Investigating the associated dynamics of 2019 Heat wave over India

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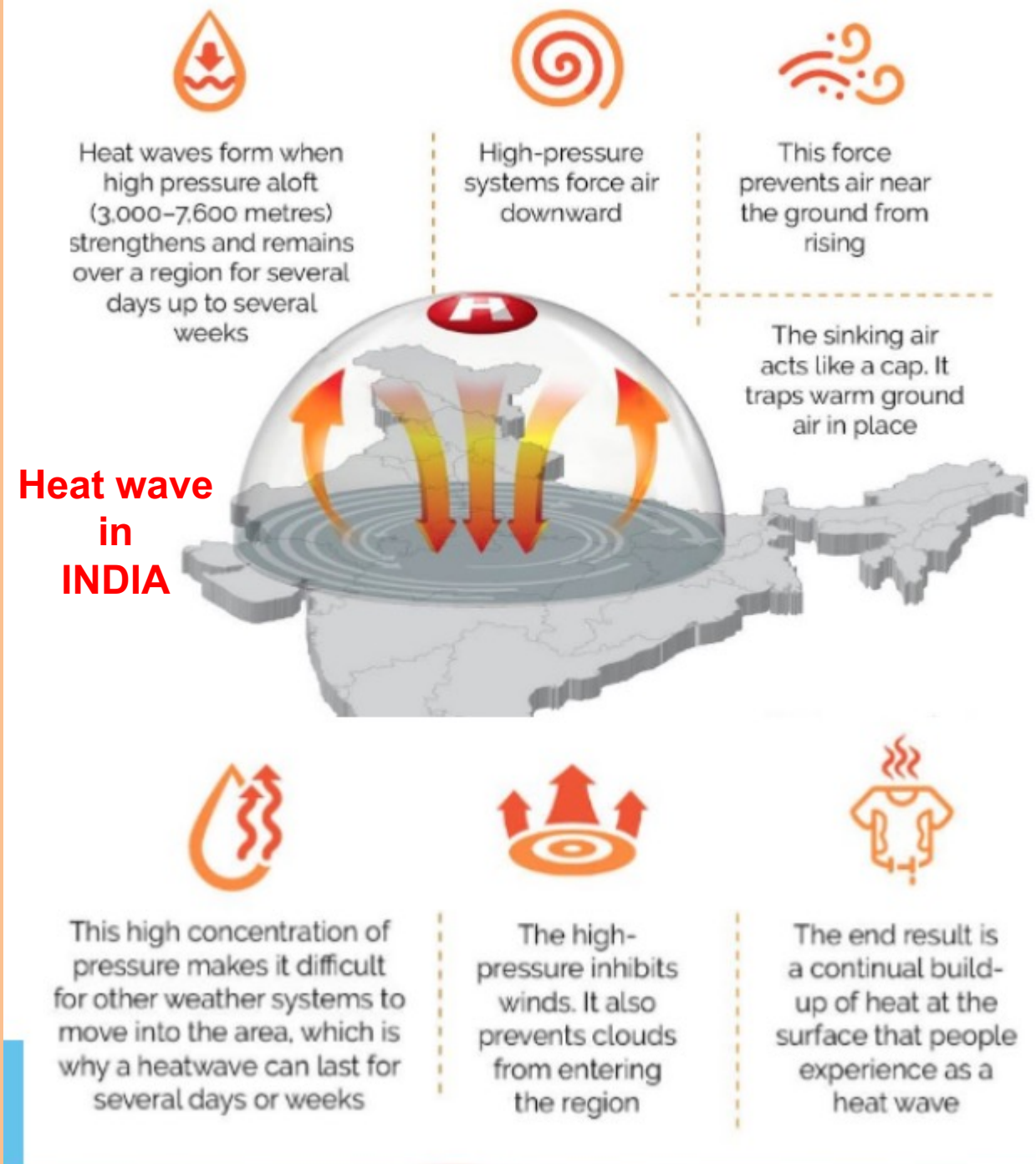
Introduction

- Heat wave (HW) is the atmospheric condition of extreme temperature when exposed, becomes fatal to the living beings.
- HW is the third largest natural disaster in India.
- The year 2015 and 1998 were the two deadliest HW events among top 5 in the world has occurred over India.
- The year 2019 was the hottest as 50.8^{o}C temperature was recorded in Churu, Rajasthan as it was the ELNINO year
- Approx. 500 people has lost life due to 2019 heat wave in India.



Data sources and Methodology

IMD

The India Meteorological Department **(IMD)** daily gridded maximum, minimum temperature (Deg C/day) and rainfall data at spatial resolution of 1^{o}x1^{o} and 0.25^{o}x0.25^{o}over the continental India for 69 year (1951-2019) period is considered.

(NCEP Reanalysis)

The reanalysis data for all other parameters is collected from the National Centres for Environmental Prediction reanalysis product available at 2.5^{o}x2.5^{o} over the period 1948-2019.

The daily mean **NOAA** Interpolated Outgoing Longwave Radiation(OLR) data of spatial coverage of 2.5^{o} x 2.5^{o} is used.

Methodology:

HW Definition used:

- The HW day is declared when the maximum temperature departure from the normal temperature (base period) is greater than 4 Deg C and persists for 2 or more days.

- To understand the dynamics of 2019 HW, the associated parameters wind, OLR, relative humidity, diurnal temperature range, total cloud cover weekly anomaly has been computed for heat wave events.

