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High-resolution model-projected changes in mid-tropospheric closed-lows and extreme rainfall events over southern Africa

C. J. Engelbrecht,[a*] F. A. Engelbrecht[b] and L. L. Dyson[c]

[a]*Agricultural Research Council – Institute for Soil, Climate and Water, Pretoria, South Africa*

[b]*Council for Scientific and Industrial Research, Natural Resources and the Environment, Climate Studies and Modelling, Pretoria, South Africa*

[c]*Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, South Africa*

* FEngelbrecht@csir.co.za

ABSTRACT:

Mid-tropospheric closed-lows (cold-core cut-off lows and warm-core tropical lows) are important rain producing weather systems for the southern Africa region. Over South Africa, most wide-spread flood events are caused by these systems. It is therefore important to explore the potential impact of anthropogenic forcing on the occurrence of closed-lows and extreme rainfall events over the region. Coupled global circulation models (CGCMs) cannot be directly applied for this purpose because of their relatively low spatial resolution – some form of downscaling is required to adequately resolve these systems and the rainfall they cause. In this study, a variable-resolution atmospheric global circulation model is applied as a regional climate model to simulate closed-low characteristics over southern Africa under current and future forcings. The model is forced with greenhouse gas concentrations according to the A2 SRES scenario and with sea surface temperatures (SSTs) and sea-ice as specified by the CSIRO Mk3 CGCM. The model projects a general decrease in closed-low frequencies over the region, which occurs in association with a general strengthening of the subsiding branch of the Hadley cell. However, the climate-change signal shows variation in time and space and certain sub-regions are projected to experience an increase in closed-low frequencies during certain seasons. A general increase in extreme rainfall events is projected over southern Africa despite the projected decrease in closed-low frequencies. It is deduced that this increase in extreme rainfall events is driven by intense convective rainfall events occurring within more frequently forming tropical-temperate cloud bands. Over Mozambique, extreme rainfall events are projected to increase in association with more frequently occurring closed-lows.