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Circling in on Convective Organization

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In radiative-convective equilibrium (RCE) simulations, the initial pattern of convective cells is often considered to be unorganized, or random. Eventually, symmetry breaking, known as self-aggregation, occurs. Using a suite of high-resolution numerical simulations, we show that the pattern of convective rain cells is already non-random a few hours after the initial onset of deep convection, and we find that cloud patterns organize into line-like structures. We suggest that the formation of these lines requires considering the specific spatial interaction between cold pool (CP) gust fronts, namely one where two CPs collide, thereby exciting new rain cells. By tracking CPs, we determine the maximal CP radius R_{max} = 20 km and show that cloud-free regions exceeding such radii always grow indefinitely, whereas smaller ones often decay. Our theory and conceptual modeling describe a mechanism, where cloud-free areas in RCE are likely to form when CPs have small R_{max} and cannot replicate, whereas large R_{max} hampers cavity formation. Our findings imply that interactions between CPs crucially control the dynamics of self-aggregation, and known feedbacks may only be required in stabilizing the final, fully-aggregated state.

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