Tornado Warning Strategies in the Dual-Pol Era

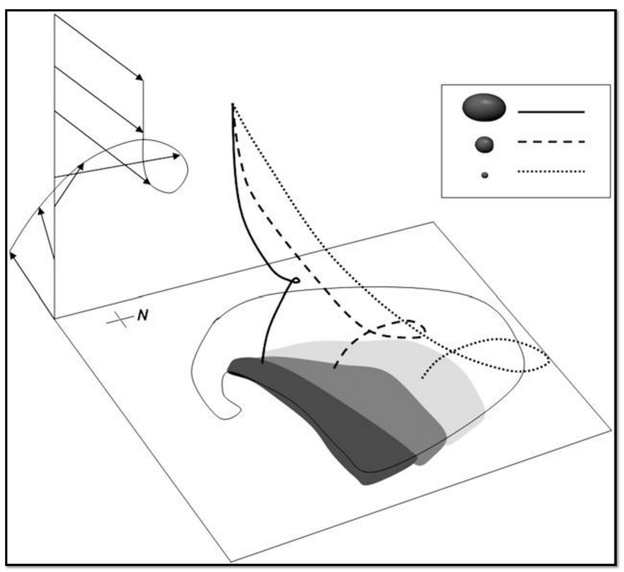
Michael L. Jurewicz, Sr. and Christopher Gitro
NOAA/National Weather Service
Binghamton, NY
Michael.Jurewicz@noaa.gov and Christopher.Gitro@noaa.gov

Initial Hypothesis / Research Progress

Prior research has shown that certain dual-polarization radar variables (differential reflectivity (Zdr) and specific differential phase (Kdp)) may provide important clues of impending tornadogenesis.

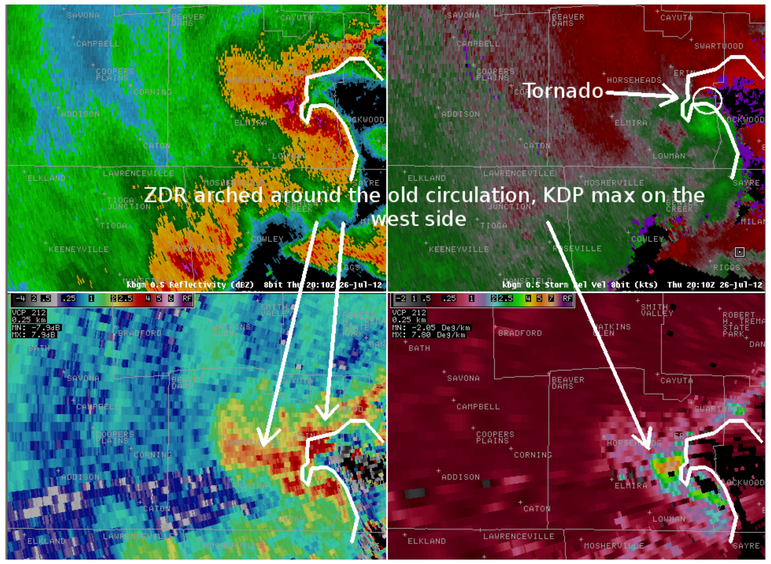
Modeling studies indicated that a preferential sorting of different sized hydrometeors can be promoted by strong low-level helicity within a tornadic storm. Typically, larger drops (implied by enhanced values of Zdr) reside within the inflow/forward side of the storm, while smaller drops (implied by enhanced values of Kdp) tend to get advected farther westward (at lower levels) into rear portions of the mesocyclone.

Crowe, et. al, 2012 tested this hypothesis, by investigating several severe storms (some tornadic) over the Southeastern U.S. in 2010 and 2011. This idea was later tested over the Northeastern U.S. in 2012 and 2013.

