



# Monitoring and Forecasting Climatic and Weather conditions causing Forest fire and its further behavior

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IMD, New Delhi**



# Objective

- Role of weather and climate on Forest fire
- Monitoring and Forecasting Systems of various real time products
- ❖ Status of current Temperature and Rainfall –daily-weekly-monthly-Seasonal scale available at various spatial scale and for station
- ❖ Forecasting-Seasonal to daily
- Development of GIS based Weather and climate guidance system to determine Risk and Vulnerability and to monitor and determine potential occurrences areas
- ❖ Integration and Overlaying of digital data of Forest cover and Forest types(Tropical deciduous forests) and area information
- ❖ Real time Weather and climate observations and their forecast -Layering in Web GIS based IBF
- ❖ Preparing Fire weather Indices-Map/grid values

## Issue and Challenges



# Role of weather and climate on Forest fire

- Besides types of vegetation, topography, human behaviour, and ignition sources, **weather and climatic conditions prevailing in the area** plays very imp role
- Weather and climate have a profound influence **on Forest fire ignition potential, fire behavior, and fire severity.**
- Temperature, relative humidity, precipitation, wind velocity and solar radiation determine the moisture vapour differential between the dead fuel and atmosphere
- As Local weather and climate are affected by both large-scale and regional atmospheric pattern, so customization and downscaling of these products and their monitoring are very much necessary.

1. Abatzoglou, J. T., Williams, A. P., Boschetti, L., Zubkova, M. & Kolden, C. A. Global patterns of interannual climate-fire relationships (2018). *Glob. Change Biol.* **24**, 5164–5175 (2018).
2. Littell, J. S., McKenzie, D., Peterson, D. L. & Westerling, A. L. Climate and wildfire area burned in western US ecoprovinces, 1916-2003. *Ecol. Appl.* **19**, 1003–1021 (2009).



# Weather is a main driver of regional fire activity-Fire weather Indices

- Besides common weather parameters like longer and extreme dry spell, extreme temperature and dry stronger wind conditions:
- ✓ Extreme fire weather is typically evaluated using fire weather indices that incorporate daily weather variables related to fuel moisture and fire behaviour.
- ✓ Several indices are used across the globe, including the Canadian Fire Weather Index System (CFWIS)
- ✓ Highly depend upon weather conditions including air temperature, relative humidity (RH), wind speed (WS) and precipitation
- ✓ Observed increases in fire weather season length have been found in areas with observed increases in temperature, WS and rain-free intervals, and decreases in RH
- ✓ Extreme values of three different measures of Fire Weather Index (Methods): (1) the fire weather index (FWI), (2) initial spread index (ISI) and (3) vapour pressure deficit (VPD).

nature  
climate change

ARTICLES

<https://doi.org/10.1038/s41558-021-01224-1>

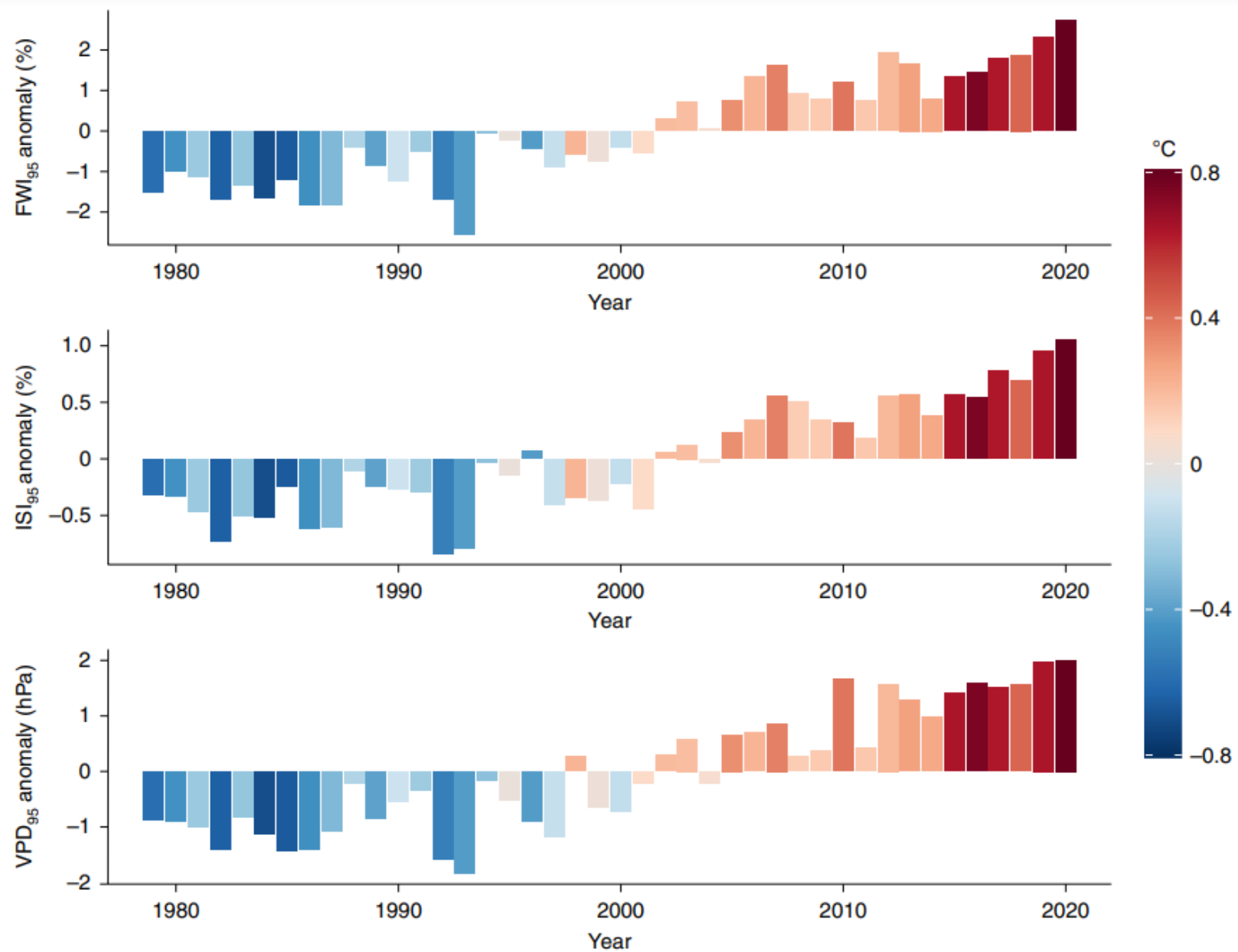
Check for updates

## Observed increases in extreme fire weather driven by atmospheric humidity and temperature

Piyush Jain<sup>1</sup>✉, Dante Castellanos-Acuna<sup>2</sup>, Sean C. P. Coogan<sup>2</sup>, John T. Abatzoglou<sup>3</sup> and Mike D. Flannigan<sup>2</sup>



भारत मौसम विज्ञान  
INDIA METEOROLOGICAL



**Fig. 2 | Anomalies in annual extreme fire weather metrics.** Anomalies in annual (fire season) global means of extreme fire weather metrics (FWI<sub>95</sub>, ISI<sub>95</sub> and VPD<sub>95</sub>) between 1979 and 2020. Each bar is coloured according to annual global mean land-surface temperature anomalies (using data from ref. <sup>29</sup>). All anomalies are calculated relative to the entire period 1979-2020.



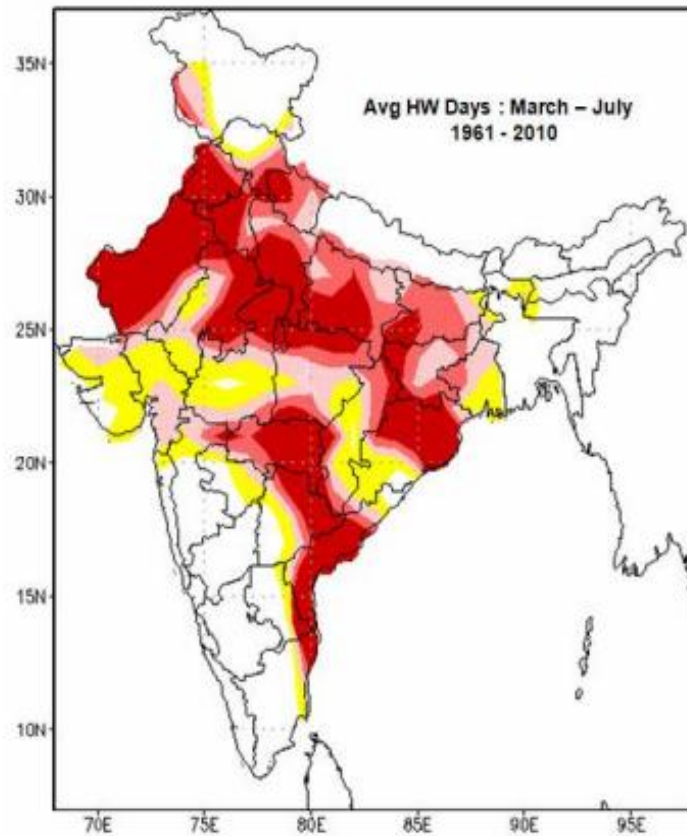
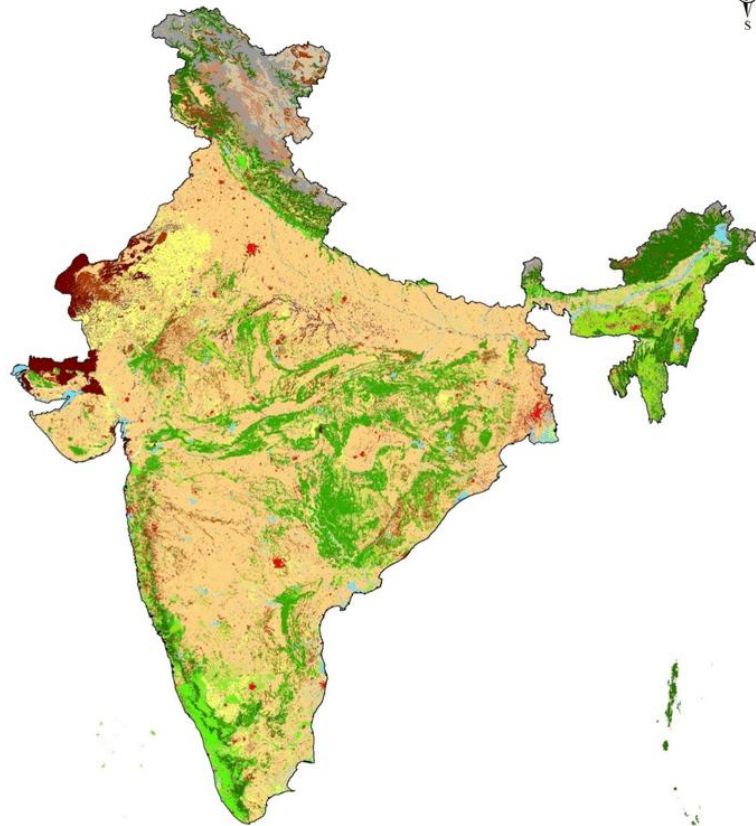


