Multi-Scale Data Assimilation of the June 13, 2010 VORTEX2 Tornadic Supercell

Therese E. Thompson, Glen Romine, Louis J. Wicker, Xuguang Wang, David Dowell

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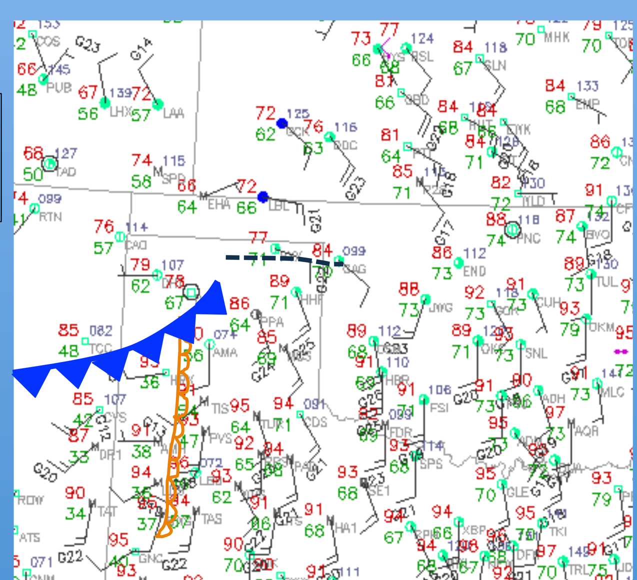
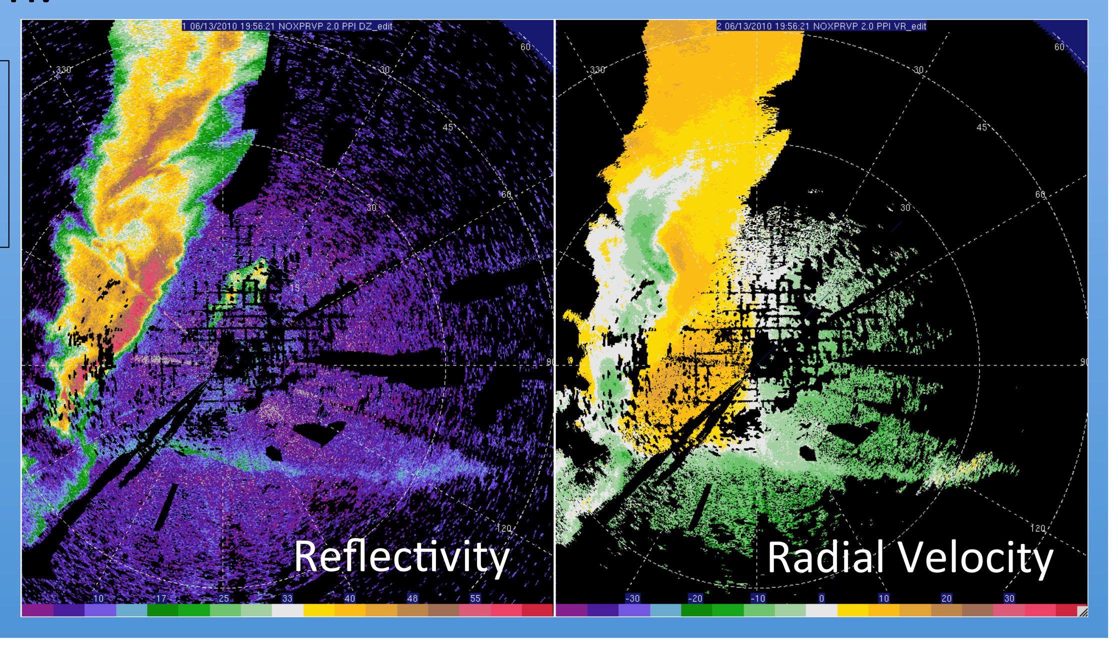
June 13 Overview

On June 13, 2010 the VORTEX2 field program collected observations in the eastern Texas and Oklahoma Panhandles. Convection developed around 18 UTC on the cool side of a South-Southwest to North-Northeast oriented cold front. The sub-severe convection slowly moved to the Northeast. An east-west oriented outflow boundary was present from the previous day's convection near the OK/TX border. The northernmost storm moved over the intersection of the two boundaries around 20 UTC. The storm quickly intensified and gained supercell characteristics. It became tornadic at ~20:52 UTC. The complex mesoscale environment and the tornadic storm were not captured well with conventional observations or WSR-88D radars. This makes the event difficult to analyze and predict without the use of data assimilation.

