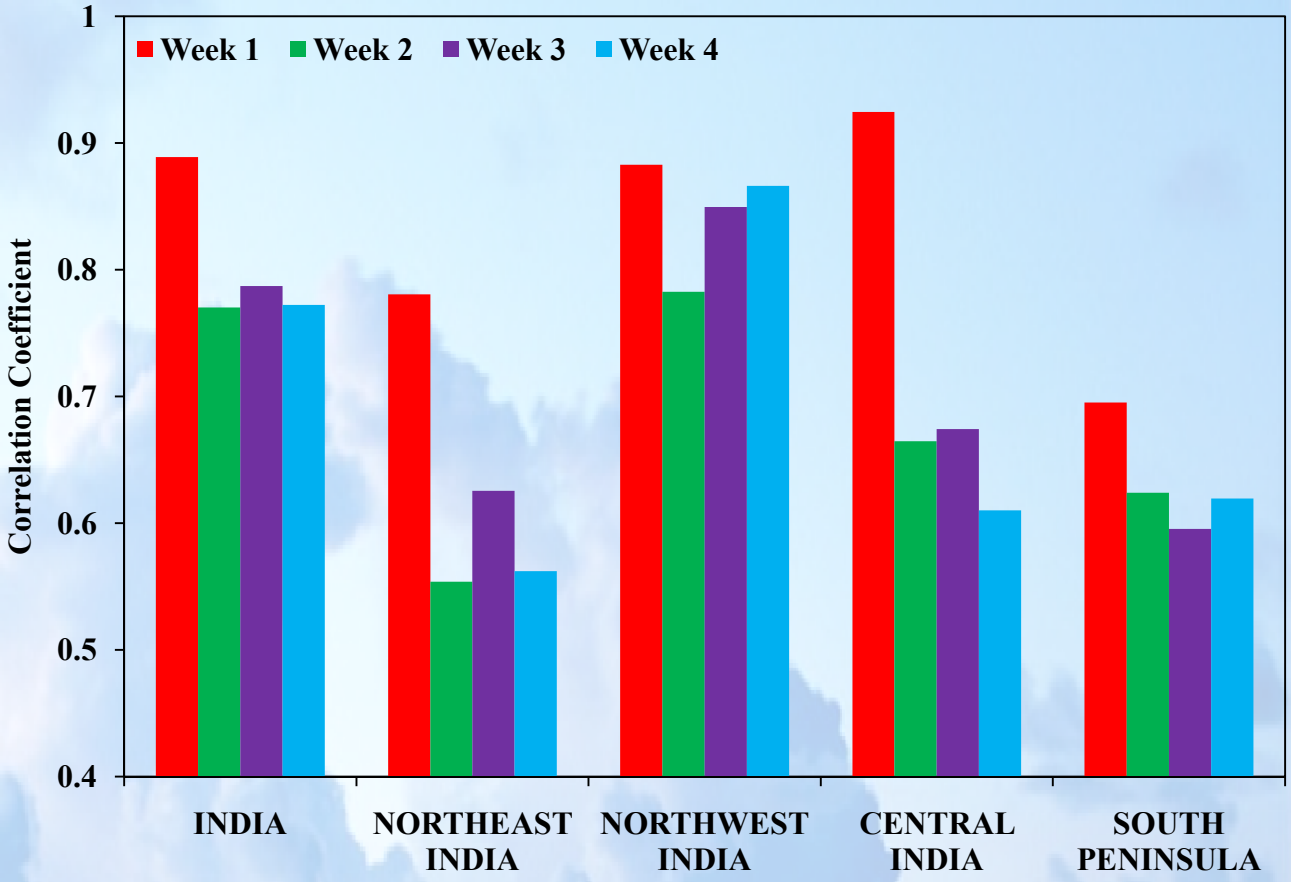






4 Week Forecast over the 4 Homogeneous regions of India

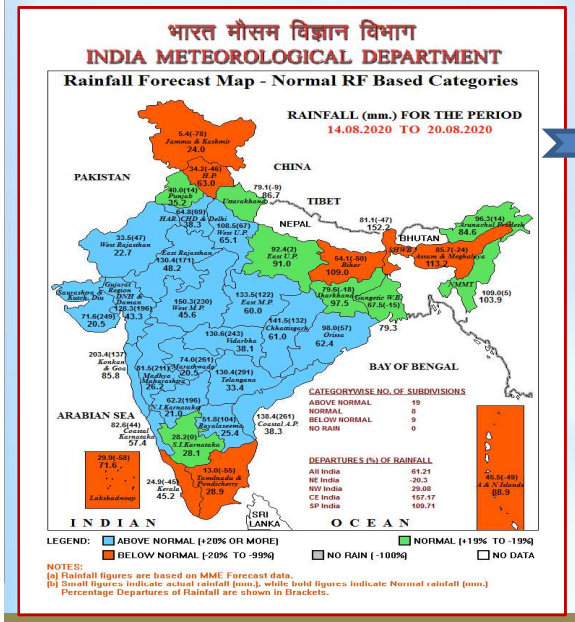


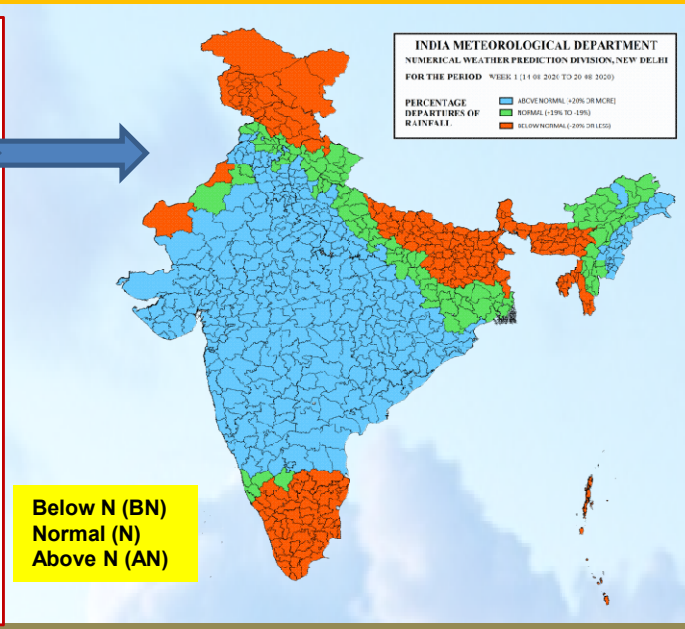


Category for verification of Met-Subdivision level forecast

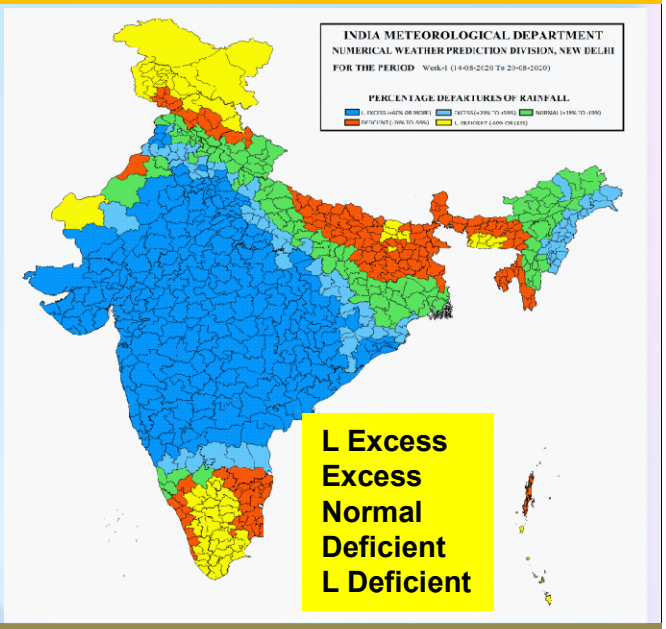
Categories	Hydrological	Agriculture
Large Excess (LE)	+60% or more	Above Normal (AN)
Excess (E)	+20% to +59%	
Normal (N)	+19% to -19%	Normal (N)
Deficient (D)	-20% to -59%	Below Normal (BN)
Large Deficient (LD)	-60% to -99%	
No Rain (NR)	-100%	

Based on 12-Aug-2020 ERF
Week-1 Forecast 14-Aug To 20-Aug 2020



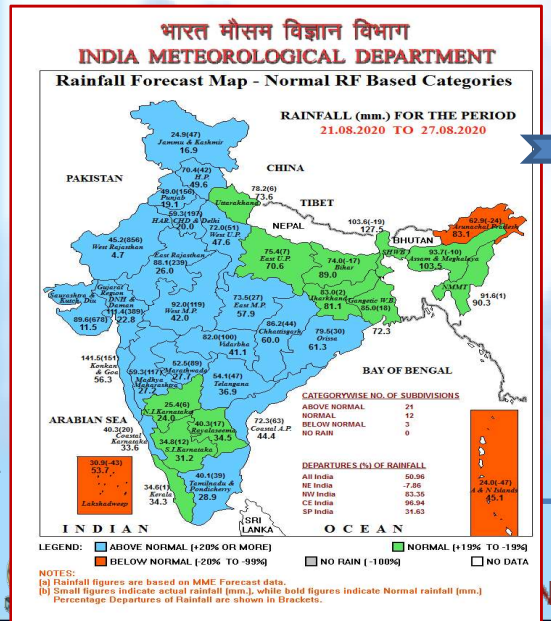


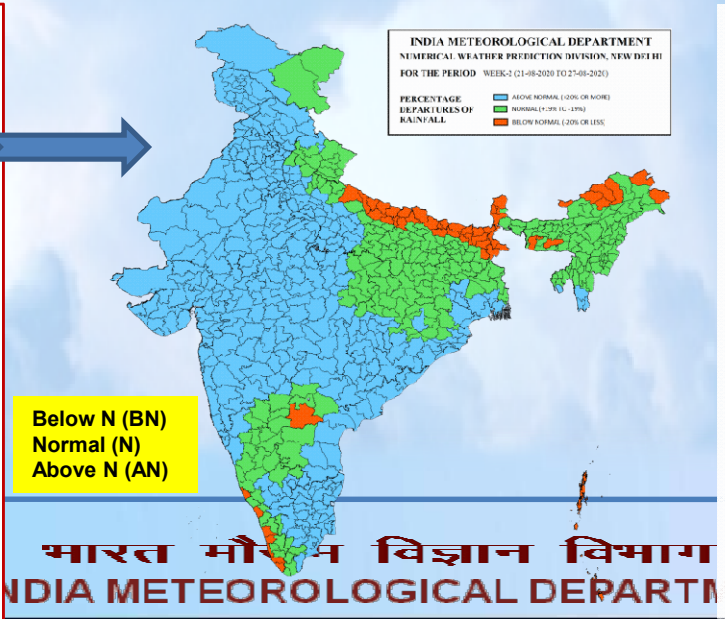
Below N (BN)
Normal (N)
Above N (AN)



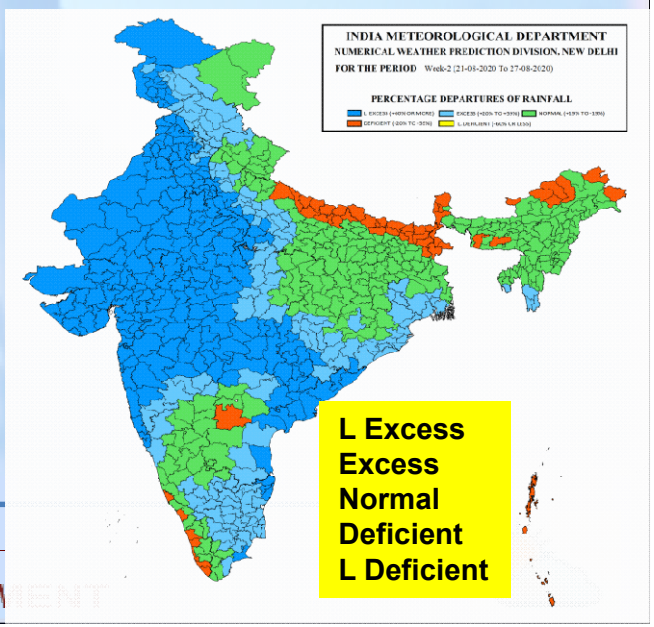
L Excess
Excess
Normal
Deficient
L Deficient

