

An Overview of CAPS Storm-Scale Ensemble Forecast for the 2014 NOAA HWT Spring Forecasting Experiment

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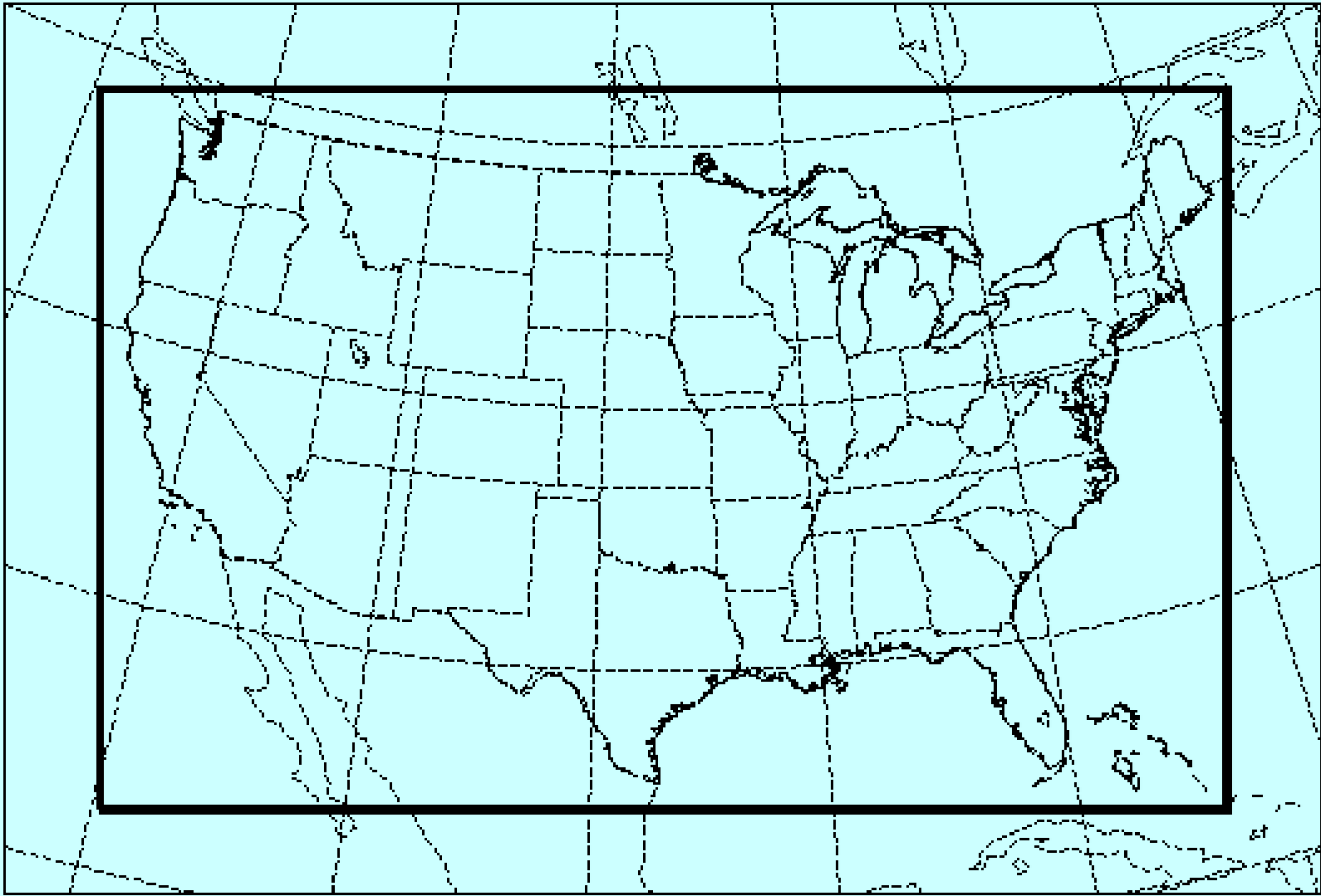
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In support of the NOAA Hazardous Weather Testbed (HWT) 2014 Spring Experiment, the Center for Analysis and Prediction of Storms (CAPS) produced multi-model storm-scale ensemble forecasts (SSEF) in realtime from 21 April through 6 June 2014 over the entire CONUS domain at 4-km grid spacing. SSEF products were generated from a 12-member sub-ensemble that consists of the multi-model, multi-physics, IC and LBC perturbation, and radar analysis members. The National Mosaic Multi-Sensor quantitative precipitation estimation (QPE) or NMQ (Zhang et al. 2011) was used as verification dataset for the SSEF QPF.