Fig. 1(a)

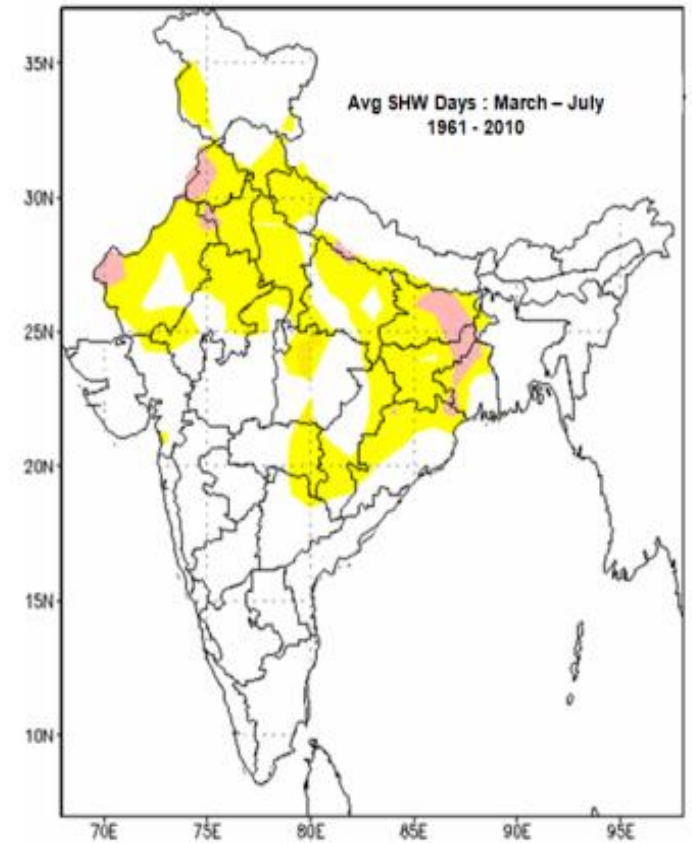
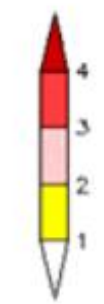


Fig. 1 (b)

**Fig.1:** Seasonal climatology map of number of HW days and SHW days over India during the hot weather season (March - July). The climatology was computed by averaging the number of HW days for the period 1961-2010



### Forest fire hotspot district map of India

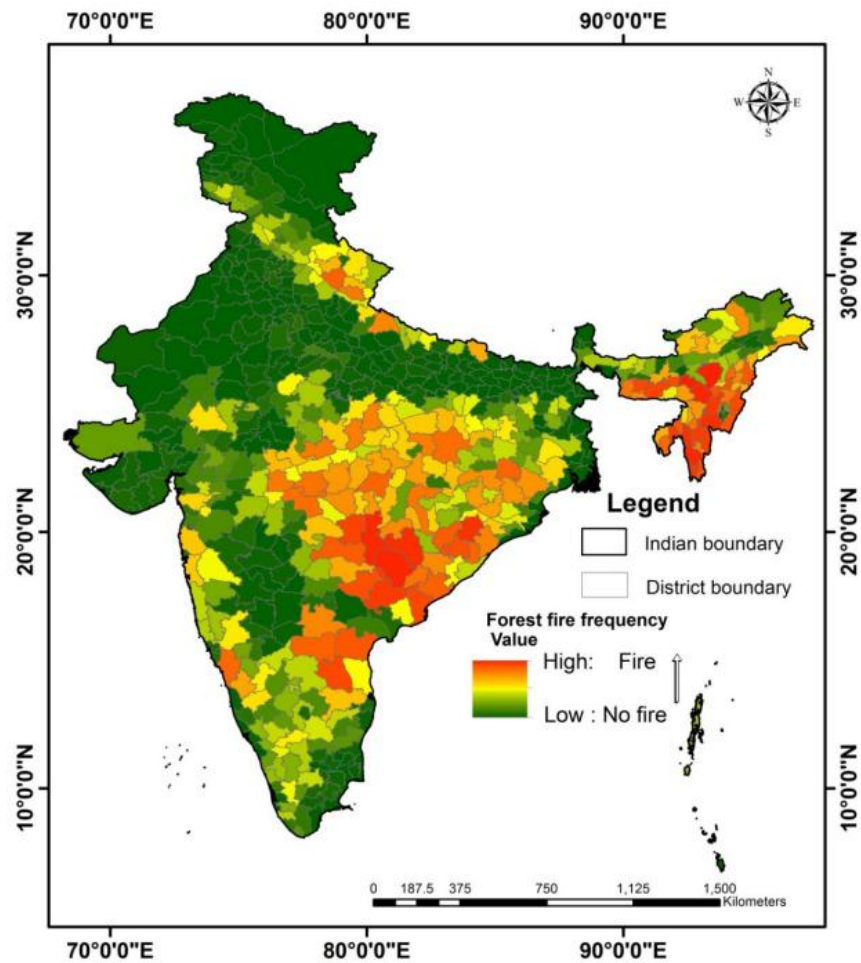


Fig. 2. The forest fire hotspot districts of India.



# Current, past data and Forecast at daily to weekly and monthly and seasonal time scale –at station, Dist based to Regional scale

- Climate datasets (maximum temperature, wind velocity, relative humidity and solar radiation)
- Boundary layer, Inversion and Height of mixed layer for Plume types and further behavior
- Dry and wet Spell
- Forecast at daily to weekly and monthly and seasonal time scale – at station, Dist based to Regional scale of Temperatures, Rainfall etc are available for guidance to identify areas of forest fire vulnerability at real time







**Warnings**      **Nowcast**      **Public Observations**      **Specialized Forecasts**

Subdivision Wise | District Wise      District Wise | Station Wise      (Multi Indian Languages)      Weather realized

scentral Bay of Bengal close to Andhra Pradesh coast by 11th May morning. • SCS 'Asani' over westcentral Bay of Bengal near latitude 15.2°N and longitude 82

**Current Weather**

Gangtok

Panjim

Aminidivi

Minicoy

Port Blair

**New Delhi**

29.4°C

64%

Southeasterly 5.4 km/h

Observation time : 2022-05-11 5.30 IST

Sunrise: 05:33 (IST)

Sunset: 19:02 (IST)

Moonrise: 14:08 (IST)

Moonset: 02:32 (IST)

Satellite      Radar      Satellite with Lightning

**Our Services**

Rainfall Information	Monsoon	Cyclone
Agromet Advisory Services	Climate Services	Urban Meteorological Services
Aviation Services	Climate Hazard & Vulnerability Atlas	Geospatial Services

**Forecasts**

- > Short to Medium Range Model Guidance      > Extended Range Outlook      > Seasonal Forecast
- > Quantitative Precipitation Forecast      > All India Weather Forecast Bulletin      > 5-day Sub-Divisional Rainfall Forecast
- > 5-day District-Wise Rainfall Forecast      > Tourism Forecast      > Interactive Track of Cyclone
- > Public Observation      > Latest CAP Alerts      > Flash Flood Bulletin

**Current Weather across Major Cities**

Mumbai	Bengaluru	Chennai	Hyderabad	Kolkata	Ahmedabad	Pune	Delhi
28.6°	22°	27°	29°	26°	30.6°	25°	29.4°



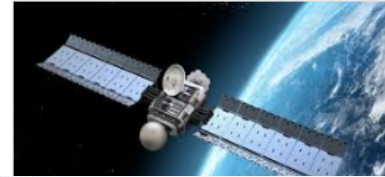


**Pune City Weather**

AWS ARG Main stations data plots, Daily Weather Reports  
Crowd Sourcing ...

**New Delhi (SFD)**

Max °C	Min °C	Rain (mm)
39.5	28	0.0



**Tracking of Pre-Monsoon Season 2022**

Daily Rainfall Spatial Maps, River Basin  
Daily Max./Min. Temperature and Data

Not secure | hydro.imd.gov.in/hydrometweb/(S(kxk2bfuiewseur45be1tbr3e))/DistrictRaifall.aspx



**Climate Monitoring and Prediction**

CFS Forecast, Climate Diagnostic, NCAR



**Climate Information**

Climatology of Smart Cities, Normal &  
Rainfall and Temperature Trends...  
Monthly Max,Min and Mean Temp. Climate  
Statewise R/F Variability Report



**Meteorological Data**

List of Stations, Data Request,  
NDC Webcharts ...



**Climate Application and Usage**

Rainfall Data Products, Rainfall Normal  
Weekly, Monthly and Seasonal SPI...



