Rapid Refresh change and subsequent HRRR impact

Assimilation of PBL-based Pseudo-Observations

Starting 00z 7/7/2011

ESRL/GSD/AMB

Stan Benjamin, Steve Weygandt, Curtis Alexander,
John Brown, Ming Hu

Proposal: Restore PBL pseudo-obs into HRRR to improve performance

Background:

- HRRR behavior similar overall in 2011 to that in 2010
- But…. reports (primarily from NWS) on HRRR in 2011 indicated a moist bias, with possibly more false alarm and poorly placed storm forecasts.
- Extra surface observations (PBL-based pseudo-obs) were used in RUC last year (and since 2005) and also used in HRRR until 14 April 2011 when HRRR initial conditions were switched to RR.
- RR/GSI code for RR-based pseudo-obs was not ready on 4/14 but was developed in early June

Proposal: Restore PBL pseudo-obs into HRRR to improve performance

Solution

- PBL-based observations were added to Rapid Refresh to improve initialization of the HRRR (primary)
- Parallel testing from 6/13 through 7/5 show clear improvement in thunderstorm forecasting for initial times from 18z through 00z from HRRR-dev (parallel HRRR with PBL-based pseudo-obs added to parallel development Rapid Refresh – RR-dev)
- Change made at 00z 7 July 2011 to RR-primary (which initialized the primary HRRR)

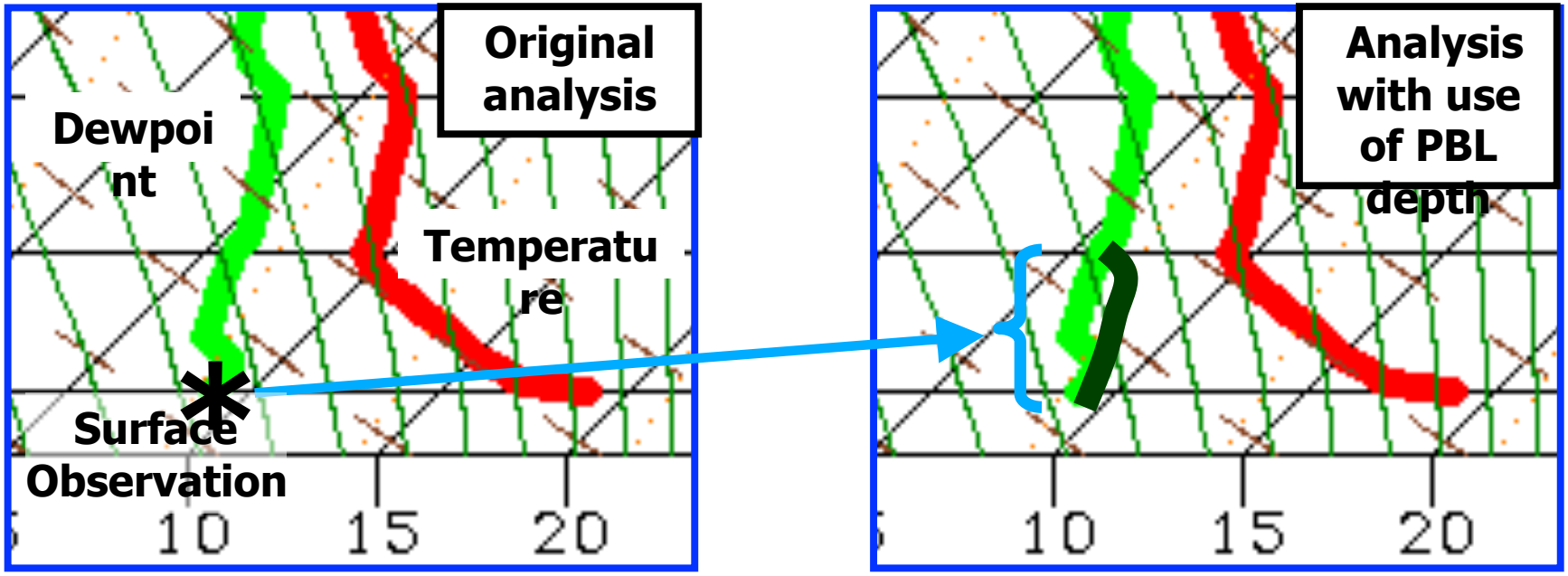
Use of surface obs information throughout boundary layer

