Impact Based Extended Range Forecast

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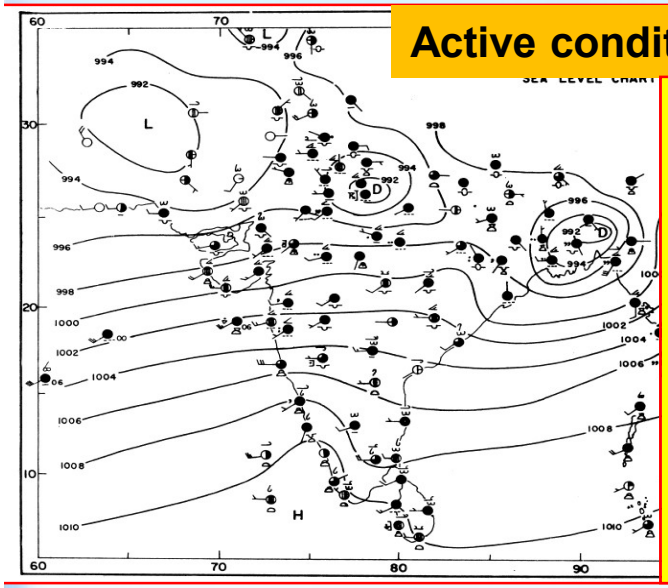
भारत मौसम विज्ञान विभाग

INDIA METEOROLOGICAL DEPARTMENT

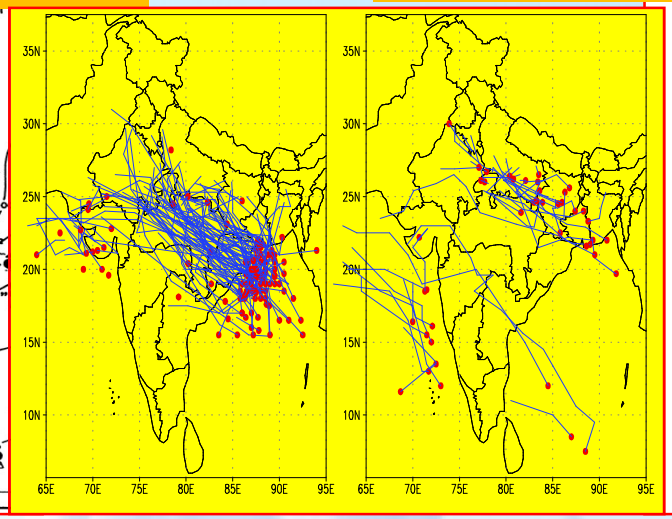
Points to be covered

- Importance of Extended Range Forecast (ERF) during monsoon and other seasons
- Benefits of IBF in ERF of Severe Weather
- Prospects of applications of IBFs of Severe Weathers in extended range time scale with examples.
- The challenging areas for improvement.

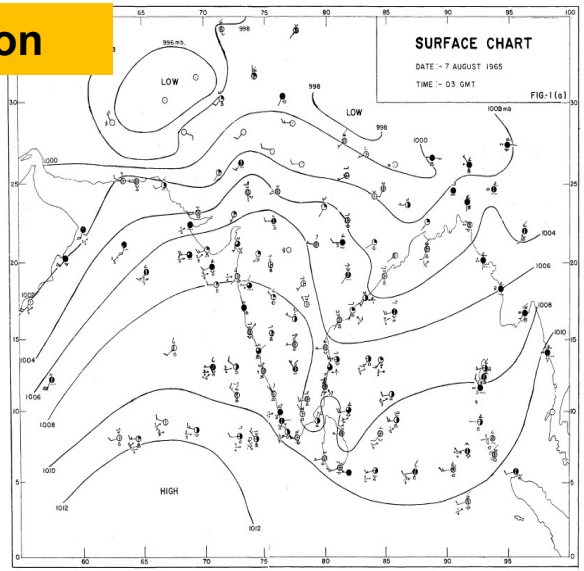
Active-Break Spells of Monsoon : Associated Synoptic & Large Scale

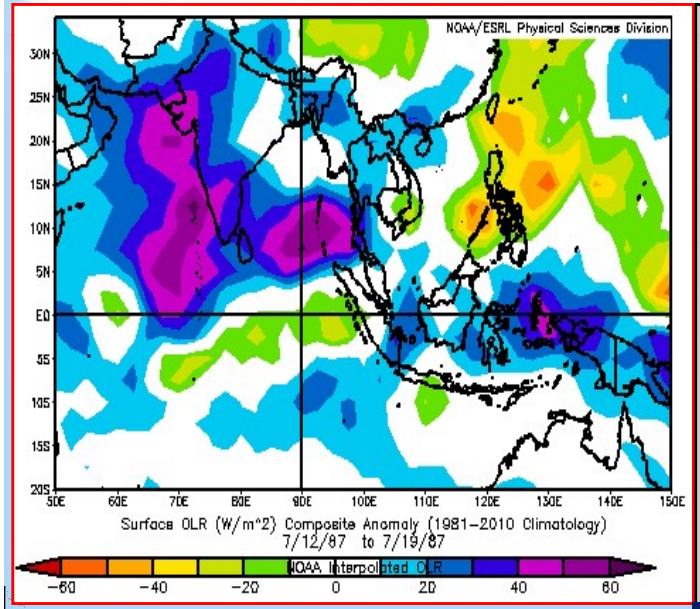


Active condition

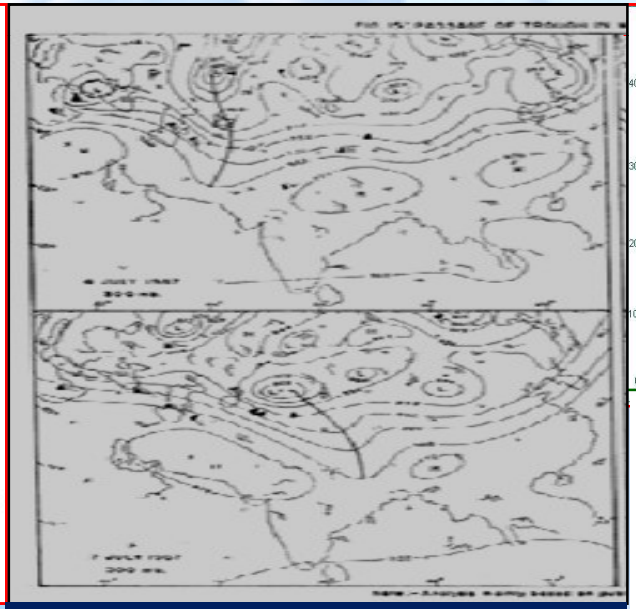


Break condition



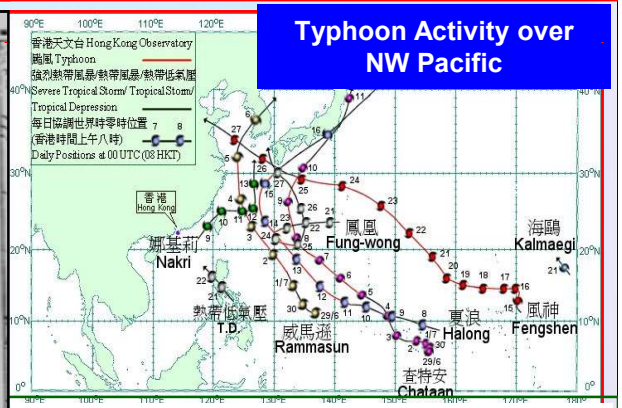


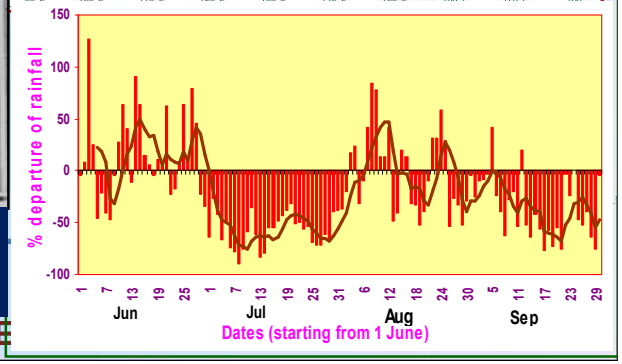
Oceanic TCZ in SH (SHET) and weak CTCZ over land



Passage of westerly trough ; (Ramamurthy 1969)

Typhoon Activity over NW Pacific





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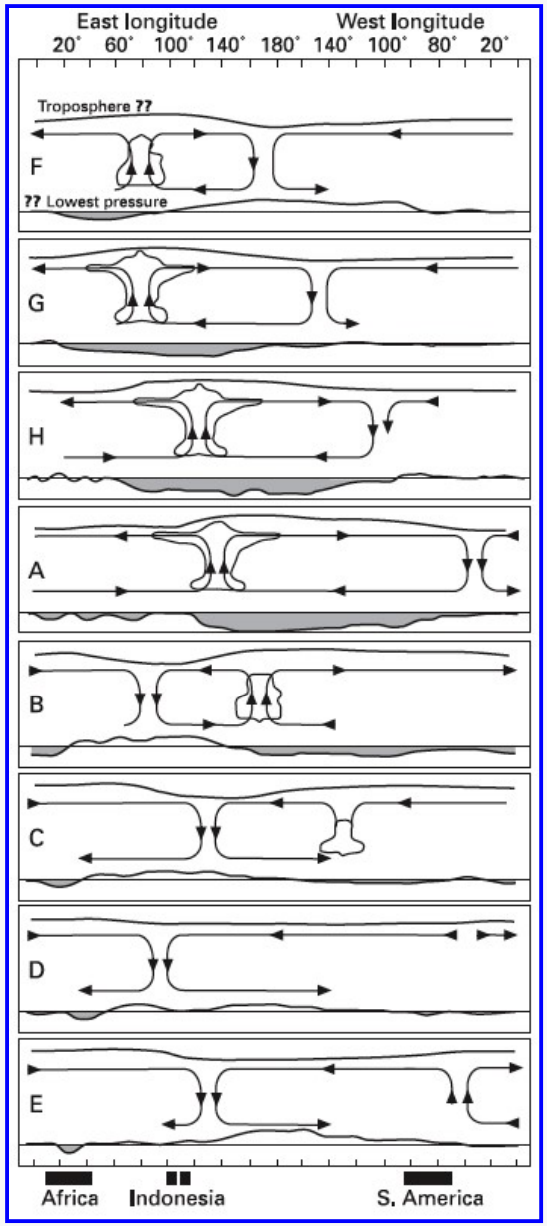
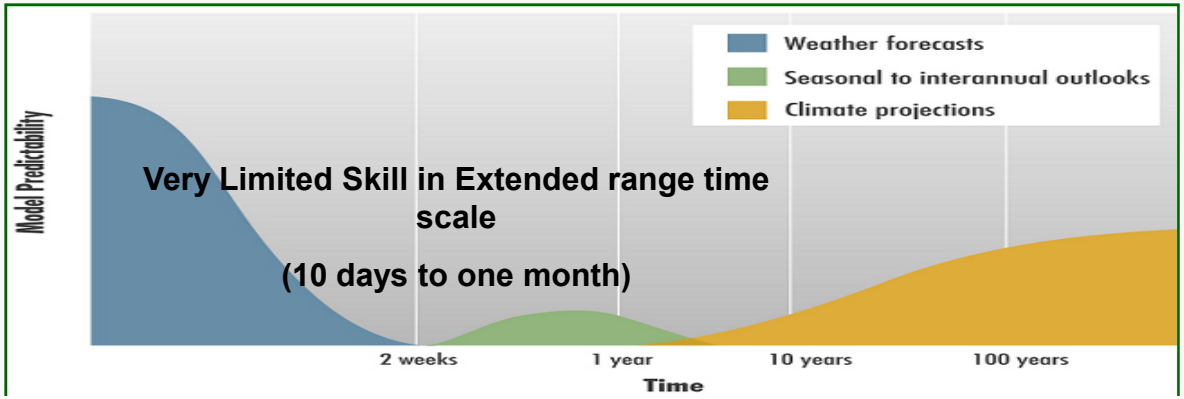
Madden-Julian Oscillation

(a.k.a. Intraseasonal, 40-50, 30-60 Day Oscillation)



Madden & Julian, 1972

- Intraseasonal Time Scale: ~40-60 days
- Planetary-Scale: Zonal Wavenumbers 1-3
- Baroclinic Wind Structure
- Eastward Propagation
  - ✓E. Hem: ~5 m/s, Surf.+Conv.+Circ. Interactions
  - ✓W. Hem: ~ > 10 m/s, ~Free Tropospheric Wave
- Tendency to be Equatorially Trapped
- Strong Seasonal Dependence:
  - ✓ NH Winter: Eastward Propagation
  - ✓ NH Summer: ~Northeast Propagation
- Significant Interannual Variability
- Potential Role of Ocean/SST Feedback
- Convection Has Multi-Scale Structure
- Significant Remote and Extra-Tropical Impacts



The benefits of impact-based forecasting

- IBF **triggers anticipatory actions** which saves lives and protects property
- IBF & warnings **communicate information** that allows **those at risk to make effective decisions to safeguard against the impact of forecast extreme weather .**
- Developing IBF & warnings **builds strong, collaborative partnerships** between IMD and sectors operating in disaster risk reduction and management
- IBF **communicates uncertainties**. Decision makers can factor the uncertainties into choosing appropriate actions.
- **Two ways feedbacks**. Producers and users of IBF & warnings share data, best practice and critical information before, during and after weather and climate events to improve the quality of forecast and warning information.
- **IBF contributes to strategic planning** : there are opportunities for forecasts to support strategic planning in the County such as through using forecasts to inform sectoral annual plans and related budgets, to raise awareness on potential climate risks and resource mobilisation for early action.

ERF Application Products for IBF

- **Disaster Risk Reduction** (Prediction *of Severe Weather like Heavy Rainfall /Cyclogenesis)*
- **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)*
- **Energy/Power Sectors** *(Tmax/Tmin, Heat wave/Cold wave)*
- **Human Health** *(Vector borne diseases)*

Severe Weather :
Tropical Cyclone

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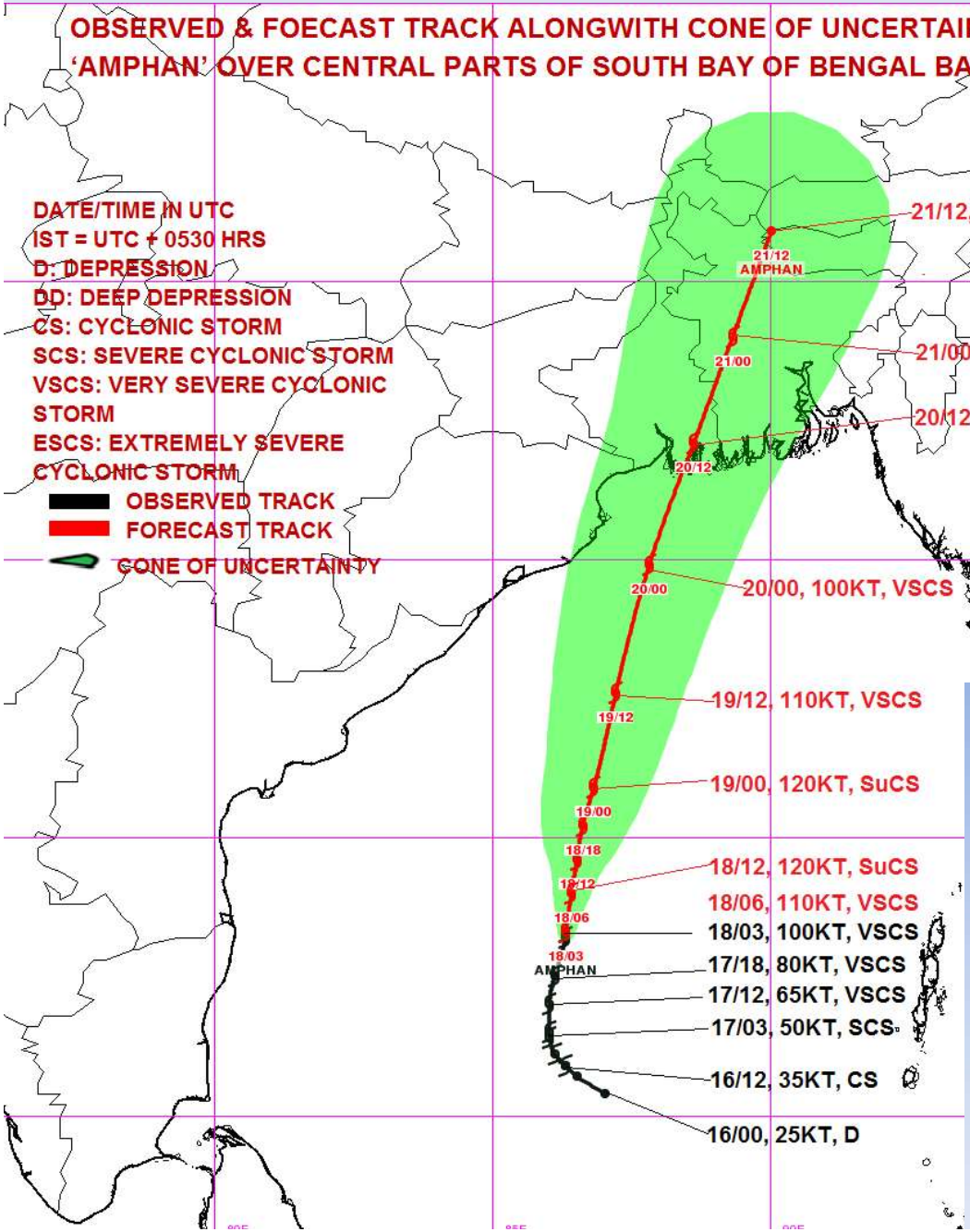
Super Cyclonic Storm 'Amphan': over the Bay of Bengal (18th May 2020): Forecast track



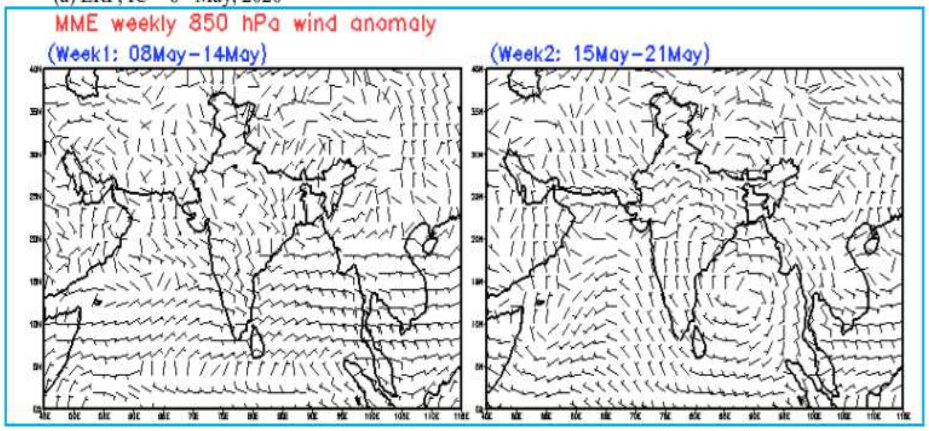
Current Location (18 May/1730 IST: 14.0N/86.3E

- **Current Intensity: 230-240kmph ,gusting to 265 kmph**
- **700 km south of Paradip, 860 km south-southwest of Digha & 980 km south-**

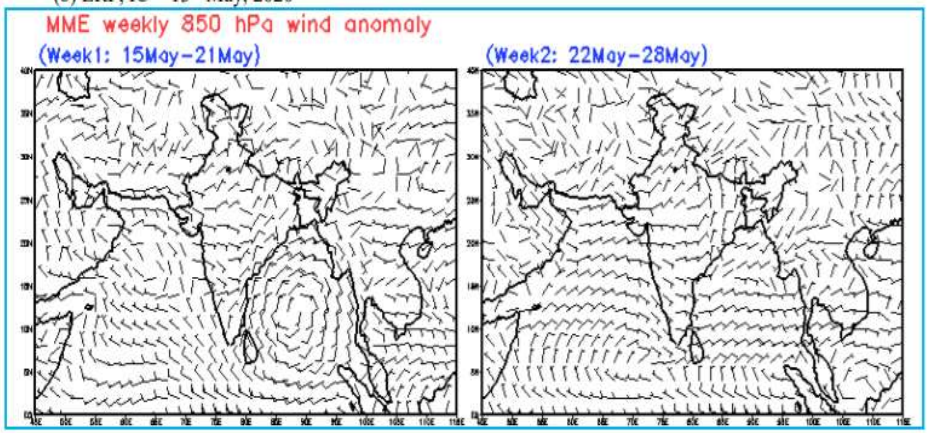
- **To cross West Bengal and adjoining Bangladesh coast between Digha and Hatia close to Sundarbans**
- **during afternoon to evening of 20th May 2020**
- **with a maximun sustained wind speed of 165-175 kmph gusting to 195 kmph**

ERF of Cyclogenesis (6th May and 13th May ICs)

(a) ERF, IC = 6th May, 2020

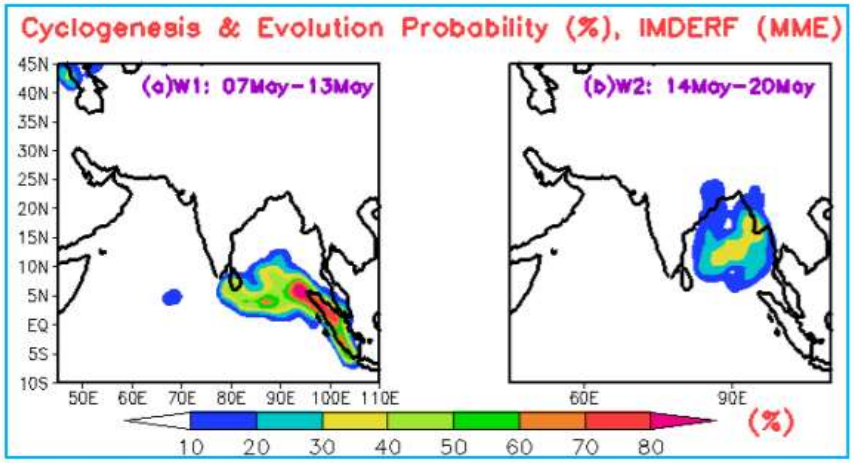


(b) ERF, IC = 13th May, 2020

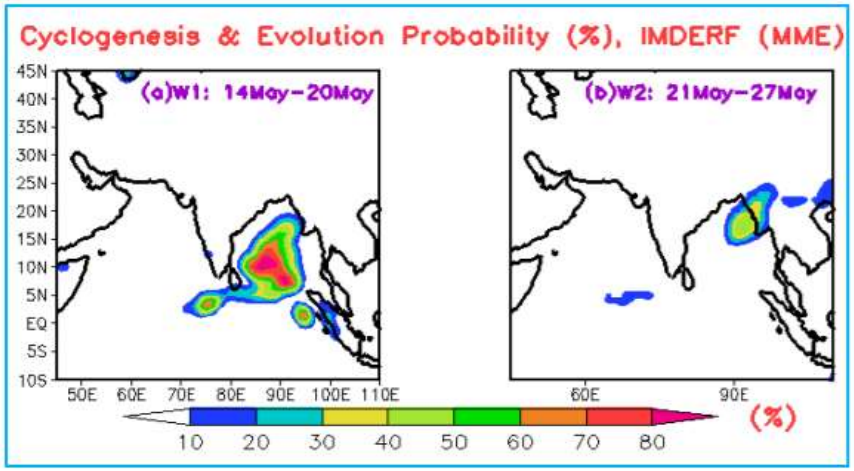


Figs. 11(a&b). The 850 hPa forecast wind anomaly for 2 weeks with initial conditions of (a) 6th May and (b) 13th May, 2020

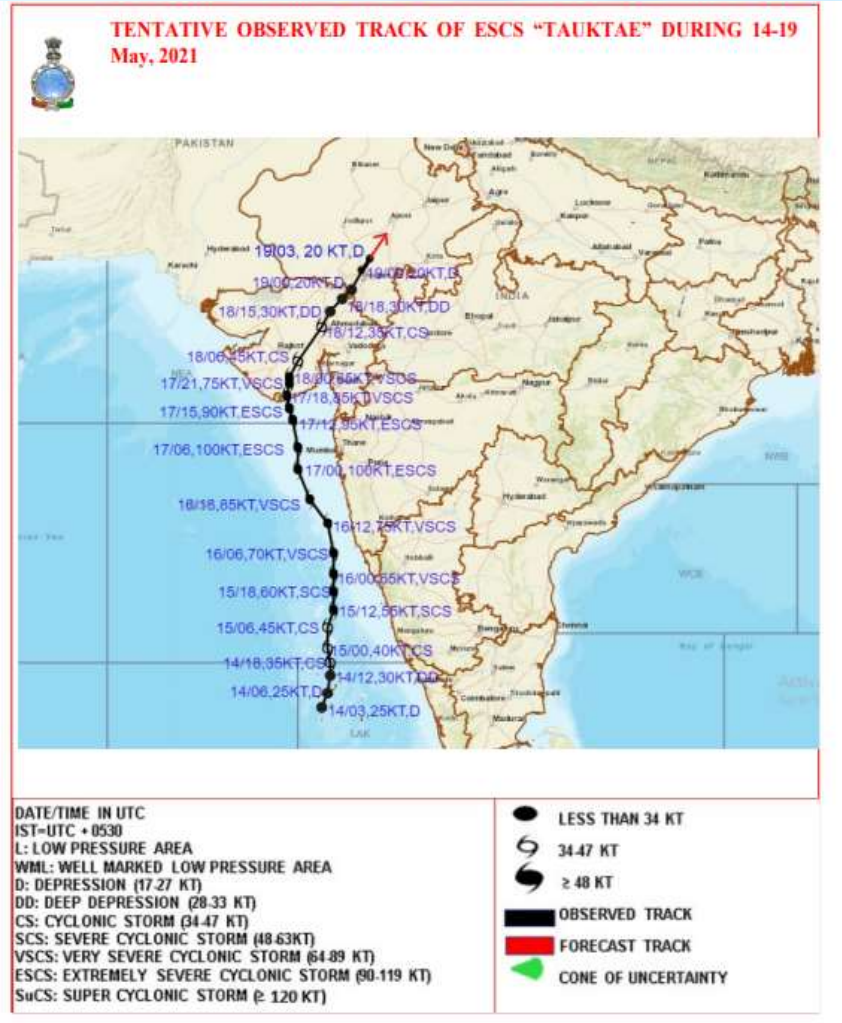
(a)

