

# Recent Increase in Occurrence of Localised Monsoon Droughts in the Indo-Gangetic Plains

[Sarat Chandra Chamarthi<sup>1</sup> \(csarat48@gmail.com\)](mailto:csarat48@gmail.com) Venugopal Vuruputur<sup>2,3</sup> Sekhar Muddu<sup>1,4</sup>

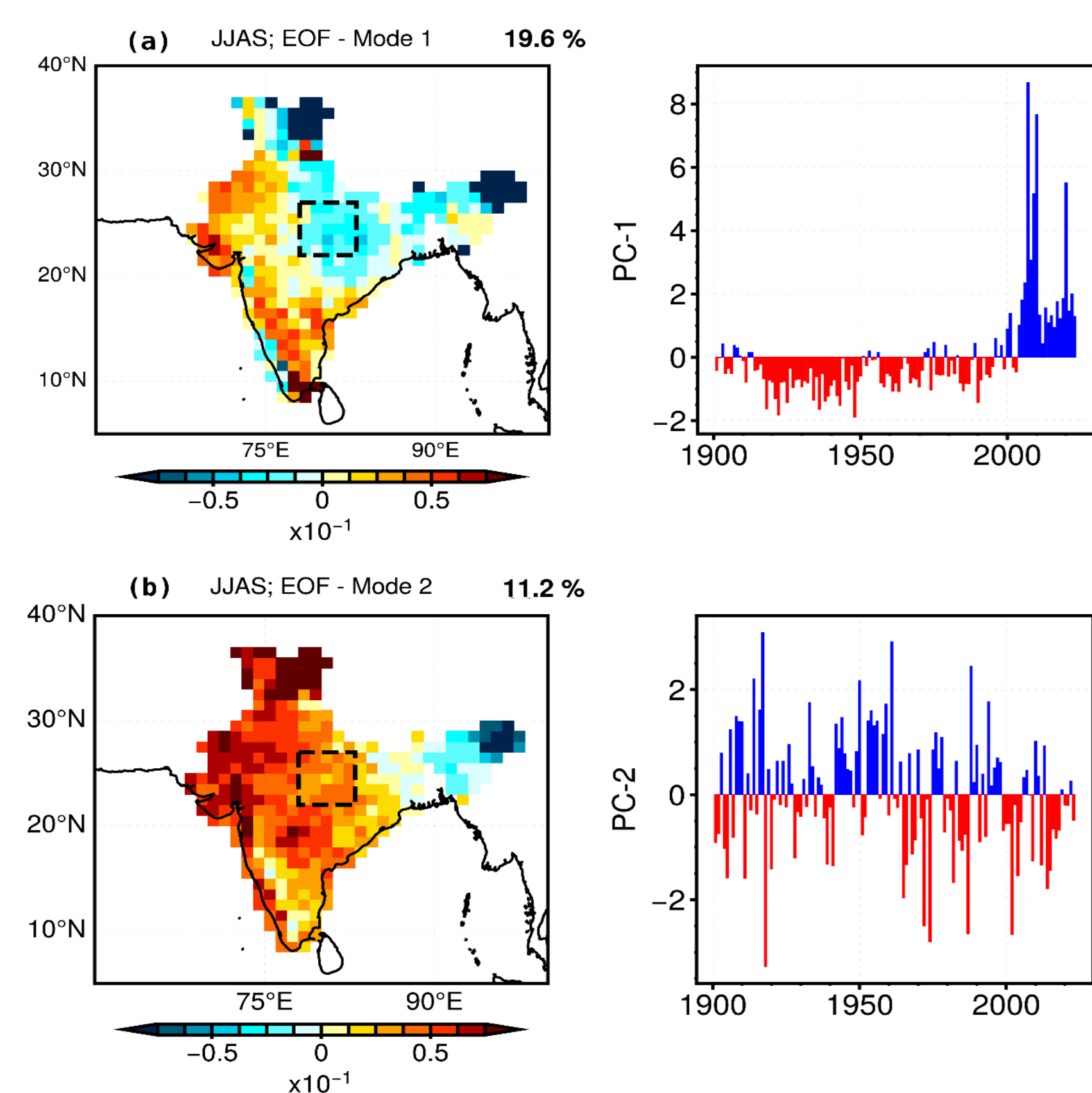
<sup>1</sup> Interdisciplinary Centre for Water Research <sup>2</sup> Centre for Atmospheric & Oceanic Sciences <sup>3</sup> Divecha Centre for Climate Change <sup>4</sup> Department of Civil Engineering Indian Institute of Science, Bengaluru, India

## Introduction

→ The Indian Summer Monsoon Rainfall (ISMR), from June to September (JJAS), has shown a decline over Indo-Gangetic Plains (IGP) in recent years.

