Improving the Understanding and Prediction of Nocturnal Convection through Advanced Data Assimilation and Ensemble Simulations for PECAN

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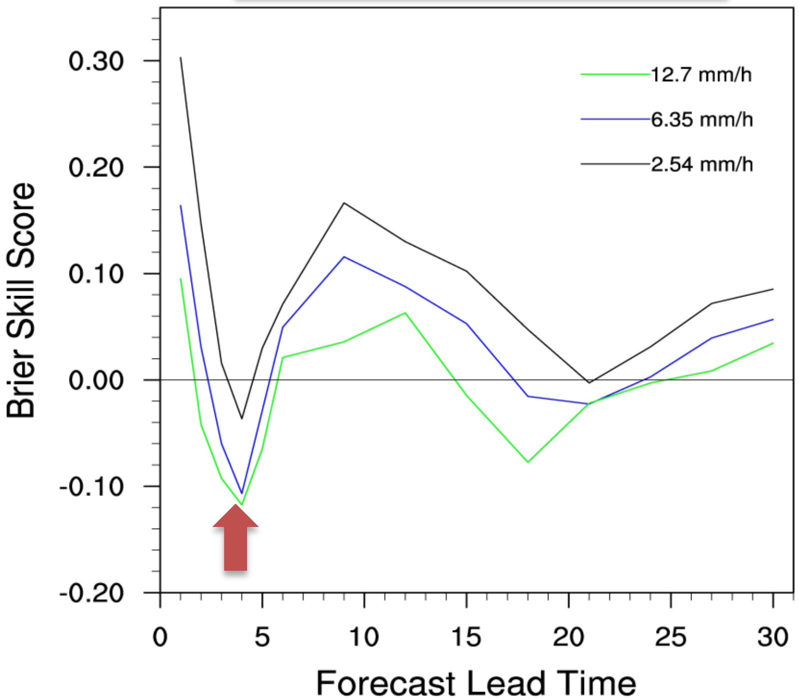
Background

2009 Spring Experiment PQPF



Johnson and Wang 2012, MWR

- ❑ a conceptual framework describing how elevated convection initiates and evolves in the presence of a SBL and a NLLJ is still lacking.

- ❑ An accurate prediction remains a challenge and requires:
  - Complete observations that adequately sample all scales involved;
  - A NWP model that can adequately represent the physical processes that govern the initiation and evolution of nocturnal convection across these multiple scales;
  - An advanced data assimilation system that can effectively combine such observations with the numerical model to provide accurate initial conditions;
  - An advanced ensemble prediction system that can effectively sample errors of the forecasts.

Objectives

- Participating field-phase of PECAN through generation of real-time convection-permitting ensemble forecasts initialized using an advanced ensemble-based DA and ensemble forecast system (e.g., initialized from 12Z and 18Z, and provided in real time to support the forecast preparation at 19Z and 02Z planned for the field phase).

- Assimilate special field experiment observations to assess the role that the unique PECAN observation systems play in improving predictive skill.

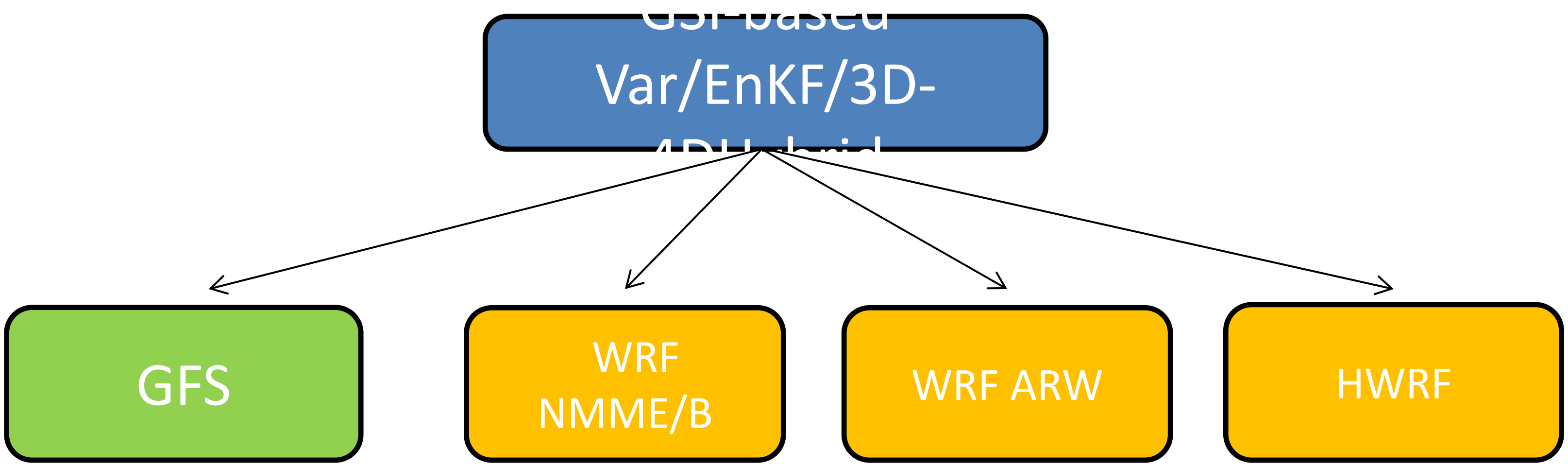
- Comprehensively diagnose the ensemble analyses and simulations to determine the dynamical and physical processes that initiate and maintain nocturnal convective systems and control their structure and evolution.