**Weather**

Daily/Weekly Weather Report, Satellite  
Marine Meteorology, Reports, Press R



**Library and Publication**



**Agromet Advisories**



**Customized Rainfall Information System (CRIS)**

**Hydromet Division**

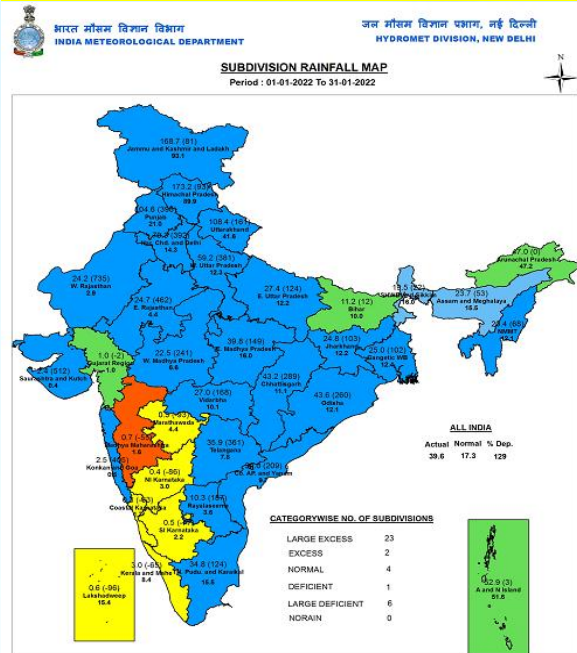
India Meteorological Department  
Ministry Of Earth Sciences  
New Delhi-110 003

Choose the States/UTs **HIMACHAL PRADES** Select District.  **GO**

Note :(1) The District Rainfall in millimeters (R/F) shown below are the arithmetic averages of Rainfall of Stations under the District.  
(2) % Dep. are the Departures of rainfall from the long period averages of rainfall for the District.  
(3) Blank Spaces show non-availability of Data

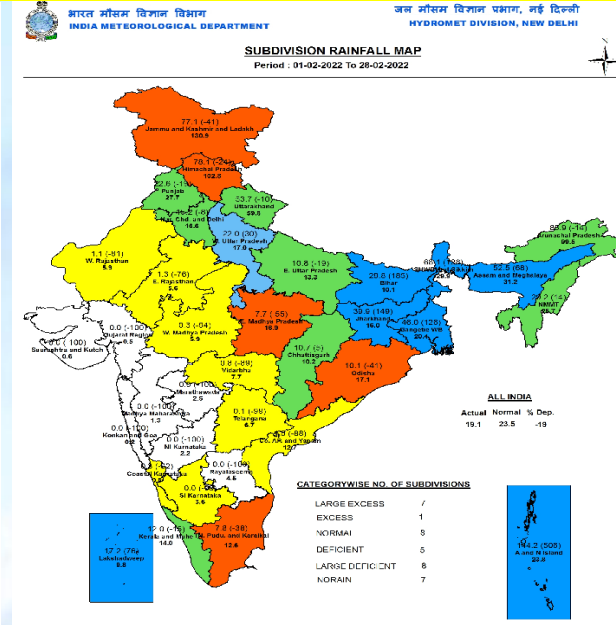


# Sub-dued Rainfall in Feb, March, April 2022



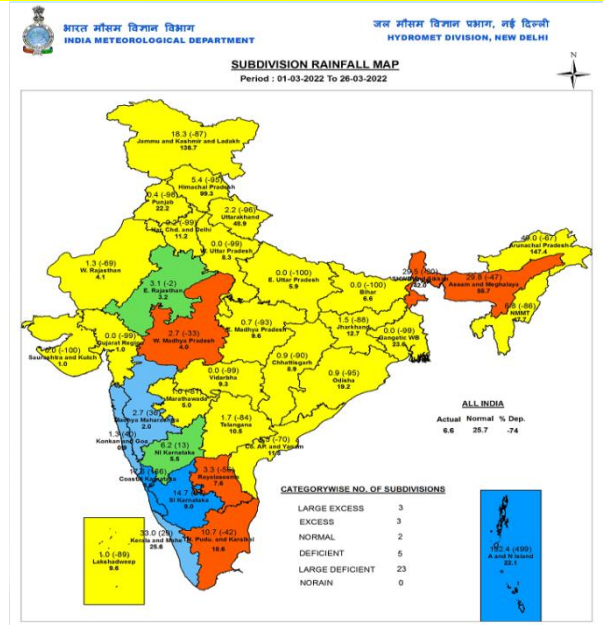
Legend  
Large Excess [80% or more] Excess [20% to 80%] Normal [19% to 19%] Deficient [69% to 20%] Large Deficient [69% to 40%] No Rain [100%] No Data

NOTES:  
a) RainFall fig  
b) Small figure  
c) Percentage



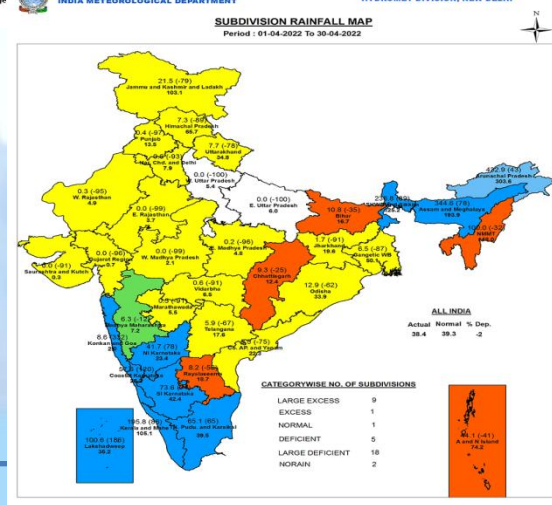
Legend  
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NOTES:  
a) RainFall figures are based on operation data.  
b) Small figures indicate actual rainfall (mm), while bold figures indicate Normal rainfall (mm).  
c) Percentage Departures of rainfall are shown in brackets.



