Comparison of EnKF analyses and observations: Impacts by deep convection on the surrounding environment

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Field experiment provides means to validate NWP model accuracy

- The Mesoscale Predictability Experiment (MPEX) conducted in 2013 has provided unique observations of these near-storm environments via upsondes

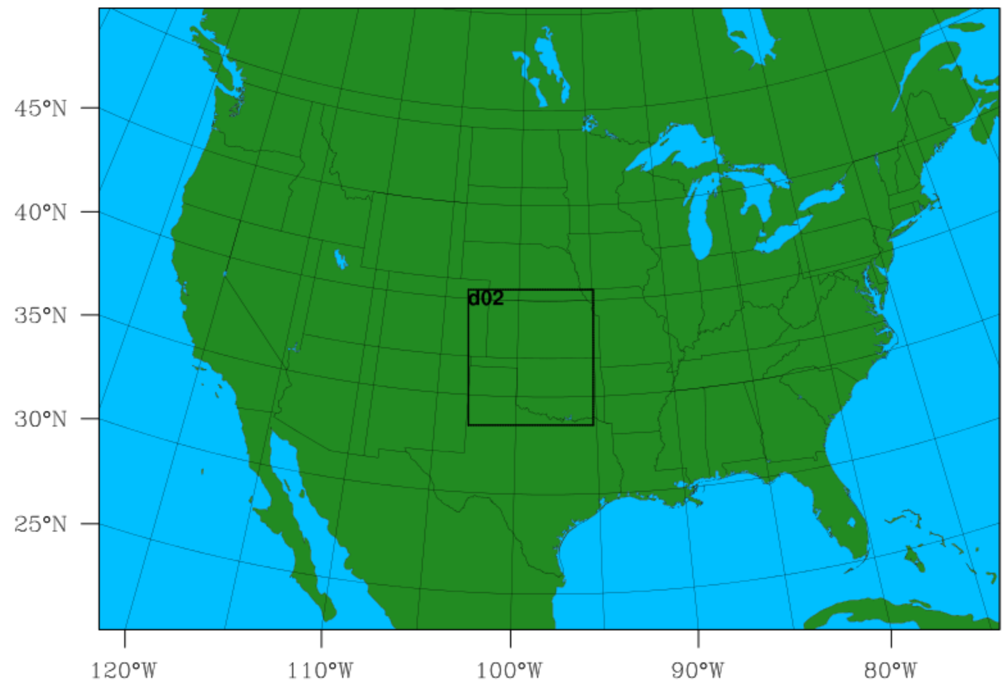
- Few studies have looked into numerical weather prediction models' ability to reproduce environments near ongoing deep convection given lack of observations

- Many studies have used NWP models to analyze convective impacts on the surrounding environment (e.g., Brooks et al. 1994 and Weisman et al. 1998)

- How well do convection allowing models replicate the surrounding mesoscale environment?

Experiments configured to properly simulate MPEX targeted convection

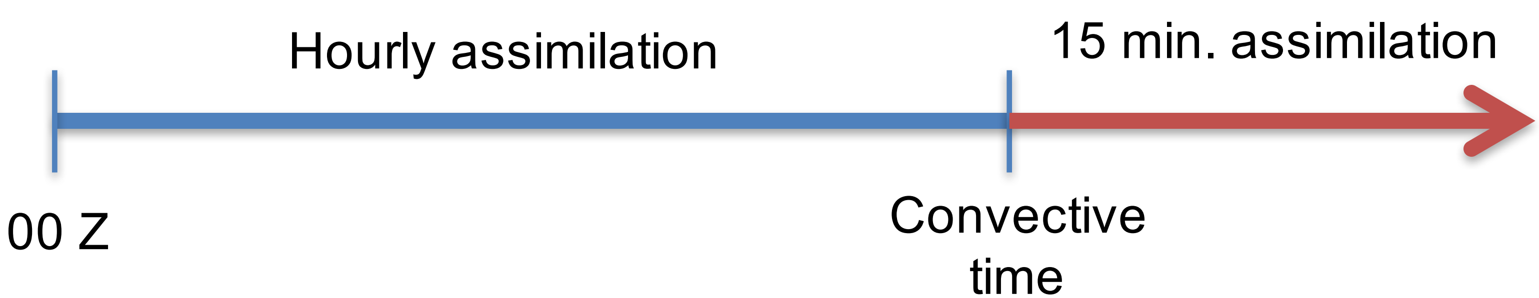
- 28-31 May 2013 KS, TX, OK convective events
- 36-member ensemble created with physics diversity using nested Advanced Research version 3.4.1 of Weather Research and Forecasting (WRF-ARW) Model and the Data Assimilation Research Testbed's (DART) ensemble adjustment Kalman filter (Anderson 2001; Wheatley et al. 2015)
- Outer domain (CONUS) has 15 km grid spacing while inner domain has 3 km grid spacing



