Growth of binary fluid convection: the role of the concentration field

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Abstract

The growth of convection in binary fluid mixtures out of different perturbations of the quiescent conductive state is investigated using finite-difference numerical simulations for realistic ethanol-water parameters with strong negative Soret coupling between temperature and concentration fluctuations. Several different analysis tools are used to elucidate the complex spatiotemporal behavior associated with the dramatic concentration redistribution during the transients. It shows first the competition between counterpropagating waves that initially superimpose to form standing wave perturbations. Having reached a critical amplitude an advective breaking of the concentration wave triggers a very fast flow-induced transition from standing to traveling wave convection with large phase velocity and large concentration field amplitudes. Strongly nonlinear advective mixing and weak long-time diffusive homogeneization then slow down the waves.

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