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Steady solutions for plumes in non-uniform stratifications NIGEL KAYE, Clemson University, MATTHEW SCASE, University of Nottingham — The plume conservation equations of Morton et al. (1956) are recast in terms of the plume radius, flux balance parameter Γ, and a dimensionless parameter that characterizes the stratification. This set of equations lead to simple analytic solutions for steady straight sided plumes in non-uniformly stratified environments. Steady plumes in non-uniform stratification can occur for both stable (Caulfield & Woods 1998) and unstable (Batchelor 1954) stratifications whose strength has a power law variation with height. We present analytic solutions for the range of stratification power-law decay rates κ for which straight sided plumes are possible. The approach used provides significant physical insight into the limits on κ that permit straight sided solutions. We also present analytic solutions for the power law behaviour with height of the fluxes of volume, momentum and buoyancy. This result demonstrates that the models of Batchelor and Caulfield & Woods are two halves of the same continuum of solutions. The flux power law behavior explains the transition between the Batchelor solutions and the Caulfield & Woods solutions that occurs when $\kappa = -8/3$. For $\kappa < -8/3$ the buoyancy flux decays with height and, therefore, the stratification must be stable. Whereas for $\kappa > -8/3$ the buoyancy flux must increase with height, requiring an unstable stratification.

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