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PRELIMINARY ANALYSIS OF THE 10 JUNE 2010 SUPERCELLS INTERCEPTED BY VORTEX2 NEAR LAST CHANCE, COLORADO

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1. INTRODUCTION

An outstanding question in the field of severe storms research is why some supercell thunderstorms produce tornadoes and others do not (e.g., Markowski et al. 2011), even though both might have significant low-level rotation on the mesocyclone scale. A more thorough understanding of the distinguishing processes occurring in these storms could lead to more accurate forecasting of tornadogenesis, increased warning accuracy, and a decreased number of false alarms, potentially saving lives and property. The Second Verification of the Origins of Rotation in Tornadoes Experiment (VORTEX2) was designed to help answer such questions by collecting wind and thermodynamic observations within both tornadic and nontornadic supercells. The VORTEX2 armada included multiple radars to collect dual-Doppler observations at both the storm- and meso-scale, and ultra-high-resolution single-Doppler observations at the tornado scale. In situ data were collected by mobile mesonets (Straka et al. 1996), StickNets (Weiss et al. 2008), and rawinsondes.

Given that environments can vary substantially from case to case, it can be difficult to compare tornadic and nontornadic storms across different days. The optimal observational approach to address this question, therefore, may be to examine observations of a pair of supercells, one tornadic and one nontornadic, evolving in close proximity to one another. The VORTEX2 armada collected one such dataset on 10 June 2010, when it deployed on two supercells in northeastern Colorado.

Throughout the day, lee cyclogenesis occurred east of the Rockies owing to the presence of an upper-level shortwave trough. This helped foster an environment conducive to severe thunderstorm development: the 0-6 km vector shear magnitude was at least 40 knots, and CAPE was above 2500 J/kg (Fig. 1). By 2300 UTC (hereafter, all times are UTC), a north-south line of supercells developed in northeastern Colorado. VORTEX2 first intercepted a nontornadic supercell near Hoyt, CO from 2345 to 0040 (June 11). After this period of coordinated data collection, a decision was made to establish a new deployment on the more impressive storm to the south, near Last Chance, CO, from 0100 to 0245 (June 11). The second supercell generated two tornadoes from 0108 to 0116 and 0122 to 0127, respectively. Coordinated observations continued after the tornadoes dissipated and the storm entered a long nontornadic phase.

This case provides rare, detailed observations of nontornadic and tornadic storms occurring in close proximity. In this paper, we present a detailed account of the data collected, a preliminary analysis of the mobile mesonet data collected for the first supercell, and a single-Doppler view of the two tornadoes generated by the second supercell. Ultimately, we intend to examine differences in the environments and internal storm processes of the two supercells to determine why tornadogenesis failed in the first supercell and succeeded twice in the second supercell.

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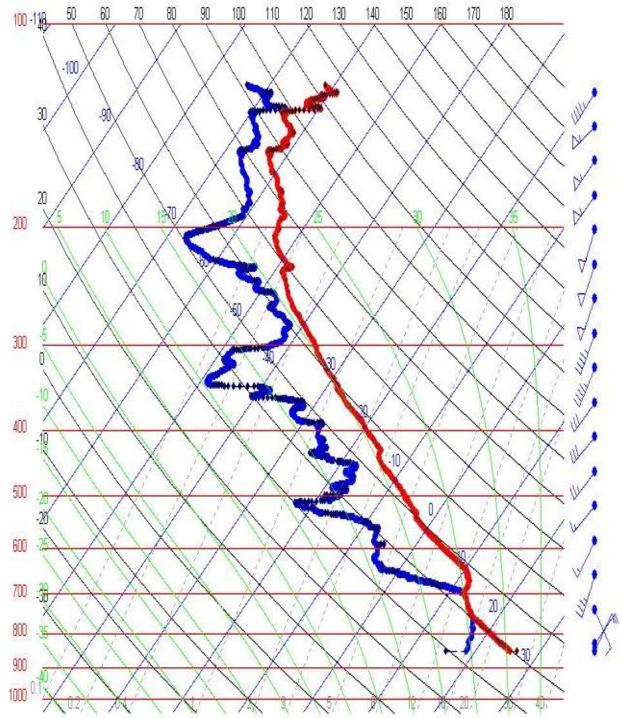

FIG 1. Mobile (NSSL1) sounding from 10 June 2010, 2342 3 miles E of Woodrow, CO. Note the 40 kts of 0-6 km vector shear magnitude in this sounding.