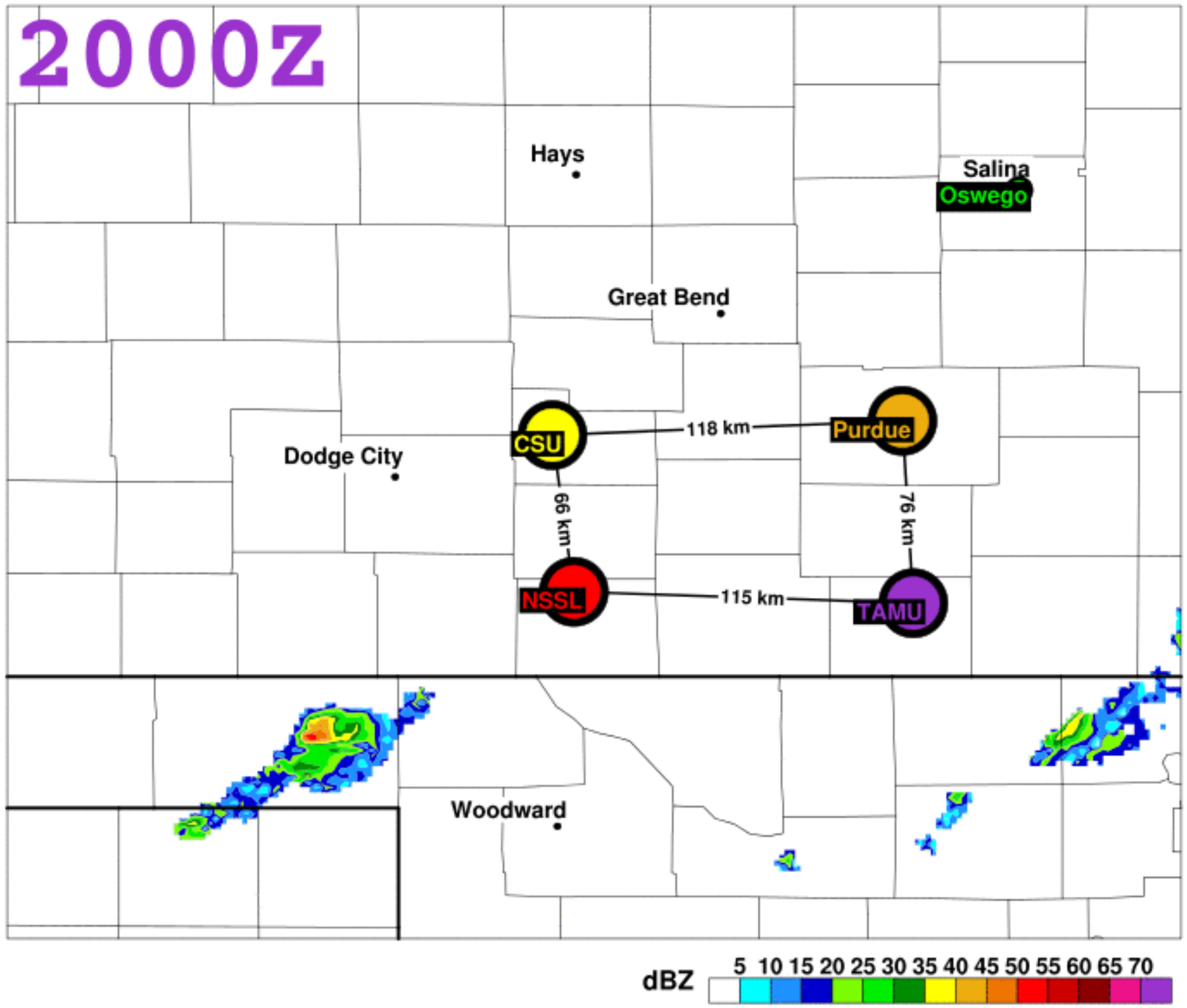
Mesoscale and storm-scale domains for all four days

Repeated assimilation cycles improve environmental initial conditions before convection initiation

- Assimilate conventional obs. in hourly cycles beginning at 00 Z each day until a specified "convective time"
- After the specified convective time, assimilate radar, surface, and NWS rawinsonde obs. on inner domain *only* every 15 mins.
- Adaptive inflation used to maintain ensemble spread and additive noise used to spin-up convection (Dowell and Wicker 2009; Sobash and Wicker 2015)



NSSL NMQ hybrid scan reflectivity valid 2000Z 28 May 2013



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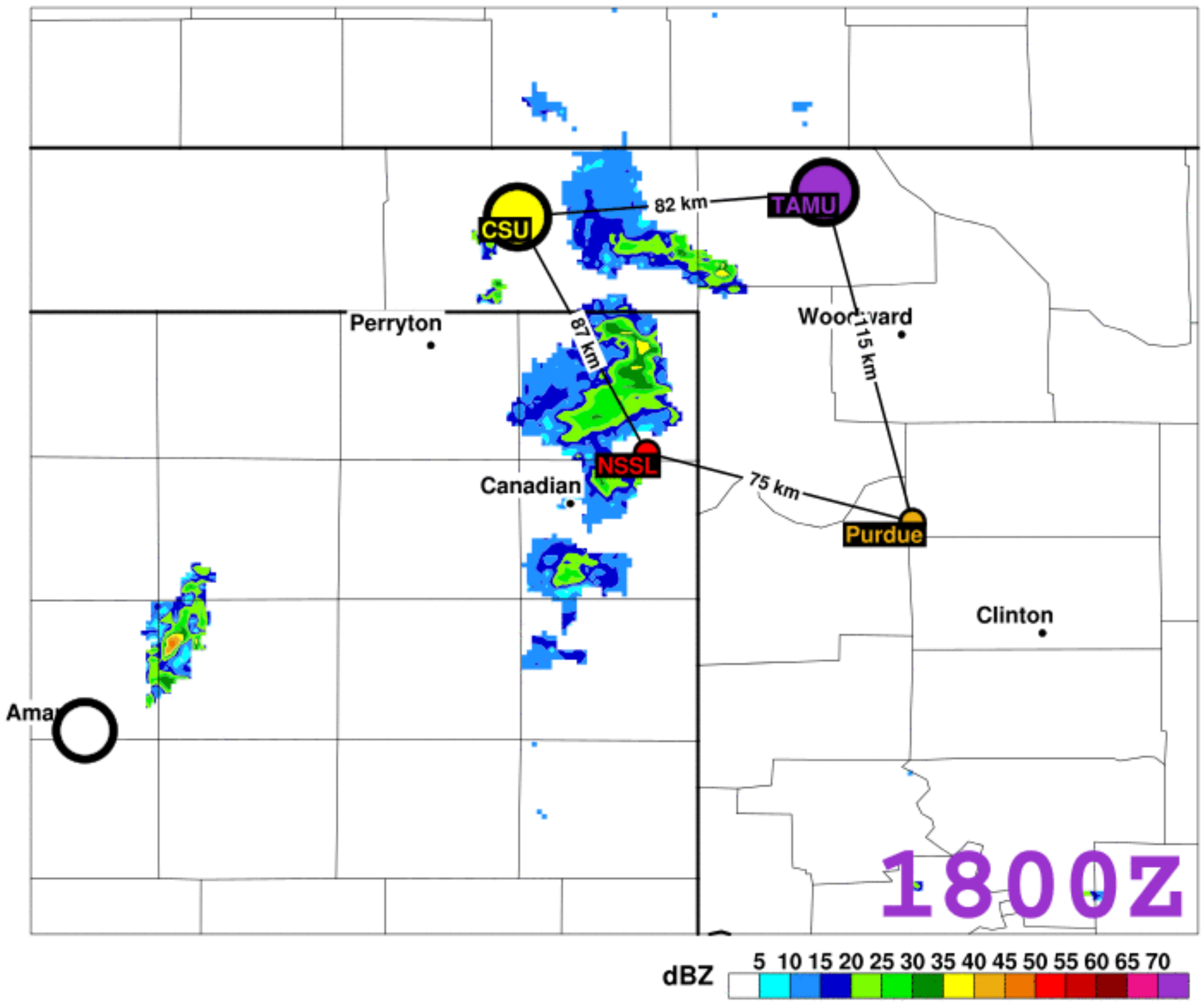
NSSL NMQ hybrid scan reflectivity valid 1800Z 29 May 2013



