Using in-situ observations to identify sources of surface energy biases in climate models : focus on West Africa

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Abstract

CMIP5 models present systematics biases in 2m-temperature, in surface energy budget and in the annual cumulated rainfall over West Africa (Roehrig et al, 2013). The analysis of SST forced simulations shows some significant biases that can be related to the latitudinal positioning of the monsoon structures. However, since the surface energy budget depends to first order on this positioning (which controls the cumulated rainfall), it is not obvious to distinguish whether the energy biases are responsible for the bad positioning or the opposite. In order to disentangle this question, and to relate the energy biases to the climate model parametrisations, we investigate the behaviour of physical processes for given dynamical conditions by relaxing the winds of the atmospheric LMDZ model toward those of ERAI reanalysis. We then confront the GCM grid point to the in situ observations collected during the AMMA campaign (2006).

This study demonstrates the great potential of the nudging method to evaluate climate models at a given grid cell against station observations. Indeed, in nudged simulations, rainfall biases are reduced so that the latitudinal stratification of the West African climatic regimes is well captured, making the comparison with in-situ observations relevant. The nudging of horizontal winds also improves the representation of the surface energy budget and 2m-temperature during the rain season, due to a better representation of the water budget. However, some identified biases still remain in nudged simulations, namely a cold bias during the dry season over Sahel, underestimated seasonal variations of surface albedo and an overestimation of the solar incoming flux. A series of dedicated sensitivity experiments conducted with the LMDZ climate model highlights the key role of the thermal inertia, the turbulent mixing length, the albedo, the aerosols and clouds in the representation of meteorological 2m-variables.