2. DATA

VORTEX2 collected an extensive data set for this case. Highlights of the data collected include six mobile radar dual-Doppler deployments and substantial mobile mesonet coverage. Refer to Fig. 2 for a summary of the data collected by VORTEX2 for this case and Fig. 3 for the radar locations for dual-Doppler deployments on the first and second supercells. Much future work will focus on the SMART-Radar 1 (SR1) and SMART-Radar 2 (SR2) (Biggerstaff et al. 2005) dual-Doppler deployment on the first supercell from 0006 to 0036 on 11 June 2010 as well as later single- and dual-Doppler deployments on the second supercell.

Mobile mesonet data also are examined because differences in cold pool characteristics are thought to influence the potential for tornadogenesis (Markowski et al. 2002). The VORTEX2 observations provide a rare opportunity to combine wind and thermodynamic fields. Five minutes of mobile mesonet data are used for each radar analysis time, with the mobile observation locations modified to correspond to the storm-relative location at the time of collection.

3. PRELIMINARY RESULTS

In the first supercell, thermodynamic data and winds measured by the mobile mesonets at 0018 (Fig. 4) indicate a virtual potential temperature deficit across the cold pool of approximately 4.5 K, slightly cold compared to cold pool observations in significantly tornadic storms (e.g., Markowski et al. 2002). Overall, none of the analyses show a strong surface mesocyclone in this first supercell.

Single-Doppler analyses of radial velocity and reflectivity from DOW7 are examined during the time period spanning the two tornadoes in the second supercell (Fig. 5). DOW7 was, at maximum, approximately 30 km from the first tornado (0108 to 0116) and only ~15 km from the second tornado (0122 to 0127) by the end of its lifecycle. The first tornado is apparent in the DOW7 sweeps at 0110:40. It tracks to the east throughout its lifetime and maintains a relatively constant intensity until 0113:45. By 0115:18, the tornado's velocity couplet is weakening and becoming increasingly asymmetric. By 0117:03, there is no suggestion of a tornadic circulation. The development of a second tornado, on the western edge of the mesocyclone, is evident by 0120:08. By 0121:59, the weakened second tornado has moved farther west of the core of the parent mesocyclone. It continues to do so throughout its life cycle. Overall, the second tornado appears to be weaker than the first tornado. The evolution of the first and second tornadoes does not seem to follow the classic model of cyclic mesocyclogenesis prior to the production of a new tornado. Rather, the same mesocyclone that produced the first tornado generates the second tornado minutes later.

4. FUTURE WORK

In order to further investigate why the first supercell did not produce a tornado but the second (nearby) supercell spawned two tornadoes, we will use dual-Doppler wind syntheses from the six dual-Doppler deployments, coupled with in situ thermodynamic measurements, to perform detailed analyses of cold pool characteristics and overall storm dynamics. We also will analyze mobile mesonet and other in situ observations to assess any differences in the mesoscale environment of the two storms that may have influenced the potential for tornado development.

