Recent trends in root-zone soil moisture over India using the GLEAM data for the period 1980-2020

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Outlines of the Presentation

1. Introduction
2. Global Land Evaporation Amsterdam Model (GLEAM) data set
3. Root zone soil moisture (RZSM) spatial variability
    I. Annual
    II. Seasonal (pre-monsoon, monsoon and post-monsoon)
4. RZSM Inter Annual Variability (IAV) anomalies
5. RZSM seasonal trends over IMD (India Meteorological Department) sub-divisions
6. Conclusion and future scope
7. References

Introduction

- Soil Moisture (SM) is a major parameter for estimating infiltration, evaporation and runoff also plays a key role in the exchange of energy, water and carbon b/w land surface-atmosphere
- Root Zone Soil Moisture (RZSM) also a key factor in land-atmospheric interactions, terrestrial evaporation and vegetation health
- Satellite-based remote sensing SM (SSM) estimates only near surface SM (0-5 cm)
- RZSM directs transpiration; it is a larger contribution to total land ET
- RZSM strongly correlates with near surface SM, that's why RZSM has been estimated from different satellite surface SM retrievals also validation of results are satisfactory
- Need to understanding the spatiotemporal trends and variability patterns of RZSM are essential for observing the anthropogenic and climate change effects on the regional and global hydrological cycles.
- Due to very sparse in-situ observations of RZSM over the globe, present study utilized GLEAM (Global Land Evaporation Amsterdam Model) RZSM product over India during the period 1980-2020

GLEAM data description

- ✓ Set of algorithms to estimate the different components of land evaporation along with surface and root zone sm at 0.25° × 0.25° spatial resolution and monthly time scale
- ✓ Since its development in 2011, GLEAM has been continuously revised and updated. In 2017, a third version of the model (GLEAM v3) was published.
- ✓ The GLEAM v3 developed with the help of new data assimilation scheme, updated water balance module and evaporative stress functions and having two data sets v3.5a and v3.5b with 10 products (Actual Evaporation, Soil Evaporation, Interception Loss, Potential Evaporation, Snow Sublimation, Transpiration, Open-water Evaporation, Evaporative Stress, Root-zone Soil Moisture, Surface Soil Moisture)
- ✓ These two datasets differ only in their forcing and temporal coverage:

  GLEAM v3.5a: a global dataset spanning the 41-year period from 1980 (January 1st) to 2020 (December 31st). The dataset is based on satellite and reanalysis data (ERA5 net radiation and air temperature).

  GLEAM v3.5b: a global dataset spanning the 18-year period from 2003 (January 1st) to 2020 (July 31st). The dataset is based on satellite data.

- ❖ Present study utilizing the GLEAM v3.5a: Root-zone soil moisture monthly (25km resolution) data set over the period 1980 to 2020