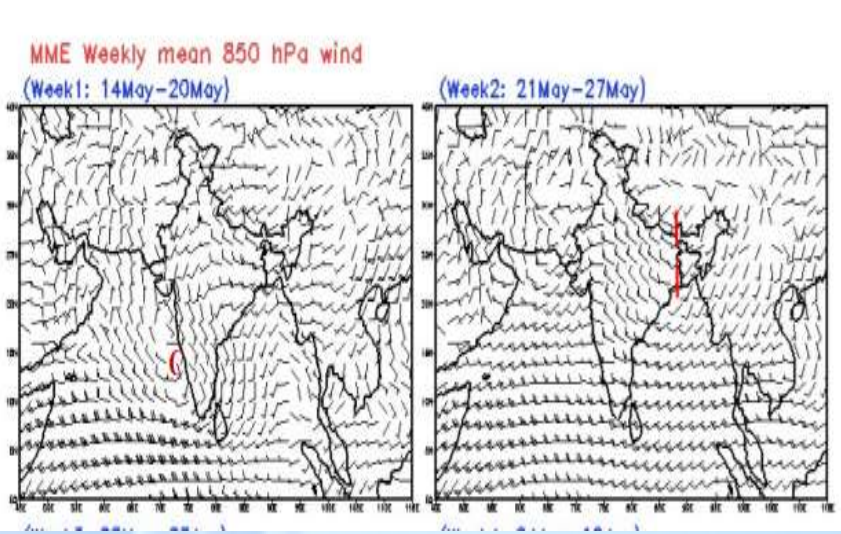


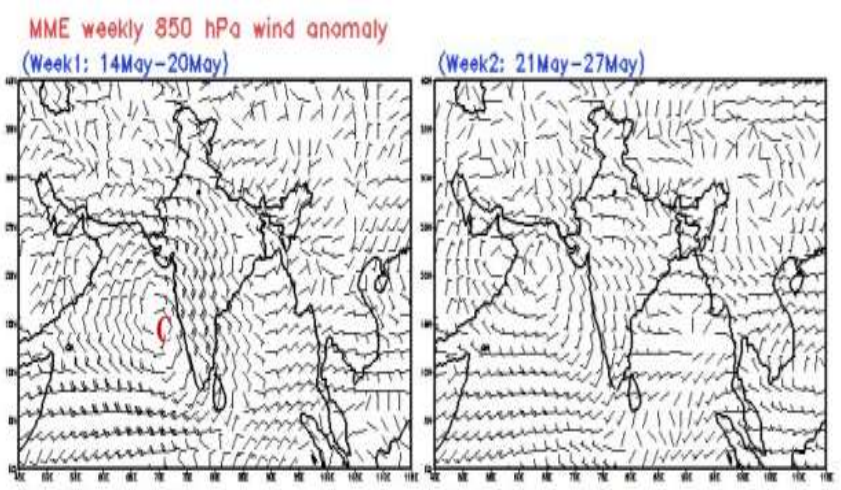
(b)



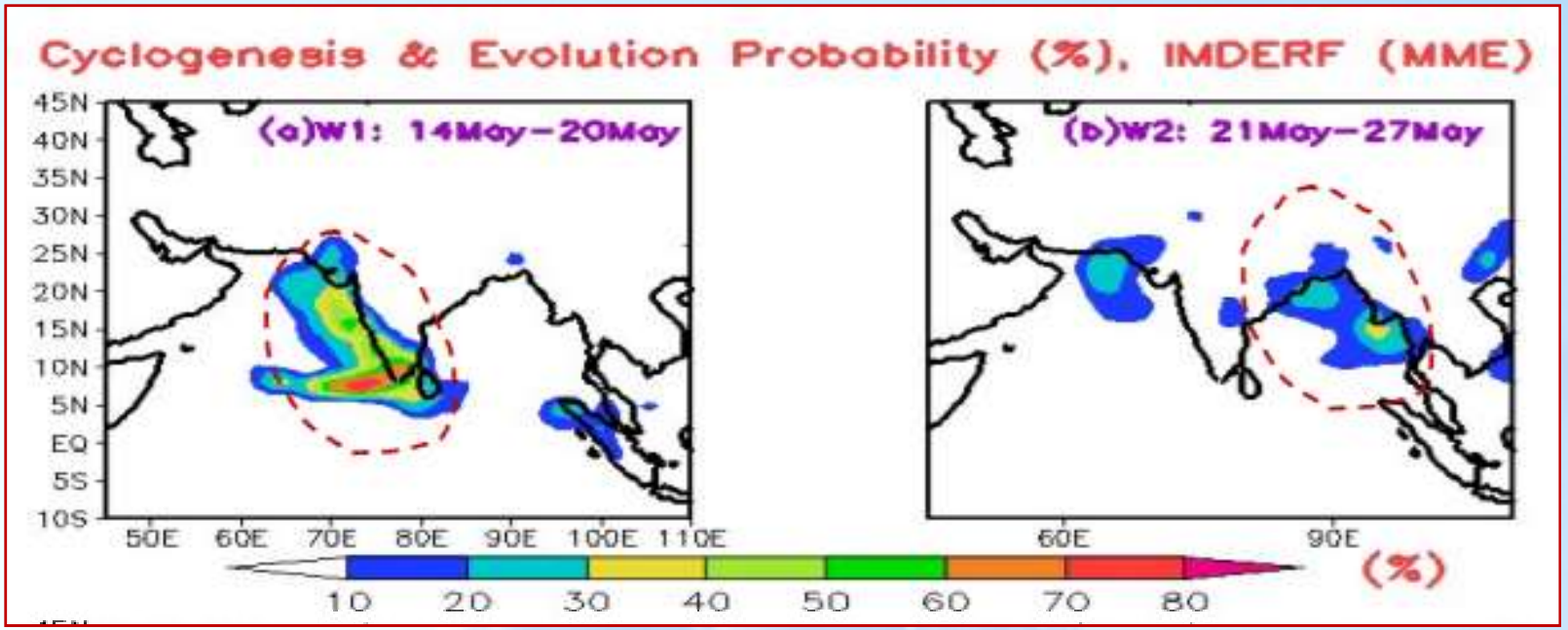
ESCS TAUKTAE (14-19 May 2021) ; IC – 12 May 2021





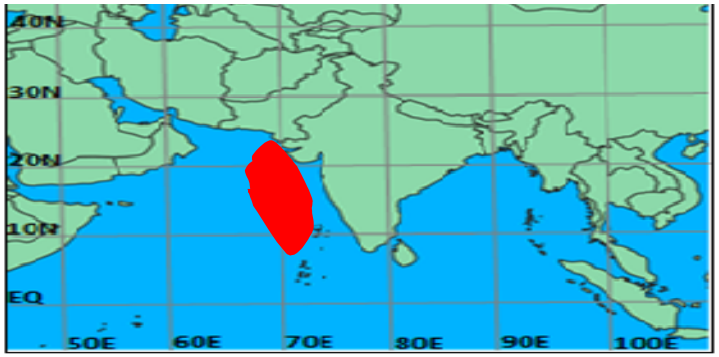


ESCS TAUKTAE (14-19 May 2021) ; (RSMC forecast) issued on 13th May

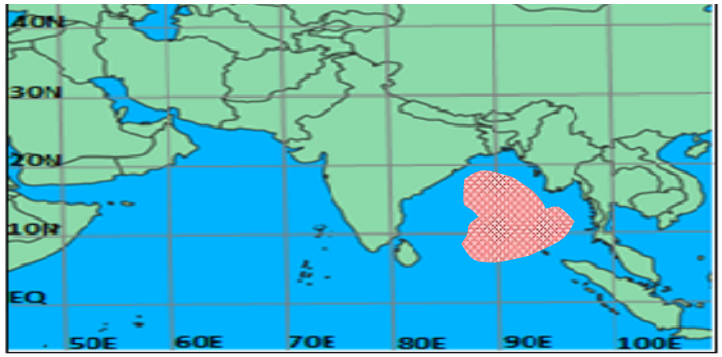


NORTH INDIAN OCEAN EXTENDED RANGE OUTLOOK FOR CYCLOGENESIS

Week1:14.05.2021-20.05.2021



Week2: 21.05.2021-27.05.2021



PROBABILITY OF CYCLOGENESIS
(FORMATION OF DEPRESSION OR HIGHER INTENSITY)

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

CONFIDENCE

Impact Forecast Issued by RSMC on 13th May, 2021

•**Impact expected:**

•Very rough to High Seas, squally weather and Gale winds with wind speed reaching more than 70-80 kmph gusting to 90 kmph, around the system centre, affecting shipping vessels and fishing operations.

•Tidal waves could inundate the Islands of Lakshadweep on 14th & 15th May.

•Very heavy to extremely heavy rainfall causing flash floods & landslides over the coastal districts of Kerala, Karnataka & Goa during 14th – 16th May and Saurashtra, Kutch, south Pakistan & west Rajasthan during 18th – 20th May. This could affect normal life & interruptions to Road & Rail traffic temporarily.

•Thunder squalls & Lightning could cause adverse impact on Human & Livestock as well as damage to Loose & unsecured structures along the coast line.

•**Warnings / Advisory:**

•Fishermen are advised not to venture into Arabian Sea during 13th – 18th May

•Ships are advised to avoid the area

•Ports along the west coast of India may take necessary pre-cautions.

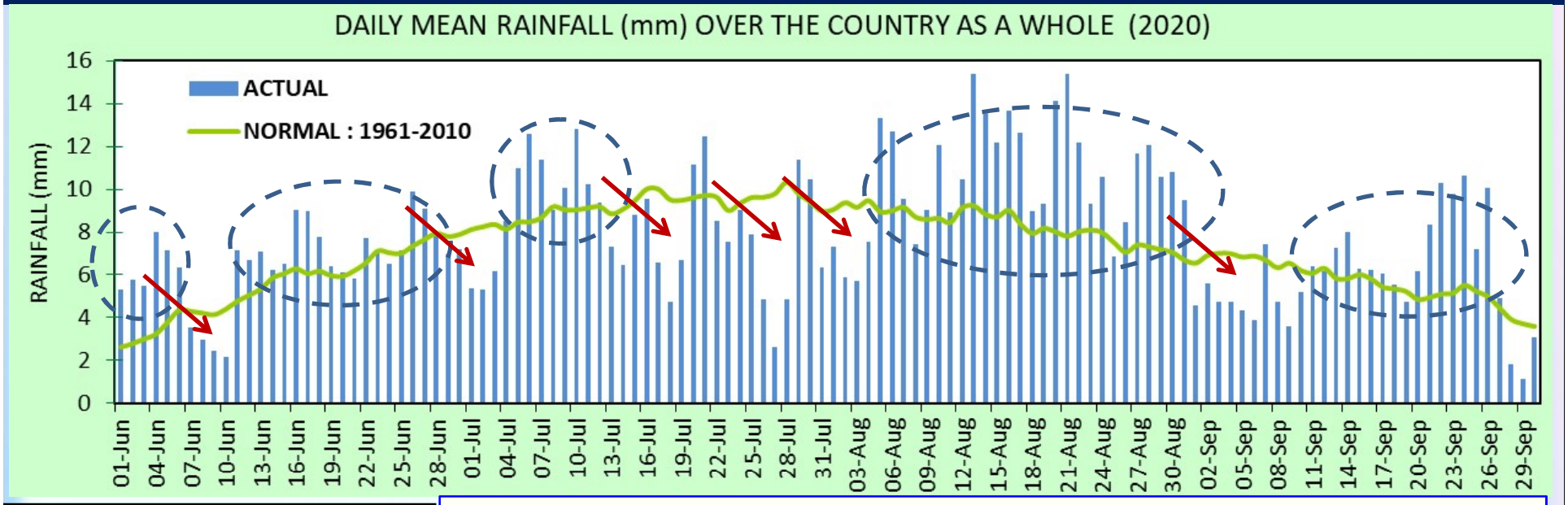
• Naval base operations may maintain necessary pre-cautions

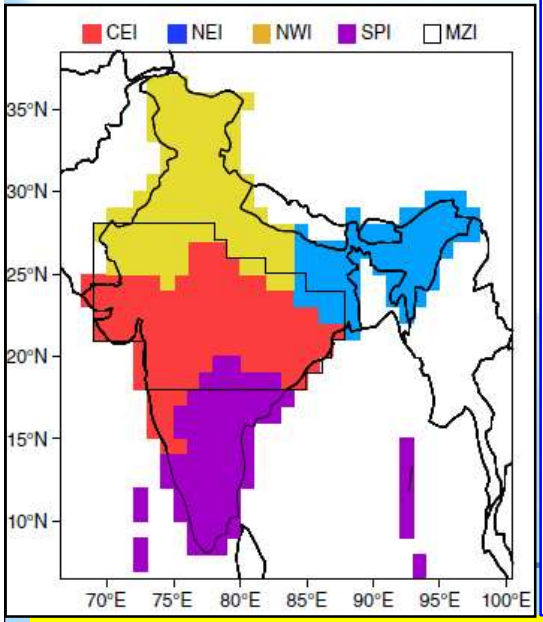
•Tourism activities may be restricted over the area specified for squally weather and rough Sea warning.

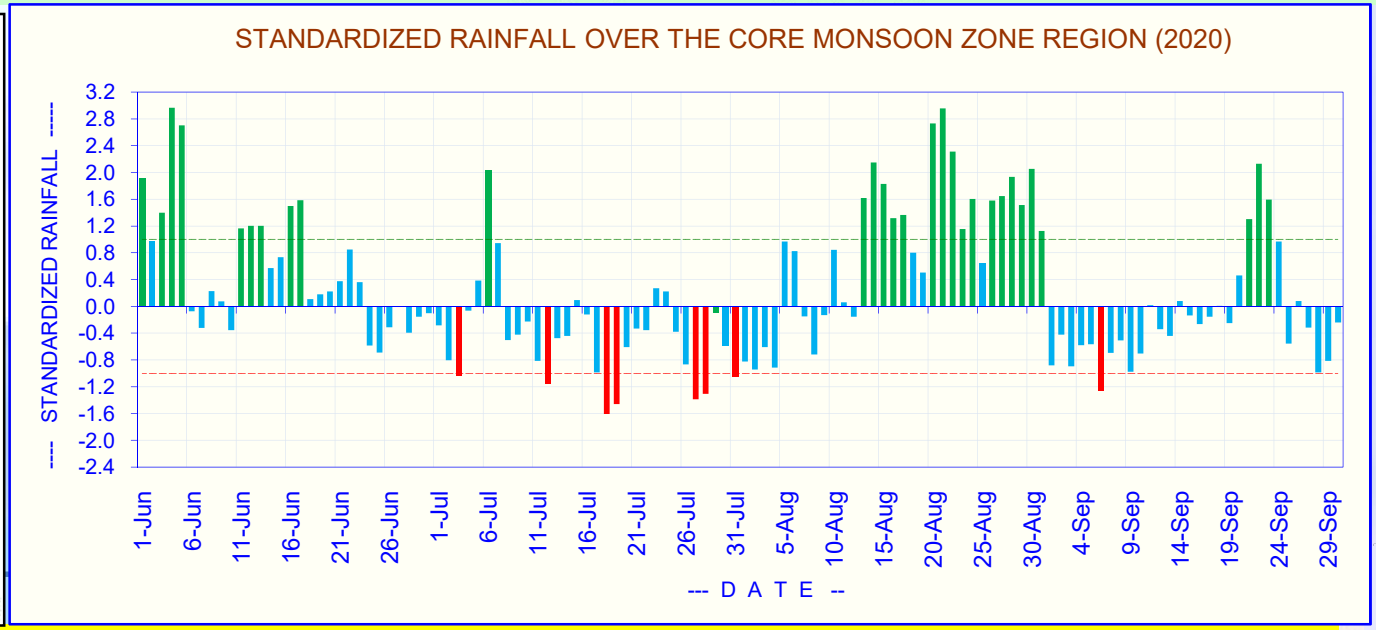
Severe Weather : Monsoon

(Active & Break cycle, Onset and withdrawal)

Intra-Seasonal Variability-2020







Overall Good Monsoon Rainfall Activity during the season with very short duration weak spells

Monsoon 2009

Seasonal (JJAS) Rainfall ; -19%

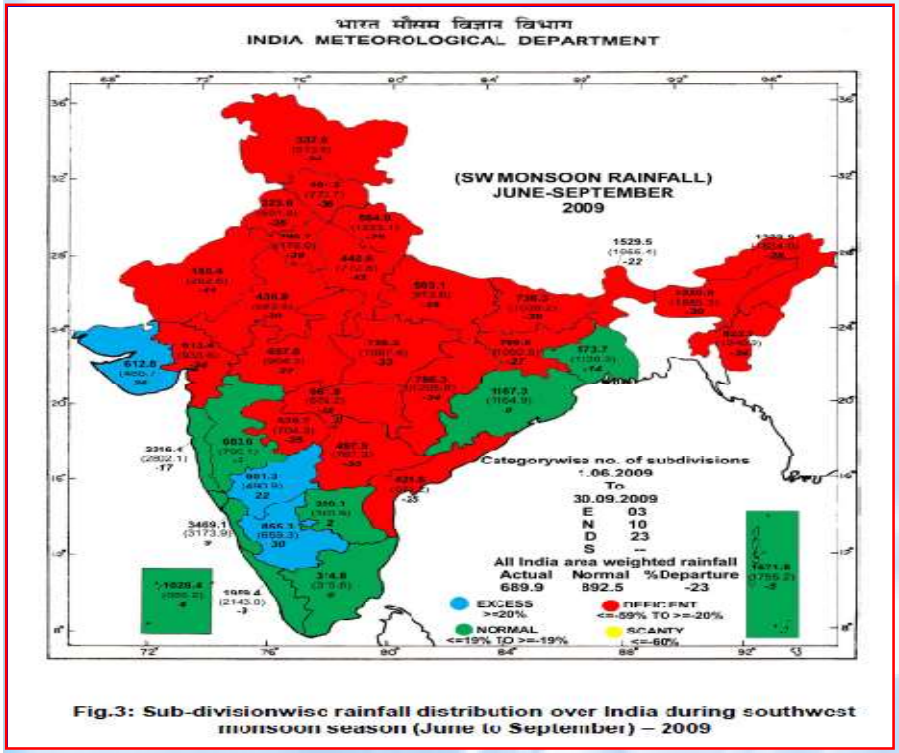
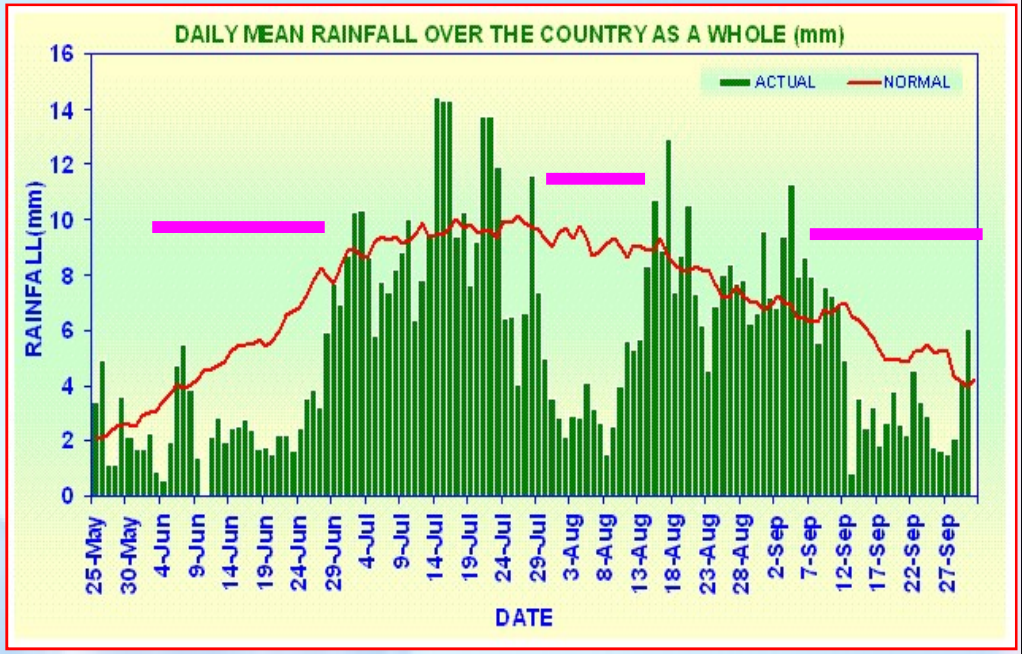
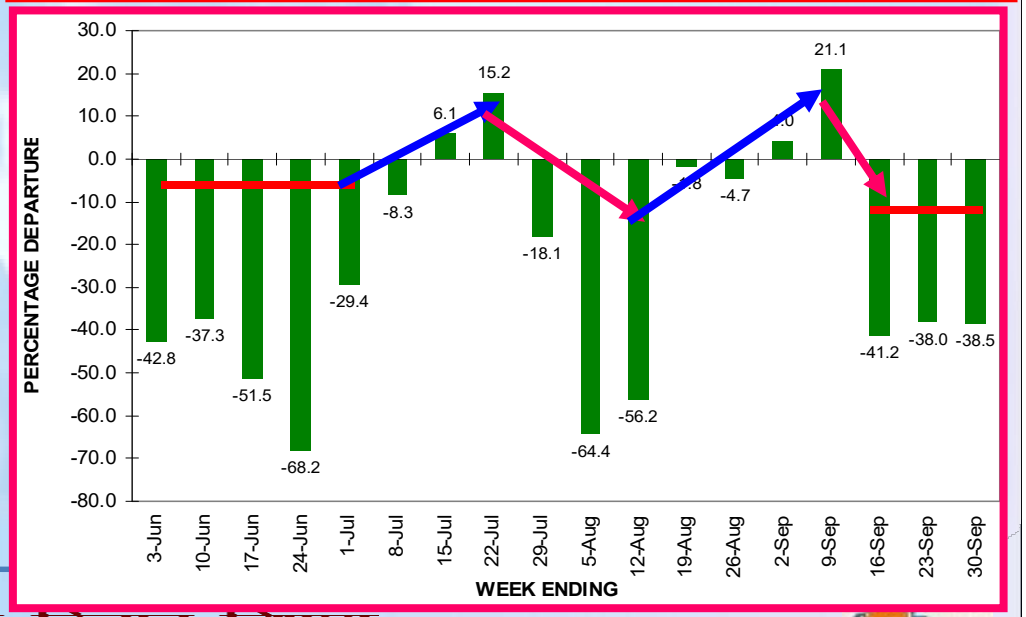


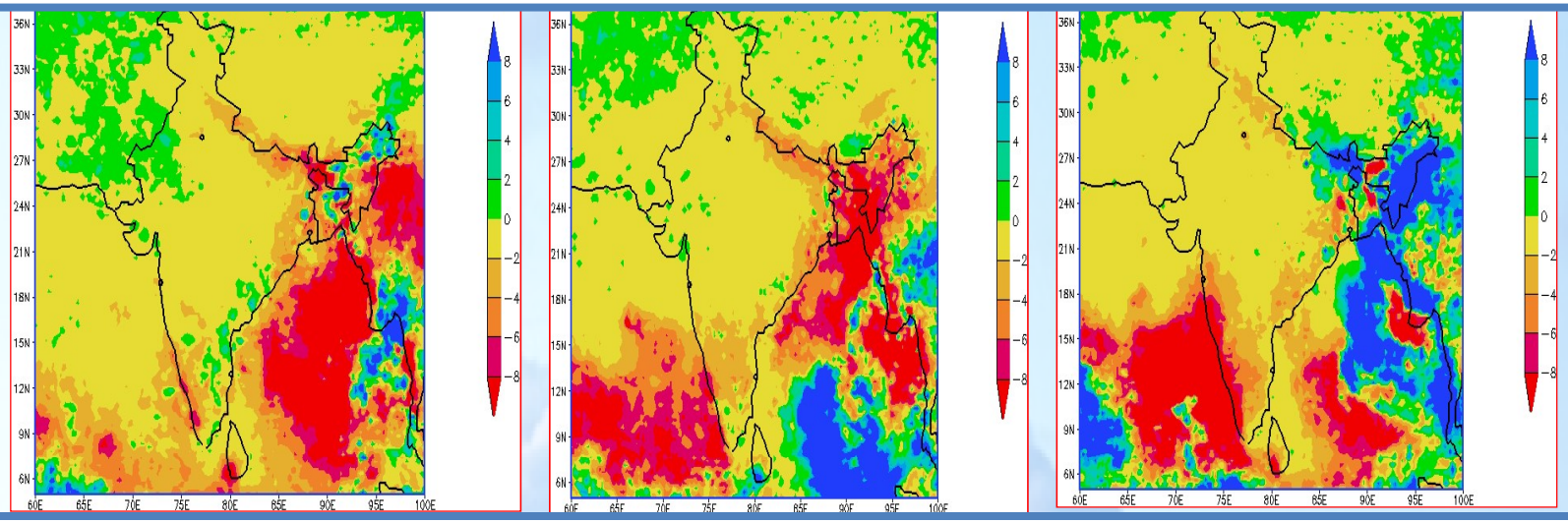
Fig.3: Sub-divisionwise rainfall distribution over India during southwest monsoon season (June to September) – 2009