Week-2 Forecast 21-Aug To 27-Aug 2020



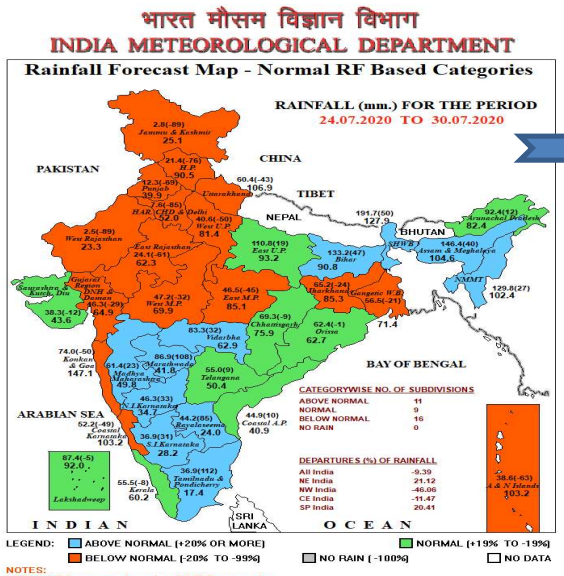


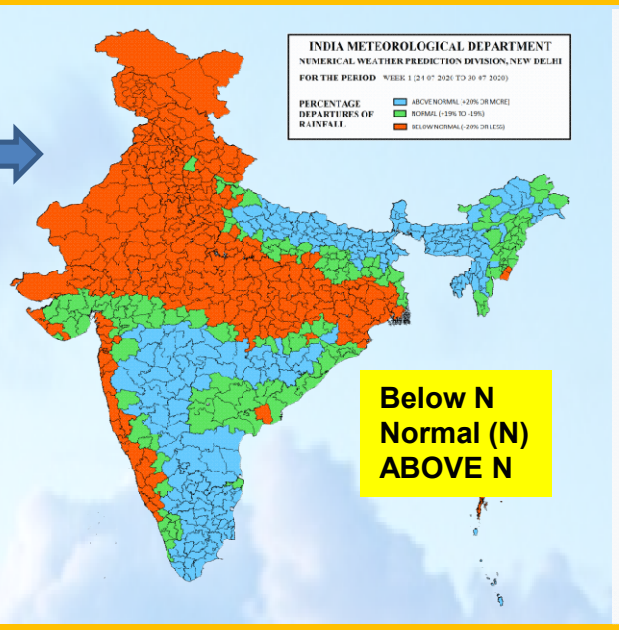
Below N (BN)
Normal (N)
Above N (AN)



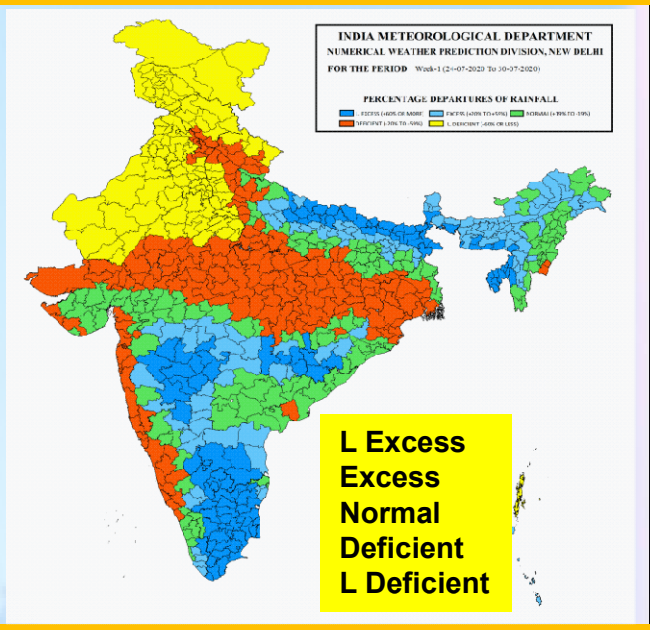
L Excess
Excess
Normal
Deficient
L Deficient

Based on 22-July-2020 ERF
Week-1 Forecast 24-July To 30-July 2020



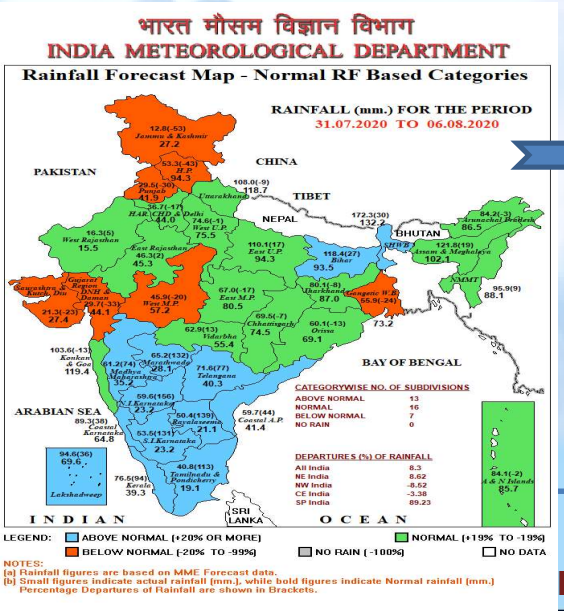


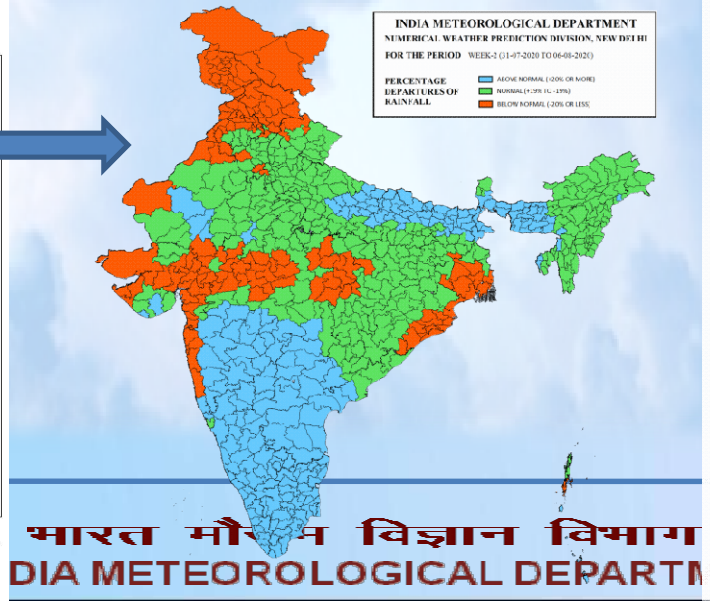
Below N
Normal (N)
ABOVE N

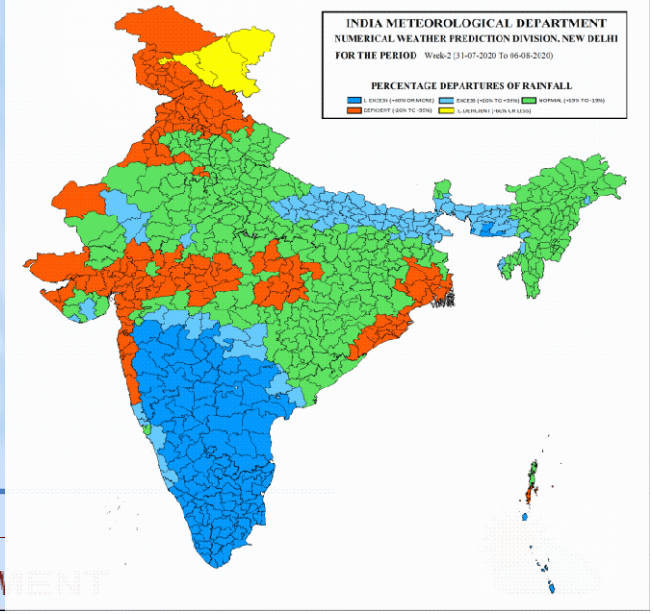


L Excess
Excess
Normal
Deficient
L Deficient

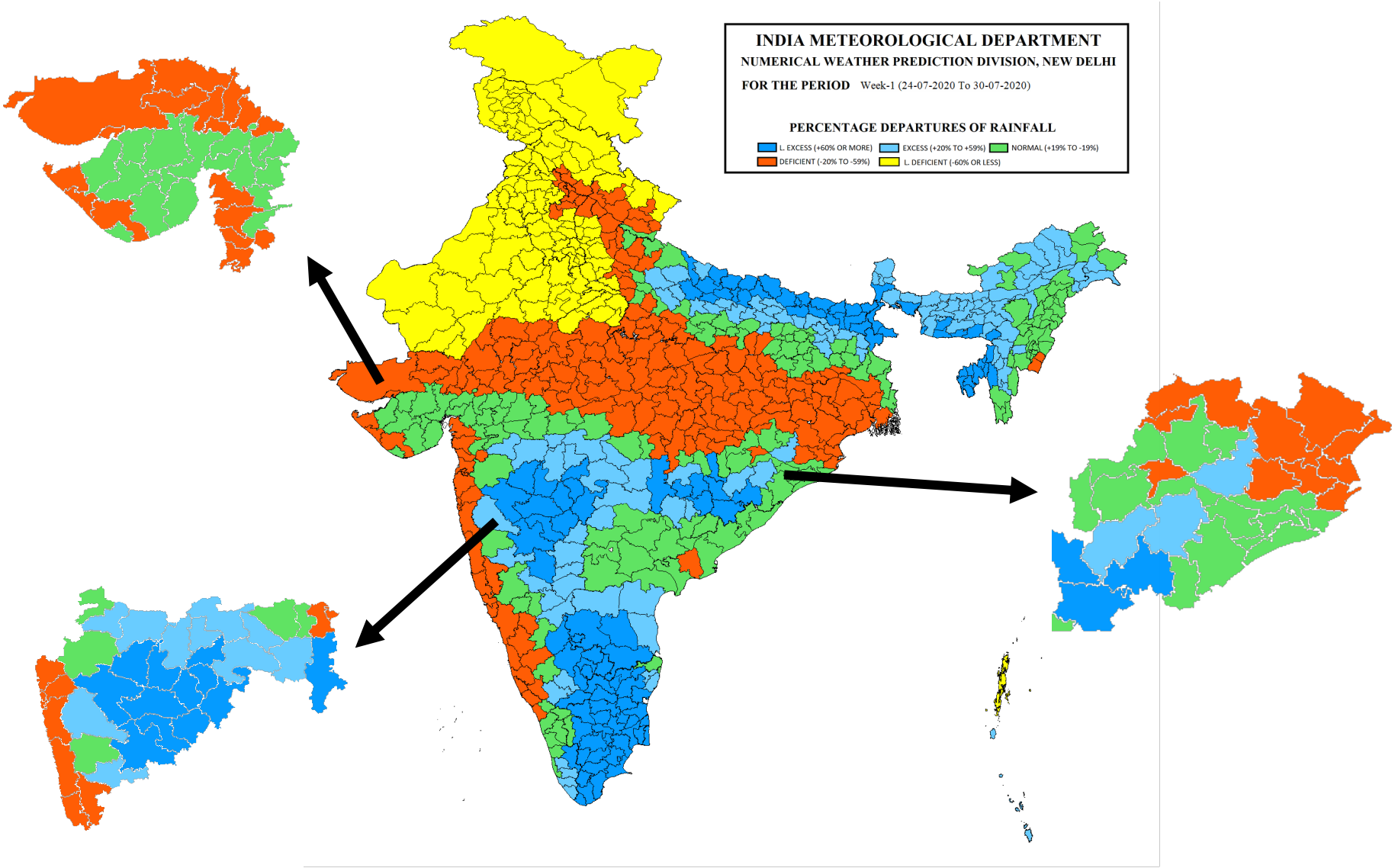
Week-2 Forecast 31-July To 06- August 2020



