Mobile mesonet observations in VORTEX2

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I. INTRODUCTION

The first field year of the second phase of the Verification of the Origins of Rotation in Tornadoes Experiment (VORTEX2) was carried out 10 May - 13 June 2009 with the goal of collecting data in severe storms to address four main foci: tornadogenesis, maintenance, and demise; tornado near-ground wind fields; relationships among tornadoes, their parent thunderstorms, and the larger-scale environment; and numerical weather prediction of supercells and tornadoes. In order to answer the outstanding questions in each of these areas, simultaneous measurements of the wind and thermodynamic fields are necessary.

A large array of mobile instrumentation, including Doppler radars, sounding units, disdrometers, StickNet probes, tornado in-situ probes, and mobile mesonet vehicles, collected complete 4-D wind and thermodynamic fields within several storms of varying morphology (e.g., multicell, supercell, and squall line), including one tornadic storm. In this paper, we highlight the data collection efforts of the mobile mesonet teams.

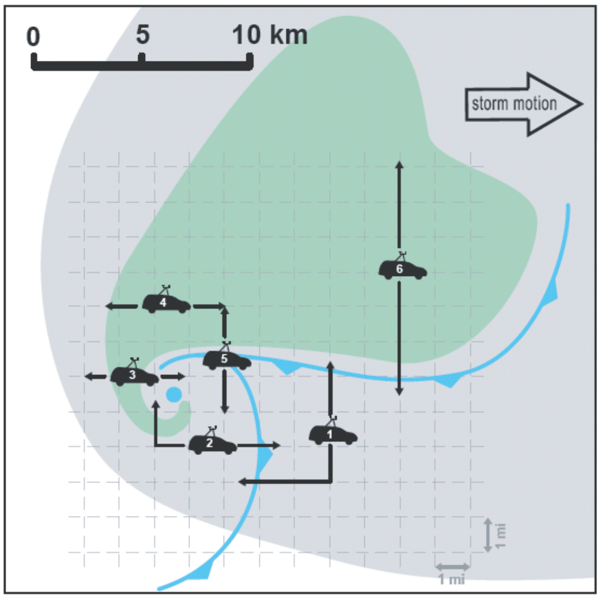

FIG. 1: Idealized deployment of the mobile mesonet for a slow-moving storm.

II. MISSION OF THE MOBILE MESONET

The official VORTEX2 mobile mesonet comprised six vehicles with rooftop meteorological instrumentation designed to measure wind, temperature, relative humidity, and pressure (Straka et al. 1996). These probes were developed at the National Oceanic and Atmospheric Administration (NOAA) National Severe Storms Laboratory (NSSL). One of the probes also served as the mobile mesonet coordination vehicle. At times, other vehicles within the VORTEX2 armada also served as part of the mobile mesonet upon completion of their primary mission (e.g., the tornado in-situ probe vehicles operated by the Center for Severe Weather Research). The mobile mesonet contributes to all four foci of the VORTEX2 project.

In the idealized mobile mesonet deployment strategy for a slow-moving storm (Fig. 1), each vehicle has a particular storm-relative mission such that all significant temperature gradients are sampled. As tornadogenesis is one of the main foci of VORTEX2, greater concentration is placed on the rear-flank region of the storm, within which the characteristics of the cold pool are thought to play an important role in the baroclinic generation of vorticity as well as its subsequent tilting and stretching. Indeed, one of the driving forces behind the VORTEX2 field campaign was the realization that the advancement of our knowledge about the important dynamical processes during tornado formation depends critically on sampling the wind field and the temperature field at the same time. Past studies using only one type of data or the other led to important theories that could be only partially confirmed with those datasets. In reality, fully coordinated data collection is often difficult to achieve owing to sparse road networks, poor communication networks, and storm hazards.

III. DATA COLLECTION ACHIEVED IN YEAR 1

In VORTEX2, the ability to display radar reflectivity with all vehicle positions overlaid via the Situational Awareness for Severe Storm Intercepts (SASSI) display greatly aided our ability to successfully accomplish our mission. As an example, data coverage during a time of strong low-level rotation is shown for the 11 June 2009 supercell in eastern Colorado in Fig. 2. For this case at this time, the most important regions of the targeted cell are sampled well by the mesonet vehicles. Although this cell was not tornadic, it provides an important comparison case for the tornadic storm as it did have strong low-level rotation. Understanding why two storms that look very similar are so different in their tornado production is one