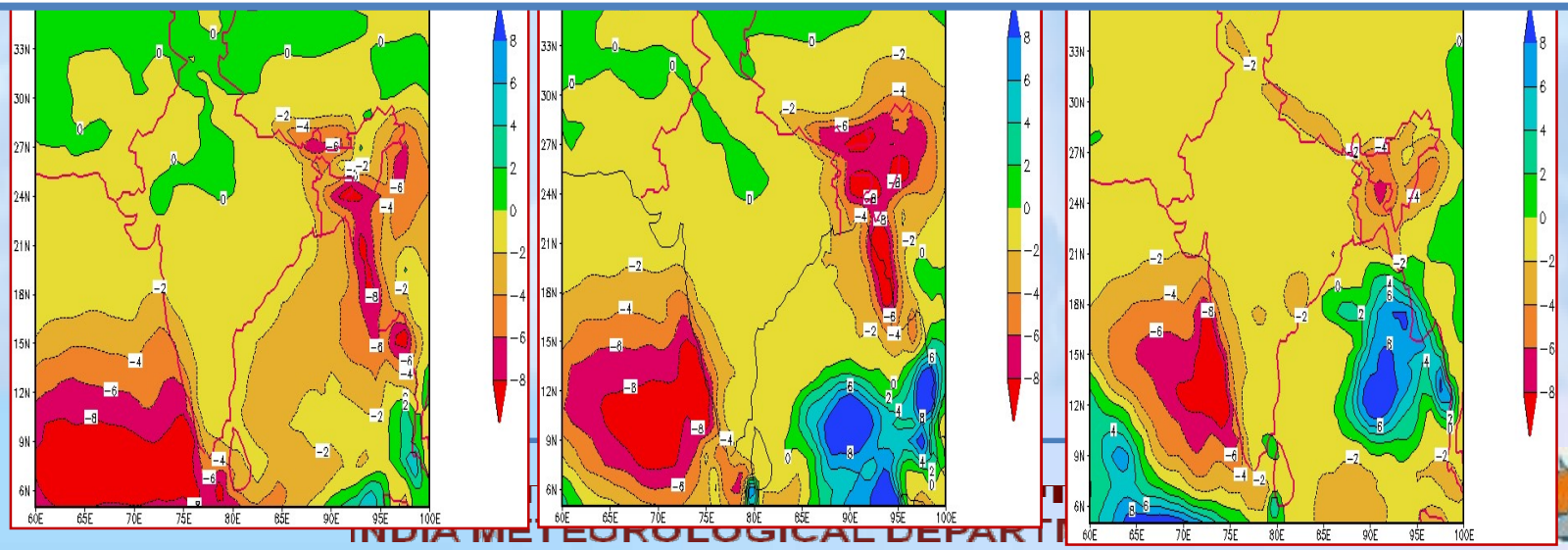


Delayed onset of monsoon over Kerala, 2012

OBS 14-20 May, 21-27May, 28May-03Jun

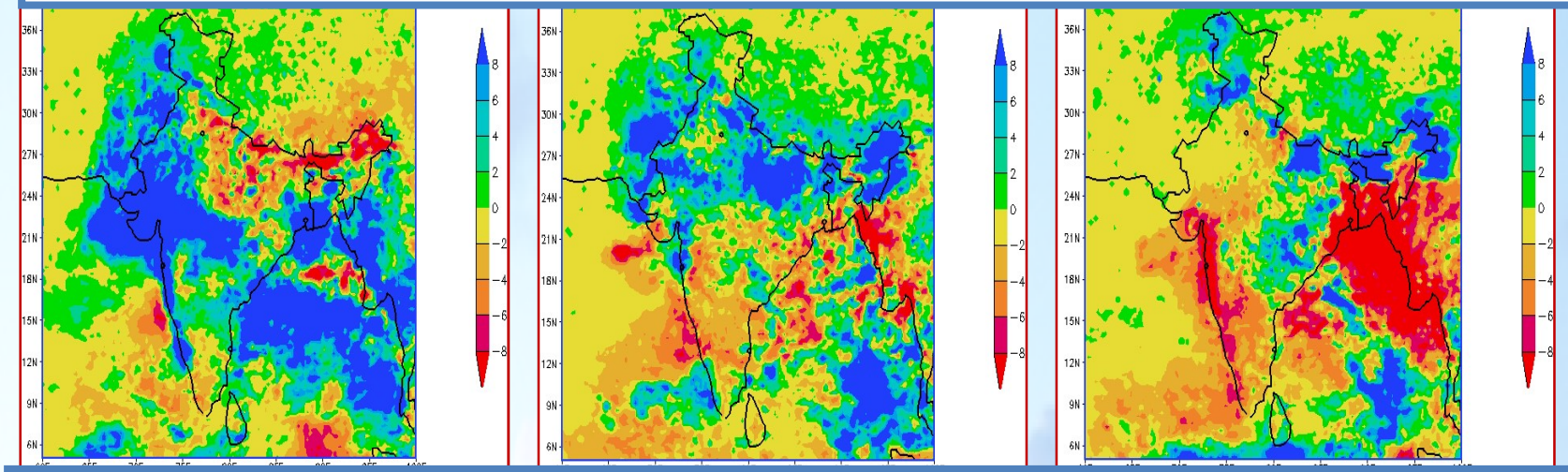


MME (9th May IC) 14-20 May, 21-27May, 28May-03Jun

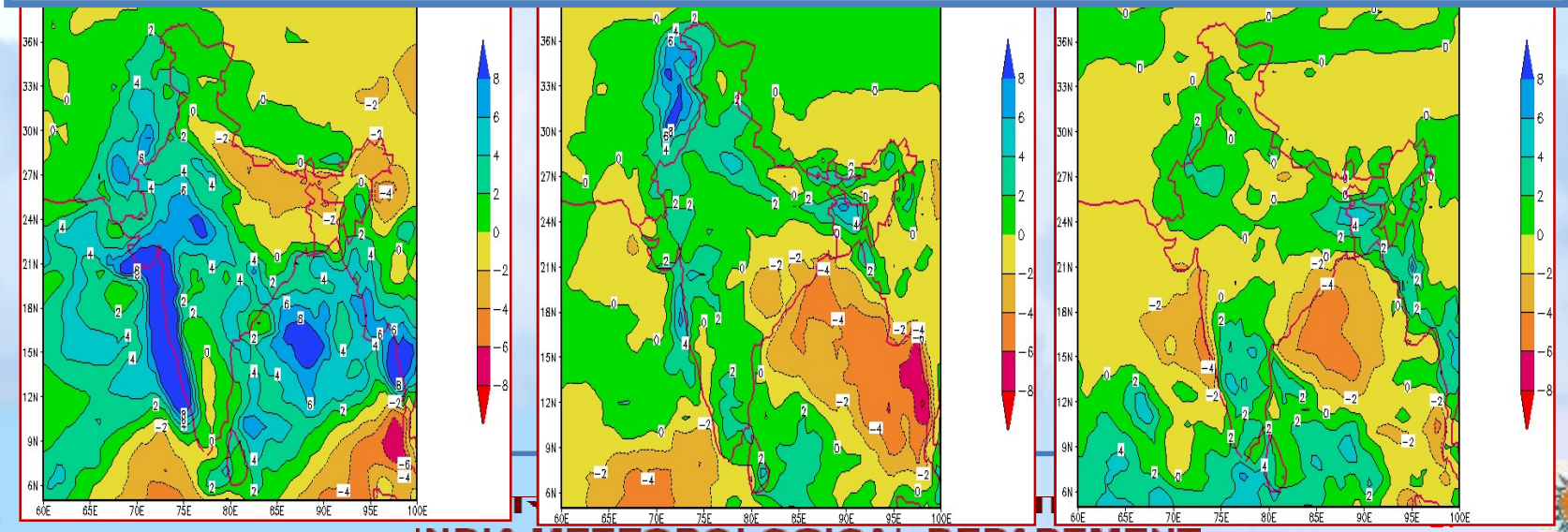


Delayed withdrawal of monsoon, 2012

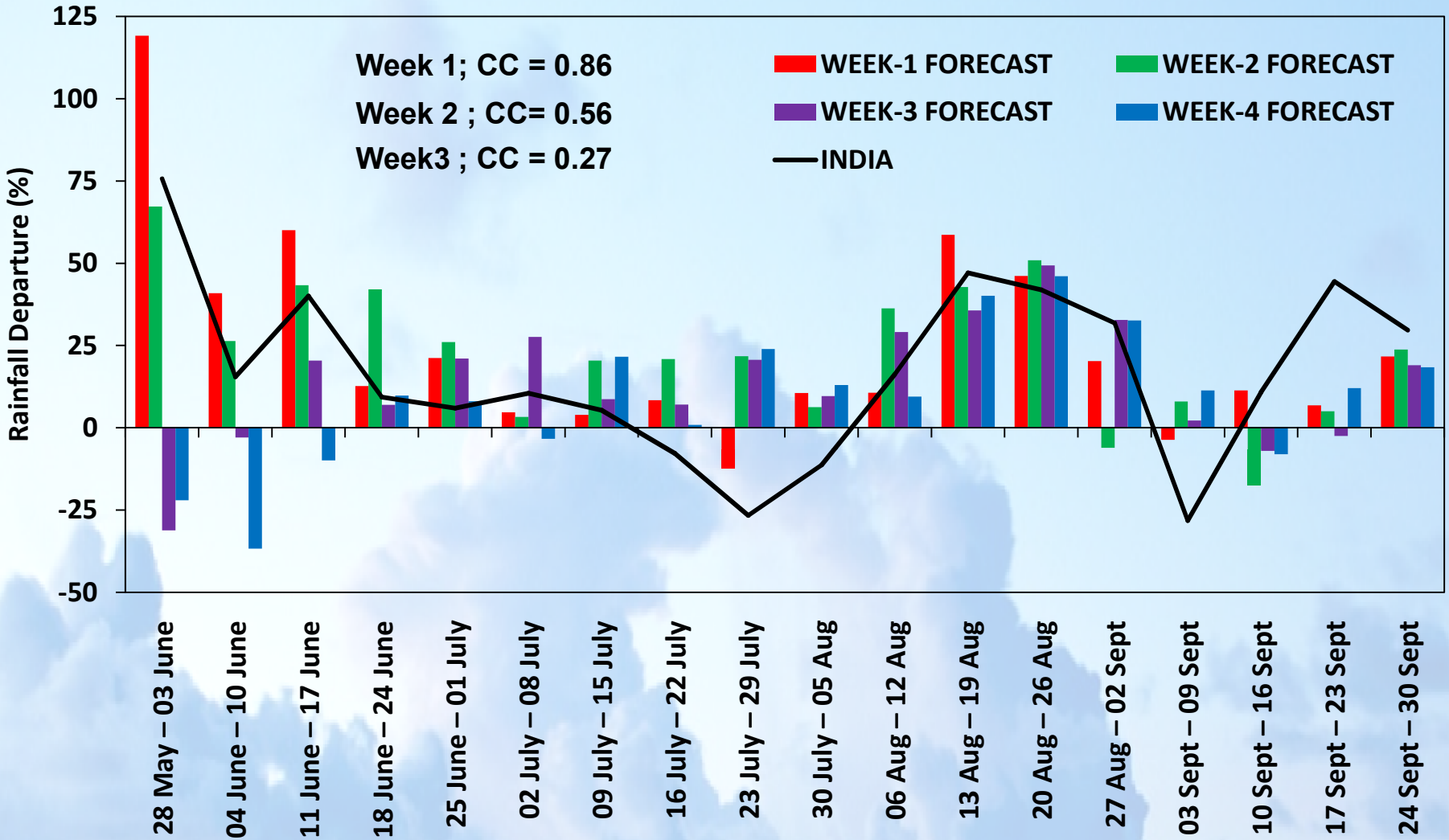
OBS 03-09 Sep, 10-16 Sep, 17-23 Sep



MME (30 Aug IC; 03-09 Sep,10-16 Sep, 17-23 Sep



4 Week Forecast over the 18 Week Period for All India, 2020



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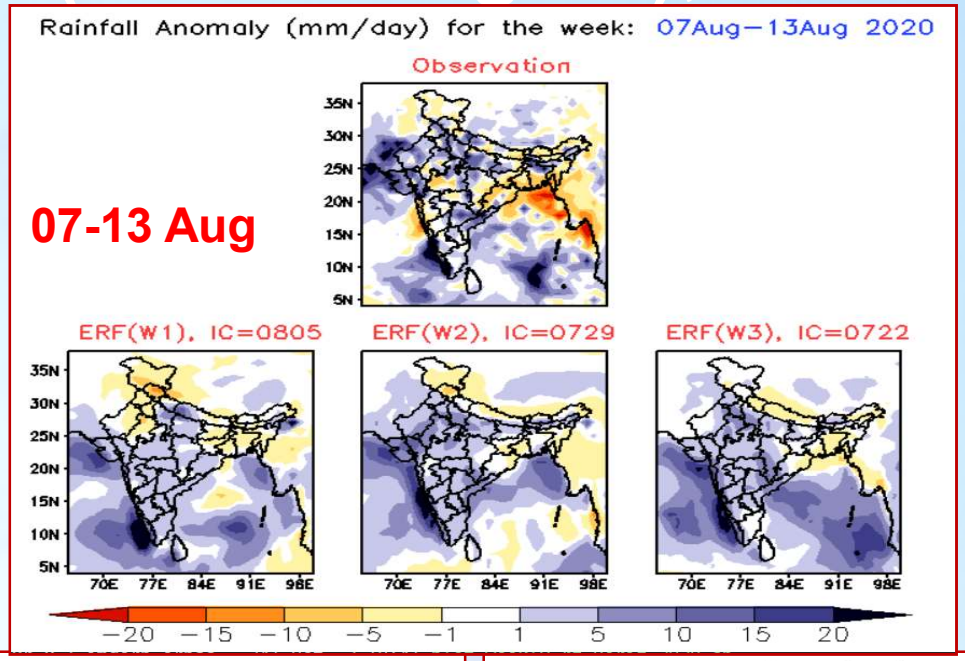
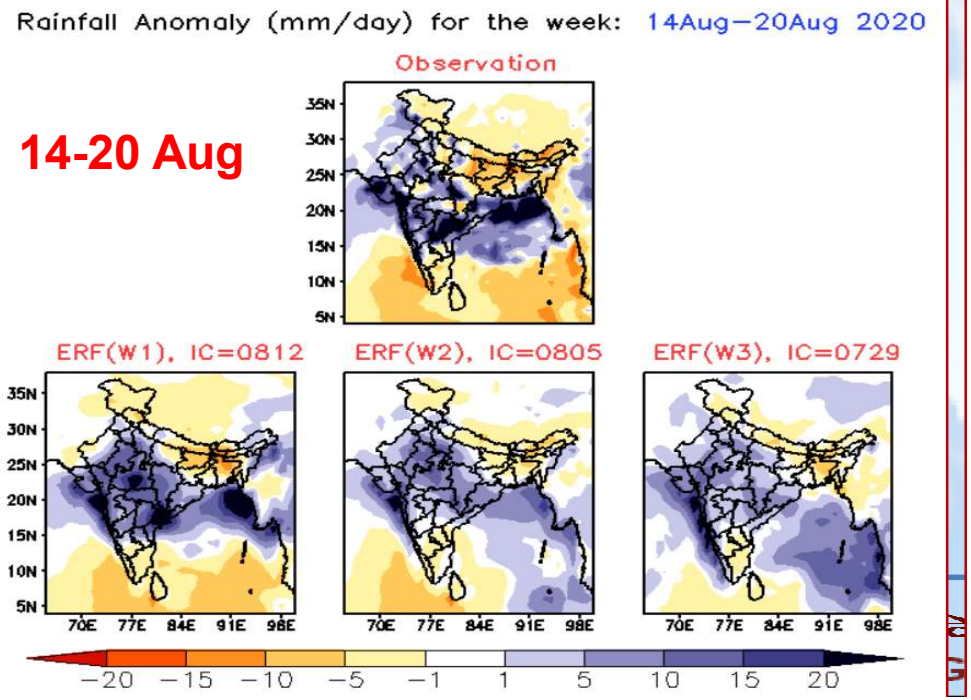
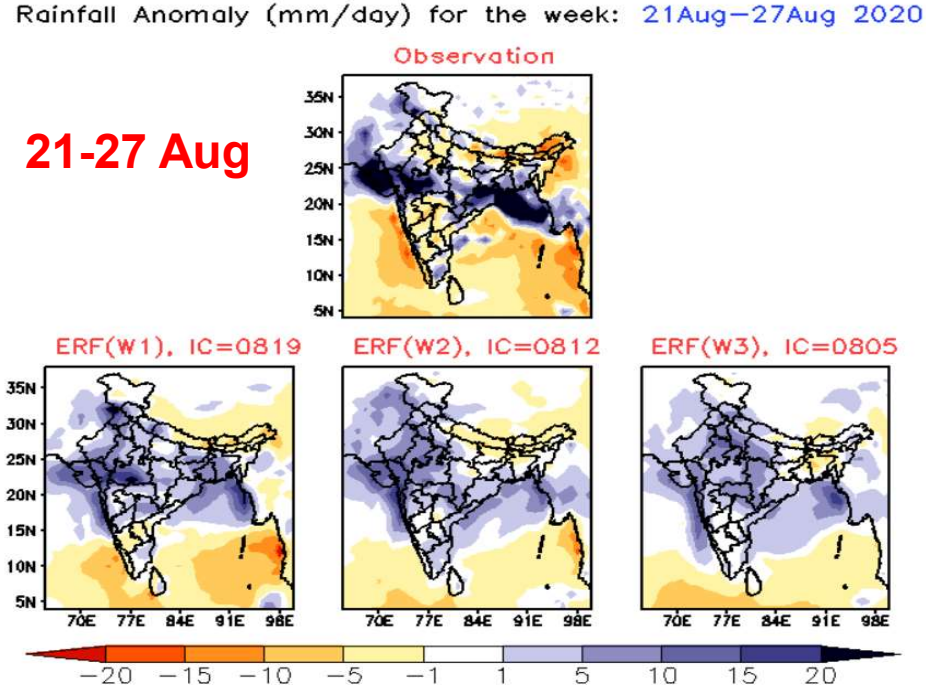
Verification (Active August); 07-27 Aug, 2020

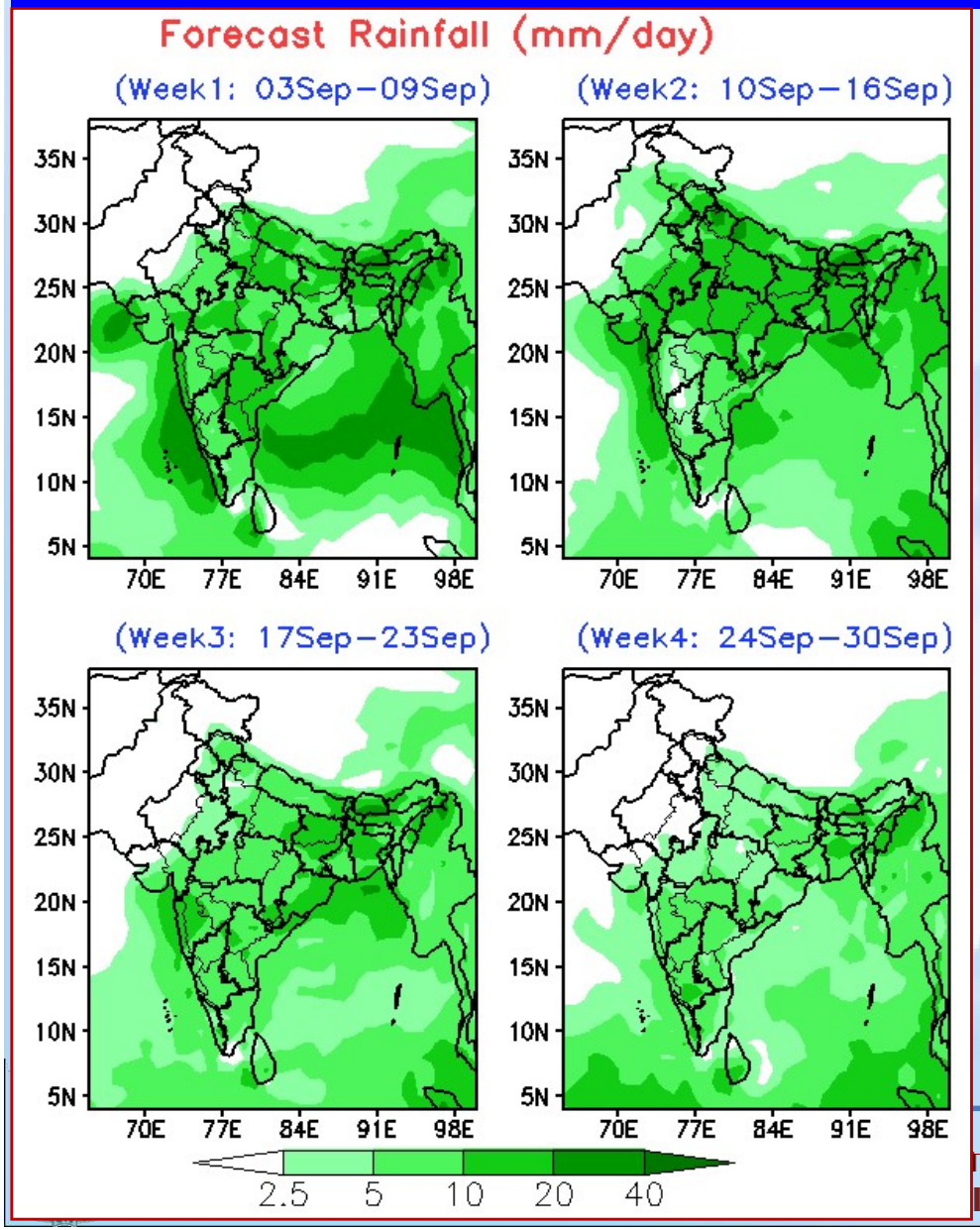


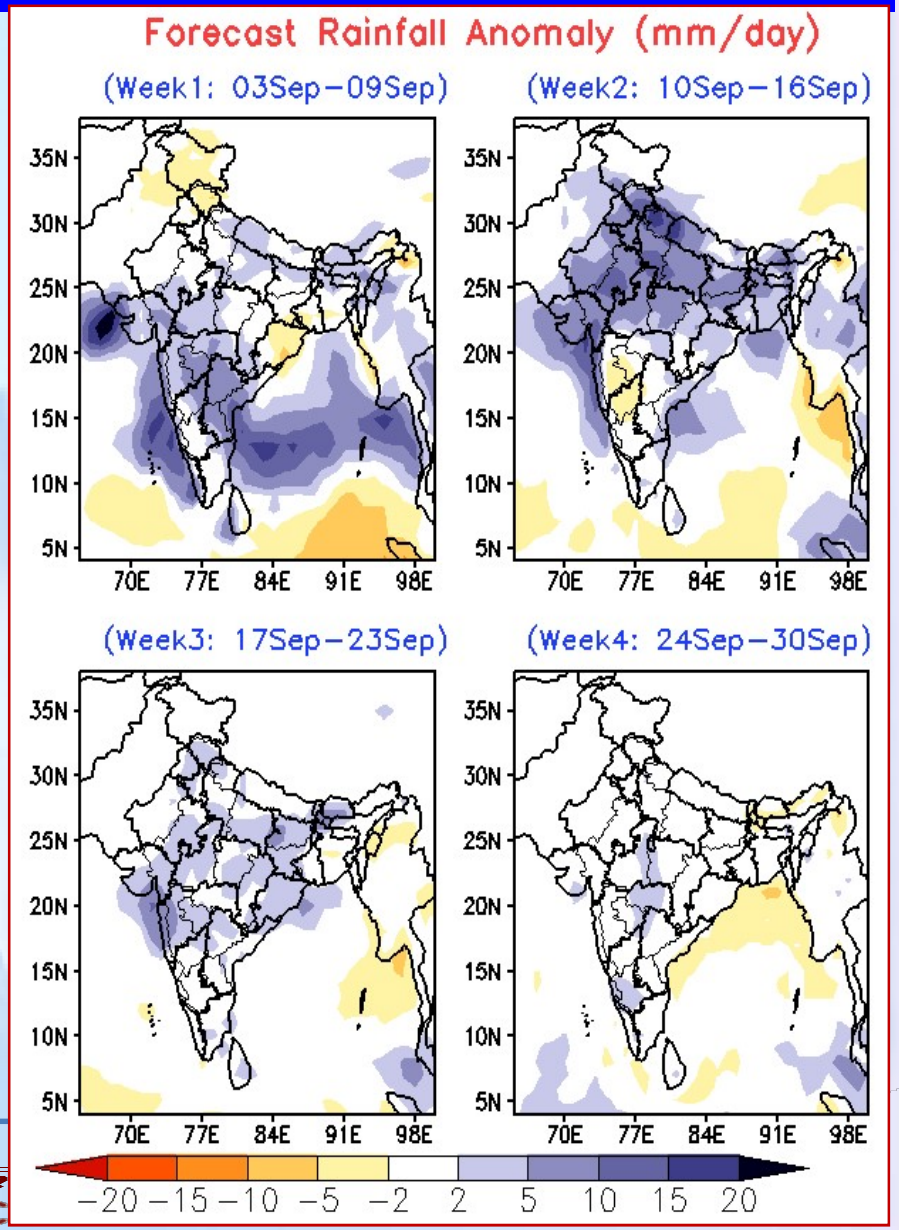




Expected Delayed withdrawal of monsoon, 2021

Latest ERF : IC of 1st September, 2021





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

MAUSAM, **69**, 1 (January 2018), 29-44

551.509 : 632.11

Usability of extended range and seasonal weather forecast in Indian agriculture

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- **IMD has started preparation of Agro-met Advisories fortnightly as well as for the season as a whole for the entire country.**
- **Based on the feedback from the farmers, it is understood that farmers need prior information of weather on extended as well as seasonal scale to make a comprehensive plan for their farming operations**

Agro-advisories IBF Based on ERF

Third party assessment of socio-economic benefits of Agro-met Services was carried out by reputed National Council of Applied Economic Research [Sharma A.(NCEAR2015)], Delhi and in their report the Council pointed out that the farming community of the country is using Agro-Meteorological Advisory Service products for critical actions during their farm operations viz.,

(i)Management of sowing in case of delayed onset of rains;

(ii)Shifting to short-duration crop varieties in case of a long-term delay in rainfall;

(iii)Deferring of spraying of pesticides for disease control on forecast of occurrence of rainfall in near future;

(iv)Managing (curtailing) artificial irrigation in case of heavy rainfall forecast.

