Stochastic and deterministic multicloud models for organized tropical convection

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Abstract:

Khouider and Majda (2006) introduced a new conceptual model parameterization for organized convection based on the interactions between three cloud types, congestus, deep, and stratiform that, according to recent satellite and in situ observations, are the dominant cloud features in organized tropical convective systems (TCS) of all scales.

The multicloud model is very successful in reproducing the main features of observed convectively coupled waves and the MJO including their phase speeds and their zonal and vertical structures, in the context of both a simple model, with a crude vertical resolution reduced to the first two baroclinic modes, and a GCM.

Since then, two versions of the multicloud model have been proposed are used. A deterministic version that facilitates linear wave analysis and a stochastic version that considerably enhances the variability and captures the observed chaotic nature of organized convection. In the deterministic version, the three cloud types interact with each other through simple adjustment equations and a moisture switch function that depends on the dryness of the middle troposphere; when the troposphere is dry congestus clouds are favored and when the troposphere is moist deep convection is promoted. The stochastic model on the other hand is based on a lattice of sites that are 1 to 10 km apart that either are occupied by a cloud of a certain type or are clear sky. The lattice sites switch from one state to another according to whether the large-scale environment is favorable to one cloud type or the other, dependent mainly on CAPE and the tropospheric dryness, as well as some plausible constraints that allow clouds to cluster through at the subgrid scale.

In this talk, both the deterministic and the stochastic models will be presented and assessed against each other. Some emphasis shall be put on the chaotic evolution of convective precipitation and gravity waves in the stochastic model.