Impact of Assimilating Radar Observations on Storm-scale EnKF System within Realistic Mesoscale Environment

By

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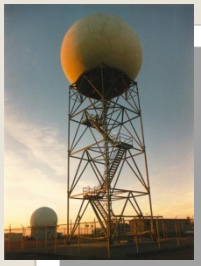
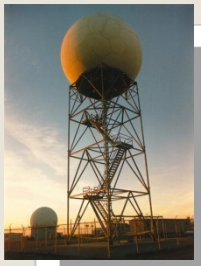


Motivation

- Assimilation of radar observations on storm-scale NWP model are essential for the predictions of severe thunderstorms.
- The development and evolution of severe thunderstorm events are strongly tied to the environment in which they develop.
- It is important to incorporate the influence of environmental variability and mesoscale forcing on the storm scale flows.



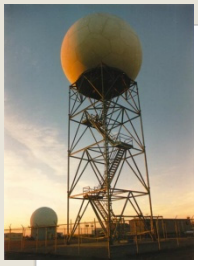
Recent Work

- Mesoscale WRF/DART EnKF system developed at NSSL shows promise.

  Fujita et al. 2007, Stensrud et al. 2009, Wheatley and Stensrud 2010.

- Storm-scale ensemble initialized from this 3D realistic mesoscale EnKF system improves the predictions of thunderstorm characteristics using 3DVAR.

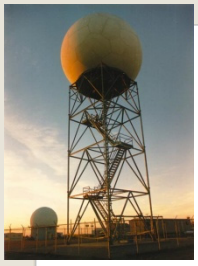
  Gao et al. 2008, Stensrud and Gao, 2010



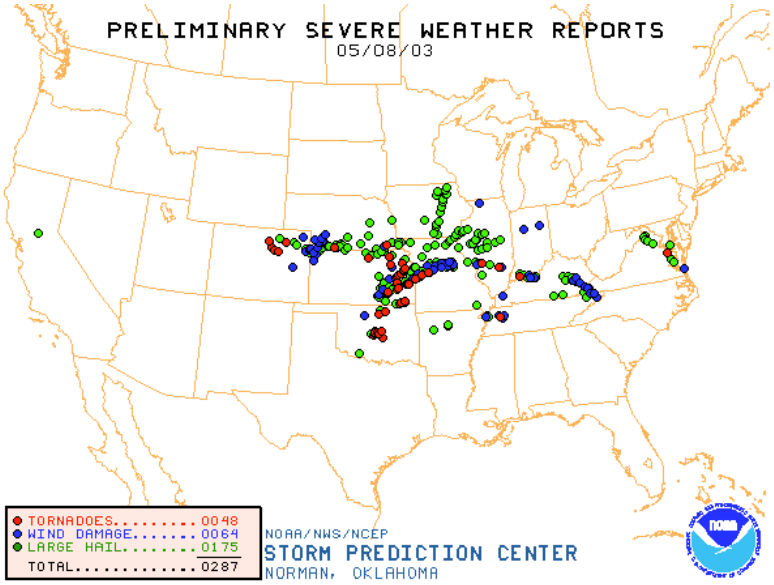
Objective

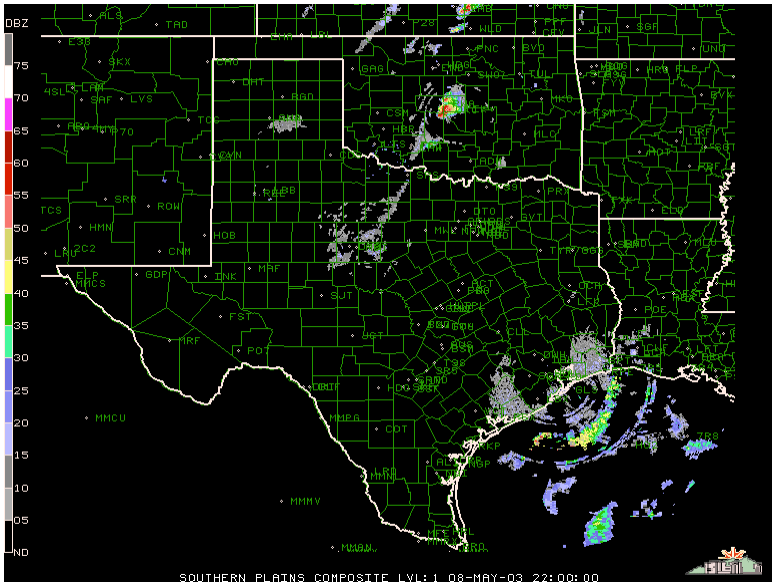
- Incorporate a storm-scale ensemble within the NSSL WRF/DART EnKF mesoscale ensemble system.