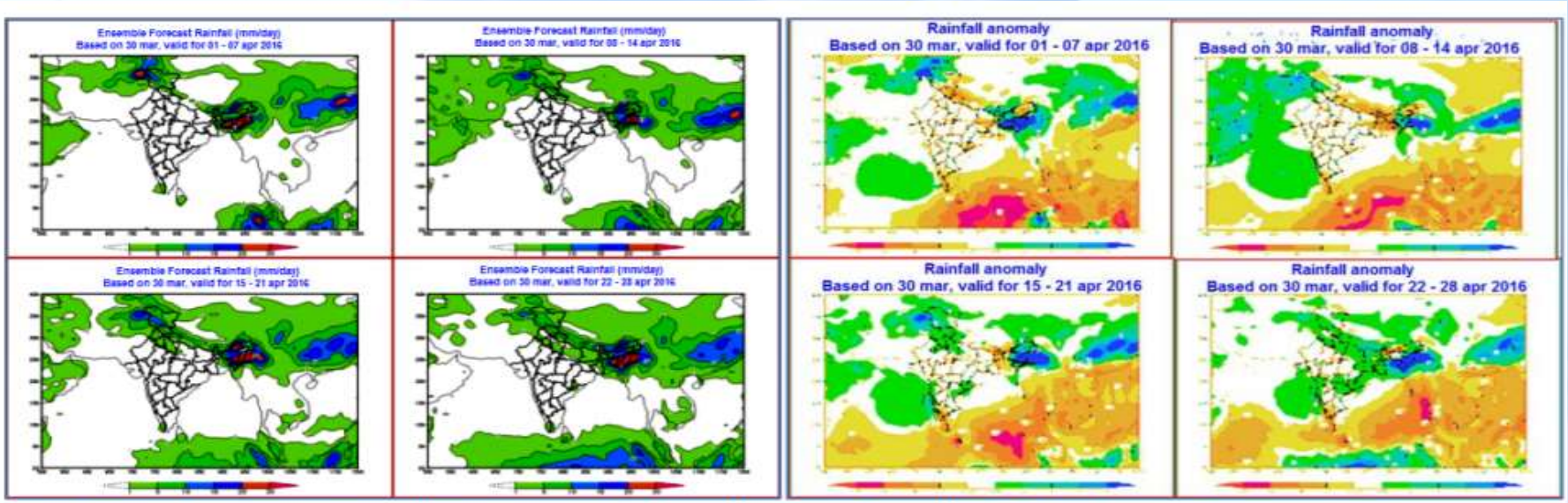
The study suggests that the Agro-met Advisory Project of IMD has the potential of generating net economic benefit up to Rs. 3.3 lakh crores on the 4-principal crops alone when Agro-Meteorological advisory Service is fully utilized by 95.4 million agriculture-dependent households.

Case study on sowing of rice based on ERWF

In Ganokdoloni village of Lakhimpur district of Assam during 2014-15, the yield of all bao varieties grown in the village was reduced substantially as compared to the earlier season (2013-14), which was due to exposure of the crop to severe moisture stress at the seedling stage (March to May), as the village was experienced with long dry spell from 24th November, 2014 to the first week of May, 2015.

Thus, the farmers in this village had lot of confusion to start sowing of bao rice in 2016. Up to 30th March, 2016, farmers of the village did not start sowing of bao varieties.

Based on the forecast of continuous rainfall during April, 2016 received from IMD, farmers were advised to complete the sowing as early as possible (within first/ second week of April). Thus, the advisory given based on extended weather forecast was proved to very useful for the farmers of the village.



Figs. 13 (a & b). (a) ERWF rainfall forecast, IC 30 MAR, 2016, (1-28 April, 2016), (b) ERWF rainfall anomaly, IC 30 March, 2016, (1-28 April, 2016)

Theoretical and Applied Climatology
https://doi.org/10.1007/s00704-021-03679-w

ORIGINAL PAPER

Kharif rice yield prediction over Gangetic West Bengal using IITM-IMD extended range forecast products

Javed Akhter[1] · Raju Mandal[1,2] · Rajib Chattopadhyay[1] · Susmitha Joseph[1] · Avijit Dey[1] · M. M. Nageswararao[1] · D. R. Pattanaik[3] · A. K. Sahai[1]

Received: 30 May 2020 / Accepted: 31 May 2021

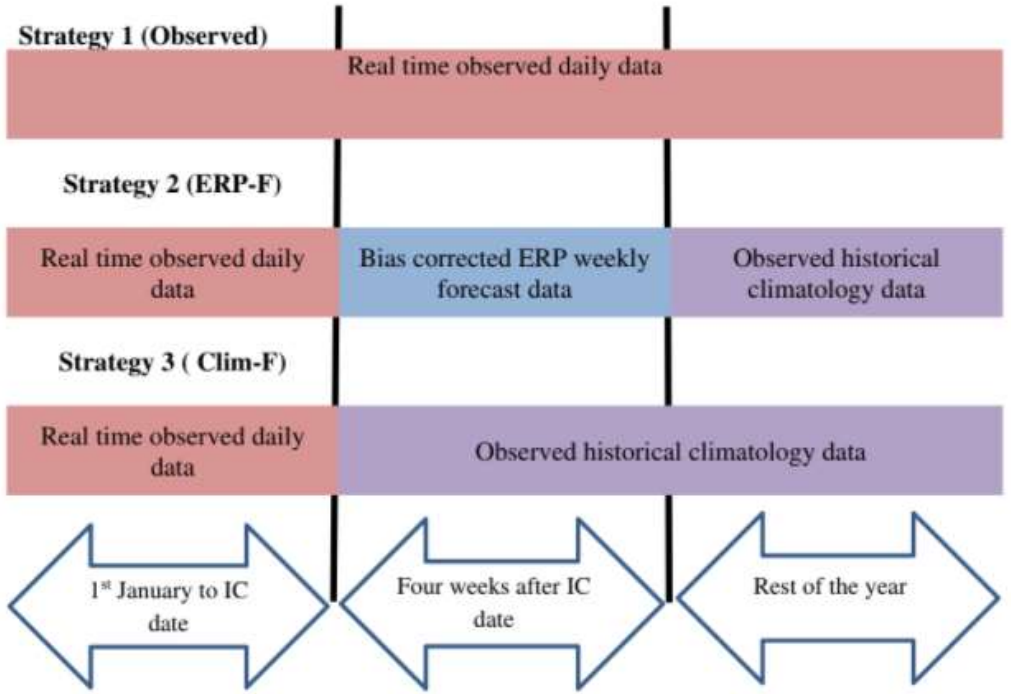


Fig. 2 Schematic diagram of three strategies for linking meteorological data to crop model for rice yield prediction

Severe Weather : Monsoon

(Heavy Rainfall)

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INDIA METEOROLOGICAL DEPARTMENT

MAUSAM, **66**, 3 (July 2015), 551-568

551.509.5 : 551.553.21 (540.27)

Rapid northward progress of monsoon over India and associated heavy rainfall over Uttarakhand: A diagnostic study and real time extended range forecast

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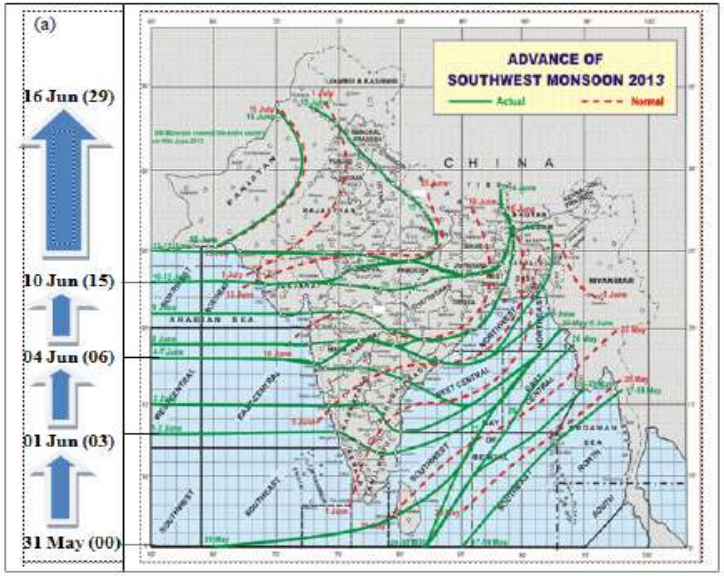
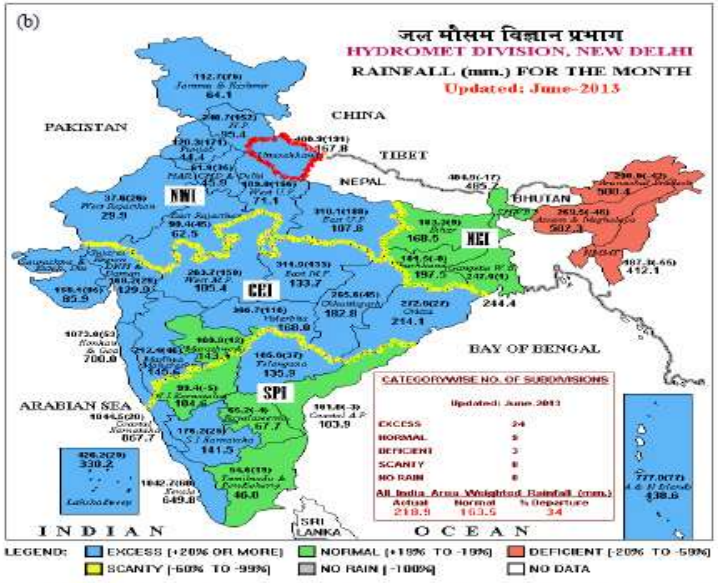
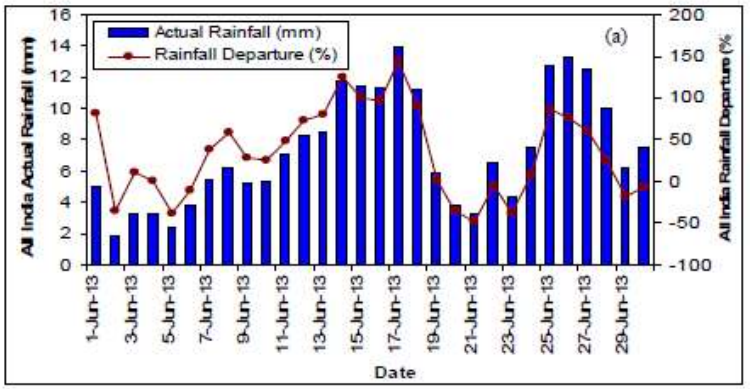
e mail : drpattanaik@gmail.com

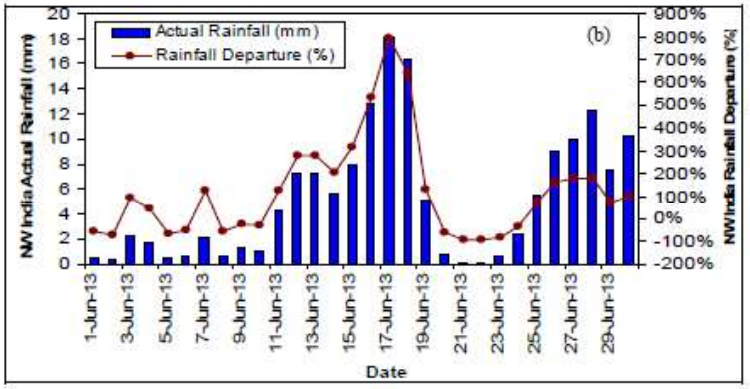
Rapid Progress of Monsoon Northward (June 2013)

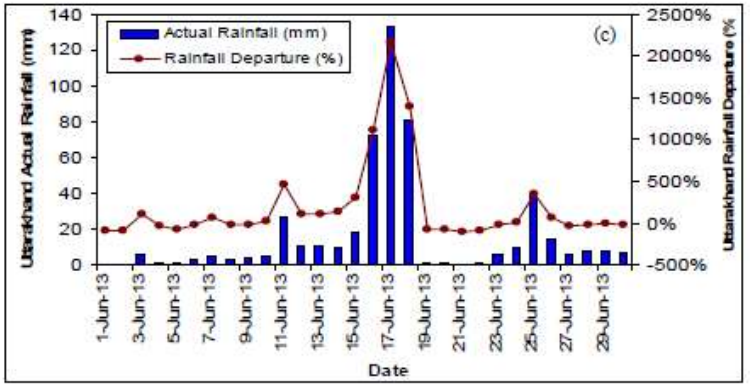




Figs. 1(a&b) (a) Onset and progress of monsoon over India during 2013. (b) Met-sub-division wise rainfall during June with circle in red indicated the meteorological sub-division of Uttarakhand. The four homogeneous regions (NWI : northwest India; NEI : northeast India; CEI : central India; SPI : south-peninsular India)

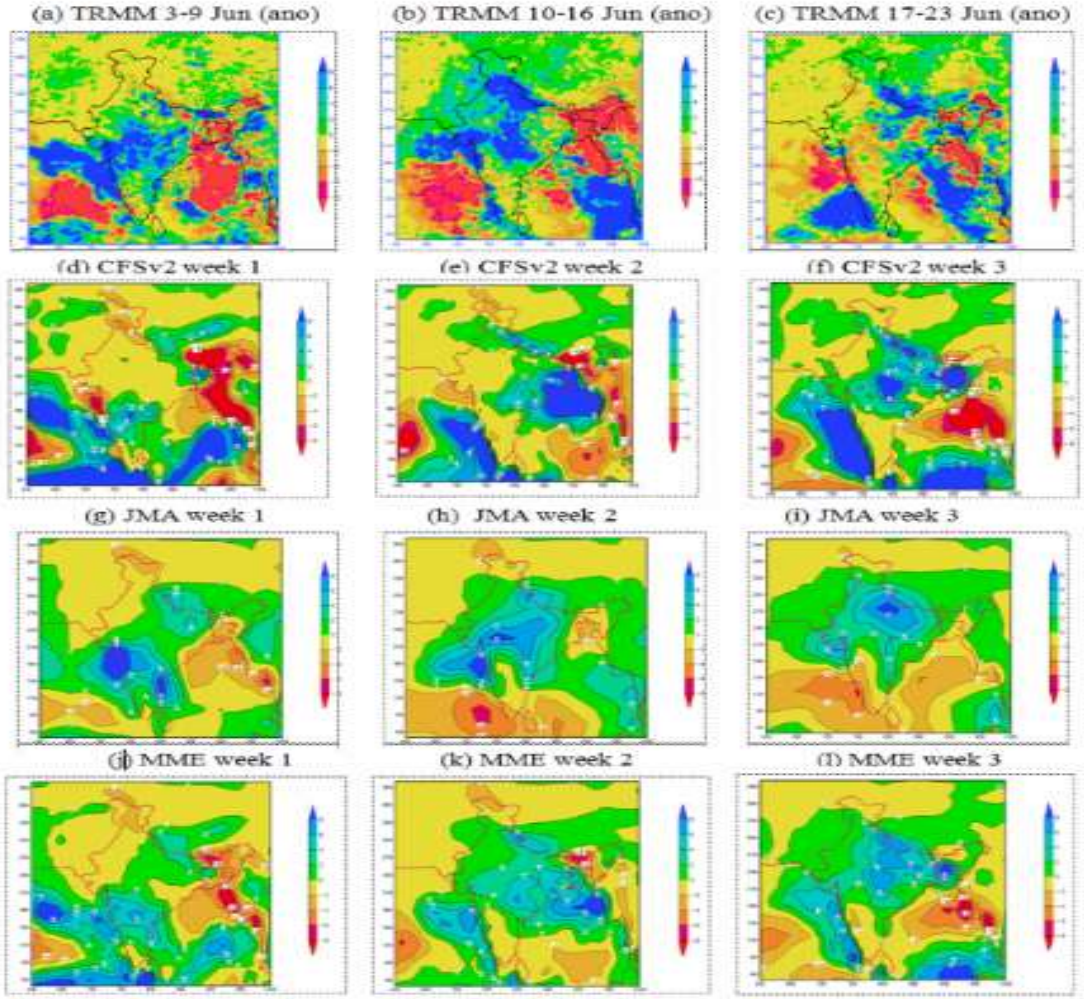






Figs. 6(a-c). Actual daily rainfall (mm) and departure (%) from normal during June, 2013 over (a) All India, (b) Northwest India and (c) Uttarakhanad met sub-division

ERF Based on 30th May, 2013



Figs. 10(a-l). Observed (TRMM) and forecasts rainfall anomaly (mm/day) from CFSv2, JMA, & MME based on 30 May, 2013 and valid for week-1 (3-9 June), week-2 (10-16 June) and week-3 (17-23 June)

Observed weekly rainfall departure along with corresponding forecast weekly rainfall departure from CFSv2, JMA and MME for the heavy rainfall weeks from 10-16 June and 17-23 June, 2013 over the meteorological subdivision of Uttarakhand

IC = 30 May 2013	Week 2 (days 12-18) June 10-16	Week 3 (days 19-25) June 17-23
Observed Rainfall	322.2%	457.2%
CFSv2 (IC 30 May)	53%	60%
JMA (IC 30 May)	291%	261%
MME (IC 30 May)	92%	97%
	Week 1(days 5-11) June 10-16	Week 2 (days 12-18) June 17-23
Observed Rainfall	322.2%	457.2%
CFSv2 (IC 6 June)	47%	69%
JMA (IC 6 June)	190%	96%
MME (IC 6 June)	83%	77%

Severe Weather : Monsoon

(Heavy Rainfall Northeast Monsoon)

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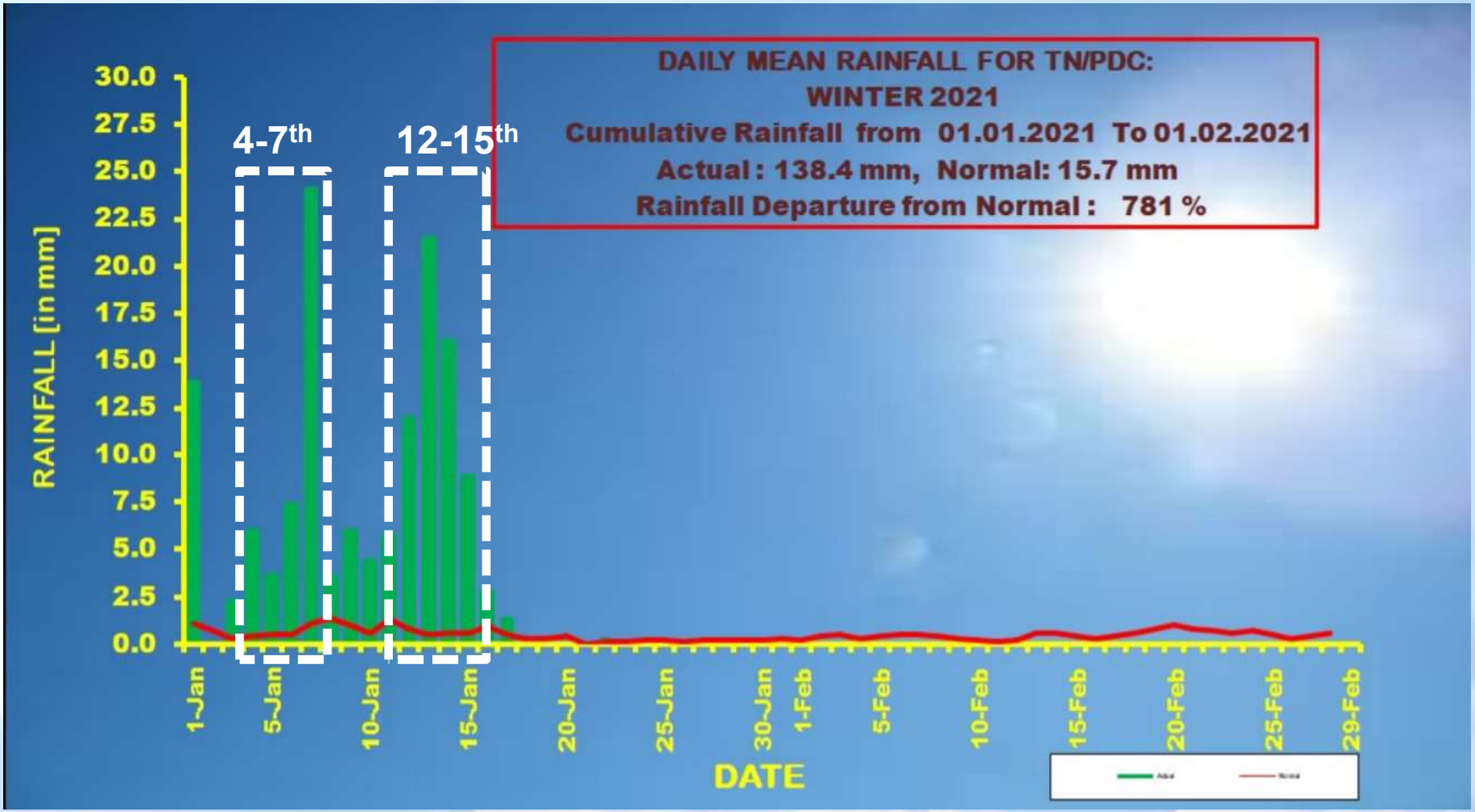
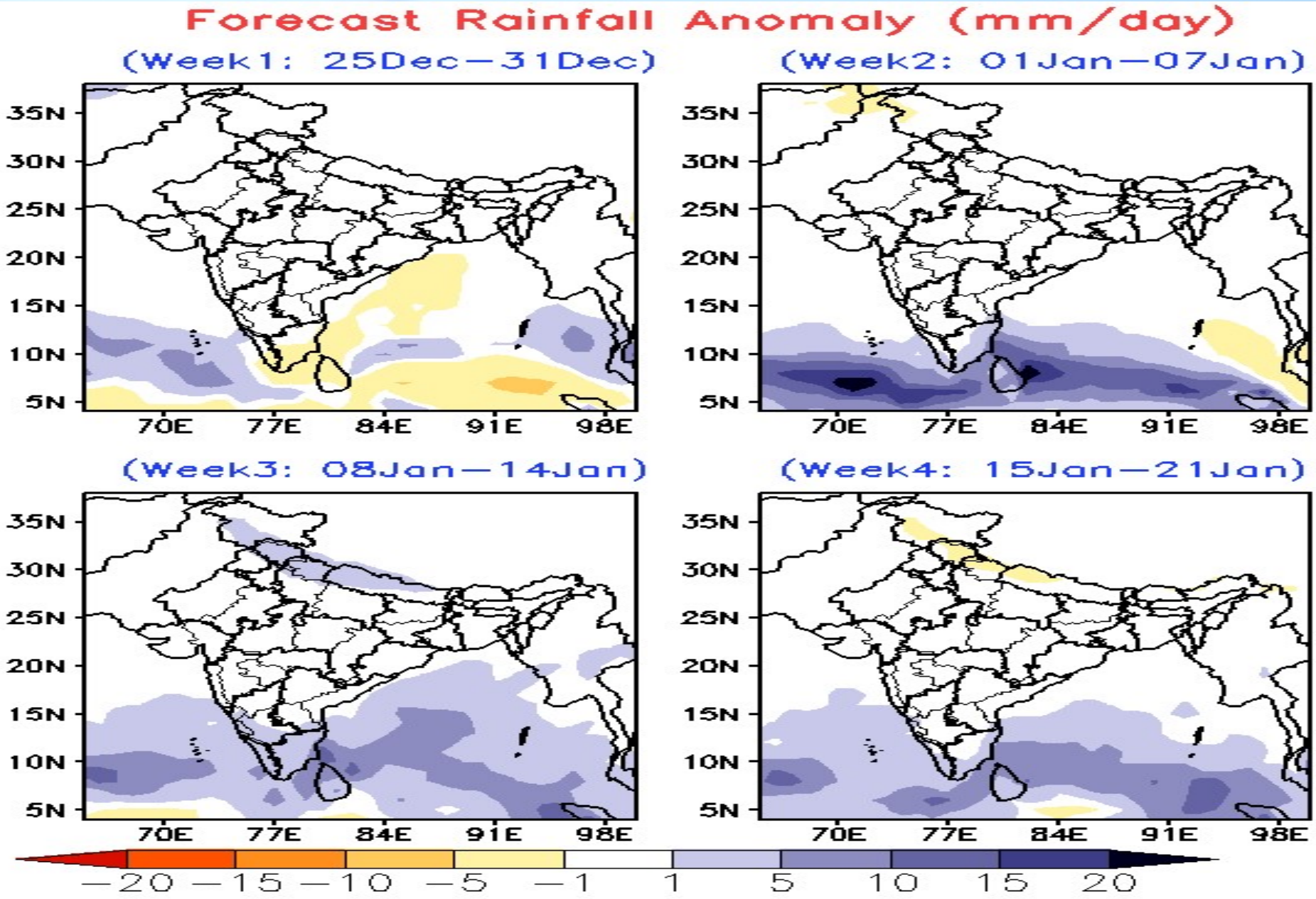
Jan 2021 rainfall over TN sub division



