An inter-comparison of model-simulated east–west climate gradients over South Africa

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Abstract

This study examines how the east–west gradient of climate over South Africa is represented in terms of mean rainfall, tropospheric humidity and circulation, and surface latent heat flux in the satellite era 1980-2001. Inter-comparisons of NCEP2 reanalysis and GPCP satellite-gauge merged rainfall with coupled general circulation model (GCM) simulations from generic CMIP-3 are made, with a focus on the maize belt 25°-29°S, 25°-30°E. The summer climatology is analysed for the zonal gradient in vertical atmospheric structure and the annual cycle of rainfall. A wet bias is found in most simulations over the eastern mountains, but in two GCMs (CSM3, PCM) it extends over the western plateau. The east-west gradient in vegetation affects the vertical flux of surface moisture into the atmosphere. ECMWF reanalysis and SAFARI-2000 flux tower data reveal that this process is triggered during daytime heating, so model ability to handle the diurnal cycle is crucial. Inter-annual variability is briefly studied and two operational ensemble models (CFS and ECHAM4) simulate and forecast summer rainfall variations with positive correlation to observed values. The AIRS satellite night and day relative humidity structure is contrasted for dry and wet January months. All five generic CMIP-3 models: GFDL2, CSM3, PCM, HADen, ECHAM4 project a drying trend in the maize area over the period 2000–2050, using the SRES A1B scenario. Recommendations for observing the surface and mixed layer moisture fluxes are given.

Keywords: east-west climate gradient, model simulation and intercomparison, South Africa