- Comprehensively evaluate ensemble analyses and forecasts against special PECAN observations to determine the appropriate modeling strategies (e.g., grid spacing; parameterization of physical processes, ensemble design) for improved prediction.

Approaches

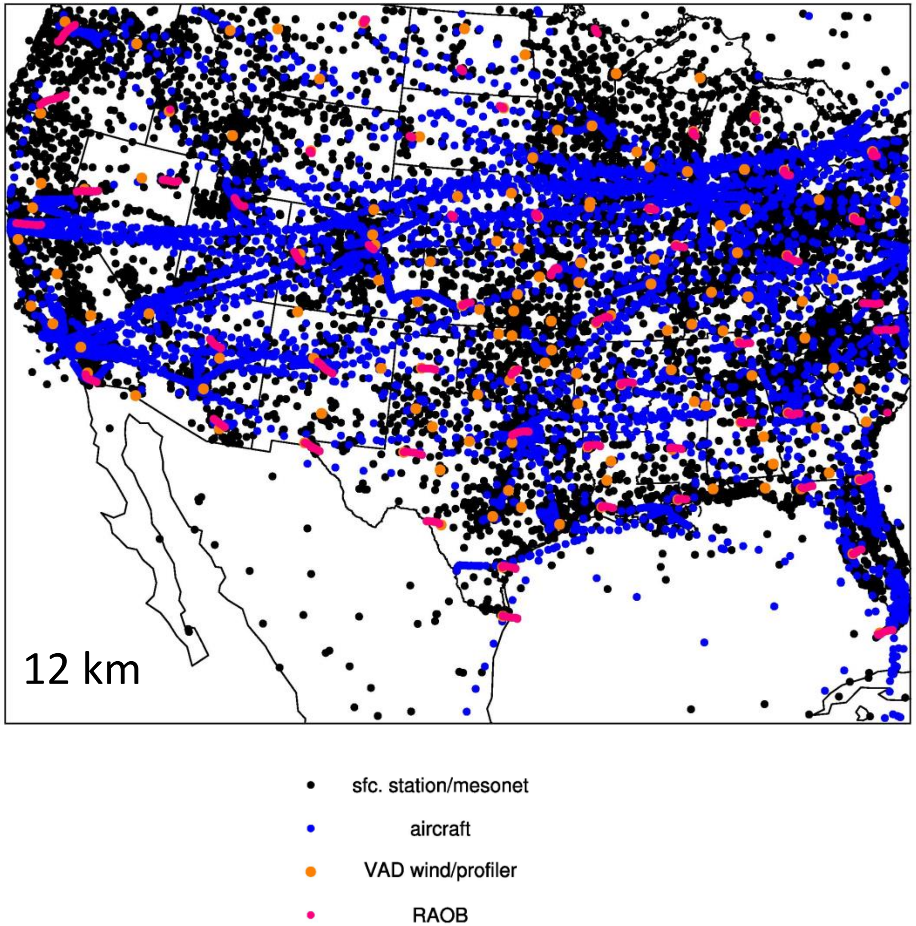
- DA and EF System:
  - DA: The GSI-based, multiscale, ensemble based DA system for WRF ARW
  - EF: Ensemble generated by the perturbed initial condition inherent in the ensemble DA, multiple physics/stochastic Kinetic backscatter, and perturbed lateral boundary.

