New Critical Length Scale for the Onset of Self-Aggregation of Moist Convection

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Self-organization of convective clouds, Convective Self-Aggregation (CSA), in an idealized modeling framework of the tropical climate, has been recognized as a key process to understand cloud-climate relationships. This study investigated how CSA occurs under an idealized radiative-convective equilibrium climate simulated by a regional cloud-resolving model with wide varieties of horizontal domain sizes and horizontal grid spacings. First of all, our results basically reproduced the results of Muller and Held (2012) that CSA is unlikely to occur from a homogeneous initial moisture field with finer resolution and/or smaller domain. However, by extending the domain size, we found that CSA occurs even with the finer resolution. Based on the dozens of experiments, we discovered a new critical domain size around 500 km above which CSA robustly occurs with a more reliable resolution range including a half kilometer. In addition to this, a sharp variation of the critical domain size across the grid spacing around 2 km became apparent. It implies that the resolution alters a multiscale interaction of moist convection ranged from individual convective elements to large-scale overturning circulation coupled with moisture field. Finally, the onset mechanism of CSA is discussed in terms of the competing effects on the boundary layer moisture distribution, by rethinking the negative effect of cold pools on the onset of CSA which have been reported by previous studies.

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