Base period : 1951-1980
Analysis year : 2019

Heat Wave weeks in 2019

Week 3 : 01-07 April 2019
Week 12: 03-09 June 2019
Week 13: 10-16 June 2019

Highest recorded maximum temperature anomaly in summer 2019

(a) 2019 MaxT Anomaly

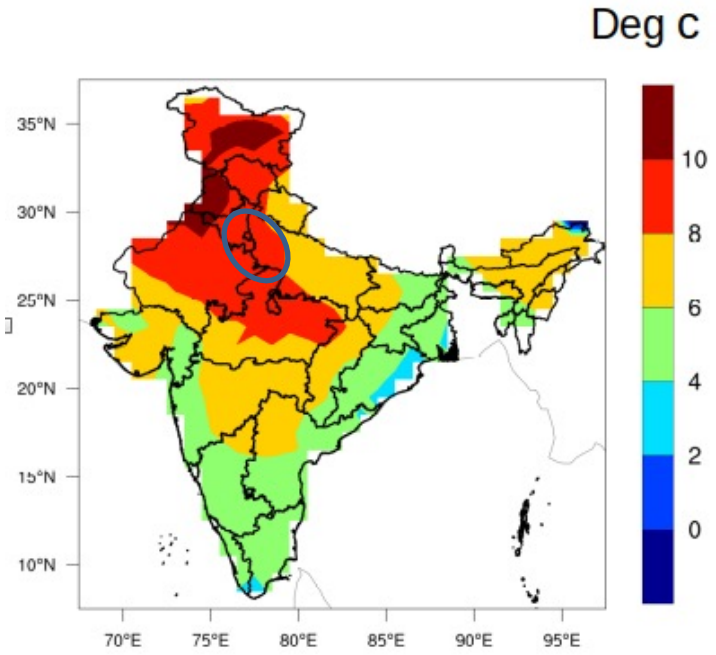


Fig (a) shows the highest recorded maximum temperature anomaly which is observed on April 30, 2019. In highlighted region the daily maximum temperature was above 50°C at Churu, Rajasthan .

(b) MaxT climatology Deg c

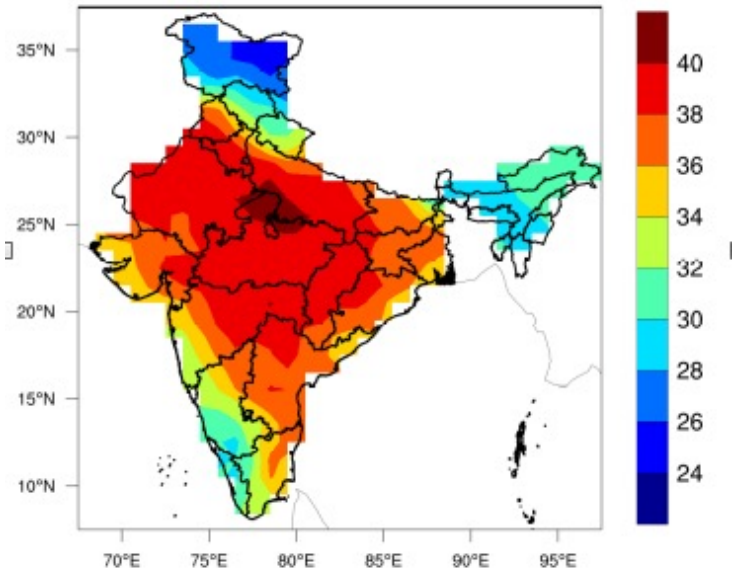


Fig (b) shows the normal maximum temperature of the base period (30 year average).

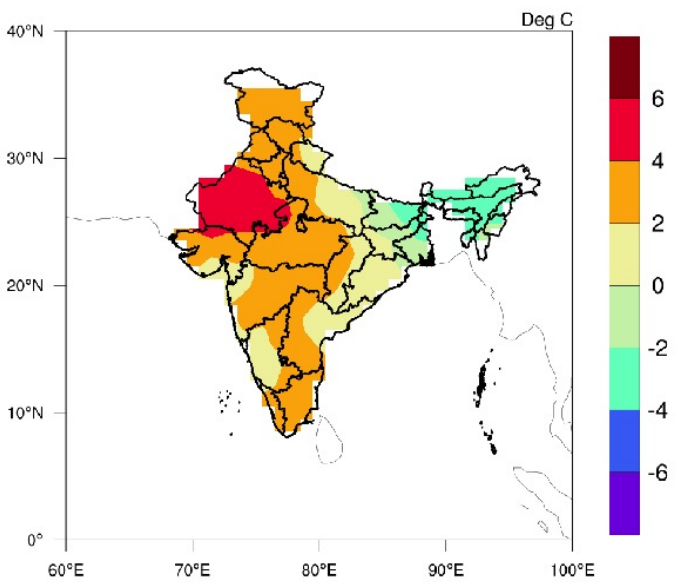
Almost throughout the country the Summer MaxT anomaly above normal was above 4 °C

Which indicates the occurrence of a strong and intense heat wave in India

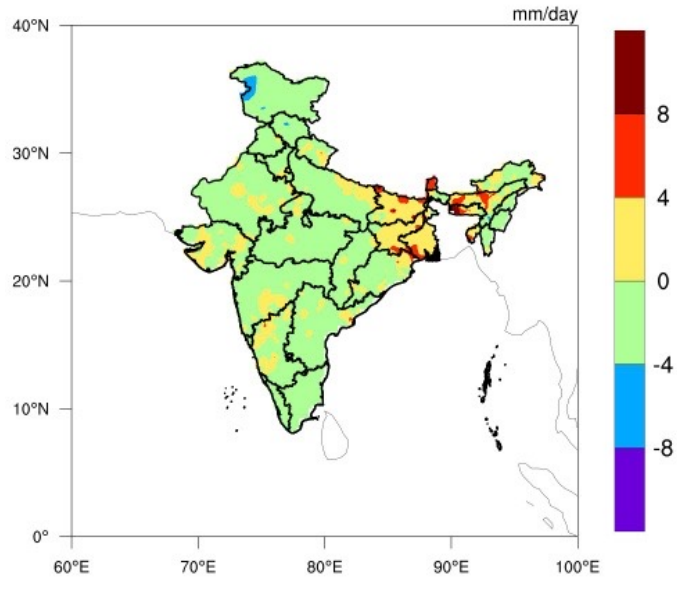
Also the weekly anomaly shows that the HW persistence was highest in 2019.