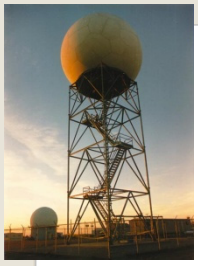
The impact of realistic mesoscale environment on storm-scale assimilation using EnKF data assimilation technique.



May 8, 2003 Oklahoma City Supercell

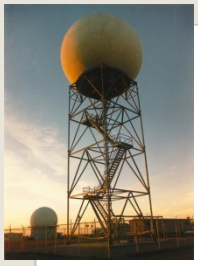






Mesoscale Ensemble

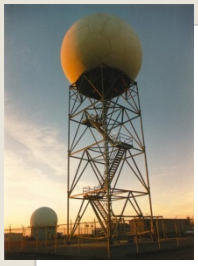
- WRF-ARW v2.2
  - Eastern two-thirds of CONUS.
  - 20-km horizontal grid spacing.
  - 35 vertical levels.
  - Mean IC/BC from 09 UTC NCEP SREF.
- 30 member ensemble
  - IC/BC perturbations from WRF-Var (Torn et al. 2006); also, soil moisture perturbations.
  - Physics diversity.
  - Assimilate hourly T, T_d, u, v and p.
  - Data Assimilation Research Testbed (DART).



Storm-scale Ensemble

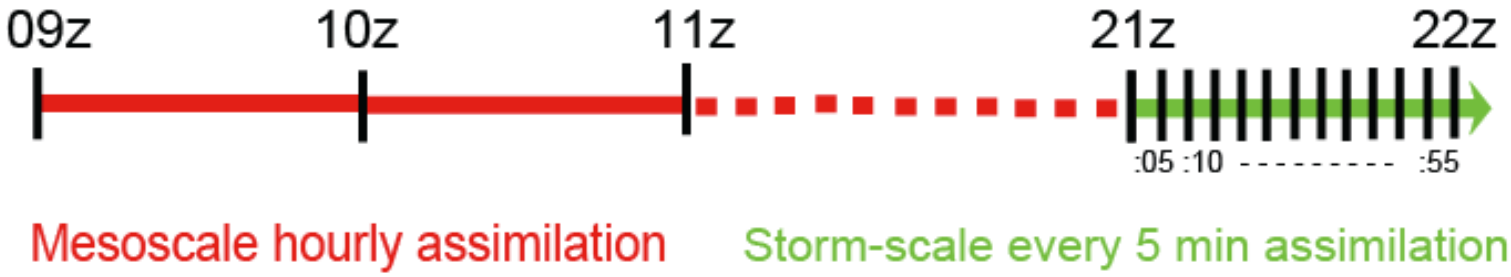
- 30 member ensemble
  - One-way nested within the 30-member mesoscale ensemble.
  - 240x240 km wide.
  - 2-km horizontal grid spacing.

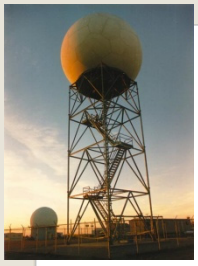
  - Physics:
    Microphysics: Purdue Lin.
    PBL: YSU.
    Shortwave radiation: Dudhia.
    Longwave radiation: RRTM
    Land Surface model: Noah



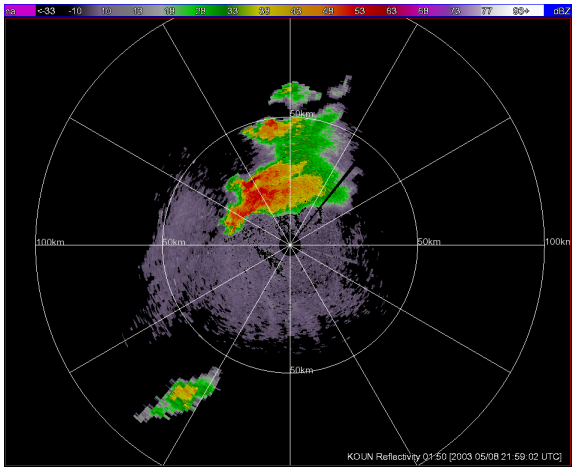
EnKF Experimental Design

- Routinely available surface and upper air observations are assimilated on the mesoscale domain for 12 hours.
- Radar observations assimilated every 5-min for 1 hour.