Problem

- Information from surface observation not used through depth of PBL by analysis
- Surface observation not retained in model forecast

Solution

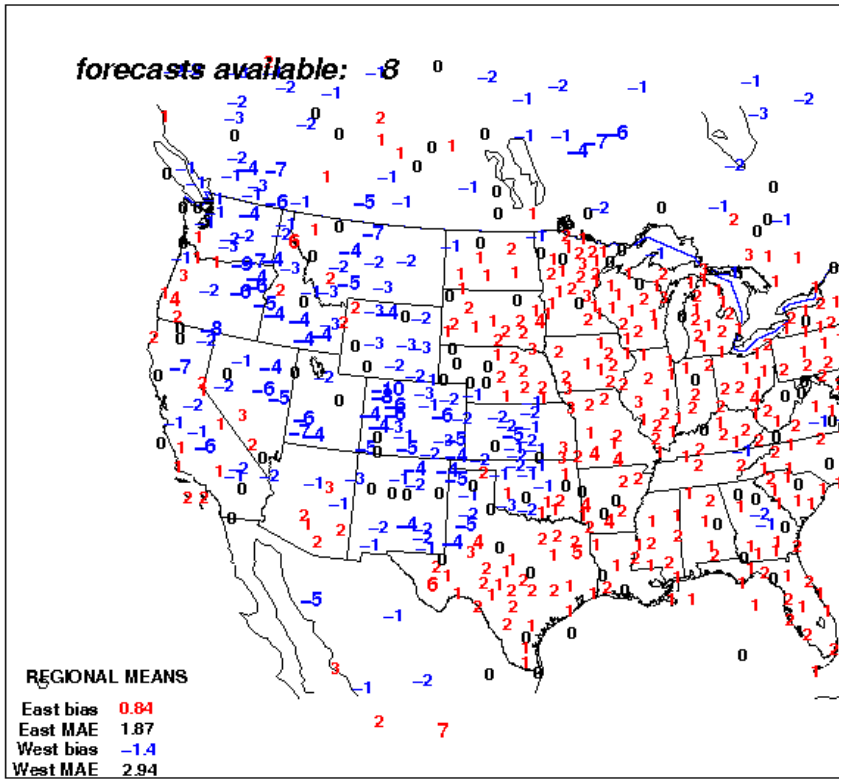
- Use METAR observation throughout PBL depth (from background field) by creating pseudo-innovations in PBL
- Better model retention of surface observations



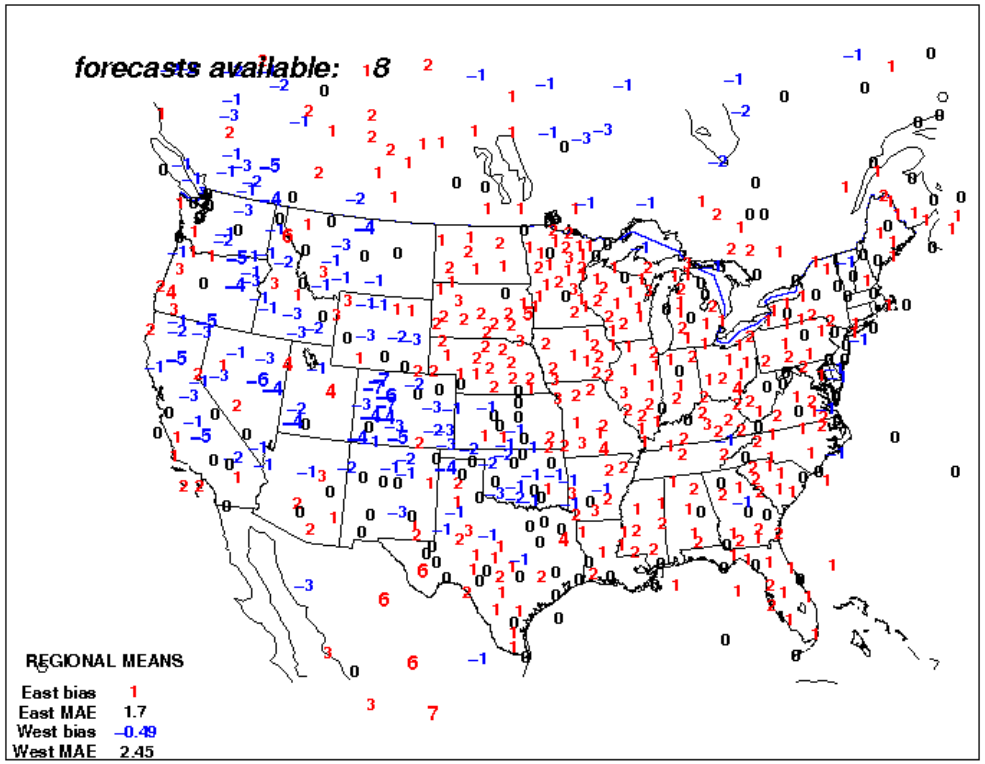
O-B 3h fcst – surface observations – 20-27 June 2011 – 00z- 2m dewp