→ During this period, Western India (WI) received excess ISMR, leading to a dipole pattern of ISMR.

→ Subseasonal evolution of ISMR dipole is yet to be explored.



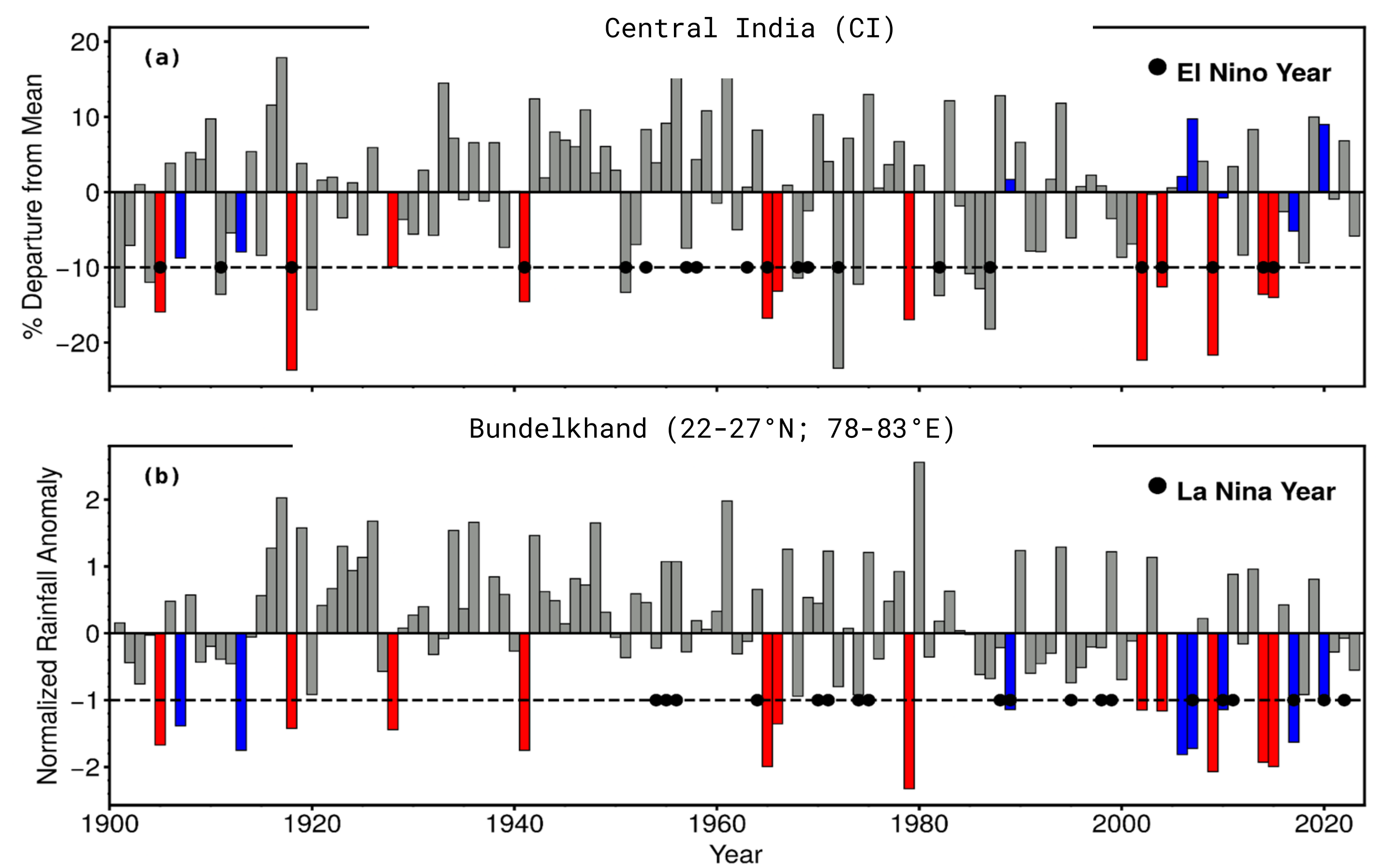
**Figure 1**  
Maps of Empirical Orthogonal Functions (EOF) and their corresponding Principal Component (PC) time series computed for interannual JJAS rainfall during 1901-2023. The first and second EOFs explain 19.6 % and 11.2 % of the total variance of interannual ISMR. The region inside the dashed rectangle is Bundelkhand. Data : IMD (1901-2023)

