Heat Events in the Indian subcontinent under a warming climate scenario: Detection and its drivers

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Introduction

Global temperatures have shown a warming trend over the last century, mainly as a result of anthropogenic activities. Rising temperatures are a potential cause for increase of extreme climate events, such as heat waves, both in severity and frequency.

Heat waves are anomalous episodes, characterized by extremely high surface air temperatures that usually last up to several days and have serious consequences. Over India, the most impacting heat waves occur during the months of March to June and can affect various sectors including health, agriculture, ecosystems and the national economy.

In May 2015, a severe heat wave due to the delayed onset of southwest monsoon affected parts of south-eastern India, which claimed more than 2500 lives.

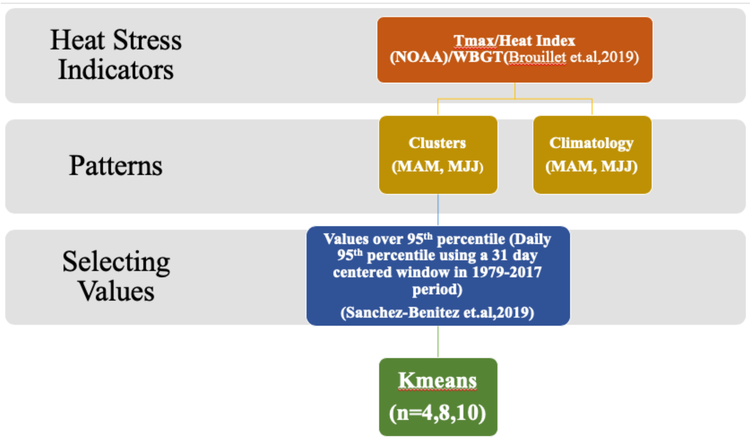
Objectives

1. To identify the heat stress conditions with the help of suitable heat indices for different regions.
2. Understanding the physical mechanisms and drivers behind the onset, duration and severity of heat events.

Data and Methods

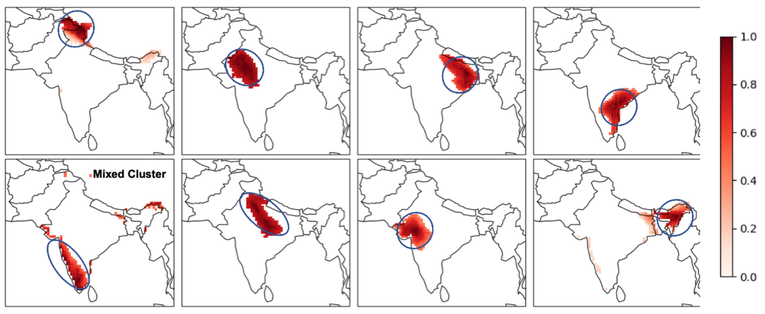
Maximum Temperature at 2 metres (MX2T & Relative Humidity (RH)
from ERA-Interim
1979-2017**, 0.5**degX**0.5**deg
[European Centre for Medium-Range Weather Forecasts]

Methods:



K Means Clustering tries to cluster data into clusters based on their similarity. The optimal number of clusters was ascertained to be **7** using the **Elbow** and **Silhouette** method.
Following are the **Tmax** clusters for **1979-2017**

Normalised Tmax clusters

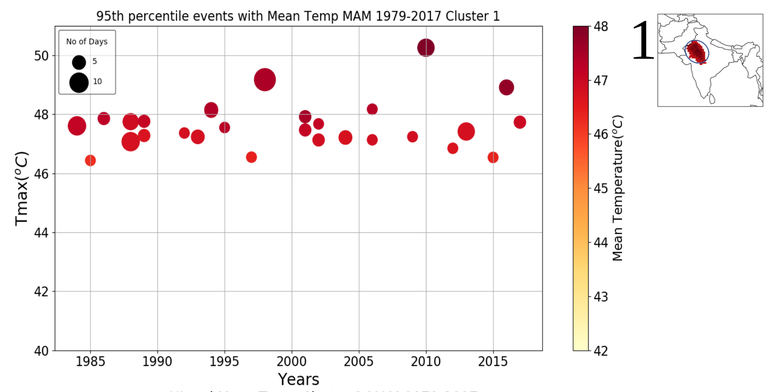


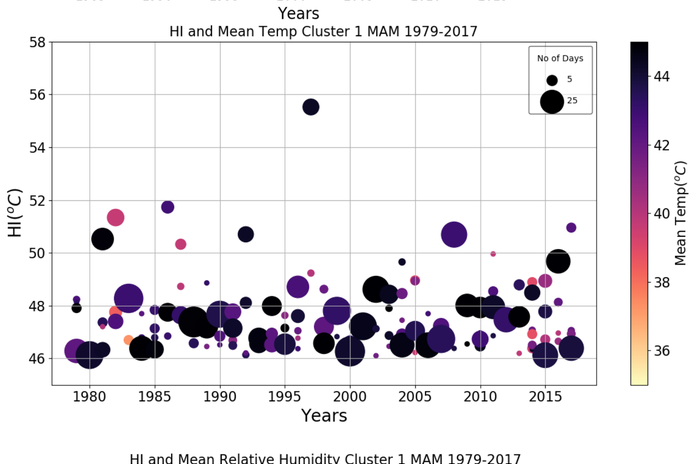
Category 4 days reduce the efficiency of the body's cooling mechanism as it blocks evaporation. Thus, along with temperature anomalies during pre-monsoon, humidity also plays role in transitional period.