SFC obs 2007 UTC

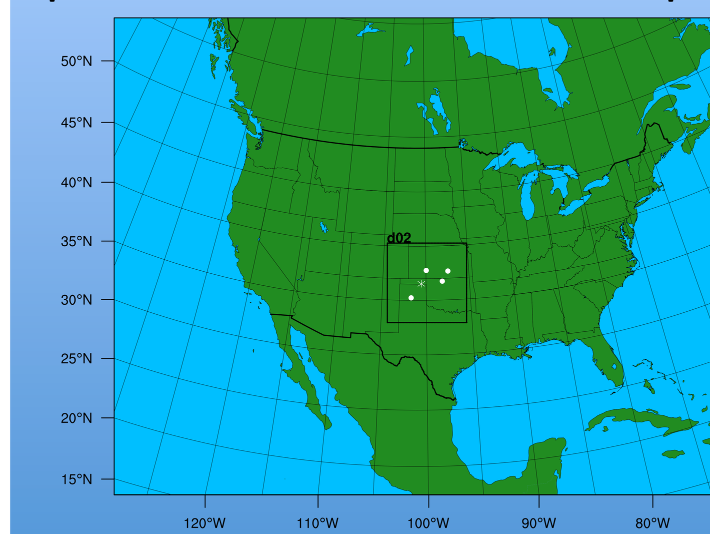


Mobile Radar NOXP 1956 UTC



WRF-DART Setup & Initialization

WRF version 3.3.1 is used with DART data assimilation to reconstruct the mesoscale environment that produced the tornadic supercell.



- Outer domain has 15 km grid spacing.
- Inner domain has 3 km grid spacing & explicit convection.
- 56 vertical levels.
- White star is the starting point of the first tornado.
- White dots WSR-88D radars. Radial velocity, reflectivity and clear air data are objectively analyzed to a 6 km grid and assimilated.
- Conventional observations assimilated: satellite winds, ACARS, METAR, Maritime, GPS, Mesonet, profilers, radiosondes.

Three variations of WRF initialization using GFS analyses for initial and boundary conditions have been tested.

1. Outer & inner domain initialized at 18 UTC on June 8th and cycles every 6 hours until 0 UTC on the 13th.
2. Outer Domain initialized at 18 UTC on June 8th and cycles every 6 hours until 18 UTC on the 12th, when the inner domain is initialized (and adaptive inflation restarts) and a forecast is made to 0 UTC on the 13th.
3. Outer & Inner Domain initialized at 18 UTC on June 12th and a forecast is made to 0 UTC on the 13th.

Each start hourly data assimilation at 0 UTC on June 13th.

The analyses are qualitatively and quantitatively similar and will be examined further in future work. Experiment #1 will be used as the background for the rest of the results shown.

Impact of Radar Data Assimilation

Two strong mesoscale convective systems move through the area during the overnight hours on June 13th. This convection produced the outflow boundary that is important to the intensification of the afternoon tornadic storm. Therefore analyzing the overnight convection is important to reconstructing the storm environment and the impact of assimilating hourly 88D radar observations is investigated.