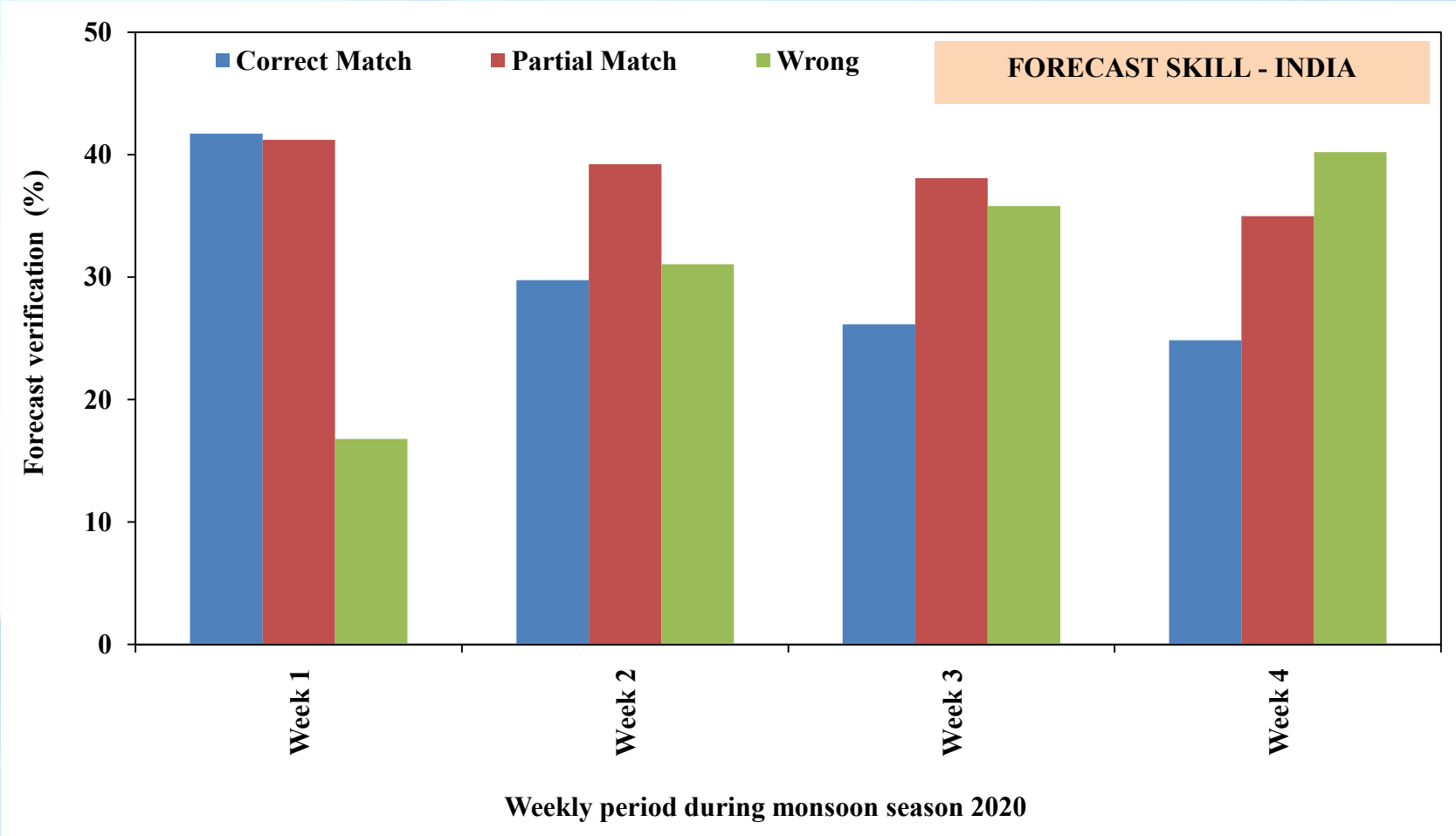




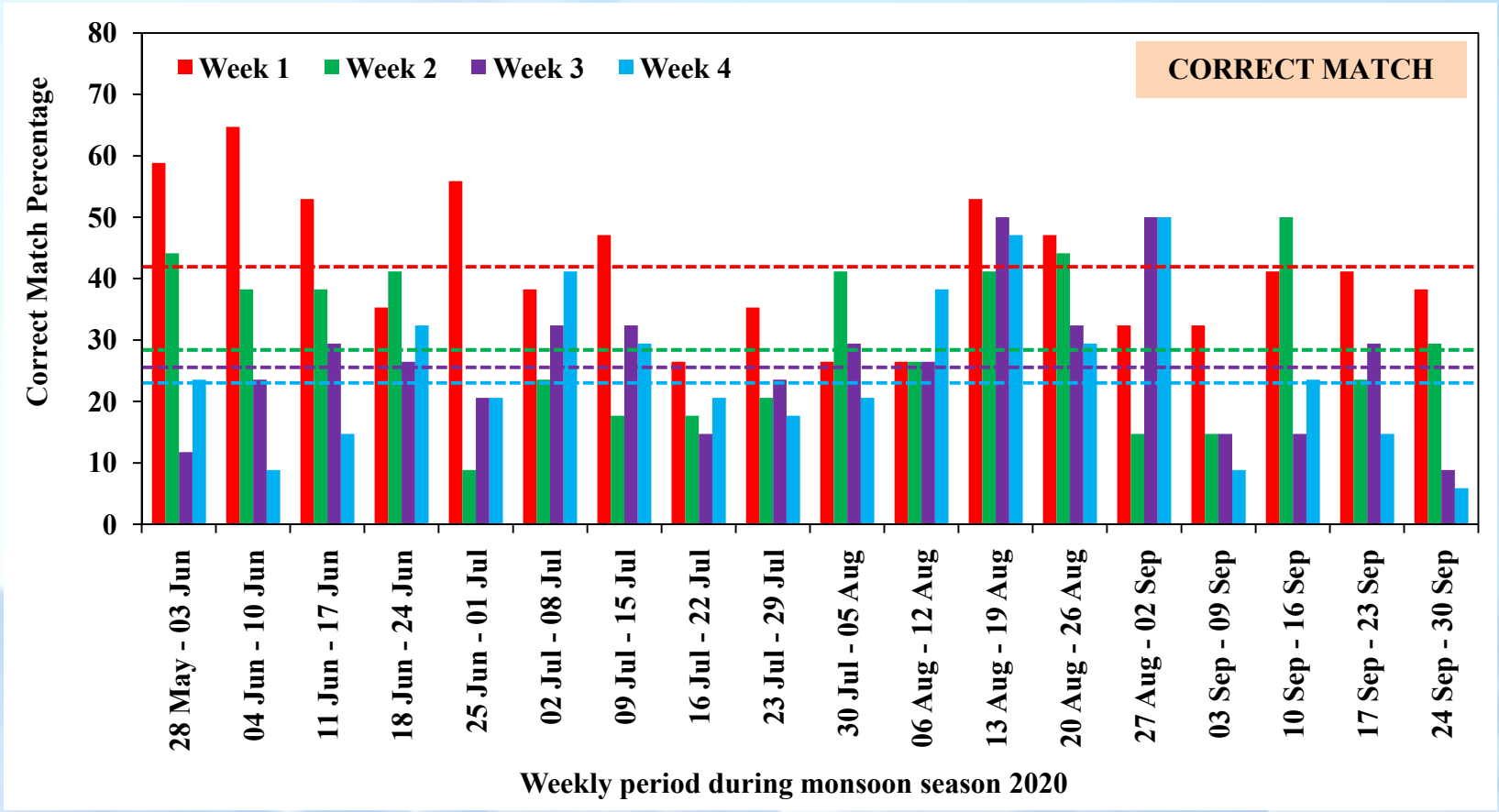
24 July – 30 July 2020



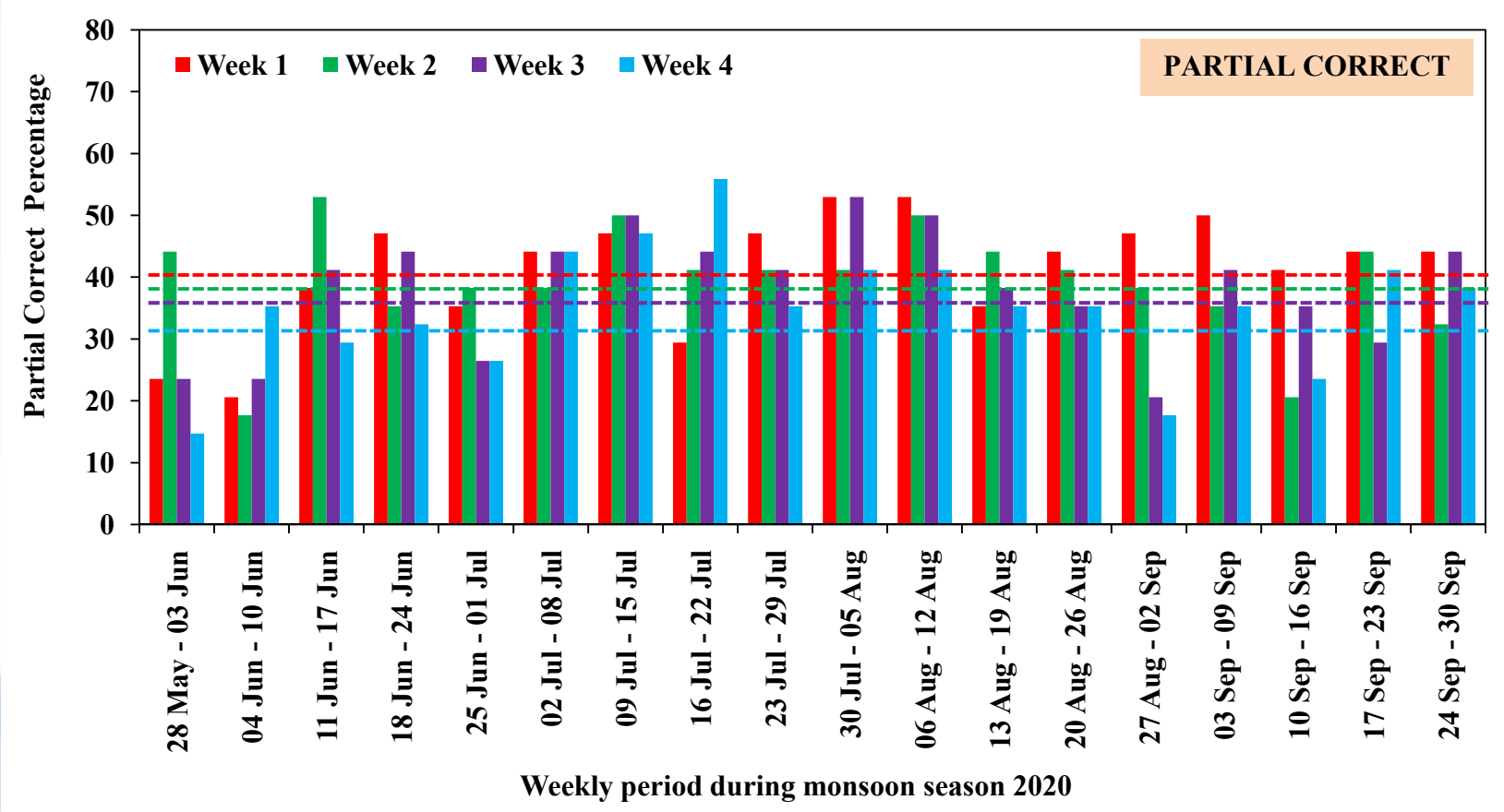
Forecast Accuracy under Different Category at Met-Subdivision level Monsoon 2020