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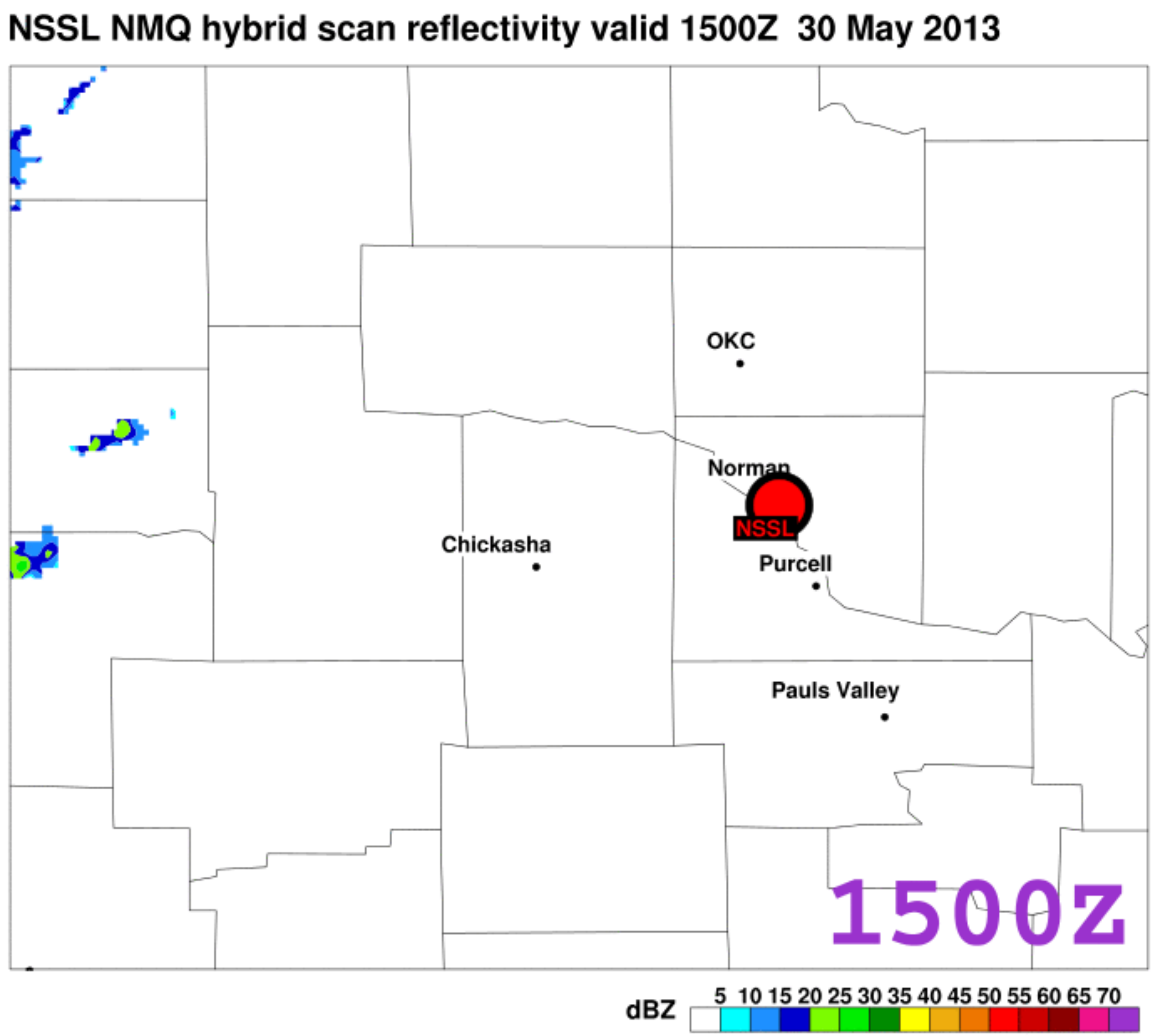