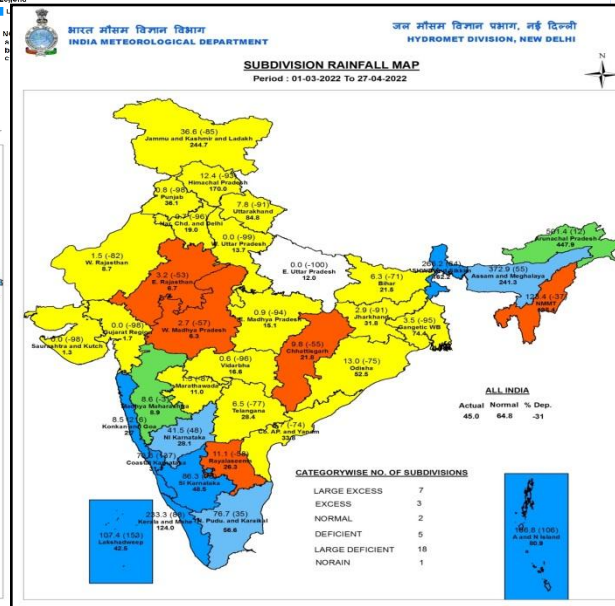
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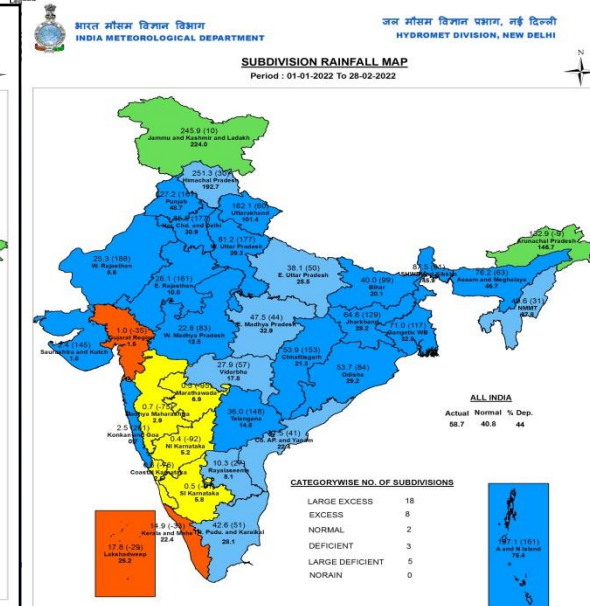
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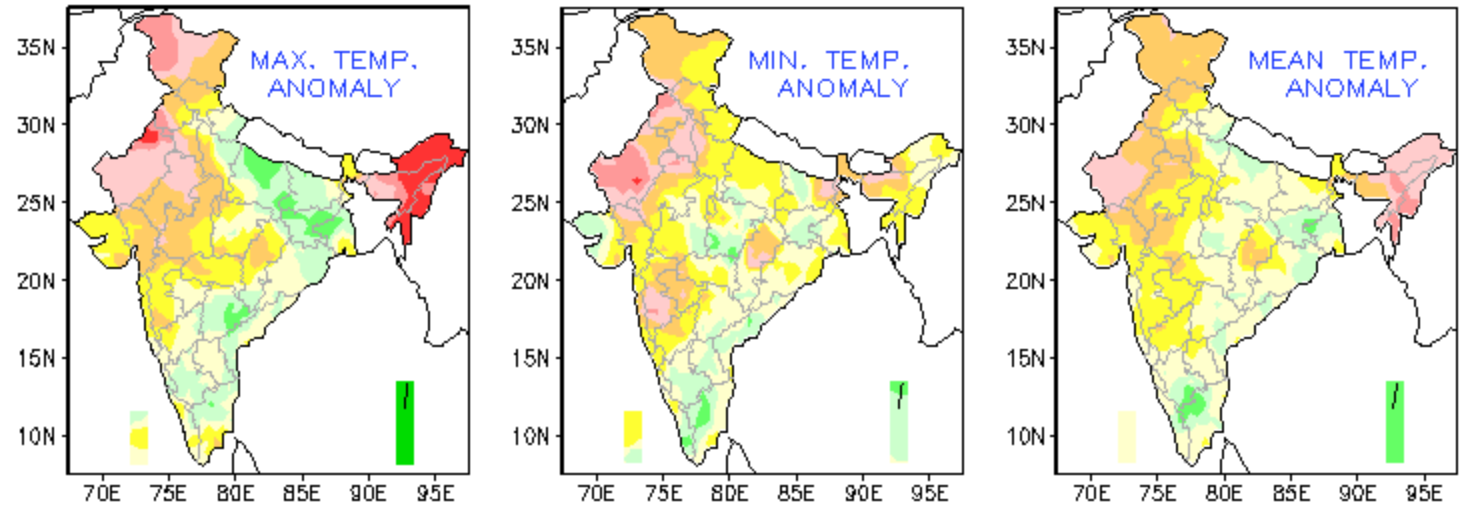
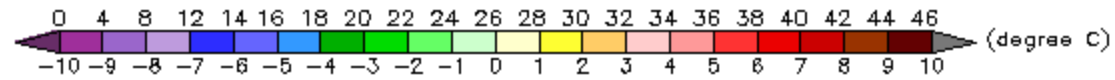
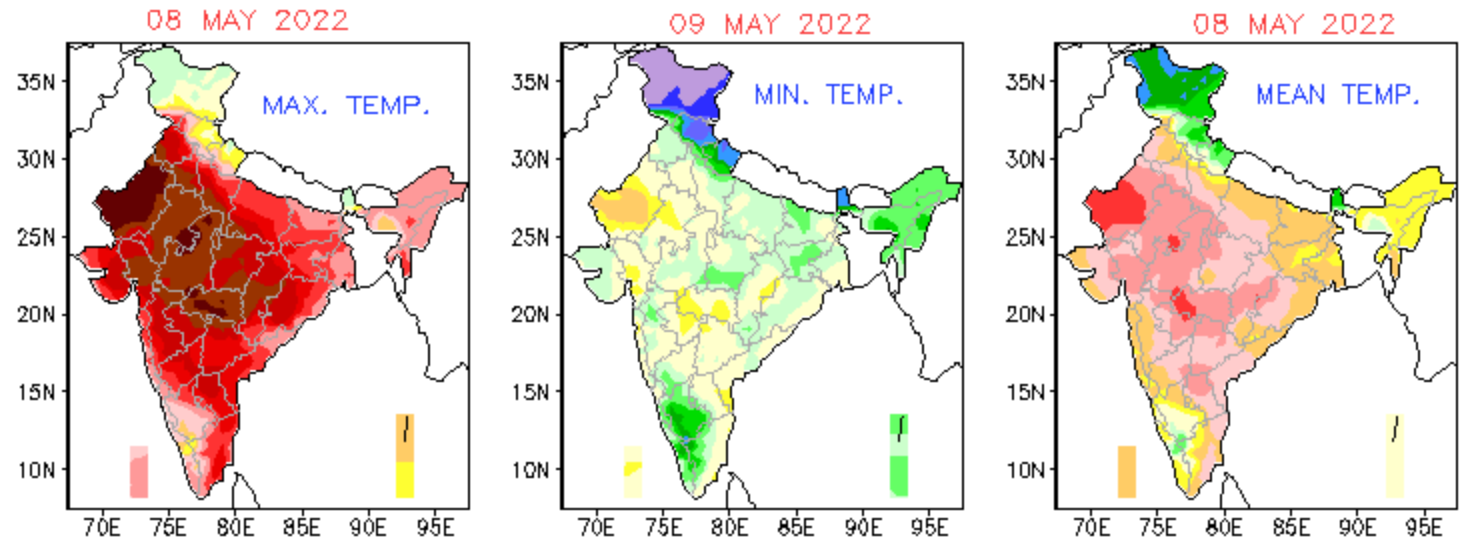
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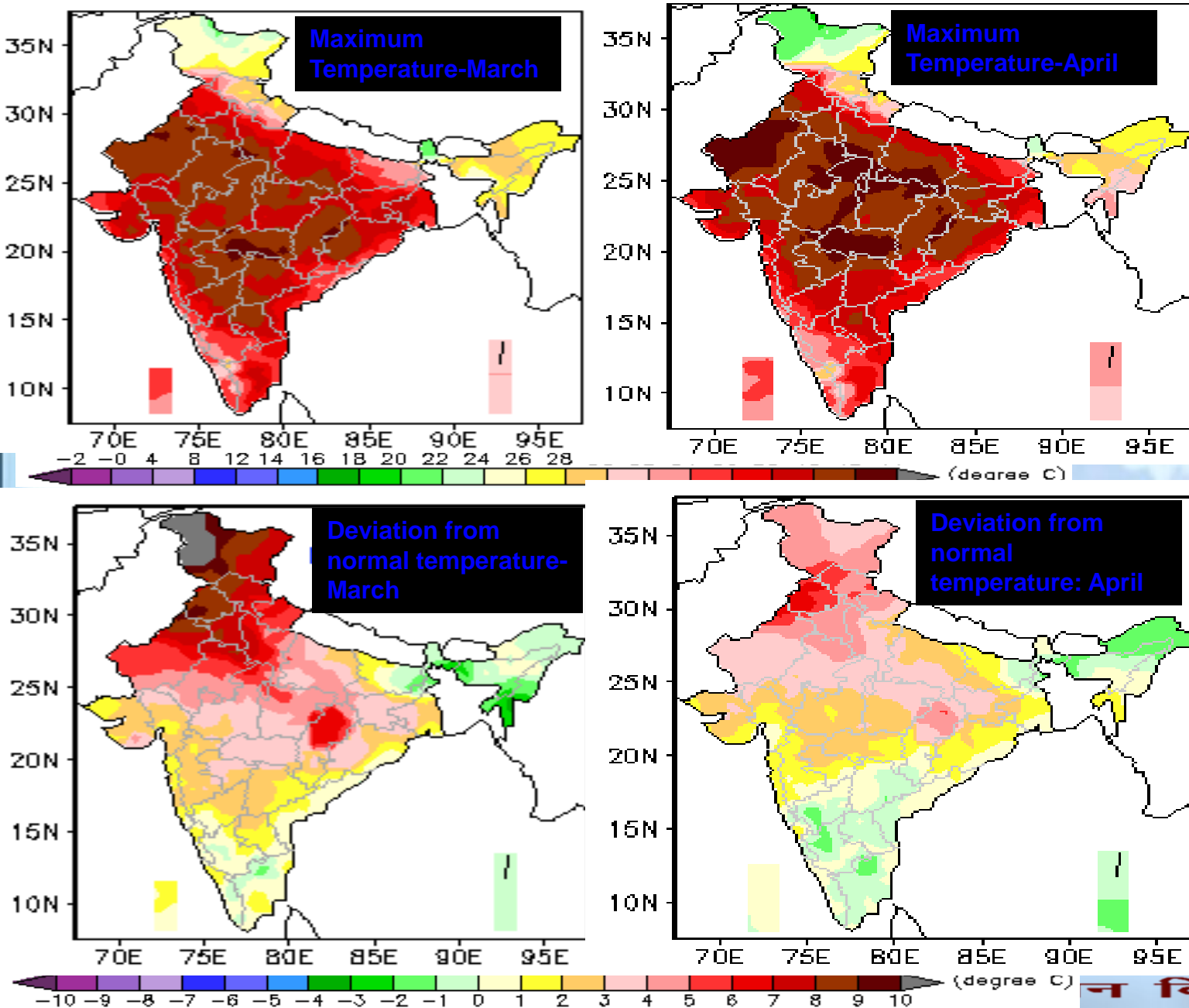
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# Observed Temperature in March and April 2022



- Maximum Temperatures (day temperatures) were 40 to 45 deg C over major parts of plains of northwest India and central India in March and April 2022
- They were above normal by about 5 to 7 deg. C. over northwest and some parts of central India in March and some parts of northwest India in April.
- Average maximum temperature of the country in March 2022 was highest in last 122 year(1901-2022) and that of April 2022 was third highest.



# Heat Wave Days in March and April, 2022

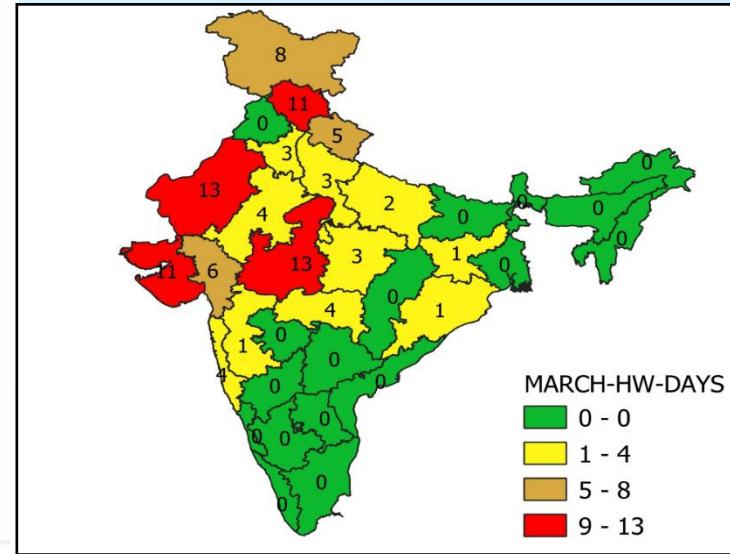
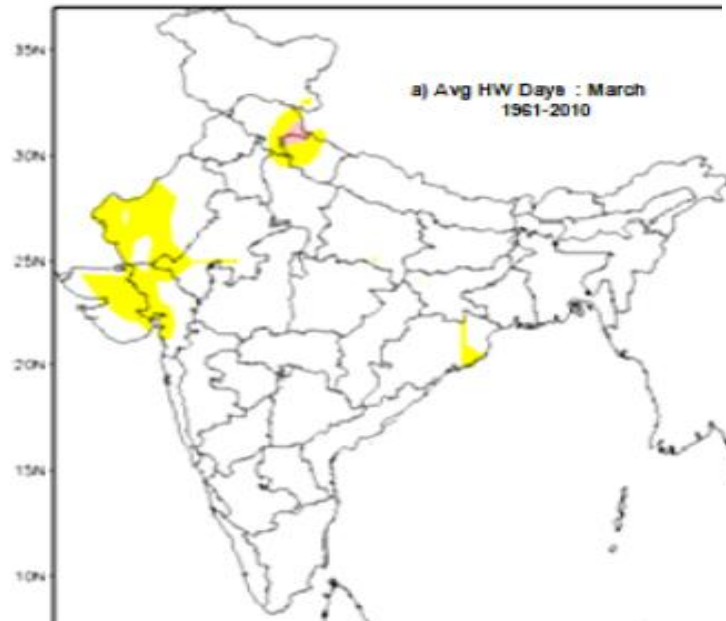
Number of heat wave days in March, 2022