Weekly Anomaly analysis of major parameters over India

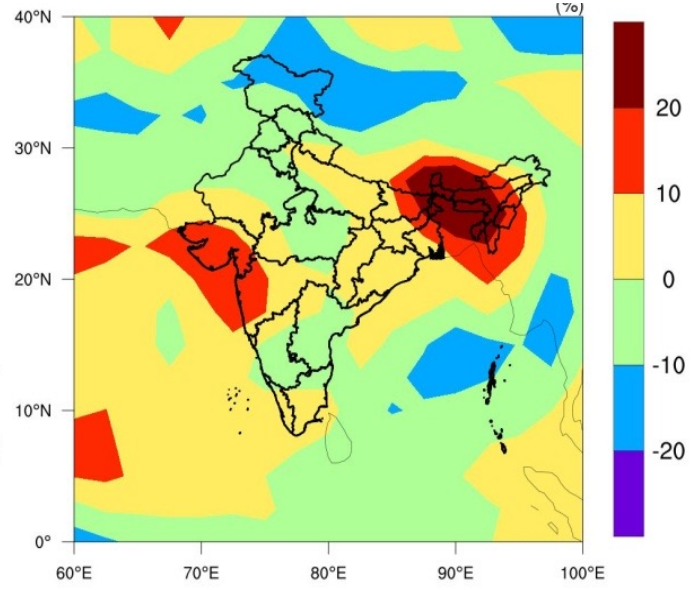
MaxT



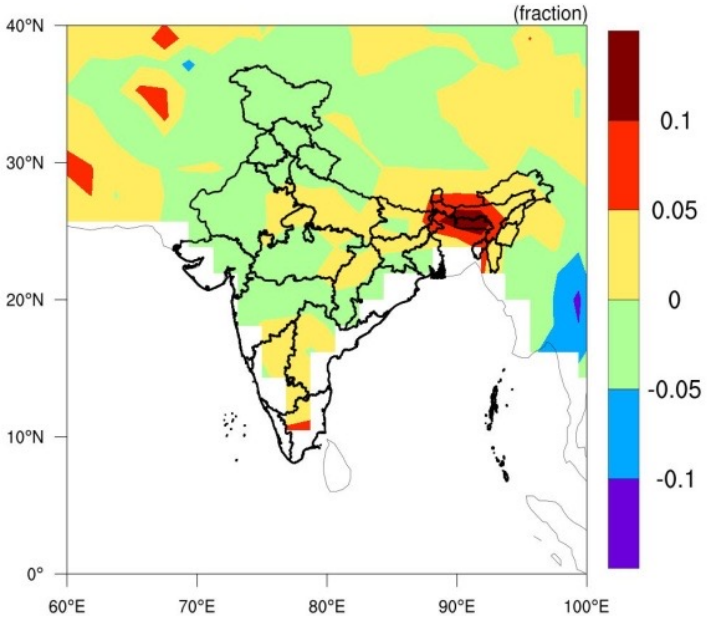
Rainfall



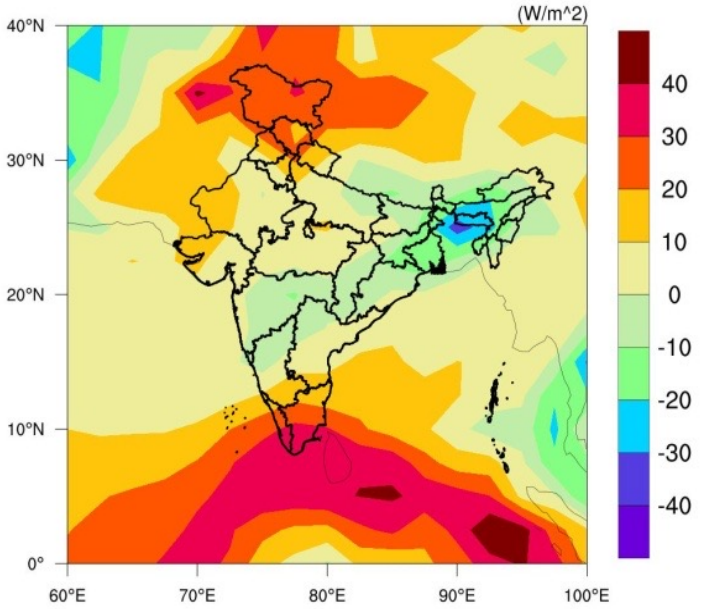
Relative Humidity



Soil moisture



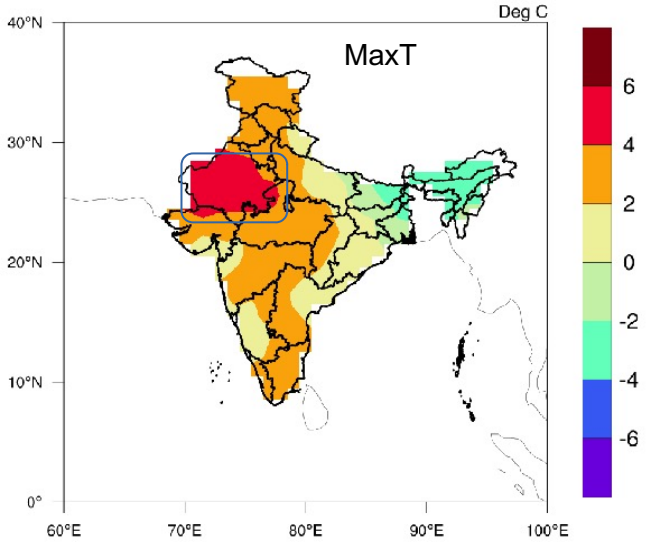
Outgoing long wave radiation



Week 3 (1-7 Apr 2019)

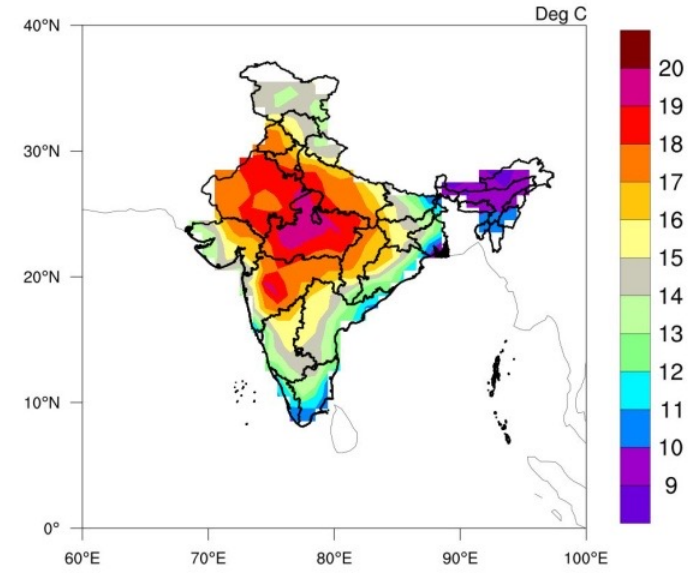
- No Rainfall
- High MaxT
- Positive Rel Humidity

