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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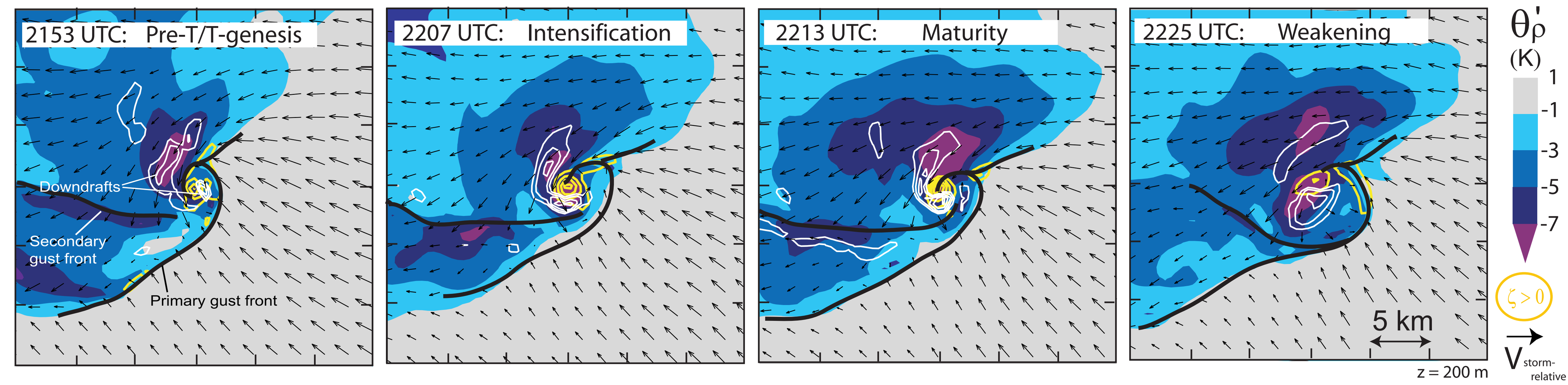
Introduction

DOW6, 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.

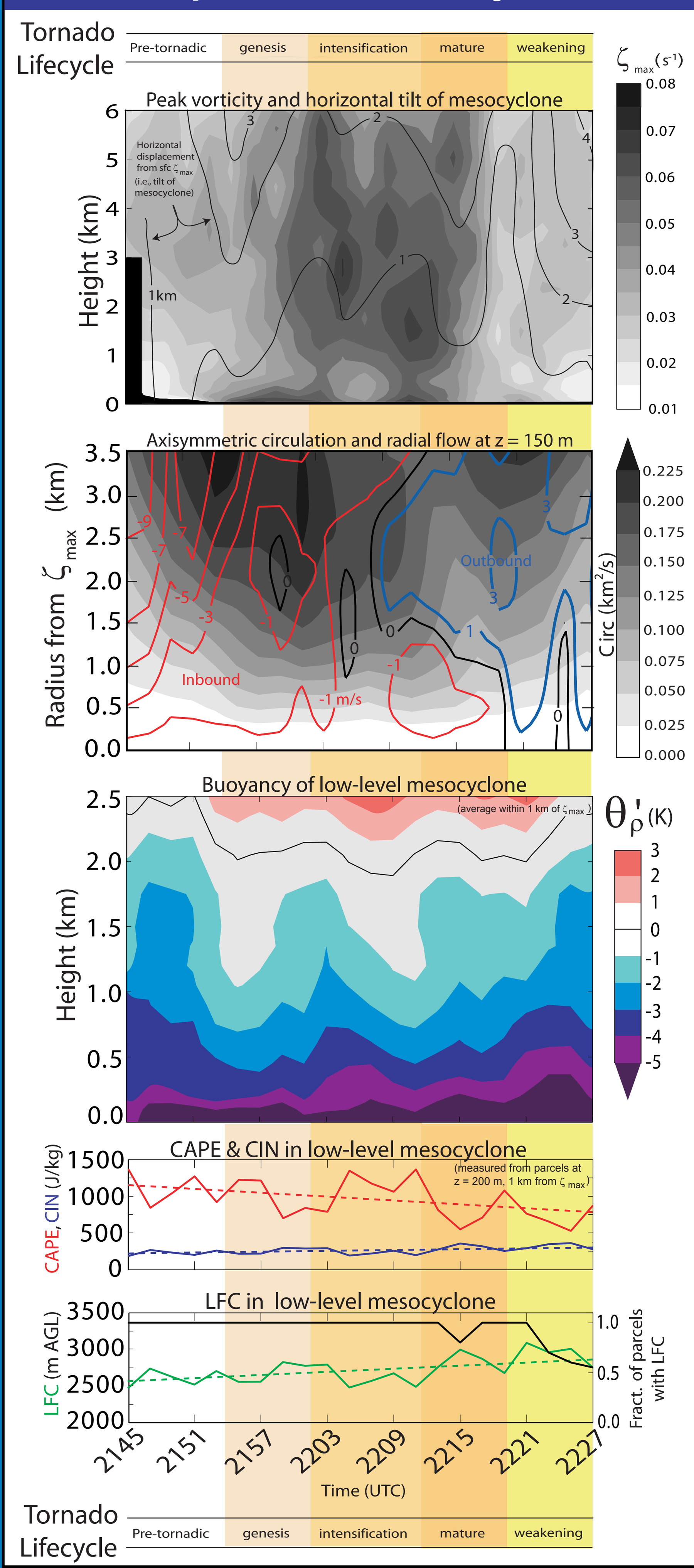
Low-level cold pool, gust fronts, and RFD during tornado lifecycle



