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Penetration of a cooling convective layer into a stably-stratified composition gradient: entrainment at low Prandtl number RAFAEL FUENTES, ANDREW CUMMING, McGill University — We study the formation and evolution of a convective layer when a stably-stratified fluid with a composition gradient is cooled from above. We perform a series of 2D simulations using the Bousinessq approximation with Prandtl number ranging from Pr = 0.1 to 7, extending previous work on salty water to low Pr. We show that the evolution of the convection zone is well-described by an entrainment prescription in which a fixed fraction of the kinetic energy of convective motions is used to mix fluid at the interface with the stable layer. We measure the entrainment efficiency and find that it grows with decreasing Prandtl number or increased applied heat flux. The kinetic energy flux that determines the entrainment rate is a small fraction of the total convective luminosity. In this time-dependent situation, the density ratio at the interface is driven to a narrow range that depends on the value of Pr, and with low enough values that advection dominates the interfacial transport. We characterize the interfacial flux ratio and how it depends on the interface stability. We present an analytic model that accounts for the growth of the convective layer with two parameters, the entrainment efficiency and the interfacial heat transport, both of which can be measure from the simulations.

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