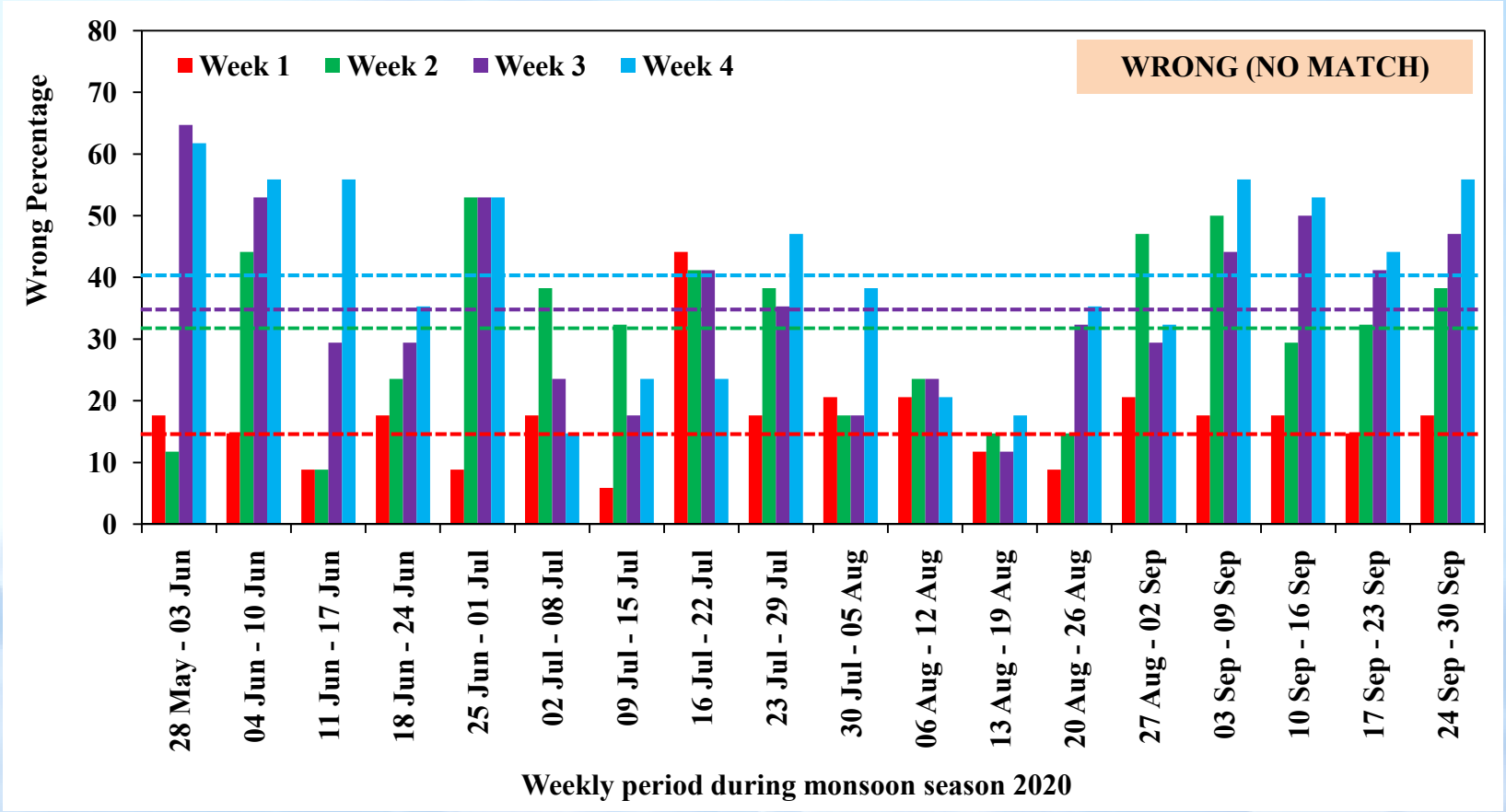
Week By Week Correct %



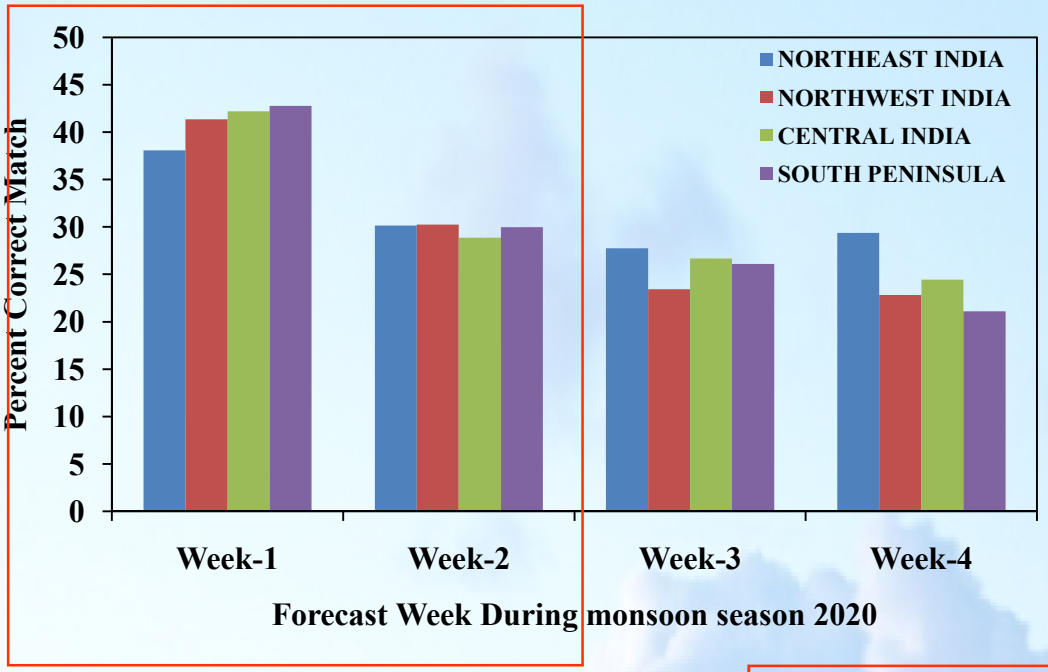
Week By Week Partial Correct %

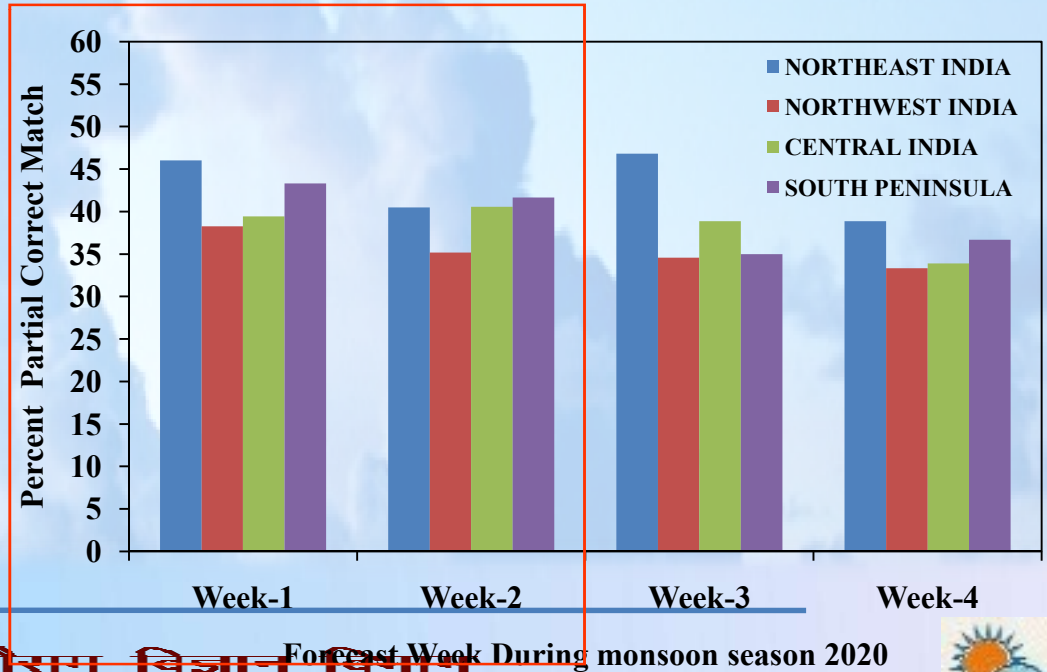


Week By Week Wrong %



Correct Category and Partially Correct Category Forecast % at Met-Subdivision level





भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT

ERF Application Products

- Agriculture & Food Security *(Active/Break cycle, Temperature; forecast at met-subdivision level for Agro-advisory)*
- Water *(Heavy rainfall forecasting, forecast at river basin scales for reservoir operation etc)*
- Disaster Risk Reduction *(Prediction of Severe Weather like Heavy Rainfall /Cyclogenesis)*

- Energy *(Tmax/Tmin, Heat wave/Cold wave)*
- Human Health *(Vector borne diseases) Experimentally it is being prepared*

Applications in Agriculture

National Agromet Advisory Service Bulletin

based on

Extended Range Weather Forecast (ERFS)

Validity: 14 - 27 August 2020

Date of issue: 14 August 2020

Issued by

AICRP on Agro-Meteorology (AICRPAM),
Central Research Institute for Dryland Agriculture (CRIDA),
Indian Council of Agricultural Research (ICAR)
&
India Meteorological Department (IMD)
Earth System Science Organization

Marathwada

- Due to cloudy and humid weather condition, there is a chance of infestation of sucking pest in cotton crop. For management, spray of 5 % NSKE or Thiamethoxam 25 % @ 40 g and Clothianidin 50 % @ 30 g per acre during clear weather condition is advised.
- Due to excess rainfall, fruit drop in citrus orchard is noticed. For management, it is advised to remove excess amount of water from orchard and spray of Trifloxystrobin 25 % + Tebuconazole 50% @ 2.5 g/ litre of water.

Vidharbha

- Under prevailing weather condition, there is a chance of pink boll worm larvae in cotton crop flowers. To control, it is advised to spray Quinolphos 25% AF @ 25 ml or Chlorpyriphos 20% EC @ 25 ml per 10 litres of water. It is also advised to collect and destroy rosette flowers/buds.

Hisar

Amount of rainfall received over Hisar is 272.1 mm (-2% deficit) during 01 June 2020 - 13 August 2020. The extended range rainfall forecast provided for next two weeks (14 - 20 August and 21 - 27 August 2020) over Hisar is below normal for week-1 and above normal for week-2.

- Under prevailing weather conditions, farmers are advised to withhold irrigation in vegetables and fruits crops.
- Farmers are also advised to go for sowing of sorghum, maize and lobia as fodder crops.
- Provide 50 g iodized salt and 50 - 100 g mineral mixture daily with animal feed/fodder to keep animals healthy.

Karnataka

Rainfall received during 01 June 2020 - 13 August 2020 over South Interior Karnataka is 526.1 mm (19% excess) and North Interior Karnataka is 415.7 mm (45% excess). The extended range weather forecast for next two weeks (14 - 20 August and 21 - 27 August 2020) over South Interior Karnataka is normal and North Interior Karnataka is above normal for week-1 and normal over South Interior Karnataka and North Interior Karnataka for week-2.

South Interior Karnataka

- Under prevailing weather condition, there is a chance of wilt diseases in redgram. It is advised for drenching with Carbendazim 50 WP @ 2 g/litre of water. Remove and burn the infected plants in the field itself.
- Due to high wind speed, it is advised to provide staking support to banana and vegetable crop to protect from uprooting of crops.

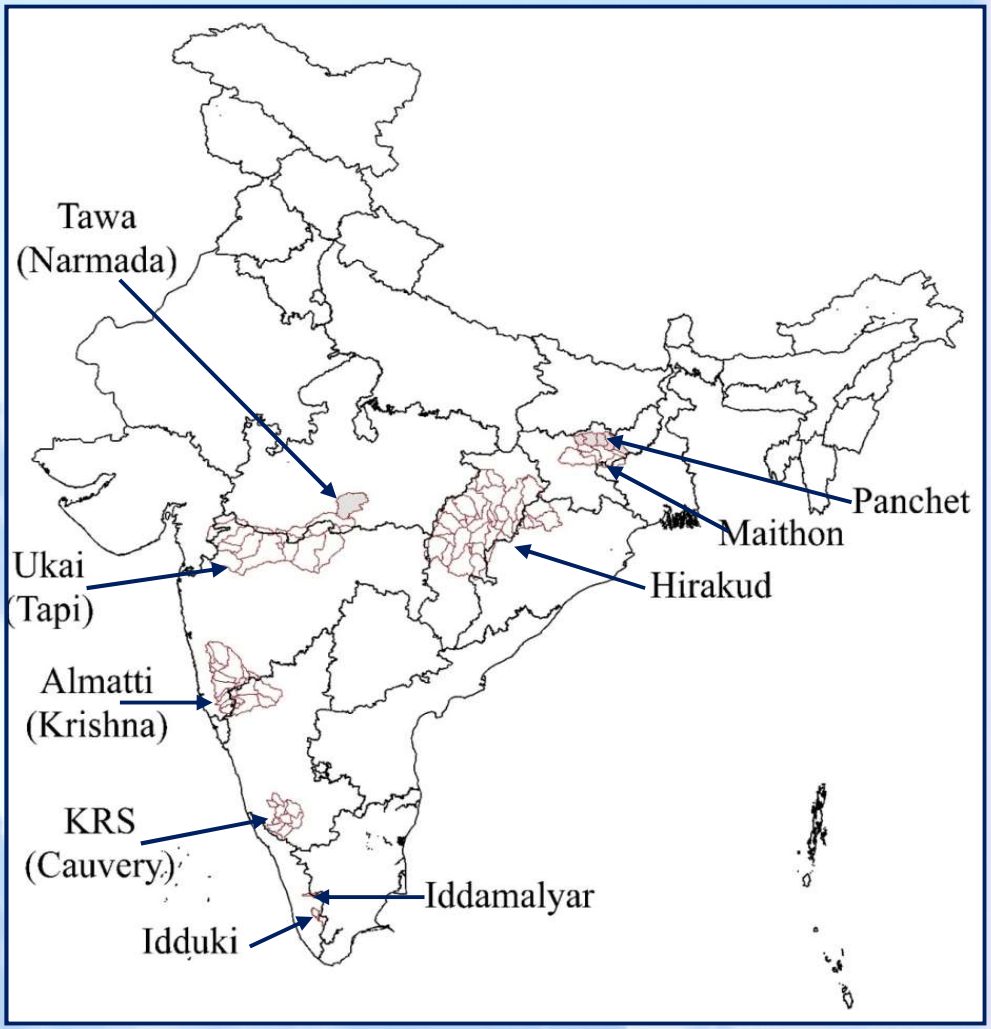
North Interior Karnataka

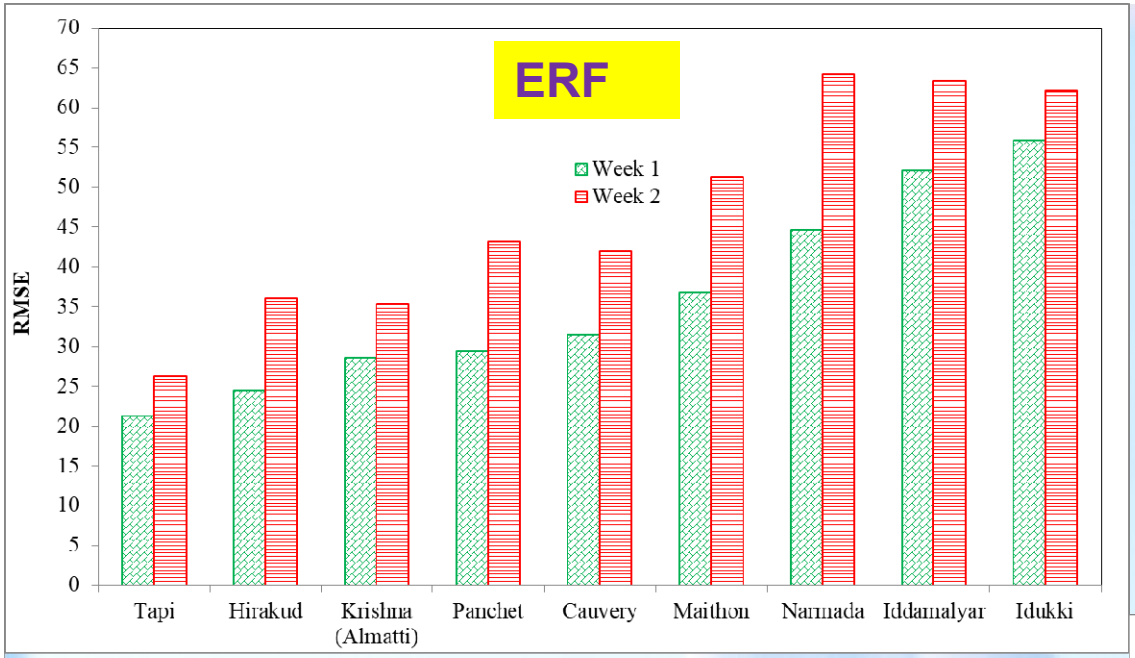
- Under prevailing rainy weather condition, sowing of *kharif* crops like bajra, redgram, groundnut (spreading type), navane, and horsegram is recommended.
- Farmers are also advised to sow the crops in rows across the slope to facilitate better soil