Reference: https://www.gleam.eu/

Annual RZSM spatial variability

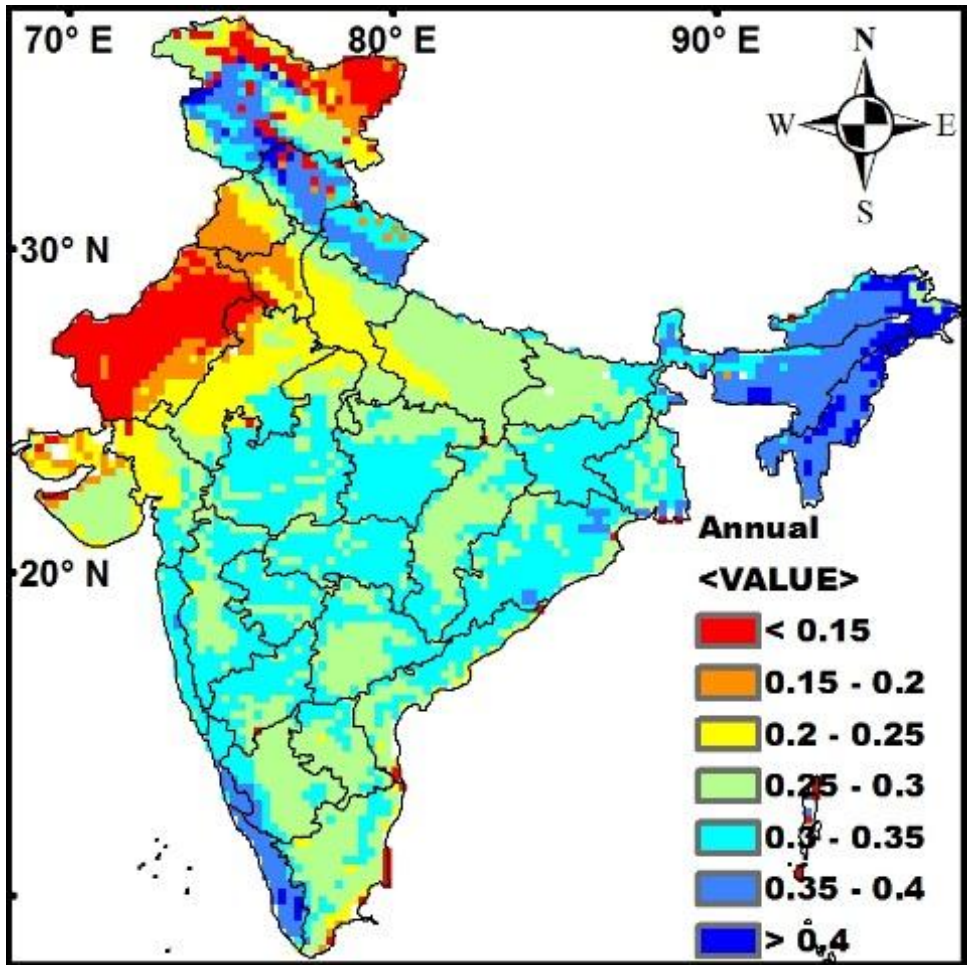

Figure: Annual RZSM climatology over India during the period 1980 to 2020

	Average	Std. dev	Trend	Sens slope
Annual	0.2854	0.0076	increasing	0.00035

Table: All India annual RZSM (area averaged) values

- Highest values (>0.35 m^3/m^3) are found over dense vegetation regions (Western-Ghats, North-East India, and foothills of Himalayas) and low values (<0.2 m^3/m^3) are found in arid and semi-arid regions of North-West India.
- The all India annual mean RZSM (area averaged) is 0.285 m^3/m^3 with the standard deviation of 0.0076 m^3/m^3 and showing a significant increasing trend ($p<0.05$) during the period 1980-2020.

Seasonal RZSM spatial variability

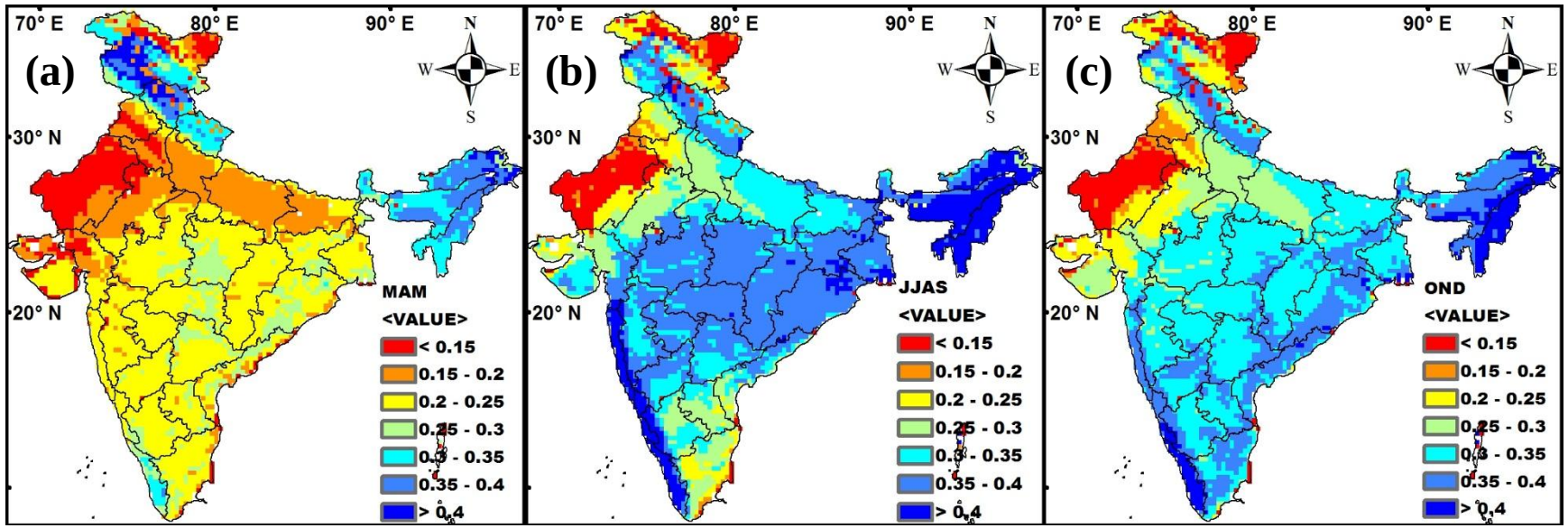

Figure: Seasonal (a) pre-monsoon (b) monsoon (c) post-monsoon RZSM climatology over different meteorological subdivisions in India for the period 1980-2020

