MMM SEMINAR SERIES

What gives supercells a leg-up over ordinary convection in resisting entrainment?

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Supercell thunderstorms are dynamically distinct from ordinary nonrotating convection. Supercells are often capable of maintaining a distinct plume-like updraft for several hours, whereas ordinary convection is characterized by series of episodic thermals with typical lifespans of < 30 minutes. This research presents new insights into why supercells are able to sustain updrafts for lengthy intervals.

Using high-resolution numerical simulations, it is shown that supercells' low-level inflow substantially increases with time as they begin to propagate strongly to the right of the mean advective flow. Mass continuity necessitates a compensatory increase in vertical mass flux as a response to the increase in horizontal low-level inflow, which in many cases results in a widening updraft rather than in increase in updraft vertical velocity. At the same time, substantial updraft vertical vorticity in supercells results in centrifugally stable flow within the supercell's lower updraft, which inhibits the buoyant generation of toroidal vorticity along the updraft's flanks. These two factors – increasing diameter and centrifugal stability with time – are shown to inhibit the breakdown of the supercell updraft into discrete thermals, and to promote a plume-like updraft structure. As a result of the wide diameter and plume-like nature of supercell updrafts, their cores become less-susceptible to entrainment-driven dilution than ordinary convection. Evidence is shown for the transport of nearly pure boundary layer air into the lower stratosphere in supercell updrafts, whereas nearly pure air is only present in the lowest few kilometers of the troposphere in ordinary convection.

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Thursday, 19 July 2018, 3:30pm
Refreshments 3:15pm
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