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Can the CMIP5 models reproduce interannual to interdecadal southern African summer rainfall variability and their teleconnections?

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This study examines for the first time the ability of 28 global climate models from the Coupled Model Intercomparison Project 5 (CMIP5) to reproduce southern African summer rainfall variability and their teleconnections with large-scale modes of climate variability across the dominant timescales. In observations, summer southern African rainfall exhibits three significant timescales of variability over the twentieth century: interdecadal (15–28 years), quasi-decadal (8–13 years), and interannual (2–8 years). Most of CMIP5 simulations underestimate southern African summer rainfall variability at these three timescales, and this bias is proportionally stronger from high- to low-frequency. The inter-model spread is as important as the spread between the ensemble members of a given model, which suggests a strong influence of internal climate variability, and/or large model uncertainties.
The underestimated amplitude of rainfall variability for each timescale are linked to unrealistic spatial distributions of these fluctuations over the subcontinent in most CMIP5 models. This is, at least partially, due to a poor representation of the tropical/subtropical teleconnections, which are known to favour wet conditions over southern African rainfall in the observations. Most CMIP5 realisations (85%) fail at simulating sea-surface temperature (SST) anomalies related to a negative Pacific Decadal Oscillation during wetter conditions at the interdecadal timescale. At the quasi-decadal timescale, only one-third of simulations display a negative Interdecadal Pacific Oscillation during wetter conditions, but these SST anomalies are anomalously shifted westward and poleward when compared to observed anomalies. Similar biases in simulating La Niña SST anomalies are identified in more than 50% of CMIP5 simulations at the interannual timescale. These biases in Pacific SST anomalies result in important shifts in the Walker circulation. This impacts southern Africa rainfall variability through interactions with the South Indian Convergence Zone, where most of the synoptic-scale rain-bearing systems that affect southern African preferably develop.