Soil moisture and land-atmosphere feedbacks

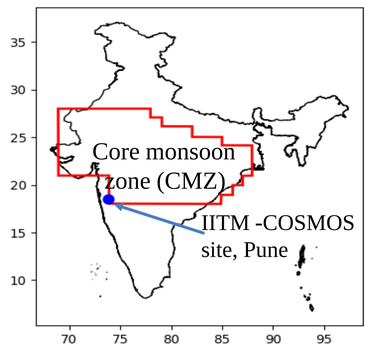
Mangesh Goswami[1], Bhupendra Bahadur Singh[1], Manish Ranalkar[2], Naresh Ganeshi[1], Madhusudan Ingale[1], Joel Sarode[1], Milind Mujumdar[1]

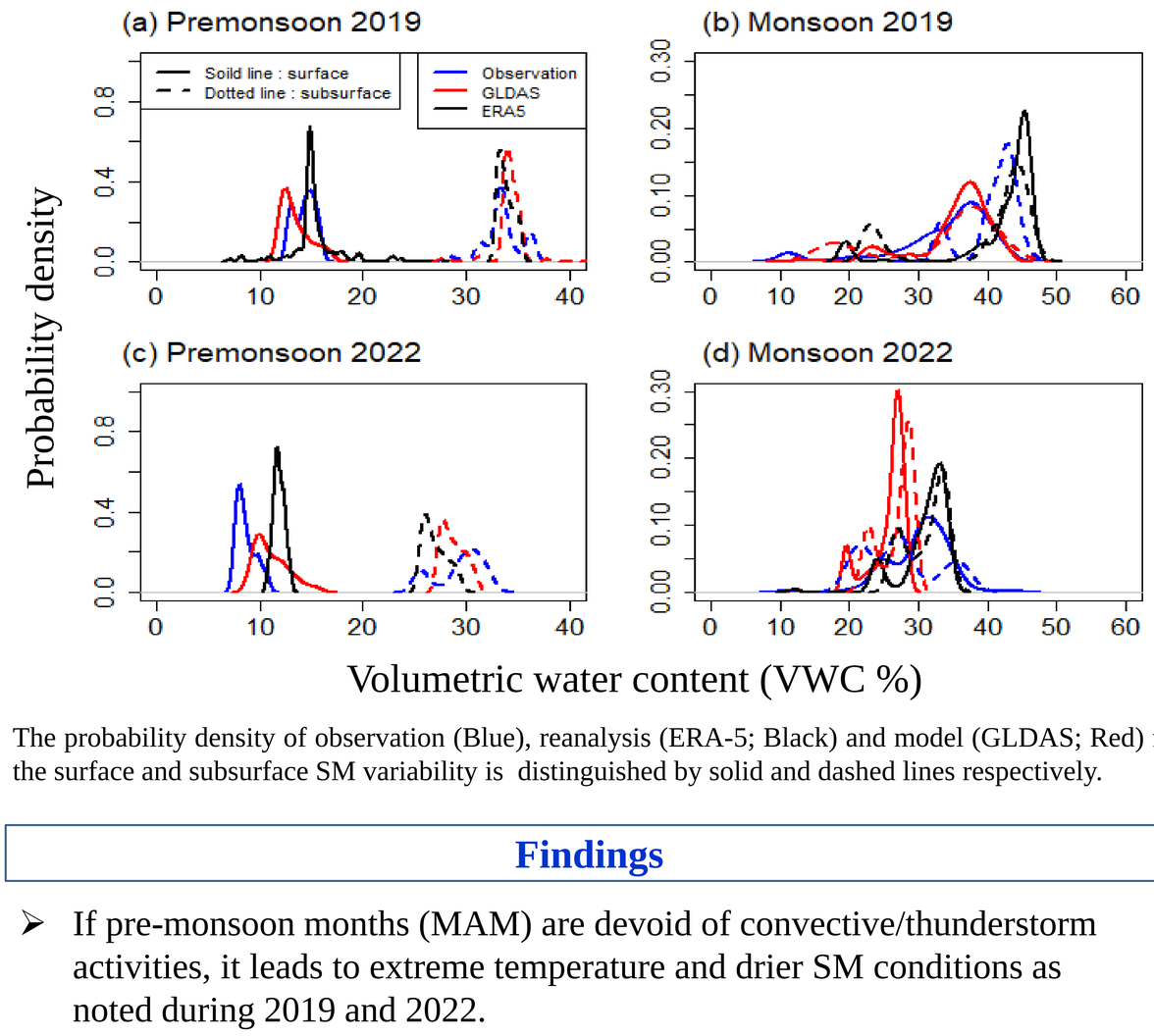
[1]Centre for Climate Change Research, Indian Institute of Tropical Meteorology, Pune, [2]India Meteorological Department, Pune

Examining surface and subsurface soil moisture variability over COSMOS-IITM site

Objective

- To understand surface and subsurface soil water dynamics for the recent cases of contrasting dry and wet conditions during the year 2019 and 2022.