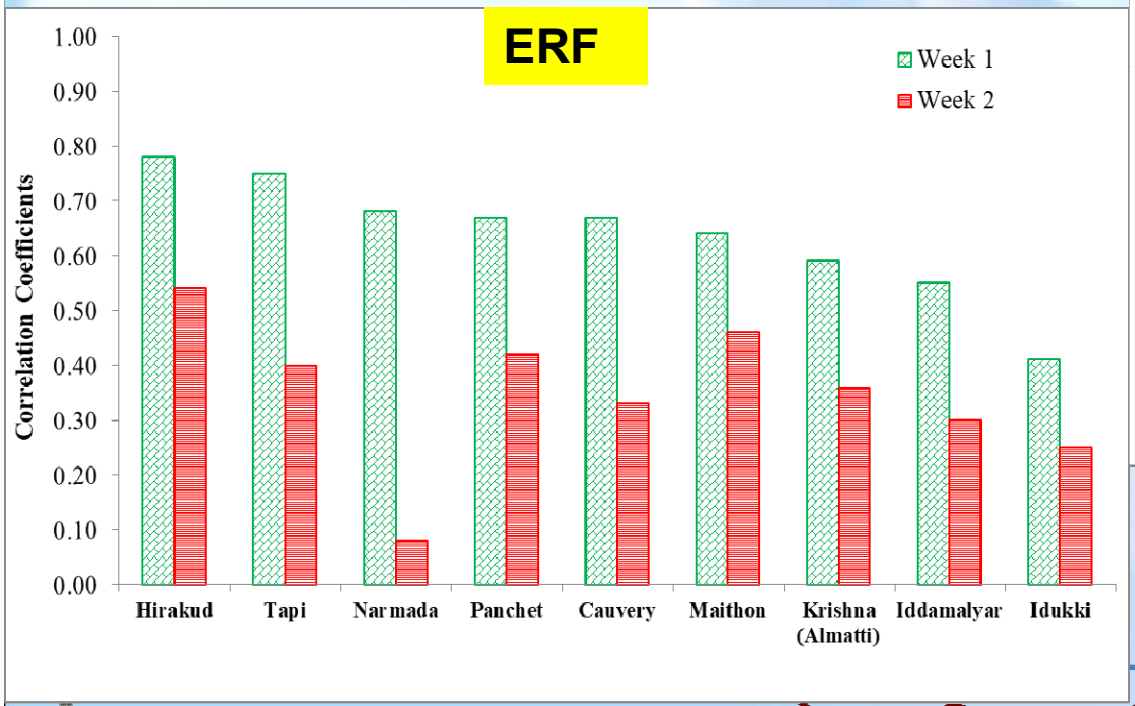
Map showing River basins

The nine river basins are:

1. **Tawa (Narmada)**
2. **Ukai (Tapi)**
3. **Almatti (Krishna)**
4. **Krisna Raja Sagar (KRS)/ Cauvery**
5. **Idukki**
6. **Iddamalyar**
7. **Hirakud**
8. **Maithon**
9. **Panchet**

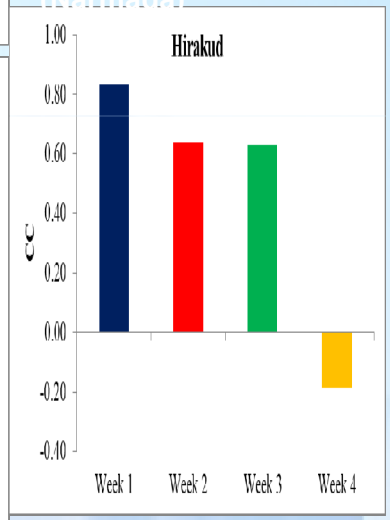


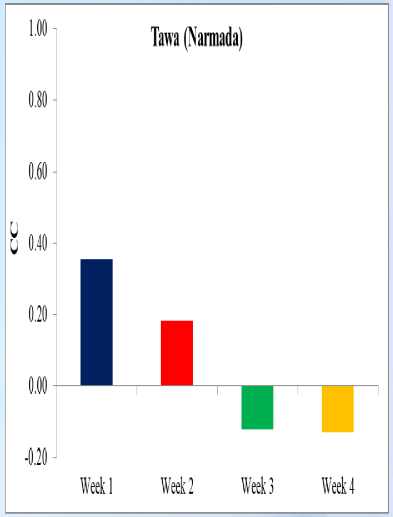




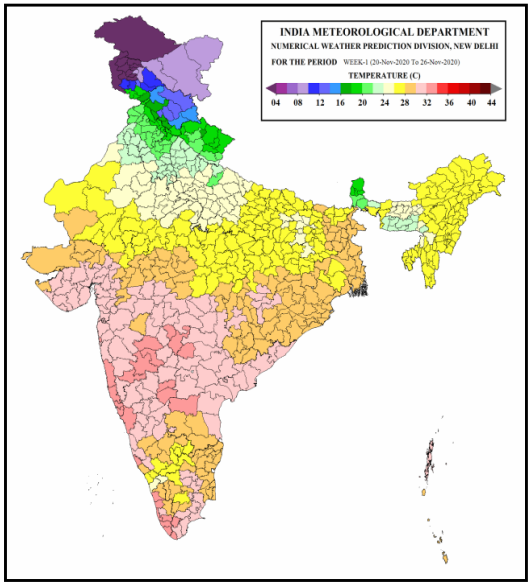
The highest Correlation Coefficients (CC) was found for the Hirakud river basin in the simulation of week 1, and followed by Tapi, Narmada, panchet, Cauvery, Maithon, Krishna, Iddamalyar, and Idukki respectively.

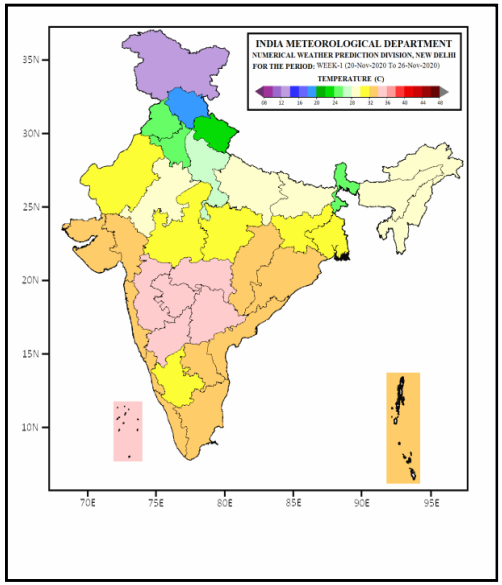
Hirakud (Mahanadi) **Tawa (Narmada)**





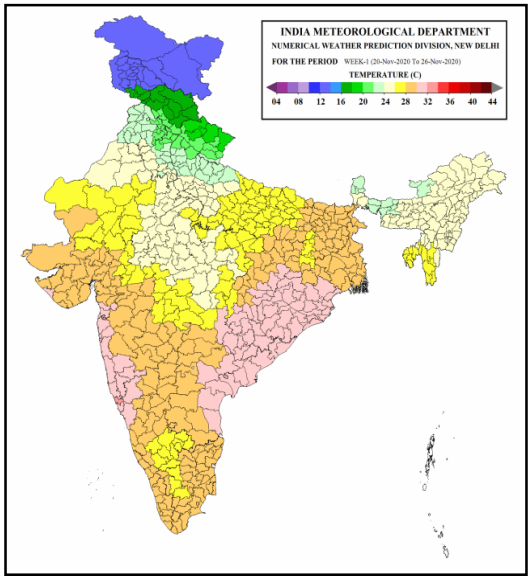
Observed Max Temperature
20-Nov-2020 To 26-Nov-2020



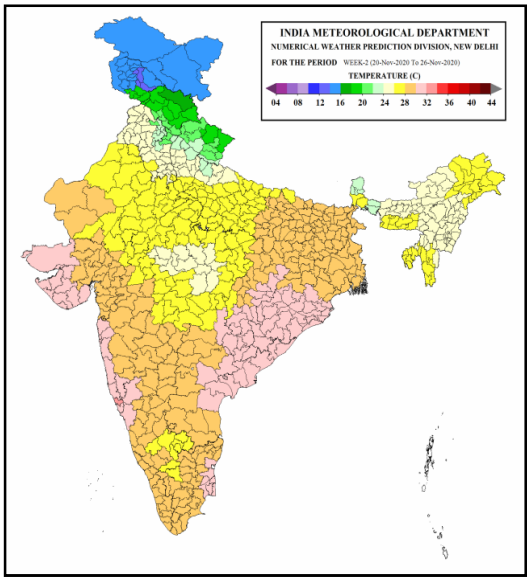


Bias Corrected Max Temperature

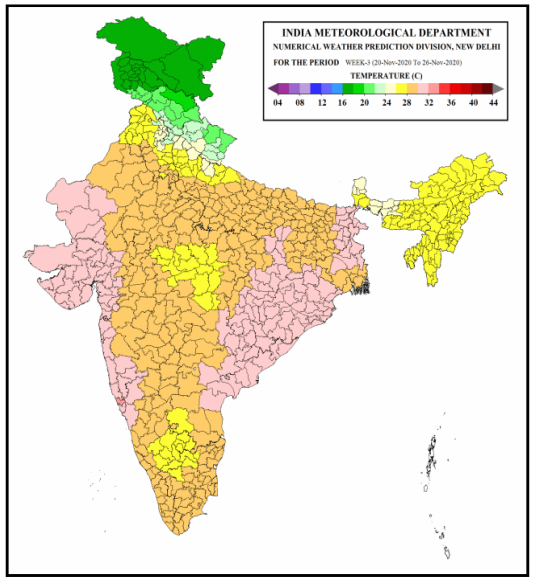
20-Nov-20 To 26-Nov-20 Week-1 Forecast

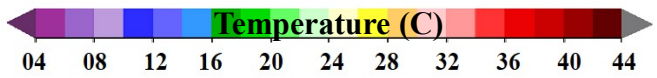


20-Nov-20 To 26-Nov-20 Week-2 Forecast

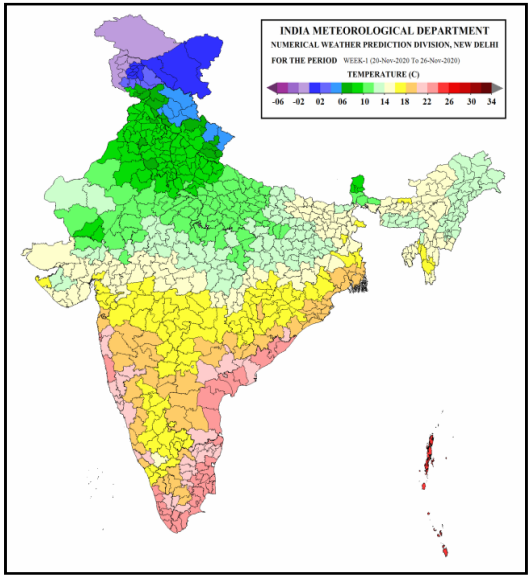


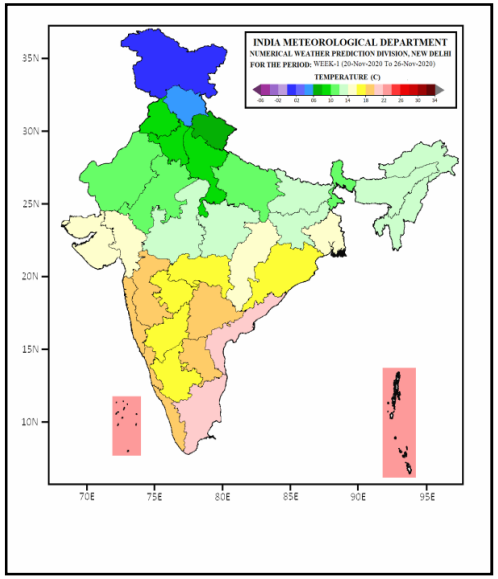
20-Nov-20 To 26-Nov-20 Week-3 Forecast





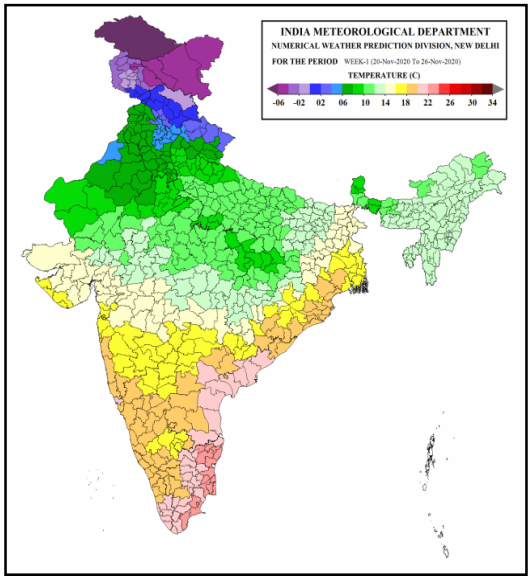
Observed Min Temperature
20-Nov-2020 To 26-Nov-2020