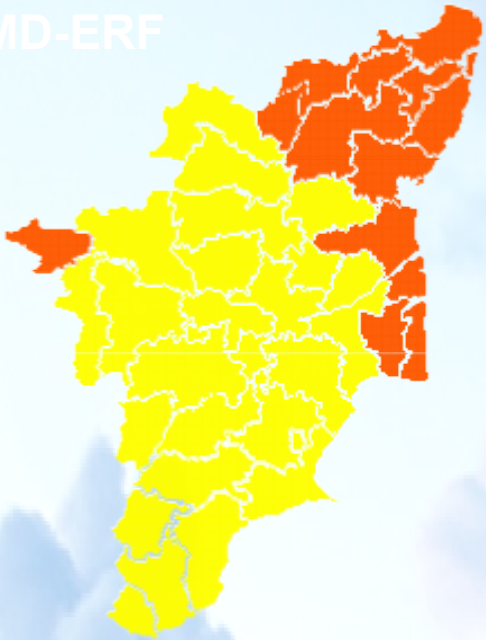
✓Rf→ 14 cm (Nor < 2 cm; 0.5 mm/day

Predicted week wise weekly rainfall anomaly (MME)



Based on 23-Dec-2020 (IMD ERF)

Week-1
25 Dec-31 Dec 2020

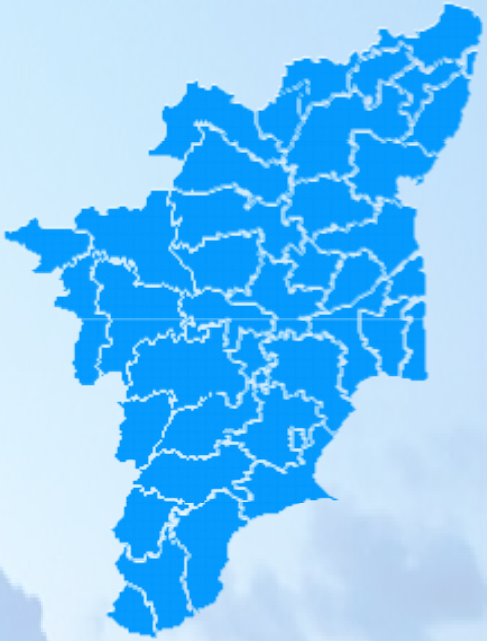


Sub-Div % Dep:

Week-2
01 Jan-07 Jan 2021

Sub-Div % Dep:

Week-3
08 Jan-14 Jan 2021

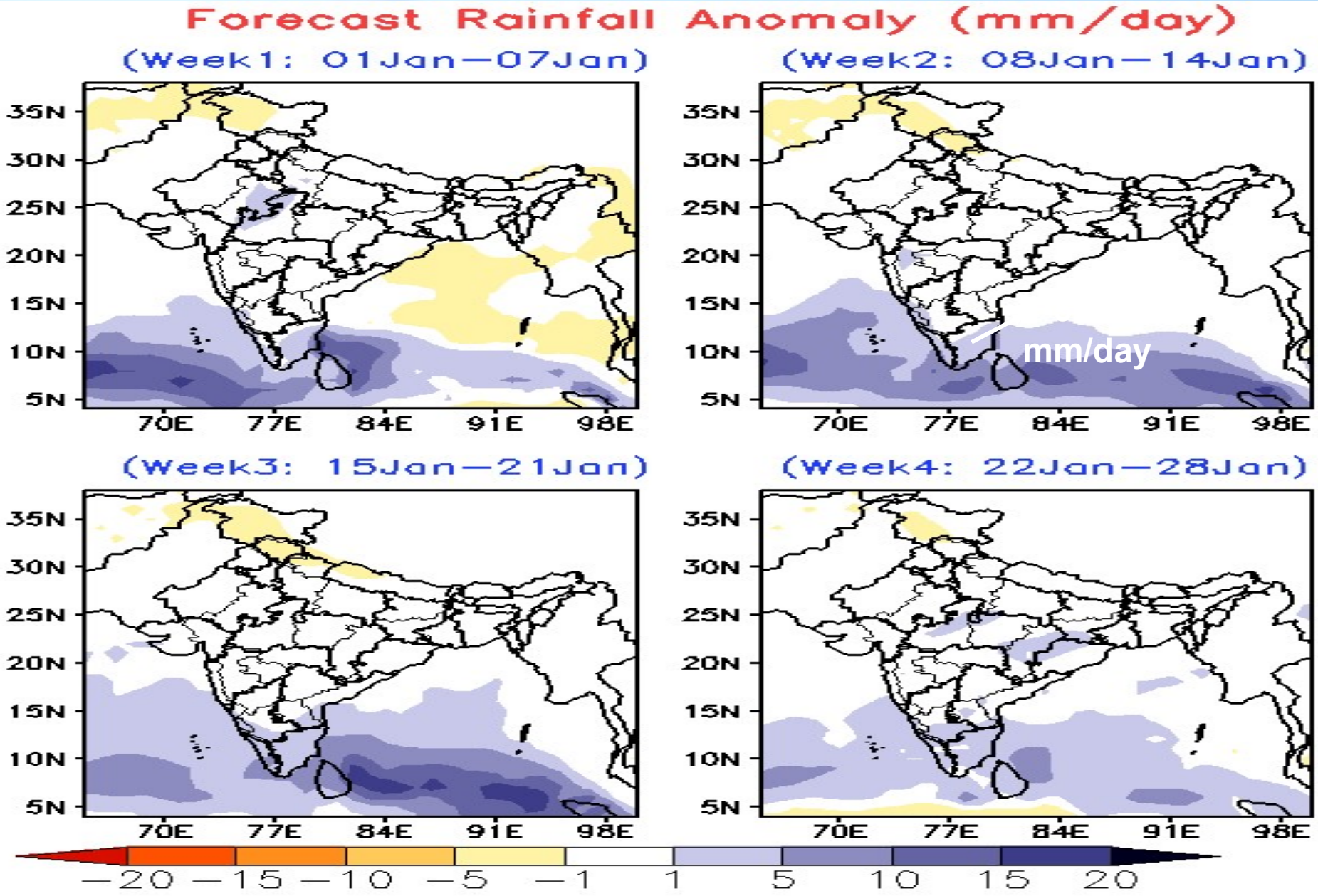


Sub-Div % Dep:

NCMRWF	Week (25-31 Dec)	Week (01-07 Jan)	Week (08-14 Jan)
23 Dec	Normal	Large Excess	Large Excess

Realised rainfall	7.8	9.3	-16	Normal	56.8	4.6	1135	L EXCESS	68.7	6.2	1008	L EXCESS

Predicted week wise weekly rainfall anomaly (MME)



Severe Weather : Monsoon

(Water Resource Management)

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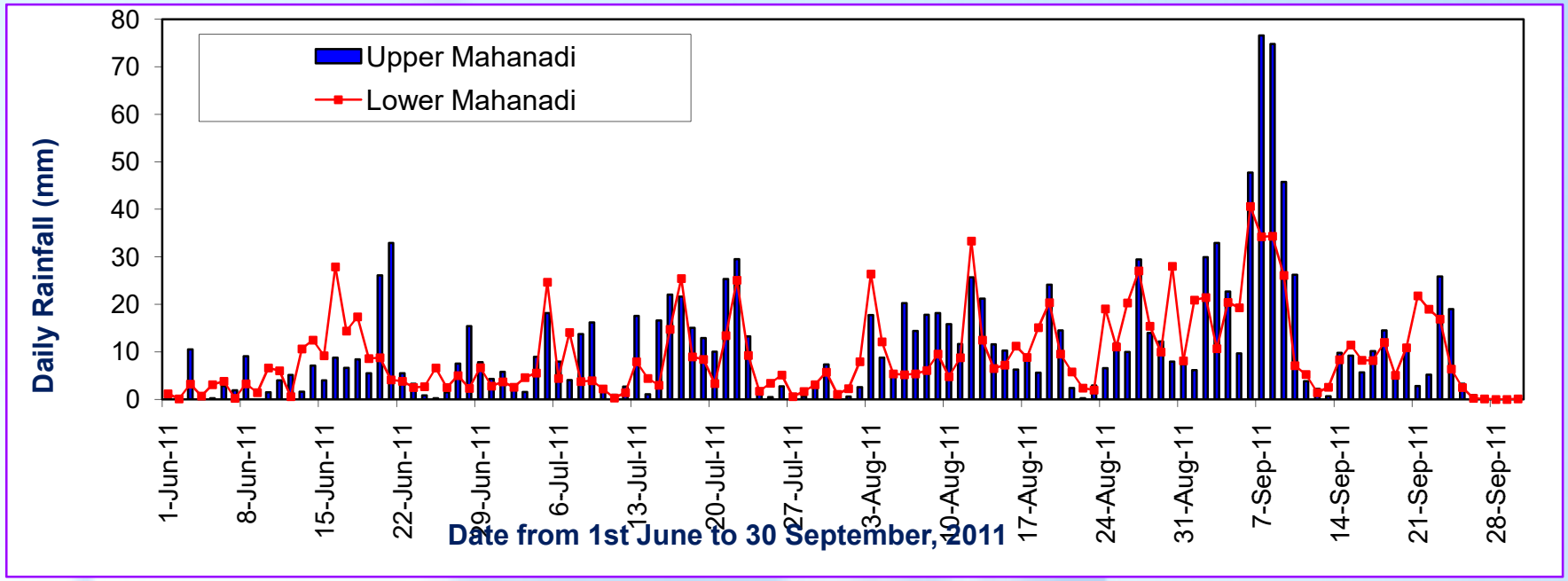
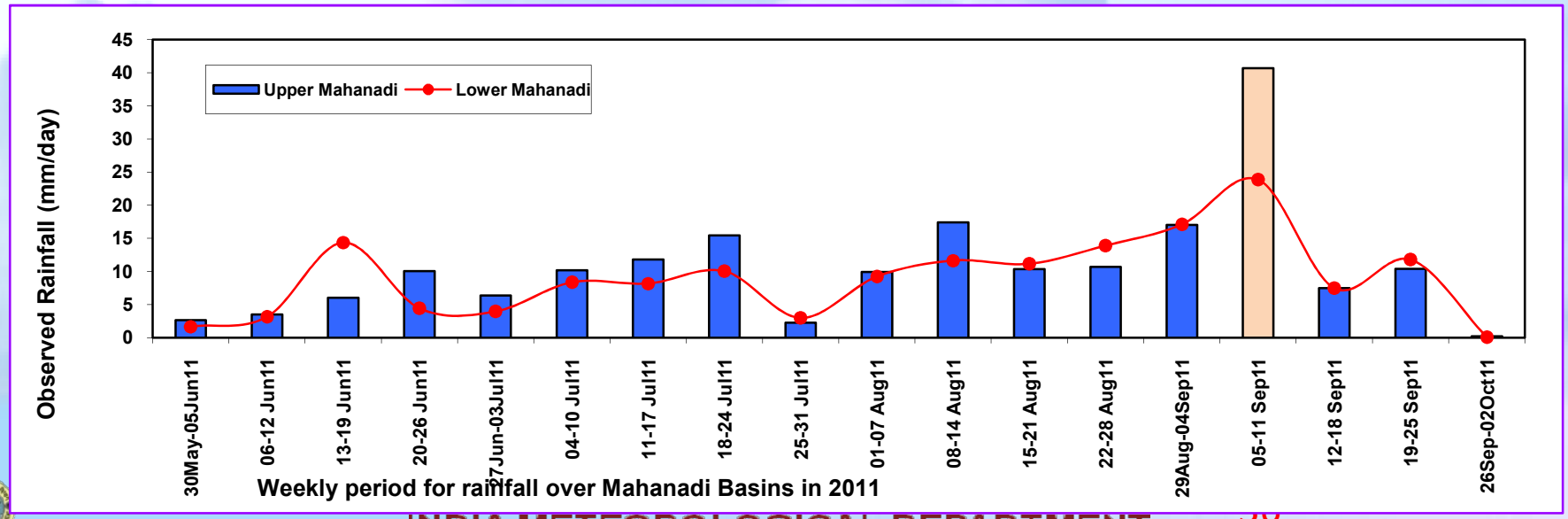
Observed Rainfall over the Mahanadi Catchments





Unprecedented Flood of Orissa, Sep 2011

Rule Curve of Reservoir level of the Dam

•Rule curve prescribes reservoir level in dam to be

•between **590 to 595 feet during 1st July to 1st August**, which is near to the dead storage. This is to facilitate flood cushioning. In case there is heavy inflow into reservoir, water can be retained and discharged in regulative manner.

•**From 1st of August reservoir level would be raised till 1st of October**, when reservoir will be filled up to FRL (Full Reservoir Level).

•The rule curve is premised on higher rainfall and inflow in July and Aug (at dead storage level in July and Aug) and lesser rainfall in September **(619-627 ft on 1st Sep).**

Rule Curve for Water Level Management of the Dam

As can be seen in subsequent analysis (section on rainfall and runoff) we find there is a clear shift towards more rainfall and runoff in the month of September.

Probably the existing rule curve is unable to accommodate cushion to September inflows.

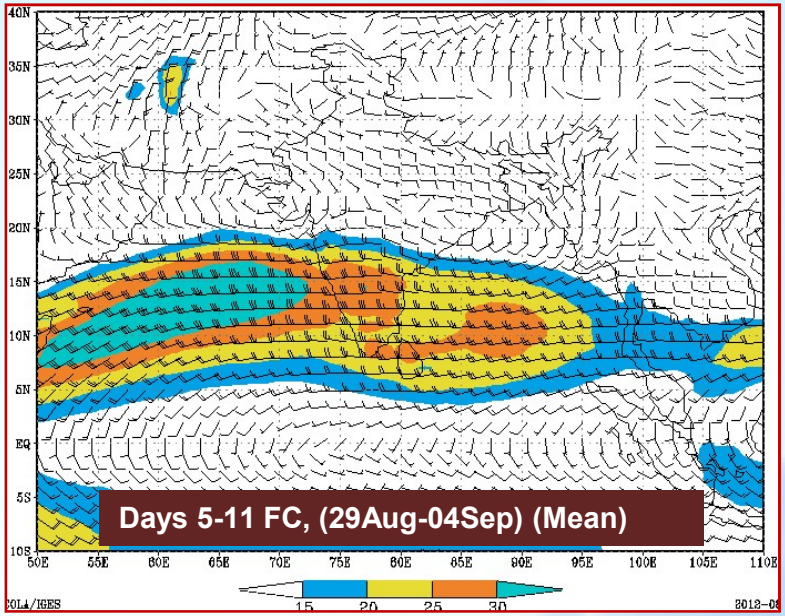
Lack of appreciation of this shift and accommodation of this into the Rule Curve along with reduction in live storage capacity and unpredicted release from dams in Chhatisgarh, is decreasing the flood cushioning ability of the Hirakud dam.

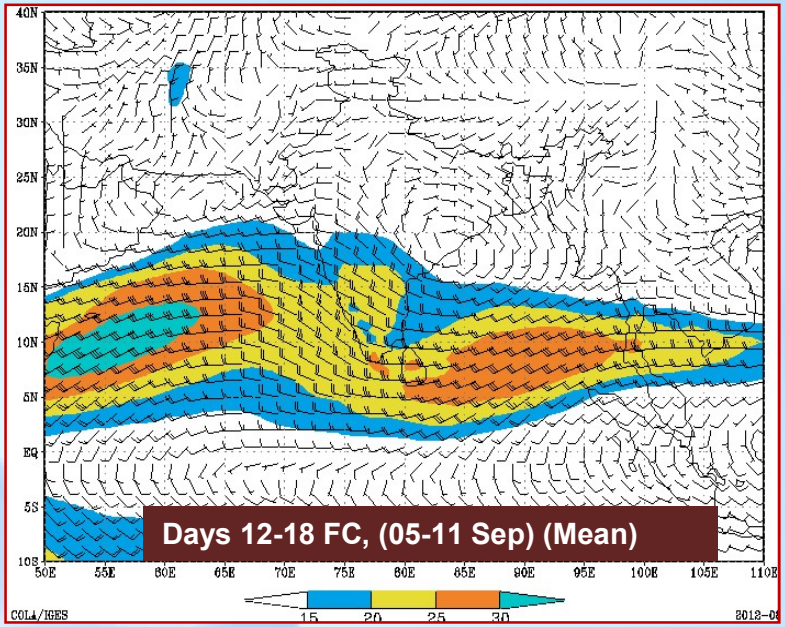
Reservoir Capacity analysis at different water levels on 5th, 7th and 8th September, 2011						
Date	Reservoir Level	Inflow (cusec)	Outflow (cusec)	Reservoir capacity in cft at these water levels (2007 data)	Change in storage (inflow-Outflow) in cft	Storage capacity available after accommodating the change in storage (MAF)
5	624.23	313253	379533	3887413.97	-5726592000.00	0.13
7	626.31	543840	482907	4199200.03	5264611200.00	-0.12
8	627.27	950630	709215	4350412.51	20858256000.00	-0.48

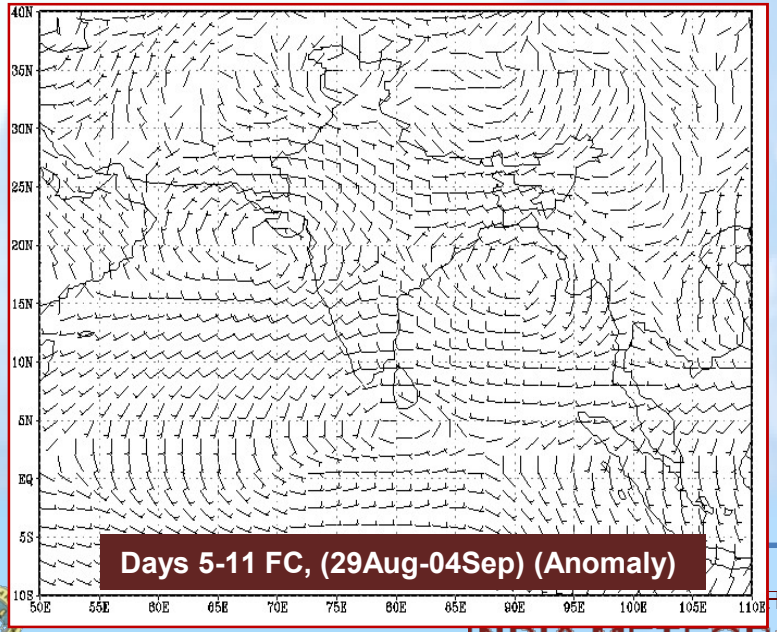
❖**This year, during 2nd September to 10th of September reservoir levels were within the limit of prescribed rule curve, though towards upper limit during 5th to 10th Sept. Due to this there was absence of any flood water retaining capacity in reservoir.**

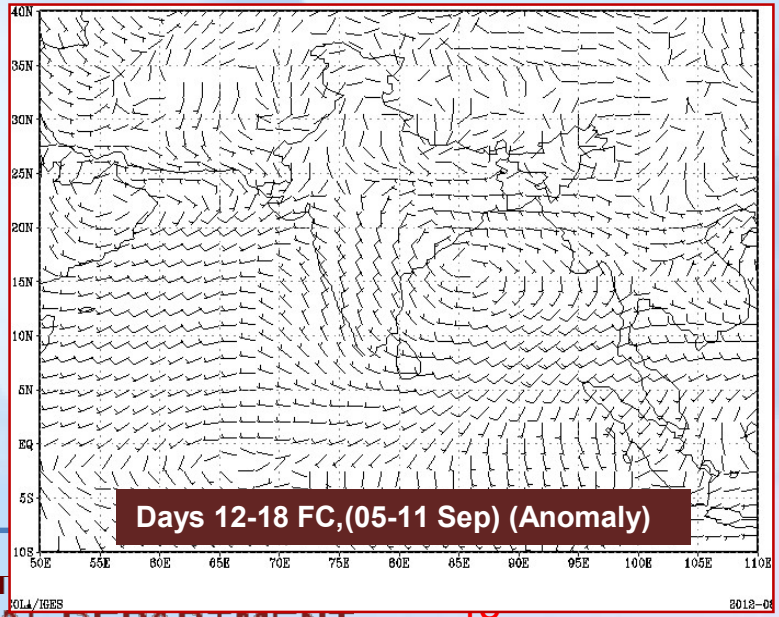
❖**When inflow, jumped up to 11 lakh cusecs at 10.00 hours on 10th September, dam authorities were forced to release of more than 9 lakh cusecs of water, which increased threat of flood in the delta.**

MME forecast 850 hPa wind and anomaly wind for 2 weeks based on 25th Aug, 2011

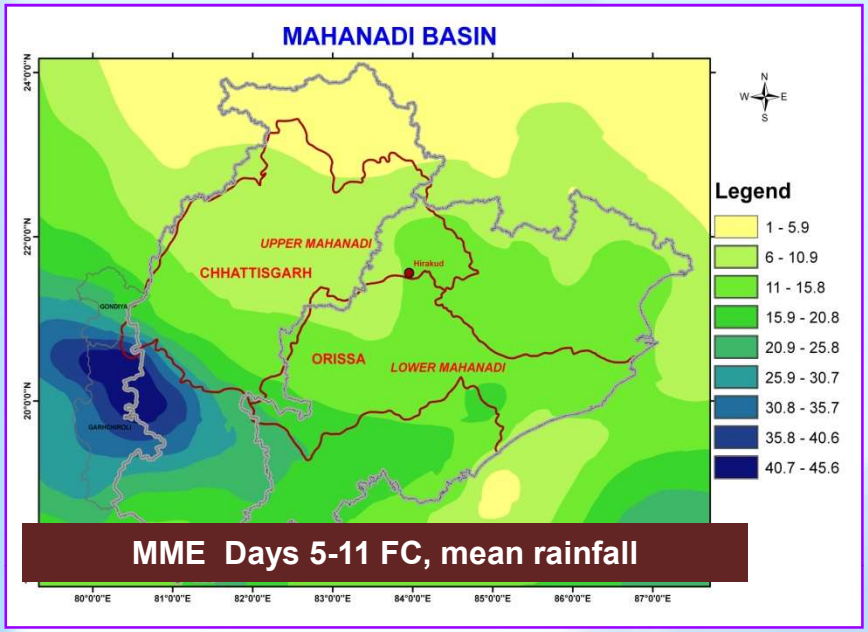


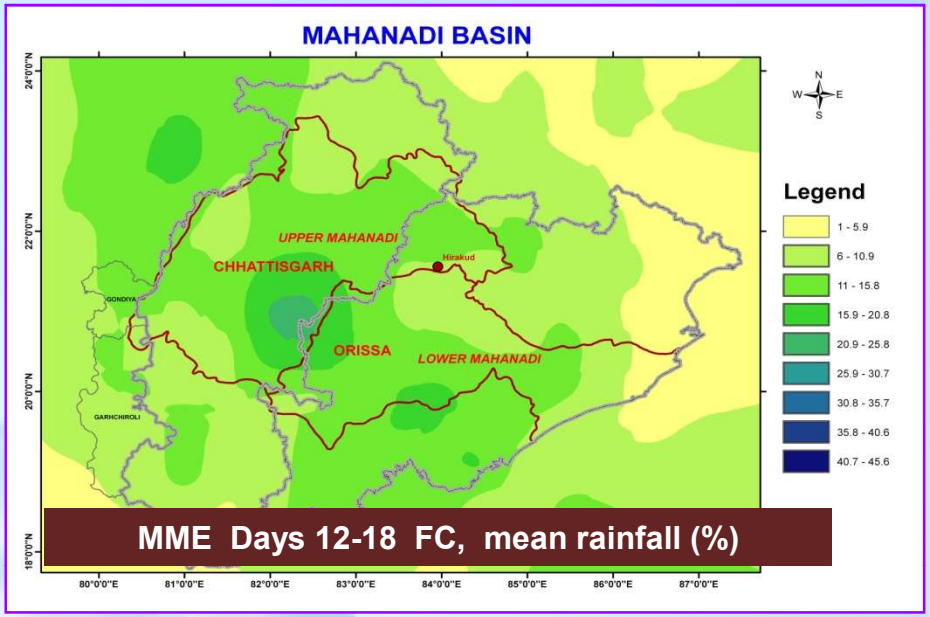


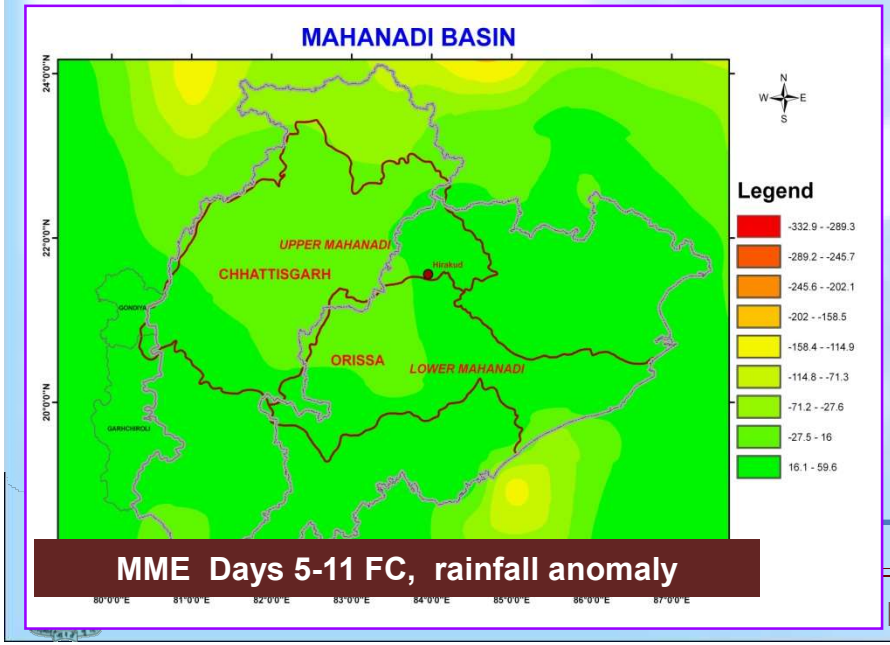


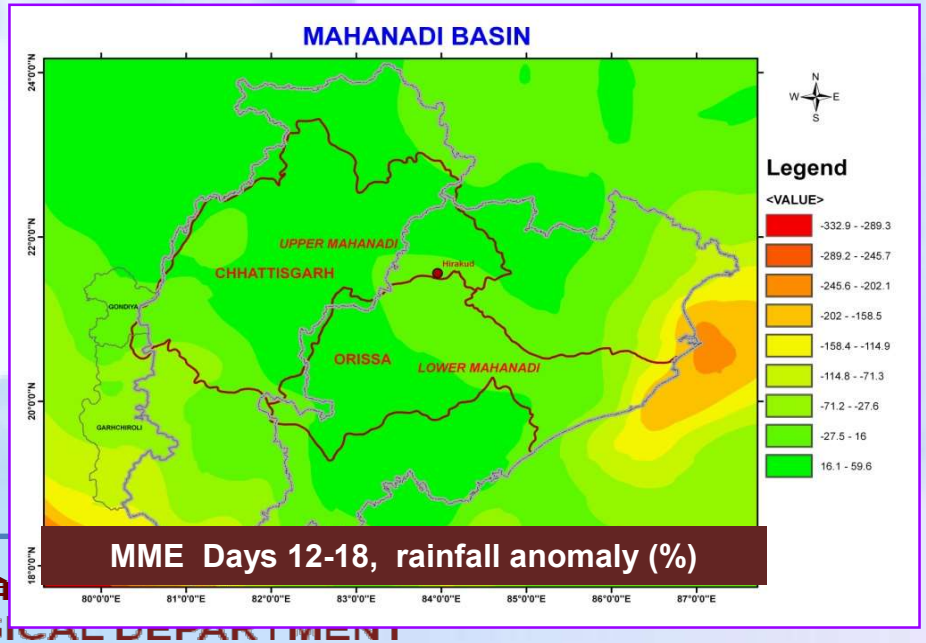


MME forecast rainfall for two weeks based on 25th Aug, 2011 (29 Aug-04 Sep), and 05-11 Sep)









