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Transient diffusive boundary layers in porous media: The linear transition region NILS TILTON, DON DANIEL, AMIR RIAZ, University of Maryland, College Park — Gravitationally unstable, transient, diffusive boundary layers play an important role in carbon dioxide sequestration in subsurface porous aquifers. Though the linear stability of these boundary layers has been studied extensively, there is little consensus concerning the critical time for instability. Nor is it clear which perturbations dominate the linear regime and trigger onset of convection due to nonlinear effects. We perform a comprehensive linear stability analysis using complementary quasi-steady and initial value problem approaches. We demonstrate that disagreement concerning the linear regime stems from an inherent sensitivity of the problem to how perturbation growth is measured. The perturbation concentration and velocity fields exhibit differing growth rates and these rates depend on the norm used to measure perturbation growth. Consequently, the critical time is not clearly defined. At later times, however, all initial perturbations tend towards the least stable quasi-steady eigenmode. We interpret this convergence process in terms of mechanisms related to the transient base-state, non-self-adjoint linear stability operator, and initial condition. Finally, we suggest potential paths for onset of convection which we demonstrate with direct numerical simulation.

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