

Article

Weather Research and Forecasting Model Sensitivity to Choice of Parameterization over Ethiopia

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Abstract: A 3-month (June–August) regime of the year 2002 summer rainfall (JJA2002) was simulated with 30 physics combinations using the Weather Research and Forecasting (WRF) model at 12-km horizontal grid resolution. The objective is to examine summer rainfall sensitivity to parameterization of microphysical, convective, and boundary layer processes and identify an best possible combination of parameterization options that performs relatively better in simulating spatial and temporal distribution of summer rains over Ethiopia. The WRF simulated rainfall was evaluated against station data and satellite rainfall products (CHIRPS and ENACTS) using mean absolute error, Pearson and Pattern correlation coefficients (PCC), pattern correlation and and error in number of rainy days as evaluation metrics. Summer rainfall is found to be most sensitive to choice of cumulus parameterization and least sensitive to cloud microphysics. All simulations captured the spatial distribution of mean seasonal precipitation with PCC ranging from 0.89–0.94. However, all simulations overestimated precipitation amount and number of rainy days. Out of the 30, the simulations that uses a combination of Grell-3D cumulus scheme, ACM2 boundary layer, Lin Microphysics, Dudhai shortwave radiation and RRTM longwave radiation scheme ranked the top and provided the most realistic simulation in terms of amount and spatio-temporal distribution of summer rainfall.

Keywords: RCM, WRF, Downscaling, Parameterization, Sensitivity, Ethiopia

1. Introduction

Advancements in scientific understanding of the climate system and climate modeling have promoted seasonal forecasting to be a well-established operational area at several national centers [1]. As a result, different centres around the world (e.g., the National Center for Environmental Prediction-NCEP, the European Center for Medium Range Weather Forecast-ECMWF, Australian Bureau of Meteorology) run seasonal forecasting systems (e.g., the Climate Forecast System version 2 [CFSV2, 2], seasonal forecast system [SEAS5, 3], and the Australian Ocean-Atmosphere Model for Climate Prediction [POAMA, 4] respectively on a global scale. These seasonal forecast products provide reasonable global perspectives and outlooks of the climate several months in advance. However, despite their potential applications for different socio-economic sectors, the usefulness of these forecasts has been limited because of their coarse spatial resolutions [1,5]. In order for such climate forecasts to be of practical societal value, it is essential for them to be issued at spatial scales appropriate to the decision maker or at the scale needed to exploit them further (e.g., using them as an input for hydrologic or crop simulation models) [5]. To address the scale problem and meet the need for regional information, downscaling seasonal forecast by using regional climate models (RCMs) became an emerging area during the last decade [5–7].

Several studies around the world have demonstrated the potential advantages of using RCMs to downscale coarse resolution climate predictions [e.g., 1,8–15]. Although

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