Issues & Challenges

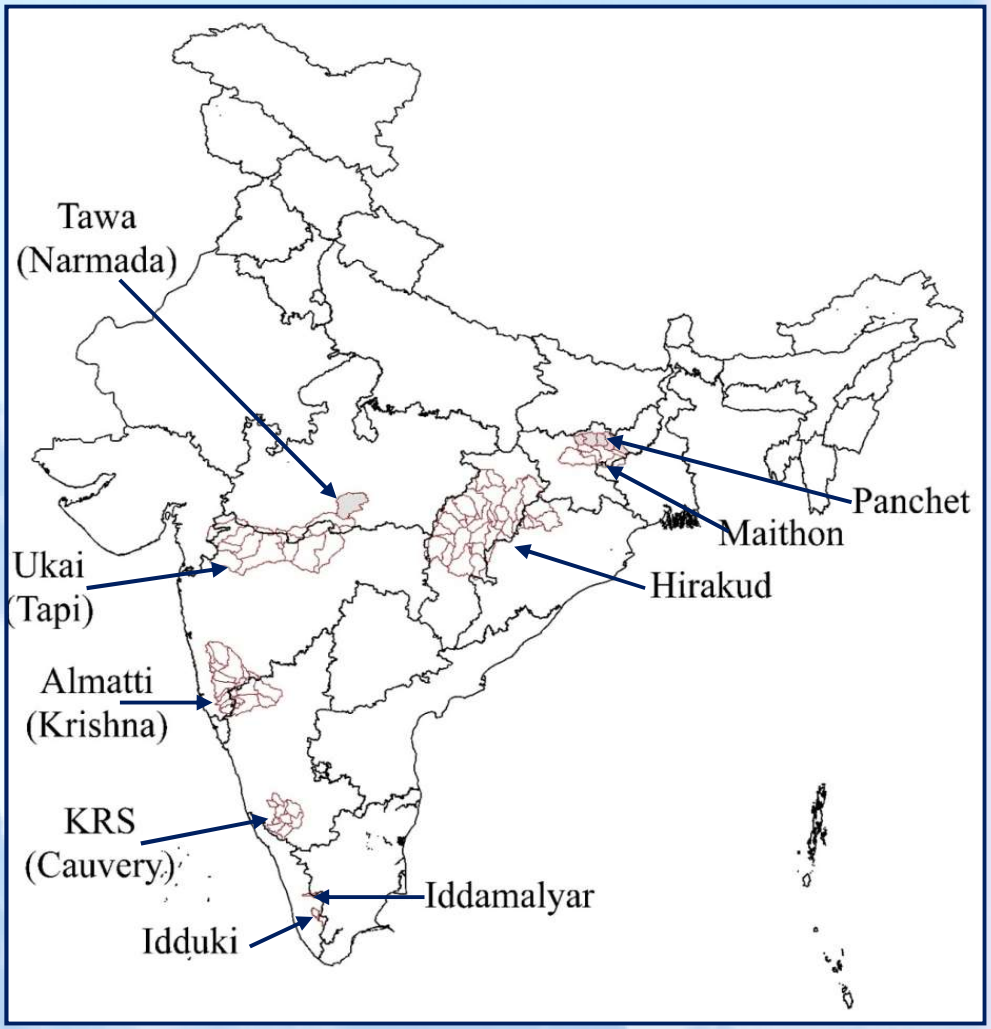
Table 1 Quantitative value of observed (OBS) and forecast rainfall departure (%) from the individual model of ECMWF (ECM), NCEP CFS (CFS) and the BMA over the UM and LM River basins for the 2 weeks from 29 August to 04 September and 5–11 September, 2011

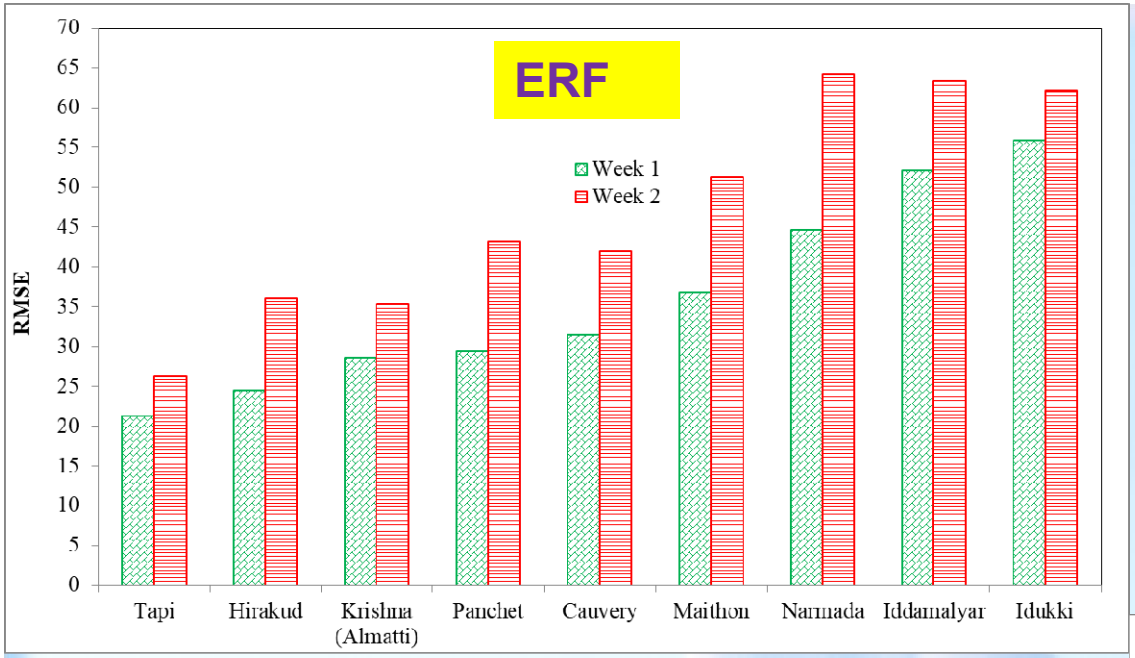
Model used and observed	Initial condition (IC) Forecast validity periods Rainfall departure in % (UM/LM)		
	25 August IC week 1 (days 5–11) (29 August–04 September, 2011)	25 August IC week 2 (days 12–18) (05–11 September, 2011)	01 September IC week 1 (days 5–11) (05–11 September, 2011)
OBS	(64.4 %/72.6 %)	(324.2 %/134.8 %)	(324.2 %/134.8 %)
ECM	(29.2 %/23.5 %)	(16.2 %/21.1 %)	(36.8 %/27.8 %)
CFS	(12.7 %/17. 9 %)	(−5.6 %/−2.5 %)	(−40.0 %/−50.6 %)
BMA	(21.6 %/22.6 %)	(5.9 %/12.2 %)	(08.2 %/03.8 %)

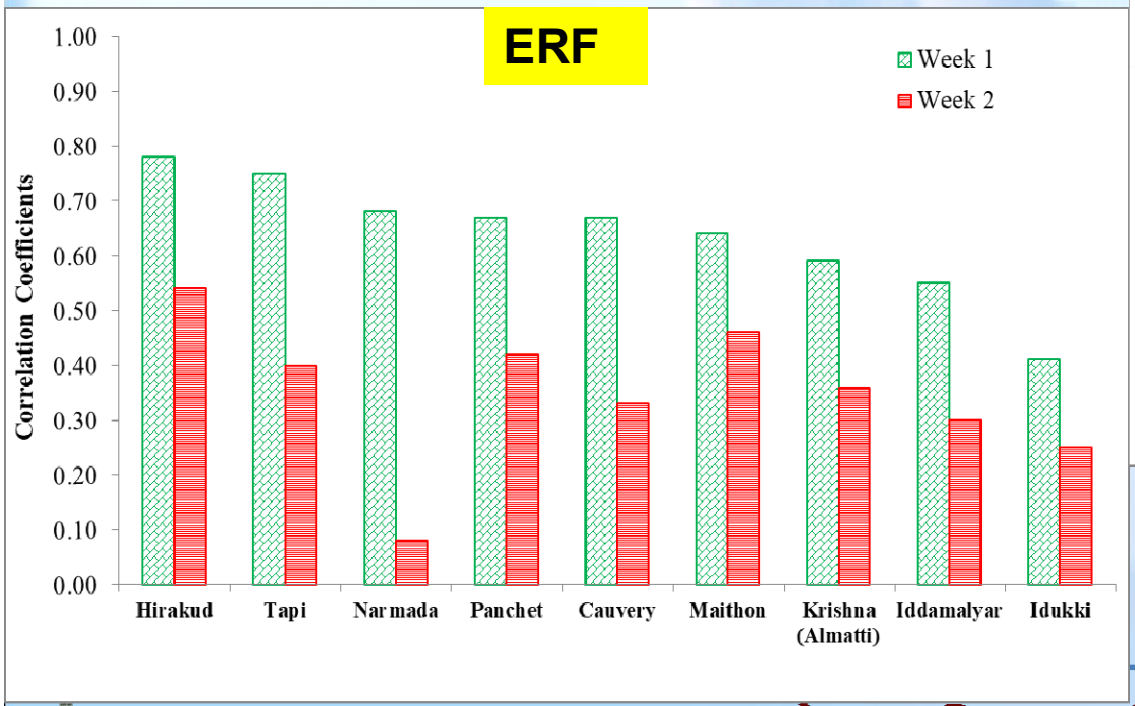
Map showing River basins

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**

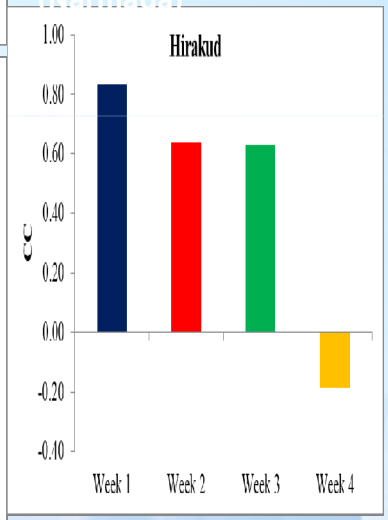


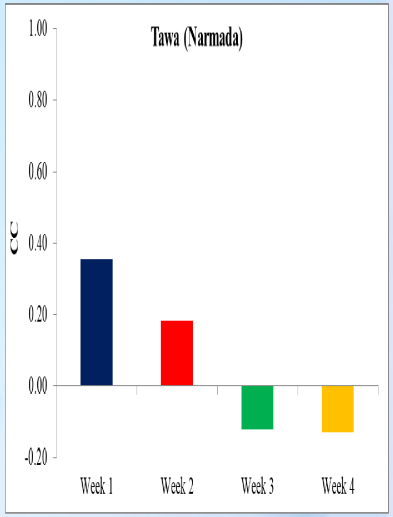




The highest Correlation Coefficients (CC) was found for the Hirakud river basin in the simulation of week 1, and followed by Tapi, Narmada, panchet, Cauvery, Maithon, Krishna, Iddamalyar, and Idukki respectively.

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





The rainfall departure over River Basins Based on 1st July 2020 IC

Forecasted

Weekly Accumulated Rain (mm)

		Panchet	Maithon	Idukki	Idamalayar	Hirakud	Cauvery	Narmada	Krishna	Tapi
02-08 Jul	Week1	72.86	77.96	34.21	53.94	81.55	72.40	85.19	91.24	53.08
09-15 Jul	Week2	93.82	115.00	27.41	34.36	56.63	43.08	47.52	82.71	23.62
16-22 Jul	Week3	104.16	112.28	36.38	40.42	102.10	33.86	79.24	50.06	45.06
23-29 Jul	Week4	110.13	116.32	78.64	75.71	99.98	52.76	88.45	61.16	55.46

Normal

Weekly Accumulated Rain (mm)

		Panchet	Maithon	Idukki	Idamalayar	Hirakud	Cauvery	Narmada	Krishna	Tapi
02-08 Jul	Week1	82.55	88.23	33.83	45.71	64.37	46.77	61.79	71.68	47.41
09-15 Jul	Week2	90.46	97.62	32.05	41.94	81.87	41.89	72.01	61.48	43.92
16-22 Jul	Week3	98.28	104.23	35.38	41.12	74.76	36.97	68.75	58.20	40.51
23-29 Jul	Week4	102.17	107.93	46.88	47.84	79.46	35.93	68.07	47.76	39.03

Percentage Departure From Normal

% Dep

		Panchet	Maithon	Idukki	Idamalayar	Hirakud	Cauvery	Narmada	Krishna	Tapi
02-08 Jul	Week1	-11.7	-11.6	1.1	18.0	26.7	54.8	37.9	27.3	12.0
09-15 Jul	Week2	3.7	17.8	-14.5	-18.1	-30.8	2.8	-34.0	34.5	-46.2
16-22 Jul	Week3	6.0	7.7	2.8	-1.7	36.6	-8.4	15.3	-14.0	11.3
23-29 Jul	Week4	7.8	7.8	67.7	58.3	25.8	46.9	29.9	28.1	42.1

Severe Weather : Monsoon

(Heat Wave & Cold Wave)

(Energy Sector)

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Heat Wave Impact

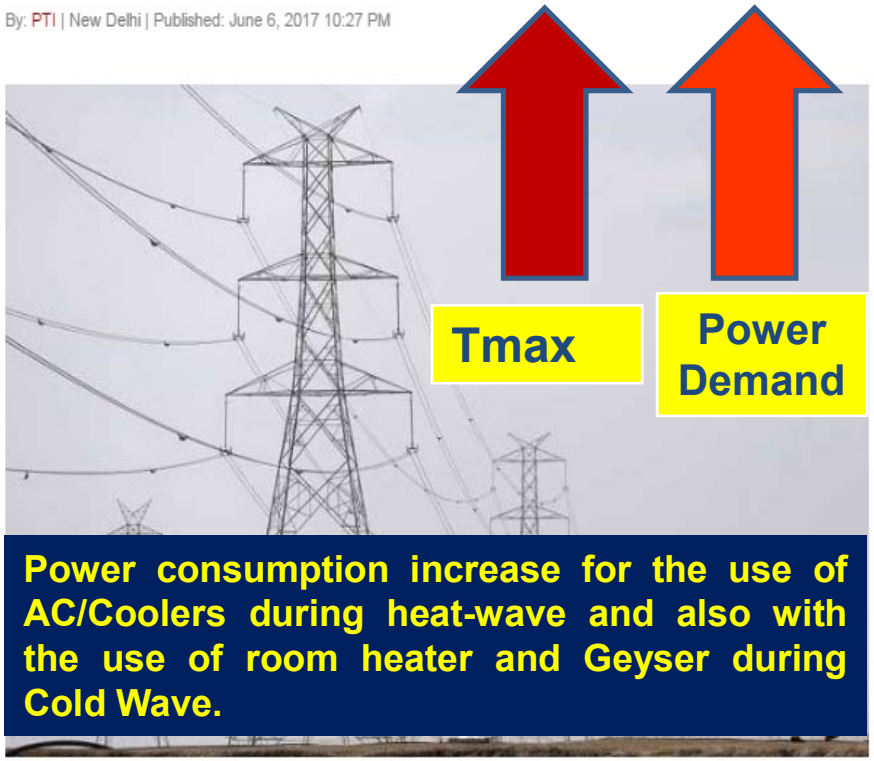
- Human Health
- Agriculture
- Poultry
- Energy/Power

Increase of Temperature Increase of Power demand

Power demand in Delhi crosses 6,500 MW mark

The peak power demand in the national capital shot up to an all time high of 6,526 MW today, with many areas facing outages due to local faults as the heatwave condition continued in the city.

By: PTI | New Delhi | Published: June 6, 2017 10:27 PM



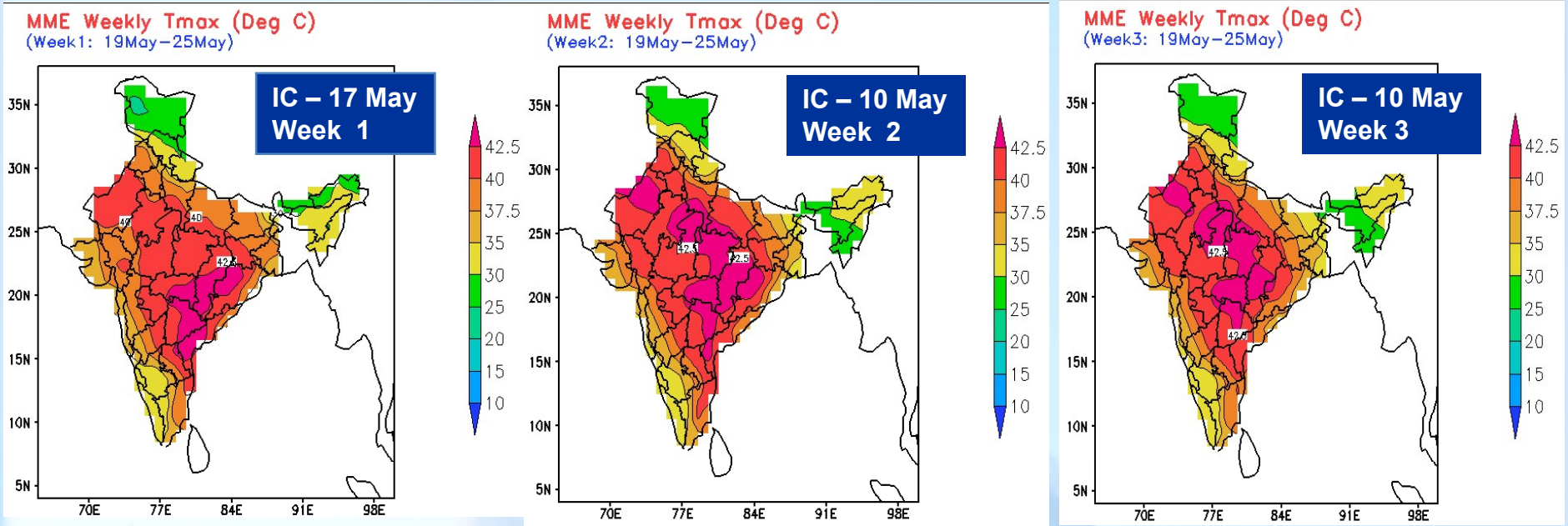
Power consumption increase for the use of AC/Coolers during heat-wave and also with the use of room heater and Geyser during Cold Wave.

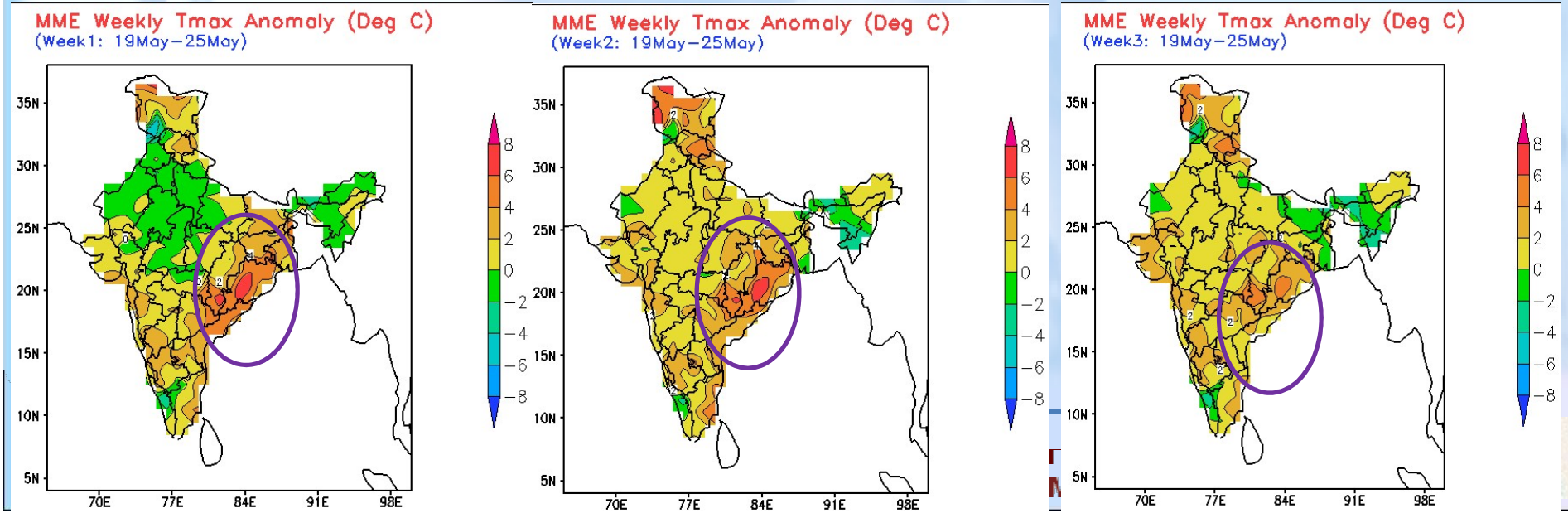
The hot summer months this year have pushed the peak power demands to record levels, with April

The peak power demand in the national capital shot up to an all time high of 6,526 MW today, with many areas facing outages due to local faults as the heatwave condition continued in the city. The soaring temperature has put pressure on power demand which rose to 6,526 MW at 3.31 pm, the highest ever recorded level in Delhi, the figures provided by the Power Department said. Yesterday, the peak power demand was recoded at 6,361 MW, the second highest in this summer season. With mercury hovering over 44 degrees Celsius mark for the past two days, the peak power demand rose to record levels and also led to outages in many parts of the city due to local faults.

