Evaluating the Impact of Non-Conventional Observations on High-Resolution Analyses and Forecasts using Observing Systems Experiments

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Introduction

2009 NRC research report *Observing Weather and Climate from the Ground Up*:

- Noted the inability to sufficiently observe the 3D mesoscale structure of the atmosphere
- Recommended that existing and new mesoscale networks be combined to form a nationwide "Network of Networks"
- Recommended that testbeds be used to determine the applicability of the "Network of Networks" approach

This work uses the CASA DFW Urban Demonstration Network

Observing system experiments (OSEs) are being performed to assess the utility of assimilating non-conventional observations in high-resolution analyses and forecasts of convection.

Case Study: A supercell thunderstorm tracked through the DFW metro on the evening of 11 April 2016, producing significant severe hail (2"+ diameter). The storm formed in the moist sector along a stationary frontal boundary.

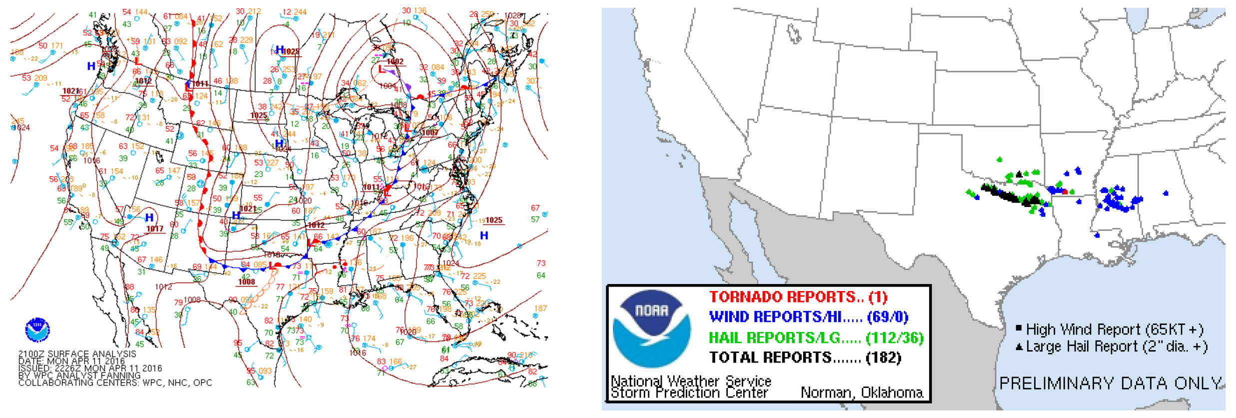
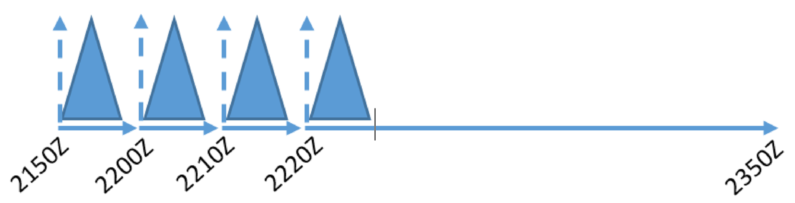


Figure 1: Surface analysis from the Weather Prediction Center (WPC) valid at 2100Z on 11 April 2016 (left) and Storm Prediction Center (SPC) severe storm reports (right).

Data and Methodology

Figure 2: Assimilation design.



Experimental setup:

- Grid Spacing 1-km
- Background and boundary conditions derived using the 21Z, 22Z, 23Z, and 00Z RAP-13km analyses
- Uses incremental analysis updating (IAU) to gradually apply the analysis increments throughout the assimilation window

Table 1: Observing System Experiments (OSEs) Performed

Experiment	Conventional surface data	Non-conventional surface data	Upper-air profiles	WSR-88D	CASA	TDWR
CONTROL	All	All	All	All	All	All
NORADAR	All	All	All	None	None	None
NO88D	All	All	All	None	All	All

Non-conventional surface data: GST MoPED, Understory, Citizen Weather Observer Program (CWOP), and WeatherBug.

