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Role of soil moisture-atmosphere interactions in model simulation of the West African Monsoon

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Land-atmosphere interactions play a major role in climate characteristics over land. One of the key features of those interactions is the feedback of soil moisture on precipitation: driven by atmosphere variability, soil moisture variations in turn modulate land-atmosphere fluxes, altering surface climate and boundary layer conditions and potentially feeding back on precipitation, both through local and large-scale processes.

Prior studies have highlighted West Africa as one of the regions where such interactions play an important role in precipitation variability. Here we investigate the role of soil moisture-atmosphere interactions on the West African Monsoon in the GFDL-ESM2M model, comparing simulations from the GLACE-CMIP5 experiment with prescribed (climatological seasonal cycle) and interactive soil moisture. Results indicate that total monsoon precipitation is enhanced in the prescribed case, suggesting that overall soil moisture-atmosphere interactions act to reduce precipitation. However, contrasting effects appear between the “core” of the monsoon (in a time- latitude sense) where precipitation is reduced with interactive soil moisture, and the “margins” (in a time-latitude view) where precipitation increases. We investigate the processes responsible for these differences, from changes in the surface energy budget and Bowen Ratio to changes in large-scale circulation and monsoon dynamics. Simulations from other GLACE-CMIP5 participating models are also analyzed to assess the inter-model robustness of the results.