Evolution toward EnKF/hybrid data assimilation for meso- and storm-scale applications with the Rapid Refresh and HRRR systems

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BACKGROUND

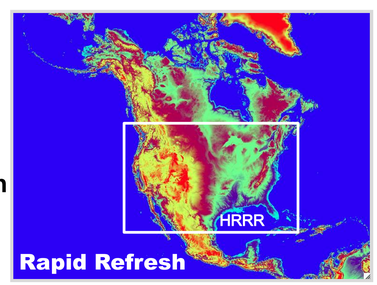
The Rapid Refresh (RAP) is an operational hourly updated regional numerical weather prediction system for aviation and severe weather forecasting.

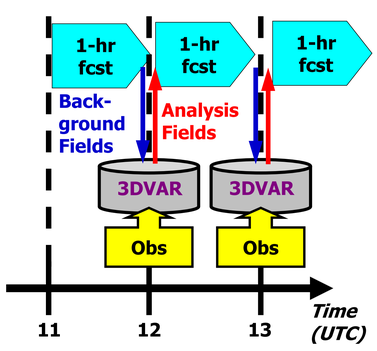
The High-Resolution Rapid Refresh (HRRR) is a real-time hourly updated CONUS convection-allowing model.

A North American Rapid Refresh Ensemble, possibly including EnKF or 3DVar-EnKF hybrid data assimilation, will be developed in the future. Initial testing for such a system is ongoing, involving a collaboration between OU/CAPS, ESRL, and NCEP/EMC.

Rapid Refresh (RAP)

- Hourly updated assimilation / model system replacing RUC
- RAP uses GSI analysis and WRF ARW model
- Implemented at NCEP May 2012
- 13km domain covers all of North America, large oceanic region
- Radar reflectivity assimilation via diabatic digital filter
- 3km HRRR initialized from RAP



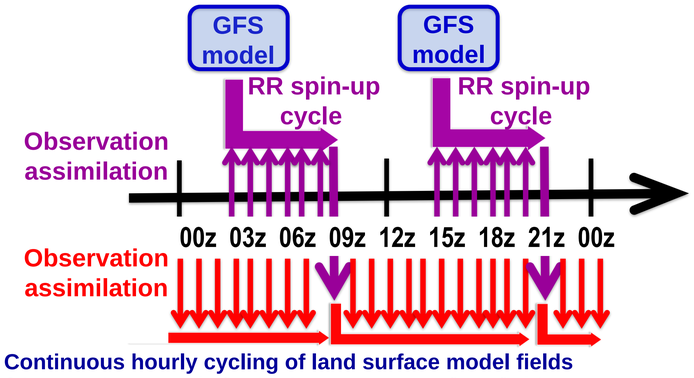


Data types – counts/hr

Rawinsonde (12h)	150
NOAA profilers	35
VAD winds	~130
PBL profilers / RASS	~25
Aircraft (V,T)	3500–10,000
TAMDAR	200 – 3000
METAR surface	2000 -2500
Mesonet (T,Td)	~8000
Mesonet (V)	~4000
Buoy / ship	200-400
GOES cloud winds	4000-8000
METAR cloud/vis/wx	~1800
GOES cloud-top P,T	10 km res.
satellite radiance	AMSUA/MHS/HIRS
Radar reflectivity	1 km res.

RAP Partial Cycling

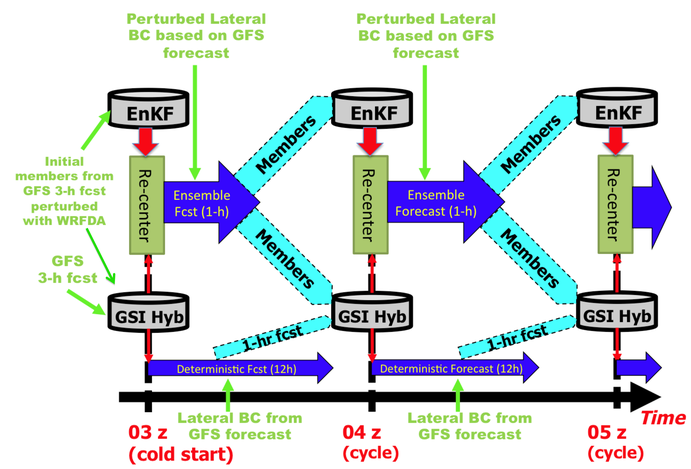
Use partial cycling with update from GFS 2 times / day



Continuous hourly cycling of land surface model fields
6 hour spin-up cycle for hydrometeors, surface fields

