National Institute of Technology Rourkela

Progress Seminar

Seminar Title	: Exploring Mechanics of Indian Summer Monsoon Rainfall in Association with different Modes of South Asian High
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Abstract	: Indian Summer Monsoon rainfall (ISMR) exhibits significant spatial and temporal variability connected to monsoon semi-permanent circulations. The South Asian High (SAH), a primary heat source located in the upper atmosphere (~200 hPa) over the Tibetan Plateau, impacts Asian monsoon rainfall during boreal summer (June-August). In recent years, the association between SAH and ISMR has gained the attention of the research and operational community of monsoon prediction for different time scales. The present thesis aims to understand the association of the different SAH modes with ISMR in the influence of climate drivers such as El Niño-Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), etc, at different spatial-temporal scales. The thesis also presents the association between SAH modes and other semi-permanent systems, such as low-level Jet, tropical easterly Jet, etc. The thesis is divided into three/four working chapters. The first working chapter addresses the dynamic linkage between ISMR and the SAH at intra-seasonal and inter-annual scales using observations. The second working chapter demonstrates their association in seasonal models (CANCM4, NEMO, CANSIP, and CFSv2). The third chapter focuses on how ENSO and IOD interact with SAH modes and their implications on ISMR. The fourth chapter will be focused on the fidelity of the high-resolution Indian ocean-land-atmosphere coupled model (IOLA) in replicating/capturing the SAH modes on ISMR and homogeneous rainfall over India. The chapter-1 considered two data periods, past-climate (1940&ndash1980) and current-climate (1981&ndash2020), to understand the changes in SAH and ISMR. Key findings suggest that the northwest-southeast (INW-SE), north-south (INS), and intensity (IINT) indices of the SAH are strongly correlated with ISMR, with a correlation of ~0.67, ~0.60, and ~0.51, respectively. In contrast, the east-west (IEW) index shows a negative correlation of ~-0.52. Notably, these relationships are more pronounced in the past-climate than in the current-climate, except for the IINT index. Specifically, the INW-SE and INS indices are closely linked with all-India, northwest India (NWI), and central India (CI) rainfall, while the IINT index is associated with south peninsular India (SPI) rainfall. Increased rainfall over NWI and SPI in the current-climate is strongly connected to positive INS and IINT indices, respectively. However, northeast India (NEI) rainfall shows no significant relation with SAH indices, though the IEW index is notably linked to increased NEI rainfall during El Niño years. Additionally, the significant positive (negative) relationship between meridional (zonal) wind shear and SAH indices, except for the IEW index, and positive SAH indices generally favor the ISMR to be stronger due to positive moisture anomalies. The second chapter addressed the above-observed relationship in four seasonal models (CANCM4, NEMO, CANSIP, and CFSv2) initialized with May conditions for the 1982&ndash2016 period. As the model data period is not uniform for past- and current-climate periods, this analysis is conducted for the total data period. Most models capture the ISMR-SAH relationship, with slight variations in the correlation analysis. The positive rainfall anomalies associated with INW-SE years are strongly attributed to cold sea surface temperature (SST) anomalies over the equatorial eastern Pacific (La Niña) and positive vorticity from a strong cyclonic circulation over the monsoon region. Conversely, IEW years show significant negative rainfall anomalies linked to El Niño patterns and negative vorticity anomalies over the monsoon region. The work related to the third and fourth chapters is ongoing.