**Figure 2:**

**Type-1 Drought :** ISMR Drought in both Central India and Bundelkhand.

**Type-2 Drought :** ISMR Drought in Bundelkhand but not in Central India.

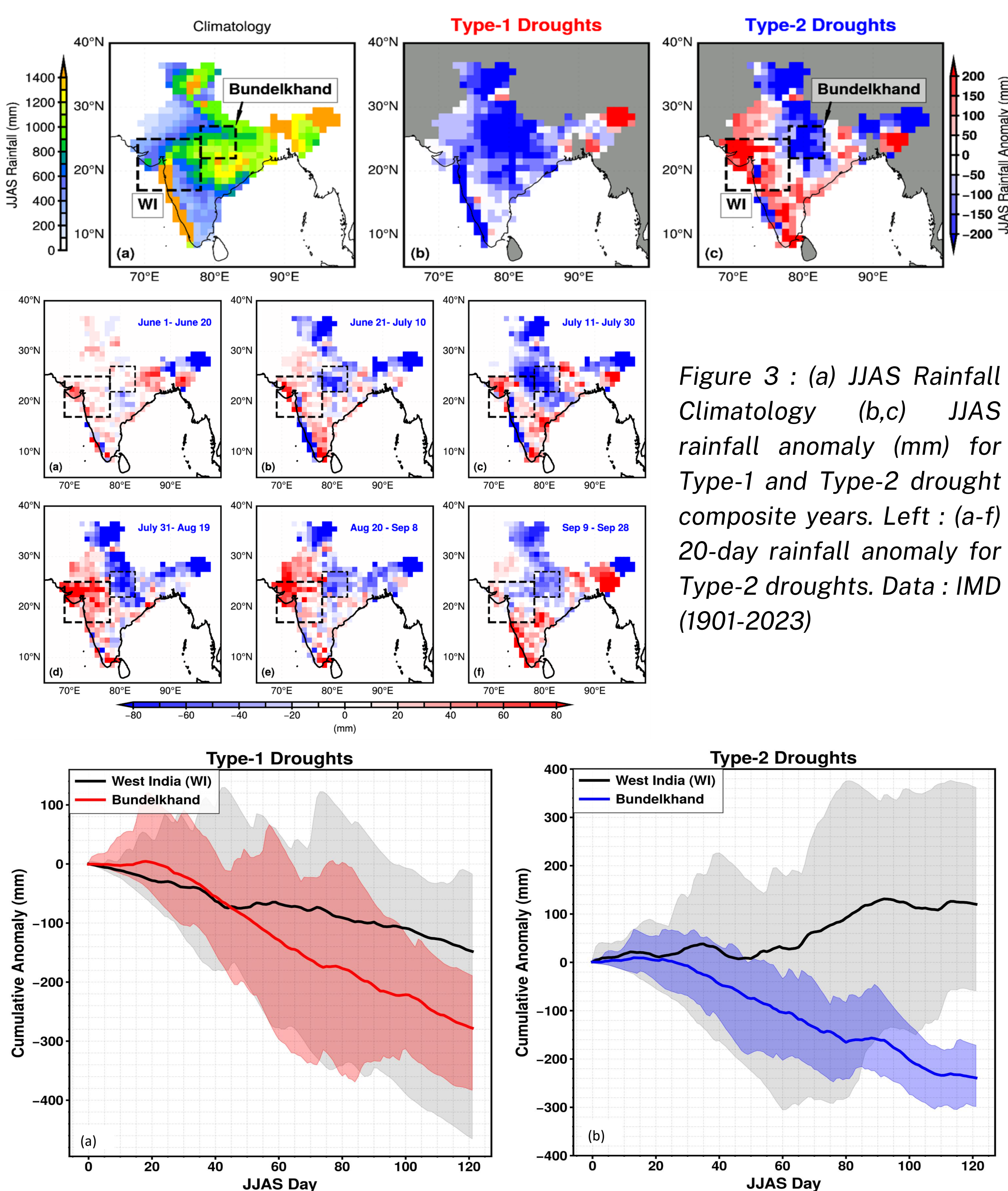
Frequent occurrence of Type-2 droughts in the past two decades