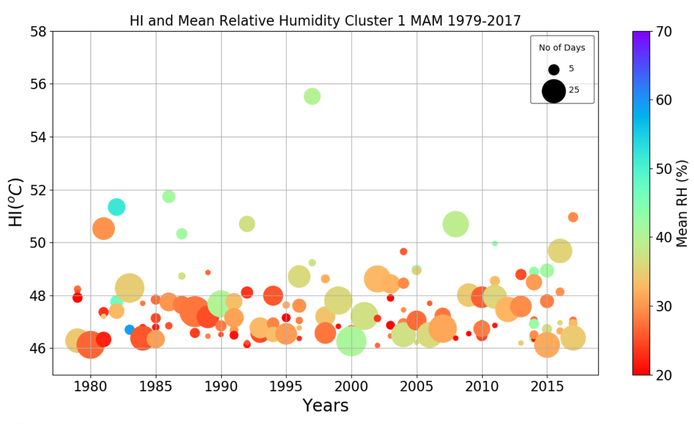
Heat Index	Risk Level	Protective Measures
Less than 91°F	Lower (Caution)	Basic heat safety and planning
91°F to 103°F	Moderate	Implement precautions and heighten awareness
103°F to 115°F	High	Additional precautions to protect workers
Greater than 115°F	Very High to Extreme	Triggers even more aggressive protective measures

Clusters (MAM)

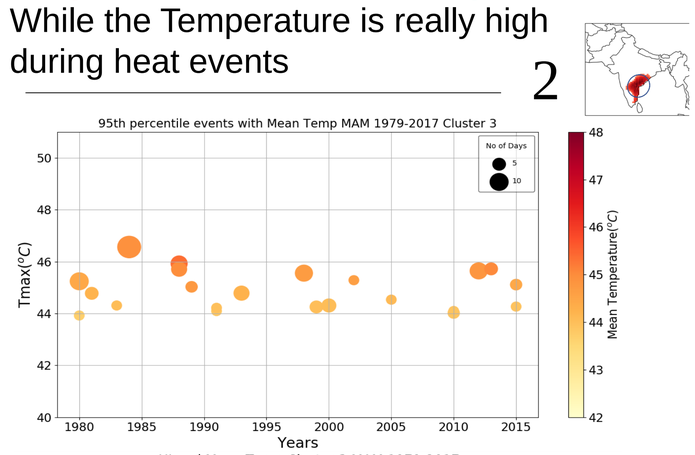
- **2** out of **8** clusters were selected based on **high population density** and differences in index**.**
- **Heat events** selected by taking temperature values exceeding **95th percentile** for **>= 3 days consecutively**
- **HI Category 4** days

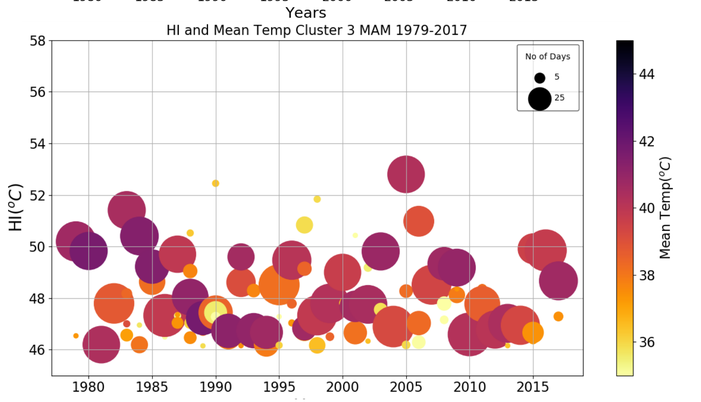


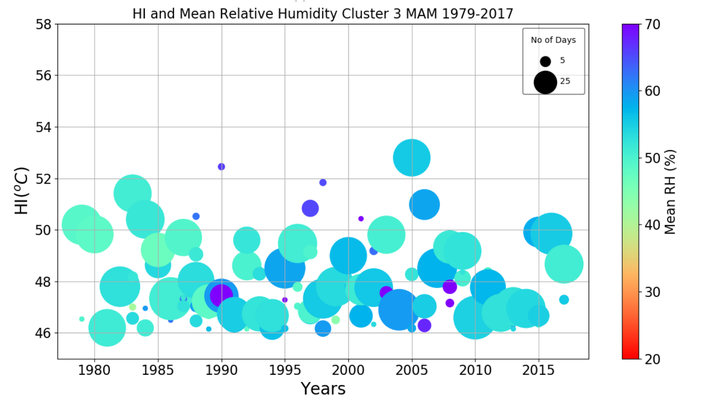




The **HI 4 category** days have **high temperature** and **low humidity**.
While the Temperature is really high during heat events



