Hierarchical organized cloud system in a large domain RCE simulation

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Idealized explicit convection simulations under a radiative convective equilibrium (RCE) condition has been applied to research on tropical convection. Recent studies using three-dimensional cloud-resolving models in RCE conditions showed that convections become aggregating from a popcorn-like scattering condition to a single region if suitable conditions are given. The phenomenon is called as ‘self-aggregation’.

In this study, we simulate self-aggregation of convection in a 5000x5000 km domain (O(10^8 km^2)). The horizontal grid spacing of the model is 4 km. This domain size is two orders of magnitude larger than almost all of the previous studies targeting self-aggregation of convection using cloud-resolving models, which typically used a domain of the order of 10^6 km^2. Although there exist studies that performed RCE simulations in the earth size sphere, they suffered from a problem of grid printing. Comparing to those global simulations, our approach does not suffer from the problem of the non-uniformity of grids.
The peruse of this study is to understand the spatial and temporal scales of the organized cloud systems and hierarchical structure of clouds observed in the tropics. The larger simulation domain is needed to enable the large-scale circulation spontaneously created and interactions of clouds with multiple scales within it.

In our simulation, like a small area self-organization studies, the wet area becomes to form one cell structure in about 40 days. In this moist patch, individual clouds form several clusters of the horizontal scale about several hundred kilometers. Oscillating behavior of those clusters is observed in units of days. The area average column integrated water vapor amount decreased as in the small area studies, but the vertical structure of water vapor is different. The wet peak is seen in the middle layer about 5 km. As a result, the radiative cooling profile also have a peak at about 5 km height.

There are two poles in the effective stream function. One is upper layer and the other is lower layer. These results may be key to hierarchical organized structure of convection. We plan to compare this result with more larger domain simulation and different SST simulation until our presentation.

Keywords: RCE, Self-aggregation, deep convection