Week 3 (1-7 Apr 2019) associated parameters analysis over India

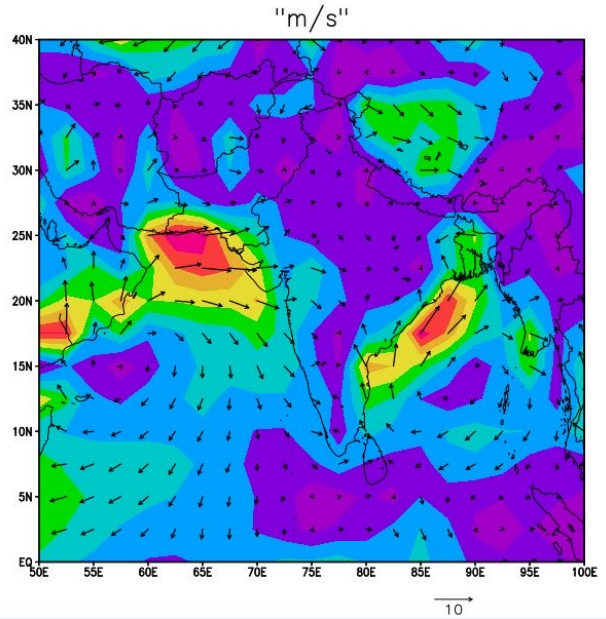


- The low total cloud cover and anomalous anticyclonic flow of wind triggered the HW event over north western (NW) India.
- The downward sinking air forms High pressure zone(HP) over the NW region.
- The sudden rise in maximum temperature leads to high DTR which leads to several health issues.

