THE SELF-ORGANIZATION OF TROPICAL CONVECTION

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Key words Tropical convection, convective organization, self-aggregation, radiative feedbacks.

The organization of tropical convection is ubiquitous, but its physical understanding remains limited. One particular type of organization is the spatial self-aggregation of convection (figure), taking the form of cloud clusters, or tropical cyclones in the presence of rotation.

We show that several physical processes can give rise to self-aggregation, and highlight the key features responsible for it using idealized simulations. Longwave radiative feedbacks yield a “radiative aggregation". In that case, sufficient spatial variability of radiative cooling rates yields a low-level circulation, which induces the up-gradient energy transport and radiative-convective instability. Not only do vertically-integrated radiative budgets matter, but the vertical profile of cooling is also crucial.

Convective aggregation is facilitated when downdrafts below clouds are weak (“moisture-memory aggregation"). Interestingly, this is sufficient to trigger aggregation in the absence of longwave radiative feedbacks. These results shed some light on the sensitivity of self-aggregation to various parameters, including resolution or domain size.

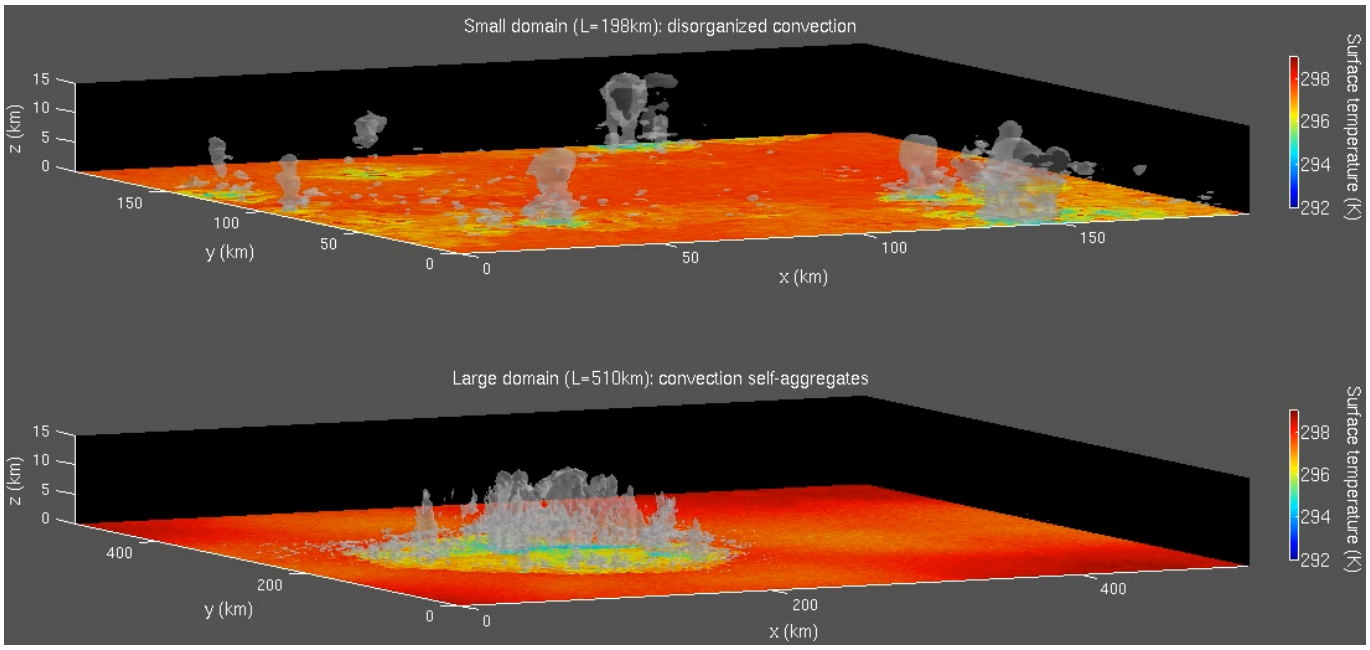

Figure. *Clouds (gray surfaces) and near-surface temperatures (colors) in two simulations in radiative-convective equilibrium. The simulations only differ by their domain size. In the large-domain simulation (bottom panel), the convection spontaneously self-aggregates in space.*