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A simple conceptual model for the scale increase in convective cloud organization

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Precipitation from convective extreme events has been shown to exceed expectations from equilibrium thermodynamics, i.e. the precipitation rate increases at more than the Clausius-Clapeyron rate under increasing near-surface temperatures. Simulations suggest that such intensification could be tied to cloud organization by cold pools. Our high-resolution large-eddy simulations show that single-event intensities are often larger when fractional precipitation area is reduced in the model domain, i.e. the area fraction - and correspondingly, the areal number density - of precipitation events is on the decrease, a circumstance that often occurs in the late afternoon of a typical convective day. Quantified by the spatial correlation function of low level moisture convergence, we show that such reductions of density are generically encountered across different large-eddy simulation setups. We find that the spatial scale, measured throughout the model day, increases approximately linearly for all simulations —- at comparable rates. To describe this linear increase, we suggest a simple conceptual model, making use of iterated Voronoi triangulations. The model is based on a repeated sequence of “firing” precipitation events and a “reproduction” process which is set off by the corresponding cold pool currents. The cold pool origins, each located at the center of a given precipitation event, thereby form the nodes of a given Voronoi mesh. The scale increase is a function of the "reproduction rate" determined by the properties of the cold pools involved. Our model may have implications for the description of extreme precipitation events and the better understanding of the super-Clausius-Clapeyron relation.