The probability density of observation (Blue), reanalysis (ERA-5; Black) and model (GLDAS; Red) for the surface and subsurface SM variability is distinguished by solid and dashed lines respectively.

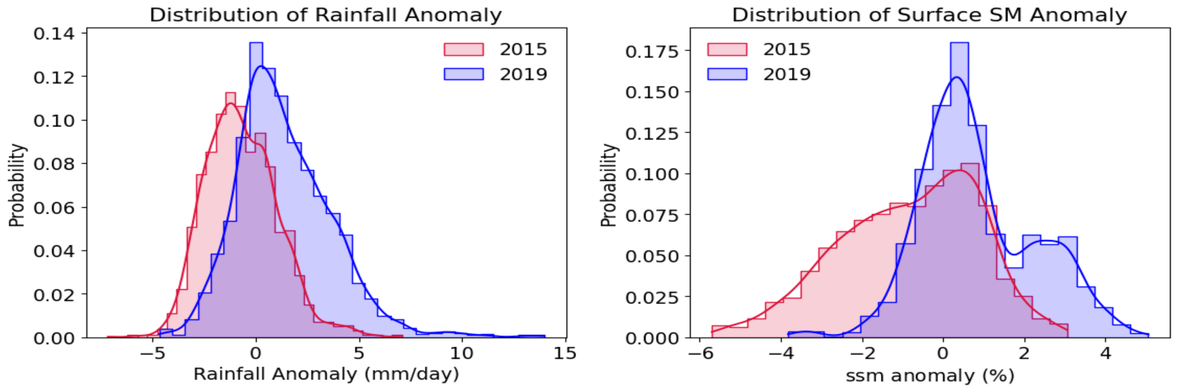
Findings

- If pre-monsoon months (MAM) are devoid of convective/thunderstorm activities, it leads to extreme temperature and drier SM conditions as noted during 2019 and 2022.
- The subsurface SM could vary significantly, constrained to the dry and wet spells which also depends on the intensity of the rainfall.

Characterizing variability in rainfall-surface SM relation over the CMZ

Objective

- To understand and characterize spatial and temporal aspects of the variability in rainfall – surface SM relation during recent deficit (2015) and excess (2019) monsoon years with respect to climatological mean of 1980-2020.



Spatial distribution of daily rainfall and surface SM anomalies (JJAS average) for CMZ of India. Data source: IMD gridded rainfall data, GLDAS soil moisture data.

Findings

- Elongated tail of 2019 rainfall anomalies → intense rainy spells → concurrent response in surface SM → Orderly response
- Negatively shifted distribution in 2015 rainfall anomalies → more break spells → Complex response
- Novel information theoretic technique suggests increase in complexity during 2015 (deficit) which may indicate the changing characteristics of the regional forcing.

Analyzing soil moisture (SM) impact on temperature extremes (ExT) in a warming climate over India

Objective

- To understand the ExT changes over the Indian region in historical and future climate by examining the impact of SM-T coupling using the SM sensitivity experiments

Soil moisture revamps the temperature extremes in a warming climate over India

Naresh G. Ganeshi, Milind Mujumdar, Yuhei Takaya, Mangesh M. Goswami, Bhupendra Bahadur Singh, R Krishnan & Toru Terao

