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Do growing cumulus experience friction?

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Efforts to tune cumulus parameterisations, notably by adjusting entrainment rates, have yielded conflicting results with no single entrainment representation producing satisfactory representation of both the sensitivity of convection to ambient humidity (which requires a high rate) and accurate representation of the mean state (which may require convection to reach the tropopause more easily). This situation calls for a rethinking of the basic assumptions upon which convection schemes are built. We argue that a crucial target is the assumption that convective plumes or thermals experience heavy drag upon ascent, which is either explicit or implicit in basic models underlying convective schemes. Relaxation of this assumption appears to be justified on the basis of heuristic fluid dynamical arguments and laboratory studies, and would tend to alleviate some basic problems by allowing highly-entraining clouds to penetrate more deeply. We present analyses of the momentum budget of numerically-simulated cumulus updrafts to reassess the role of damping due to friction-like processes, in order to determine more rigorously whether friction should be reduced or eliminated in idealised cumulus models. A fundamental issue that arises in this computation is the ambiguity in defining what exactly constitutes the "parcel" that is represented in the idealised ascending-parcel calculation, in a realistic situation of a strongly deforming and turbulent fluid with rapid phase changes.