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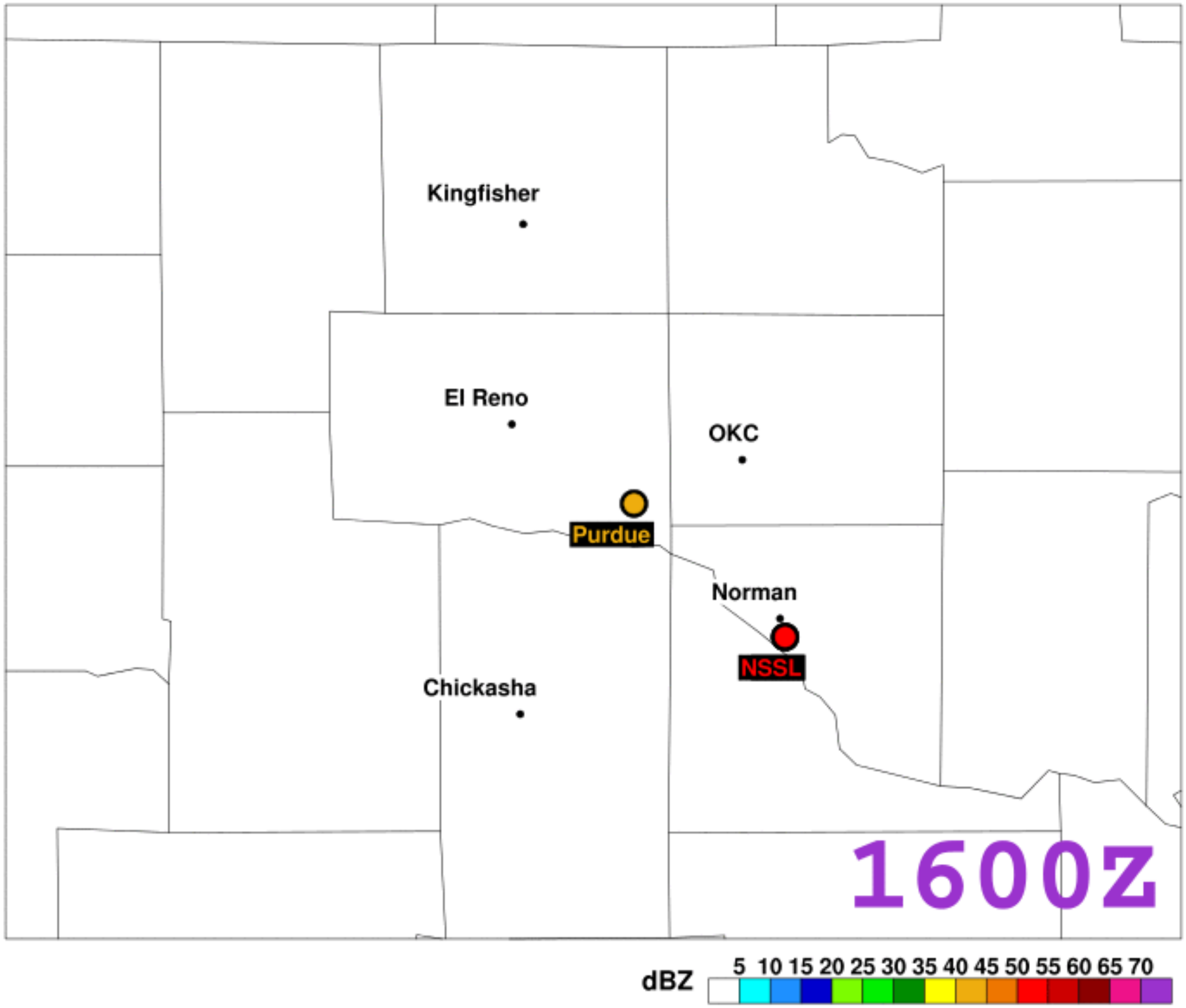
NSSL NMQ hybrid scan reflectivity valid 1600Z 31 May 2013