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



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.

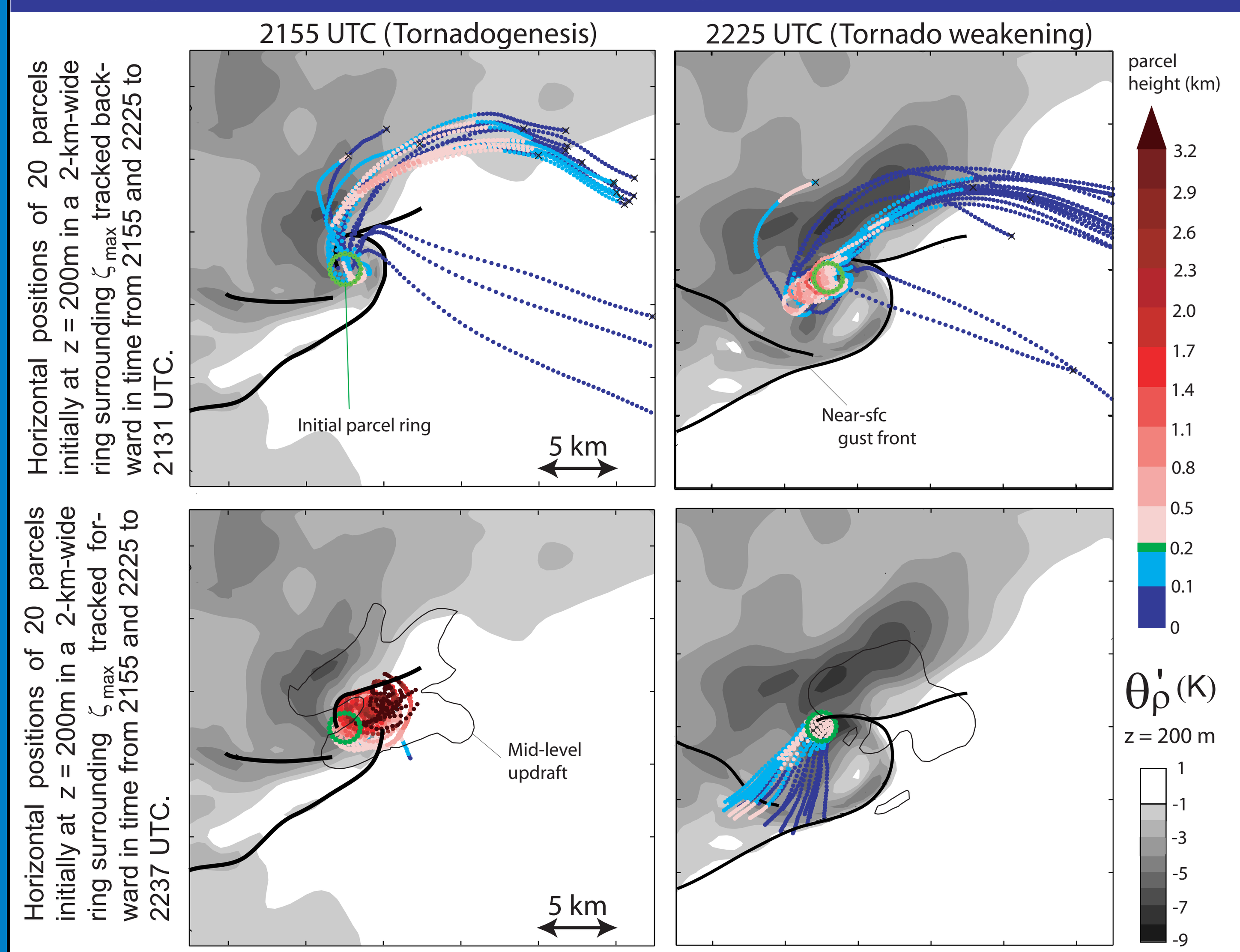
During tornado maturity and demise, circulation decreases and outward radial flow develops.