	Average	Std deviation	Trend	Sens slope
Pre-Monsoon	0.2273	0.0067	increasing	0.00028
Monsoon	0.3285	0.0110	increasing	0.00031
Post-Monsoon	0.3085	0.0133	increasing	0.00039

Table: All India different seasonal RZSM (area averaged) values

- ✓ If we observe the seasonal variability, the highest RZSM during the southwest monsoon (June-September) season and low values in the pre-monsoon season (March-May) for most of the sub-divisions classified by the India Meteorological Department.
- ✓ The seasonal all India mean RZSM values are 0.23 m^3/m^3, 0.33 m^3/m^3, 0.31 m^3/m^3 during pre-monsoon, monsoon, and post-monsoon seasons respectively

Inter Annual Variability Anomalies of annual and seasonal RZSM

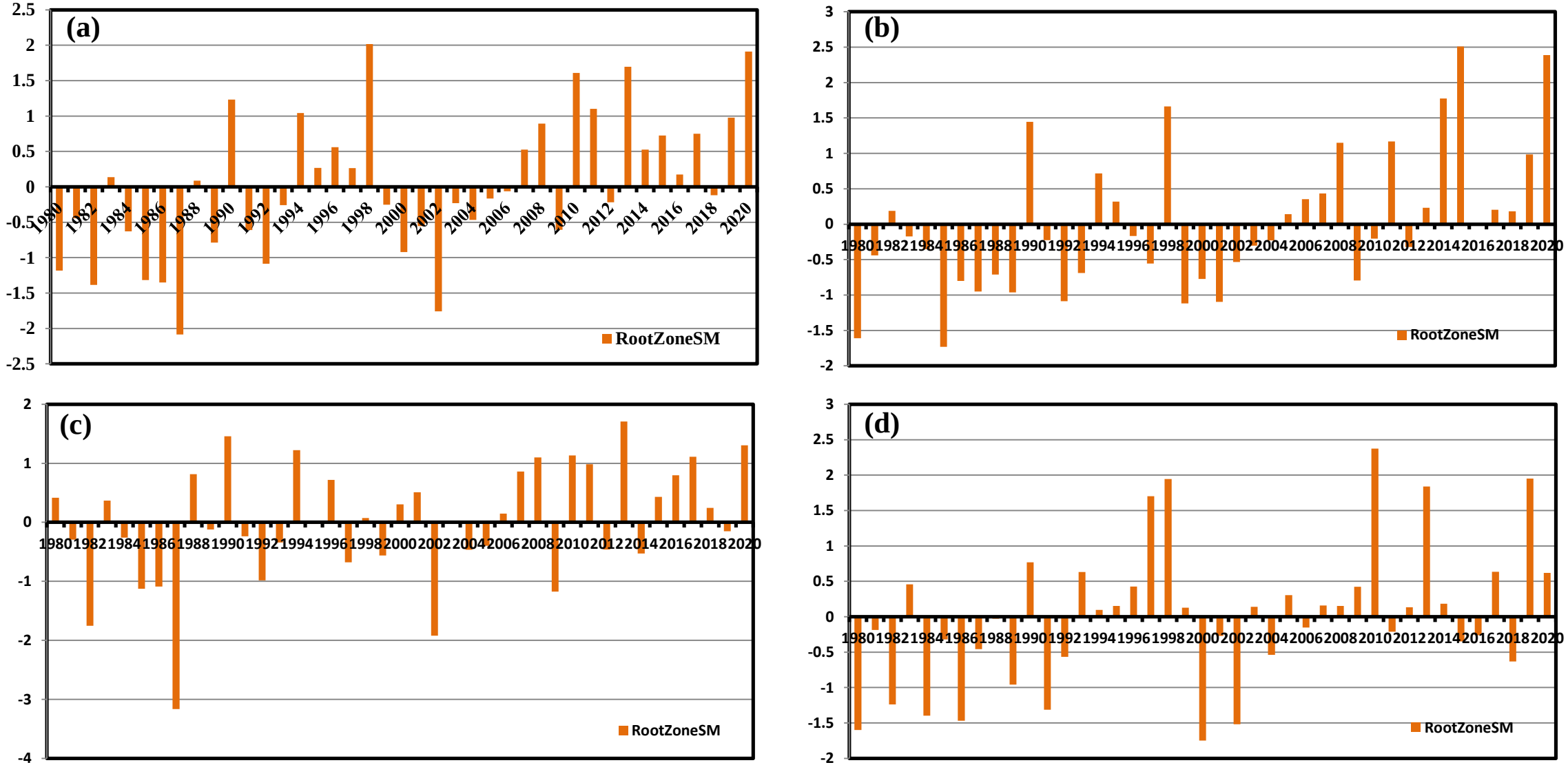

Figure: Inter Annual Variability anomalies of RZSM ((a) Annual (b) Pre-monsoon (c) Monsoon (d) Post-monsoon) over India during the period 1980 to 2020

RZSM seasonal trends

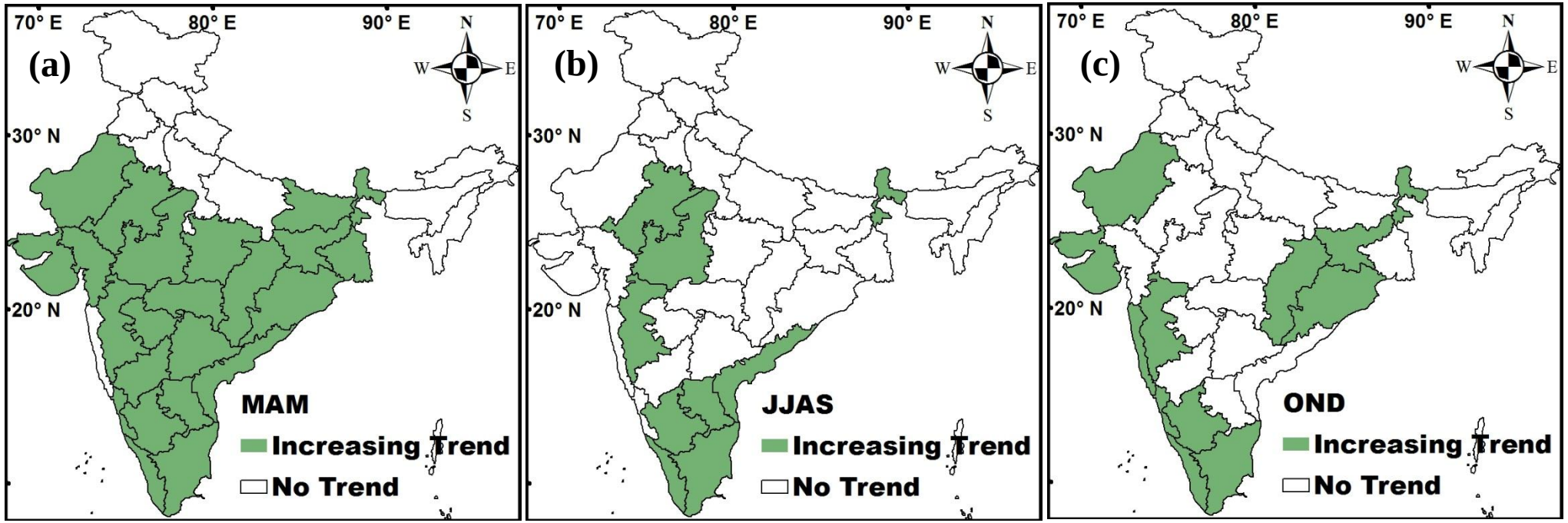

Figure: Seasonal (a) pre-monsoon (b) monsoon (c) post-monsoon RZSM trends over different meteorological subdivisions in India for the period 1980-2020

- ✓ Significant increasing trend in all seasons during the study period.
- ✓ The sub-division wise trend (Mann-Kendall test) analysis shows that the pre-monsoon RZSM showed a tremendous increasing trend in most (23 out of 34) of the sub-divisions (except north and northeast India) whereas in monsoon and post-monsoon season only 9 and 12 sub-divisions showed an increasing trend in India respectively.

Conclusion and Future Scope

Conclusion:

- ✓ The present study improves our understanding of the regional scale hydrological cycle and the importance of realistic representation of irrigation and land use land cover changes in climate models for better prediction of monsoon and other natural disasters in India.

Future Scope:

- ❖ The trends of RZSM are comparable to the trends of precipitation (P), skin temperature (Tskin), and actual evapotranspiration (AET) to investigate how they influence the RZSM trends over each subdivision wise of India.

Thank You!!

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