Heat wave in March, 2022

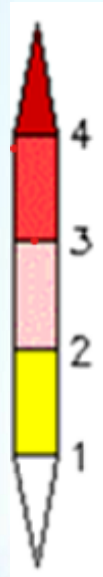
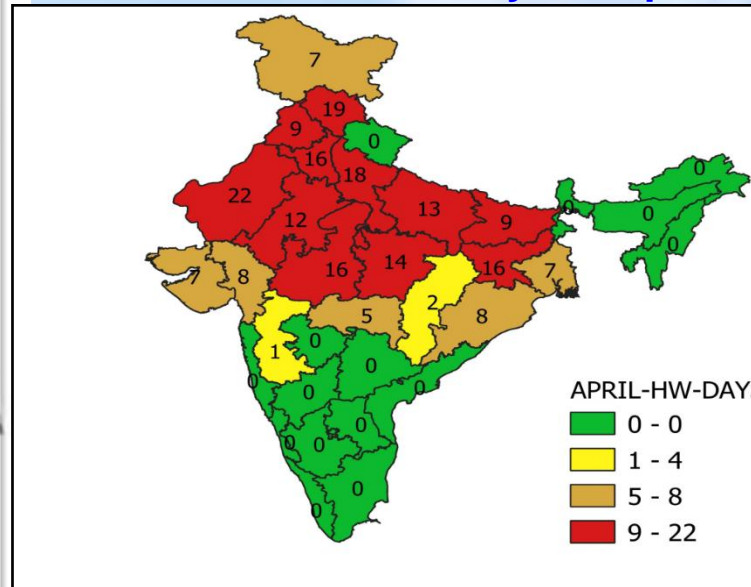
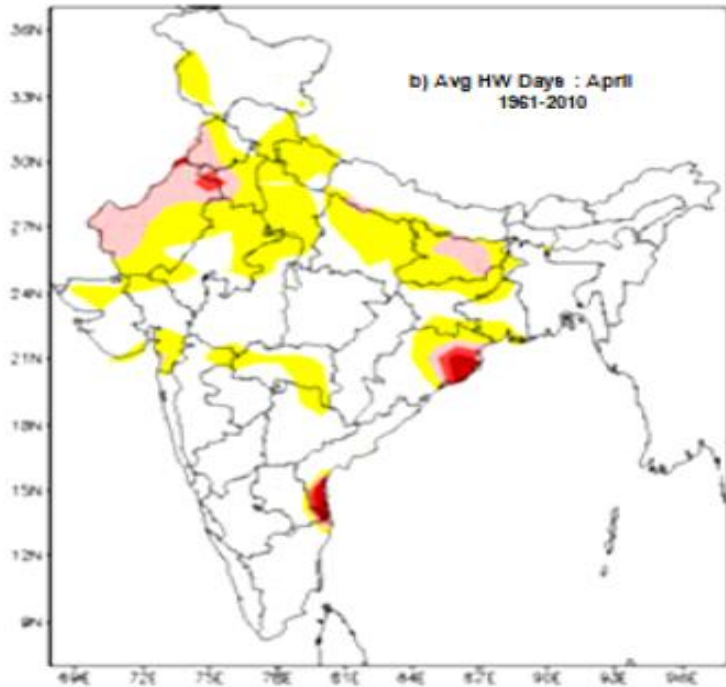
- ❖ 10 to 15 days of heat wave prevailed West Rajasthan, West MP, Saurashtra and Kutch. HP in March and 1 to 5 days in remaining parts of northwest and central India against the normal of 1 to 3 days in these regions

Heat wave in April, 2022

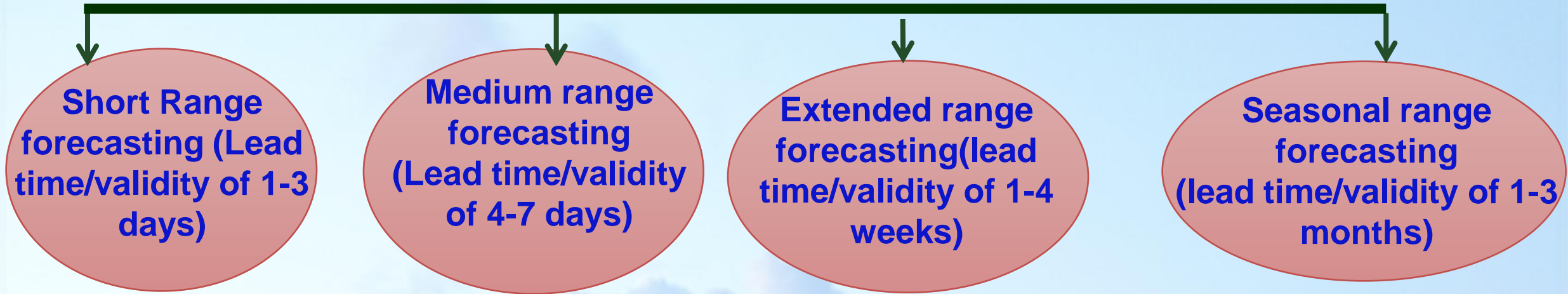
- ❖ 10 to 20 days of heat wave prevailed major parts of northwest and central India against the normal of 1 to five days



Number of heat wave days in April, 2022



# Heat wave Forecasting and Warning Process



- **Seasonal Forecasting (1 to 3 months lead time/validity)**
- The seasonal forecasting process is in vogue since 2016
- The forecast is based on multi-model dynamical ensemble forecasting scheme
- Seasonal Forecast of temperature was issued on 1<sup>st</sup> March 2022 for period of March to May
- ❖ Monthly forecast of temperature was issued on 1<sup>st</sup> March for the month of March, on 1st April for the month of April and on 30th April for the month of May
- **Extended range Outlook (1 to 4 weeks lead time/validity):**
- ❖ Bulletins in extended range valid for next four weeks is issued every Thursday.



Government of India  
पृथ्वी विज्ञान मंत्रालय (एम. ओ. ई. एस.)  
Ministry of Earth Sciences (MoES)  
भारत मौसम विज्ञान विभाग  
INDIA METEOROLOGICAL DEPARTMENT

Seasonal (March to May) and Monthly (March) 2022 Outlook for the  
Temperature and Rainfall

**Highlights**

a) **Temperature** - During the upcoming hot weather season (March to May (MAM)), normal to above normal minimum temperatures are most likely over many parts of northwest India, most parts of northeast India, some parts of central India, east coastal region and some areas along the foothills of the Himalayas. Above normal maximum temperatures are most likely over many areas from west and adjoining areas of central India, northwest India and northernmost parts of northeast India. However, below normal maximum temperatures are likely over most parts of the south peninsula and east and northeast India and northern plains.

During March, normal to below normal minimum temperatures are most likely over most parts of India except some parts of eastern, southeastern & northwestern peninsula. Normal to below normal maximum temperatures are likely over most parts of the south peninsula and east and northeast India whereas above normal maximum temperatures are most likely over many parts of western and central India.

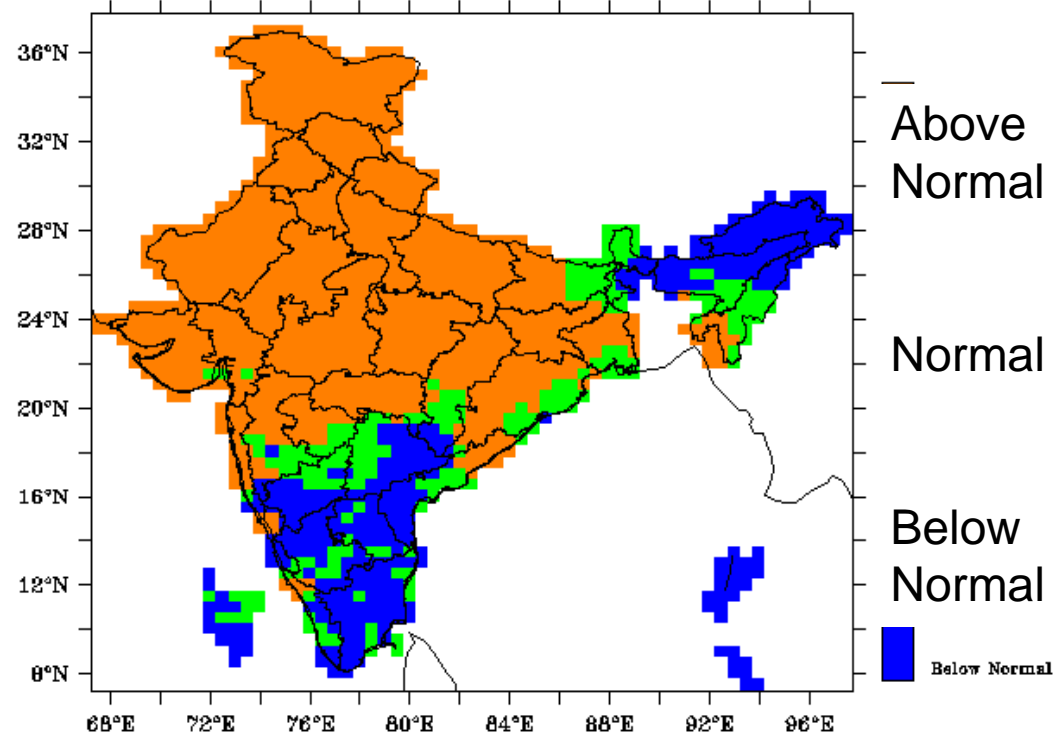
b) **Rainfall** - The rainfall in March 2022 averaged over the country is most likely to be normal (83-117% of LPA). Below normal rainfall is most likely over most areas of northwest and central India and some parts of northeast India. Normal to above normal rainfall likely over many parts of south Peninsula.