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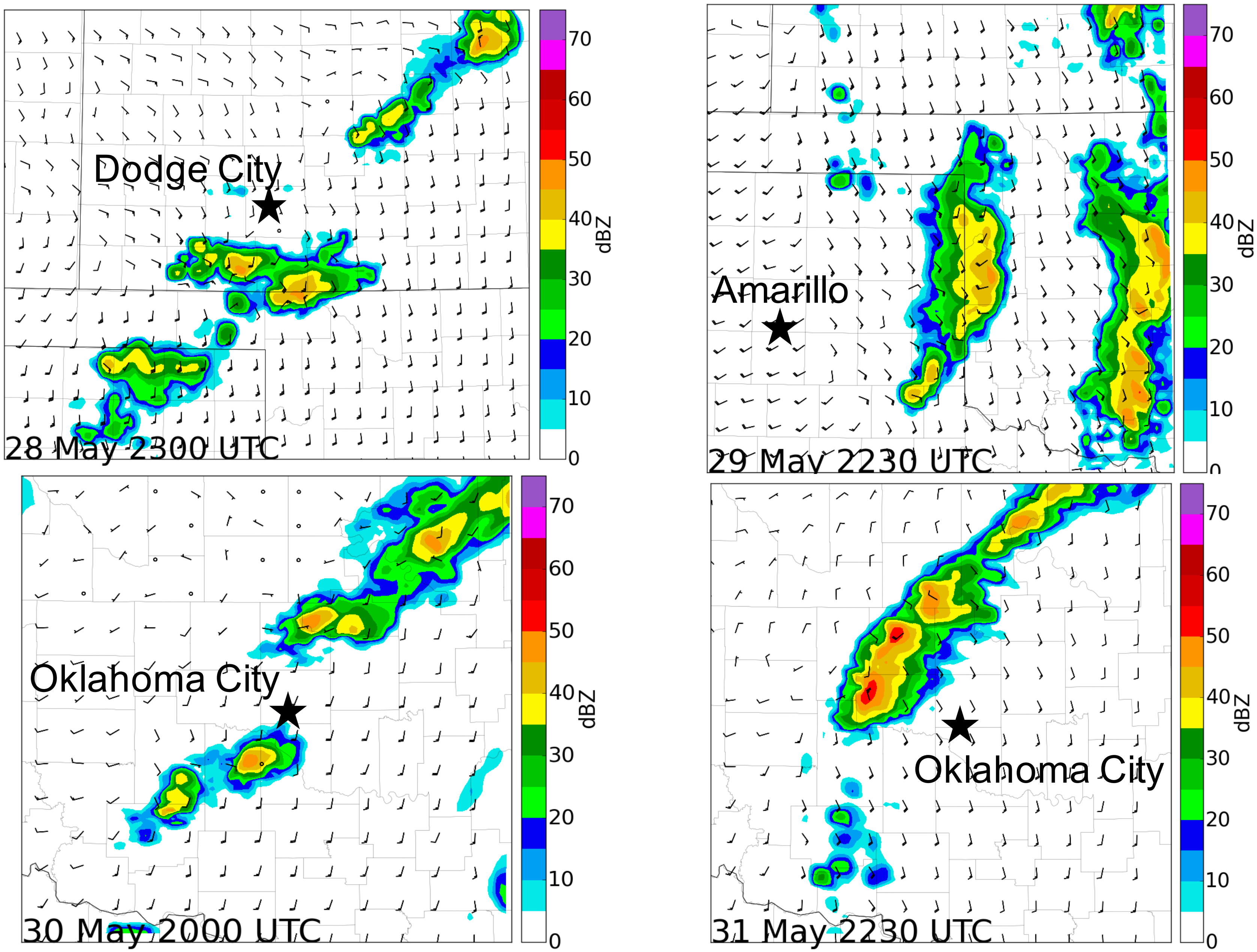
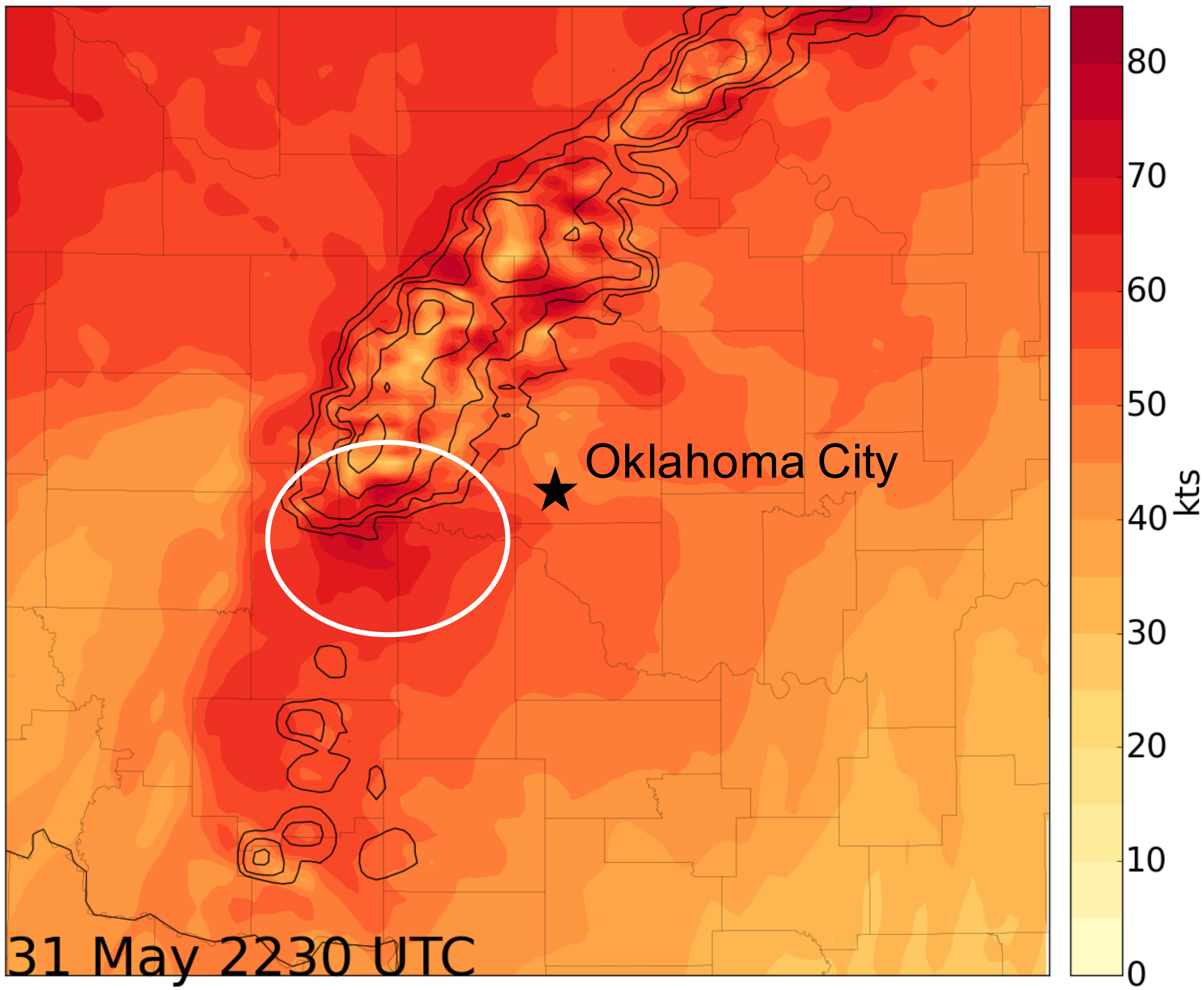
Reflectivity EnKF analyses examples show correct storm locations