Results

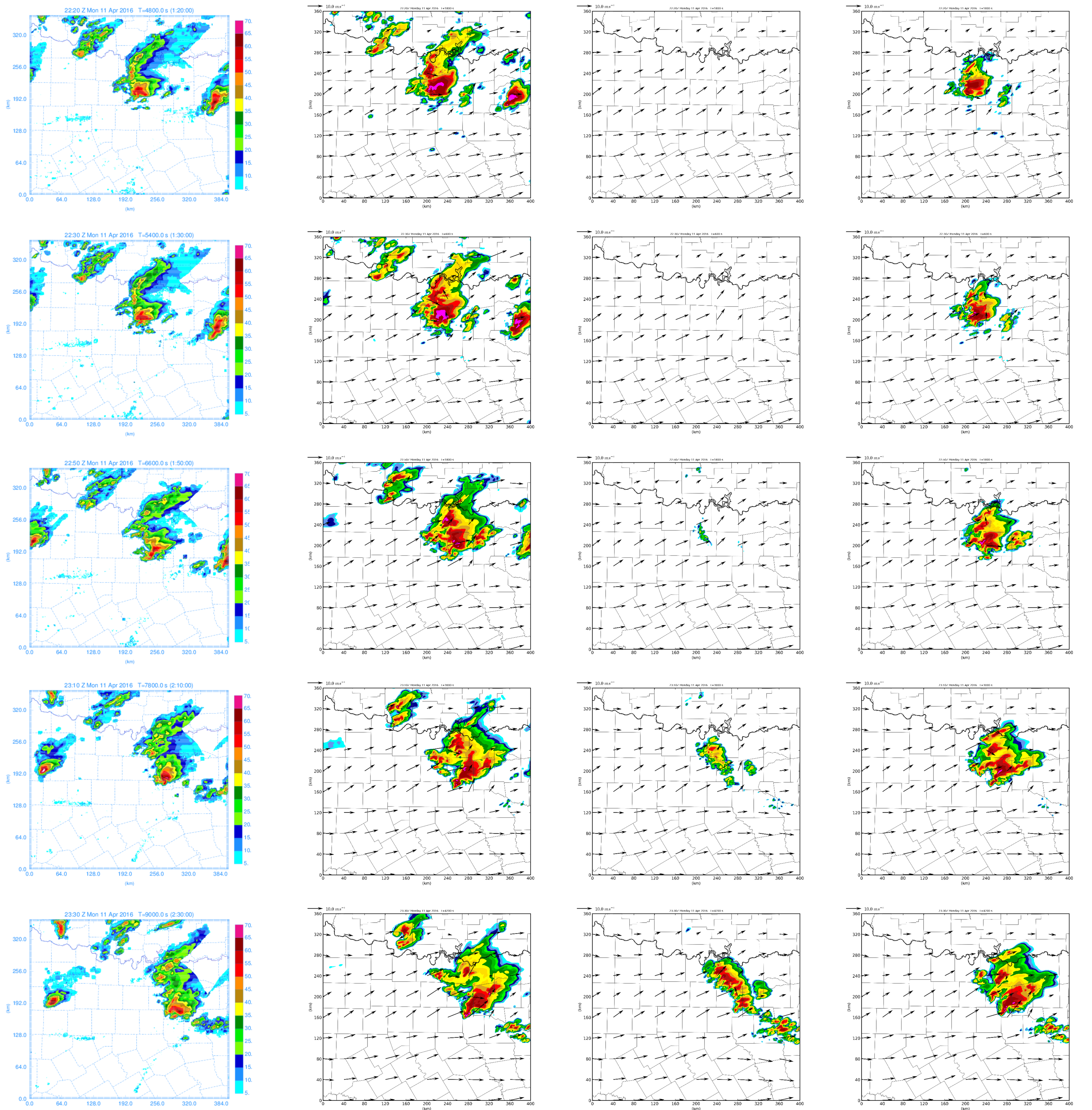


Figure 3: The left column shows mosaicked reflectivity from the WSR-88D network. The remaining columns show simulated reflectivity and wind for the CONTROL, NORADAR, and NO88D experiments, respectively. All figures are shown at roughly 2 km AGL.