	East US MAE	East Bias (F-O)	West US MAE	West Bias (F-O)
RR-primary	1.87	0.84	2.94	-1.40
RR-dev (w/ PBL pseudo-obs)	**1.70**	1.00	2.45	-0.49

RR–Prim Mean 2–m DewPt Temp Bias (C) 20110620–20110627 0



RR–Dev Mean 2–m DewPt Temp Bias (C) 20110620–20110627 00Z FHR:03

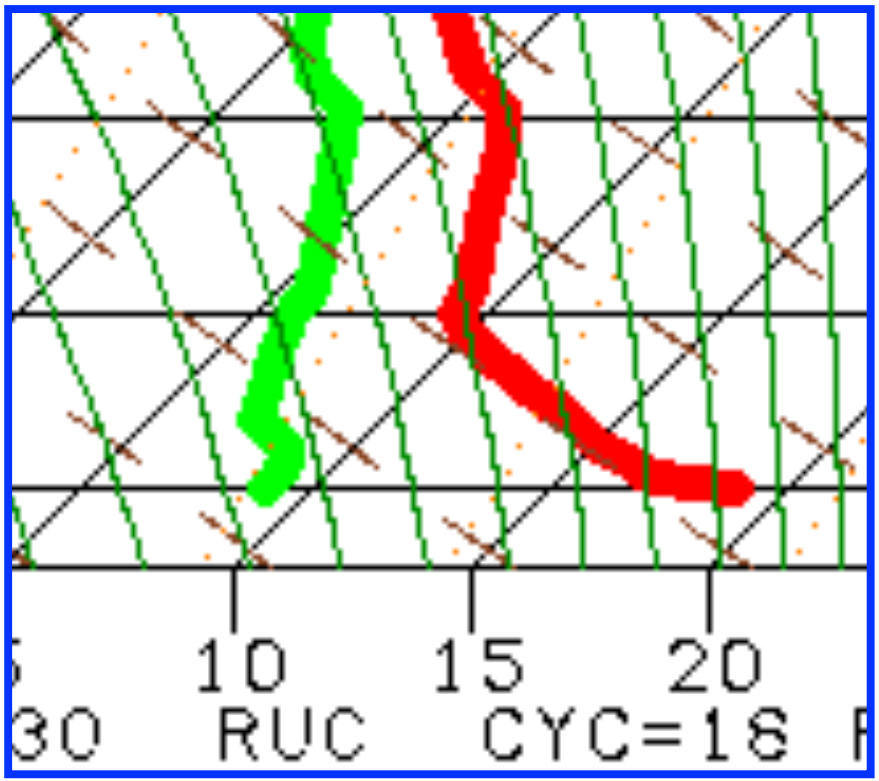


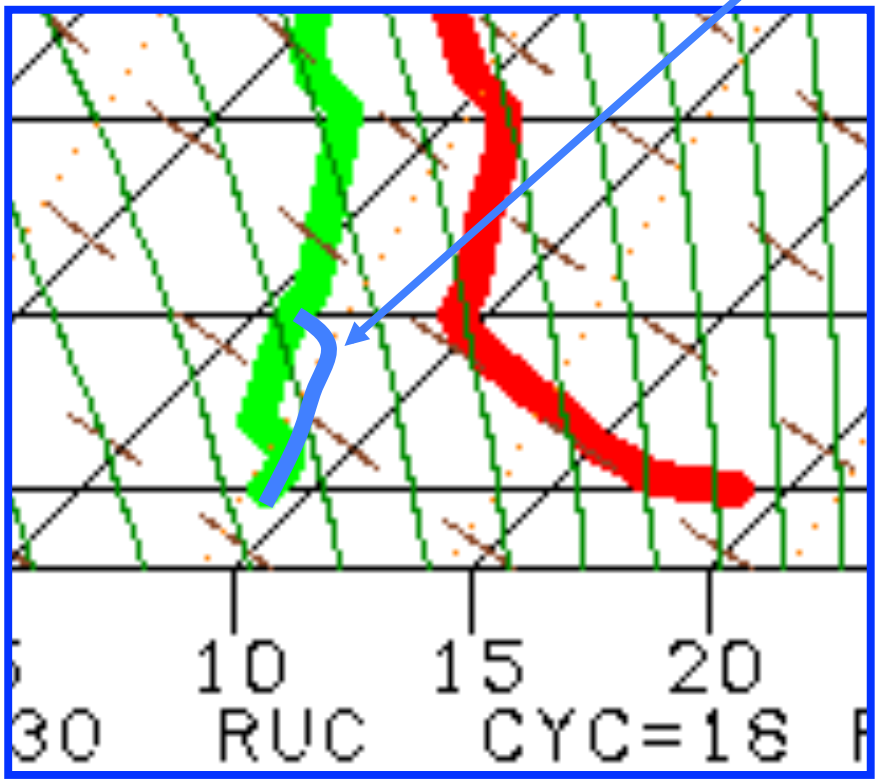
Boundary-layer (PBL) based "pseudo-observations"

- Built from METAR obs through PBL depth (calculated from 1h fcst)
-Assimilated in RUC since 2005 (initializing HRRR until 4/14/2011)
- **Added to RR-dev and HRRR-dev 13 June 2011**
- **Added to RR-primary (and HRRR primary) 00z 7 July 2011**

RUC operational analysis
18z 3 Apr 02
IAD (Dulles Intl. Airport)

Effect of PBL-based METAR assimilation → better retention of surface observations in model

