Entrainment in Cumulus Clouds: Which resolution is cloud-resolving?

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Systematic numerical experiments to determine the spatial resolution required to resolve a moist thermal show convergence at a scale proportional to the smaller of the initial thermal diameter D_0 and a buoyancy length scale L_{buoy}. The buoyancy length scale $L_{buoy.} = \Delta T_0/\Delta\Gamma$ (ΔT_0 is the initial buoyancy excess of the thermal and $\Delta\Gamma$ is the ambient stratification) describes the maximum vertical displacement that can be induced against the stratification in the environment by buoyancy-driven pressure perturbations in the cloud, and thus the maximum scale of eddies that cross the cloud boundary. For typical atmospheric conditions where the cloud size D_0 is larger than L_{buoy}, numerical simulations of the mixing processes in cumulus clouds must resolve L_{buoy}.