- Linkage to operational NWP: The DA (Var/EnKF/hybrid) system developed based on NWS operational DA system GSI is further extended and tested with regional, meso/convective scale modeling systems, following operational implementation of the hybrid DA at NCEP for GFS on May 22, 2012 (e.g., Wang, Kleist, Parrish, and Whitaker 2013, MWR).



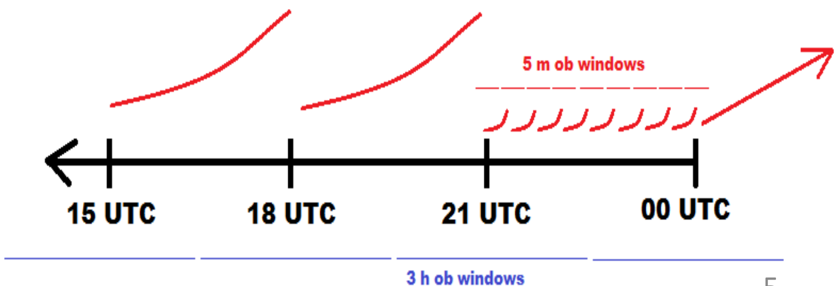
Multi-scale data assimilation & ensemble forecast system

U observations assimilated at 00 UTC 20 May

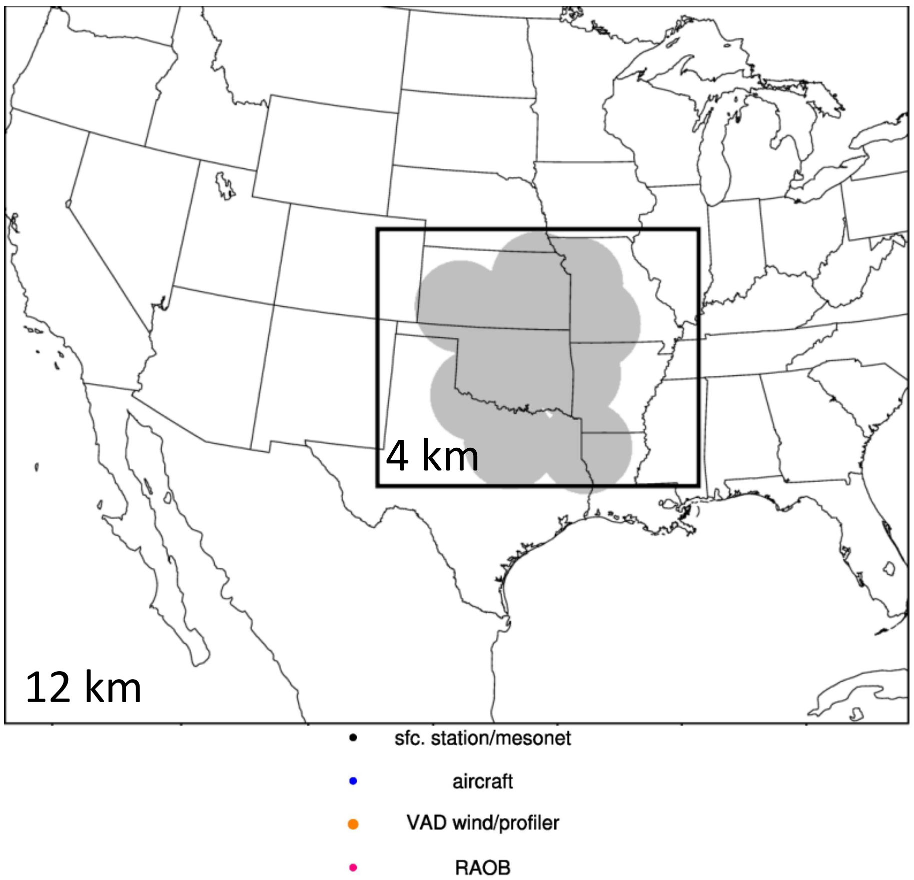


Johnson, Wang et al. 2014

- **Outer Domain**
  - Currently assimilate operational conventional surface and mesonet observations, RAOB, wind profiler, ACARS, and satellite derived winds every 3 hours to define synoptic/mesoscale environment
  - Add and assimilate PECAN obs.