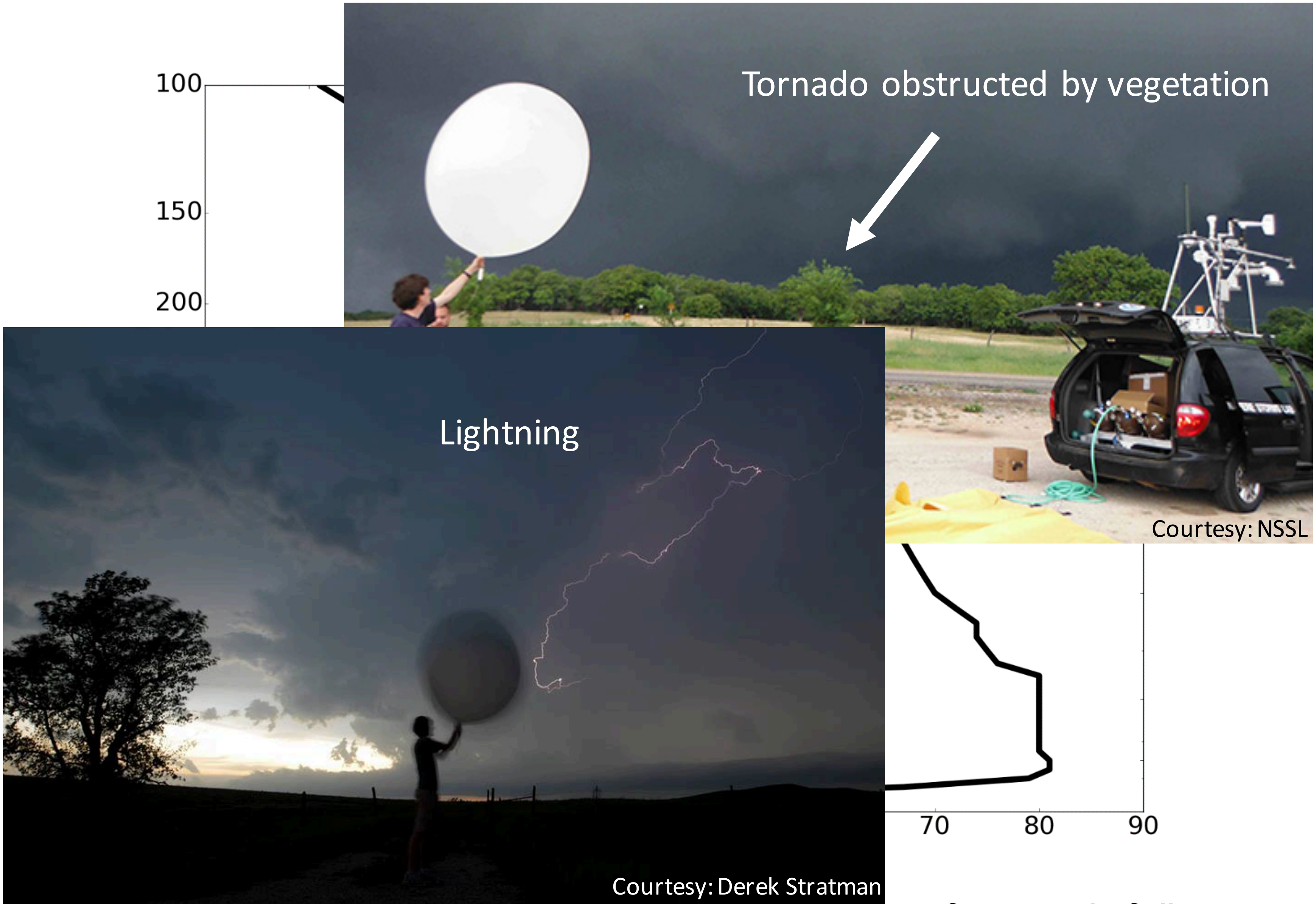


0-6 km wind shear ensemble mean analysis example exhibits enhanced wind shear within tornadic supercell inflow



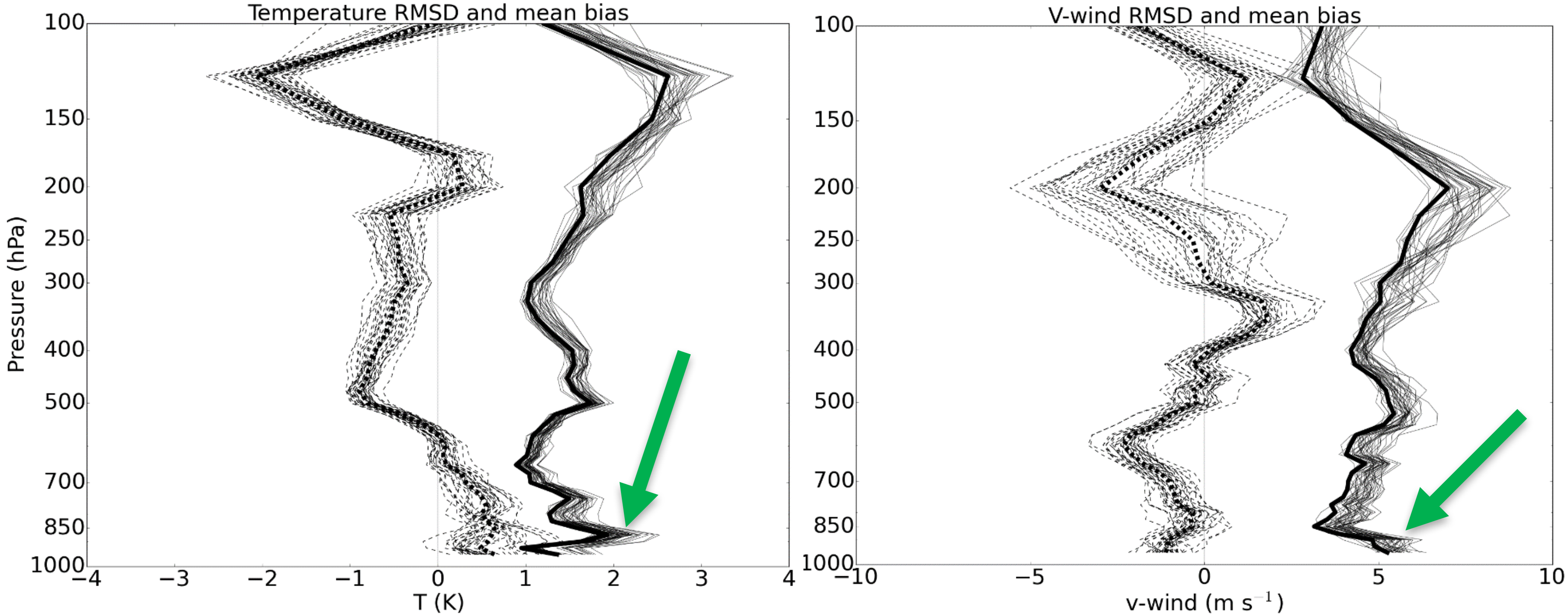
Solid contours - ensemble mean analysis low-level reflectivity