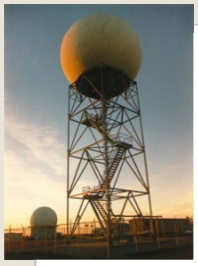




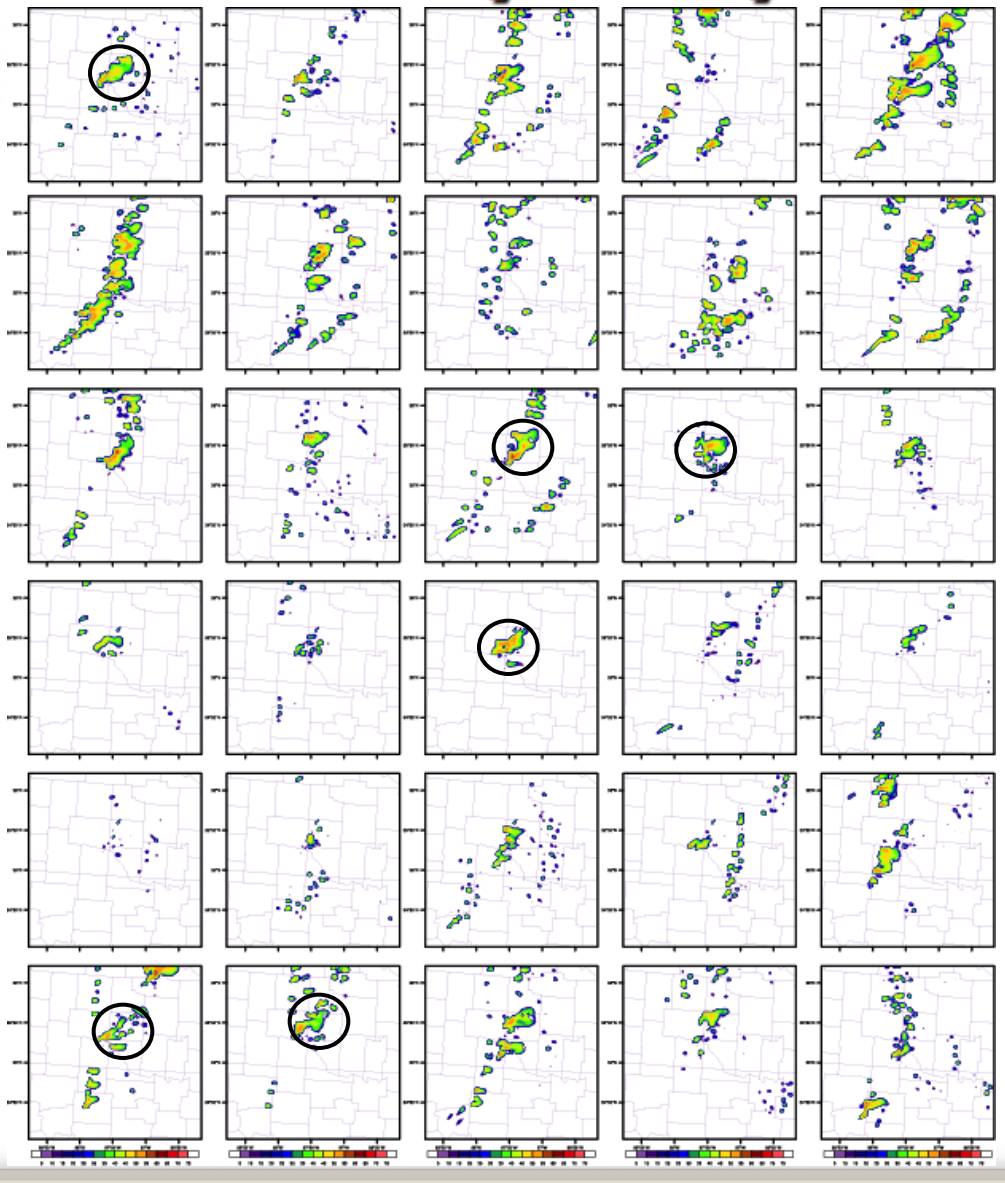
EnKF Radar-Data Assimilation

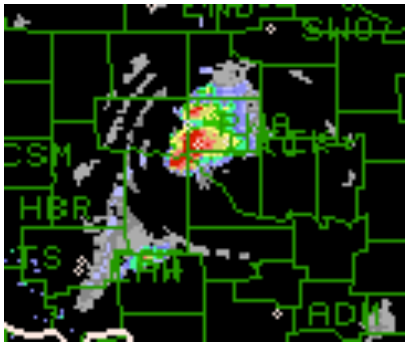


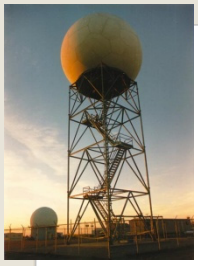
- Radial velocity and reflectivity observations from KOUN radar are assimilated at native radar coordinates.
- 1 km range resolution and 1^{o} azimuthal sampling.
