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Barotropic and baroclinic contributions to the mid-level mesocyclone

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Numerical simulations and observations of supercells suggest that the updraft-scale mesocyclone is often characterized by a rather smooth, cyclonically-curved flow, in which comparatively intense and compact vortices are embedded. One of the questions addressed in the presentation is why the updraft-scale mesocyclone tends to be characterized by a “curved flow” rather than a coherent vortex. Initial analysis suggests that this structure is consistent with the shear- and curvature-vorticity equations, predicting that tilting of horizontal streamwise vorticity yields vertical curvature vorticity. Also, the talk will address the compact vortices, which are much more unsteady than the broad mesocyclone and which sometimes are shed from the western side of the updraft. Based on preliminary research these vortices are associated with baroclinically-augmented vorticity and are suspected to contribute to the temporal variability of precipitation in the hook-echo region of the supercell. Using the CM1 cloud model, forward trajectories are analyzed and vorticity decomposition into baroclinic and barotropic parts is applied in order to isolate the dynamical cause of the compact vortices. Possible effects of these vortices on outflow characteristics in the hook-echo region and on near-ground rotation will be discussed.