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Deep convection, subsidence, and large-scale circulations in Eulerian and Lagrangian models

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In contemporary Eulerian general circulation models, the coupling between upwards transport of airmass and tracers in deep convective clouds and transport by large scale (resolved) circulation patterns is normally not explicitly simulated. Instead, it is frequently assumed that the transport of airmasses by updrafts, downdrafts, and mesoscale circulations is a closed process: any upwards mass transport in convective updrafts is exactly balanced by downwards transport in convective downdrafts and between-cloud mass-balance subsidence, all in the same column. For some types of cloud systems, this approximation may generally hold well. However, this is not necessarily always the case; updrafts can also take place in regions of large-scale, low-level convergence, and be connected to larger circulation systems such as the Hadley or Walker cells, in which case the mass-balance subsidence will occur up to thousands of km away from the updrafts. There are many important implications resulting from the neglect of this coupling, for both Eulerian models, as well as for Lagrangian trajectory and parcel dispersion models which are driven by winds from these Eulerian models. Though some of these have been discussed extensively at conferences and workshops, many are not familiar to the community as a whole. We examine the relationship between convection, subsidence and large-scale low-level convergence, and present a focused overview of the implications of this relationship and its treatment in current Eulerian and Lagrangian models.