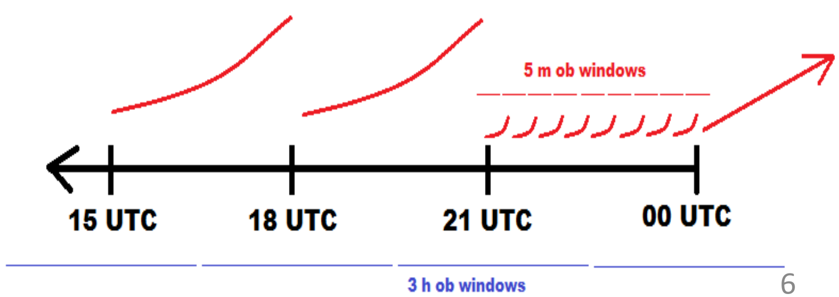


Multi-scale data assimilation & ensemble forecast system

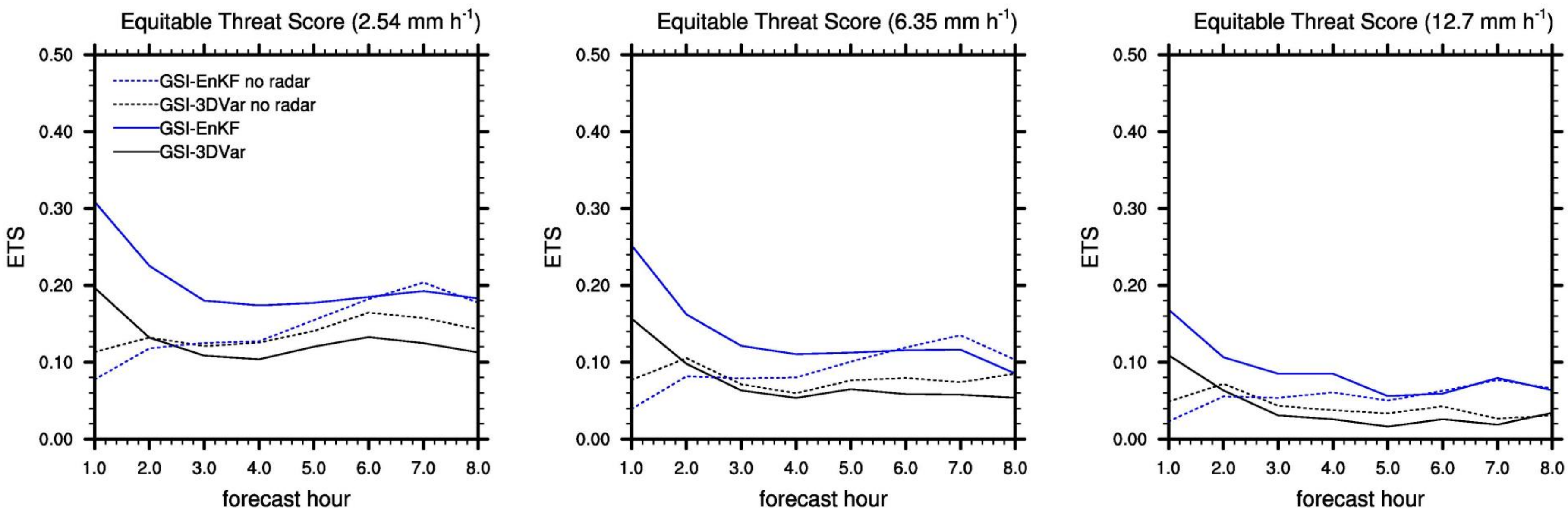


- **Inner Domain**
  - Currently assimilate velocity and reflectivity from NEXRAD radar network every 5 min during last 3hr cycle
  - Add and assimilate PECAN obs.