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

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

CAPE decreases, CIN and LFC increase, and number of parcels with a LFC decreases during tornado lifecycle, particularly after intensification period.

Trajectories of parcels entering low-level mesocyclone



Most parcels transect 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.

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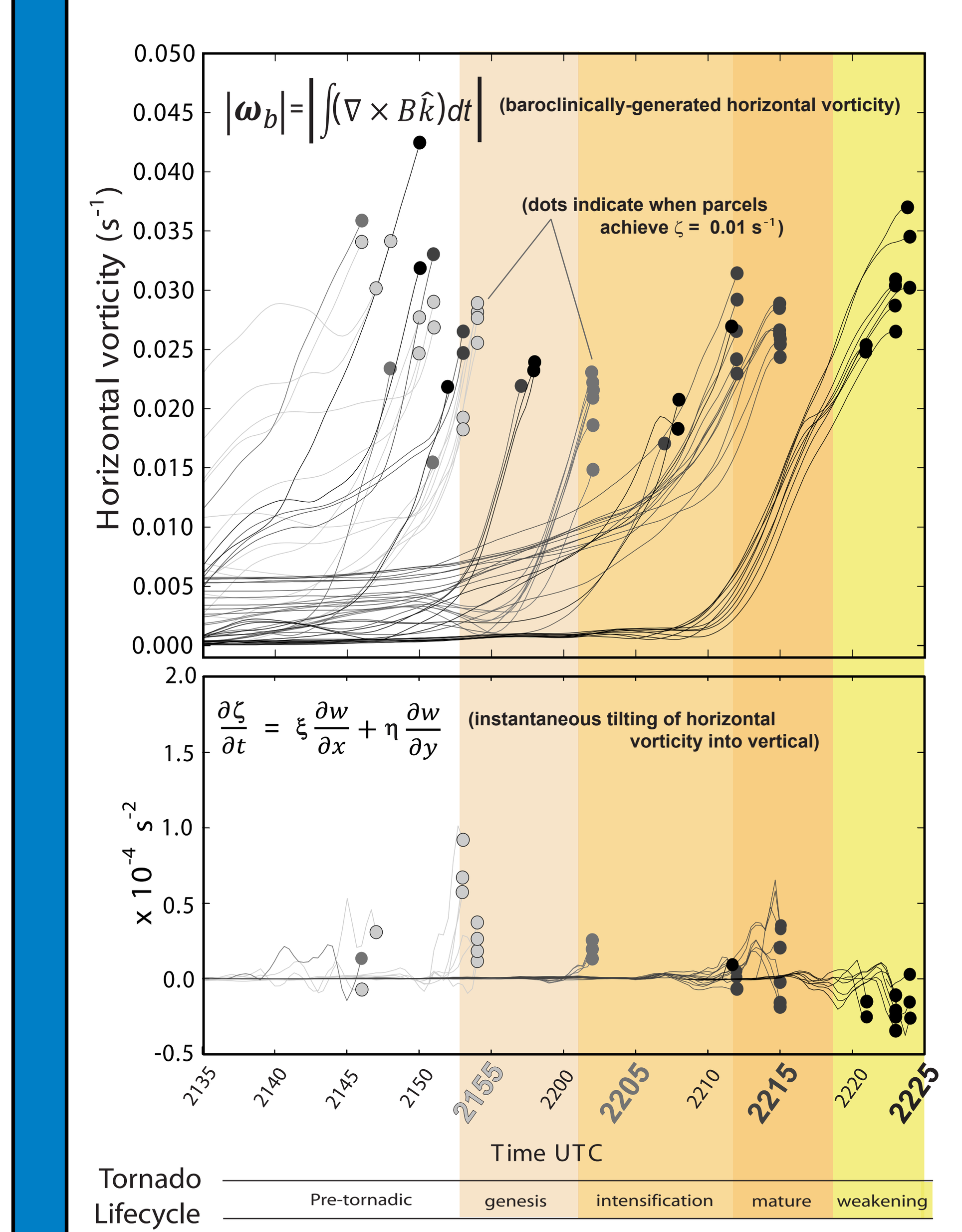
Vorticity production in forward flank