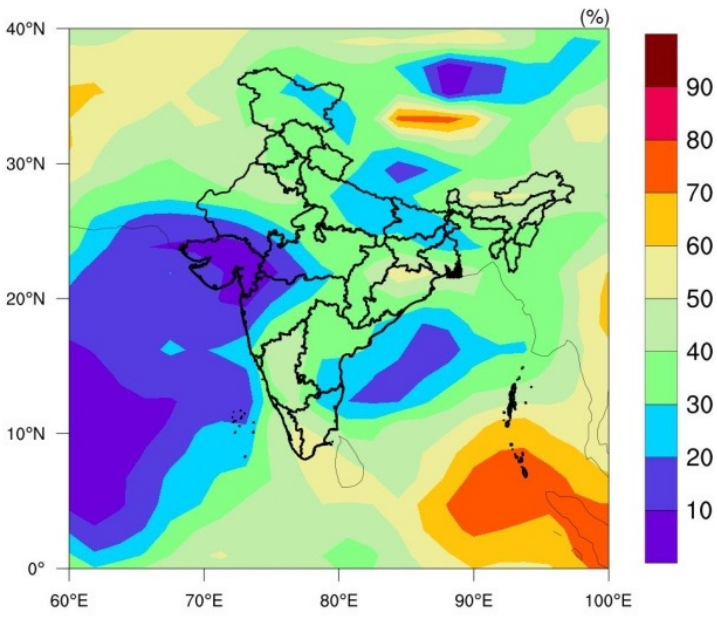
Diurnal Temperature Range



Wind

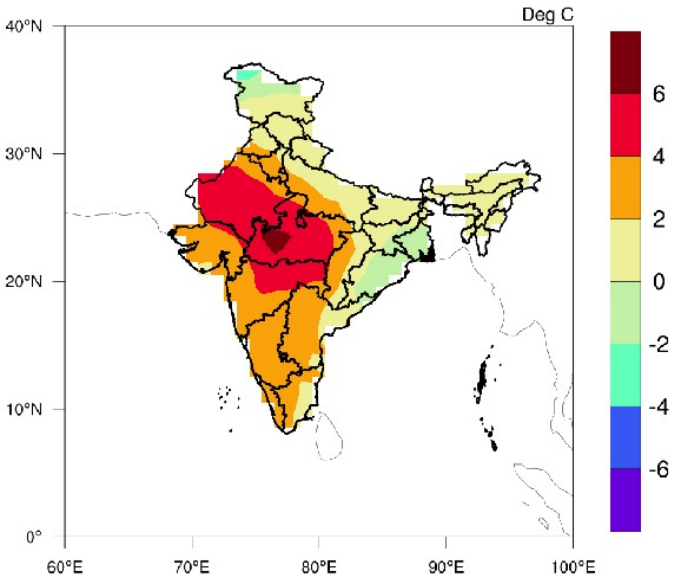


Total cloud cover

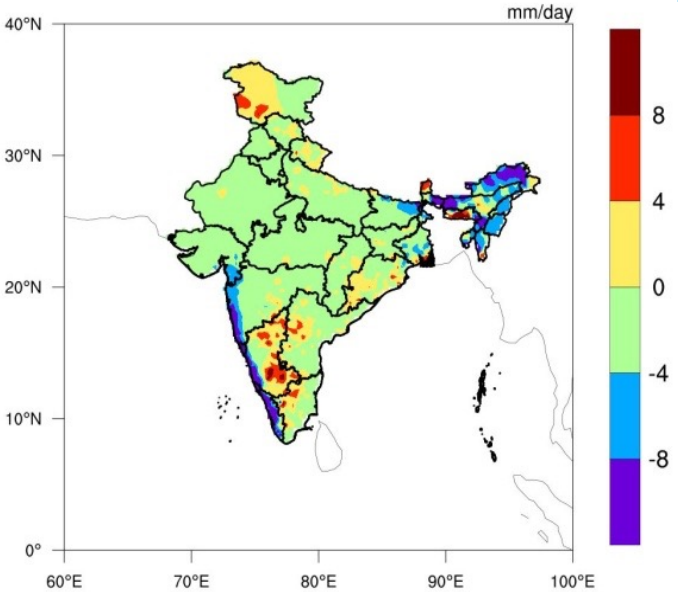


Week 12 (3-9 Jun 2019) anomaly analysis over India

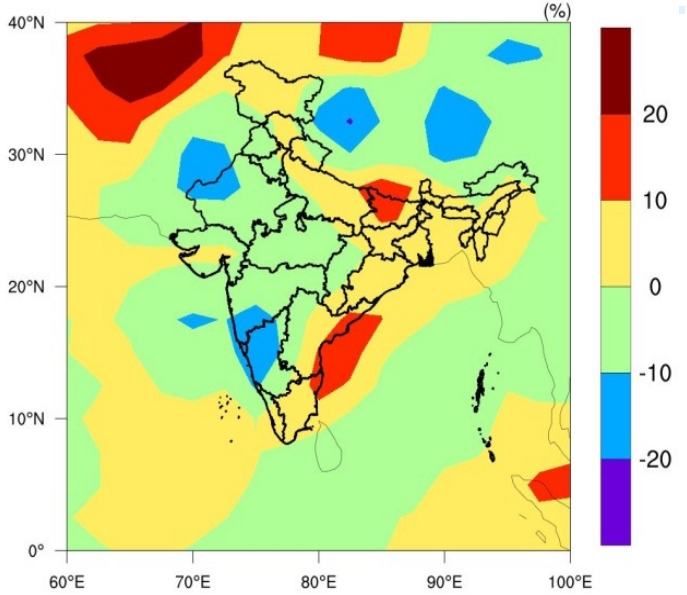
MaxT



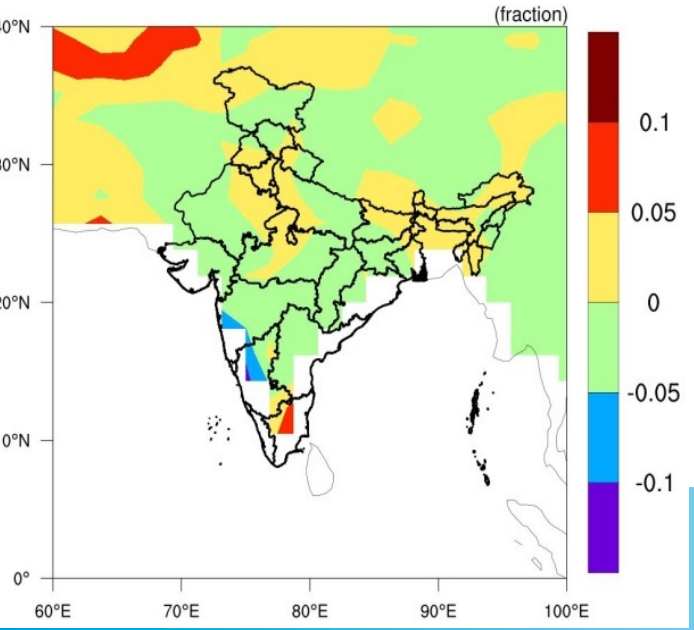
Rainfall



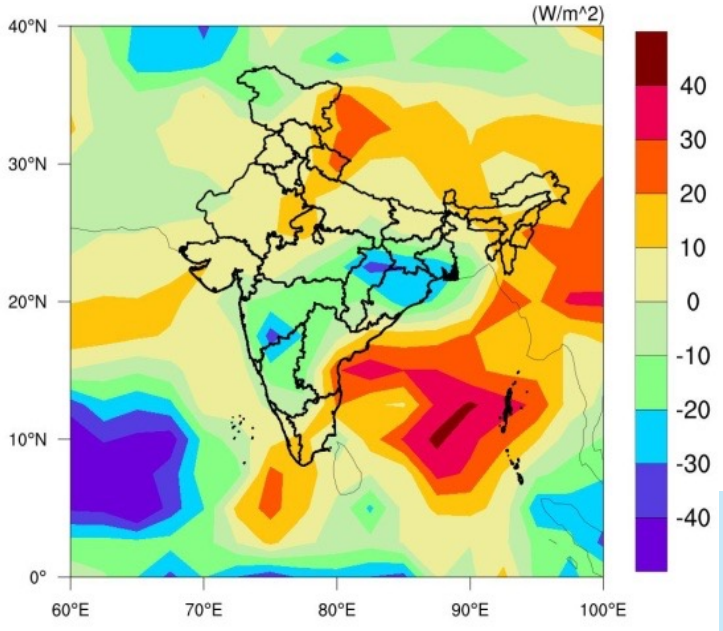
Relative Humidity



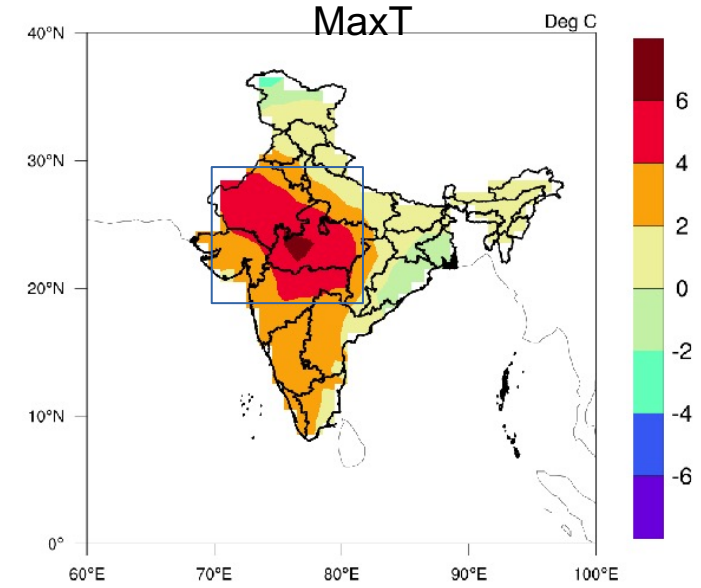
Soil moisture