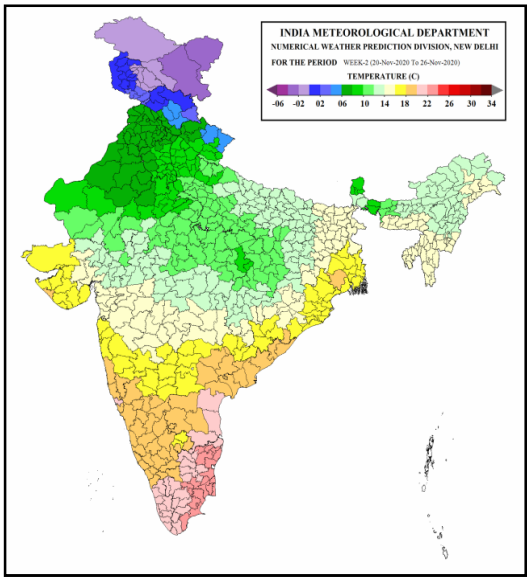


Bias Corrected Min Temperature

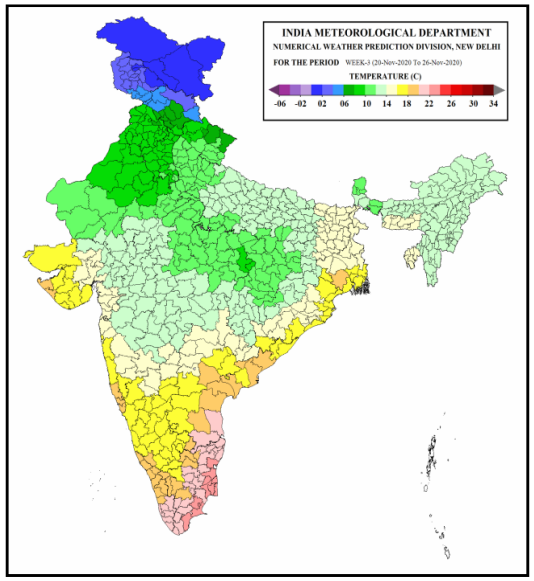
20-Nov-20 To 26-Nov-20 Week-1 Forecast



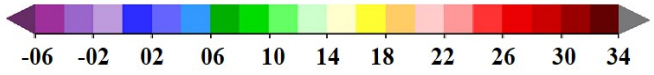
20-Nov-20 To 26-Nov-20 Week-2 Forecast



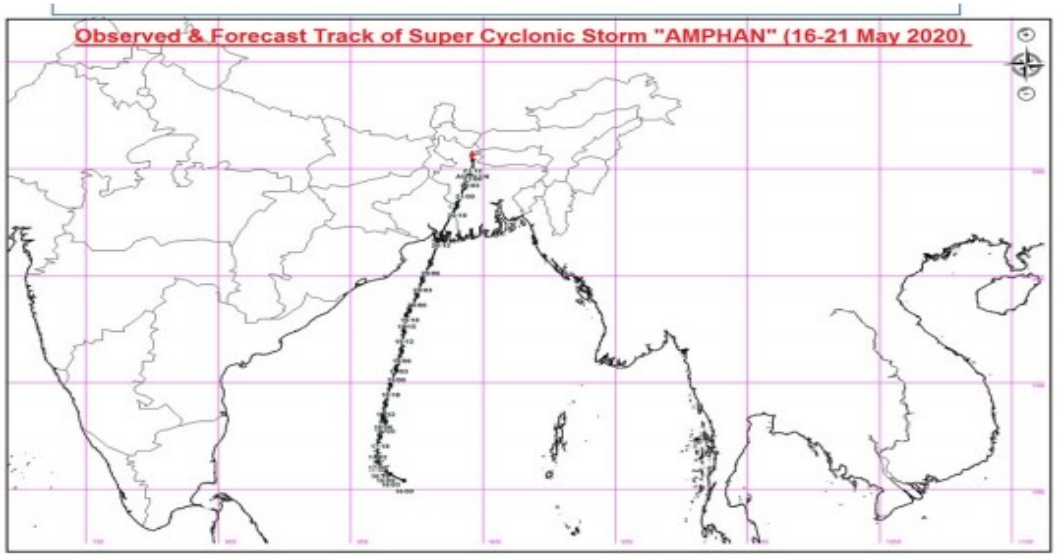
20-Nov-20 To 26-Nov-20 Week-3 Forecast

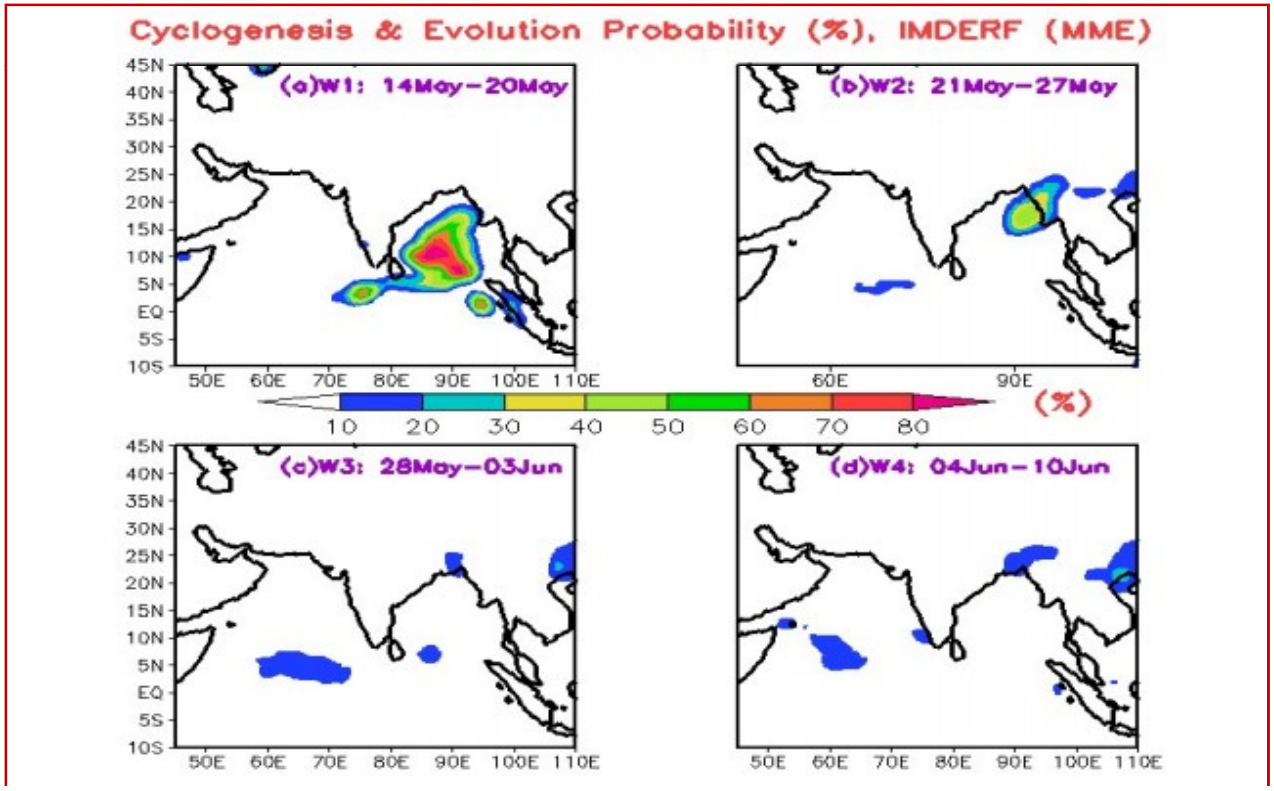


Maximum



Extended Range Forecast of Cyclogenesis Probability "AMPHAN"

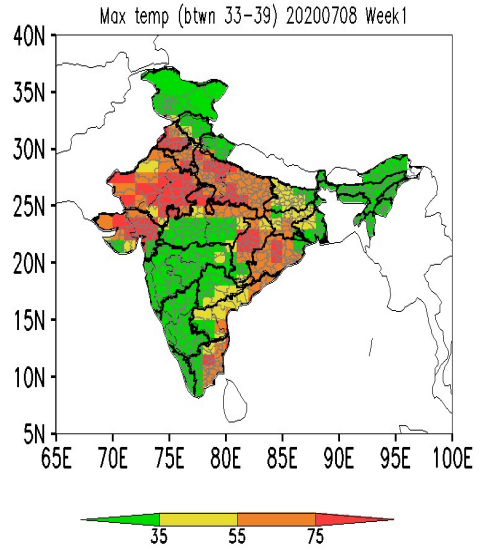


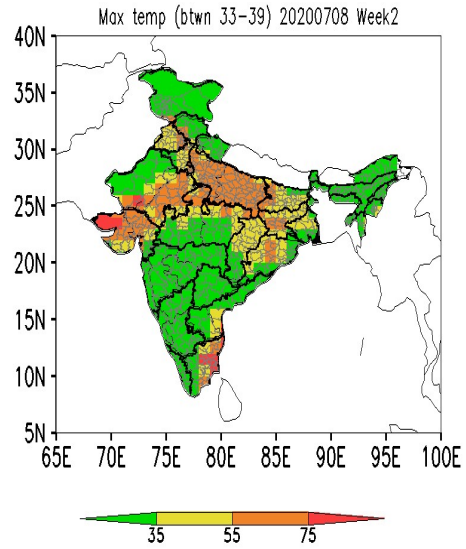


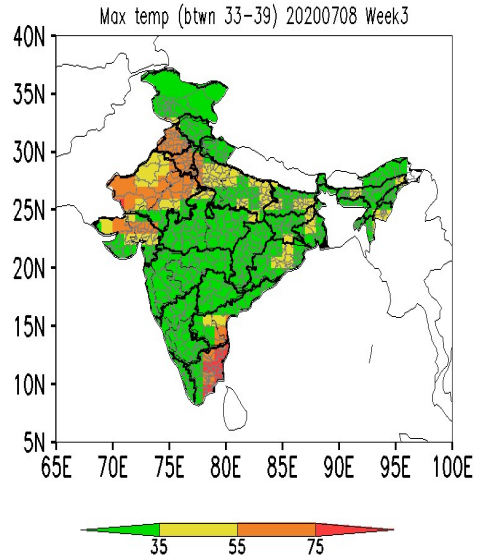
IC : 12
May 2029

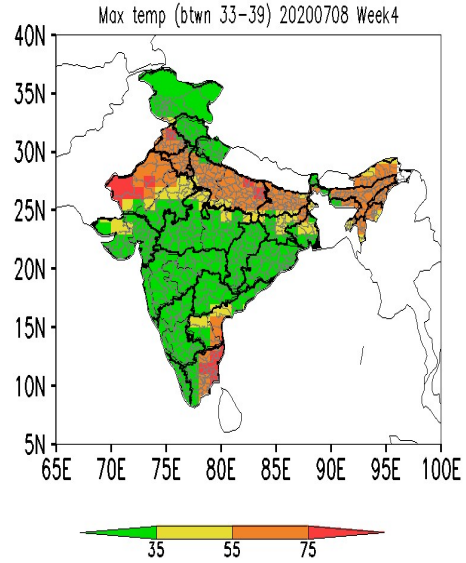
PROBABILISTIC PREVALENCE OF TRANSMISSION WINDOW FOR MALARIA TMAX (33-39 C) AND TMIN (16-19 C); IC 8TH JULY 2020

Tmax (33-39 C)

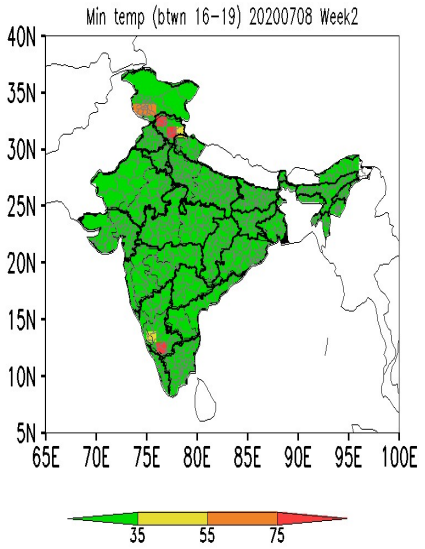


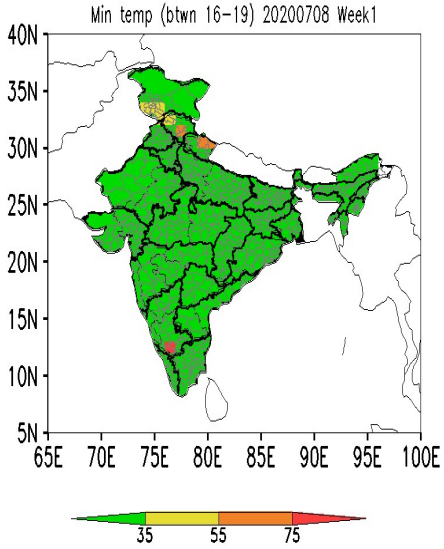


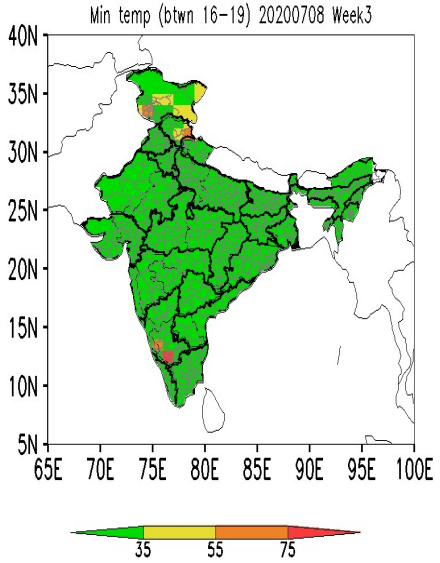


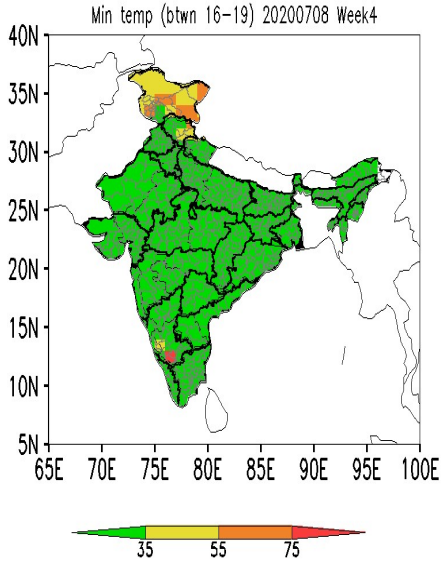


Tmin (16-19 C)