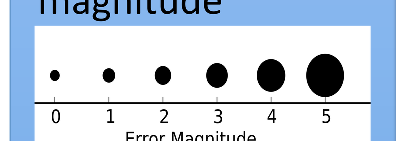
Data Assimilated →

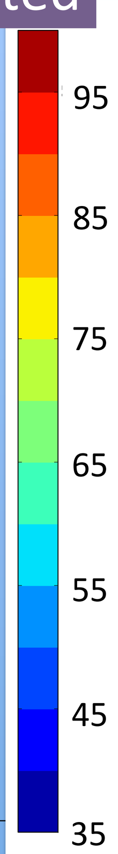
20 UTC Inner D

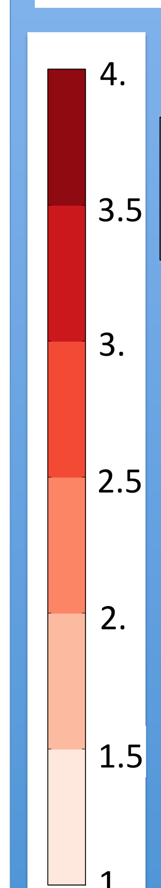
Contours: Mean SFC T (°F) Analysis

Dot Color: SFC T (°F) Observation

Dot Sizes: Innovation (ob – f) magnitude







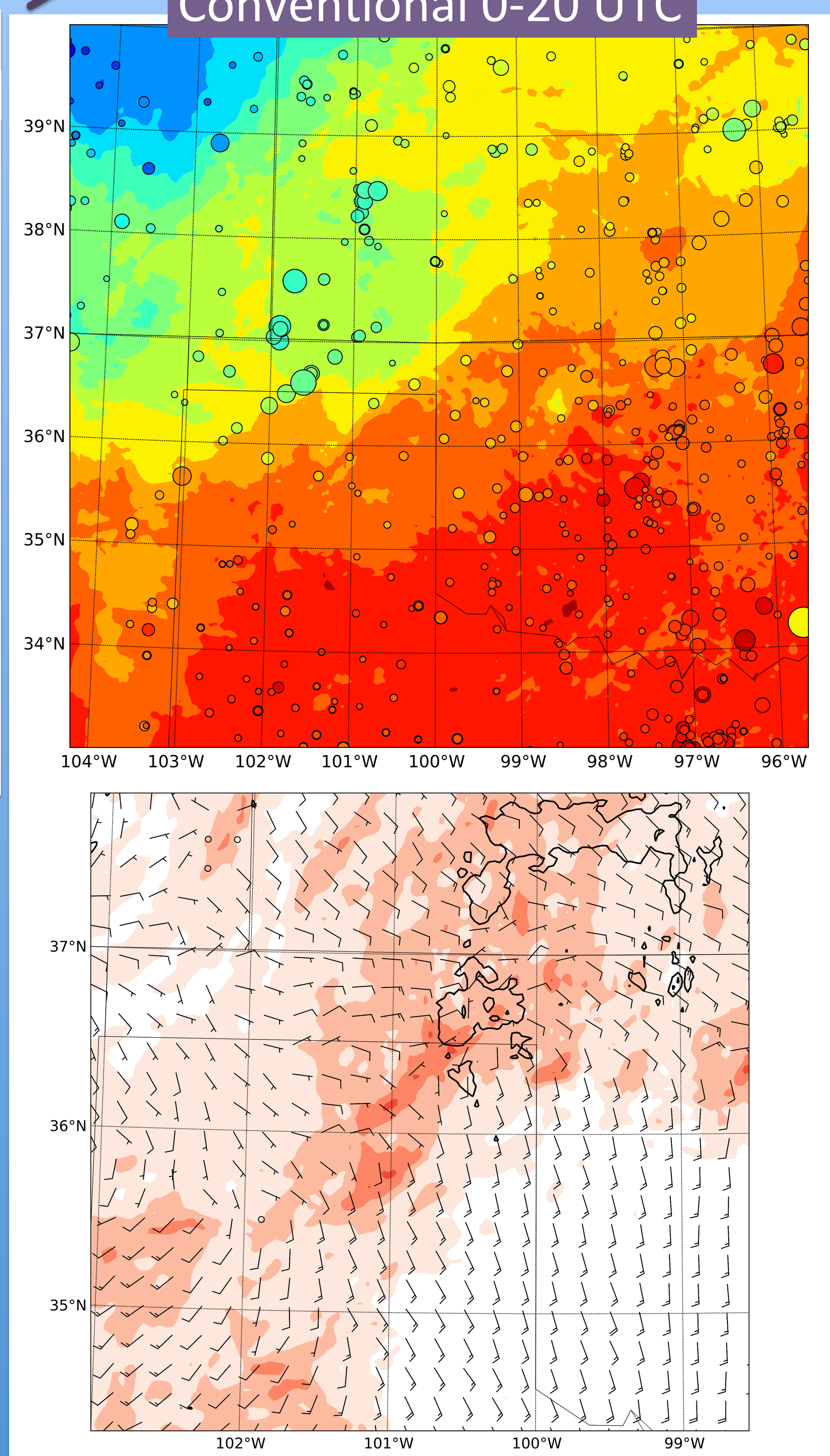
20 UTC Part of Inner D

Red Shading: Wind speed spread of priors (m/s)