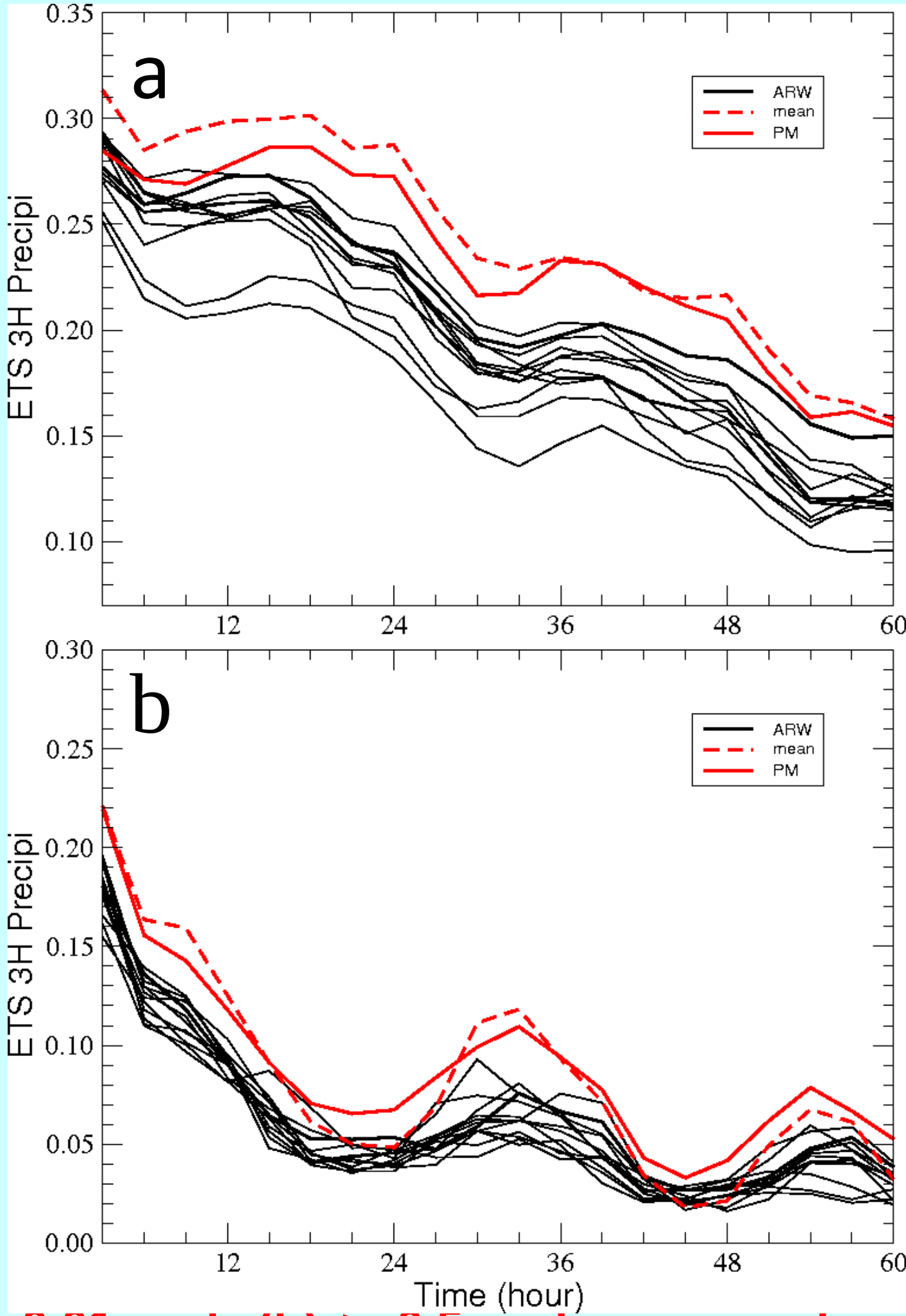
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CONUS domain (1200x768)



Forecast domain for the 2014 HWT Spring Experiment (thick inner box) .