- Assimilate reflectivity observations ≥ 0 dBZ and radial velocity only where reflectivity > 5 dBZ.
- Additive noise technique to maintain spread -(Dowell and Wicker, 2009).



Reflectivity Analyses at 22:00 UTC



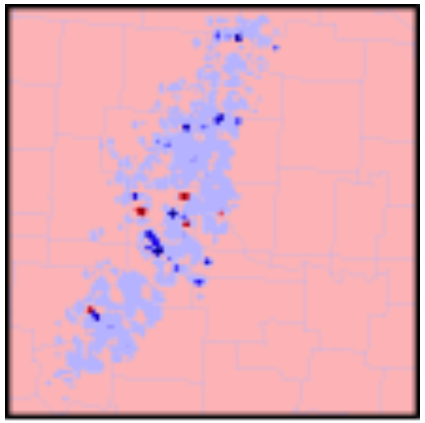


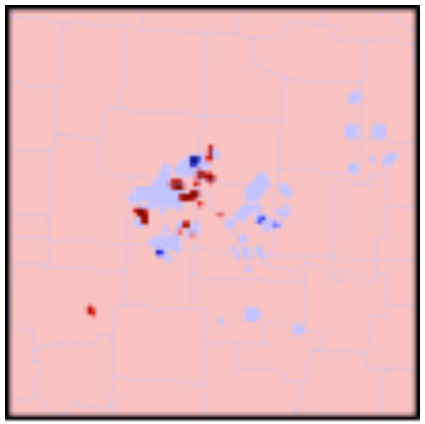


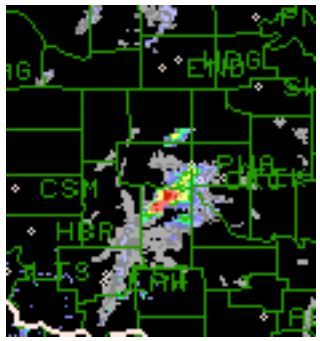
dBZ Difference (Posterior – Prior)

