P1.1 Study of Microphysical and Thermodynamic Structures within Supercell Thunderstorms

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MOTIVATION

1. *What are the characteristics of particle-size distribution (PSD) and fall velocity at the surface within the supercell thunderstorms? How do these characteristics vary between tornadic and non-tornadic storms?*
2. *How do the surface PSD relate to dual-polarization observations? How do hydrometer characteristics change within the 3-dimensional space?*
3. *What are the steady-state and intermittent microphysical processes and what is their role for cold- versus warm-cloud microphysical processes? How do they affect small-scale dynamics?*

STATE-OF-THE -ART

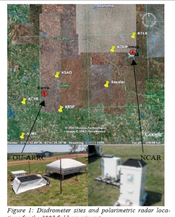


Figure 1: Disdrometer sites and polarimetric radar locations for the 2007 field experiment.

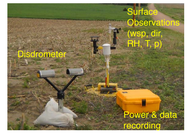
There have been excellent instrumentation sites and experiments combining multiple polarimetric dual-Doppler measurements with disdrometer observations… but how does the supercell thunderstorm know?

In order to address the science questions, in particular within tornadic and non-tornadic storms, we need more mobility!

NEW APPROACH: MOBILE DISDROMETER

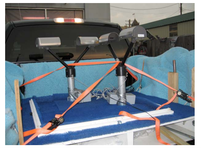
The weather remains the challenge:

- *Correctly predict storm motion and place the instruments at the right location at the right time*
- *Data quality decreases in regimes with high wind & turbulence*
- *The instruments are exposed to hail and tornadoes*



IDEA: Deploy instruments ahead of the storm; storm passes over instruments; then redeploy

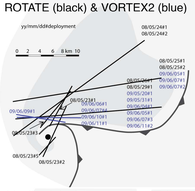
Radar Observations of Tornadoes And Thunderstorm Experiment (ROTATE) 2008



Verification of the Origins of Rotation in Tornadoes EXperiment (VORTEX) 2009

Data Sets & Deployment

Sampled cases during ROTATE (black) & VORTEX2 (blue)



ROTATE

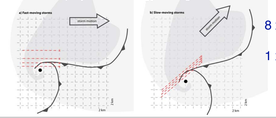
2 instruments (truck deployments)

6 x supercell thunderstorms
5 x squall lines
2 x MCs

VORTEX2

2 unmanned disdrometers (Glen Romine, U. of Illinois)
2 unmanned/truck-deployable disdrometers (CU)

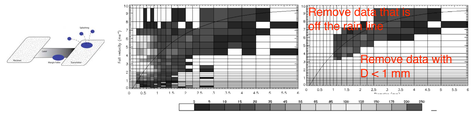
Idealized deployment strategy during VORTEX2



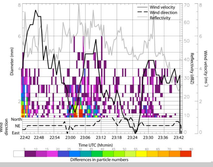
8 x non-tornadic ST (with 2-3 deployments)
1 x tornadic ST (3 deployments)

Quality Control

1.)Splashing and Margin Fallers

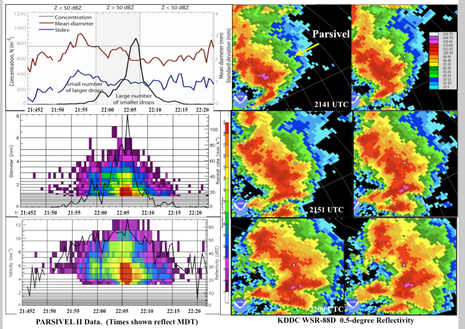


2.) Influence of wind direction – orientation of the instrument



26 May 2008

(Squall line)

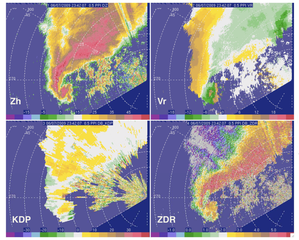


PARSIVEL II Data. (Times shown reflect MDT)

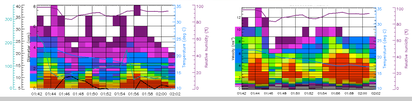
KDDC WSR-88D 0.5-degree Reflectivity

31 May 2009

(Supercell thunderstorm, NW Missouri)

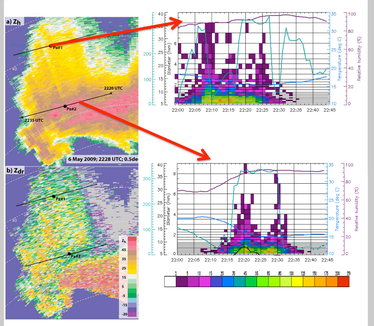


Preliminary NOXP data 23:42 UTC



5 June 2009

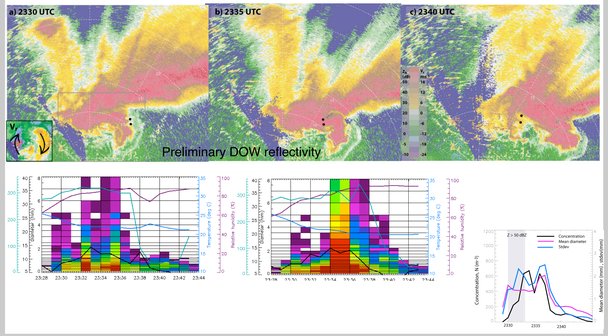
(Tornadic supercell thunderstorm, Chuckwater, WY)



NOXP radar - Courtesy: Don Burges

9 June 2009

(Supercell thunderstorm, Greensburg, KS)



Conclusion & Outlook

- Demonstrated feasibility of mobile disdrometer deployment – lost only one blade anemometer during VORTEX2
- Accomplished coordinated disdrometer observations with dual-Doppler and dual-polarization measurements
- During the VORTEX 2009 the instruments were successfully deployed in 9 supercell thunderstorm including one tornadic supercell at Chuckwater, WY.
- Challenge was the coordinate disdrometer deployment with the mobile radar operations (i.e., coverage of polarimetric radars and dual-Doppler areas), the storm motion with respect to the road network.

- The deployment of more mobile disdromters during VORTEX2 2010 in order to : i) cover larger parts of the storm within in polarimetric and dual-Doppler coverage, ii) staggered deployment in time allows for observing temporal evolution of the microphysics and allows for a better radar coverage, and iii) failure of single instrument does not affect the entire mission.
- Compare PSD from several deployments within the same area of the storm; determine PSD and thermodynamic parameter as reference for model validation

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