

# Disentangling increasing compound extremes at regional scale during Indian Summer Monsoon

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## Abstract

Compound extremes exhibit greater adverse impacts than their univariate counterparts. Studies have reported changes in frequency and the spatial extent of extremes in India; however, investigation of compound extremes is in the infancy state. This study investigates the historical variation of compound dry and hot extremes (CDHE) and compound wet and cold extremes (CWCE) during the Indian summer monsoon period from 1951-2019 using monthly data. Results are analyzed for 10 identified homogeneous regions for India. Our results unraveled that CDHE (CWCE) frequency has increased (decreased) by 1-3 events per decade for the recent period (1977-2019) relative to the base period (1951-1976). Overall, there is increasing (decreasing) pattern of CDHE (CWCE) is high across North-central India, Western India, North-eastern India and South-eastern coastlines. Our findings help in identification of the parts of the country were affected by frequent and widespread CDHE during the recent period, which is alarming. More detailed assessments are required to disentangle the complex physical process of compound extremes to improve risk management options.



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Co-PRoPARE

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## Background and Motivation

- ISM precipitation is crucial for agricultural activities... India has witnessed compound dry and hot summers that occurred during 1957, 1972, 1979, 2002, 2009 and 2014, causing a significant crop yield reduction<sup>1</sup>.
- Widespread increase in compound extremes is likely to pose a substantial challenge to the future food security of billions of people....
- Present study disentangle different types of compound extremes and identify climate change hotspots.

## Methodology

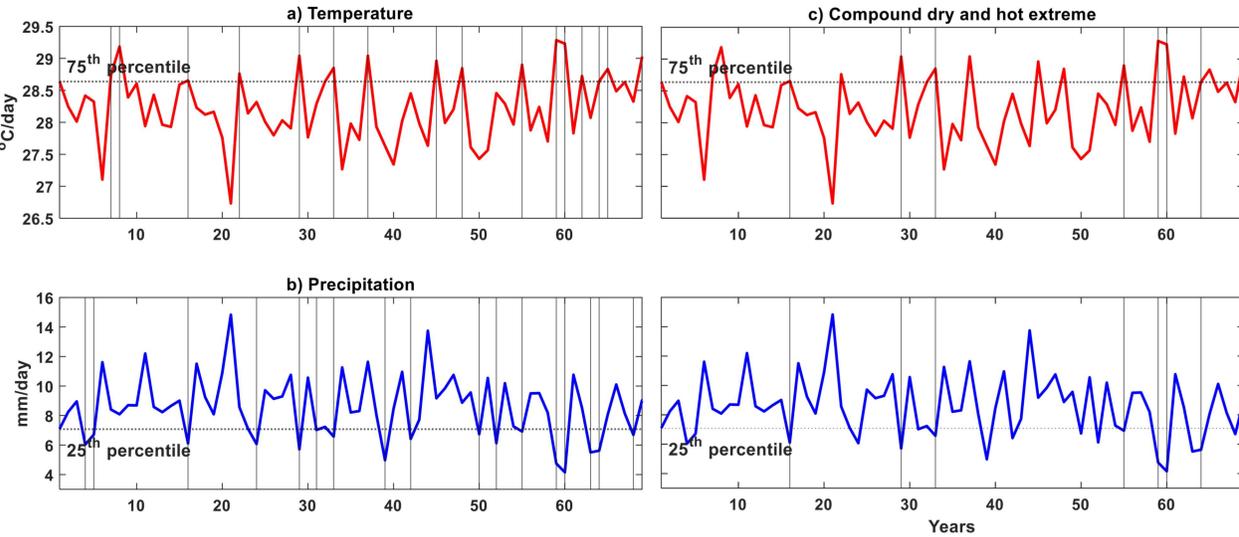
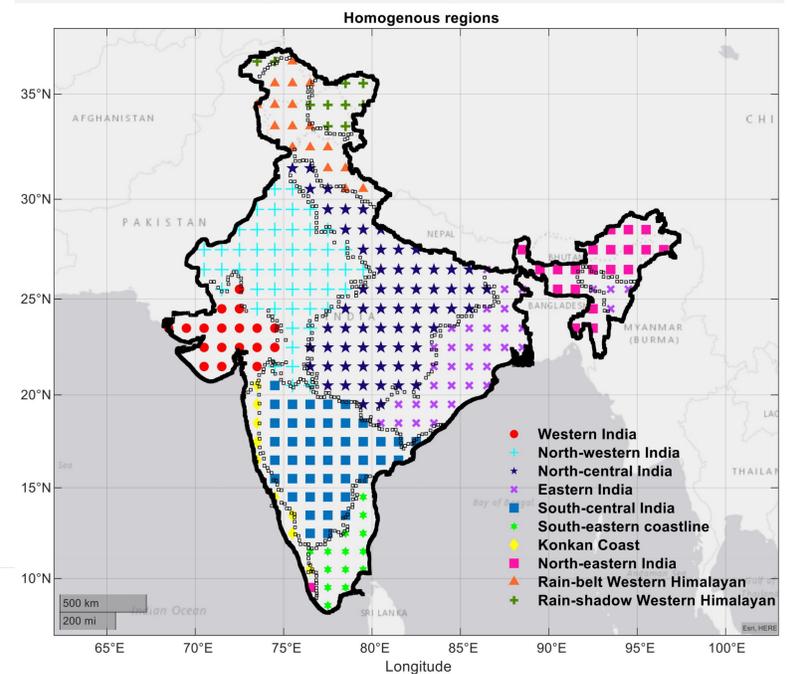
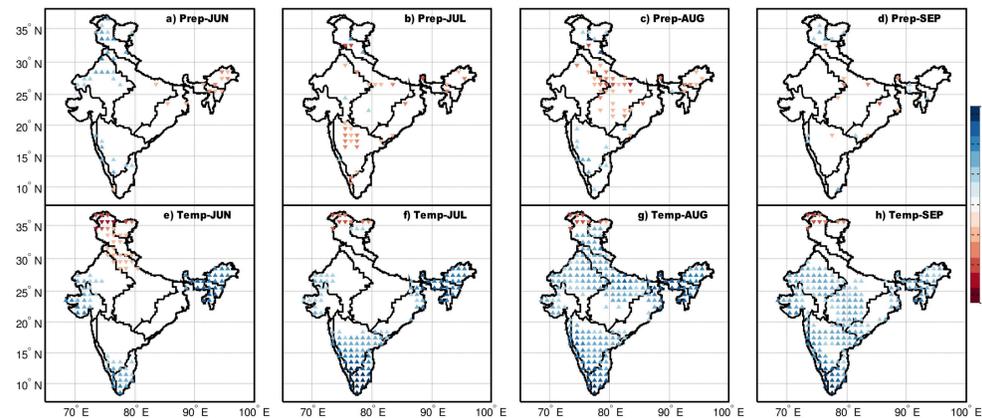


