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African Easterly Waves and Superparameterization

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This study examines the dynamics of African easterly wave (AEW) in the Superparameterized Community Climate System Model (SP-CCSM). Conventional general circulation models (GCMs) have difficulty representing AEW dynamics over West Africa. One reason is that the coarse resolution of these models limits their ability to represent the multi-scale interactions between the large-scale dynamics and individual convective systems, which are important for the origin and development of AEWs. The SP-CCSM has been designed to better simulate the interactions between small-scale circulations and large-scale dynamics, by replacing the conventional parameterizations with a 2D cloud resolving model embedded within each GCM grid column. With this approach we are able to capture the interactions between clouds and the global circulation of the atmosphere. The goal of our work is to improve our understanding of the multi-scale interactions that occur between AEWs and convection over West Africa.

The implementation of the superparameterization into the CCSM improves the overall representation of monsoon precipitation over West Africa. Most notably, the region of maximum precipitation is shifted from the Gulf of Guinea in CCSM (not realistic), to over the continent in SP-CCSM. The biases found in precipitation for both models are thought to be linked to anomalously warm sea surface temperatures in the Gulf of Guinea and a misrepresentation of the equatorial Atlantic cold tongue (a common problem for coupled GCMs). AEWs and their relationship with convection are also improved in the SP-CCSM. In the standard model, little to no easterly wave activity is found over West Africa, and the relationship with convection is tenuous at best. SP-CCSM on the other hand produces strong AEWs over the region that exhibit similar horizontal and vertical structures to observations. The simulated waves are also shown to be strongly coupled to convection, and results suggest that barotropic and baroclinic energy conversions as well as diabatic heating from convection are critical for the development of AEWs in SP-CCSM.