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Vertical Velocities in Cumulus Convection: Implications for Climate and Prospects for Realistic Simulation at Cloud Scale

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Cumulus mass fluxes are essential controls on the interactions between cumulus convection and large-scale flows. Cumulus parameterizations have generally been built around them, and these parameterizations are basic components of climate models. Several important questions in climate science depend also on cumulus vertical velocities. Interactions between aerosols and convection comprise a prominent example, and scale-aware cumulus parameterizations that require explicit information about cumulus areas are another. Basic progress on these problems requires realistic characterization of cumulus vertical velocities from observations and models. Recent deployments of dual-Doppler radars are providing unprecedented observations, which can be compared against cloud-resolving models (CRMs). The CRMs can subsequently be analyzed to develop and evaluate parameterizations of vertical velocities in climate models. Vertical velocities from several cloud models will be compared against observations in this presentation. CRM vertical velocities will be found to depend strongly on model resolution and treatment of sub-grid turbulence and microphysics. Although many current state-of-science CRMs do not simulate vertical velocities well, recent experiments with these models suggest that with appropriate treatments of sub-grid turbulence and microphysics robustly realistic modeling of cumulus vertical velocities is possible.