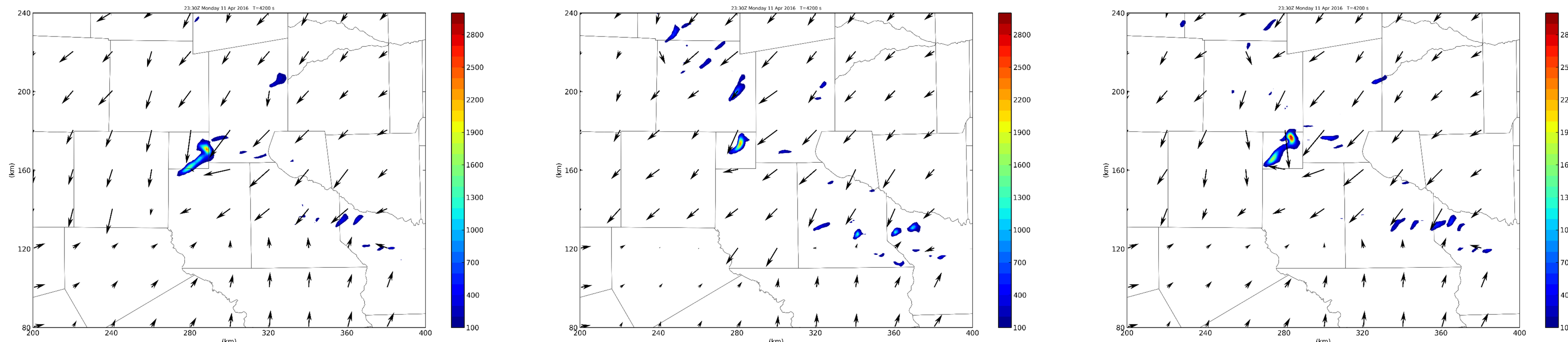


Figure 4: 1 to 5 km updraft helicity (UH) and surface winds for the CONTROL, NORADAR, and NO88D experiments, respectively. The figures are zoomed in to show the region of interest.

Discussion

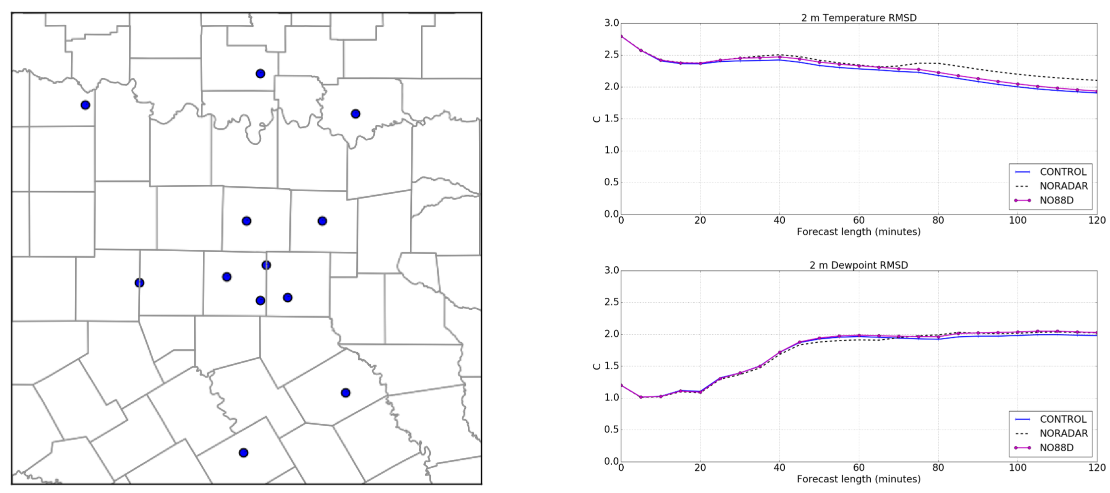


Figure 5: Locations of the ASOS and Oklahoma Mesonet stations used to assess experiment performance (left), root mean square difference (RMSD) of surface temperature (upper right), and RMSD of dew point temperature (lower right).

The model must "spin-up" the thunderstorm when no radar data is assimilated (NORADAR). Even with the degraded storm structure, an updraft helicity (UH) center is located in roughly the same location as for the CONTROL experiment at 2330Z.

The storm structure appears fairly similar for the NO88D and CONTROL experiments, although the NO88D UH center appears to be slightly stronger. However, the neighboring storm is missing as it is outside of the CASA/TDWR coverage area.

Future Work

Future work will be devoted to determining the impact of the non-conventional surface and radar data, with a particular emphasis on the non-conventional surface data.

In addition, model simulated hail will be quantitatively compared with radar observations of hail using the Maximum Estimated Size of Hail (MESH).

Acknowledgements

This work is supported in part by the National Mesonet Program. DFW Testbed and CASA work is funded by NSF, NWS, and several members of the NCTCOG. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect those of the funding agencies. Numerical modelling experiments were performed using OU OSCER (Schooner) supercomputing resources.

Observations Lead the Way

Our research seeks to find the most important data among those already deployed. Other data that would be useful for this scale:

- A mesoscale network of lower tropospheric profiles (temperature and moisture)—this could potentially be achieved using Unmanned Aerial Vehicles or a combination of radiometers and lower atmospheric wind profilers.
- A more uniform distribution of surface observations to better cover more data sparse rural areas.