Scheduled power cuts by the distribution companies (discoms) BSES and Tata Power Delhi Distribution Limited (TPDDL) also added to people's miseries in the sweltering heat. Delhi Chief Minister Arvind Kejriwal today directed the government officials to report the unscheduled power cuts to him on daily basis. He also directed the discoms to increase the capacity of their call centres for satisfactory disposal of consumer's complaints

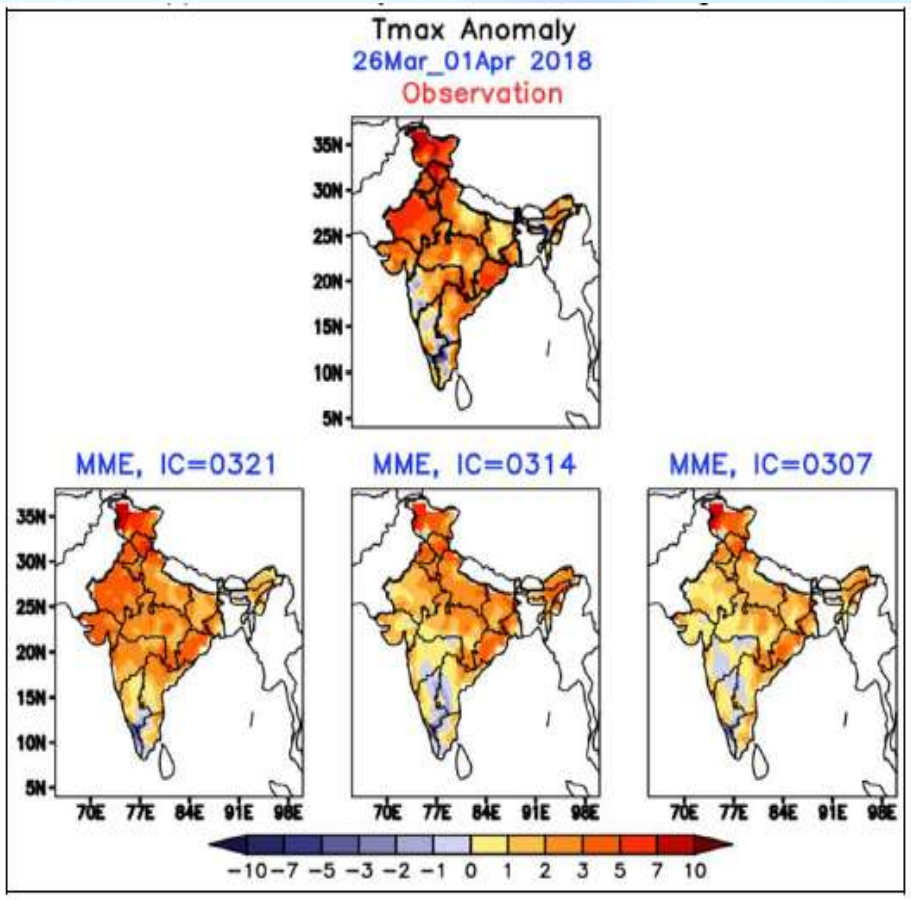
ERF Tmax & Tmax anomaly Based on (19-25 May 2019)



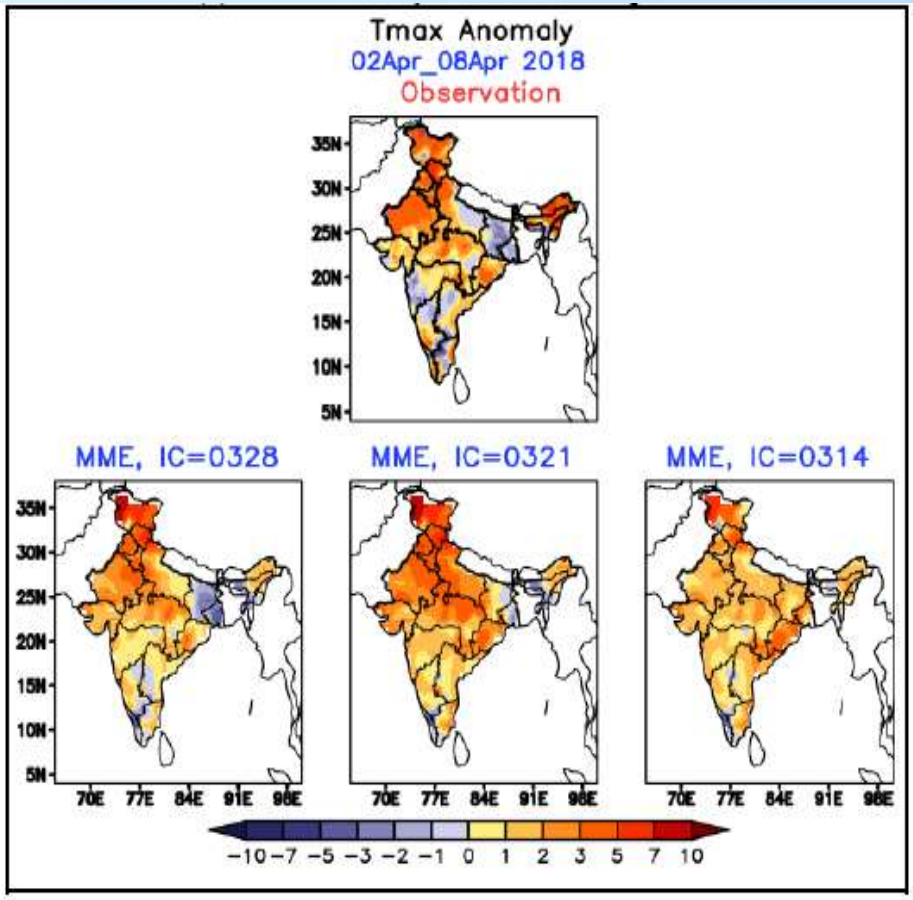


Heat Wave Forecast

Tmax Anomaly
For the Target Week (26 March-01 April), 2019
ICs : 21 March, 14 March & 07 March



Tmax Anomaly
For the Target Week (26 March-01 April), 2019
ICs : 21 March, 14 March & 07 March



Impacts of Winter Weather on Various Sectors

Impact Parts of Coldwave, Fog, Snow and Frost impacts many sectors like"

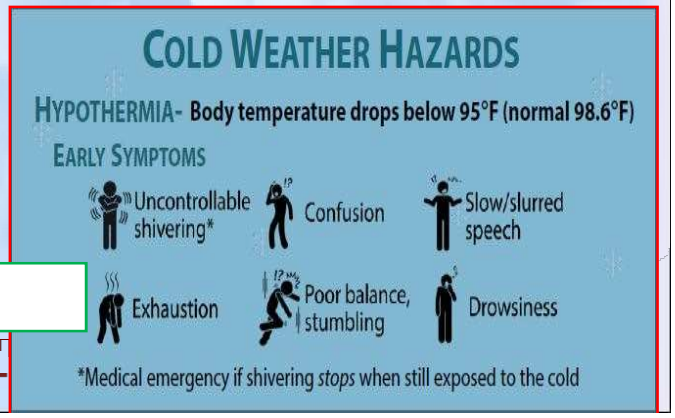
- Human lives and Health
- Transport Sector
- Agriculture, Live Stock
- Power Sector
- Aviation Sector

AGRICULTURE

AVIATION

HIGHWAYS

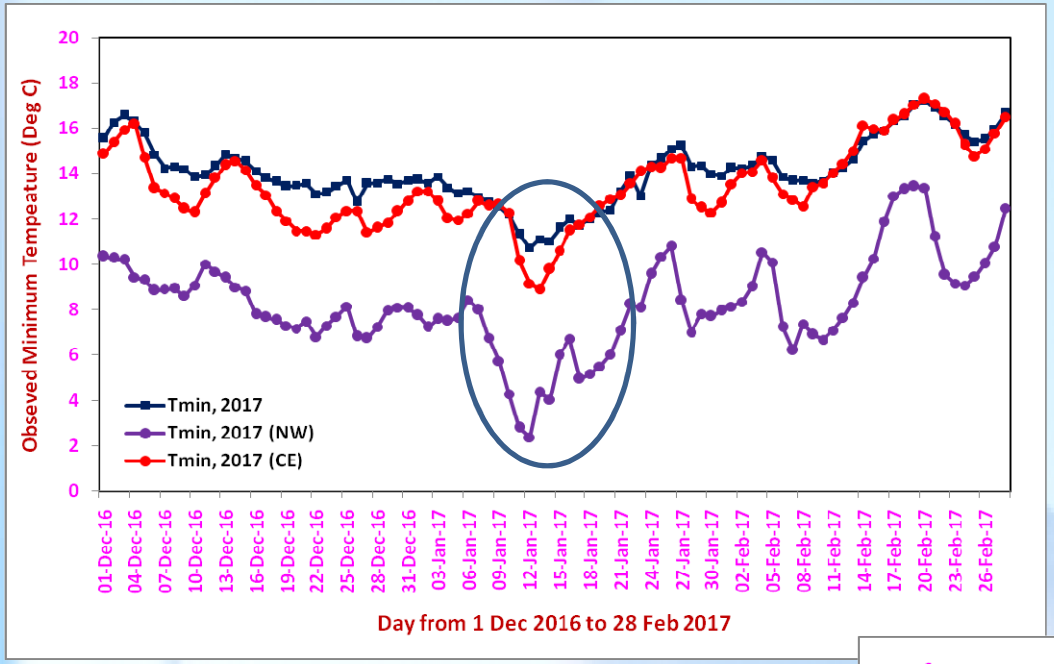
POWER



HEALTH

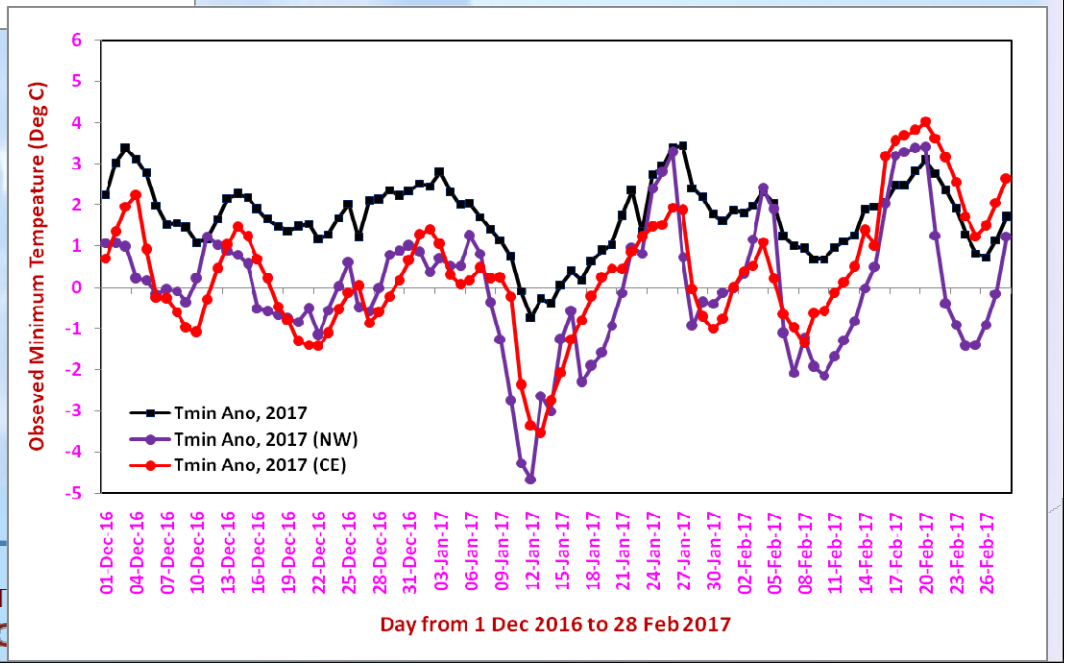
भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPART

Cold Wave of winter 2016-17



Tmin Actual

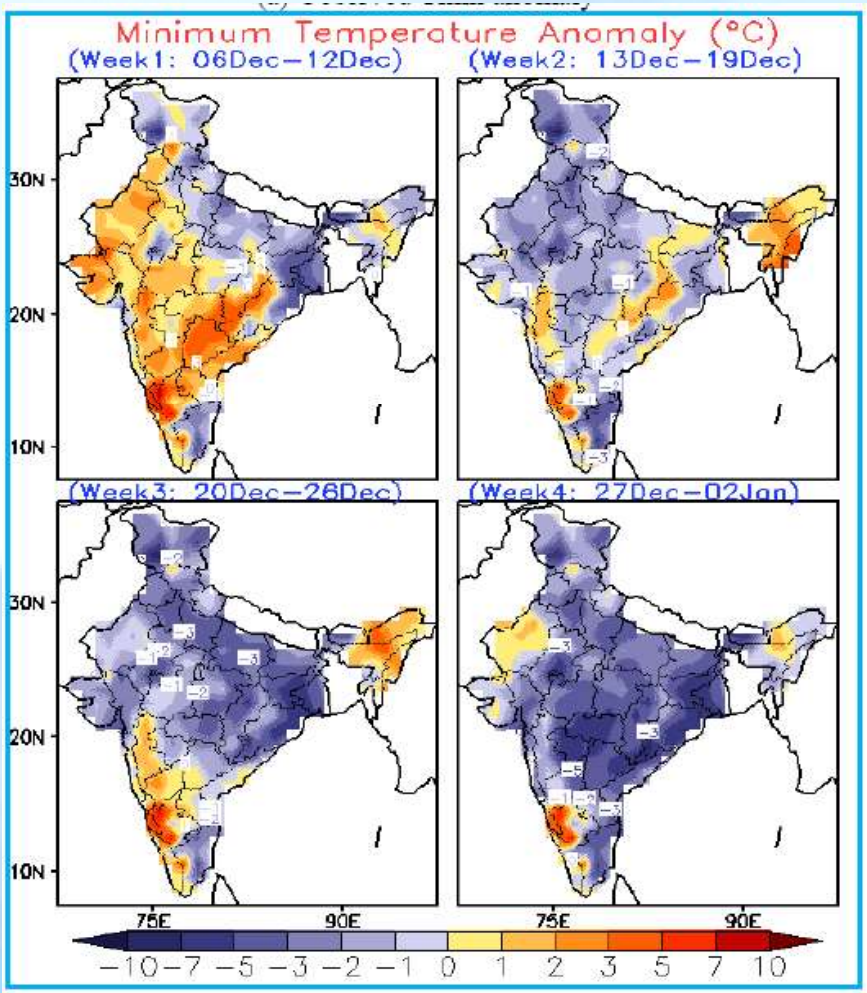
Tmin Anomaly



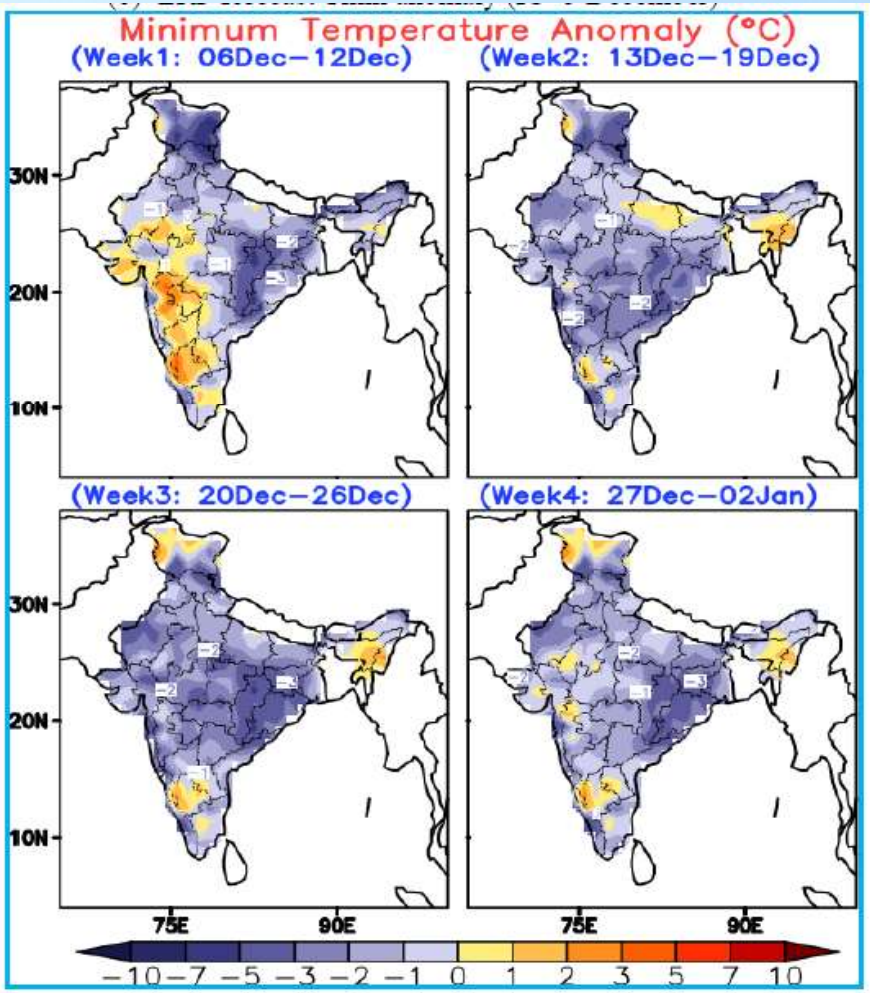
भारत मौस
INDIA METEORO

Cold Wave Forecast

Minimum Temperature Anomaly
06 Dec 2018 -02 Jan 2019



Extended Range Forecast for 4 weeks
Based on 5th Dec 2018



भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT

Colder November: Power demand in Delhi surges past last year's peak

Sidharatha Roy | TNN | Updated: Nov 25, 2020, 09:58 IST

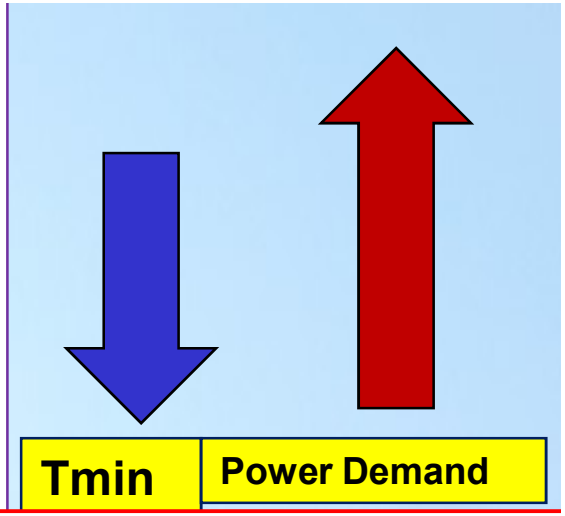
A- A+

Representative image

NEW DELHI: With the temperatures plummeting in the city, the seemingly early onset of winter this year is

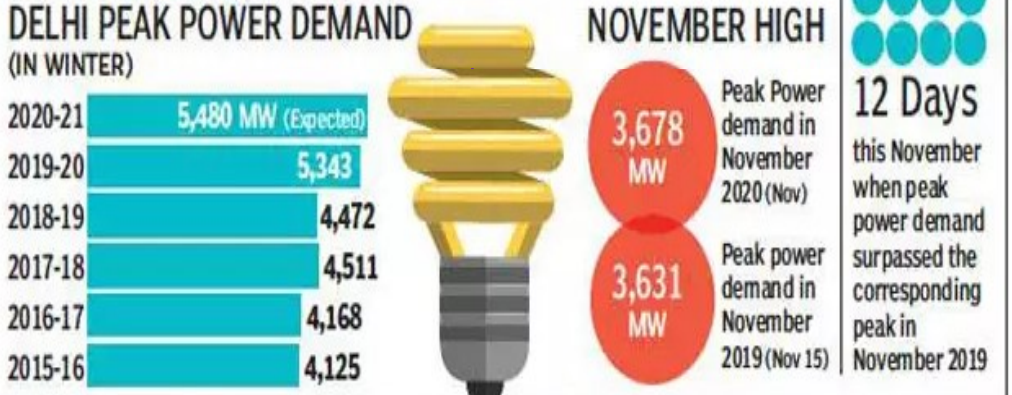
On November 20, the season's peak power demand

3,631MW recorded on November 15 last year, accord



NEW HIGHS

DELHI PEAK POWER DEMAND (IN WINTER)



NOVEMBER HIGH

3,678 MW — Peak Power demand in November 2020 (Nov)

3,631 MW — Peak power demand in November 2019 (Nov 15)

12 Days this November when peak power demand surpassed the corresponding peak in November 2019

HOW DISCOMS HAVE GEARED UP FOR WINTER

- Accurate demand (load) forecasting day-ahead in 96 time slots, Intra-day basis and medium term (fortnight to one year)
- Discoms using advanced statistical forecasting models using complex algorithms, combined with state-of-the-art weather forecasting solutions, including artificial intelligence and machine learning
- Long-term agreements from power-plants
- Use of 'banking', 'reserve shutdown', 'power exchange' to dispose of surplus power as well as ensuring reliable power supply
- Short-term power purchase from exchange, if needed

TOI; 25th November, 2020

भारत मौस
INDIA METEOR

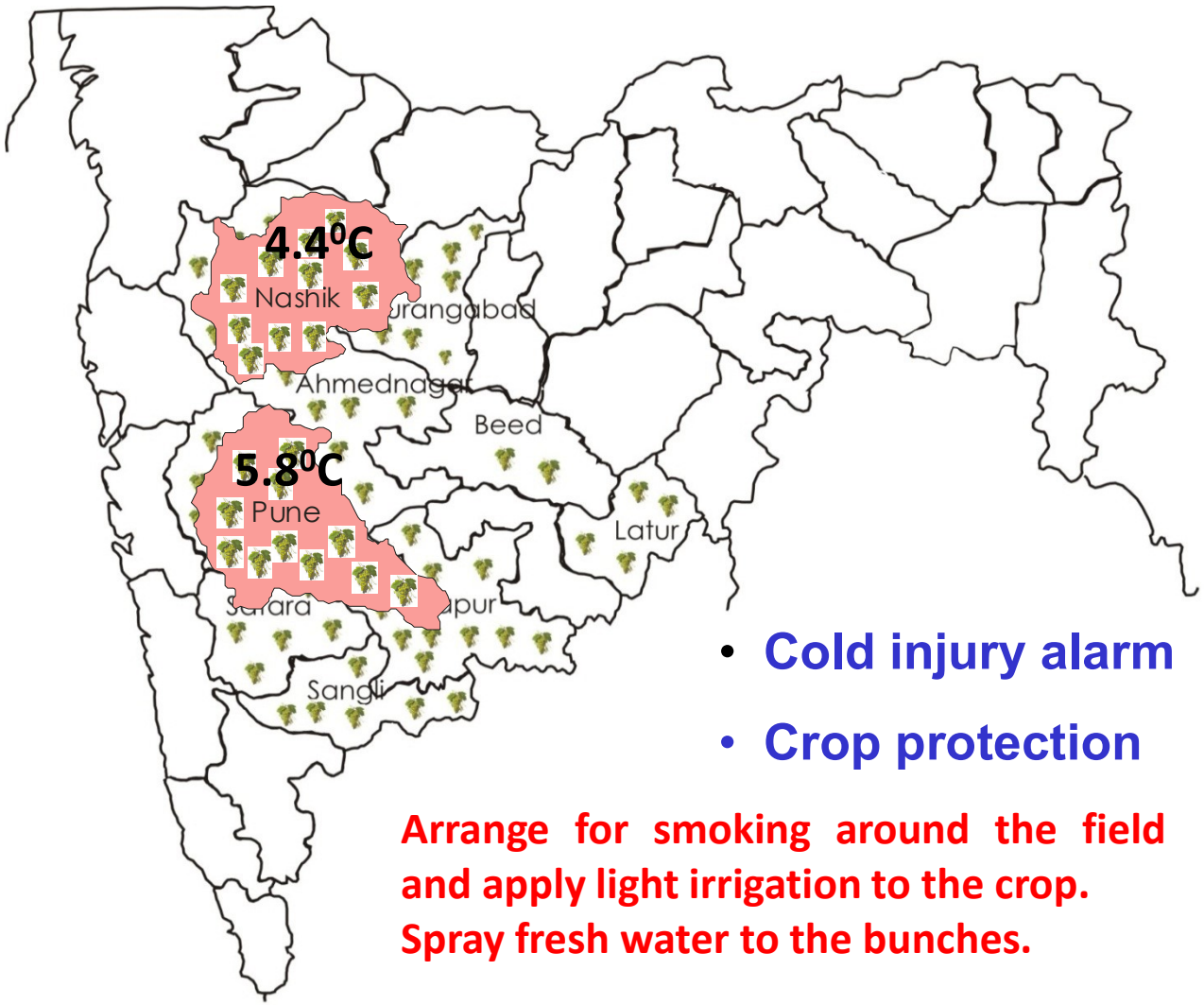
Advisories for Agriculture, Livestock & Poultry in view of cold wave

Protection of banana crops from cold

- On 26th December 2017, the minimum temperature was around 10^0C in **Madhya Maharashtra (Pune, Jalgaon, Nashik, Dhule district**), it is detrimental for the crop especially newly planted crop and so to avoid this apply irrigation at night time. Apply 250 to 1000 g neem cake per banana plant according to crop growth stage. The banana bunch should be covered by 6% perforated white plastic bag.

- **In view of the cold wave conditions in north Rajasthan, Uttar Pradesh, Punjab, Haryana, Chandigarh & Delhi and Bihar from 12th to 14th January 2018, keep animals inside the sheds during night hours and provide dry bedding to protect them from cold.**
- **During 12th to 14th January 2018, for Poultry, keep the chicks warm by providing artificial light in the poultry sheds.**

Cold injury on grapes



- Cold injury alarm
- Crop protection

Arrange for smoking around the field and apply light irrigation to the crop. Spray fresh water to the bunches.

Grapes could suffer cracks due to the extreme cold conditions in the traditional belt of the crop in Nasik region where mercury dropped to 4.4⁰C (during first week of Jan. 2012, the lowest in the state, in Pune recording minimum temperature of 5.8⁰C and also next to Nasik where an average minimum temperature of 5 to 6⁰C was recorded.