5. ACKNOWLEDGMENTS

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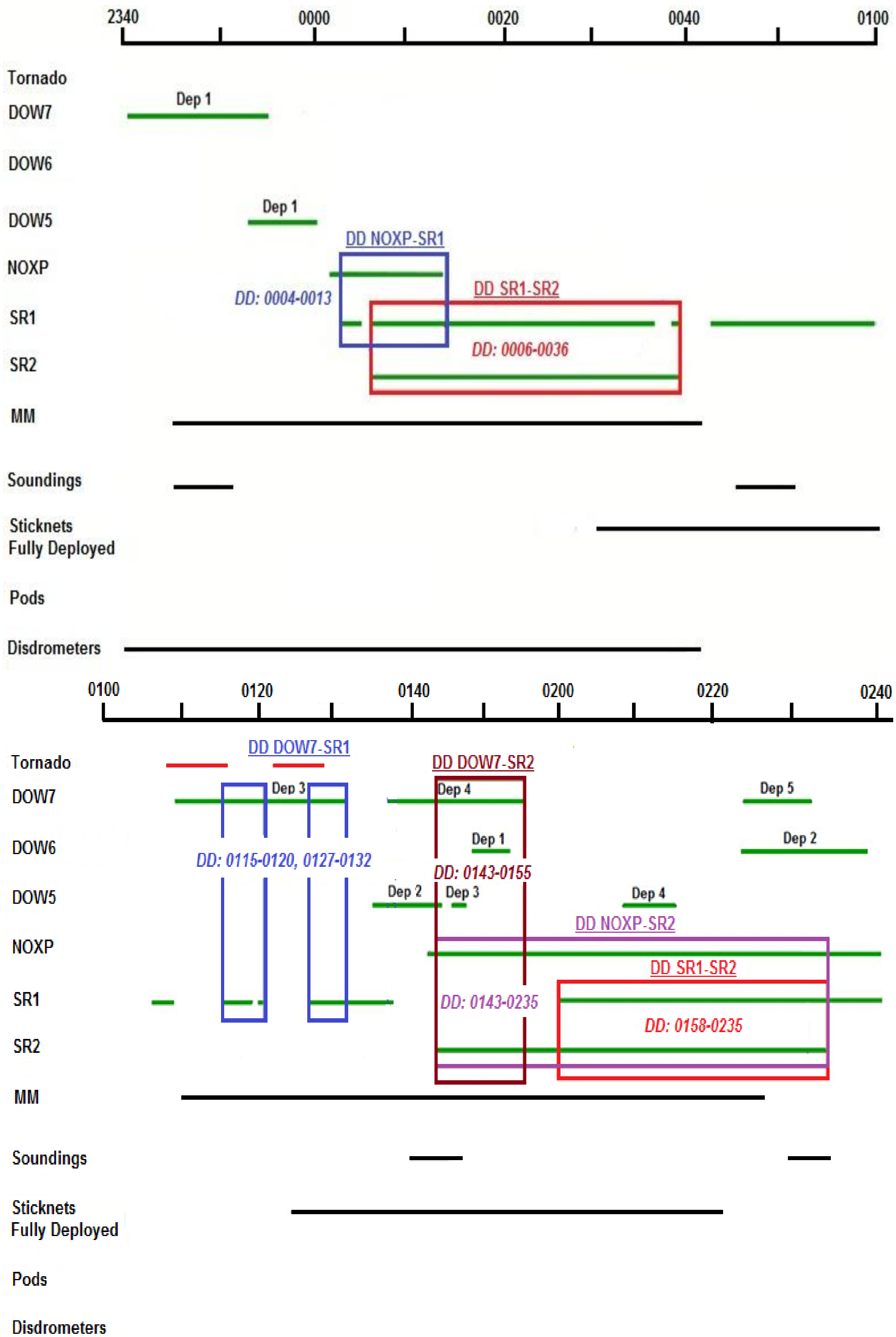

FIG 2. Summary of data collected by VORTEX2 for this case. The colored boxes indicate a dual-Doppler deployment. 'Mobile mesonet' is abbreviated as 'MM.'