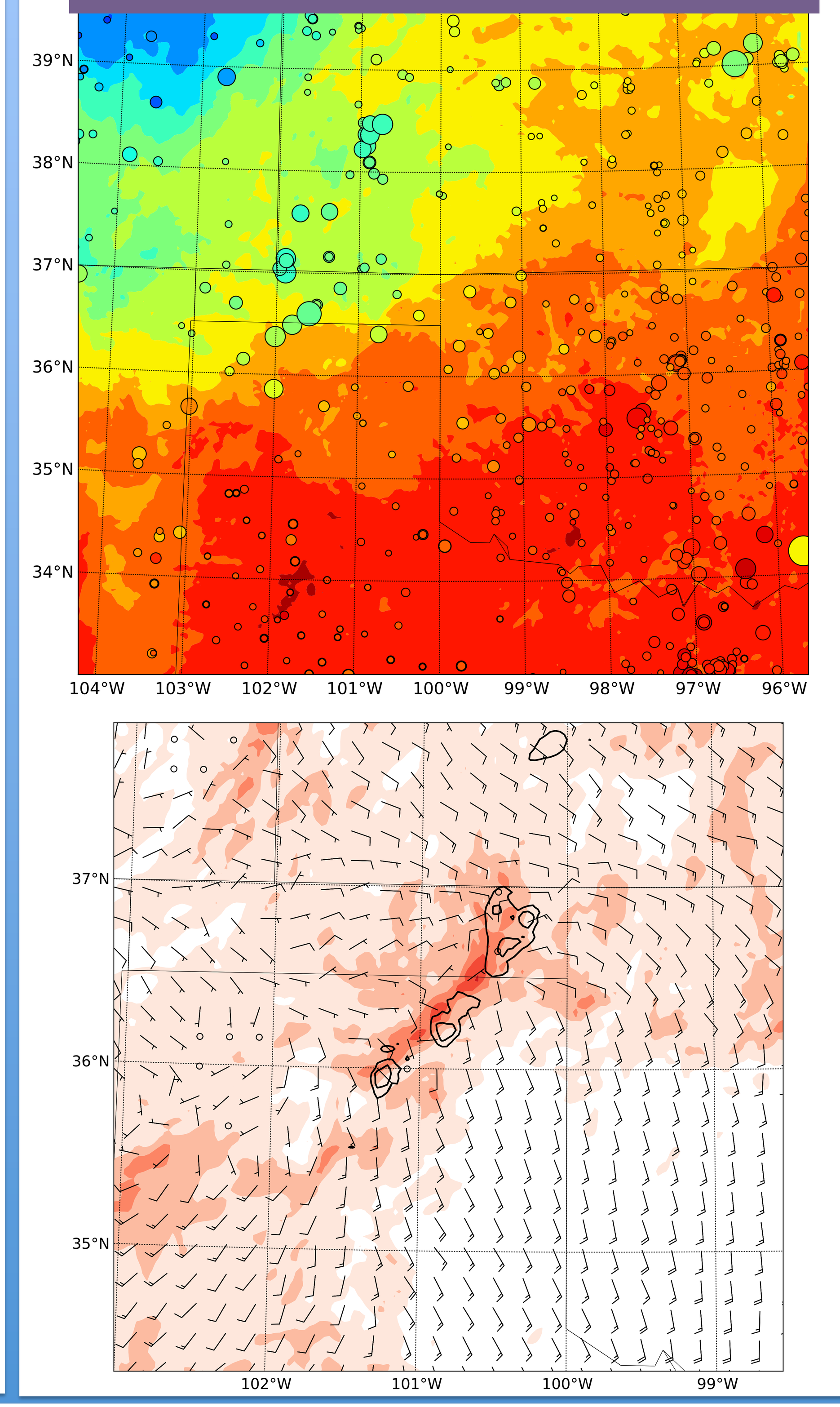
Barbs: Mean analysis wind (knots)

