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Uncertainties from above and below: West African monsoon patterns generated by a WRF multi-physics ensemble

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The credibility of regional climate simulations over West Africa stands and falls with the ability to reproduce the West African Monsoon (WAM) whose precipitation plays a pivotal role for people's livelihood. In this study, the ability of a 27-member mixed-physics ensemble of the Weather Research and Forecasting model to represent the WAM is investigated in a process-based manner in order to extract transferable information on parameterization influences. The uncertainties introduced by three cumulus (CU), microphysics (MP) and planetary boundary layer (PBL) parameterizations are analyzed to explore interdependencies of processes leading to a certain WAM regime during the wet year 1999. We identify the modification of the moist Hadley-type meridional circulation that connects the monsoon winds to the Tropical Easterly Jet as the main source for inter-member differences. It is predominantly altered by the PBL schemes because of their impact on the cloud fraction, that ranges from 8 to 20 % at 600 hPa during August. More low- and mid-level clouds result in less incoming radiation, weaker precipitation and a southward displaced African Easterly Jet and monsoon rainband. This identifies the representation of clouds as a critical "uncertainty from above" in simulating the WAM. The partitioning of sensible and latent heat fluxes is found to be another major source for the ensemble spread inducing "uncertainties from below" for the modeled monsoon regime. Finally, we show that regionally adapted simulations at convection-allowing scales with ingested dynamical land surface parameters improve the representation of convection, net radiation and surface flux partitioning.