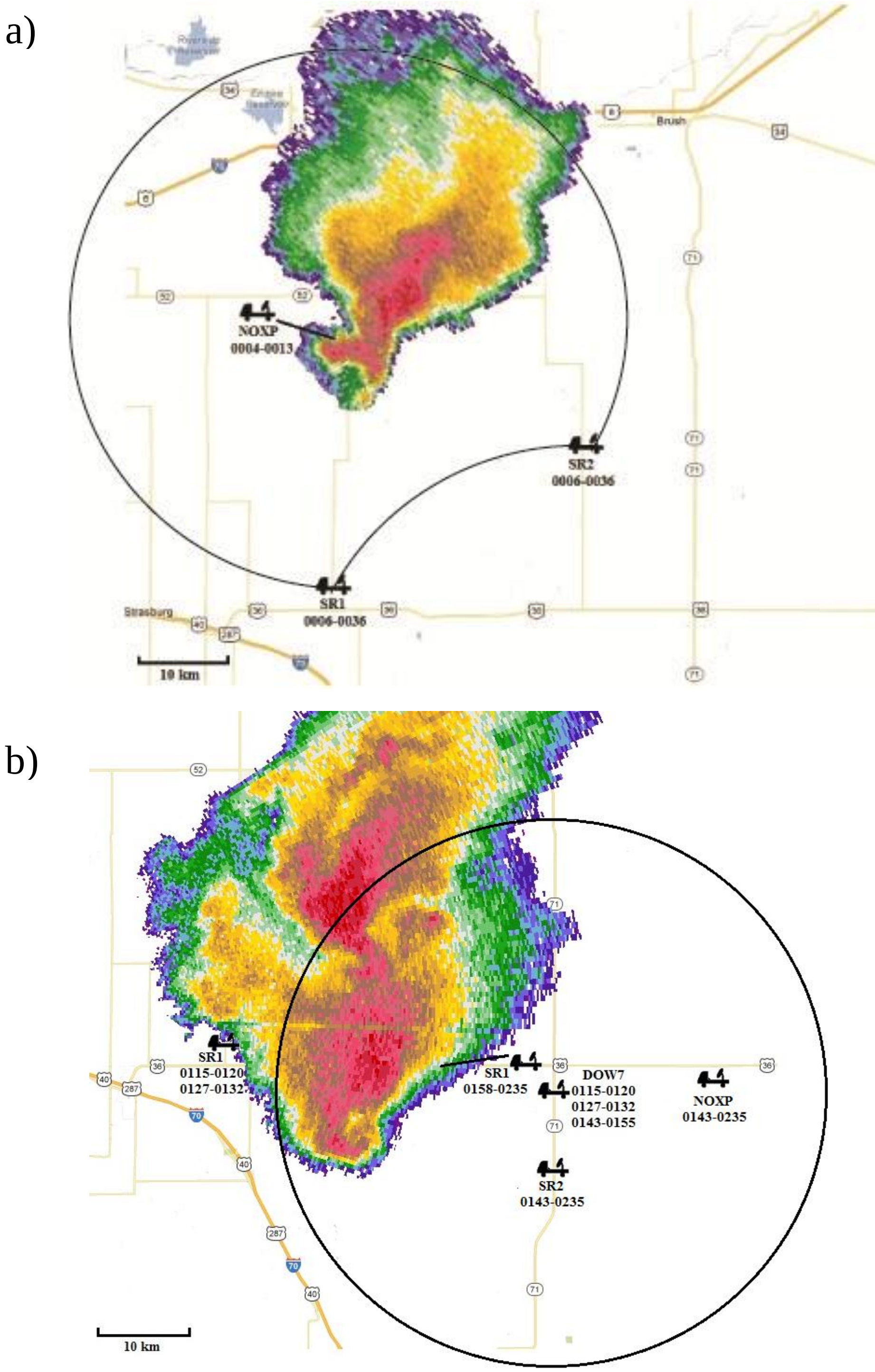

FIG. 3. Radar dual-Doppler deployments map for a) the first supercell (KFTG WSR-88D logarithmic reflectivity factor at 0.5° at 0028). Times indicate dual-Doppler coverage, and the SR1-SR2 dual-Doppler lobe is shown. b) Second supercell (KFTG WSR-88D logarithmic reflectivity factor at 0.5° at 0114), with the DOW7 30-km range ring indicated.

