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Representing tropical deep convection in high-resolution climate models

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The representation of tropical convection remains a relatively weak component of coupled Global Climate Models (GCMs), due to the inherent complexity of the problem, in particular due to the numerous scale interactions involved. This weakness impacts directly on the simulated tropical circulation and is one of the main areas requiring parametric improvement in order to make an overall advance in the simulation of tropical variability.

With the continual increase in computer power, the resolution of coupled GCMs is increasing. With time these models will begin to move into the resolution range presently occupied by Regional Climate Models (RCMs) and Numerical Weather Prediction (NWP) models, namely the ∼20-100km range. It therefore seems pertinent to utilise the latter models in order to understand and improve the representation of deep convection at the resolution of future coupled GCMs

RCMs offer one route for assessing and improving the representation of deep convection at high-resolution. In this work we have configured the Rossby Centre Regional Climate Model (RCA) to run over the tropical eastern Pacific and central America at 2 horizontal resolutions, ∼33km and ∼15km. The 33km model used a relatively large domain with prescribed SSTs and lateral boundary conditions derived from the ERA40 reanalysis. The ∼15km model encompassed a smaller domain and was forced at the lateral boundaries by results from the larger ∼33km model. In this manner both models experienced similar large scale forcing, allowing us to study the sensitivity of parameterised deep convection to increased resolution.

In the RCA model, deep and shallow convection are parameterised using the Kain-Fritsch scheme, while a prognostic moist TKE scheme is used for boundary layer turbulence. A bulk-microphysics scheme is used for large-scale condensation processes, following the general approach of Sundqvist schemes. In this presentation we evaluate the representation of deep convection over the eastern tropical Pacific in the 2 model integrations. We make extensive use of high-resolution observations, such as the TRMM tropical rainfall data at high temporal resolution, in order to evaluate the simulated frequency distribution of precipitation intensity and occurrence. We further try to make a complete evaluation of the simulated regional water-cycle, using observed estimates of vertically integrated water vapour, surface radiant and turbulent fluxes and satellite derived cloud cover. Some preliminary conclusions regarding the sensitivity of simulated convection to increased resolution are presented, along with suggestions for future work to increase the benefits of higher model resolution in representing deep convection.