

Explaining convective self-aggregation onset with a stochastic reaction-diffusion model of the Tropics

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In an attempt to explain some differences existing between cloud-resolving models (CRMs) about the occurrence, under certain circumstances, of states in which convection self-aggregates, a simplified, two-dimensional, stochastic model was developed. Its prognostic equation governs the evolution of column total water relative humidity in tropical free troposphere, including convective moistening, diffusive lateral transport and subsidence drying, similar to Craig and Mack (2013), but with convection treated as a point process and stochastic variability in convective outbreak accounted for. Therefore the model allows to employ domain sizes and resolutions similar to idealized CRM simulations.

We found that, depending on the chosen parameter settings, the model can reproduce equilibrium states of strong aggregation and randomly distributed convection, analogous to CRMs. Large ensembles of experiments were performed for different values of subsidence timescale, moisture diffusion coefficient and the parameter determining convective sensitivity to background humidity, as well as for a range of domain sizes and resolutions. Using dimensional arguments, combined with empirical fits from numerical data, we define a dimensionless quantity whose value indicates whether a clustered state is likely to emerge for a given experimental configuration. This quantity contains dependencies on all the model processes and also includes domain size and resolution.

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