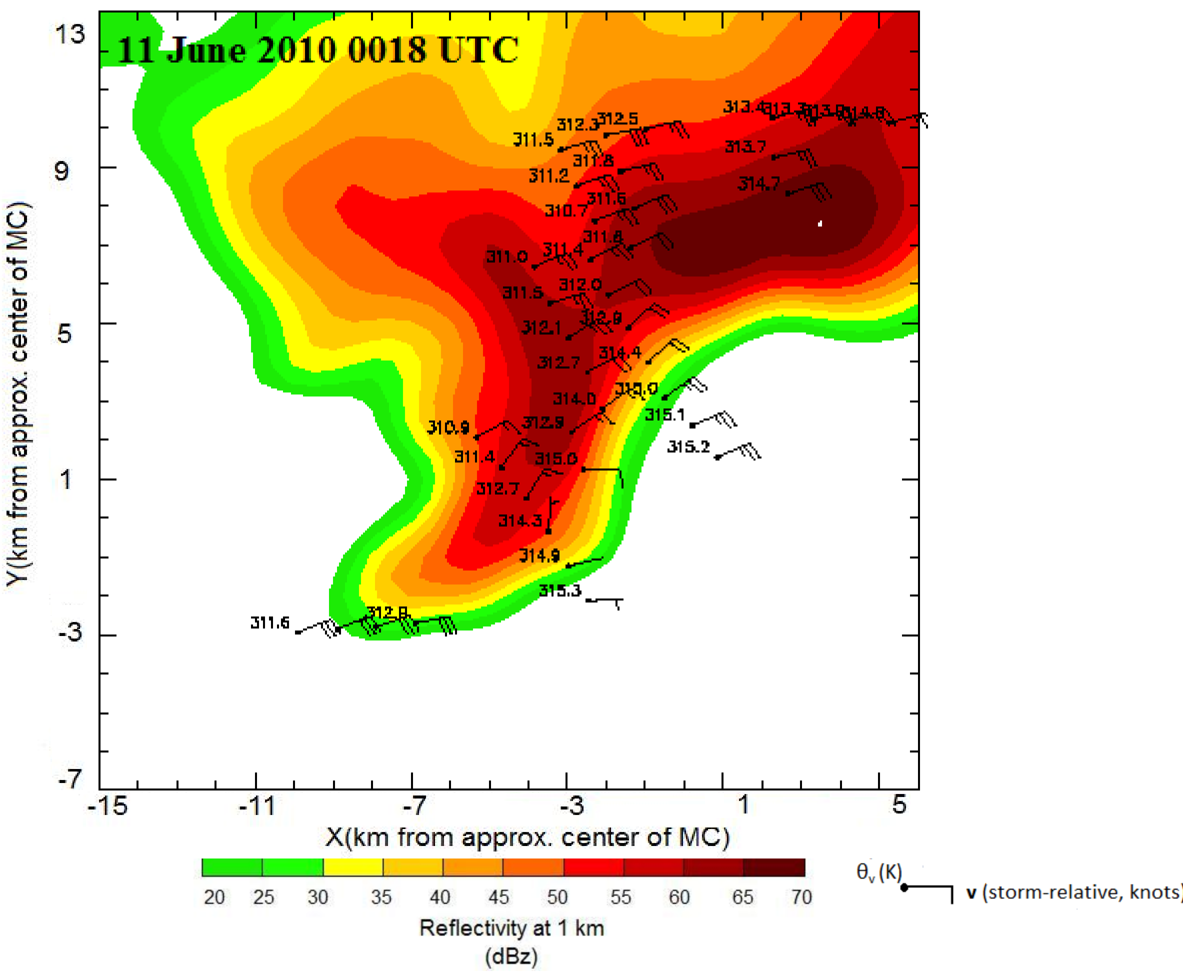

FIG 4. Objectively analyzed mobile radar (SR1) logarithmic reflectivity factor (dBz) at 1 km along with mobile mesonet surface observations of virtual potential temperature (K) and storm-relative winds (minimum observation separation of 1 km).

