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Competition between convection of mesoscale patterns and its impacts on self-organization in idealized CRM simulations

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This study first aims to address why mesoscale convective patterns are important and investigate the effects on both dynamics and thermodynamics using a cyclic cloud-permitting model, CM1. A set of idealized experiments to address the competition between isolated and agglomerated, organized convection using large-domain simulations with explicit representations of both convective-scale and domain-scale circulations. The atmosphere is uniformly destabilized with homogeneous forcing and with convective forms across the entire domain (organization gradient) modulated by vertical wind shear. Even without interactive radiation and surface fluxes, interactions among two regimes of cloud ensembles in different mesoscale forms lead to the formation of large-scale circulations, with intensified precipitation supported by the upwelling branch of overturning. Large-scale circulations tend to be more amplified as organization gradient increases, implying an essential role in dynamics and a faster process in preconditioning convective organization in more complex physical processes. From fully interactive RCE in domains initialized with different wave-like convective patterns but similar domain-wise thermodynamic states, we further show that convective patterns of a small wavenumber, analogy as larger organization gradient, fasten the drying effect by expanding dry patches with time. This control experiment implies that a more rapid self-aggregation process (separation between moist and dry regimes) through convective-radiative feedbacks may be bolstered by the presence of more distinct convective patterns.

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