- Outer domain analysis cycle provides IC/LBCs for

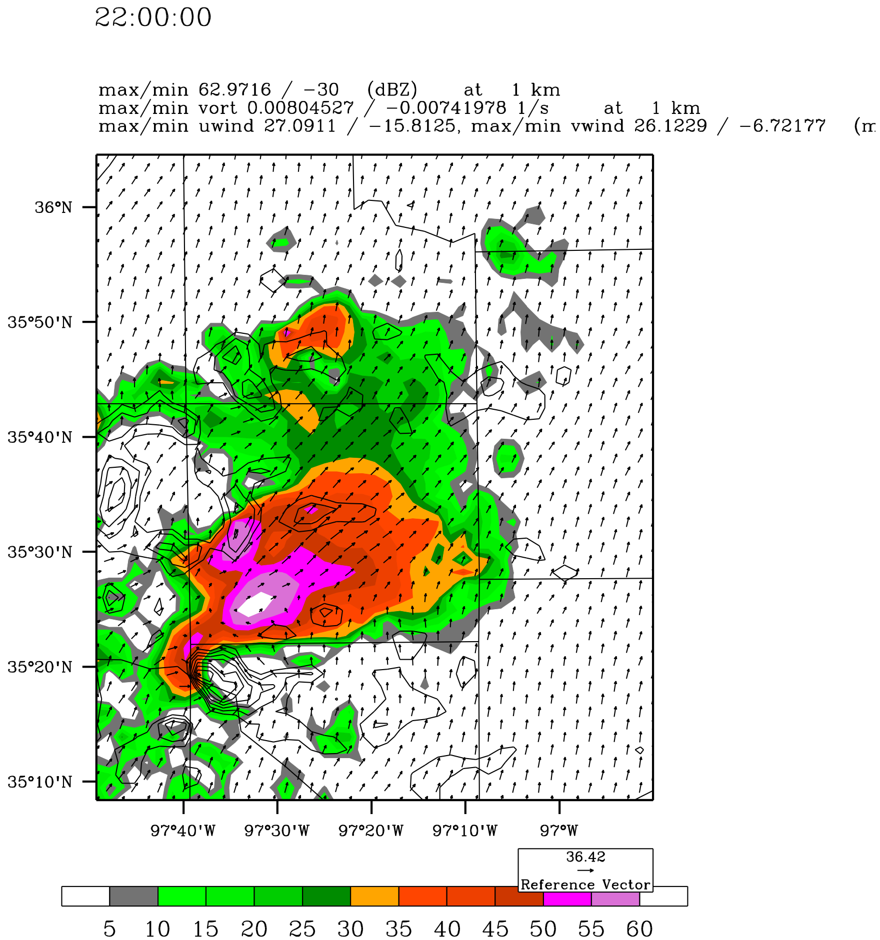


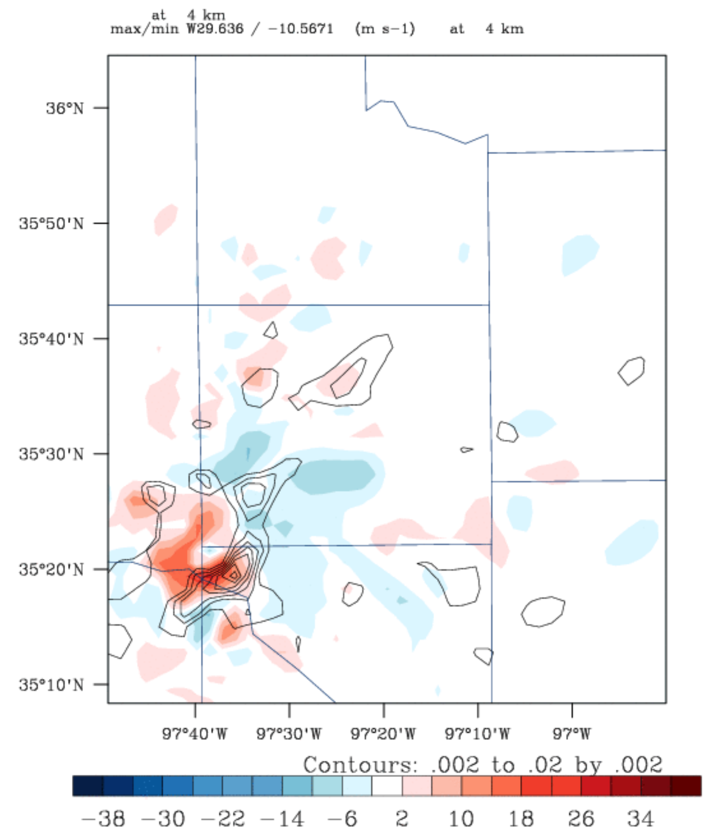
Precipitation forecast skill averaged over 10 complex, convectively active cases



- GSI-EnKF forecasts are more skillful than GSI-3DVar forecasts for all thresholds and lead times.
- Benefits of radar data are more pronounced assimilated by GSI-EnKF than GSI-3DVar.

May 8th 2003 OKC Tornadic Supercell





Ref and vorticity at 1 km

W and Vort. at 4 km

Lei, Wang et al. 2014