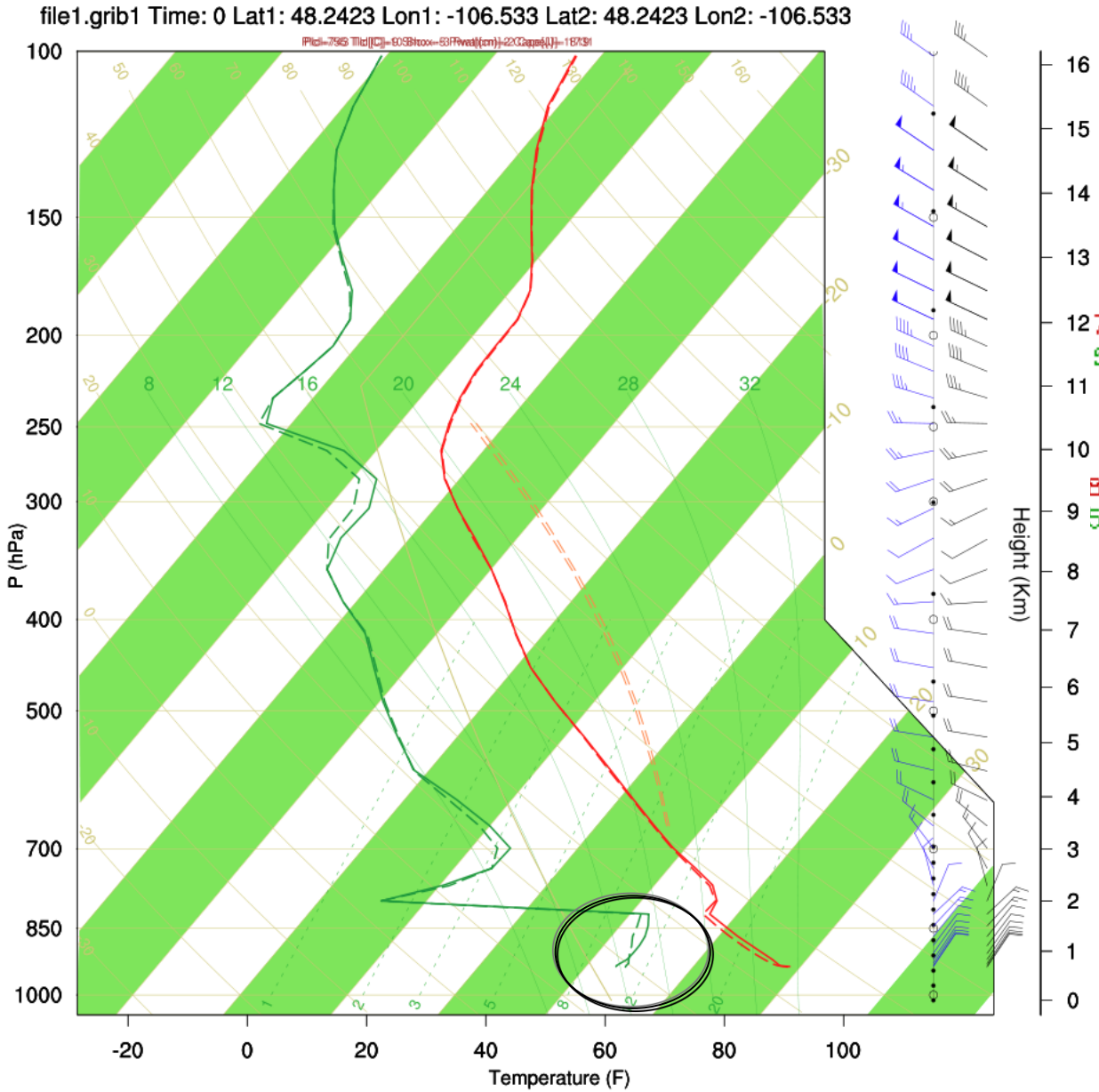




References

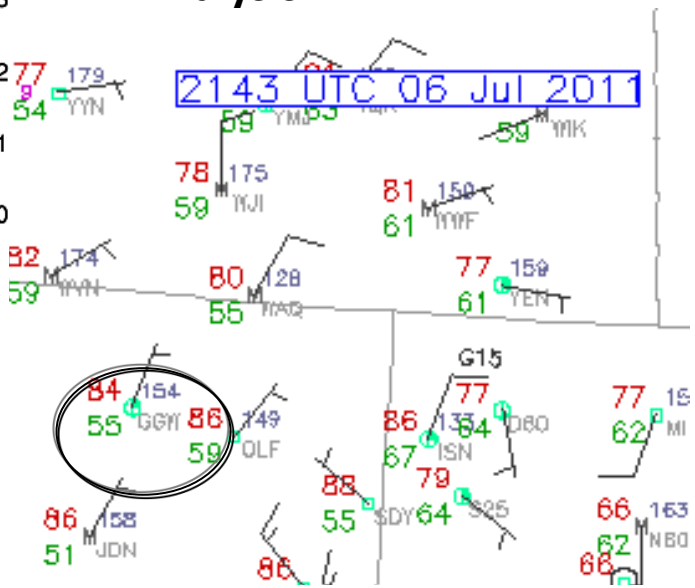
- Benjamin, S.G., S. Weygandt, D. Devenyi, J.M. Brown, G. Manikin, T.L. Smith, and T. Smirnova, 2004**: Improved moisture and PBL initialization in the RUC using METAR data.** 11th Conf. on Aviation, Range, and Aerospace Meteorology , Hyannis, MA, Amer. Meteor. Soc., CD-ROM, **17.3.** PDF

- Benjamin, S.G., B.D. Jamison, W.R. Moninger, S. R. Sahm, B. Schwartz, T.W. Schlatter, 2010**: Relative Short-Range Forecast Impact from Aircraft, Profiler, Radiosonde, VAD, GPS-PW, METAR, and Mesonet Observations via the RUC Hourly Assimilation Cycle.** *Mon. Wea. Rev.***, *138***,** 1319-1343**.** ***PDF***
    - see sections 2 and 4.c