81 upsondes released over four-day period



Sample size decreases with height due to a variety of upsonde failures

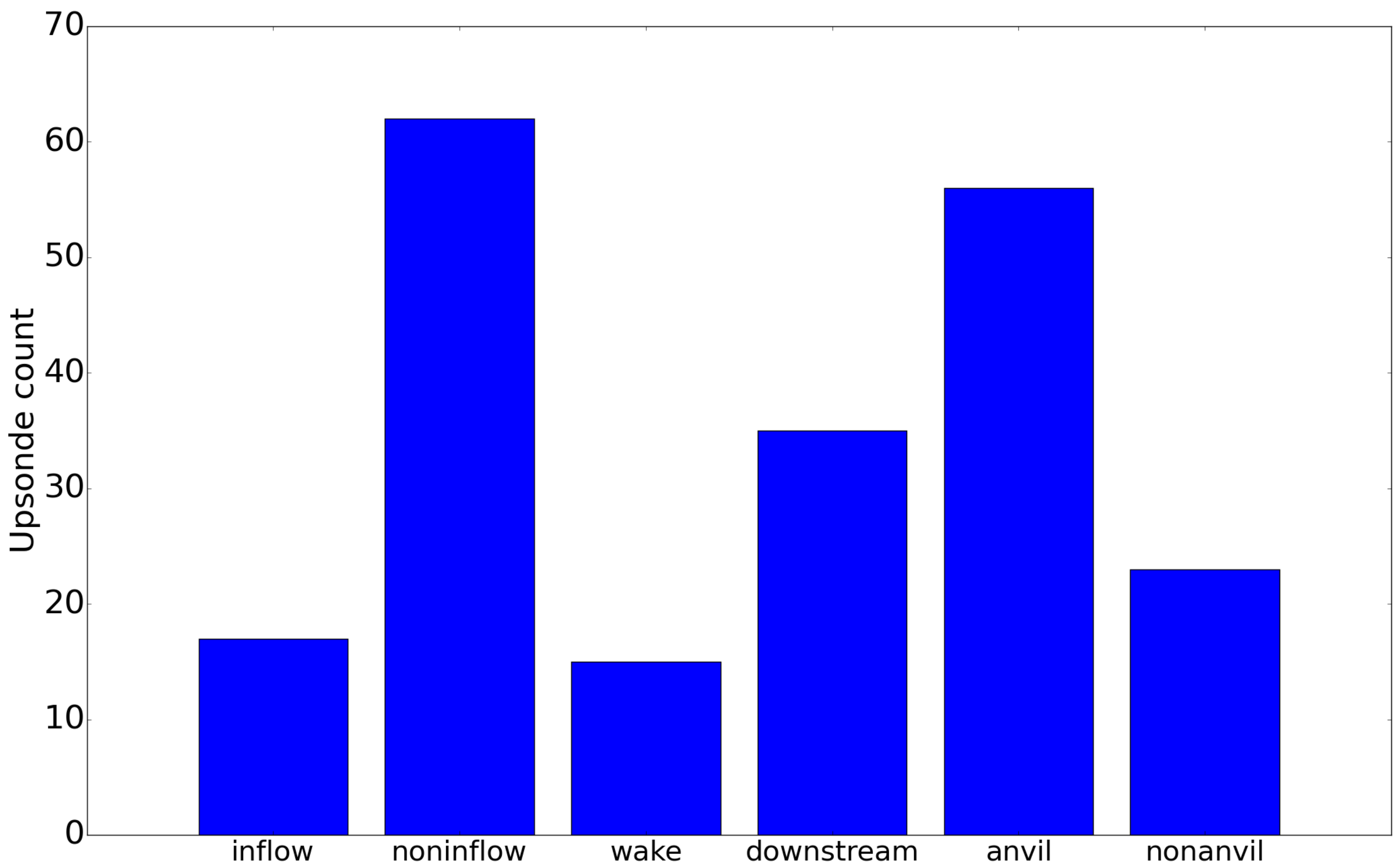
Vertical error profile examples reveal biases



Root mean square difference (RMSD) of ens. mean – thick solid; ens. mems. – thin solid
Mean bias of ens. mean – thick dashed, ens. mems. – thin dashed

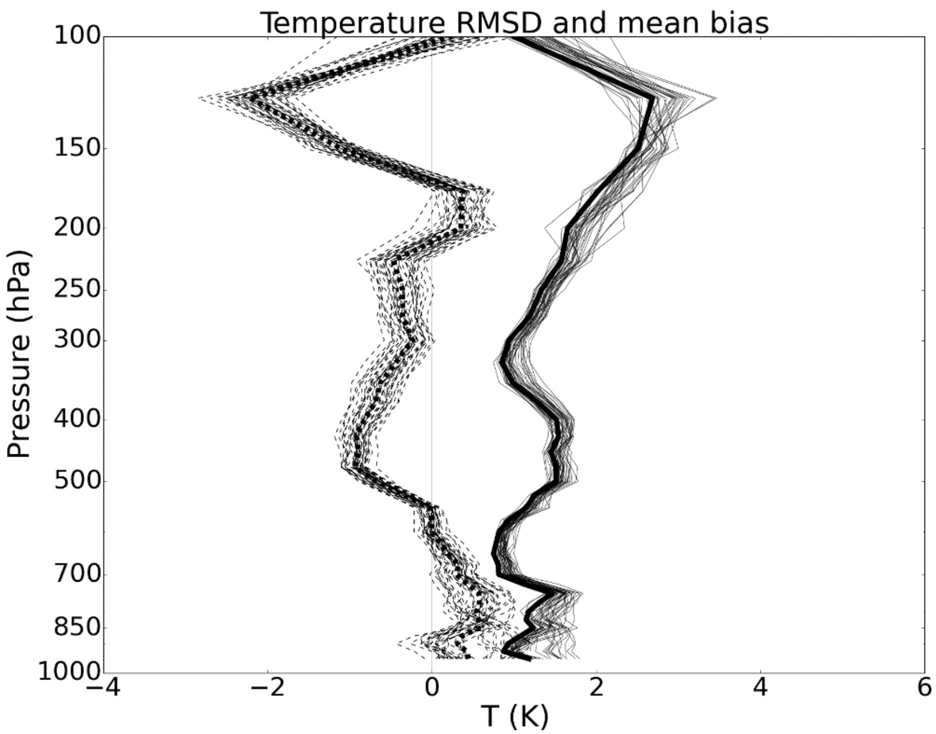
Are analysis biases larger in specific near-storm environment regions than others?