Slide from IMD, Pune

Challenging areas and need more research

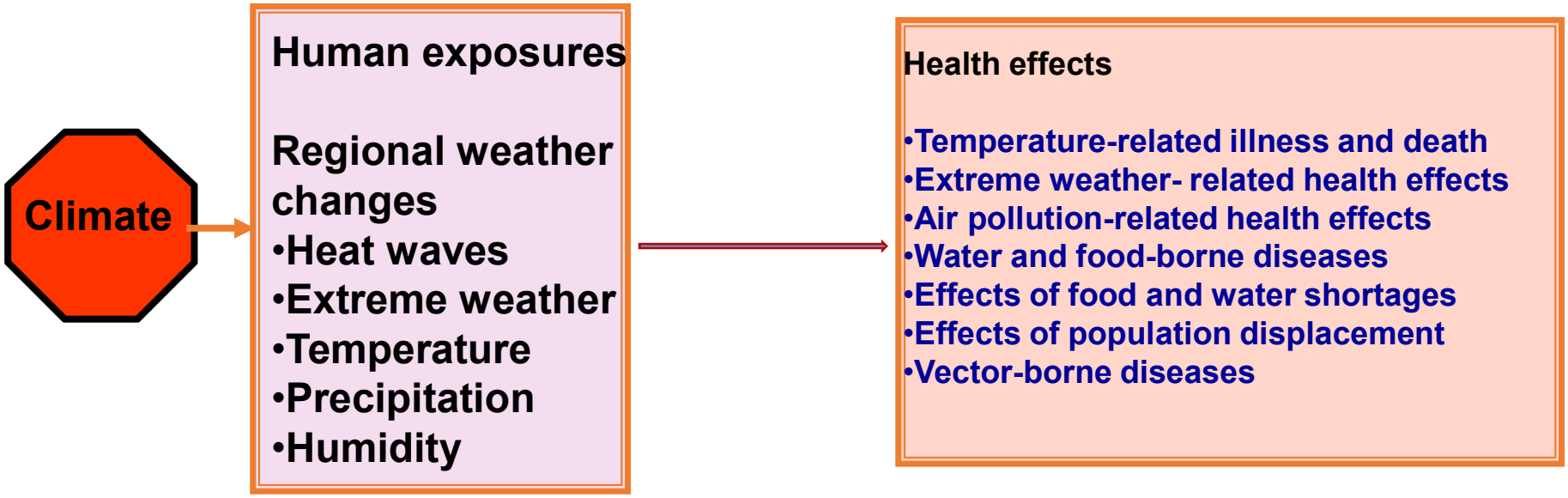
- **Need better understating of the physical processes behind winter systems like WD, Fog, Haze, Coldwave etc.**
- **Though the monitoring and prediction of winter weather systems using different NWP models have improved in recent times, the impact studies of such events need to be carried out through collaborations.**
- **One area not well understood is the morbidity and illness, associated with cold waves.**
- **Attempt should be made for the real time prediction of such silent disastrous events – suitable criteria need to be developed for impact studies for applications in various sectors.**

This half day webinar will discuss some aspect of this

Severe Weather : Monsoon

(Health)

Climate and Health



Number of days	Number of days
with Tmax $\leq$ 35; Tmin $\geq$ 20; RH $\geq$ 55%	with 25 $\leq$ T $\leq$ 30°C; 60 $\leq$ RH $\leq$80%

Patz, J.A., Engelberg, D. and Last, J., 2000. The effects of changing weather on public health. Annual Review of Public Health, 21: 271-307

Climate information for Health

(Experimental basis)

Based on Extended Range Weather Forecast

(Valid from 15th to 28th March, 2019)

Issued on 15th March, 2019

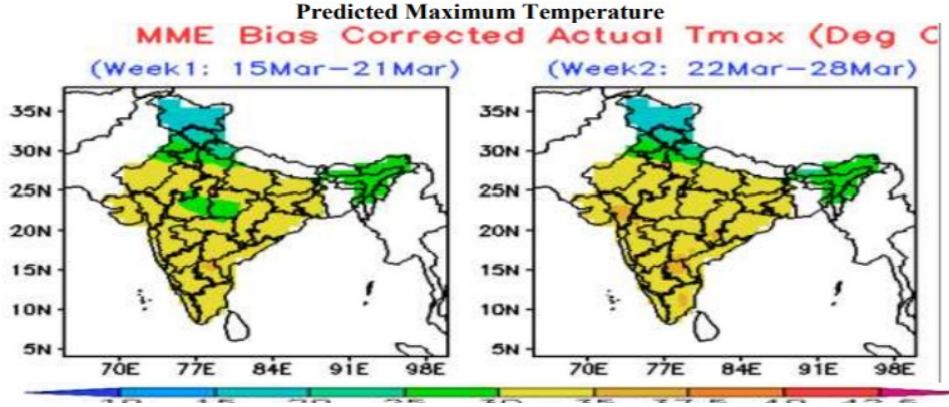
Office of Climate Research and Services, India Meteorological Department, Pune

Realised Weather during 01st Mar to 14th Mar 2019

- Major parts of the country experienced maximum temperature below 35ºC except some places in Maharashtra, Telangana, Karnataka, Kerala, Tamil Nadu and major parts of the country experienced minimum temperature below 20ºC except some places in Maharashtra, Goa, Karnataka, Telangana, Chhattisgarh, West Bengal, Odisha, Andhra Pradesh, Kerala, Tamil Nadu during 01st to 07th Mar 2019.
- Major parts of the country experienced maximum temperature below 35ºC except some places in Maharashtra, Chhattisgarh, Odisha, Telangana, Karnataka, Kerala, Tamil Nadu and major parts of the country experienced minimum temperature below 20ºC except some places in Maharashtra, Goa, Karnataka, Telangana, Chhattisgarh, West Bengal, Odisha, Andhra Pradesh, Kerala, Tamil Nadu during 08th to 14th Mar 2019.

Weekly Prediction of maximum and minimum temperature

Predicted Maximum Temperature



Weather Warning

- **Jammu & Kashmir, Himachal Pradesh, Uttarakhand, few parts of Punjab, will experience minimum temperature below 10.0 °C during 15th to 21st Mar 2019.**

ERFS based weekly evolution of transmission window for Malaria

Week	VBD	Threshold minimum temp (Th-Tmin)	Region(s) with Predicted Tmin within range of Th-Tmin	Threshold maximum temp	Region(s) with Predicted Tmax within range of
15th to 21st Mar 2019	Malaria (*Plasmodium falciparum*)	16-19°C	North–east Karnataka, Uttar Prad Rajasthan, of Odisha, Kerala, Tan		
	Malaria (*Plasmodium vivax*)	14-15°C	Haryana, r Rajasthan, Pradesh, Maharashtr and North-e		
22nd to 28th Mar 2019	Malaria (*Plasmodium falciparum*)	16-19°C	Madhya Pr parts of Maharashtr Uttar Prade eastern sta Karnataka.		
	Malaria (*Plasmodium vivax*)	14-15°C	Punjab, Ha Rajasthan, of Uttarakh eastern stat		

ERFS based weekly evolution of transmission window for Dengue

Week	VBD	Threshold minimum temp (Th-Tmin)	Region(s) with Predicted Tmin within range of Th-Tmin	Threshold maximum temp (Th-Tmax)	Regio n(s) with Predicted Tmax within range of Th-Tmax
15th to 21st Mar 2019	Dengue virus	11.9°C	Haryana, major parts of Rajasthan, Punjab, some parts of Uttar Pradesh, Madhya Pradesh, few parts of North-eastern states.	Not known	-
22nd to 28th Mar 2019	Dengue virus	11.9°C	Punjab, Haryana, some parts of Rajasthan, Uttar Pradesh, few parts of Uttarakhand and North-eastern states.	Not known	-

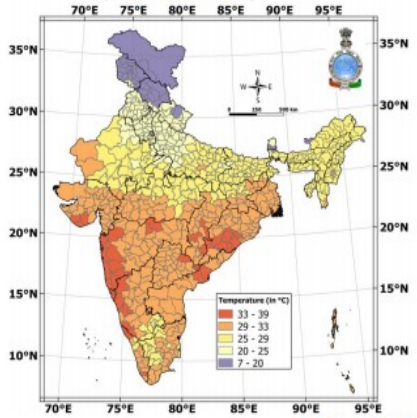
Glossary:

SN	Malaria VBD	Threshold minimum temp (Th-Tmin)	Threshold maximum temp (Th-Tmax)
1	*Plasmodium falciparum*	16-19°C	33-39°C
2	*Plasmodium vivax*	14-15°C	

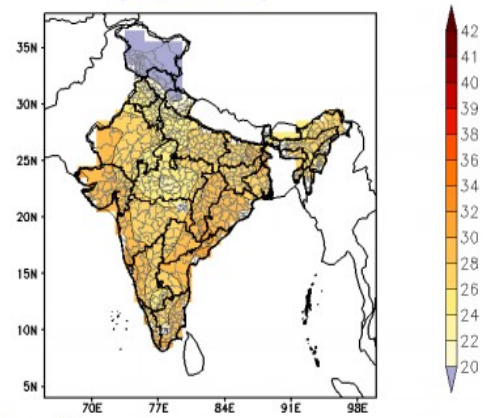
Climate Service for Health Sector

Predicted Maximum Temperature

GFS weekly Tmax (°C)
(week 1: 20 Nov –26 Nov)

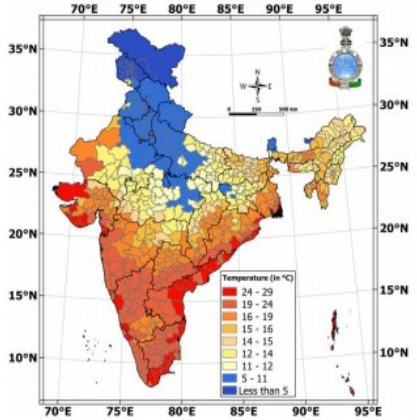


MME weekly Tmax (°C)
(week 2: 27 Nov –03 Dec)

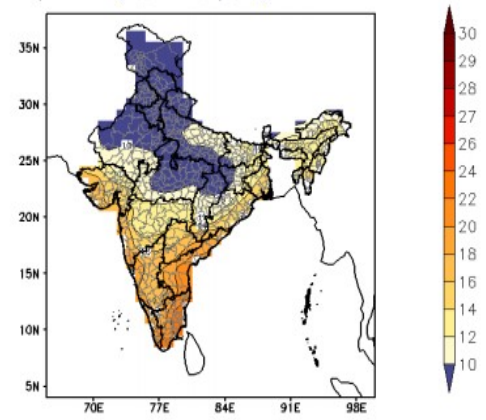


Predicted Minimum Temperature

GFS weekly Tmin (°C)
(week 1: 20 Nov –26 Nov)



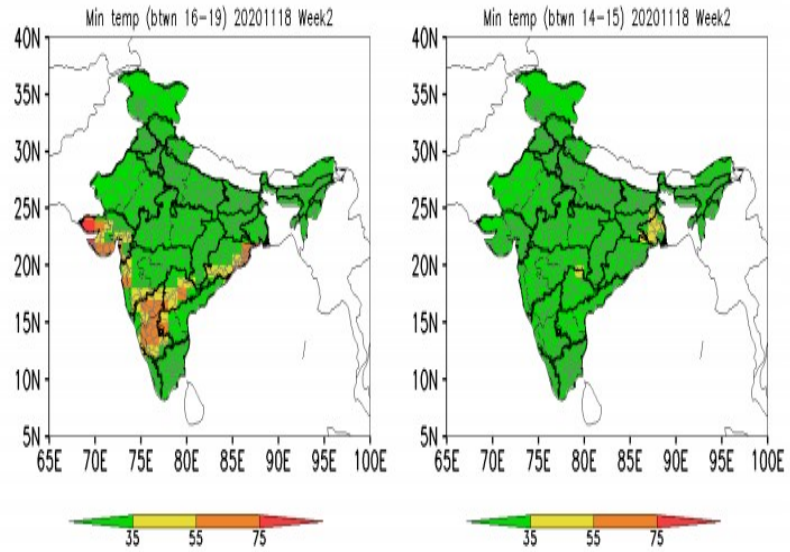
MME weekly Tmin (°C)
(week 2: 27 Nov –03 Dec)



Weather Warning

- Ladakh, major districts of Jammu & Kashmir, Hamirpur district of Himachal Pradesh and Tawang district of Arunachal Pradesh will experience minimum temperature below 5°C during 20th to 26th November, 2020.

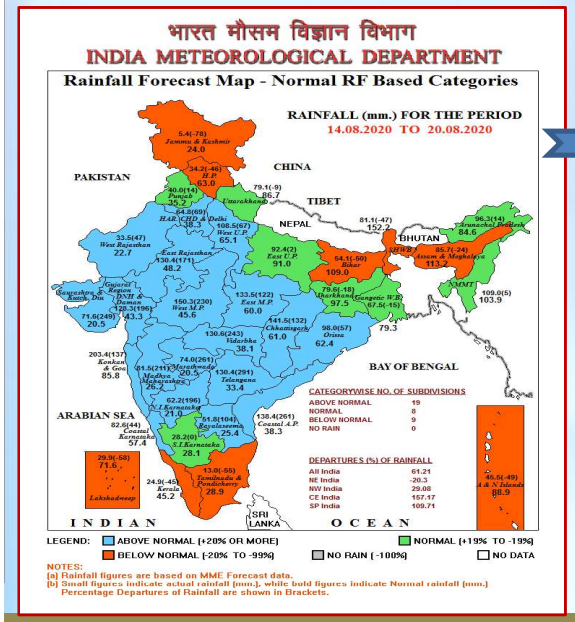
Predicted probabilistic Minimum Temperature map

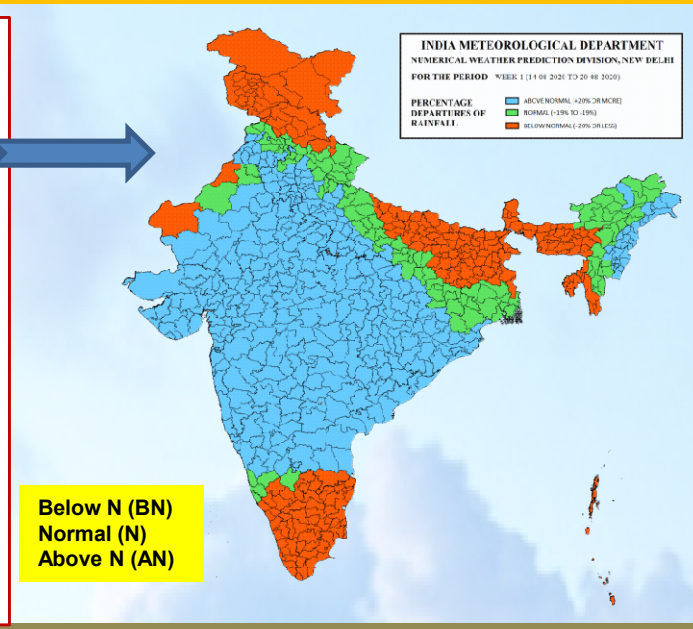


Probabilistic weekly evolution of transmission window for Malaria (*Plasmodium falciparum*).			
Second week (27th Nov to 03rd Dec 2020):			
1	**75** probability level		Some districts of Gujarat, few districts of West Bengal and Odisha.
2	**55-75** probability level		Major districts of Karnataka, some districts of Gujarat, Odisha, few districts of Maharashtra, Telangana and Andhra Pradesh.
3	**35-55** probability level		Some districts of Gujarat, Maharashtra, Telangana, Odisha, Karnataka, few districts of Chhattisgarh, Andhra Pradesh and Kerala.
4	**Less than 35** probability level		Major districts in rest of states.

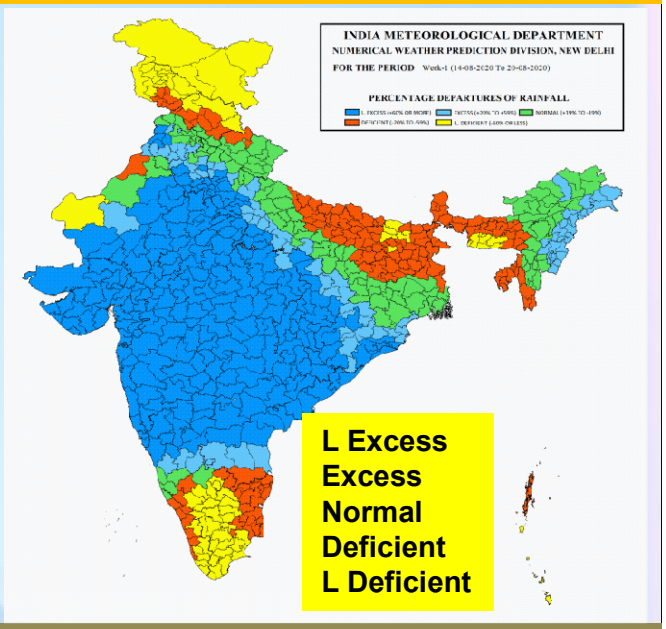
ERF at smaller spatial domains (Districts)

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



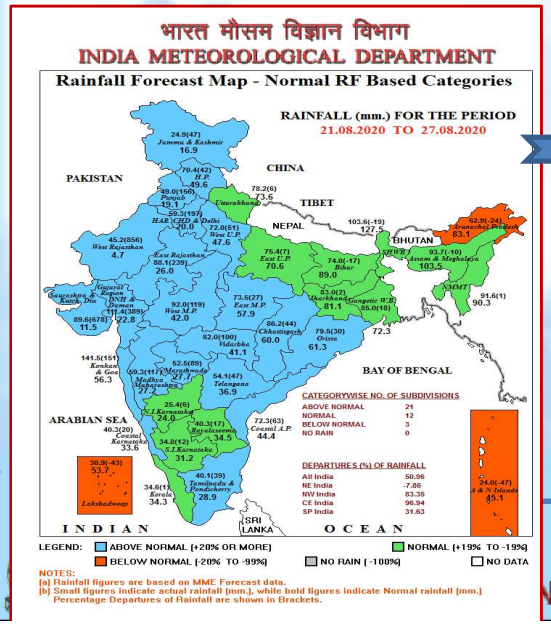


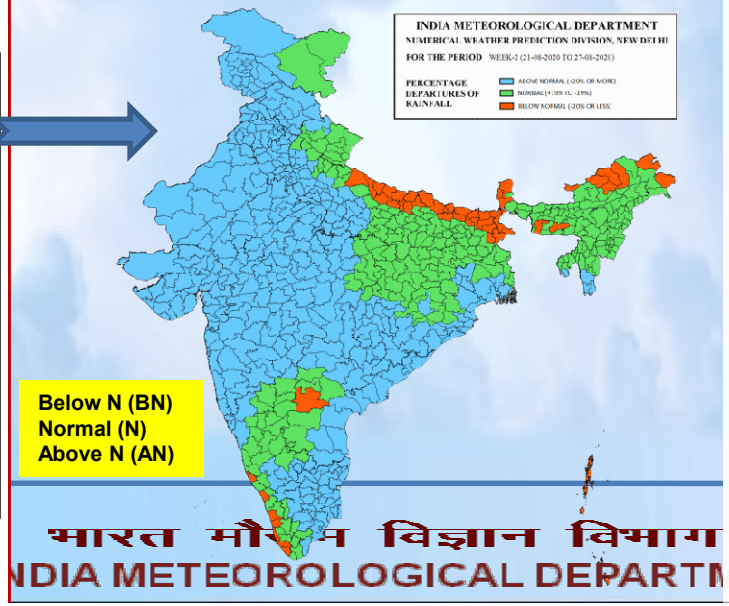
Below N (BN)
Normal (N)
Above N (AN)



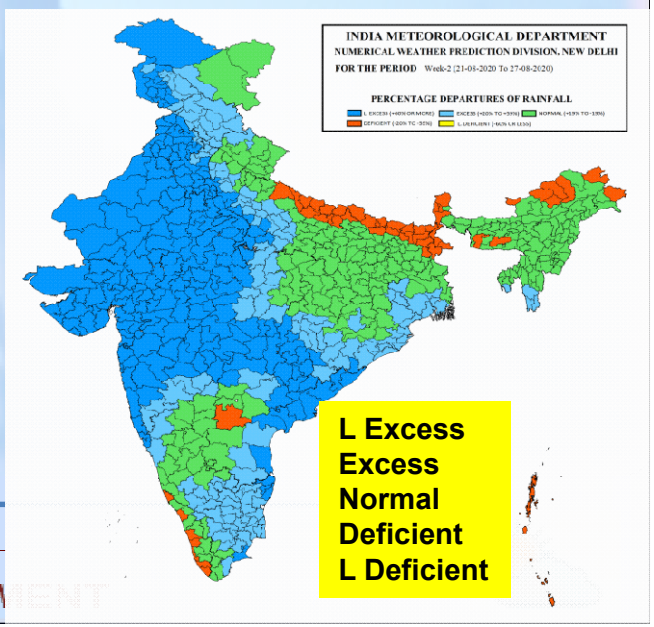
L Excess
Excess
Normal
Deficient
L Deficient

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



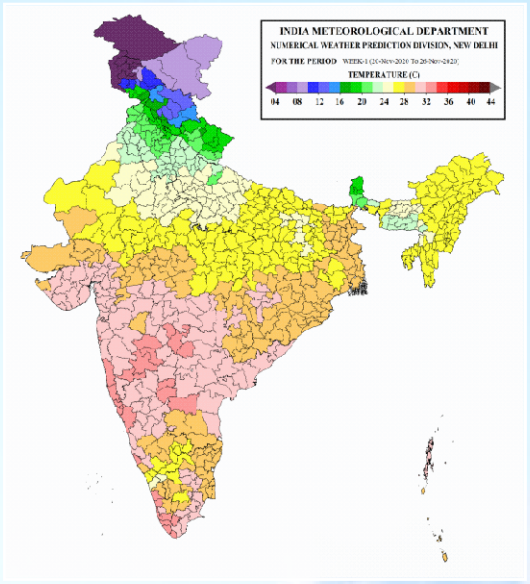


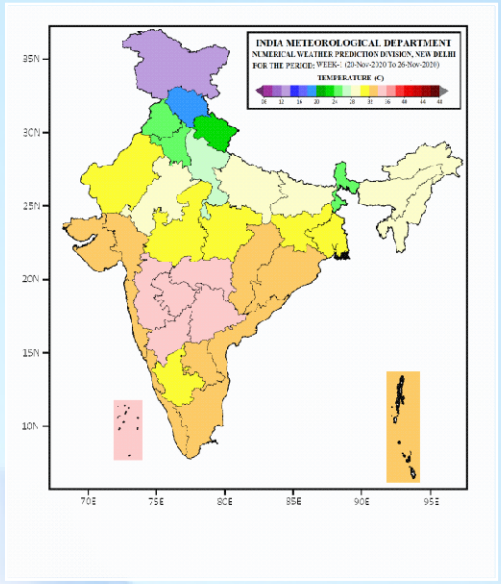
Below N (BN)
Normal (N)
Above N (AN)



L Excess
Excess
Normal
Deficient
L Deficient

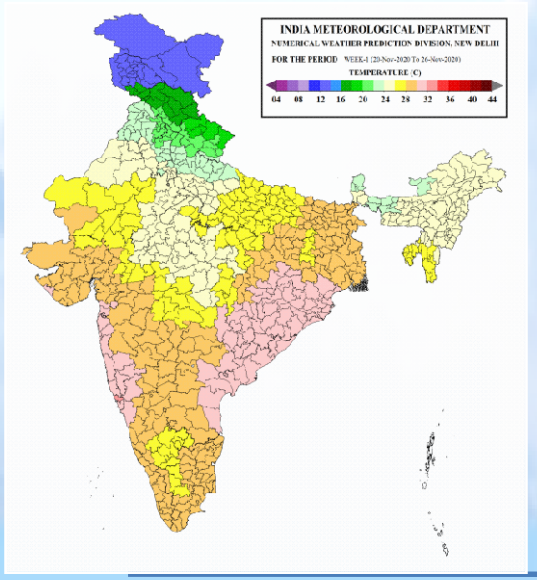
Observed Max Temperature
20-Nov-2020 To 26-Nov-2020



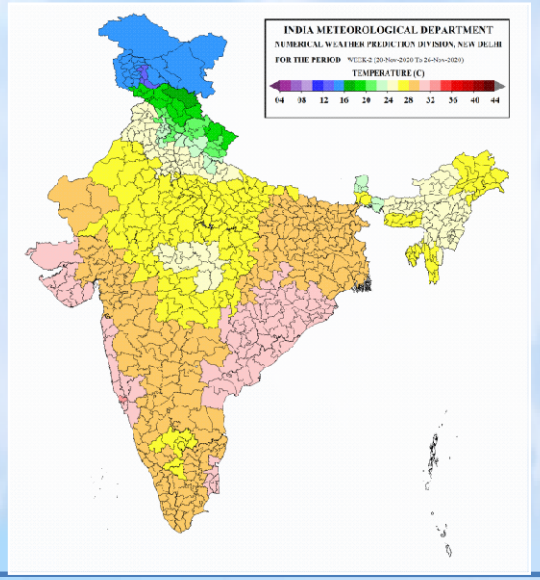


Bias Corrected Max Temperature

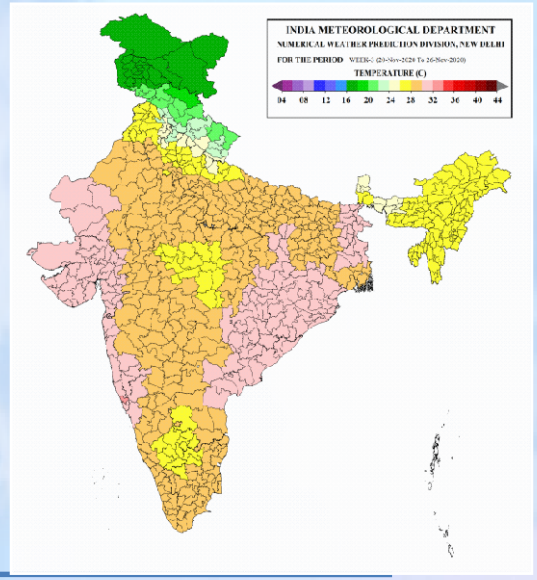
20-Nov-20 To 26-Nov-20 Week-1 Forecast



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



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



Maximum Temperature (C)

04 08 12 16 20 24 28 32 36 40 44

INDI MENT

SWOT of Impact Based ERF

Strengths: We have our own ERF operational coupled modelling systems.

Huge demand of forecasts in this time scale .

•**Weaknesses:** Longer lead time daily forecast on smaller spatial scale has problem.

•Lower skill at smaller spatial scales

•How to communicate forecast uncertainty to users.

•Development of a best probabilistic MME.

•To have a robust ERF modelling system.

•With longer lead IBF will be qualitative .

•Developing Impact models are not easy

Opportunities: Lot of potential in sectoral applications, Tourism (Ag, Hydro, Power and Health, Disaster Management, etc)

Threats: If we don't fulfill the demands of the users, private companies can do the work.

THANK YOU