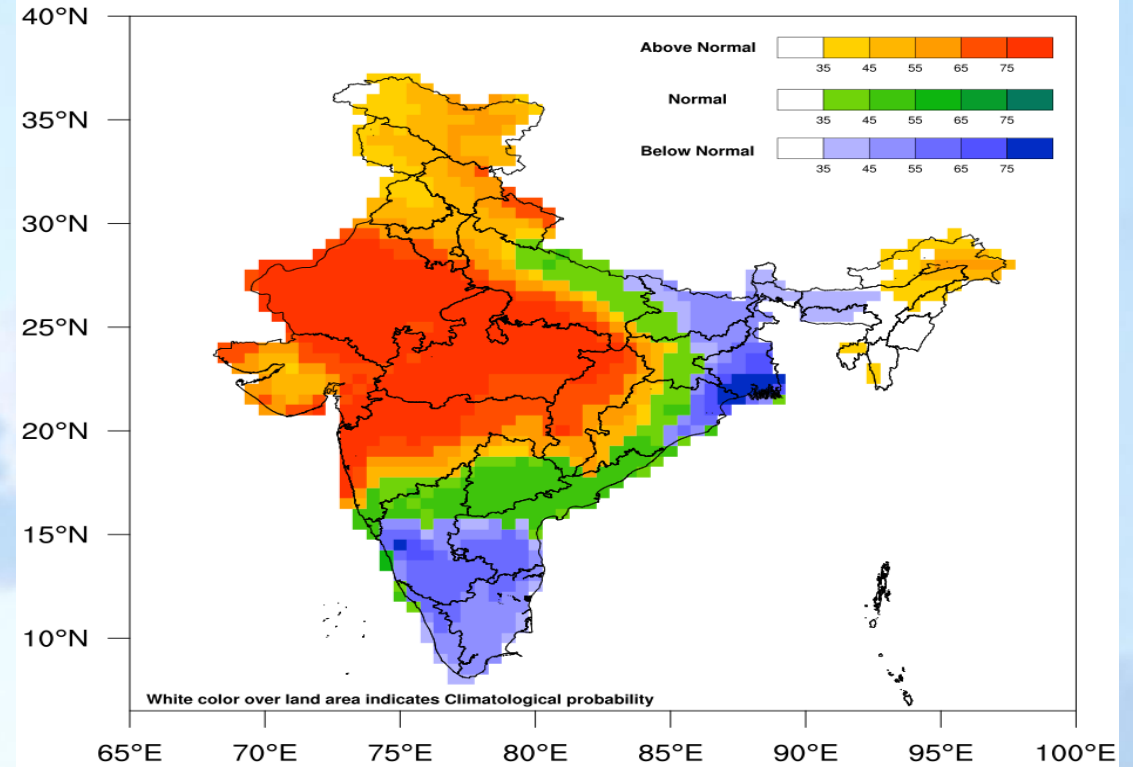


# Verification of Forecast of Maximum Temperature of April 2022

## Observed Maximum Temperature Category in April, 2022



## Forecast Maximum Temperature Category for April (issued on 31st March 2022)



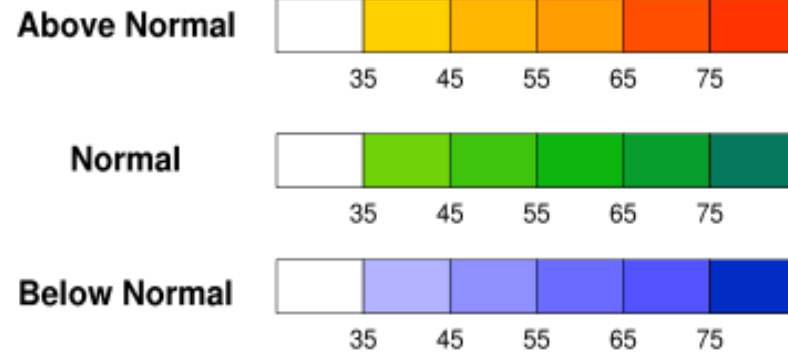
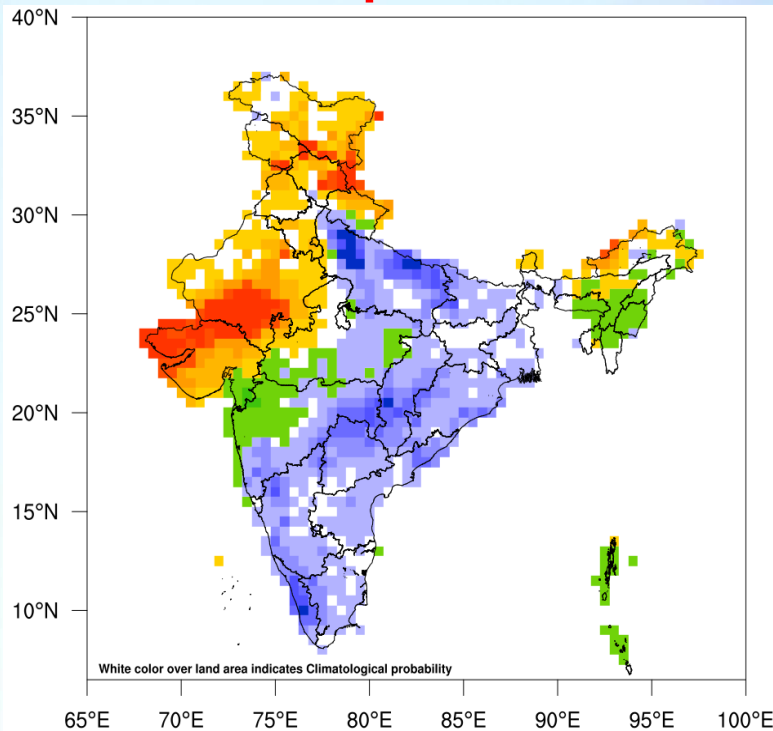
Above normal Maximum temperature over central and northwest India were correctly predicted and Below normal Maximum Temperature over many parts of South Peninsula were also correctly predicted. However, below normal maximum temperatures observed over Northeast India could not be correctly predicted.

5/11/2022



# Probabilistic Forecast of Temperature during May 2022

## Maximum Temperature Forecast Probability for May 2022



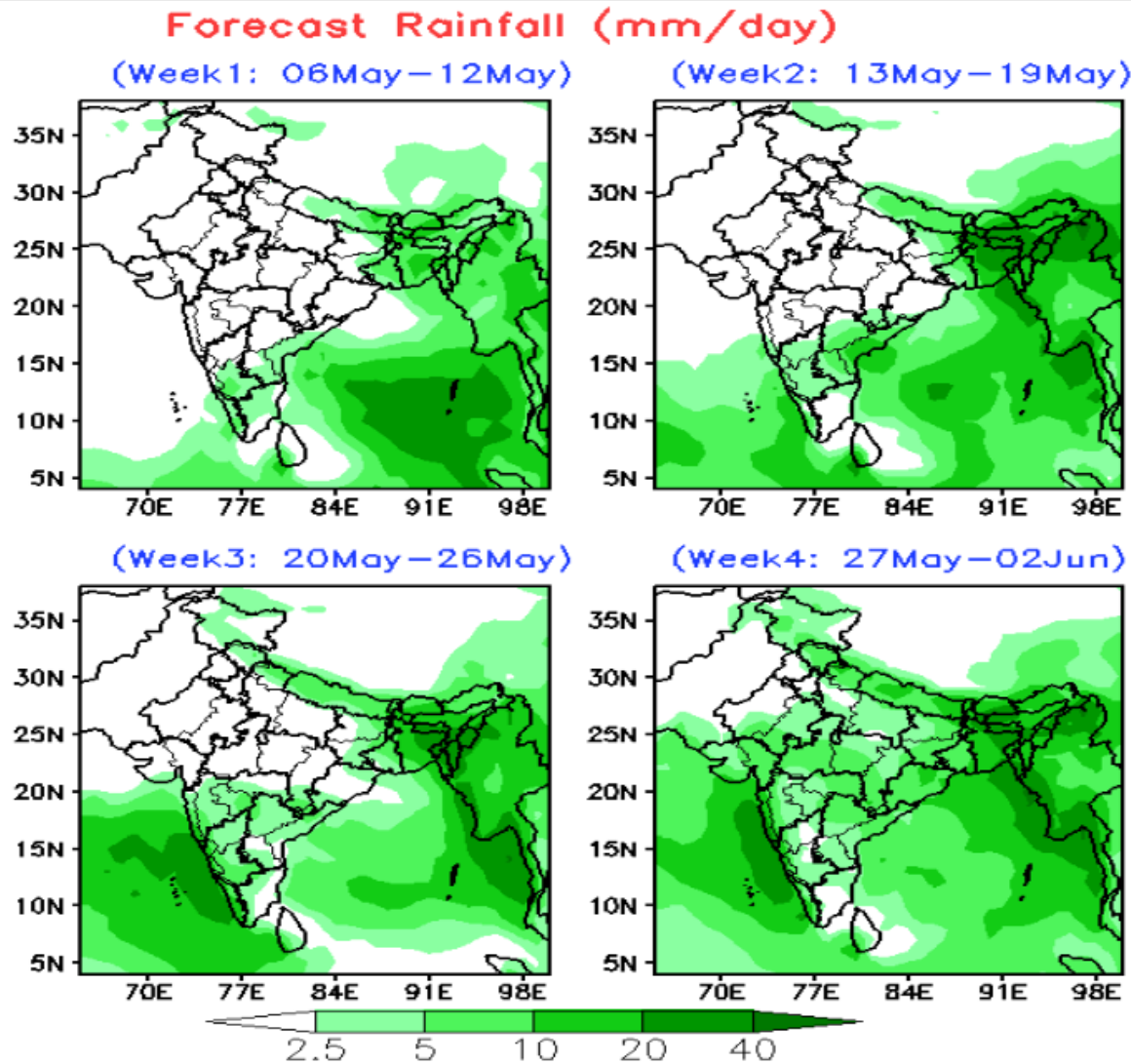
### Max. Temperature Forecast for May, 2022:

- Above normal maximum temperatures are likely over most parts of westcentral and northwest India and northern parts of northeast India.
- Normal to below normal maximum temperatures are likely over remaining parts of country.