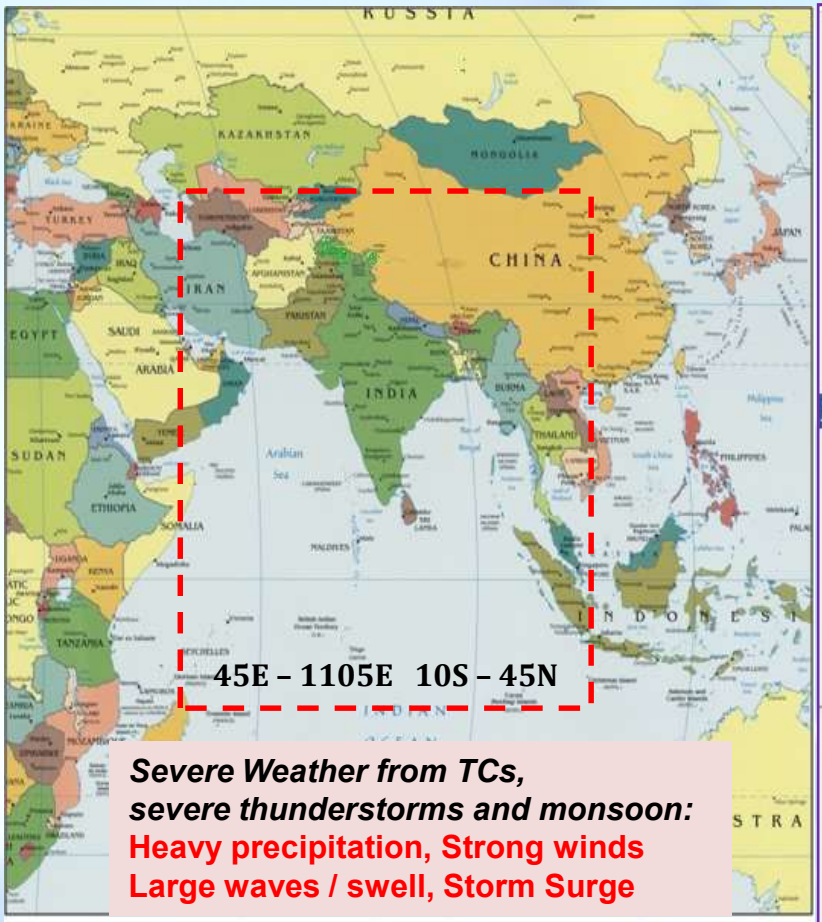




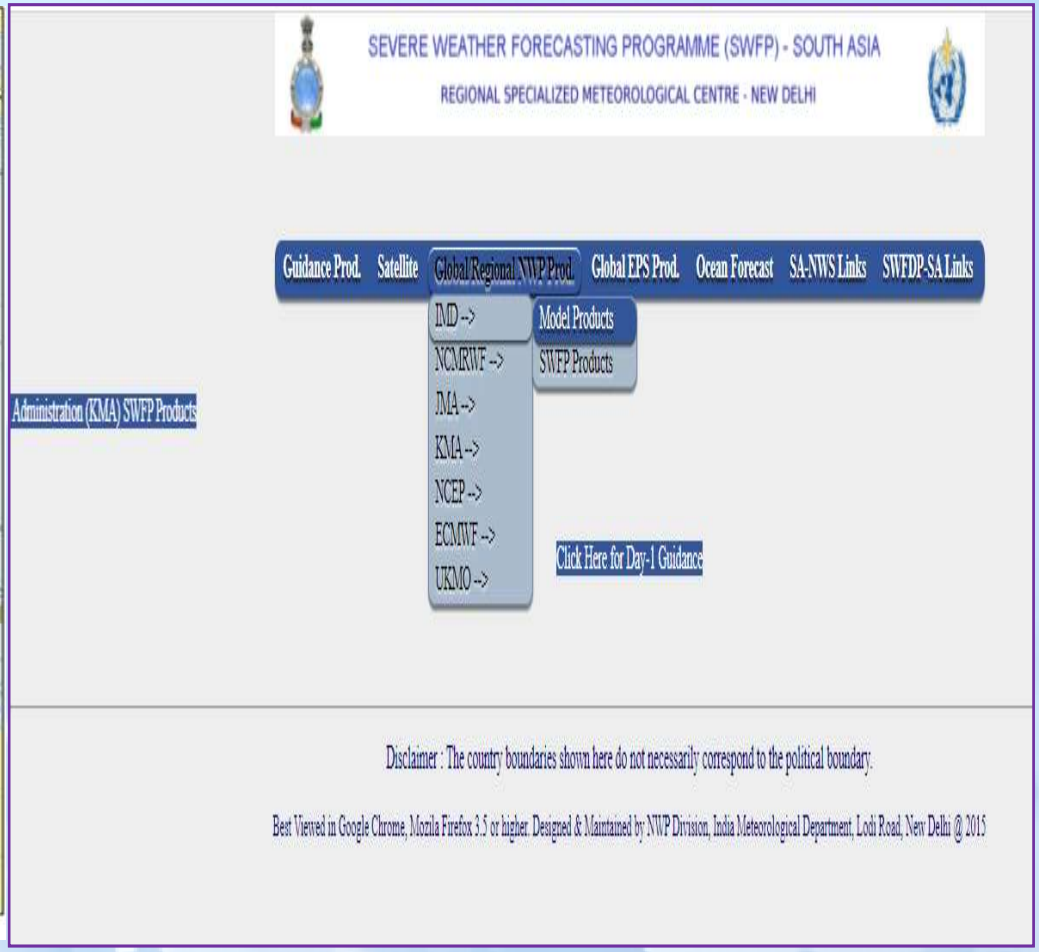




Severe Weather Forecast Project (SOUTH ASIA)



Severe Weather from TCs, severe thunderstorms and monsoon:
Heavy precipitation, Strong winds
Large waves / swell, Storm Surge

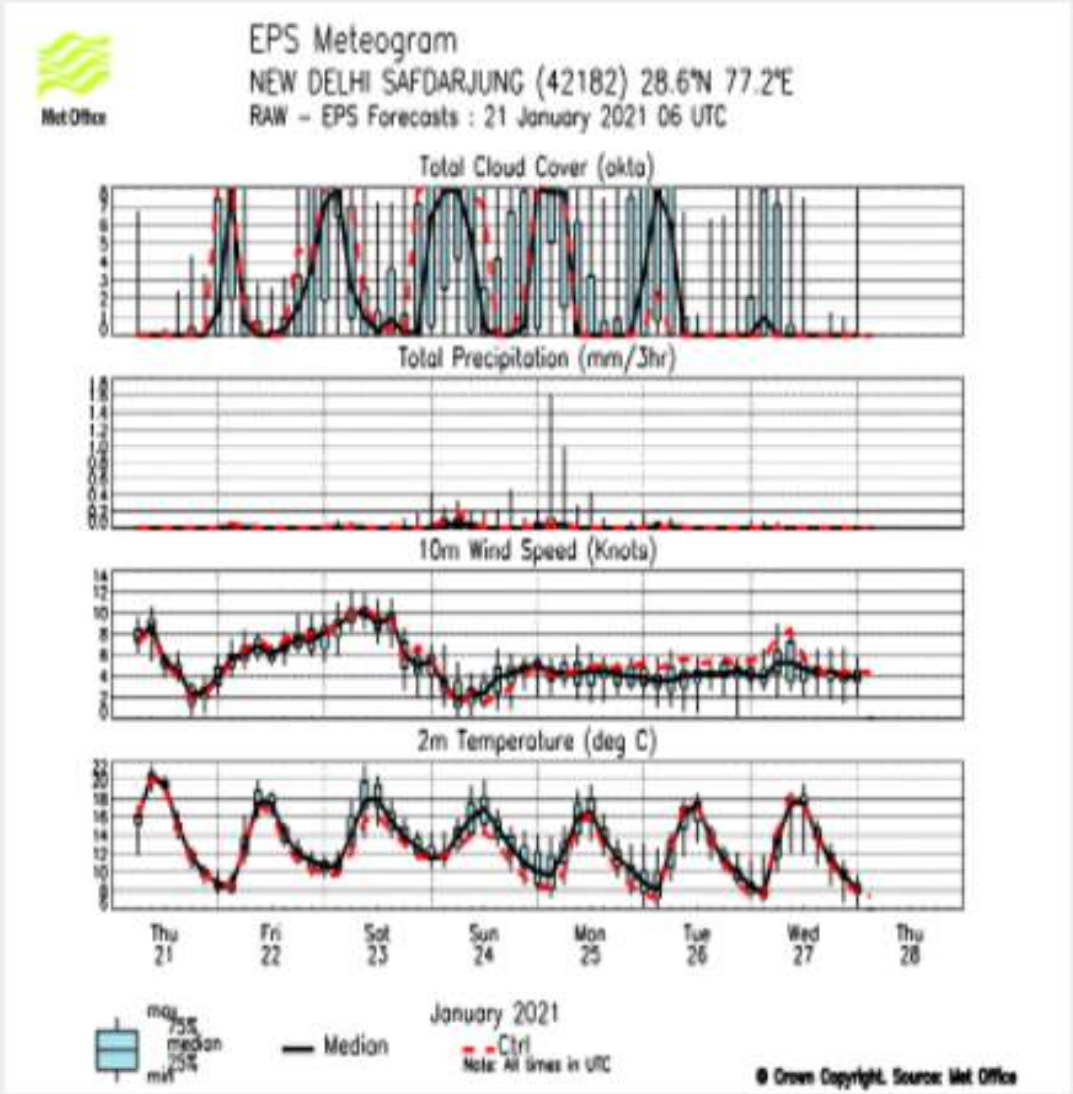


Korean Meteorological Administration (KMA) SWFP Products

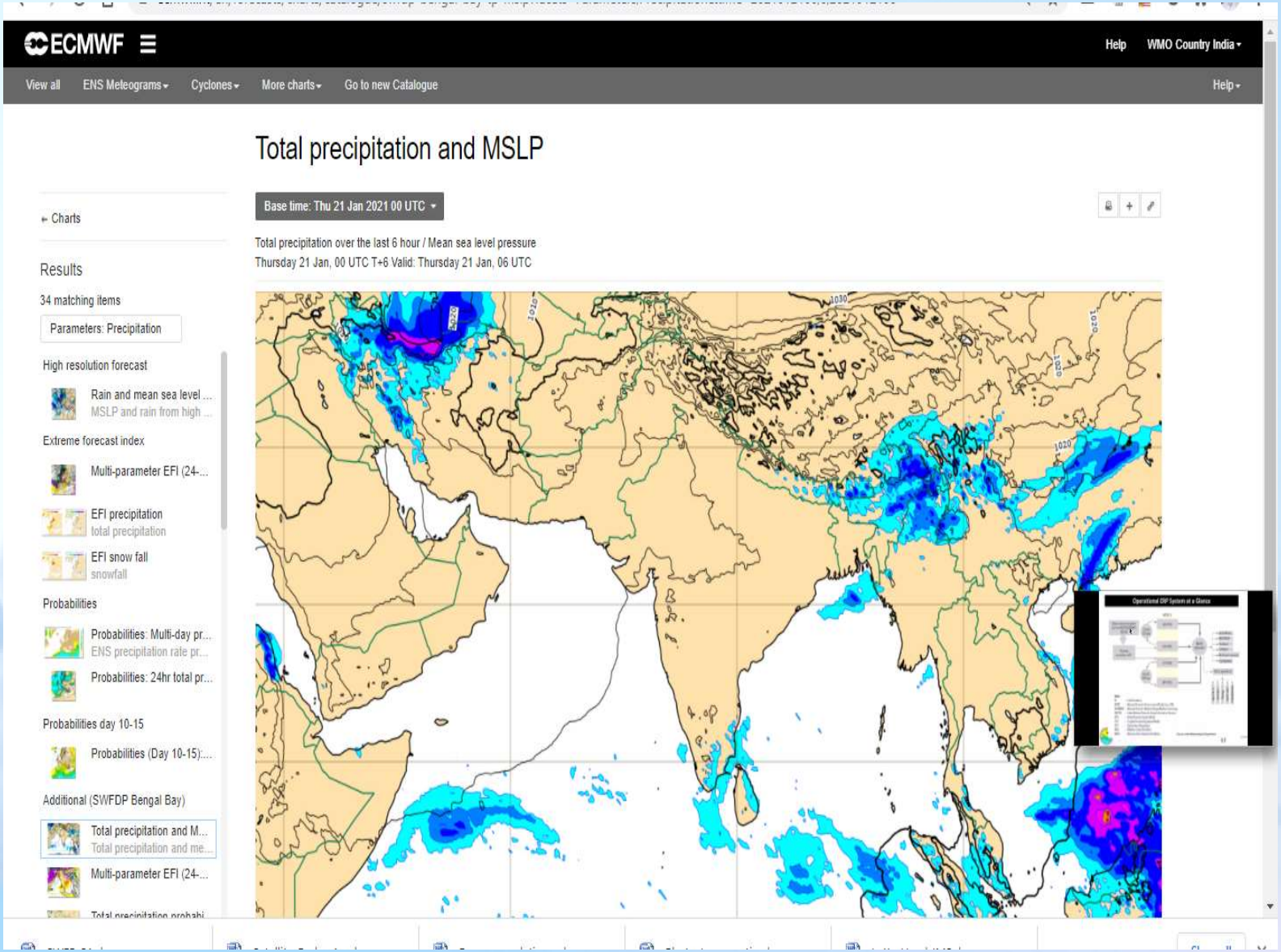
UK Met Office EPS Meteograms

Bangladesh | Bhutan | India | Maldives | Myanmar | Nepal | Pakistan | Sri Lanka | Thailand