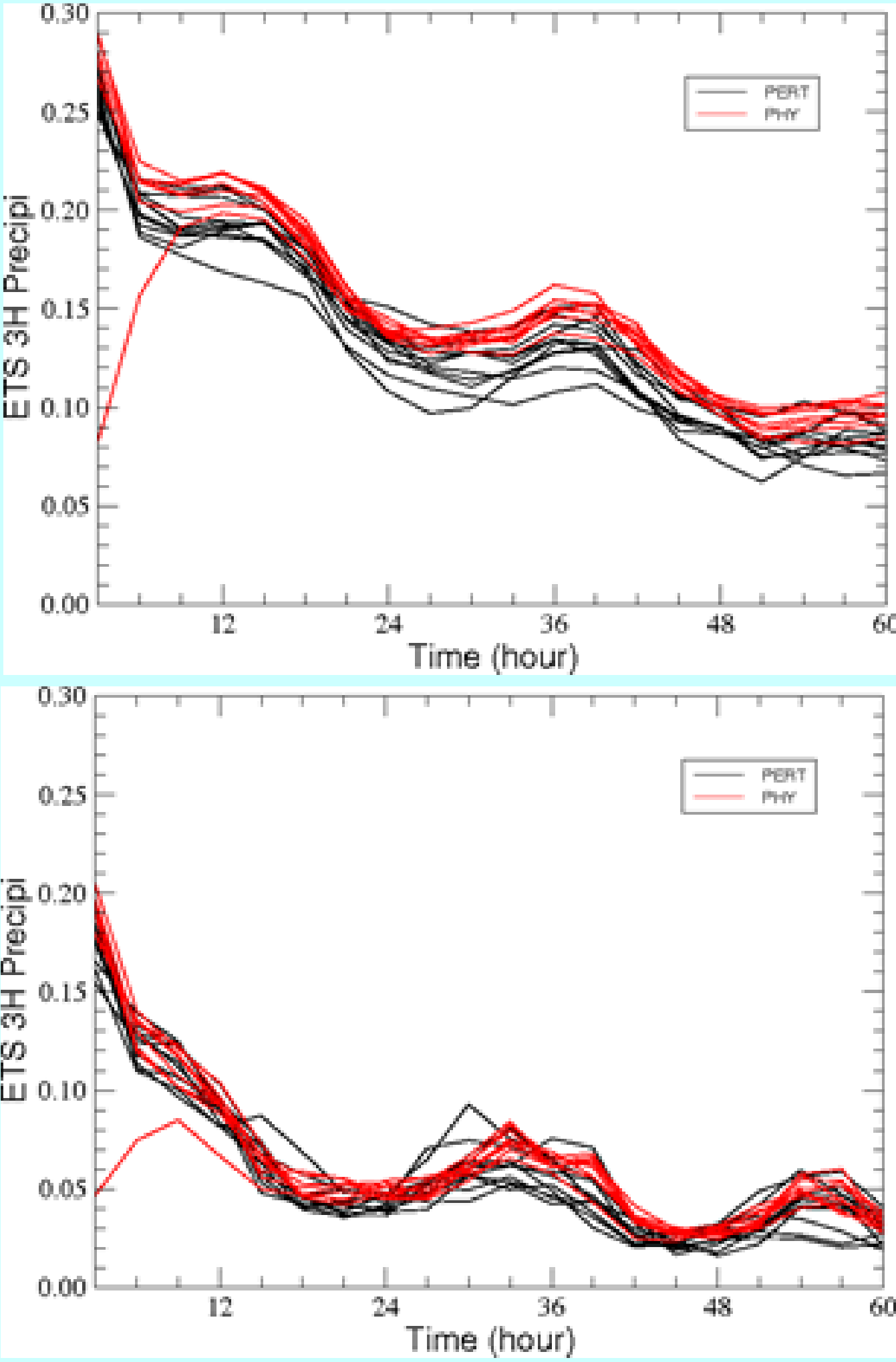
ETS of 3-hourly QPF



(a) ≥ 0.01 inch (b) ≥ 0.5 inch, averaged over all 2014 CAPS SSEF forecasts initiated at 0000 UTC.

Highlight

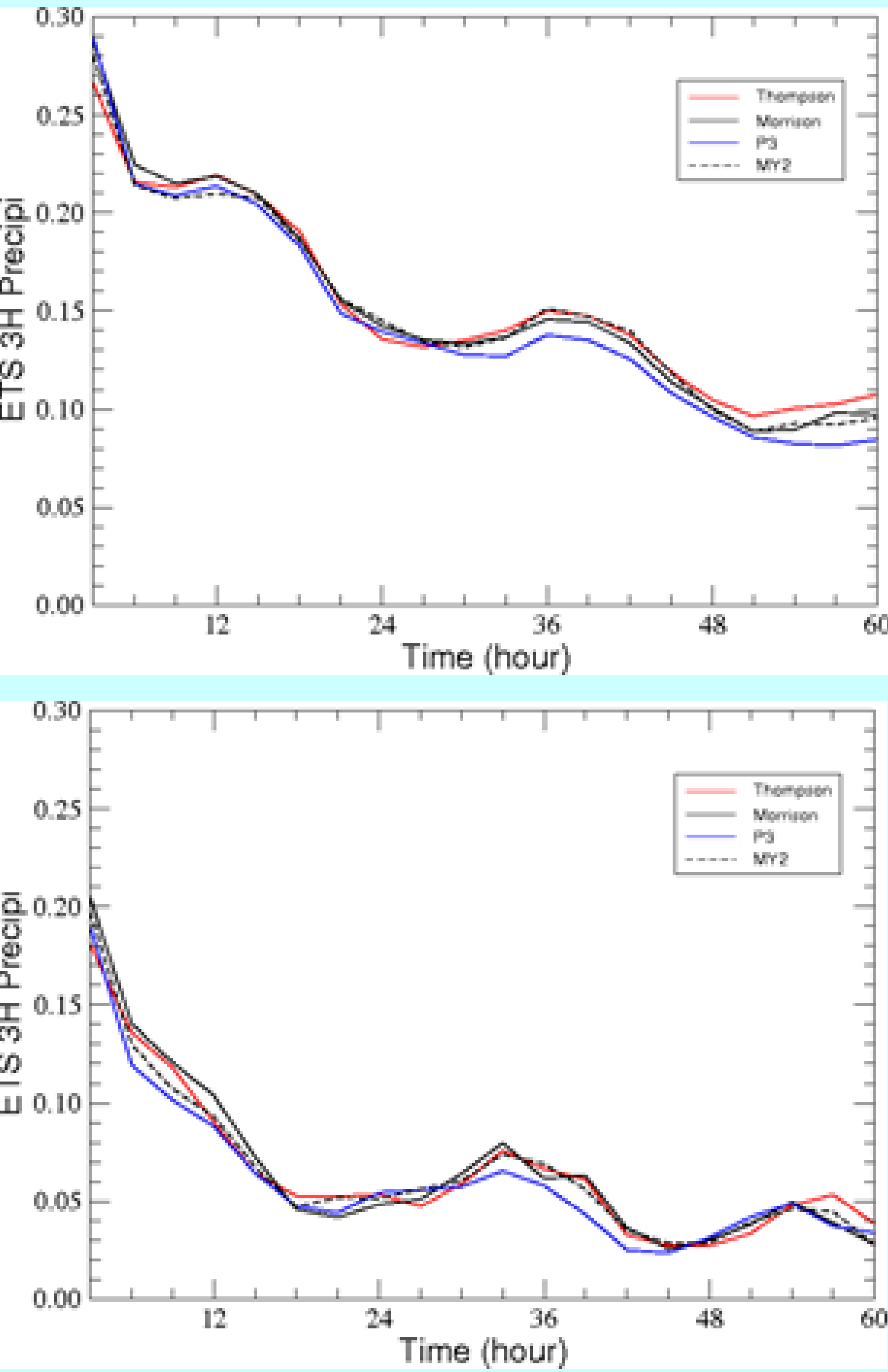
- 24 members (20 ARW, 4 COAMPS)
- 60 h forecast, initiated at 0000 UTC
- WRF-ARW V3.5.1
- Synthetic GOES IR BT product (CRTM)
- Simulated dual polarimetric radar product: zdr, kdp
- HAILCAST product (developed by AFWA)
- Experimental EnKF ensemble forecast system, with 40-member ensemble background, a one hour EnKF cycling at 15 min interval, and a 12-member ensemble forecast of 24-h starting 0000 UTC over the same CONUS domain as regular SSEF
- 3D/4D visualization experiment



