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Projected changes in mean rainfall and temperature over East Africa based on CMIP5 models

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ABSTRACT: This study presents potential future variations of mean rainfall and temperature over East Africa (EA) based on five models that participated in the Coupled Model Intercomparison Project Phase 5 (CMIP5) and representative concentration pathways (RCPs): 4.5 and 8.5. In this study, climate simulations of two timeframes, a baseline period (1961–1990) and projection period (2071–2100), are compared. The models reproduce EA's bimodal rainfall pattern but overestimate and underestimate seasonal rainfall of October–December (OND) and March–May (MAM), respectively. Rainfall is projected to increase under the two scenarios. Larger increases in rainfall will occur during the OND season than during the MAM season and in RCP8.5 than in RCP4.5. During the last half of the 21st century, EA is likely to warm by 1.7–2.8 and 2.2–5.4 °C under the RCP4.5 and RCP8.5 scenarios, respectively, relative to the baseline period. Scenario uncertainty is projected to exceed model uncertainty from the middle to the end of the 21st century. The central parts of Kenya and the Lake Victoria Basin will witness the highest increases in seasonal rainfall. The probability density functions (PDFs) of future seasonal rainfall show a positive shift and a statistically insignificant increase in variance relative to the baseline. Thus, EA is likely to experience an increase in extreme rainfall events. Understanding the future climate variability in EA is important for planning purposes but these results are based on relatively course resolution models prone to bias and therefore should be used with caution. There is a need for further research on climate projections over EA, including determining the causes of the poor performance of global models in reproducing rainfall climatology and trends over the region.

KEY WORDS climate projection; rainfall; temperature; CMIP5; East Africa

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1. Introduction

Understanding ongoing and projected climate variability and change is essential for long-term planning at the global, regional, and local scales and is particularly important for countries/regions whose economies are heavily reliant on rain-dependent sectors. East Africa (EA; Kenya, Uganda, and Tanzania) is one such region and is highly vulnerable to the effects of climate variability and change (IPCC, 2007). This region's economy is strongly reliant on rain-fed agriculture (World Bank, 2008). Sustainable socioeconomic development in EA is paramount and requires making good use of available climate information to maximize agricultural productivity while protecting the environment. Consequently, the demands for research aimed at minimizing the uncertainties in climate projections are also growing. This study provides climate information for guiding the formulation and possible implementation of policies. One area that should be thoroughly researched is the vulnerability of agriculture to the effects of projected climate change. This research can be achieved by using available accurate and timely information regarding the expected changes in both mean and extreme climate events, which is still limited in EA (Omondi *et al.*, 2014; Ongoma *et al.*, 2016a).

Currently, general circulation model (GCM) simulations forced by specified variations in greenhouse gases (GHGs) are commonly used to understand future climate change. Although the performance of the models remains limited, the results from the models provide a qualitative guide for the expected climate (Knutti and Sedláček, 2013). The uncertainty in the models occurs for many reasons, including the accurate characterization of future GHG emissions. However, Jakob (2010) singled out simulations of moist, deep convection as the main source of uncertainty in model projections of the future climate over Africa and globally.

Rainfall is the most valuable weather parameter in EA (Muthama *et al.*, 2012), which explains why rainfall has been studied in more depth relative to other weather

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