Understanding the impact of soil moisture variations on temperature extremes over the Indian region

*Naresh Govind Ganeshi[1,2], Milind Mujumdar[1], R Krishnan[1], Mangesh Goswami[1,3], Yuhei Takaya[4], Toru Terao[5]

1. Centre for Climate Change Research, Indian Institute of Tropical Meteorology, Pune, India, 2. Department of Atmospheric and Space Sciences, Savitribai Phule Pune University, Pune, India, 3. Kavayitri Bahinabai Chaudhari North Maharashtra University, Pune, India, 4. Meteorological Research Institute, Climate Research Department, Ibaraki, Japan, 5. Faculty of Education, Kagawa University, Kagawa, Japan

Soil moisture (SM) and its long-term memory are known to be linked to near-surface temperature variations through land-atmosphere interactions. While previous studies have reported the association between temperature extremes over India and large-scale atmospheric circulation, the role of land-atmosphere coupling on temperature extremes over the monsoon-dominated Indian region is not well understood. In the present study, we have analysed multiple hydro-meteorological datasets and climate model outputs to understand the impact of SM variations on the occurrence of temperature extremes in a changing climate. Long-term climate observations reveal that the surface temperature over India increased by 0.7^{o}C during 1901-2018, whereas the regional summer monsoon rains have decreased by about 7% since 1950. Our analysis shows that the decrease of SM over north-central India (NCI), in association with the declining monsoon precipitation, has altered the characteristics of temperature extremes in the region through strong land-atmosphere coupling. It is found that the frequency, duration and variability of temperature extremes over NCI have significantly risen during the post-1980, in association with the depletion of soil moisture in the region. Our analysis indicates that the drying trend of SM over the NCI in the recent decades has favoured a significant increase in the occurrence of temperature extremes through enhancement of sensible heat flux and reduction of latent heat flux. In addition, it is noted that the loss of soil moisture memory has led to an increase in the variability of temperature extremes over the region.

Keywords: Temperature extremes, soil moisture, soil moisture memory, soil moisture-temperature coupling, north-central India, surface energy partitioning