ETS of 3-h accumulated precipitation ≥ 0.01 inch (top) and 0.5 inch (bottom) from all ARW members, averaged over all 2014 CAPS SSEF forecasts initiated at 0000 UTC. PERT (black) and PHY (red) refer to ARW perturbed members and physics only (non-perturbed) members, respectively. The c0 (no radar) member is shown as red lines with the lowest initial scores.

Microphysics options

A new P3 (Predicted Particle Properties) microphysics by Morrison and Milbrandt was implemented

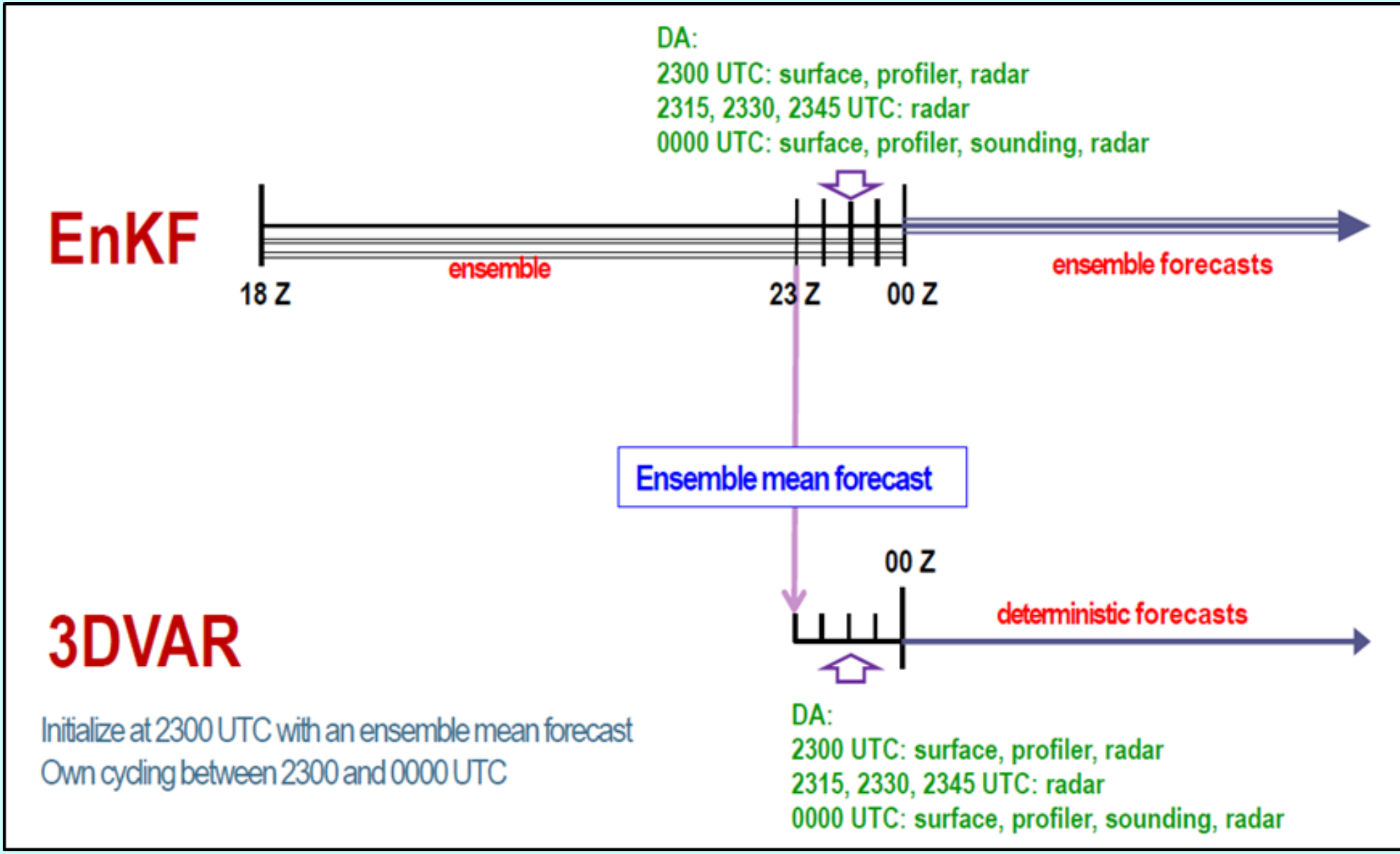


ETS of 3-h accumulated precipitation ≥ 0.01 inch (top) and 0.5 inch (bottom) from four microphysics-only members, averaged over all 2014 CAPS SSEF forecasts initiated at 0000 UTC.

