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Time-dependent plume dynamics C.P. CAULFIELD, BPI/DAMTP, University of Cambridge, M.M. SCASE, Civil Engineering, University of Nottingham, A.J. ASPDEN, Lawrence Berkeley National Laboratory, S.B. DALZIEL, DAMTP, University of Cambridge — We generalize the classical turbulent plume model of Morton, Taylor & Turner (1956) to consider time-varying isolated sources of buoyancy in both unstratified and stratified environments. When the source buoyancy flux is reduced rapidly, we find that the plume narrows transiently from the classical straight-sided similarity solution towards another straight-sided similarity solution originally considered in the context of statically unstable ambient density distributions by Batchelor (1954). We verify this behaviour quantitatively by considering a large ensemble of laboratory experiments. Our results suggest that plume pinch-off is typically quite difficult to achieve. Conversely, when the source buoyancy flux increases rapidly, we find that a transient "bulge" propagates up the plume, separating regions of the plume associated with the original and final plume source conditions. We identify scaling laws for the various properties of this bulge, which are verified numerically by an ensemble of large eddy simulations. We show that our model equations can also be applied directly to the starting plume model of Turner (1962) if the increased entrainment through the top of the starting plume is accounted for appropriately.

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