National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Understanding Microclimate and Land Surface Conditions of Complex Orography Himalayan Region
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Abstract : The Himalayan region is a crucial ecosystem with complex topography and diverse vegetation impacting weather, climate, and hydrology through atmosphere-biosphere interactions. Limited high-resolution measurements of microclimate and land surface conditions constrain the understanding of atmosphere&ndashbiosphere interactions across timescales and made dependent on numerical models. The primary objective of the thesis is to understand the evolution of microclimate and associate land surface conditions using analyses and model outputs. The land surface conditions have been prepared using high resolution land data assimilation system (HRLDAS based on Noah-MP land surface model) for historical and future time periods of different SSP scenarios. The rainfall, temperature conditions from CMIP6 models which serves as the forcing to Noah-MP are analyzed and evaluated for the region. The most parts of Himalayan region have been exhibited increased precipitation and temperature extremes under both SSP scenarios. Extreme precipitation (5 to 40 %) and daily rainfall intensity (5 to 20%) are projected to increase, while maximum and minimum temperatures are expected to rise by 5&ndash6°C under SSP5-8.5, with more warm extremes and fewer cold extremes under both SSP2-4.5 and SSP5-8.5. Given the limited availability of*in-situ* observations across the Himalayan region, the present study focuses on Uttarakhand as the representative domain for implementing HRLDAS. Having different vegetation types in the study domain, initially the one-dimensional Noah-MP is customized over Uttarakhand state for customization and validation for 10 years at in-situ station locations. Various regional and global analyses were examined, and ERA5-Land was identified as the most suitable forcing. Simulations with realistic vegetation (deciduous and evergreen forests) reproduced soil moisture (SM) soil temperature (ST), and fluxes more accurately, highlighting the need of realistic vegetation representation in land models. Then three-dimensional HRLDAS is set up at 2 km resolution (2011&ndash2021) and showed good agreement with in-situ, satellite, and reanalysis datasets, capturing diurnal variation, slightly overestimating SM (-0.02 $m^3m^{\&minus3}$ to 0.02 $m^3m^{\&minus3}$, and accurately simulating ST (correlation 0.94 bias &minus0.34 °C). Overall, HRLDAS outperformed GLDAS and IMDAA, providing a reliable dataset for the complex orography region. Later the land surface conditions have been developed for historical period (1995-2014), near-future (2021-2040), mid-future (2041-2060) and far-future (2081-2100) time periods using CMIP6 data. During the historical period, the SM is overestimated compared to ESACCI, while ST is underestimated in all months except the summer season when compared with ERA5-Land. Future SM decreases under SSP2-4.5, whereas most regions show an increase under SSP5-8.5 with reference to the historical period. ST exhibits stronger warming in high-elevation areas compared to low-elevation regions under both SSP2-4.5 and SSP5-8.5 scenarios. In this thesis, these datasets have been studied in understanding land surface conditions. Being it is high resolution, the dataset can be used extensively in hydrological, atmosphere&ndashbiosphere interaction&rsquo models, and most importantly in initializing the atmospheric models for improved weather prediction, etc.

Keywords: Himalayas, Uttarakhand, Temperature and Rainfall, Land surface conditions HRLDAS, Future projections