The Utility of Considering ZDR and KDP Signatures in the Tornado Warning Process

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ABSTRACT

Prior research over the central and southeastern United States demonstrated the usefulness of interrogating certain dual-polarization radar fields in potentially tornadic situations. The two primary variables of focus were differential reflectivity (ZDR) and specific differential phase (KDP). It was shown that in tornadic events, areas of enhanced ZDR typically resembled an arc-shaped configuration. These ZDR arcs tended to form along the right inflow sides of the parent supercells, indicative of areas of preferentially large raindrops near the updraft core. In the meantime, regions of enhanced KDP tended to develop much deeper into the mesocyclone, indicative of many small raindrops.

Forty-two potentially tornadic events in the northeastern United States were investigated in the 2012-2014 time period. These cases represented a mixture of both linear (quasi-linear convective systems (QLCS)) and discrete supercellular types. Varied degrees of drop size sorting were evident in 23 out of 26 tornadic cases, as areas of enhanced KDP formed well to the west of the regions where ZDR was maximized. For a subset of these tornadic cases (8 out of 26), ZDR arcs were also evident at the leading edges of parent supercells near the updraft core. In 14 out of the 16 non-tornadic database events, ZDR and KDP maxima significantly overlapped, with specific KDP maxima tightly clustered near maximum regions of ZDR. This pattern indicated a lack of drop size sorting/hydrometeor separation.

In addition to evaluating the behavior of ZDR and KDP, patterns of base velocity (V) and storm-relative motion (SRM) were also investigated for all 42 cases. In this way, direct comparisons could be made between the effectiveness of utilizing newer dual-polarization techniques, versus more traditional velocity analyses, in discriminating between tornadic and non-tornadic storms.

The most recent results over the northeastern United States matched quite well with those previously achieved over the central and southeastern United States. As a result, there is growing confidence that these radar techniques can help discriminate between tornadic and non-tornadic storms, and that they can also be applied in a wide range of geographic settings.