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Anthropogenic radiative forcing of southern African and Southern Hemisphere climate variability and change

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Abstract

This paper explores the hypothesis that the more realistic depiction of the atmosphere's ability to absorb and release radiation in atmospheric model simulations, through the more realistic representation of the time-varying concentrations of stratospheric ozone, greenhouse gasses, aerosols and sulphur dioxide, can improve the model's skill to simulate inter-annual variability over southern Africa. The paper secondly explores the role of different radiative forcings of future climate change over southern Africa and the Southern Hemisphere. Through a set of AMIP-style experiments, it is demonstrated that including the direct (radiative) effects of aerosols in the simulations decreases the model's bias in simulating near-surface temperatures. Trends in near-surface temperatures are more realistically simulated in the presence of time-varying vs climatological CO2. The inclusion of time-varying ozone concentrations, and in particular Antarctic stratospheric ozone, leads to an improvement in model skill in simulating the inter-annual variability in rainfall and circulation over southern Africa. Evidence is presented that radiative forcing from anomalous Antarctic stratospheric ozone played a role in the failure of the teleconnection to southern Africa during the 1997/1998 El Niño. Despite the recovery of stratospheric ozone concentrations to pre-industrial values during the 21st century, a pronounced poleward displacement of the westerlies is projected to occur in response to the enhanced greenhouse effect.