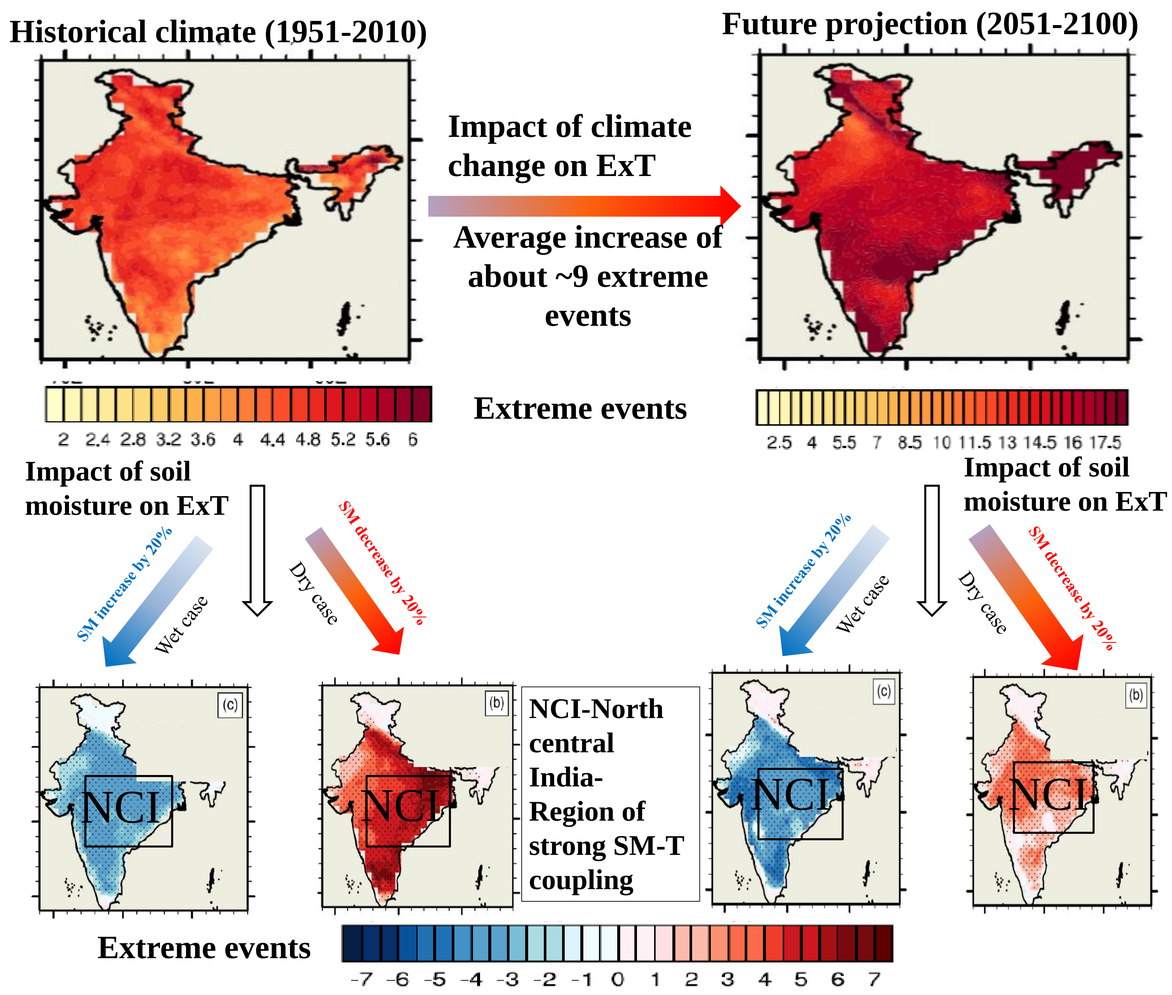
npj Climate and Atmospheric Science **6**, Article number: 12 (2023) | Cite this article

Model simulation experiments

- Impact of SM-T coupling on ExT is investigated using the MRI-AGCM (3.2) high-resolution (~60 km) climate model simulations.
- A suite of model experiments (HIST, FUT, DRY-SM (HIST), WET-SM (HIST), DRY-SM (FUT) and WET-SM (FUT)) are analyzed for the historical (HIST: 1951-2010) and future (FUT: 2051-2100) periods.
- The DRY-SM and WET-SM simulations are sensitivity experiments in which the SM initial conditions are perturbed on 1st day of each month (-20 % for the DRY-SM, and +20 % for the WET-SM for both climates)

Findings

Extreme temperature event is defined if the daily T_{max} value at each grid point is greater than 90th percentile T_{max} of the corresponding day and persists at least for three consecutive days.



- More than 70% area of the Indian landmass has experienced significant changes in characteristics of ExT due to SM perturbations.
- Over NCI, a 20% departure in SM significantly revamps frequency, duration and intensity of ExT by 2–5 events/year, 1-2 days/event and 0.5–2.1 °C, respectively.
- Importantly, the impact of SM perturbations on of ExT characteristics becomes less prominent with intensification of global warming.