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Large-scale cluster formation in fingering convection

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Fingering convection is a form of convective flow based on a doubly-diffusive instability, and peculiarly characterized by counter-gradient density transport. It is of particular interest in oceanography, where fingering due to temperature and salinity stratification is suspected to play an important role for vertical dyapicnal mixing in the subtropical oceans. Far from instability these flows are highly nonlinear and produce large vertical fluxes of salinity, temperature and density. In some instances a secondary instability leads to the formation of characteristic density staircases.
In this study we explore turbulent fingering convection in high-resolution 2D and 3D numerical simulations, in the highly nonlinear regime, that is at high Rayleigh number and at low density ratio. We report on the formation of characteristic clusters of fingers in the flow. These clusters, with dimensions significantly larger than the characteristic scale of individual fingers, are long-lived and play a relevant role for the dynamics of the flow. The physical mechanisms leading to finger clustering and associated changes in density fluxes and density stratification in the flow are explored. The numerical simulations which develop clusters eventually also develop density staircaises.