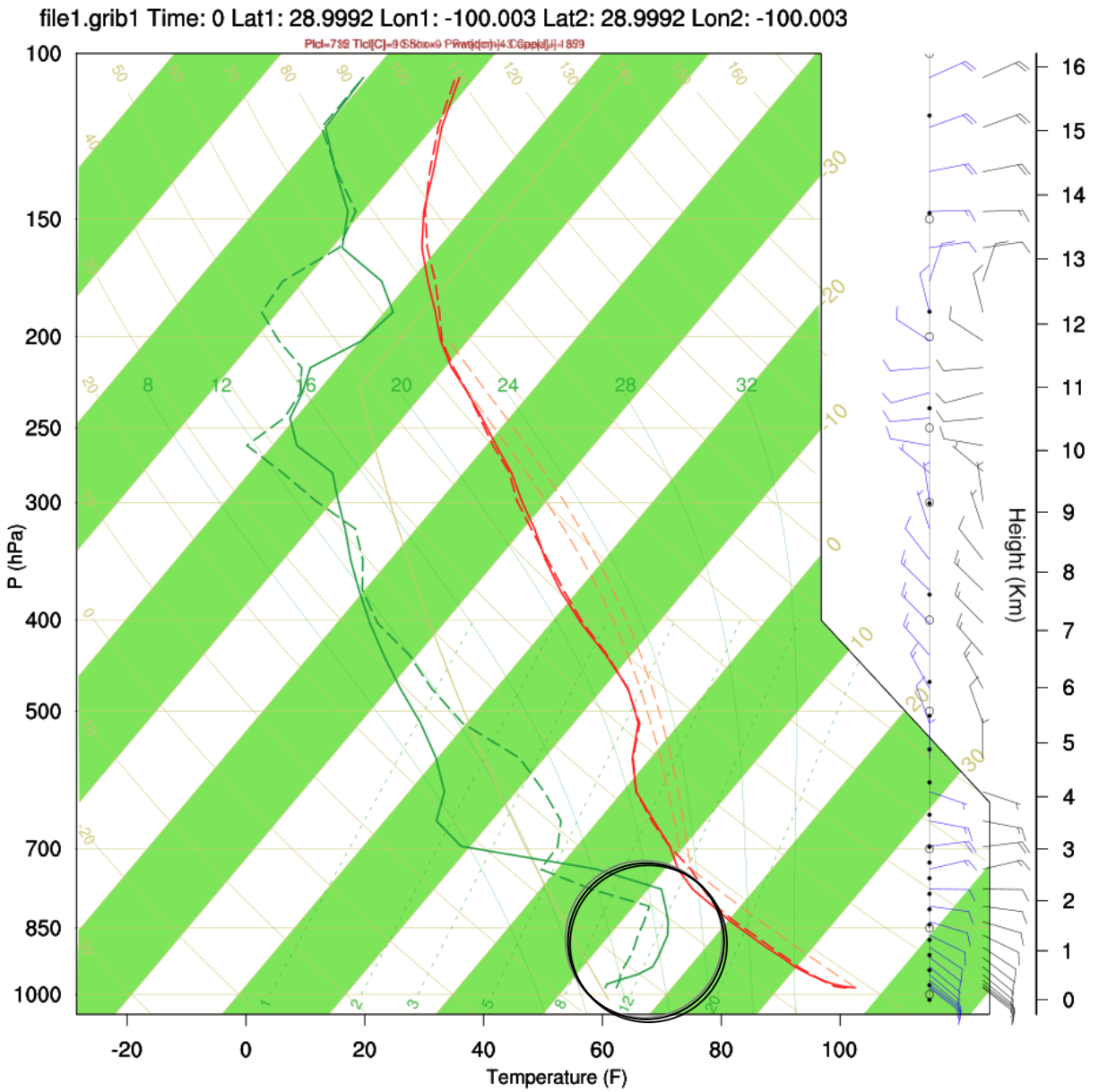


RR (solid), RR-dev (dashed)