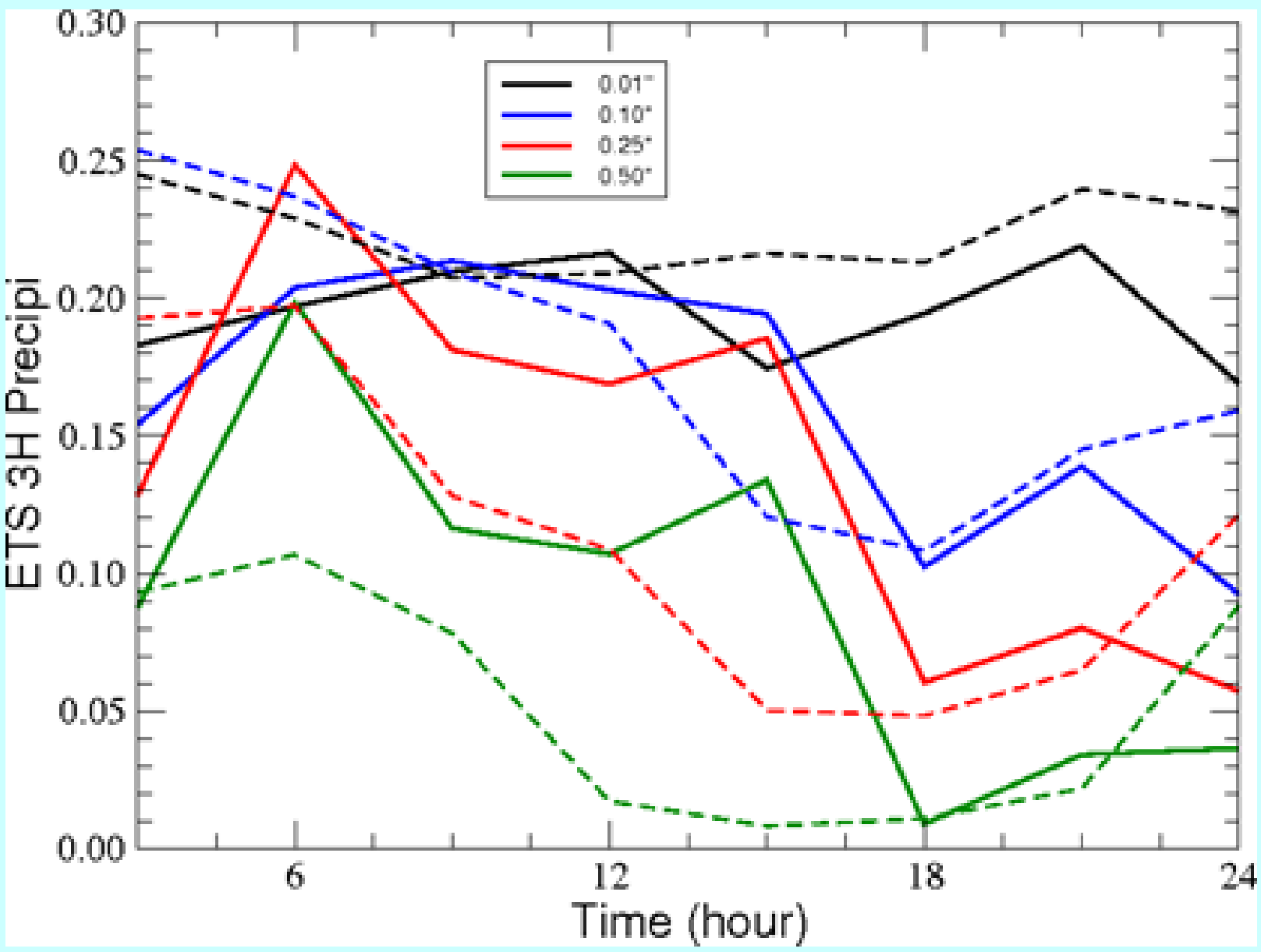
EnKF ensemble forecast

- A one hour EnKF cycling at 15 min interval from 2300 UTC to 0000 UTC following a 5-h 40-member ensemble forecast initiated from 1800 UTC, over the same CONUS domain as other regular SSEF.
- The 40-member background ensemble is configured with initial perturbations and mixed physics options to provide input for EnKF analysis. Each member uses WSM6 microphysics with different parameter settings. No radar data is analyzed for this set of runs. All members also include random perturbations with recursive filtering of ~ 20 km horizontal correlations scales, with relatively small perturbations (0.5K for potential temperature and 5% for relative humidity). EnKF analysis (cycling), with radar data and other conventional data, is performed from 23 to 00 UTC every 15 min over the CONUS domain, using as background the 40-member ensemble.
- A 12- member ensemble forecast (24h) follows using the 00 UTC EnKF analyses. In addition, two deterministic forecasts, one from the ensemble mean analysis and another from 3DVAR analysis, are also produced.