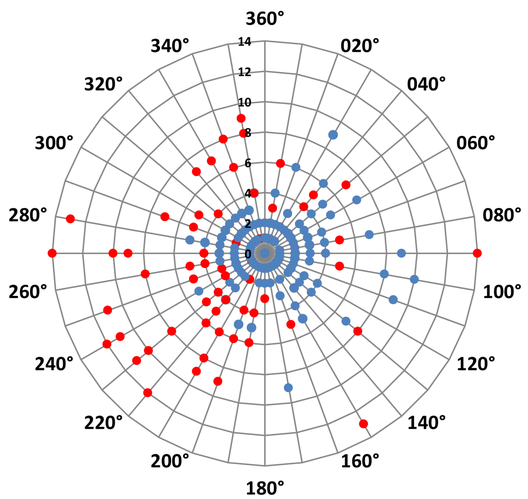


This image (Kumjian and Ryzhkov, 2009) demonstrates the concept of preferential size sorting within a supercell thunderstorm.

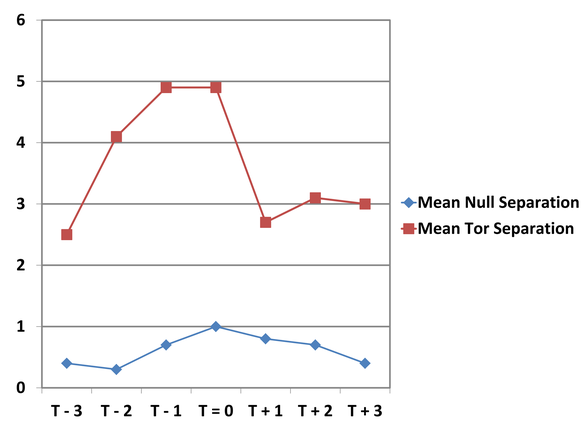
Latest Work / Results



At this time (2010 UTC, 26 Jul 2012), an EF-1 tornado was on the ground in south-central New York State. The white polyline represents the horizontal reflectivity gradient (upper-left panel), and is also used as a point of reference in the remaining frames to demonstrate the relative positions of Zdr (lower left) and Kdp maxima (lower right).



This polar plot represents, for a given volume scan, the relative positions of Kdp maxima (red dots for tornadic cases and blue dots for non-tornadic) versus Zdr maxima (the center point). For the most part, in non-tornadic events, relatively little separation was seen between Zdr and Kdp maxima. Conversely, in tornadic events, much greater separation distances were noted (Kdp maxima typically displaced to the west of Zdr maxima).



This scatter plot chart also illustrates the potential link between drop size sorting and tornadogenesis. Particularly between T-2 (along the x-axis, 2 volume scans prior to either tornado touchdown (red dots) or tornado warning issuance in non-tornado events (blue dots)) and T=0 (tornado touchdown or warning issuance times), note the large horizontal Zdr and Kdp separation differences (in nmi (y-axis)) between tornadic and non-tornadic cases.

Take Home Points

- It has been theorized that drop size sorting is a by-product of low-level, storm-scale helicity in tornadic cells
- This hypothesis was tested for a number of events over the Southeastern U.S. in 2010-2011 (Crowe, et. al, 2012)
- 30 cases (13 tornadic and 17 non-tornadic) were then investigated over the Northeastern U.S. from 2012-2013
- In most tornadic events for the latter study, Kdp maxima became separated from Zdr maxima, while in non-tornadic events, relatively little separation typically occurred
- This seems to well match both the original theory and Crowe's initial results
- ***These results could ultimately prove useful in the tornado warning process***

References

Kumjian, M.R. and A. Ryzhkov, 2009: Storm-relative helicity revealed from polarimetric radar measurements. *J. Atmos. Sci.*, **66**, 667-685.

Crowe, C.C., C.J. Schultz, M. Kumjian, L.D. Carey, and W.A. Petersen, 2012: Use of dual-polarization signatures in diagnosing tornadic potential. *Electronic J. Operational Meteor.*, **13** (5), 57-78.