An investigation of the tornadic stage of the Goshen County, Wyoming, supercell of 5 June 2009 using EnKF assimilation of mobile radar data collected during VORTEX2

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Introduction

DOWs, DOW7, NOXP, and KCYS radial velocity observations collected in the Goshen County storm are assimilated into WRF simulations of a supercell using the ensemble Kalman filter. We are using the resulting 4-D analyses to evaluate mesocyclone-scale processes associated with tornado formation, maintenance, and demise.

Methodology

- Observations assimilated every 2-min,
- 50 ensemble members,
- 500 m horizontal grid spacing.

- Stretched vertical grid (80 m near ground),
- Lin et al. (1983) microphysics,
- Flat terrain, no radiation or sfc fluxes,
- Horizontally homogeneous environment.

Properties of mesocyclone during tornado lifecycle

Mesocyclone is strongest during tornado intensification and maturity.

Mesocyclone is most tilted during tornadogenesis and while tornado is weakening.

Near-sfc circulation increases rapidly during tornadogenesis. Strong radial inflow also present.

During tornado maturity and demise, circulation decreases and outward radial flow develops.

During tornadogenesis and intensification, mesocyclone becomes slightly less negatively buoyant.

During tornado maturity and weakening, mesocyclone becomes slightly more negatively buoyant.

Trajectories of parcels entering low-level mesocyclone

Most parcels transit forward-flank baroclinic zone en route to low-level mesocyclone throughout tornado lifecycle.

During tornadogenesis, parcels enter low-level mesocyclone from near the ground and ascend into mid-level updraft.

During tornado demise, parcels descend within the mesocyclone and diverge in the low-level outflow.

Vorticity production in forward flank

Largest baroclinically-generated horizontal vorticity present at end and beginning of tornado lifecycle. Less horizontal vorticity is produced during intensification.

Largest tilting production of vertical vorticity is during tornadogenesis. Tilting steadily decreases through remainder of tornado lifecycle.

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Conclusions

During tornadogenesis and intensification, the potential for convectively-driven low-level updraft is relatively high. Low-level convergence and updraft near the tornado suggests this area of the storm became less favorable for the tilting and stretching of vorticity despite a larger amount of horizontal vorticity available.

Two downdraft maxima present during tornado formation (one west and one southeast of tornado). One larger downdraft present near tornado during demise.

Secondary rear-flank gust front develops SE-S of tornado during its formation. Secondary gust front merges with primary gust front as they surge ahead of tornado during its demise.

Properties of mesocyclone during tornado lifecycle

Low-level cold pool, gust fronts, and RFD during tornado lifecycle

Acknowledgements

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