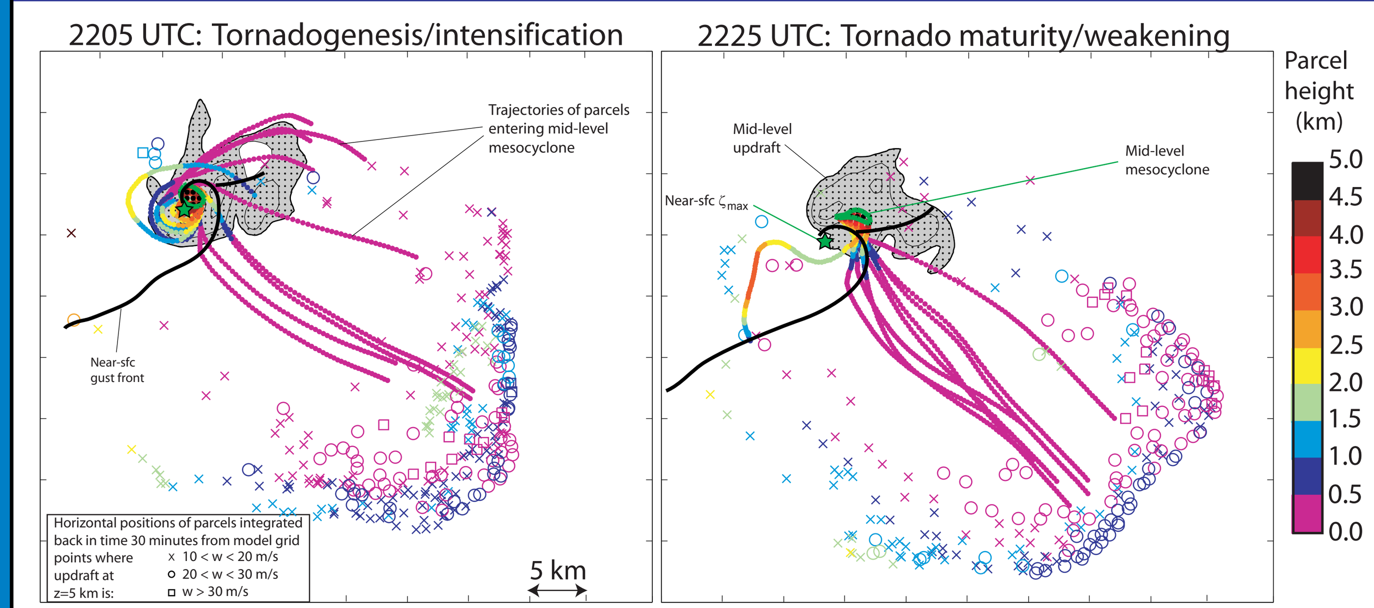
Certain Lagrangian vorticity tendency terms are calculated along the trajectories of the parcels entering the low-level mesocyclone that traverse the forward-flank baroclinic zone:



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.

Parcels entering mid-level updraft and mesocyclone



During tornadogenesis, many parcels entering mid-level mesocyclone ascend through low-level mesocyclone into main updraft.

During tornado maturity and weakening, most parcels enter mid-level mesocyclone more directly from the inflow environment, spending no time within low-level mesocyclone and outflow.

Conclusions

The location underneath the main updraft that was once favorable for tornadogenesis subsequently becomes less favorable for tornado maintenance.

During tornadogenesis and intensification, the potential for convectively-driven low-level updraft is relatively high. Low-level convergence and updraft promote tilting and stretching of vorticity near the tornado.

During tornado maturity and demise, the more negatively buoyant low-level outflow is less easily lifted into the main updraft. The decrease of 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.