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ORIGINAL PAPER

Evaluation of CMIP5 twentieth century rainfall simulation over the equatorial East Africa

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Abstract
This study assesses the performance of 22 Coupled Model Intercomparison Project Phase 5 (CMIP5) historical simulations of rainfall over East Africa (EA) against reanalyzed datasets during 1951–2005. The datasets were sourced from Global Precipitation Climatology Centre (GPCC) and Climate Research Unit (CRU). The metrics used to rank CMIP5 Global Circulation Models (GCMs) based on their performance in reproducing the observed rainfall include correlation coefficient, standard deviation, bias, percentage bias, root mean square error, and trend. Performances of individual models vary widely. The overall performance of the models over EA is generally low. The models reproduce the observed bimodal rainfall over EA. However, majority of them overestimate and underestimate the October–December (OND) and March–May (MAM) rainfall, respectively. The monthly (inter-annual) correlation between model and reanalyzed is high (low). More than a third of the models show a positive bias of the annual rainfall. High standard deviation in rainfall is recorded in the Lake Victoria Basin, central Kenya, and eastern Tanzania. A number of models reproduce the spatial standard deviation of rainfall during MAM season as compared to OND. The top eight models that produce rainfall over EA relatively well are as follows: CanESM2, CESM1-CAM5, CMCC-CESM, CNRM-CM5, CSIRO-Mk3-6-0, EC-EARTH, INMCM4, and MICROC5. Although these results form a fairly good basis for selection of GCMs for carrying out climate projections and downscaling over EA, it is evident that there is still need for critical improvement in rainfall-related processes in the models assessed. Therefore, climate users are advised to use the projections of rainfall from CMIP5 models over EA cautiously when making decisions on adaptation to or mitigation of climate change.

1 Introduction

Climate change has become unequivocal starting from the last half of the twentieth century (IPCC 2007). As a result, many studies have been carried out during this time, and more are ongoing in an effort to devise strategies for adapting to and mitigation against effects of climate variability and climate change. The studies have seen development of various models to simulate climate variability and climate change, with a lot of emphasis being put on future projections. Global circulation models (GCMs) are used widely in climate research today. The GCMs that simulate the climatic condition of a given region or the entire world differ depending on the initial and boundary conditions, corresponding climate variables and by structure. Therefore, it is important to assess the abilities of different GCMs to reproduce the observed variations in climate variables.

The recent operational project on the climate change is World Climate Research Program's (WCRP's) Working Group on Coupled Model Intercomparison Project Phase 5 (CMIP5), whose output is in use globally (Taylor et al. 2012). The CMIP5 simulations were used in the preparation of the IPCC Fifth Assessment Report (AR5) (IPCC 2013). The data from these models is being employed in different regions in climate change assessment through dynamical downscaling transformation to regional or local level. Despite the fact that the models have undergone numerous improvements in spatial resolution and other forms, there still

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