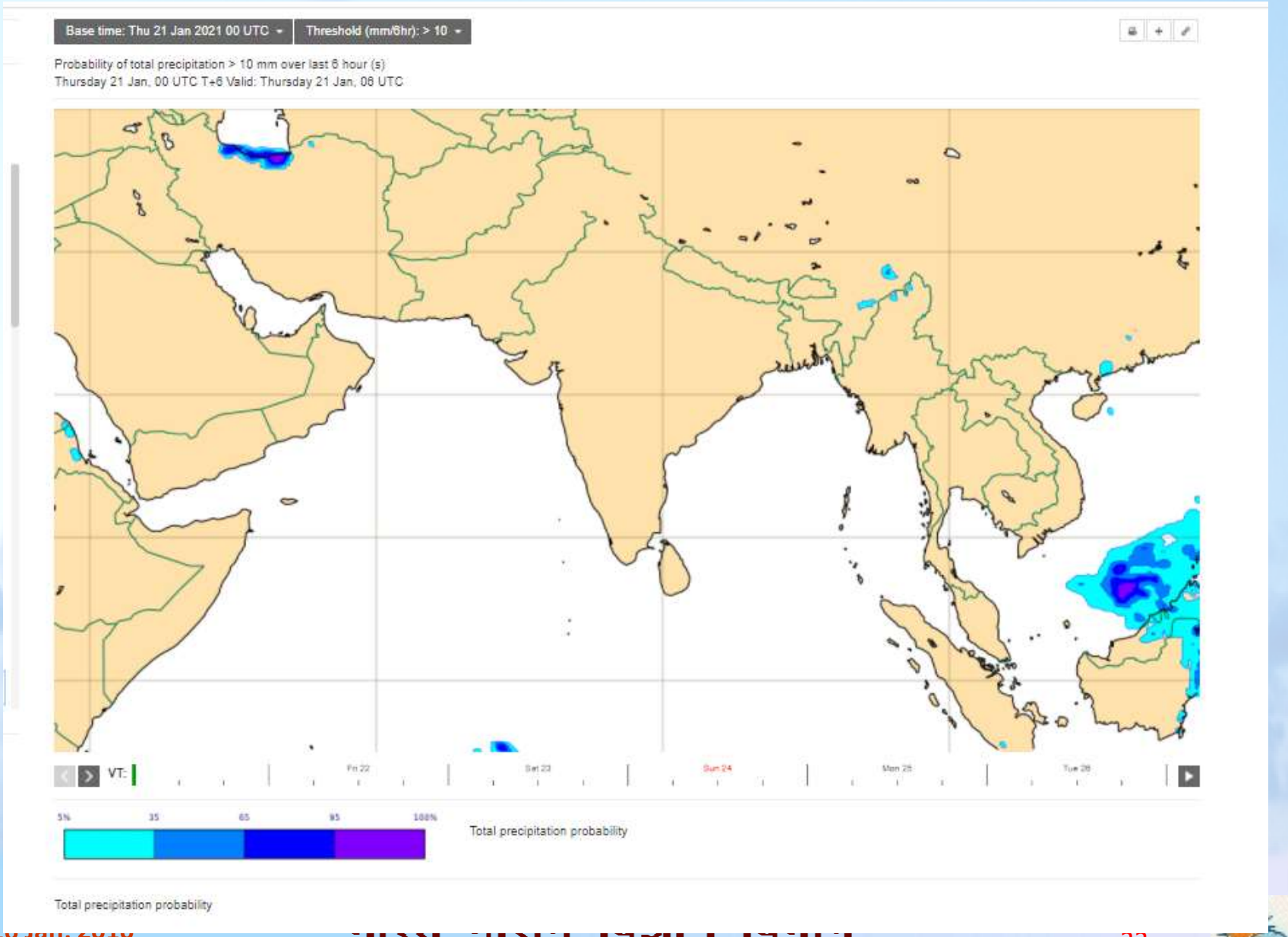
SELECT STATION : NEW DELHI (SAFDARJUNG) SUBMIT



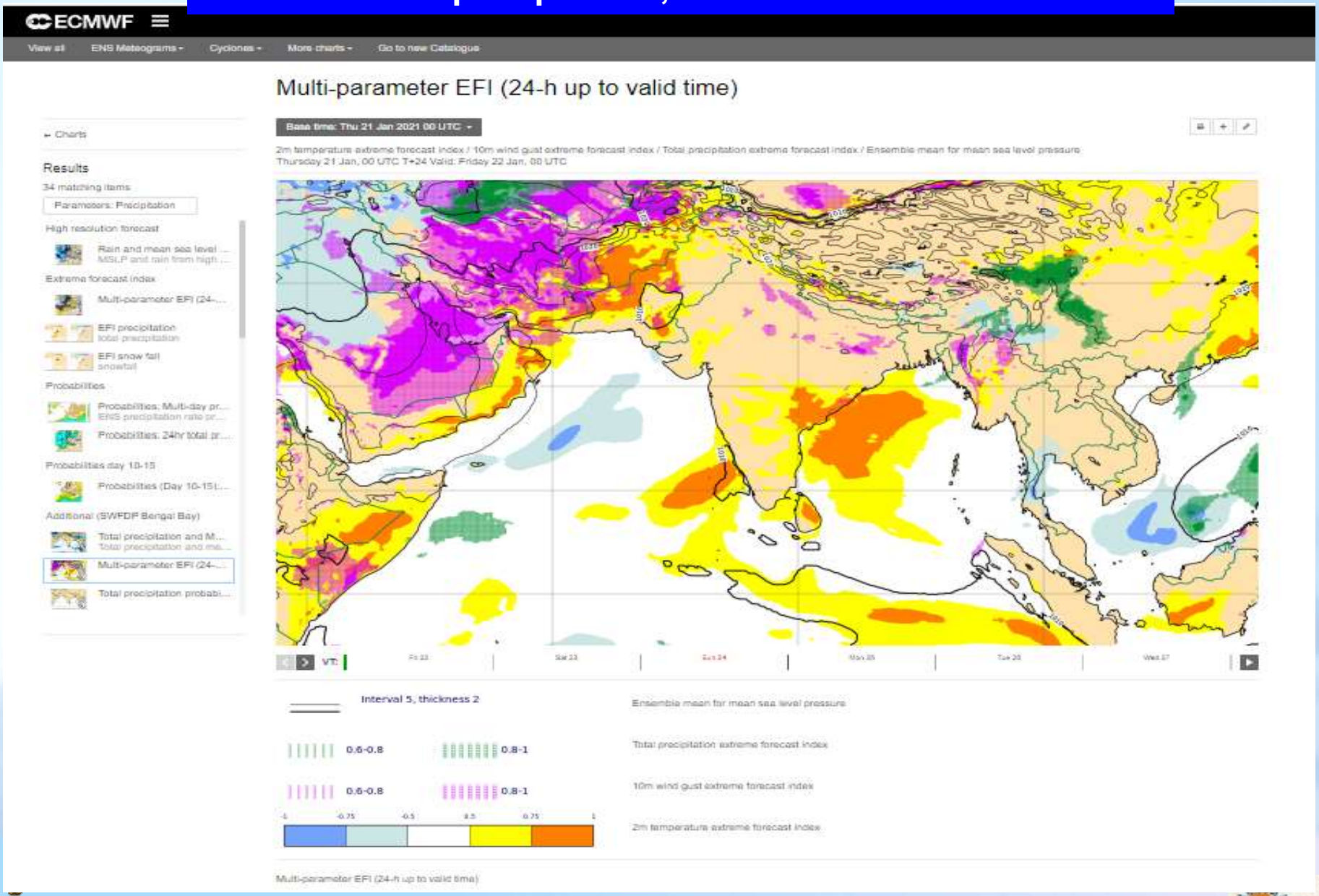
Total Precipitation



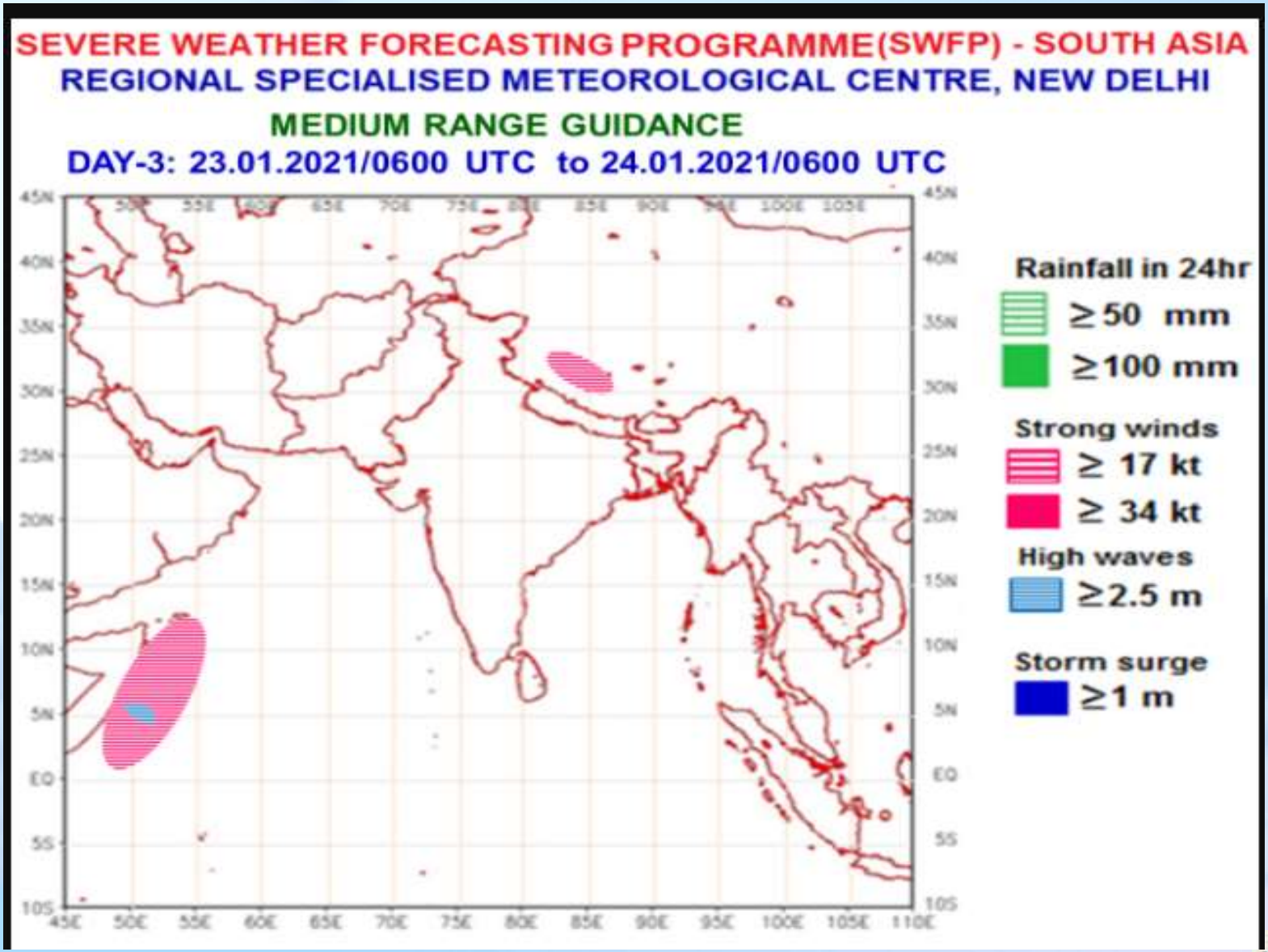
Rainfall Probability



Extreme Forecast Index
Total precipitation, 10 m wind and 2mT



Forecast Guidance Products



Summary

- Ensemble and MME products are very essentials for improvement in extreme weather forecasting at smaller spatial scales.

- IMD is generating as well as using various ensemble products for its applications in different sectors.

- ERF forecast is skilful upto 2/3 weeks at all India and homogeneous regions scales.

- Upto 2 weeks it is being used at Met-Sub division/districts level.

- Further developments are also needed to reduce the gap between what we can provide and what user wants.

THANK YOU