Outgoing long wave radiation

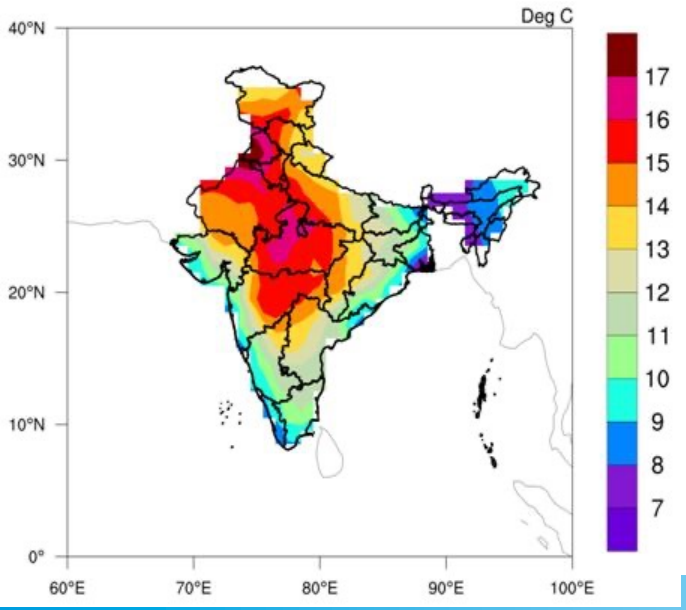


Week 12 (3-9 Jun 2019) associated parameters analysis over India

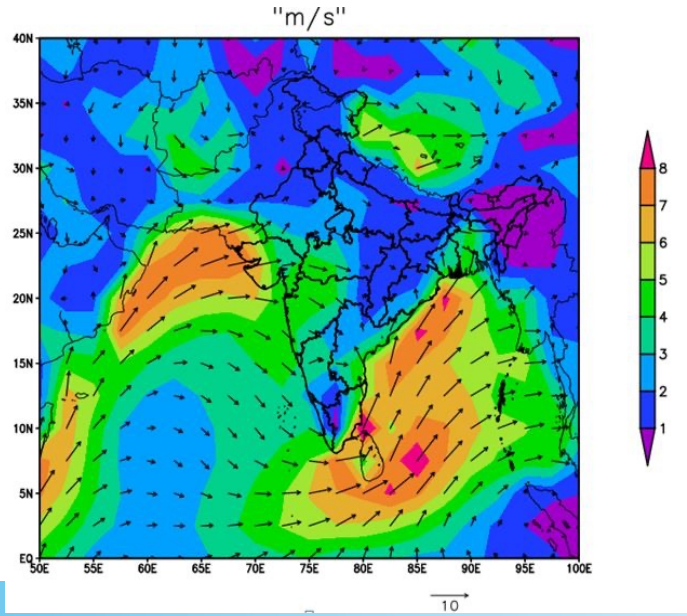


- The low total cloud cover and anomalous anticyclonic flow of wind triggered the HW event over north western (NW).
- Due to the prevailing El nino condition, the spread of HW was more over the NW and central part of country.
- Intensity & Spread of HW in continental India depends on ENSO

