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Deep moist convection as a governor of the West African Monsoon

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Climate models struggle to capture monsoons and fail to represent the water cycle in West Africa with sufficient accuracy to provide confidence in even the sign of projected rainfall change. Global models all use parameterisations of deep convection and struggle to represent both the diurnal cycle and the upscale organisation of the convection. Here, we use 40-day continental-scale convection-permitting simulations over summertime West Africa to evaluate how the representation of convection affects the modelled synoptic-scale meteorology and the implications for weather and climate prediction. The convection-permitting simulations give a more realistic distribution and diurnal cycle of convection with upscale organisation and a more realistic monsoon flow.

The impact of representation of convection on the monsoon is explained by the differences between the heating from parameterised and explicit convection and the representation of cold-pool outflows, which in explicit runs form an important component of the monsoon. The convective storms act as a governor to the WAM system: the monsoon provides moisture for convection, while the convection weakens the monsoon flow and delays its diurnal cycle. The explicit versus parameterised differences are consistent with the forecast bias exhibited in this region by global model forecasts. Improved parameterisations of convection that capture storm structures, their diurnal cycle and rainfall intensities will substantially improve weather and climate predictions of the WAM and many varied aspects of Earth system modelling.