Member 6 **Member 18**

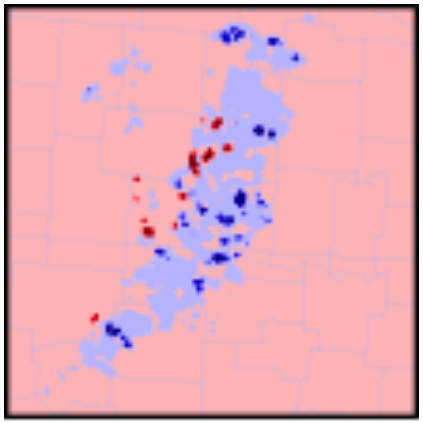
21:30

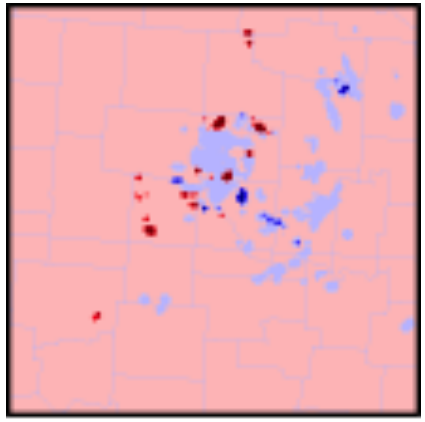


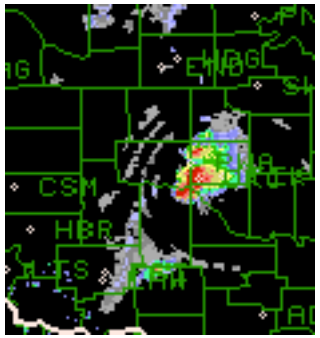


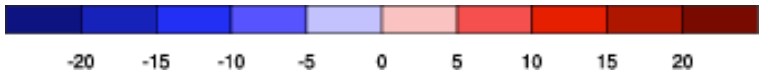


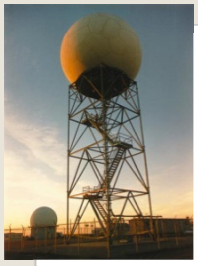
22:00



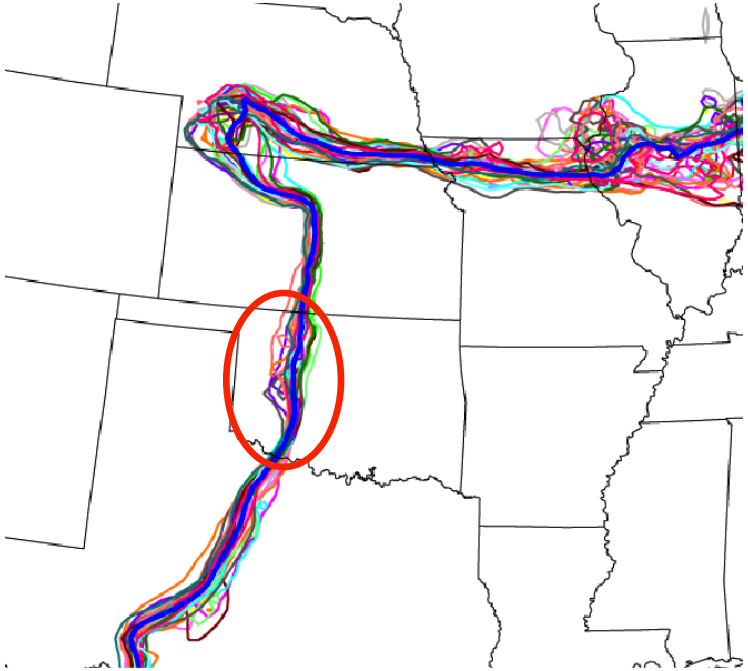


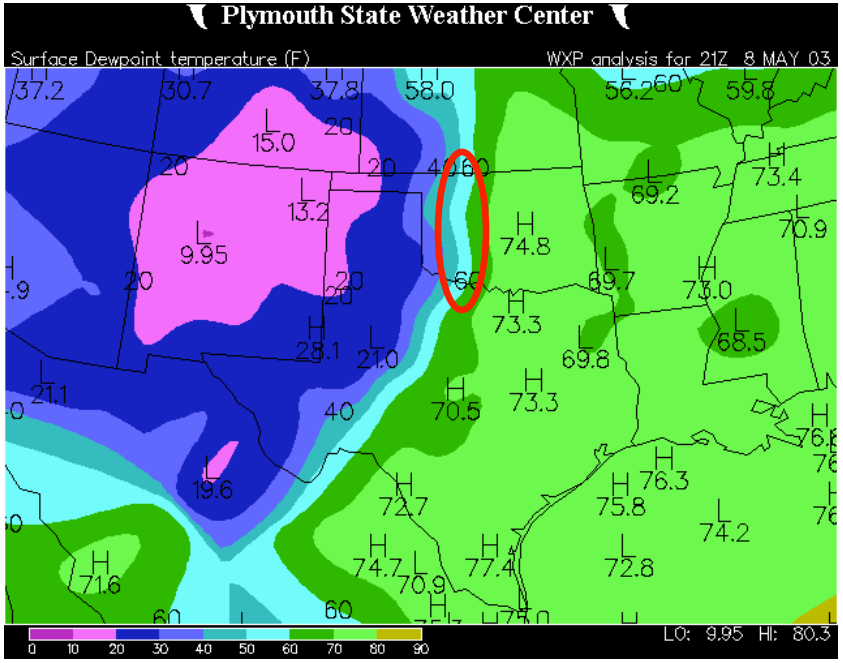


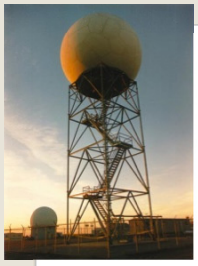




Isolines of 55ºF Surface Dewpoint Temperature at 21 Z

