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Observed decadal variability of southern African rainfall, their teleconnections, and uncertainties

Bastien Dieppois (1,2,3), Benjamin Pohl (4), Mathieu Rouault (3), Mark New (2), Damian Lawler (1), and Noel Keenlyside (5)

(1) Centre for Agroecology, Water and Resilience, Coventry University, Coventry, UK, (2) African Climate & Development Initiative, University of Cape Town, Cape Town, RSA, (3) Department of Oceanography, MARE Institute, University of Cape Town, Cape Town, RSA, (4) Centre de Recherches de Climatologie, UMR 6282 Biogéosciences, CNRS/Université de Bourgogne, Dijon, France, (5) Geophysical Institute, University of Bergen and Bjerknes Centre for Climate Research, Bergen, Norway

This study examines for the first time the changing characteristics of summer and winter southern African rainfall, and their teleconnections with large-scale climate through the dominant timescales of variability. The summer and winter rainfall indices exhibit three significant timescales of variability over the 20th century: interdecadal (15–28 year), quasi-decadal (8–13 year) and interannual (2–8 year). Teleconnections with global sea-surface temperature and atmospheric circulation anomalies, which have been established here using different data sets, are different for each timescale. Uncertainty related to the choice of observed-based SST and reanalysis data sets appears stronger over the winter rainfall region and at the interdecadal timescale. However, only SST and atmospheric anomalies which show an agreement greater than 90% between data sets, or between the members of the reanalysis, have been described. Tropical/subtropical teleconnections emerge as the main driver of summer rainfall variability. Thus, shifts in the Walker circulation are linked to the El Niño Southern Oscillation (ENSO) and, at decadal timescales, to decadal ENSO-like patterns related to the Pacific Decadal Oscillation and the Interdecadal Pacific Oscillation. These global changes in the upper-zonal circulation interact with asymmetric ocean-atmospheric modifications between the South Atlantic and South Indian Oceans; together these lead to shift in the South Indian Convergence Zone, and a modulation of the development of convective rain bearing systems over southern Africa in summer. Such regional changes, embedded in quasi-annular geopotential patterns, consist of easterly moisture fluxes from the Mascarene High, which dominate southerly moisture fluxes from the St Helena High. Winter rainfall variability is more influenced by mid-latitude atmospheric variability, in particular the Southern Annular Mode, but interactions with ENSO remain, especially in the subtropics. Asymmetrical changes in the mid-latitude westerlies between the Atlantic and Indian Oceans are thus impacting preferentially the southwestern regions of southern Africa.