GGW – Glasgow, MT
22z – 6 Jul 2011
Analysis

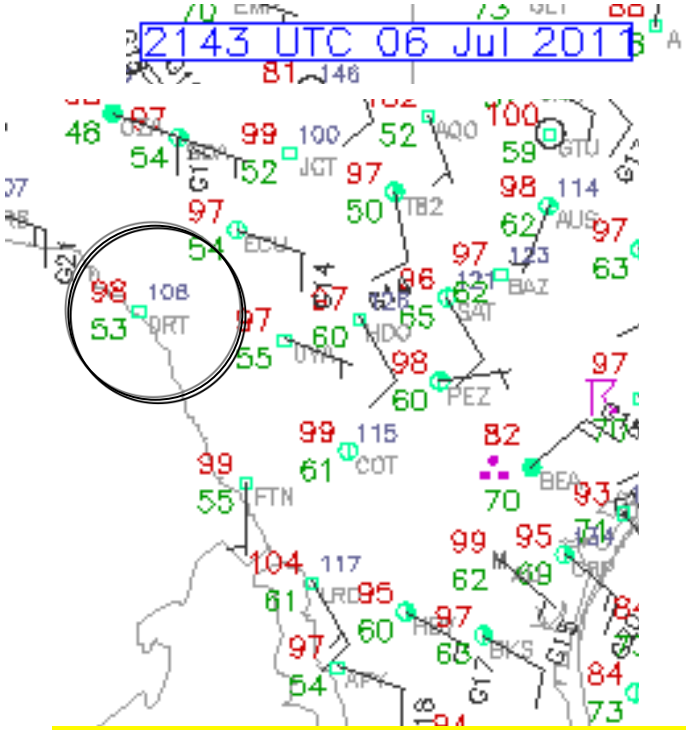


Note more evenly mixed water vapor sounding in RR-dev consistent with observed surface dewpoint



RR (solid), RR-dev (dashed)