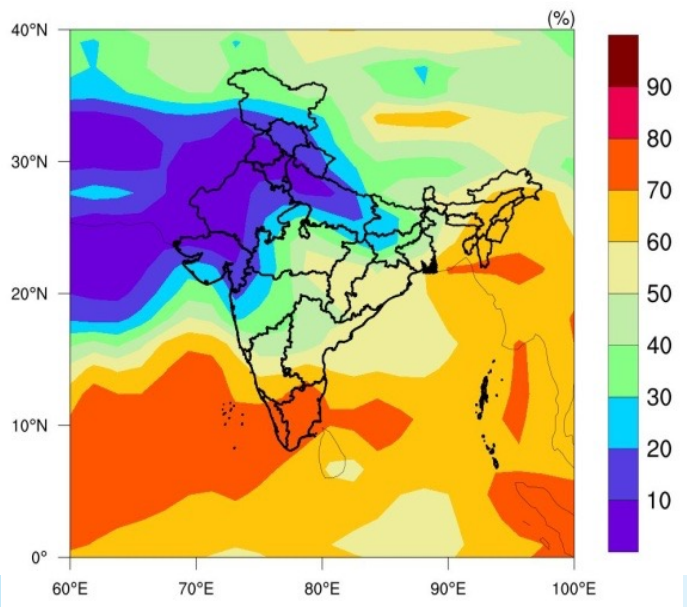
Diurnal Temperature Range



Wind

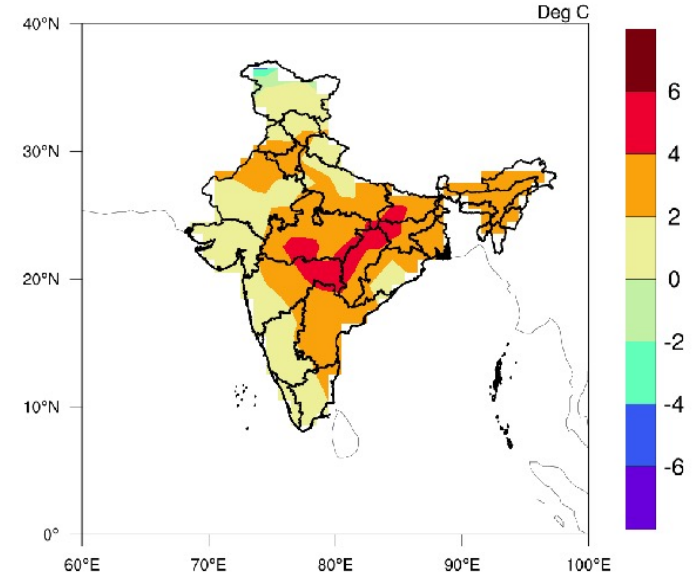


Total cloud cover

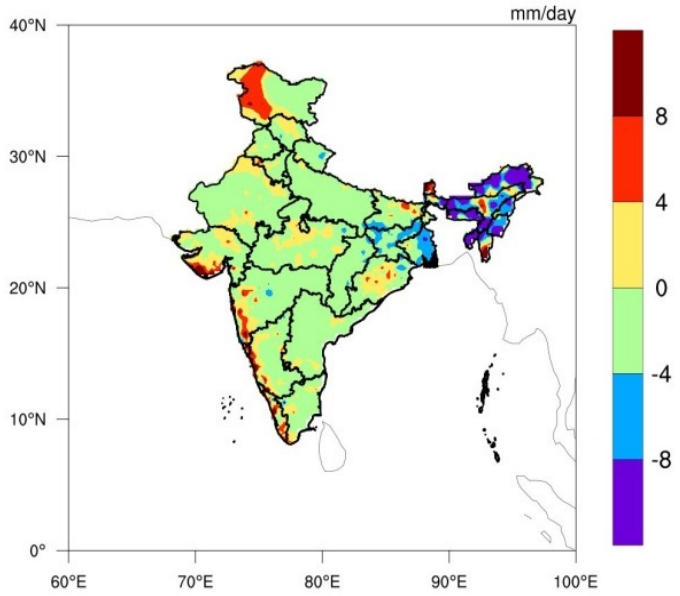


Week 13 (10-16 June 2019) anomaly analysis over India

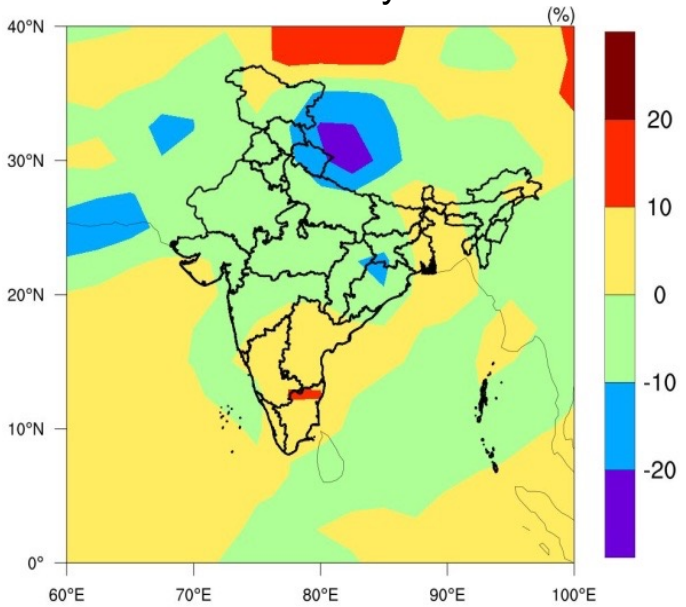
MaxT



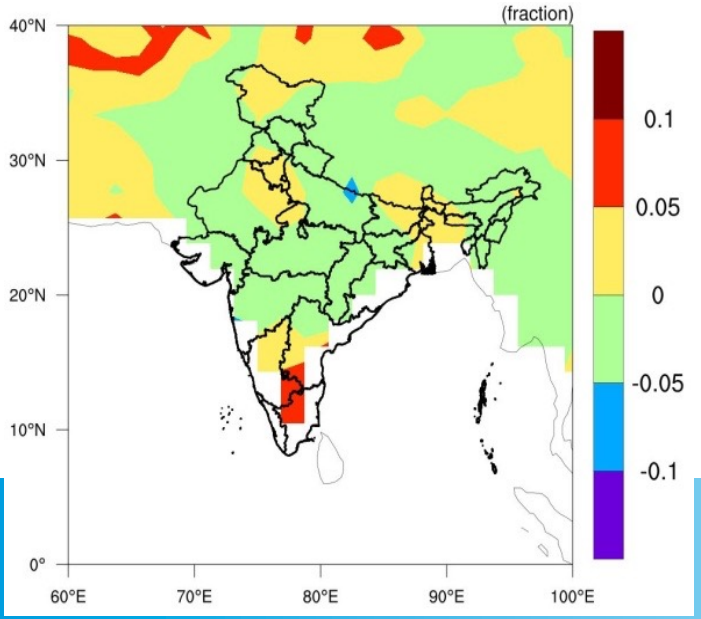
Rainfall



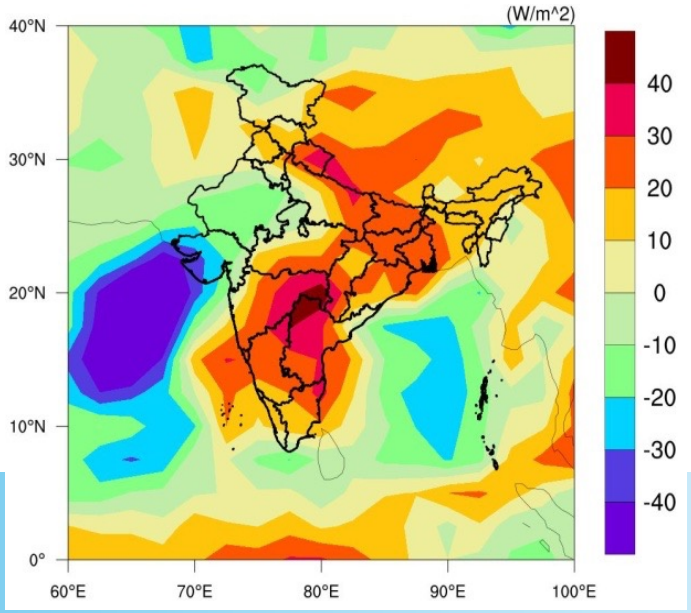
Relative Humidity



Soil moisture

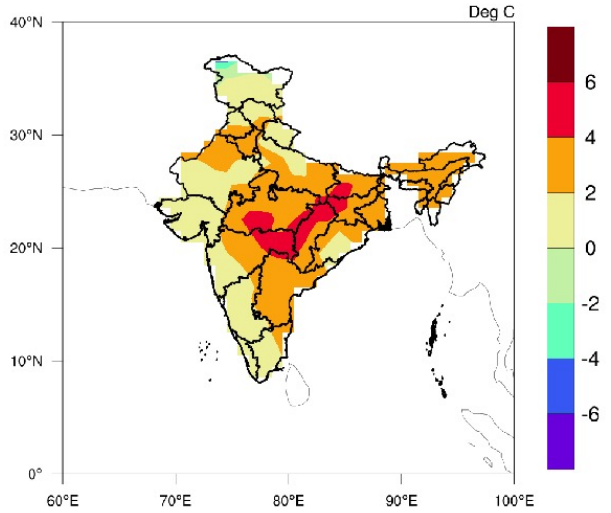


Outgoing long wave radiation



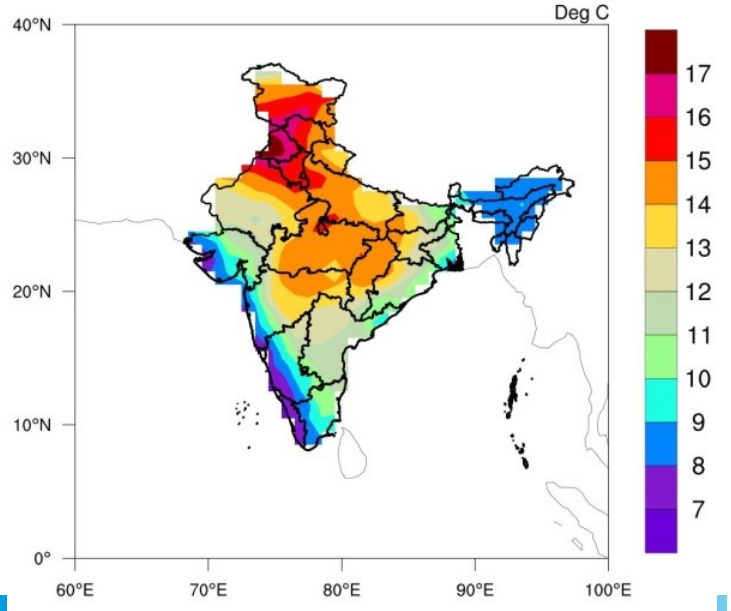
Week 13 (10-16 Jun 2019) associated parameters analysis over India

MaxT

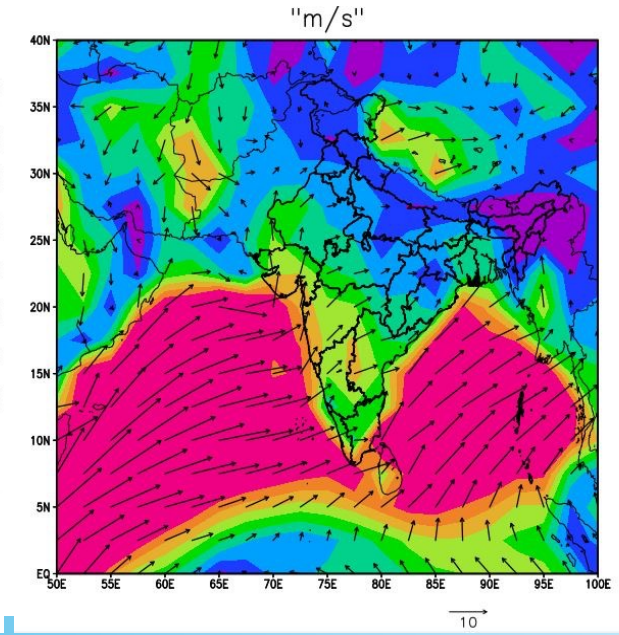


- The low total cloud cover and anomalous anticyclonic flow of wind triggered the HW event over north western (NW) India.
- The downward sinking air forms High pressure zone(HP) over the NW region.
- The total cloud cover is very low which shows the clear sky conditions over NW region.

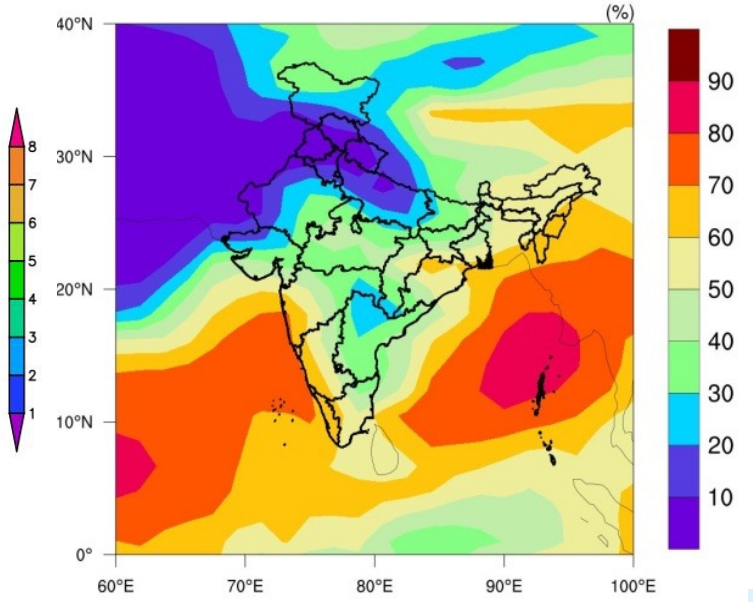
Diurnal Temperature Range



wind



Total cloud cover



Conclusion

- The year 2019 daily maximum temperature during mid May and early June, was above 45 Deg C for plains region & the highest recorded was 50.8 Deg C at Churu, Rajasthan. The observed anomaly was above 4 ^{o}C over the whole country and reached up to 10 ^{o}C in NW part.
- The succeeding HW was observed over India in 2019 and also the longest HW was also observed.
- The observed diurnal temperature range is above 15 ^{o}C over the central Indian region and the extreme high DTR is associated with the cardiovascular disease morbidity.
- The observed rainfall, soil moisture anomaly negative for all the three week which are the favorable condition for the occurrence of HW phenomenon.
- The relative humidity anomaly is positive during all the three weeks in coastal region of India which increases the thermal humidity index and favor thermal discomfort for the living beings.
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- The DTR and total cloud cover are used as the proxy to each other. The low cloud cover indicates the presence of more heat in atmosphere due to the clear skies in daytime .The clear relation of Heat budget reflected on the soil moisture also.
- The observed outgoing long wave represents the cooling of air and the negative anomaly for week 12 and week 13; which shows the more heated air worsens the HW conditions.
- All the associated parameters will be used for model physics and forecasting the temperature extremes which will be helpful for many sectors.

Acknowledgement

- UGC For Fellowship
- CSIR – 4PI for support
- Head, CSIR-4PI for encouragement