Decadal variability of Monsoon Core Zone rainfall

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Introduction

❖The fluctuations at timescale ranging from one to few decades are referred to as decadal variability (Han et al., 2014).

❖Studies have shown that the Indian summer monsoon rainfall (ISMR) exhibits decadal variability with alternate epochs of above-normal and below-normal rainfall (Kripalani and Kulkarni 1997; Kripalani et al., 1997; Mehta and Lau, 1997; Krishnamurthy and Goswami 2000).

❖Kripalani and Kulkarni (1997) suggested that the impact of El Niño (La Niña) is far more severe during the below-normal (above-normal) rainfall epochs. Moreover, Krishnamurthy and Goswami (2000) suggested that the decadal ENSO variability modulates the inter-annual ENSO-monsoon relation.

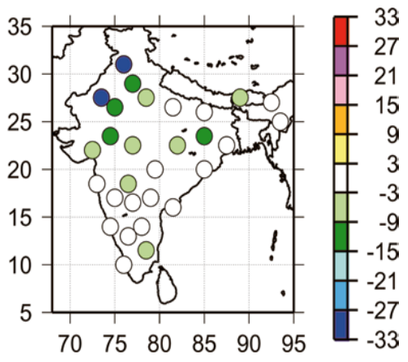

Fig. : The Warm Minus Cold (phases of PDO) decadal composite of low-pass filtered summer monsoon rainfall over 29 sub-divisions of India, expressed as percentage departure from normal, are shown by circles located within each sub-division.

❖Krishnan and Sugi (2003) reported inverse relationship between PDO and ISMR.

❖Using long observed Indian rainfall data and coupled model simulations, Krishnamurthy and Krishnamurthy (2013) suggested that the PDO influences the variability of monsoon rainfall and ENSO-monsoon relation.

❖However, comprehensive picture and mechanisms of the spatio-temporal variability of the ISMR on decadal time scale is yet to be clearly understood.

Objectives

To study the decadal variability of Monsoon Core Zone rainfall and its association with sea surface temperature variability

Data & Methodology

➢ **Observation Data**

SST: ERSSTv5 (1854–2020, 2°×2°) - (Smith and Reynolds, 2003)

Precipitation: UDEL; 1900–2014 , 0.5°x0.5°

GPCC version 2018; 1900–2016, 0.5°x0.5°

IMD; 1900–Present, 0.25°x0.25° – (Pai et al., 2014)

Techniques: Spectrum, wavelet analysis, Band pass filter, EOF, Correlation and composite analysis

Results & Discussion

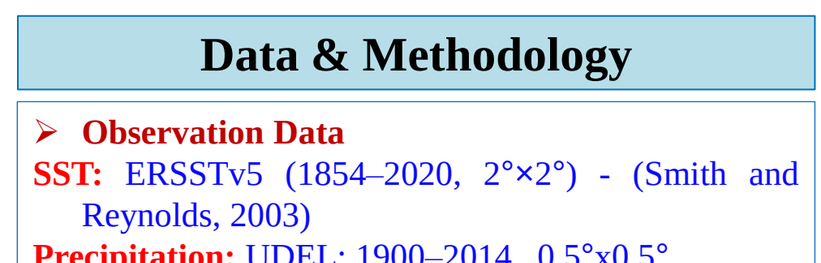

Fig. : Spatial distribution decadal variability of summer monsoon rainfall over India. The standard deviation of 7-20 years bandpass ltered summer monsoon rainfall (mm/day) from **a** GPCC, **b** UDEL and **c** IMD. The selected area in **c** using dashed lines representing the domain considered for MCZ rainfall index.

✓Bandpass filtered rainfall shows decadal variability strength is maximum over WG and MCZ.

Results & Discussion

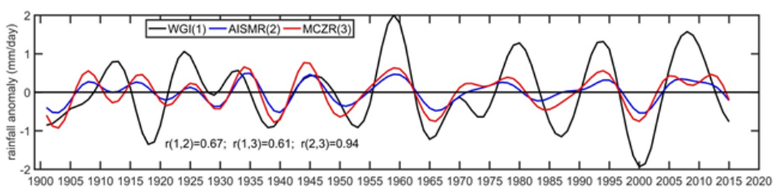

Fig. : Band pass filtered summer monsoon rainfall anomaly averaged over different regions

➢ The filtered WGI is correlating 0.67 and 0.61 with filtered AISMR and filtered MCZR respectively suggests WGI variability is coherent only about 50% with AISMR variability.

➢ AISMR and MCZR displayed high coherence between them.

This motivated us to study the WG (Halder et al., 2022) and MCZ rainfall decadal variability separately

Temporal evolution of rainfall variability over MCZ.

