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GCM Model Selection Procedure for Downscaling

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Downscaling has been widely used in studies of regional and/or local climate as it yields greater spatial resolution than general circulation models (GCM) can provide. It can approached in two distinct ways: 1) Statistical and 2) Dynamical. Statistical downscaling utilizes mathematical relationships between large-scale and regional/local climate to transform GCM or reanalysis data to a higher spatial resolution. Dynamical downscaling comprises forcing the lateral boundaries of a regional climate model with reanalysis or GCM data. However, there is no set technique to select said GCM(s).

A comprehensive yet easily applicable selection procedure was created to address this. Using reanalysis data and/or observational data, the space-time climatic anomalies and the mean state of the climate are evaluated for the region of interest. East Africa was utilized as a case study and GISS-E2-H r6i1p3 was found to perform the strongest. This procedure cannot, however, tell whether the models can reproduce the key processes of the region. To examine this, the ability of the models to simulate the Indian Ocean Dipole were evaluated. It was found that higher ranked models were better able to capture it than lower ranked ones. Furthermore, to ensure that a higher ranked model yielded a better downscaling simulation, three 10-year regional climate model simulations over East Africa were undertaken, where they were respectively forced by the highest ranked GCM (GISS-E2-H r6i1p3), the lowest ranked GCM (IPSL-CM5A-LR r4i1p1) and the MERRA-2 reanalysis product. The simulated surface temperature and precipitation for Equatorial East Africa were compared with a gridded observational dataset (CRU TS 4.04). Results showed that the higher ranked GCM produced a better downscaled simulation than the lower ranked one, a result that was more evident for surface temperature than precipitation.