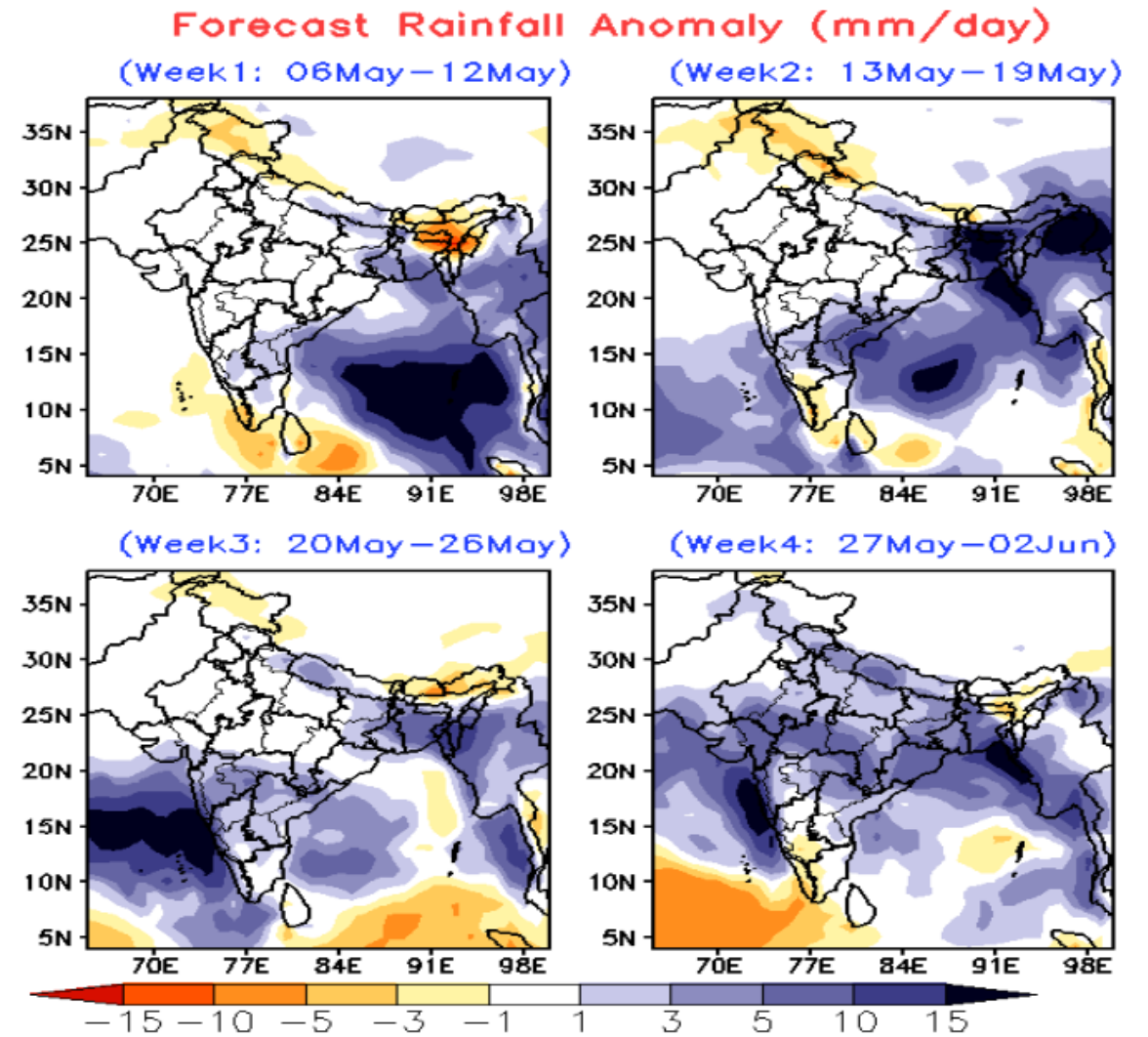


# EXTENDED RANGE FORECAST (ERF)

## FORECAST RAINFALL (WEEK1-WEEK4)



## FORECAST RAINFALL ANOMALY (WEEK1-WEEK4)



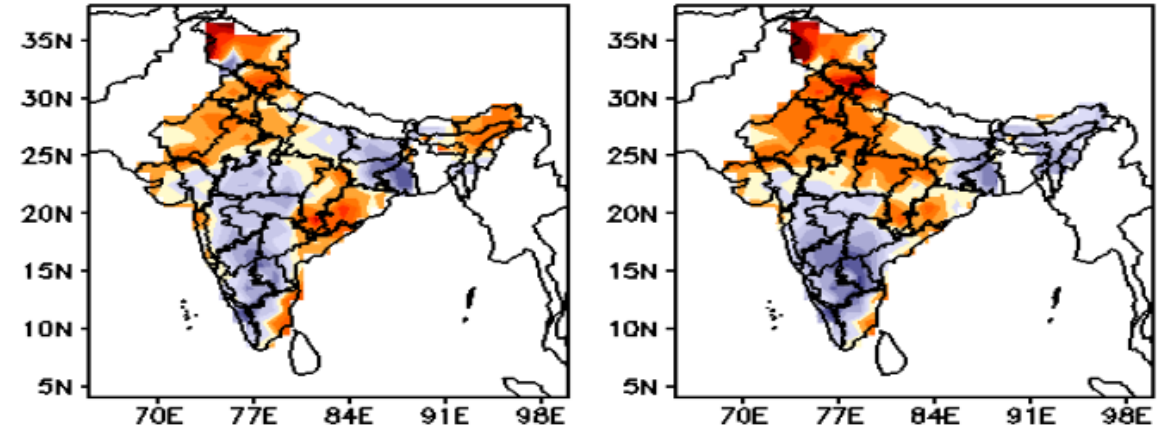
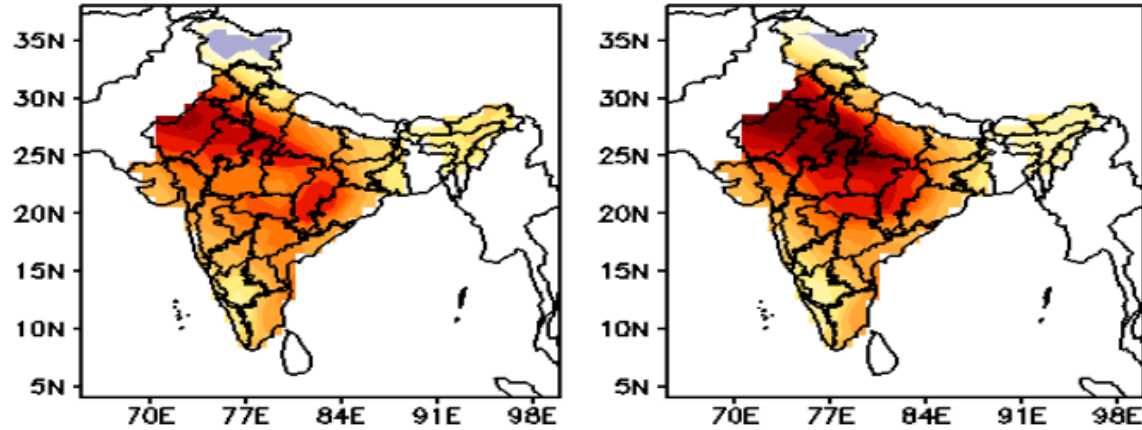
# EXTENDED RANGE FORECAST (ERF)

## FORECAST TMAX. (WEEK1-WEEK4)

## FORECAST TMAX. ANOMALY (WEEK1-WEEK4)

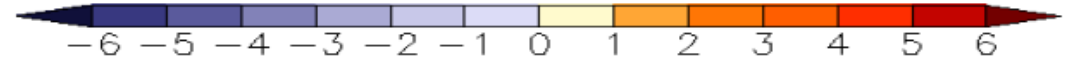
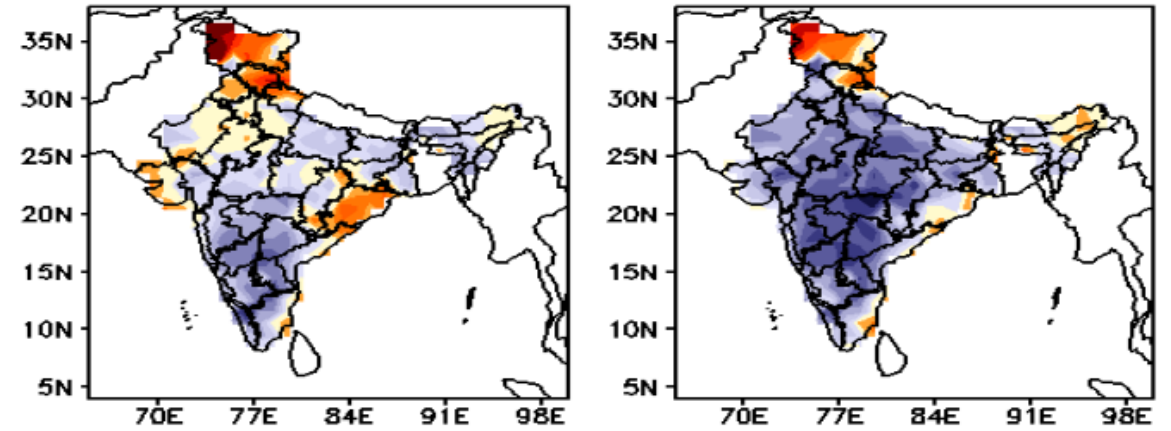
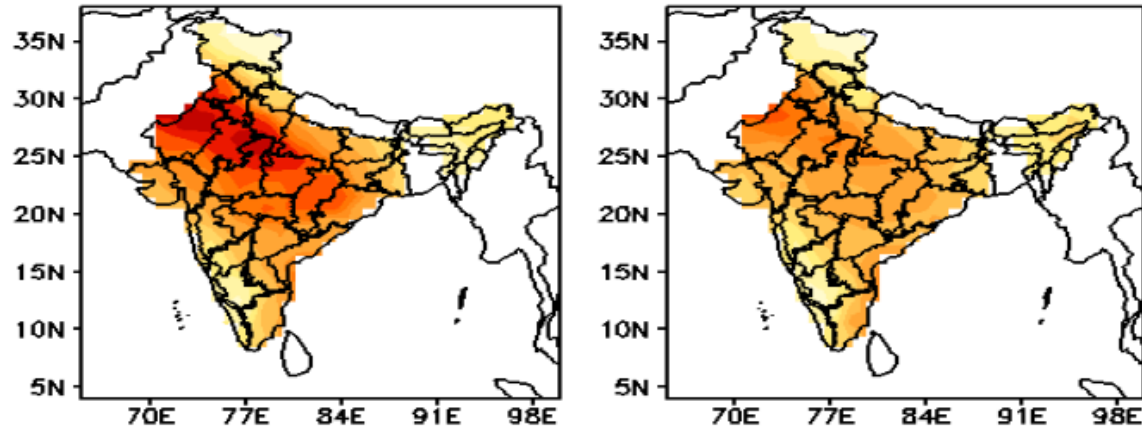
MME Bias corrected forecast Tmax (Deg)  
(Week1: 06May-12May) (Week2: 13May-19May)

