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Role of soil moisture for the Amazon dry bias simulated by MPI-ESM

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A common deficiency of current state of the art global climate models and Earth System Models (ESMs) is the simulation of dry biases over various continental regions. While part of the biases originate from remote or coupled atmosphere-ocean processes and deficits of the ESMs, part of the biases are related to shortcomings in the simulation of land surface hydrology. This dual origin of a bias is also the case for the simulation of a dry bias over the Amazon simulated by the newest ESM version of the Max Planck Institute for Meteorology, MPI-ESM. Hagemann et al. (2013) evaluated the MPI-ESM ensemble of CMIP5 (Coupled Model Intercomparison Project Phase 5) simulations and found that the coupling to the ocean leads to a large negative precipitation bias over the Amazon catchment throughout the whole year, which is primarily induced by biases in simulated SST patterns and associated moisture transport. But they also noted that an insufficient representation of land surface processes is probably contributing to the dry bias during the boreal summer that is persistent in the fully coupled ESM and in the ESM versions driven by observed SST and sea ice (ECHAM6/JSBACH). Some studies also claim that biases over the Amazon catchment may feedback on the circulation and associated moisture transport. As soil moisture-atmosphere feedback effects play an important role in several regions of the globe, the role of soil moisture for the Amazon dry bias simulated by MPI-ESM shall be investigated in more detail. A replacement of the previous bucket scheme for soil moisture with a five layer hydrology scheme led to a significant reduction of the summer warm bias over the Amazon, but the impact on the precipitation dry bias was low. In order to analyse the role of soil moisture in more detail, two sensitivity simulations will be conducted with ECHAM6/JSBACH using the 5-layer hydrology scheme, one where the soil moisture is kept in a dry state and one where it is kept in a wet state. Differences in surface water and energy fluxes will be compared to the reference simulation, and potential model deficits related to the summer dry bias will be highlighted. Implications for improvements of the JSBACH land surface model will be stated, which may also be advantageous for other ESM groups whose ESM simulations suffer from similar biases.

Reference

Hagemann, S., A. Loew, A. Andersson, 2013: Combined evaluation of MPI-ESM land surface water and energy fluxes. J. Adv. Model. Earth Syst., 5, doi:10.1029/2012MS000173.