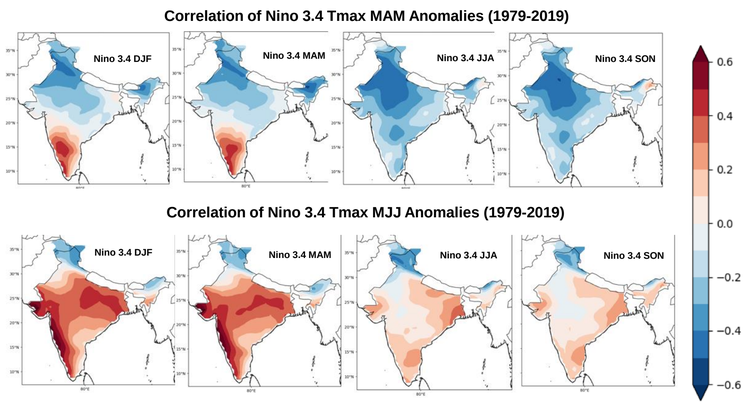




The **discomfort is higher** because of high humidity and temperatures.

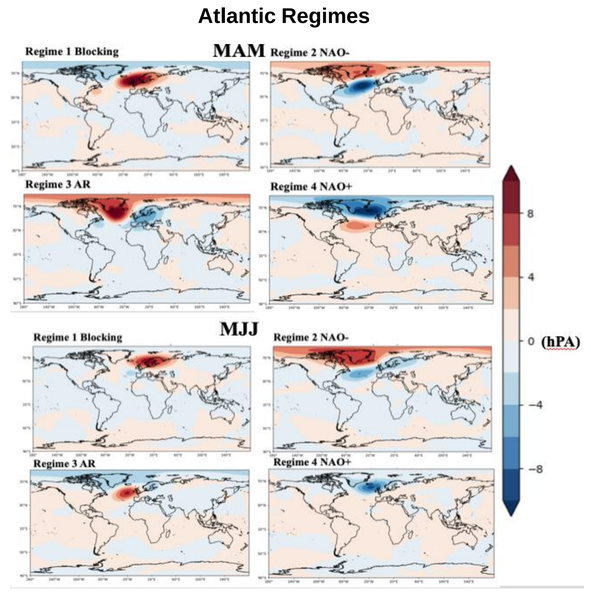
Heat Events and Physical Drivers

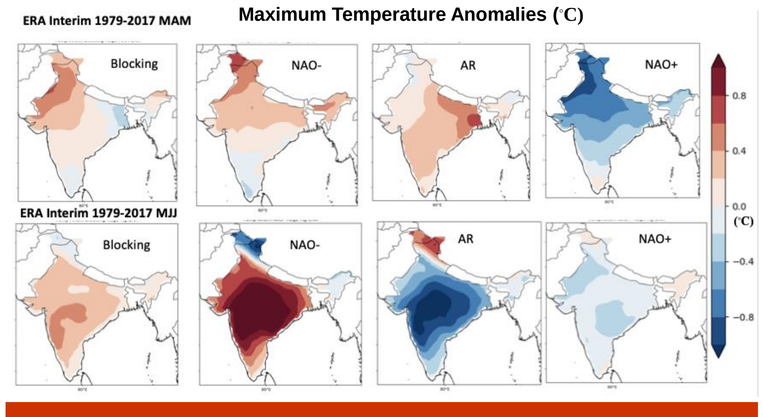
Maximum Temperature anomalies for the season MJJ shows a positive correlation of 0.6 with Nino 3.4 region in east Pacific Ocean. There is a high correlation with central, west and east coast region of India. The east Indian region correlation is in agreement with Ratnam et.al (2016).



Temperature Anomalies and Atlantic Regimes

Maximum Temperature Anomalies with the 4 Atlantic Regimes, Blocking, NAO-,Atlantic Ridge and NAO+ was done. Positive & Negative anomalies are seen in central India for MJJ.





Conclusions

1. The index to identify heat events in India are different for each region in India, since the regions respond differently during the pre-monsoon(MAM) and transitional period (MJJ).
2. Further investigation into the physical drivers of the clusters is needed.

References

1. Ratnam J V, Behera S K, Ratna S B, Rajeevan M and Yamagata T. Anatomy of Indian heat waves Sci. Rep. 6 24395 (2016) .
2. P. Rohini, M. Rajeevan, A. K. Srivastava, On the variability and increasing trends of heat waves over India. Sci. Rep. 6, 26153 (2016).
3. A Sánchez-Benítez et al., Tracking Iberian heatwaves from a new perspective. Weather and Climate Extremes (2019).