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Updating projections of changes in southern African summer rainfall using multi-time-scale empirical statistical downscaling

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The water management community has hitherto underestimated many of the uncertainties in climate impact scenarios, in particular, uncertainties associated with decadal climate variability. For instance, southern African summer rainfall has recently been shown to exhibit significant periodicities at the interannual timescale (2-8 years), quasi-decadal (8-13 years) and inter-decadal (15-28 years) timescales, which have major consequences for human livelihoods and ecosystems. However, at this time-scale, uncertainty in the state-of-the-art global climate models (GCMs), such as used in the Coupled Model Intercomparison Project 5 (CMIP5), is particularly sensitive to internal climate variability and to little changes model physics. In addition, non-stationarity in statistical downscaling is widely recognized as a key problem, in which time-scale dependency of predictors may play an important role. This study therefore aims at improving climate-impact scenarios for water resource in southern African by introducing new model selection criteria and by using a multi-time-scale approach for statistical downscaling.
All simulations from 28 CMIP5 models have therefore first been selected based on their capability to reproduce southern African summer rainfall variability and their teleconnections with global sea-surface temperature at the interannual to interdecadal timescales. Most of CMIP5 GCMs underestimate southern African summer rainfall variability and their teleconnections with Pacific SSTs at the interannual to interdecadal timescales. However, analysing both historical and pi-control runs, some CMIP5 models show capabilities in simulating observed statistics at the interannual and quasi-decadal time-scales, suggesting potential skills for statistical downscaling at these time-scales. A multi-timescale regression based downscaling procedure, which determines the predictors across the different timescales, has thus been used to simulate southern African summer rainfall. This multi-timescale procedure shows much better skills in simulating decadal timescales of variability compared to commonly-used statistical downscaling approaches.