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The Stochastic Multicloud Model as part of an operational convection parameterisation in a comprehensive GCM

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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.

Here, we use observations of tropical convection to inform the design of a novel convection parameterisation with stochastic elements. The novel scheme is built around the Stochastic MultiCloud Model (SMCM, Khouider et al 2010).

We present the progress made in utilising SMCM-based estimates of updraft area fractions at cloud base as part of the deep convection scheme of a GCM. 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. The closure thus receives a stochastic component, potentially improving modeled convective variability and coherence.

For initial investigations, we apply the above methodology to the operational convective parameterisation of the ECHAM6 GCM. We perform 5-year AMIP simulations, i.e. with prescribed observed SSTs. We find that with the SMCM, convection is weaker and more coherent and continuous from timestep to timestep compared to the standard model. Total global precipitation is reduced in the SMCM run, but this reduces i) the overall error compared to observed global precipitation (GPCP) and ii) middle tropical tropospheric temperature 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.