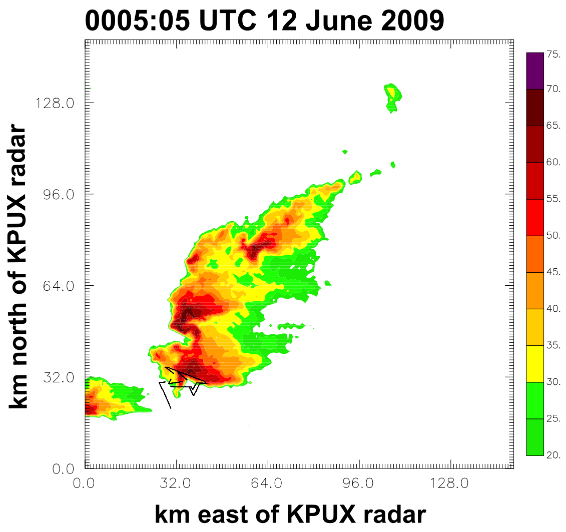

FIG. 2: Mobile mesonet sampling for the 11 June 2009 supercell in eastern Colorado near Las Animas. Each track corresponds to the traverse of a mobile mesonet vehicle during the time of the radar volume. Radar data are from the KPUX 88D.

key to unraveling tornadogenesis.

The first year of VORTEX2 occurred during a record low in the number of tornadic storms; thus, the potential for intercepting tornadoes was severely limited within the VORTEX2 domain. However, one tornadic storm in eastern Wyoming on 5 June 2009 provided an unprecedented coordinated dataset beginning approximately twenty minutes before tornado formation and continuing past tornado demise. A preliminary analysis of mobile mesonet potential temperatures for this case (Fig. 3) reveals a relatively small (~ -1.5 K) potential temperature deficit in the rear-flank area compared to the ambient environment, in line with previous measurements made within tornadic storms (Markowski et al. 2002).

IV. FUTURE WORK

VORTEX2 is a highly collaborative project, and analysis of data from the first year of VORTEX2 is just beginning. The data shown here will be combined with those from other platforms to create a comprehensive picture of tornado formation and demise on 5 June 2009. Similar data for non-tornadic cases will be used for comparison to address the outstanding questions that inspired VORTEX2. Analysis techniques will include dual-Doppler syntheses at multiple scales and assimilation of single-Doppler and thermodynamic data. The integration of multiple disparate datasets will be a significant challenge but one that is necessary to move our knowledge forward.

Similar data collection efforts will be undertaken in the second year of VORTEX2 to be held 1 May to 15 June 2010.

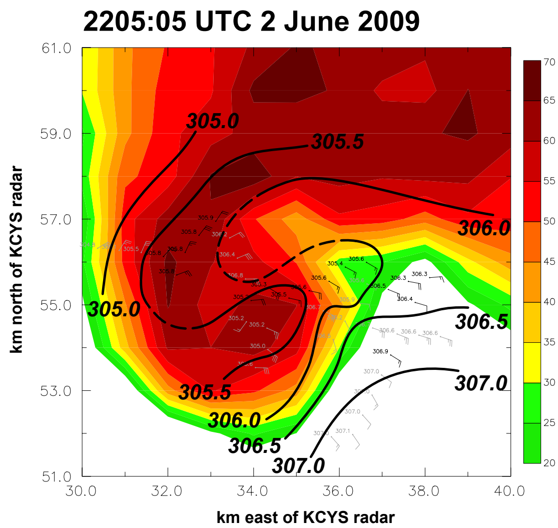

FIG. 3: Preliminary analysis of mobile mesonet potential temperature data for the 5 June 2009 tornadic supercell in eastern Wyoming. A steady-state assumption is made over a 10-min period centered on each analysis time, which corresponds to the time of the low-level 88D sweep. Data collected more than 2.5 minutes on either side of the analysis time are in gray. All winds are storm-relative and in knots. Radar data are from the KCYS 88D.

V. ACKNOWLEDGMENTS

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VI. REFERENCES

Straka, J. M., E. N. Rasmussen, and S. E. Fredrickson, 1996: A mobile mesonet for finescale meteorological observations. *Journal of Atmos. and Oceanic Tech.*, **13**, 921 - 936.

Markowski P. M., J. M. Straka, and E. N. Rasmussen, 2002: Direct surface thermodynamic observations within the rear-flank downdrafts of non-tornadic and tornadic supercells. *Mon. Wea. Rev.*, **130**, 1692-1721.