Environment region upsonde counts vary

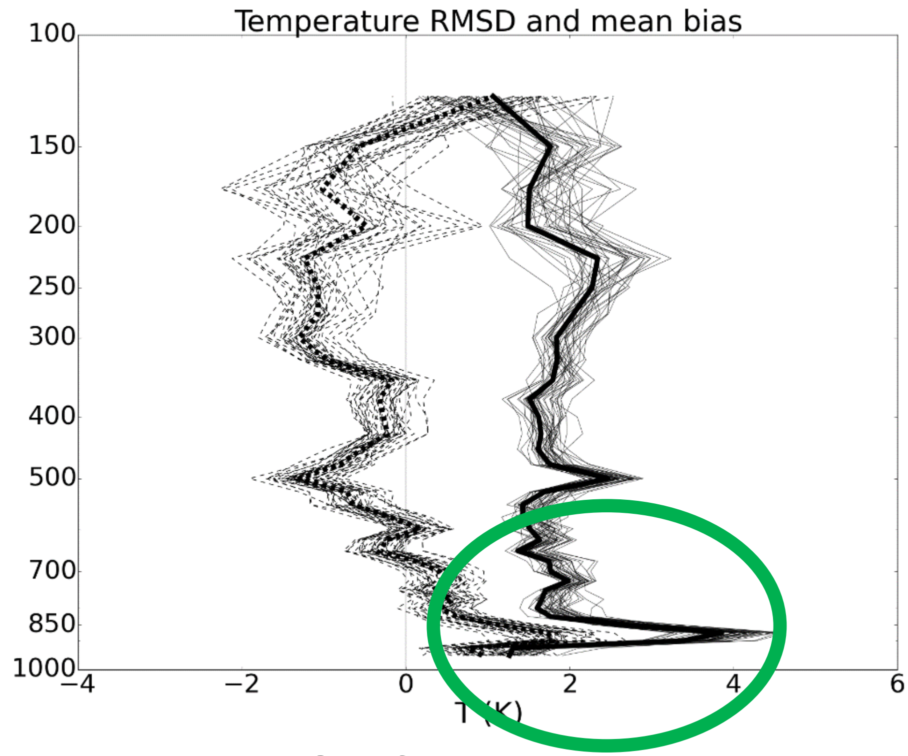


Many upsonde samples span multiple categories

850 hPa temperature error originates within outflow



Non-outflow samples



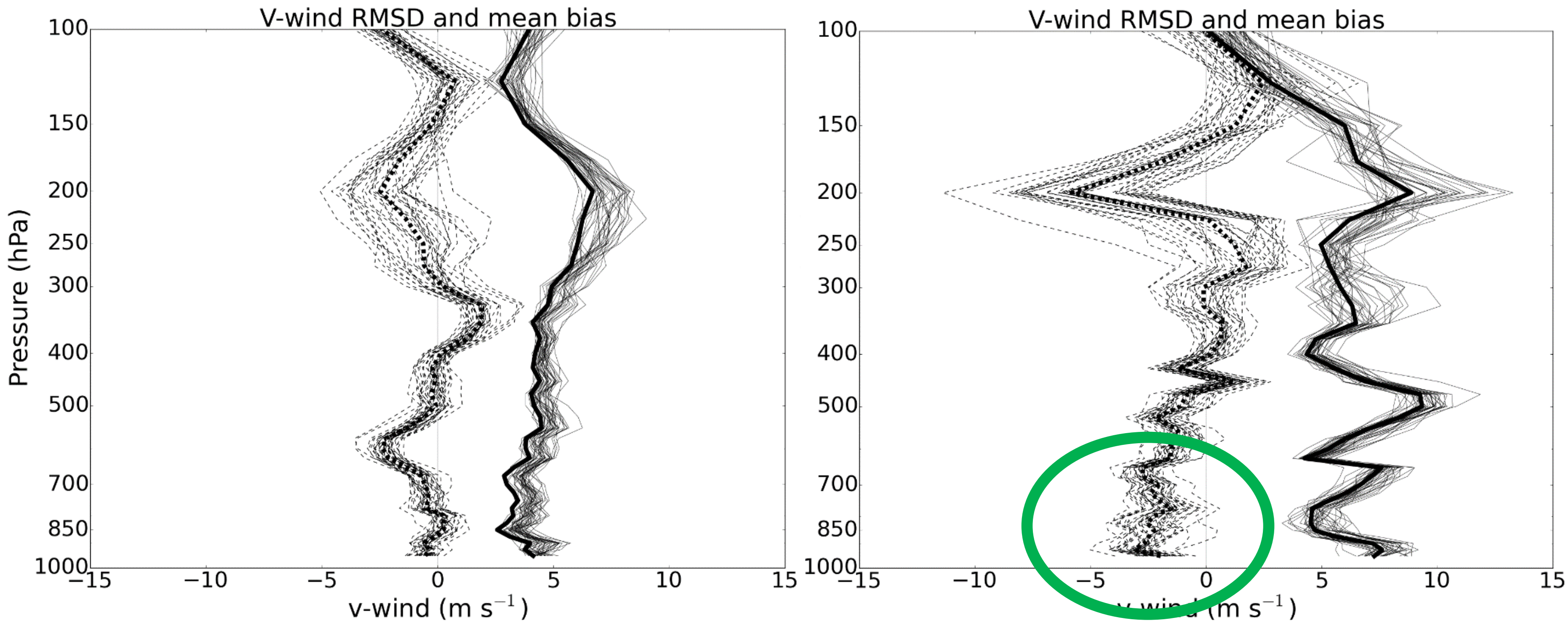
Outflow samples

Root mean square difference (RMSD) of ens. mean – thick solid; ens. mems. – thin solid
Mean bias of ens. mean – thick dashed, ens. mems. – thin dashed

Large warm bias near 850 hPa appears in outflow analyses

Analyses appear to have shallower cold pools; some cases of outflow not having spatial extent in analyses

Low-level meridional wind bias originates within inflow



Non-inflow samples

Inflow samples

Root mean square difference (RMSD) of ens. mean – thick solid; ens. mems. – thin solid
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Larger analysis negative bias within inflow regions

Model under predicts meridional wind component intensity within inflow, which is generally enhanced by convection

In summary, EnKF radar and surface DA allows analyses to reasonably depict near-storm environments, including convective impacts

- Errors in some fields are specific to particular regions of near-storm environments
- These four cases reveal a northerly bias of meridional inflow winds and shallow cold pool bias
- How will environmental errors grow during a short-term forecast? How sensitive is forecasted convection evolution to environmental errors?