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Edge intensification of convection in a self-aggregation study

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Numerical studies of radiative-convective equilibrium frequently show, despite homogeneous initial and boundary conditions, a transition from an initially homogeneous humidity field with randomly distributed convection to a state in which convection is confined to a single approximately circular moist region. Investigating the spatial distribution of convection within the moist region using a radiative-convective equilibrium simulation we show that convection is regularly intensified at the edge of the moist region which is reminiscent of current high-resolution simulations over the tropical Atlantic where convection has been shown to be intensified at the edge of the Intertropical Convergence Zone.

We here propose that the distribution of convection within the moist region and also the size of the moist region depend on the convectively induced cold pools. In particular, we show that as the simulation reaches a steady state with a single moist region of approximately constant size, the convective part of this region is entirely made up of individual cold pools whose combined effect is to balance the strong low-level inflow caused by the radiatively driven shallow circulation. At the boundary of the convective region, where the inflow meets the cold pools, a convergence line forms which we relate to the edge intensification of convective activity. Treating the entire convective region as a single "super-cold pool" we show that estimating the potential propagation speed of the super-cold pool boundary matches the speed of the inflow velocity and that an imbalance between inflow and super-cold pool speed is linked to changes in the area of the convective region. In particular, we find oscillations of the area with a multi-day period where the area expands (contracts) if the super-cold pool propagation speed is greater (smaller) than the inflow speed.