Illustration of a typical compound dry and hot extreme (c) and its comparison with univariate events (a) Temperature >75th percentile and (b) Precipitation <25th percentile. The vertical and horizontal lines are shown to visualize an event and the threshold used to define the event)

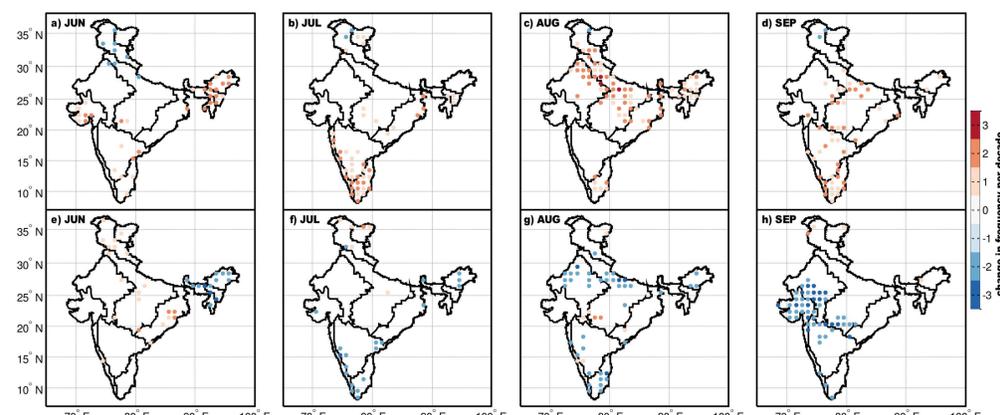
## Homogenous regions of India



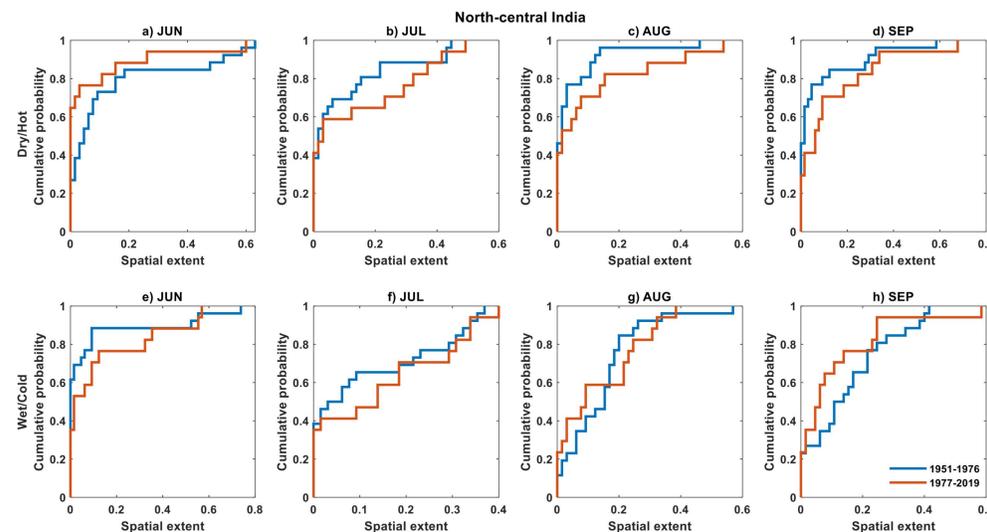
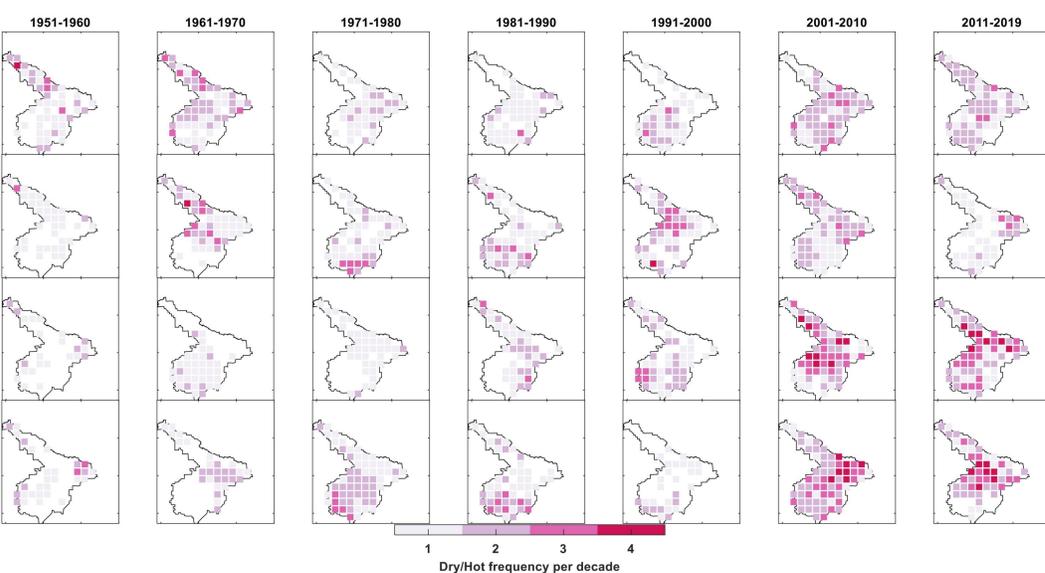
## Changing pattern of precipitation and temperature



## Changes in the frequency of compound extremes



## Changes in the spatial extent of compound extremes



## Conclusions

- Study finds a widespread three-fold rise in compound dry and hot summer monsoon extremes during the past decades over India.
- This increasing pattern of CDHE is high across North-central India, Western India, North-eastern India and South-eastern coastlines.

## Remarks

Know more....



<sup>1</sup> R.K. Guntu, and A. Agarwal, Scientific reports, 11, 16447 (2021).