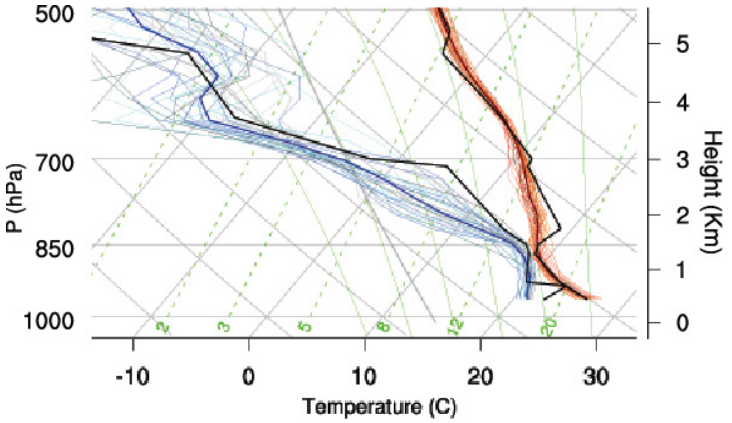




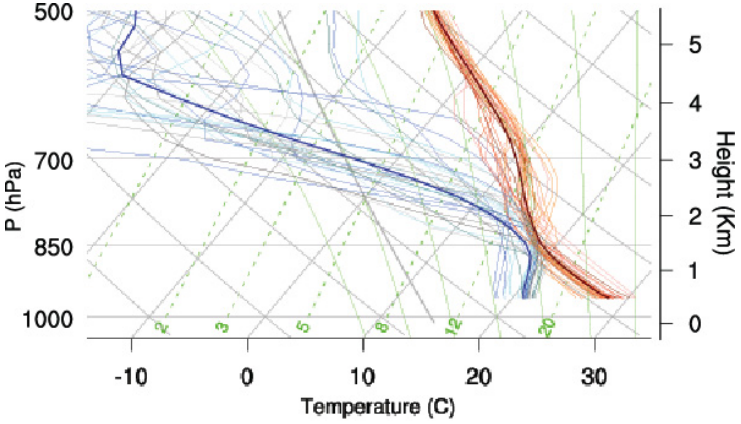


OUN Soundings

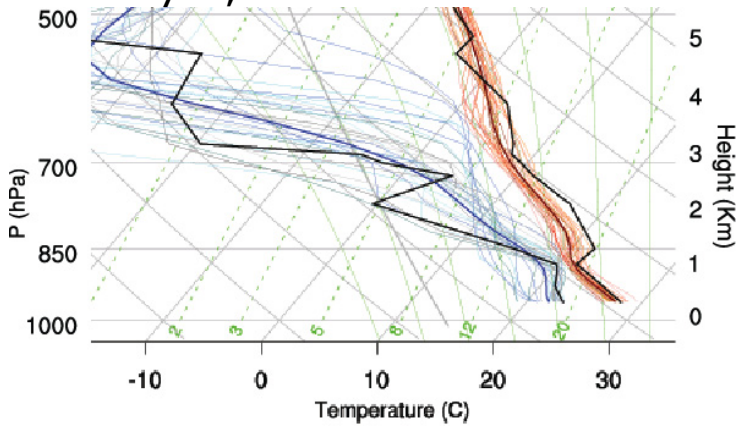
May 8, 2003 18 UTC



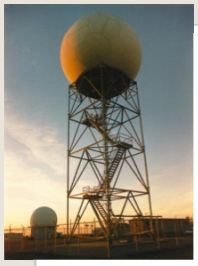
May 8, 2003 21 UTC



May 9, 2003 00 UTC



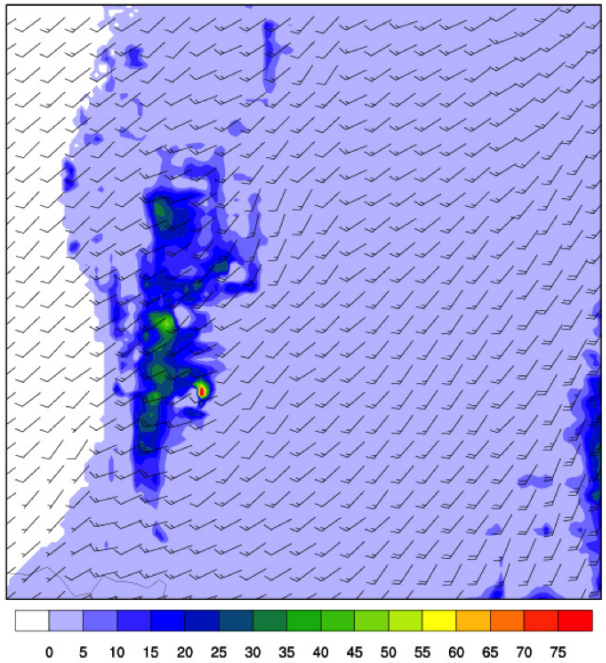
Ens. mean T profile in red.
Ens. mean Td profile in blue.
Rawinsonde observations in black.



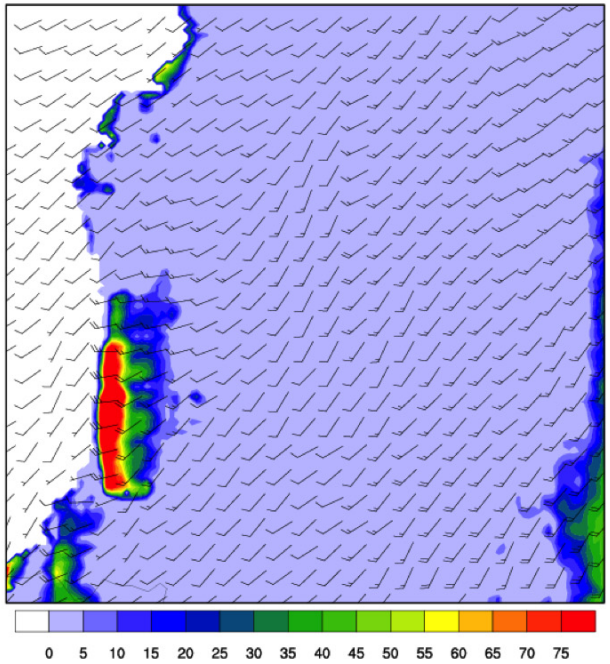
CIN (J/kg) at 21:10Z

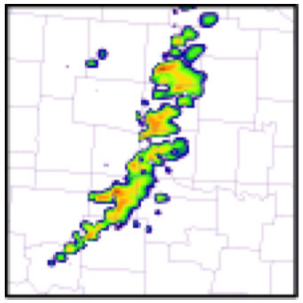
At 21:10 Z

Ens mem 6

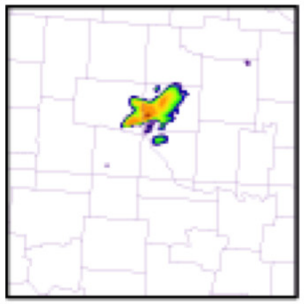


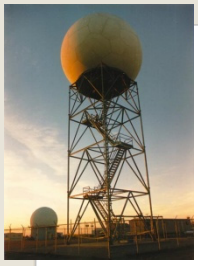
Ens mem 18





Analyses at 22:00 Z





Concluding Remarks

- The spurious cells are very hard to suppress.
  - Environment has very weak convective inhibition.
  - Strong mesoscale forcing embedded in the flow.

Acknowledgements:

David Dowell (NCAR)
Lou Wicker (NSSL)