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Improving convection parameterisations in general circulation models

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An adequate representation of convective processes in numerical models of the atmospheric circulation (general circulation models, GCMs) remains one of the grand challenges in atmospheric science. In particular, the models struggle with correctly representing the spatial distribution and high variability of tropical convection. It is thought that this model deficiency partly results from formulating current convection parameterisation schemes in a purely deterministic manner which lack memory effects on the grid-box scale.

Progress made in utilising stochastic model-based estimates of updraft area fractions at cloud base as part of the deep convection scheme of a GCM (ECHAM6) are presented. The updraft area fractions are used to yield one part of the cloud base mass-flux used in the closure assumption of convective mass-flux schemes.

AMIP-style simulations, i.e. with prescribed observed SSTs, with and without the new convection parameterisation are presented. We find that with the stochastic model approach, convection is weaker and more coherent and continuous from timestep to timestep compared to the standard model. Total global precipitation is reduced in the stochastic model run, but this reduces i) the overall error compared to observed global precipitation (GPCP) and ii) middle tropical moisture biases compared to ERA-Interim. Hovmoeller diagrams indicate a slightly higher degree of convective organisation compared to the base case and Wheeler-Kiladis frequency wavenumber diagrams indicate slightly more spectral power in the MJO range.