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Future projection of surface air temperature trend over Humid Subtropical Indo-Gangetic Plain, India: Role of internal variability and external forcing factors

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During 1961−2000, the CRU based summer surface air temperature (SAT) exhibits a significant cooling trend ($\sim -3°$C/40 yrs.) in the Humid Subtropical Climate Zone, India. Here we investigate the contribution of internal and external factors, which are driving this cooling trend. Using the Community Earth System Model-Large Ensemble (CESM-LE), we analyze the historical climate change in presence of internal climate variability. The summer SAT trend during the historical period exhibit an amplified cooling ($< -3°$C), whereas, a warming trend ($>= 4°$C) is projected in all the ensemble members under RCP8.5 scenario. The total trend is partitioned into contributions from the externally forced response and internal climatic variability. Further analyses reveals that external forcing displays a cooling and warming trend over the region under historical and RCP8.5 scenarios, respectively, while internal variability displays mixed cooling (in most cases) and warming signals. Therefore, the internal variability introduces a wide range of uncertainty to the future projection in climate models. In historical period, the signal to noise ratio is less than 1, which indicates that the internal climatic variability dominates over the forced response. But in future decades the SNR is much higher than 1. However, to a greater extent internal variability will mask the warming trend over the region, even under RCP8.5 scenario. Furthermore, to quantify the role of different external forcing factors we used the CCSM4 single forcing simulations for the historical period. The simulation results from CESM-LE and CCSM4 suggest that the cooling trend over the region is primarily due to the combined influence of internal variability ($\sim$73%) and partly due to aerosol ($\sim$10%) and ozone only forcing, which strongly mask the warming effect of GHG and solar forcing.