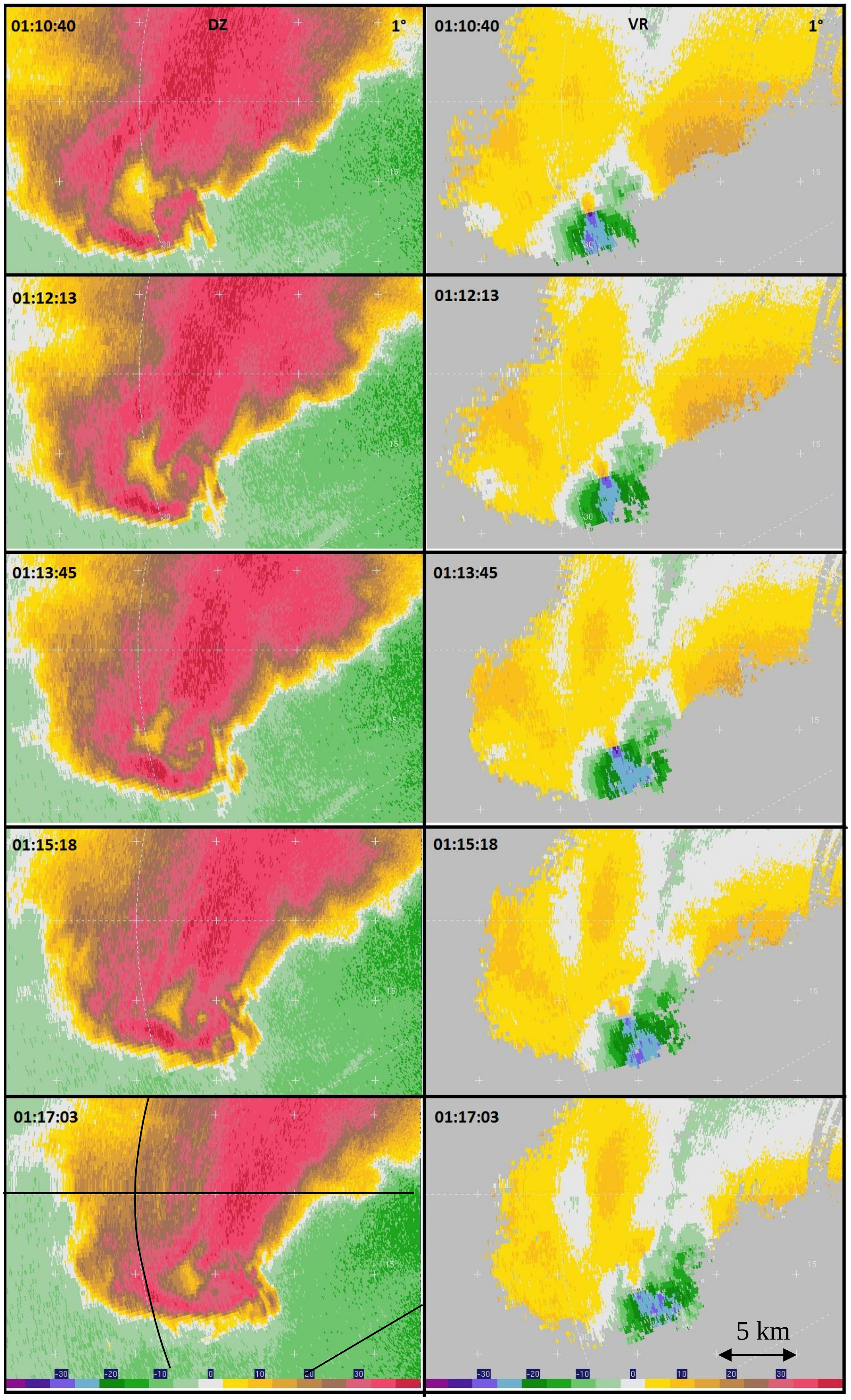

FIG 5. DOW7 logarithmic reflectivity factor (dB*Z*, left column) and radial velocity (m/s, right column) showing the evolution of the first tornado (0108 to 0116) and second tornado (0122 to 0127) at the indicated times. Tic mark interval is 5 km. The 30-km range ring and a few radials are highlighted in the bottom left panel to aid interpretation of the radial velocities.