Black Contours: 20 and 40 dBZ mean analysis reflectivity

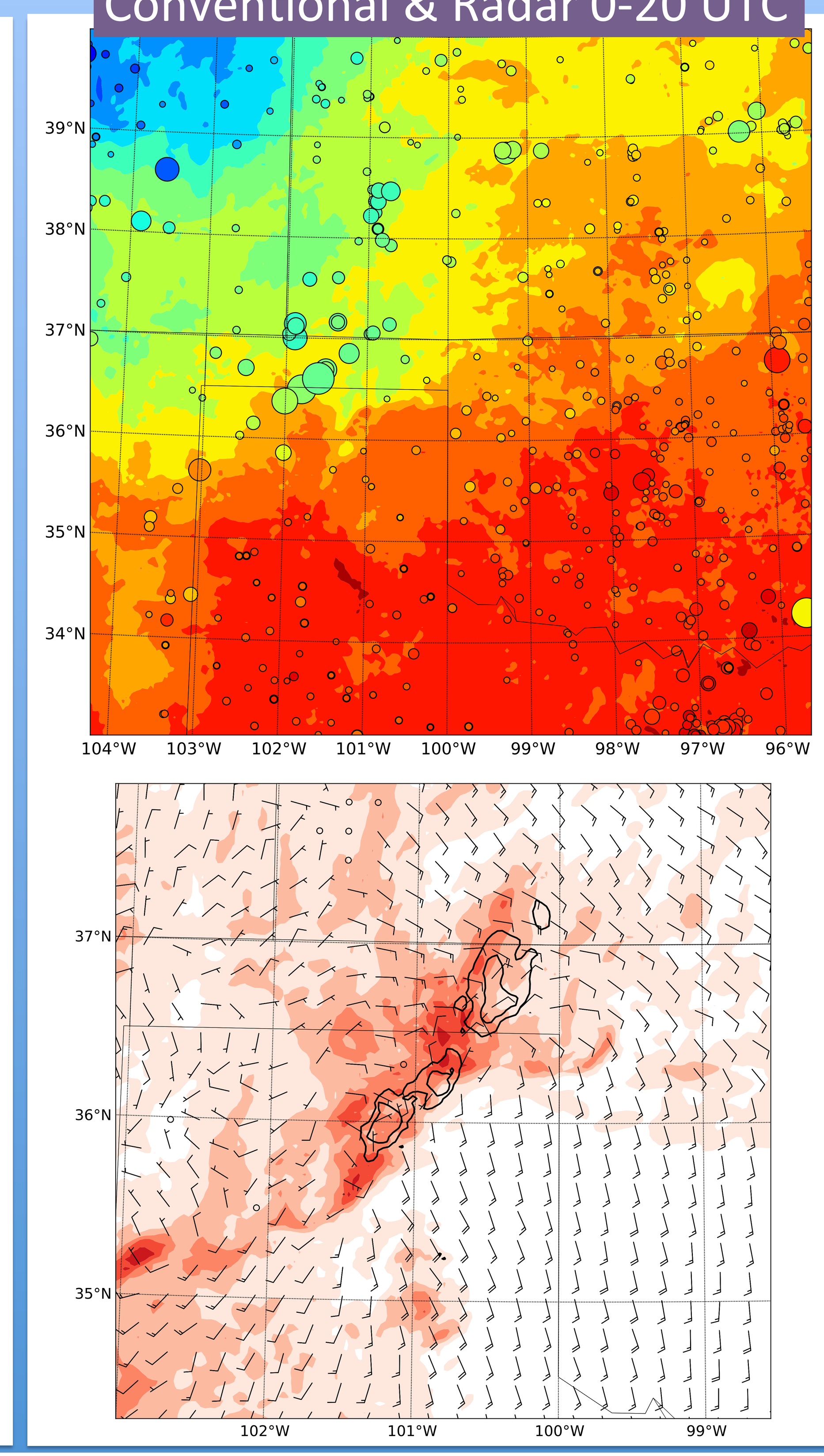
Conventional 0-20 UTC



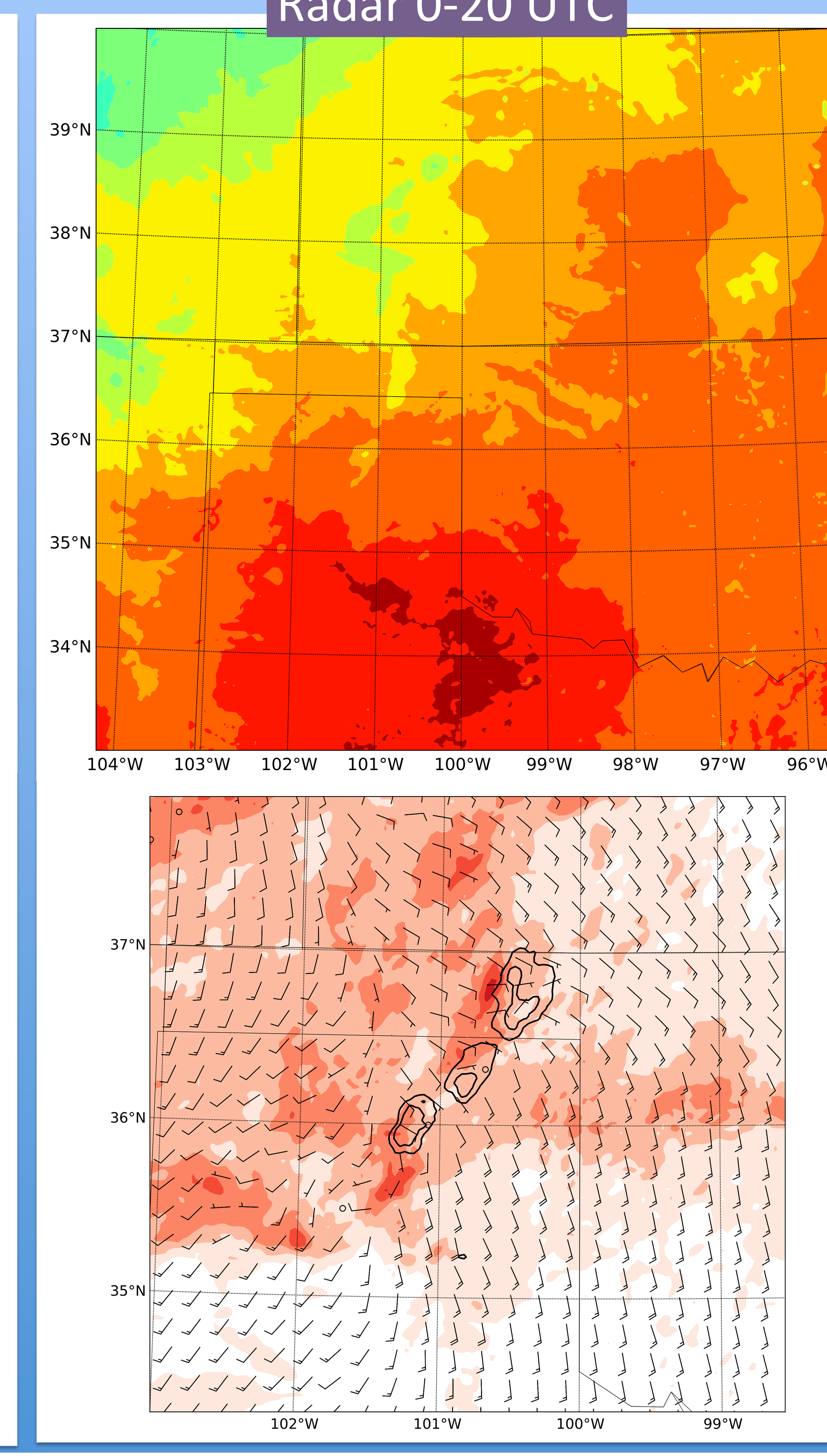
Conventional 0-17 UTC, Conventional & Radar 18-20 UTC



Conventional & Radar 0-20 UTC



Radar 0-20 UTC



The conventional obs improve the sfc temp analysis, however the cooler air on the NW side of the front is not well represented. The radar obs improve the storm location and intensity. Forecasts will be examined in the future to determine predictability of the tornadic storm given these storm environments.

20 UTC Observations

METAR & mesonet wind obs, reflectivity (dBZ) obs, and outflow boundary location