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Convection-circulation interactions over West Africa in simulations with explicit and parameterised convection

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This work examines the representation of convection-circulation coupling over tropical West Africa in convection-permitting models. Tropical West Africa is not only a region characterised by extremely high-impact weather, in the form of intense and frequent organised convection, but it is also a region of strong baroclinicity and wind shear, and therefore an excellent natural laboratory for examining the connections between mesoscale convection and synoptic circulations. Developing understanding ofconvection-circulation coupling is crucial to informing development of convection parameterisations and improving regional forecasts of high-impact weather.

We evaluate output from the CP4-Africa configuration of the Met Office Unified Model to investigate links between convective activity and synoptic motions. To illustrate its strengths in representing convection-circulation feedbacks, CP4 output is compared to that from a similar UM configuration which uses a convection parameterisation.

We examine the mean diurnal cycle of circulation during the storm season. Distinct diurnal patterns in circulation tendency are compared to patterns in updraughts and precipitation, which illustrate different forms of convection which can be observed at different points during the day. A “congestus” mode convects up to around the freezing level from morning until early evening, while deep organised convection triggers in the mid-to-late afternoon and persists overnight. The two forms of convection appear to cause characteristically different responses in the synoptic circulation.

To confirm which physical processes cause changes to circulation in the region, we calculate terms in the circulation tendency equation. Separating these terms into mean and eddy-flux contributions allows us to establish the extent to which mesoscale systems and synoptic structures each influence the diurnal changes to circulation.