Flow diagram for the realtime EnKF and 3DVAR storm-scale forecasts

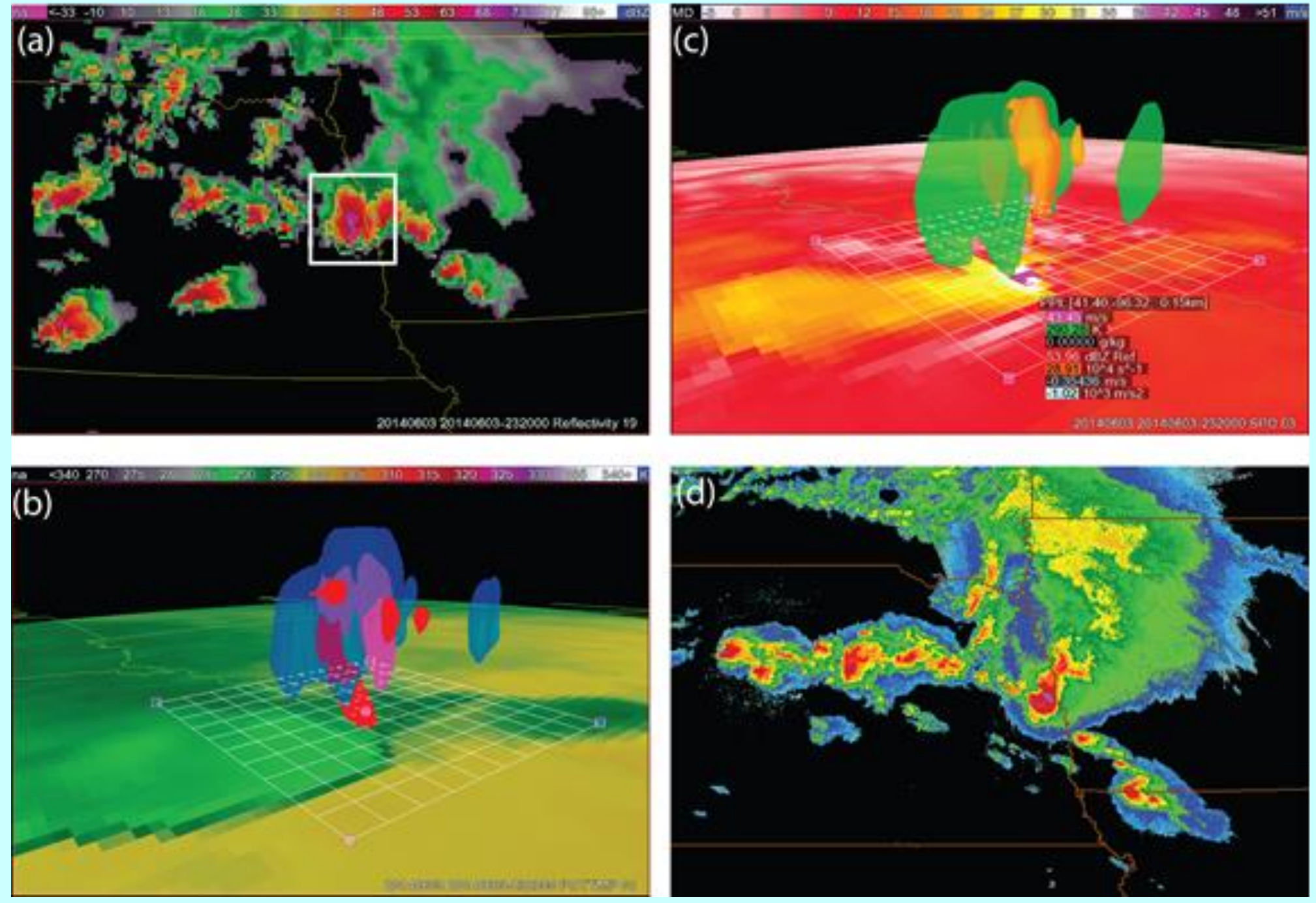


The EnKF DA are performed from 2300 UTC to 0000 UTC at 15 minute intervals. A 3DVAR DA is carried out on the ensemble mean forecast at 2300 UTC followed by its own DA cycles to facilitate direct comparison with the EnKF forecasts.



ETSS of probability matched mean 3-h accumulated precipitation ≥ 0.01 (black), 0.10 (blue), 0.25 (red), and 0.5 inches (green) for the 12-member EnKF based forecasts started from the EnKF ensemble analysis (solid) and the regular 12-member HWT SSEF forecast started from 3DVAR analysis (dashed) at 0000 UTC on 29 May 2014.

3D/4D Visualization



Example of viewing a model storm in 3D using WDSS-II display software. (a) Plan view of simulated reflectivity on model level 19 valid 2320 UTC for the 00Z SSEF control member. The white box encloses the storm interrogated in 3D in panels (b) and (c). In (b), isosurfaces of vertical velocity > 21 m s⁻¹ (light purple), vertical vorticity $> 45 \times 10^{-3}$ (red), and graupel mixing ratio > 4 g kg⁻¹ (blue) are shown from a perspective from the southwest of the storm. The underlying color fill shows potential temperature (K) on the lowest model level. In (c), isosurfaces of the product of vertical velocity and vertical vorticity (m s⁻²) $> 53 \times 10^{-3}$ (orange) and simulated reflectivity > 54 dBZ (green) are shown from the same perspective as in (b). The underlying color fill in (c) is the wind speed on model level 3 (about 150 m AGL). The observed composite reflectivity valid at 2110 UTC from the NSSL multi-radar multi-sensor analysis is shown in (d).