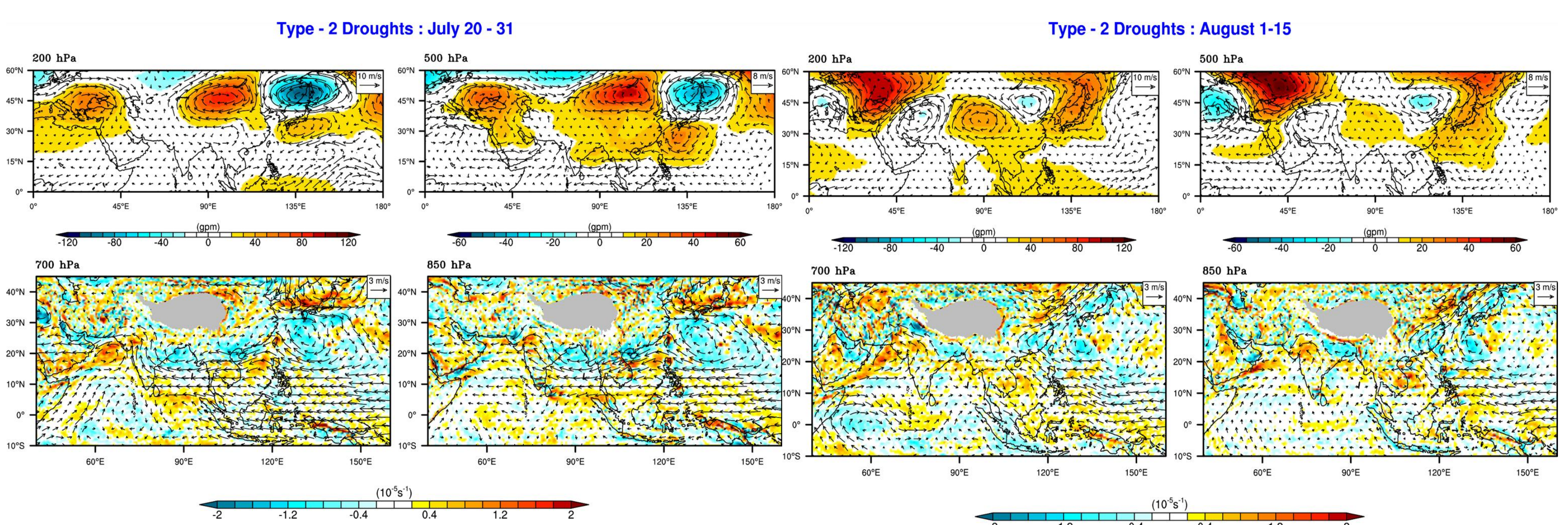
→ The region of deficit in the ISMR dipole is concentrated in the **Bundelkhand** region within IGP (Figure 1).

→ To understand the localised ISMR deficit, we categorise the droughts in this region as **Type-1** and **Type-2**.

## Results



**Figure 3 :** (a) JJAS Rainfall Climatology (b,c) JJAS rainfall anomaly (mm) for Type-1 and Type-2 drought composite years. Left : (a-f) 20-day rainfall anomaly for Type-2 droughts. Data : IMD (1901-2023)



**Figure 5 :** Geopotential Height (GPH; gpm) anomaly and Wind anomaly at 200 and 500 hPa level. Relative vorticity anomaly ( $10^{-5}s^{-1}$ ) and wind anomaly at 700 and 850 hPa levels. Only the five most recent Type-2 drought years were included in the composites. The shaded region in grey denotes the Tibetan Plateau. Data : ERA5 1970-2022

## Summary

- Two types of ISMR droughts ( **Type-1** & **Type-2** ) are identified in the IGP region.
- Frequent occurrence of **Type-2** droughts since 2000.
- Contrasting evolution of subseasonal rainfall in **Type-2** droughts results in a dipole pattern.
- **Type-2** Droughts: Lower-level anticyclones modulated by the upper-level Rossby jet result in a zonal asymmetry in convergence over WI and IGP.
- A Potential case for a "negative feedback loop": decreasing rainfall decreased Soil moisture and Evaporation decreased atmospheric moisture, further reducing rainfall in IGP.