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A framework for process-based assessment of regional climate model experiments: applied to projections of southern African precipitation

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There is a demand from adaptation planners for regional climate change projections, particularly the finer resolution data delivered by regional models. However, climate models are subject to important uncertainties, and their projections diverge substantially, particularly for precipitation. So how should decision makers know which futures to consider and which to disregard? Model evaluation is clearly a priority. The majority of studies seeking to assess the validity of projections are based on comparison of the models' twentieth century climatologies with observations or reanalysis. Whilst this work is very important, examination of the modelled mean state it is not sufficient to assess the credibility of modelled changes. Direct investigation of the mechanisms for change is also vital.

In this study, a framework for process-based analysis of projections is presented, whereby circulation changes accompanying future responses are examined, and then compared to atmospheric dynamics during historical years in models and reanalyses. This framework has previously been applied to investigate a drying signal in West Africa, and will here be used to examine projected precipitation change in southern Africa. An ensemble of five global and regional model experiments will be employed, consisting of five perturbed versions of HadCM3 and five corresponding runs of HadRM3P (PRECIS), run over the CORDEX Africa domain. The global and regional model runs show contrasting future responses: there is a strong drying in the global models over southern Africa during the rainy season, but the regional models show drying over Madagascar and the south west Indian Ocean. Circulation changes associated with these projections will be presented as a first step towards understanding the mechanisms for change and the reasons for difference between the global and regional models. The interannual variability will also be examined and compared to reanalysis to explore how well the models represent the dipole between southern Africa and Madagascar in the twentieth century simulations. This analysis could shed light on the credibility of the projected changes, and the relative trustworthiness of the global and regional models.

This research makes a valuable contribution to the understanding of mechanisms for change in southern Africa. It also has wider relevance for regional climate model studies, in highlighting the need to evaluate models on a case by case basis, and providing a framework for assessment which could be applied to other models and other regions.