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Heavy precipitation events over East Africa in a changing climate: results from CORDEX RCMs

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Abstract
The study assesses the performance of 24 model runs from five COordinated Regional climate Downscaling Experiment (CORDEX) regional climate models (RCMs) in simulating East Africa's spatio-temporal precipitation characteristics using a set of eight descriptors: consecutive dry days (CDD), consecutive wet days (CWD), simple precipitation intensity index (SDII), mean daily annual (pr_ANN), seasonal (pr_MAM and pr_OND) precipitation, and representatives of heavy precipitation (90p) and very intense precipitation (99p) events. Relatively better performing RCM runs are then used to assess projected precipitation changes (for the period 2071–2099 relative to 1977–2005) over the study domain under the representative concentration pathway (RCP) 8.5 scenario. The performance of RCMs is found to be descriptor and scope specific. Overall, RCA4 (r1i1p1) forced by CNRM-CERFACS-CNRM-CM5 and MPI-M-MPI-ESM-LR, REMO2009 (r1i1p1) forced by MPI-M-MPI-ESM-LR, and RCA4 (r2i1p1) forced by MPI-M-MPI-ESM-LR emerge as the top four RCM runs. We show that an ensemble mean of the top four model runs outperforms an ensemble mean of 24 model simulations and ensemble means for all runs in an RCM. Our analysis of projections shows a reduction (increase) in mean daily precipitation for MAM(OND), an increase(decrease) in CDD(CWD) events, and a general increase in SDII and the width of the right tail of the precipitation distribution (99p–90p). An increase in SDII and 99p–90p implies a possibility of occurrence of heavy and extreme precipitation incidences by the end of the twenty-first century. Our findings provide important information to support the region's climate change adaptation and mitigation efforts.

Keywords Intraseasonal precipitation variability · CORDEX · Regional climate model · RCP 8.5 · Global warming

1 Introduction

Precipitation in East Africa (EA) is quite variable in both time and space (e.g. Opiyo et al. 2014; Kiros et al. 2017; Ogega 2017). While the region tends to experience more deficit than surplus precipitation events, major heavy precipitation events have been recorded over time which, often, lead to massive losses in life and property (e.g. Kilavi et al. 2018). An assessment of several climate indices done by Omondi et al. (2014) pointed towards a general decrease in historical precipitation trends over EA. Déqué et al. (2017) assessed the impact of + 2° warming on tropical Africa's climate using several regional climate models (RCMs). Their assessment showed a possibility of increased extreme precipitation events by 2100. Further, precipitation projections over the Greater Horn of Africa under 1.5 °C and 2 °C global warming indicate (i) uncertainty in changes in precipitation, (ii) increasing dry spells, and (iii) decreasing wet spells over the region by 2100 (Osima et al. 2018). However, none of these studies have made an in-depth assessment of (1) the capability of RCMs (analysing individual model runs) to reproduce EA's spatial and temporal precipitation extremes

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