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Assessing the Uncertainty in Downscaling Approaches using Hydrological Model

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General Circulation Models (GCMs) play an important role in defining the climate change impacts at a global scale, but its coarser resolution limits its direct application at regional scale. To understand the meteorological variability at regional scale, regional climate models have been developed which use the GCM outputs as boundary condition to downscale them at finer scale. Two broad classes of downscaling are dynamical, which involve developing physics based regional model and statistical, which involves establishing statistical relationship between coarse scale climate variables and fine resolution variable of interest. The two approaches perform well in their own domain, however, comparing the results, obtained using two approaches with different basis leads to a source of uncertainty, associated with the approach. Here, we quantify the uncertainty associated with approach in terms of hydrologic variables that are simulated separately using dynamically and statistically downscaled climate forcings. GCM model named EC-Earth has been statistically downscaled (SD) using multi-site kernel regression method and it has been compared with dynamically downscaled CORDEX outputs of the same GCM. For this, period from 1981 to 2005 has been considered as baseline period and period from 2016 to 2040 has been considered as future period. Since, these meteorological outputs affect the regional hydrological components such as runoff, Evapo-Transpiration (ET), soil moisture, and baseflow; simulated outputs from a meso-scale hydrological model named Variable Infiltration Capacity (VIC) model has been used to compare these downscaled variables. Advantage of this model is that it considers the effect of Land Use/Land Cover (LULC), vegetative properties, and soil properties at sub-grid level; which plays an important role in the hydrology of a region. Comparatively more future increase in all the hydrological variables over major part of India was simulated using SD outputs, then CORDEX outputs. Also, downscaling uncertainty showed decrease in minimum and maximum temperature derived from SD model as compared to CORDEX data. Partial correlation of each hydrological variable with meteorological data showed future change in precipitation and maximum temperature as the most affecting variables which will influence the change in hydrological parameters as compared to wind and minimum temperature. However, CORDEX results showed change in precipitation and maximum temperature as the major parameters that will affect ET, runoff and soil moisture; whereas statistically downscaled results showed only change in precipitation as the most influential variable.

Keywords: Dynamical and Statistical Downscaling, Hydrological model, Uncertainty analysis