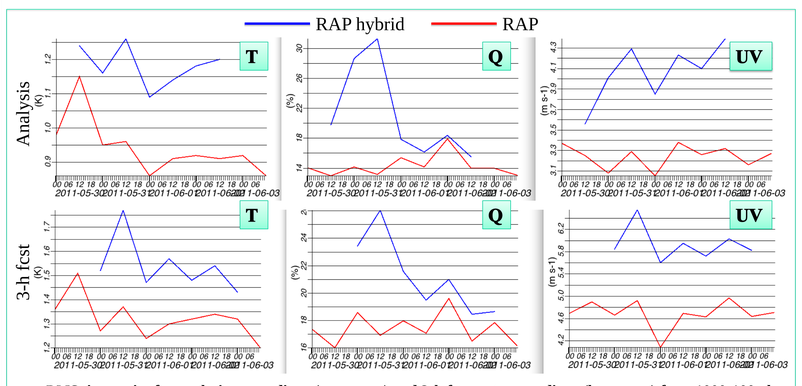
RAP Hybrid System

Hourly cycling of a 2-way hybrid system for testing a future implementation of the Rapid Refresh Ensemble

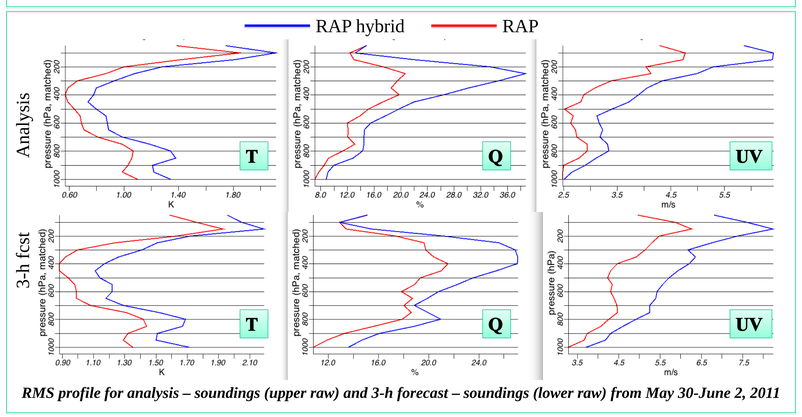


- Same domain and 13-km grid spacing as in operational RAP (758 × 567 × 50 grid points)
- Hourly cycling with GSI Hybrid (2 way) and EnKF
- Cold start at 03Z May 30, 2011 and continuous cycling for 3 days
- 40 ensemble members

Results of First Test



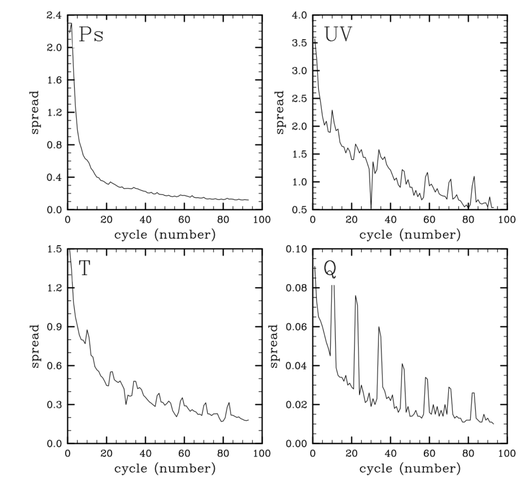
RMS time series for analysis – soundings (upper raw) and 3-h forecast – soundings (lower raw) from 1000-100mb



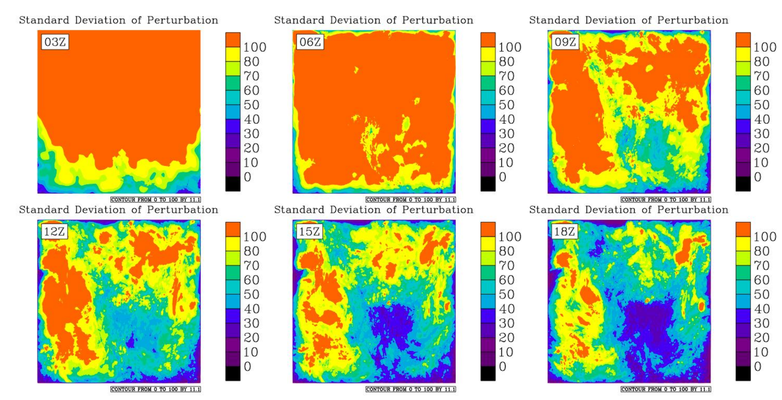
RMS profile for analysis – soundings (upper raw) and 3-h forecast – soundings (lower raw) from May 30-June 2, 2011

RAP-hybrid analysis and 3-h forecast do not fit the observations as closely as RAP, suggesting the observations are not having great enough influence in this initial test.

Diagnosis of RAP Hybrid



Time series of prior observation-space ensemble standard deviation



Horizontal distribution of prior standard deviation of surface pressure perturbation at 03z (cold start), 06z, 09z, 12z, 15z, and 18z May 30, 2011

- Ensemble spread decreases very quickly with cycling.
- Spread becomes particularly small near the lateral boundaries and in data rich areas.
- Large localization radii and 0.9 inflation were used in this experiment.

SUMMARY AND FUTURE WORK

Summary: A RAP 2-way hybrid system has been built and cycled hourly for 3.5 days.
The comparison with the operational RAP and the diagnosis of ensemble spread indicate the need to increase ensemble spread.

Plans: improve the ensemble component of the system

- Reduce localization radius
- Increase inflation
- Use coarse resolution ensemble (dual-resolution hybrid)