MME forecast Tmax anomaly (Deg C)  
(Week1: 06May-12May) (Week2: 13May-19May)



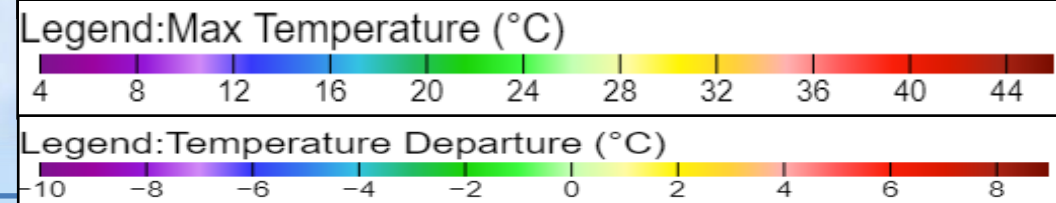
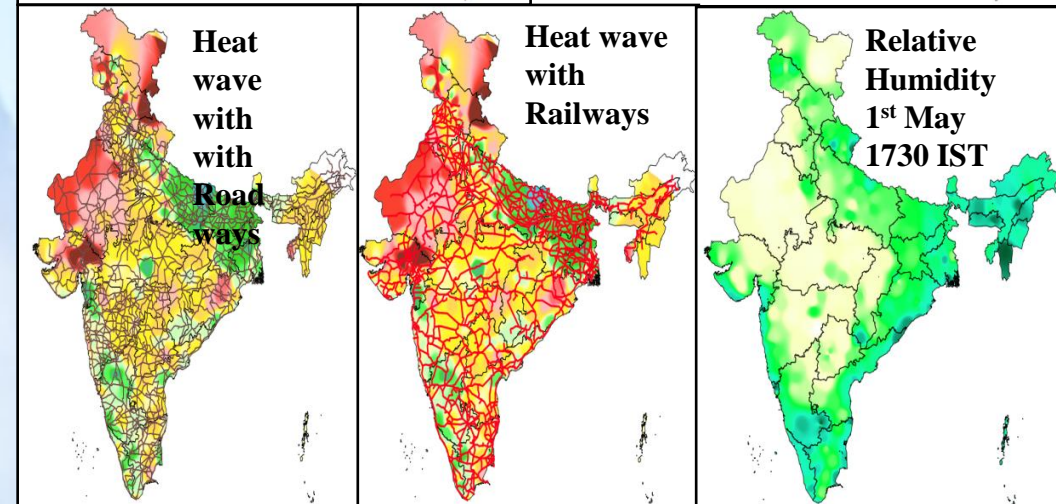
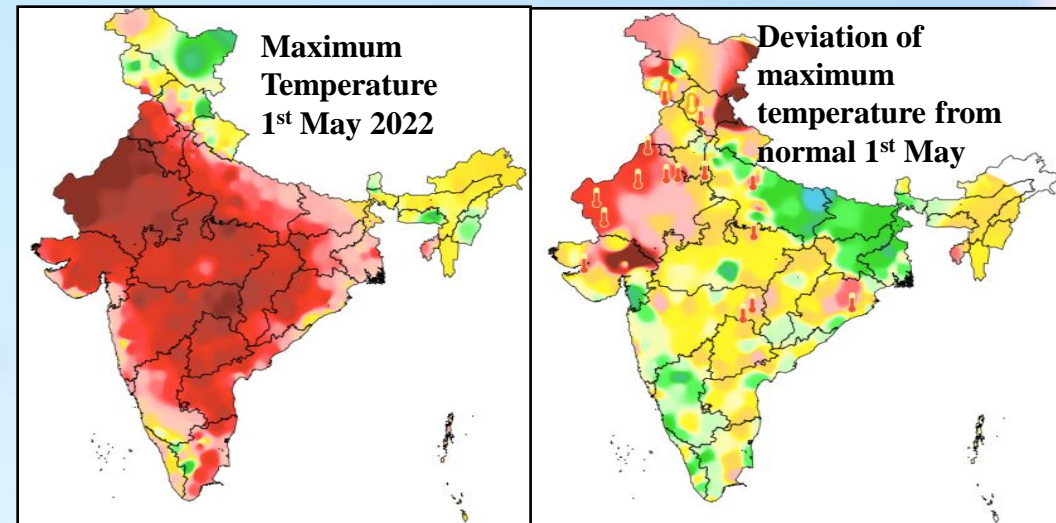
(Week3: 20May-26May) (Week4: 27May-02Jun)

(Week3: 20May-26May) (Week4: 27May-02Jun)



# Daily- for 5 days period-Impact based Heat Wave Warning

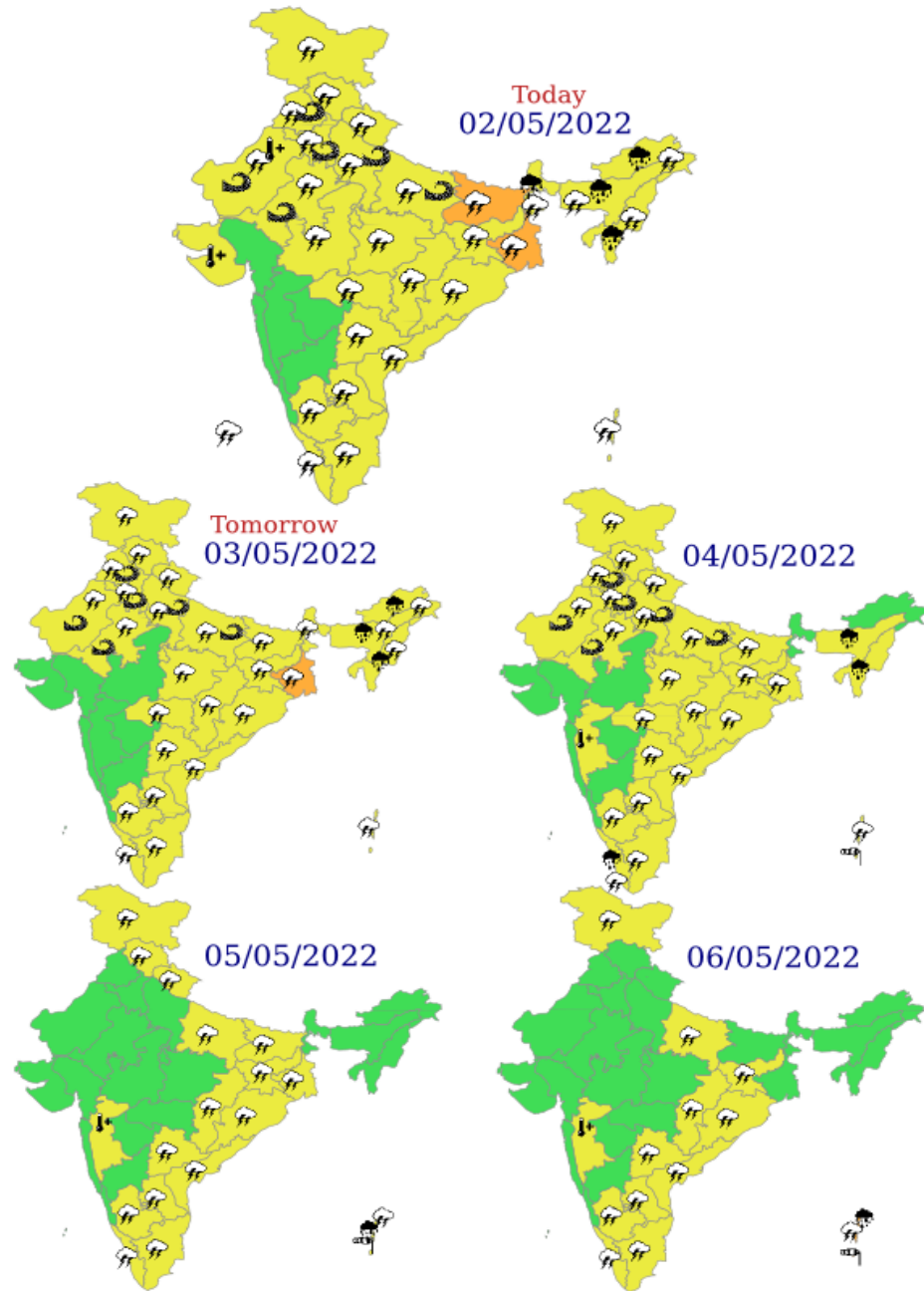
- Impact based heat wave warning is issued daily twice at district and station level valid for next five days
- Following information is provided daily for heat wave warning
  - a) Past Maximum temperature, its Deviation from normal temperature and forecast for next five days
  - b) Past Heat Wave conditions and forecast for next five days
  - c) Actual Warm Nights and forecast for next five days
  - d) Past Relative Humidity (RH) and forecast for next five days
  - e) Extreme temperatures extending 90, 95 and 98 percentile.
  - f) Socio economic attributes like Railway lines, Highway network, power sector network layered with above to assess the heat wave impact on these sectors



Link for Heat Wave web-page is [http://imdgeospatial.imd.gov.in/Min\\_Temperature/#5/22.752/82.803](http://imdgeospatial.imd.gov.in/Min_Temperature/#5/22.752/82.803)



# District wise Impact Based Heat Wave Warning for next 05 days:An example



चेतावनी 01 मई

(उपरोक्त दिवस 0830 तक जारी)



चेतावनी 02 मई

(उपरोक्त दिवस 0830 तक जारी)



चेतावनी 03 मई

(उपरोक्त दिवस 0830 तक जारी)



चेतावनी 04 मई

(उपरोक्त दिवस 0830 तक जारी)



चेतावनी 05 मई

(उपरोक्त दिवस 0830 तक जारी)



Meteorological Centre, Jaipur

Most Vigil (Take Action)

Be prepared/ updated (Keep Vigil)

Be aware (Be updated)

No Warning



# Issue and Challenges for forest fire warning system

- » Forest Fire vulnerability-digital data at location/dist basis
- » Forest coverage-Shape file
- » Fire Weather indices map



# THANKS



**भारत मौसम विज्ञान विभाग**  
**INDIA METEOROLOGICAL DEPARTMENT**

