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Entraining gravity currents CHRIS JOHNSON, ANDREW HOGG, School of Mathematics, University of Bristol — Large-scale gravity currents, such as those formed when industrial effluent is discharged at sea, are greatly affected by the entrainment and mixing of ambient fluid into the current, which both dilutes the flow and causes an effective drag between the current and ambient. We study these currents theoretically by combining a shallow-water model for gravity currents flowing under a deep ambient with an empirical model for entrainment, and seek long-time similarity solutions of this model. We find that the dependence of entrainment on the bulk Richardson number plays a crucial role in the current dynamics, and results in entrainment occurring mainly in a region close to the flow front, reminiscent of the entraining current 'head' observed in natural flows. The long-time solution of an entraining lock-release current is a similarity solution of the second kind, in which the current grows as a power of time that is dependent on the form of the entrainment model, approximately as $t^{0.44}$. The structure of a current driven by a constant buoyancy flux is quite different, with the current length growing as $t^{4/5}$. Scaling arguments suggest that these solutions are reached only at very long times, and so may be attained in large natural flows, but not in small-scale experiments.

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