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ORIGINAL PAPER

Diagnosis of East African climate and the circulation mechanisms associated with extreme wet and dry events: a study based on RegCM4

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Abstract The latest version of the International Centre for Theoretical Physics (ICTP) regional climate model (RegCM4) is used in this study to examine the East African climate, focusing on October to December (OND) rainfall and the circulation mechanisms associated with extreme wet and dry events over the period 1991–2008. Grell convection scheme with Fritsch-Chappell closure assumption is used. The experiment was performed with the initial and lateral boundary conditions obtained from ERA-interim gridded reanalysis at a 1.5° resolution. The simulation period was 1990–2008 at a resolution of 50 km. Results show that the model realistically simulates the annual cycle, the OND mean seasonal rainfall, and its interannual variability over the East African region, where the simulated rainfall tends to underestimate the observed rainfall. There is however a significant positive correlation between the simulated rainfall and the rainfall datasets used to evaluate the model performance. Further analysis revealed that, the model captures well the observed circulation anomaly patterns, with divergence at low level and convergence at upper level during dry years, and for wet years, convergence (divergence) was simulated at low (upper) level, especially over the western Indian Ocean and the study area. Dry years are hence characterized by sinking motion as oppose to wet years which depict rising motion. These were corroborated by the pressure vertical velocity (omega), which showed positive (negative) anomalies over the region during dry (wet) years. The findings from this study provide insight into the circulation anomaly associations with wet and dry events in the region. The observed biases indicate that the ability of the model in simulating the East African climate is still a significant challenge. Therefore, future work needs to focus on improving the performance of the model in climate research over the region.

Keywords Regional climate model · Rainfall · Circulation mechanism · East Africa

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Introduction

Rainfall is the most important climate variable over East Africa since several sectors of the economy depend mostly on water resources (Ogwang et al. 2014; Ogallo and Oludhe 2009). Its variability and predictability are therefore important aspects to address in climate research over the region. Like other tropical regions, interannual and intra-seasonal variability of rainfall in Equatorial East Africa (EEA) results from complex interactions of forced and free atmospheric variations. The region experiences and is sensitive to large climate fluctuations.

Variations in the intensity and timing of rainfall over the region have been recorded to have adverse effects on agriculture and other social-economic aspects in the region. For instance, during the ENSO event of 1982/83, Africa suffered