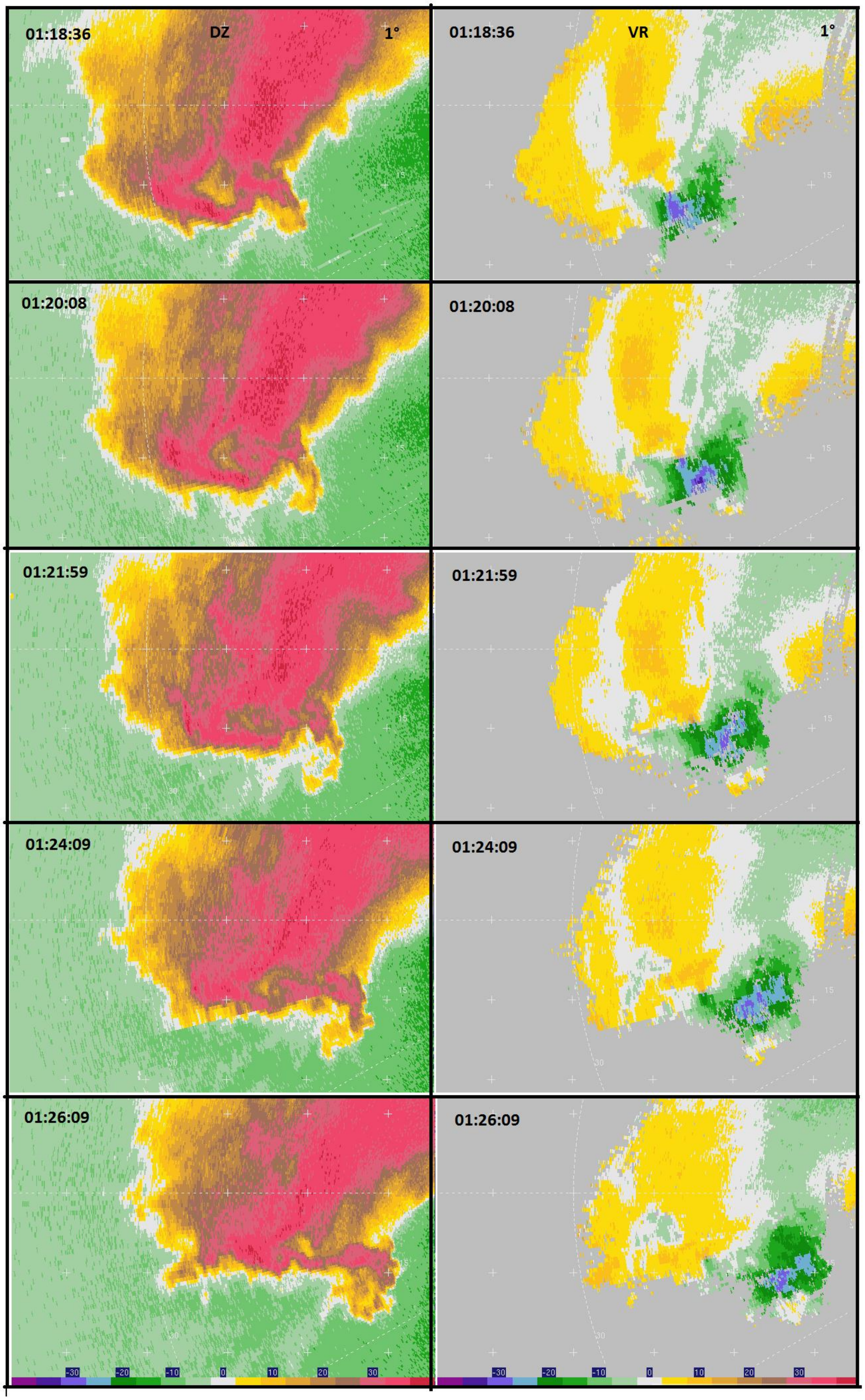

FIG 5. (continued)