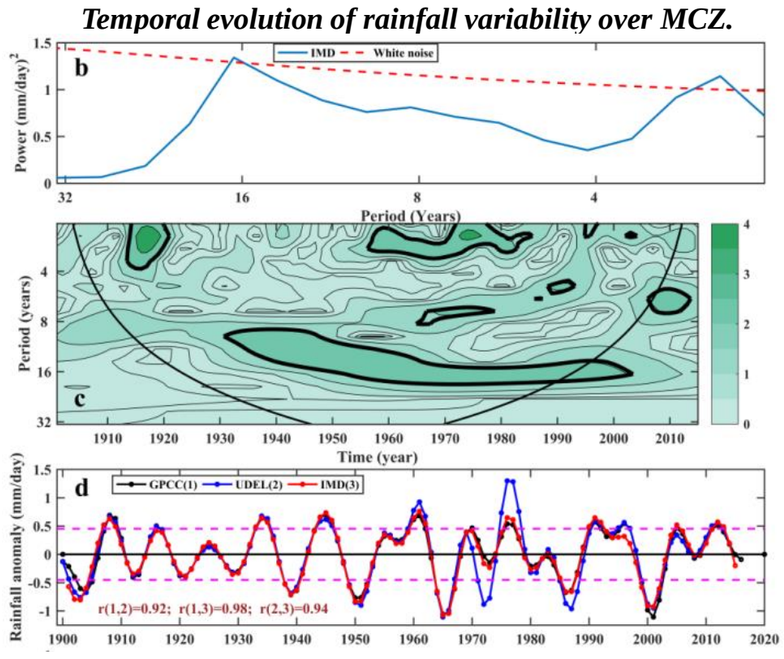

Fig. : power spectrum, wavelet and bandpass filtered summer monsoon rainfall anomaly (mm/day) of MCZ from IMD

➢ MCZI from GPCC, UDEL, and IMD datasets displayed high coherence with each other confirms the robustness of the MCZ rainfall variability.

✓spectrum and wavelet analysis is the basis to apply 7-20 years bandpass filtered to MCZI from GPCC, UDEL, and IMD data sets for extracting decadal and multidecadal signal

➢ decadal variability strength is high from 1930–2005 compared to the earlier period.

Relation of MCZ rainfall variability with dominant SST indices

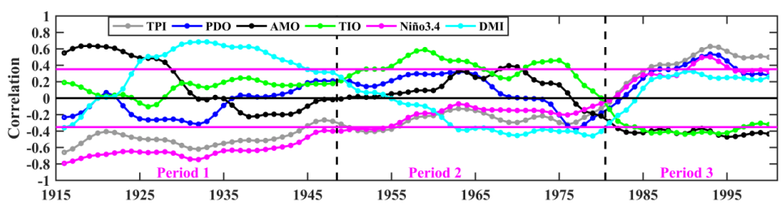

Fig. : 31 years running correlation of filtered WGI with different filtered SST indices. Magenta line represents the 90% confidence level for correlation.

✓The analysis indicates that the MCZ rainfall decadal variability displays changes in the temporal correlation with the dominant SST modes.

✓MCZ rainfall variability during 3 different periods are studied, which are as follows: period 1 (1901-1948), period 2 (1949-1980), and period 3 (1981-2010).

Results & Discussion

Teleconnection of MCZ rainfall variability to Indo-Pacific SST

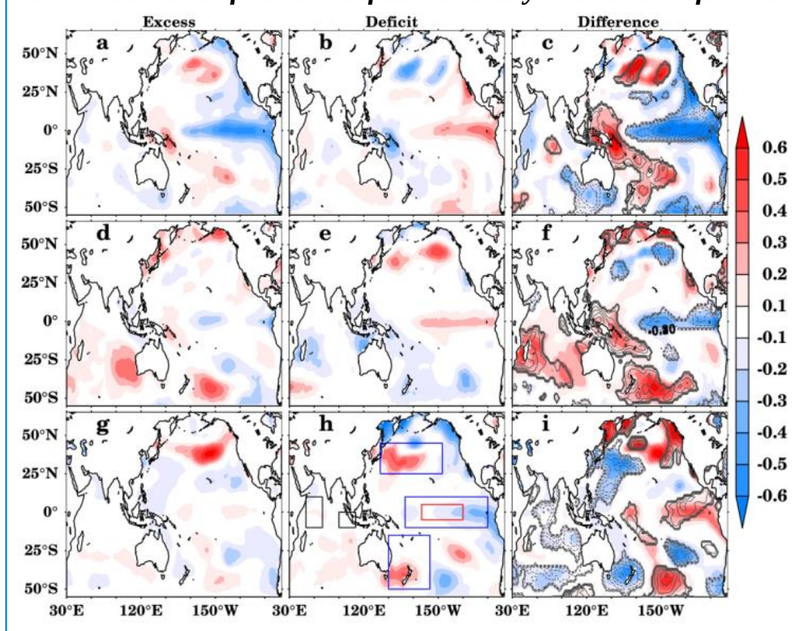

Fig. : Composite of summer mean SSTA (°C) from ERSSTv5 for **a** excess, **b** decit rainfall years and **c** dierence (**a – b**) for period 1 (1901 – 1948). **d, e and f** same as **a, b and c** but for period 2 (1949 – 1980). **g, h and i** same as **a, b and c** but for period 3 (1981 – 2010). Contours in panels **c, f, and i** showing the correlation of filtered MCZI with filtered SST at 90% confidence upon student t-test.

✓Interdecadal Pacific Oscillation, Niño3.4 region SST (DMI) variability displayed a significant negative (positive) correlation during period 1.

✓During period 2, Topical Indian Ocean shows positive correlation.

✓During peeriod 3, IPO, Pacific Decadal Oscillation (PDO) and Niño3.4 SST variability display positive and Tropical Indian Ocean (TIO) basin-wide SST, Atlantic Multi-decadal Oscillation (AMO) displays negative significant correlation with MCZ rainfall variability.

Summary/Conclusion

- **Filtered rainfall variability displayed maximum strength over the monsoon core zone (MCZ) after the Western Ghats (WG).**
- **Decadal variability of rainfall displayed amplification during the recent period over MCZ (1930–2005) compared to the earlier period.**
- **Decadal variability in rainfall over the MCZ displays time varying relationship (correlation) with the dominant SST modes.**
- **Dynamical and thermodynamical processes to be studied for MCZ rainfall decadal variability.**

Acknowledgements & References

Acknowledgements

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References

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