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Rainfall Trends over the Indo-Pak Summer Monsoon and Related Large-Scale Dynamics

Muhammad Latif (1), Faisal Syed (2), and Abdel Hannachi (2)

(1) Department of Meteorology, COMSATS Institute of Information Technology, 44000, Islamabad, Pakistan, (2) Department of Meteorology, Stockholm University, 10691 Stockholm, Sweden

The study of regional rainfall trends over South Asia is critically important for food security and infrastructure. This study investigates the presence of trends in seasonal and sub-seasonal (June through September-JJAS) rainfall obtained from multiple observed datasets. The obtained results identified a dipole-type structure in rainfall trends over the region north of the Indo-Pak subcontinent, where significant increasing trends are seen over the core monsoon region of Pakistan and significant decreasing trends are observed over the central-north India and adjacent areas. The study strongly suggests that strengthening of Vertically Integrated Meridional Moisture Transport (VIMMT) over the Arabian Sea is likely reason for the trend of rainfall in the core monsoon region of Pakistan. In contrast, over the central-north India region, the rainfall trends are significantly decreasing due to the weakening of IMT over the Bay of Bengal. The leading EOF clearly shows the strengthening (weakening) patterns of VIMMT over the Arabian Sea (Bay of Bengal) in seasonal and sub-seasonal interannual time-scales. The regression analysis between the principal components and rainfall confirms the dipole pattern over the region. Our results also suggest that the Circumglobal Teleconnection in upper troposphere influence in maintaining the mean rainfall over Pakistan via cross-equatorial flow of moisture into the Arabian Sea.

We also investigate seasonal JJAS rainfall trends using historical and climate change (RCP4.5 and RCP8.5) simulations from a set of regional climate models from Coupled Model Intercomparison Project (CMIP5). Trends and asymmetry of seasonal rainfall show great variability across models. Meridional moisture transport and associated large-scale dynamics will also be discussed.