DRT – Del Rio, TX
22z – 6 Jul 2011
Analysis

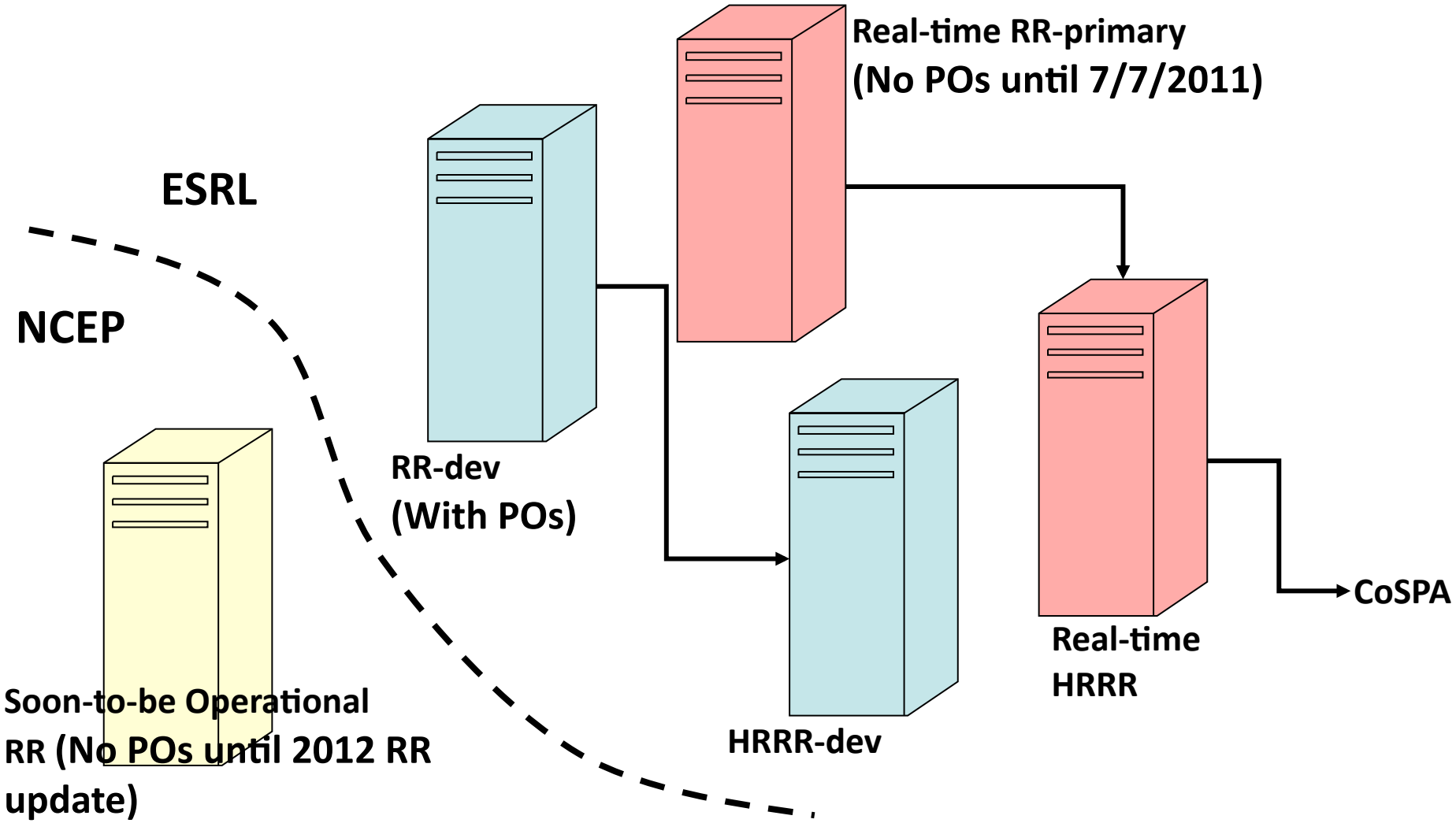


Note more evenly mixed water vapor sounding in RR-dev consistent with observed surface dewpoint

Proposed Solution / Change

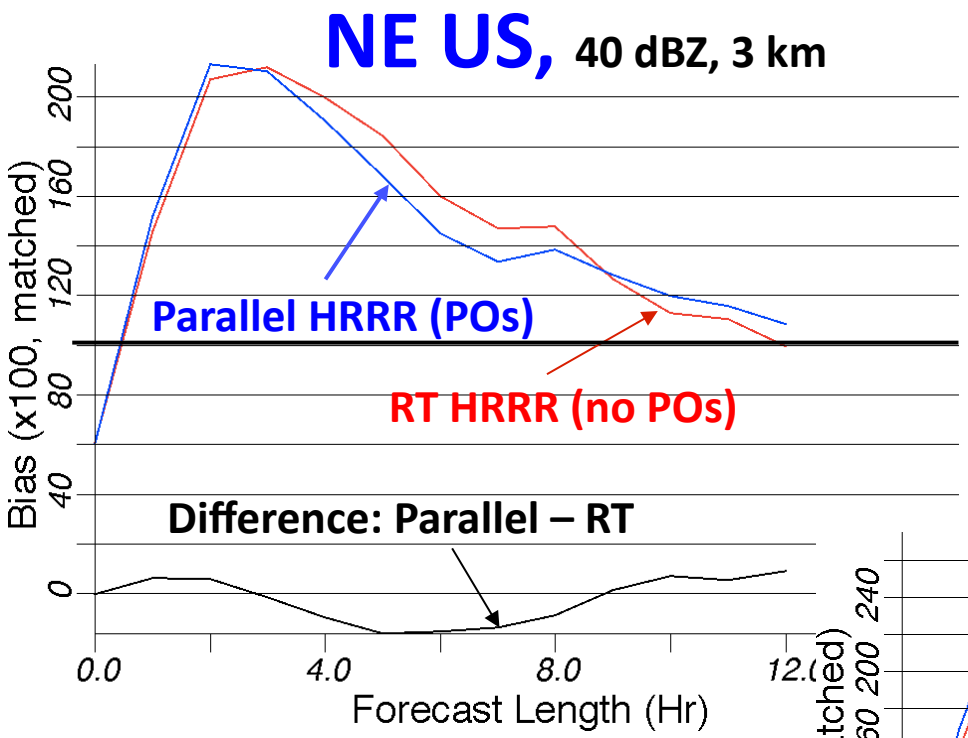
- **<u>Additional observations in RR running at ESRL (which also initialized the HRRR-primary)</u>**
  - Boundary-layer based “pseudo-observations”
  - Built from METAR obs through PBL depth (calculated from 1h fcst)
  - Used in RUC since 2005 (feeding HRRR until 4/14/2011 → WRF-RR used)

RR & HRRR Configuration



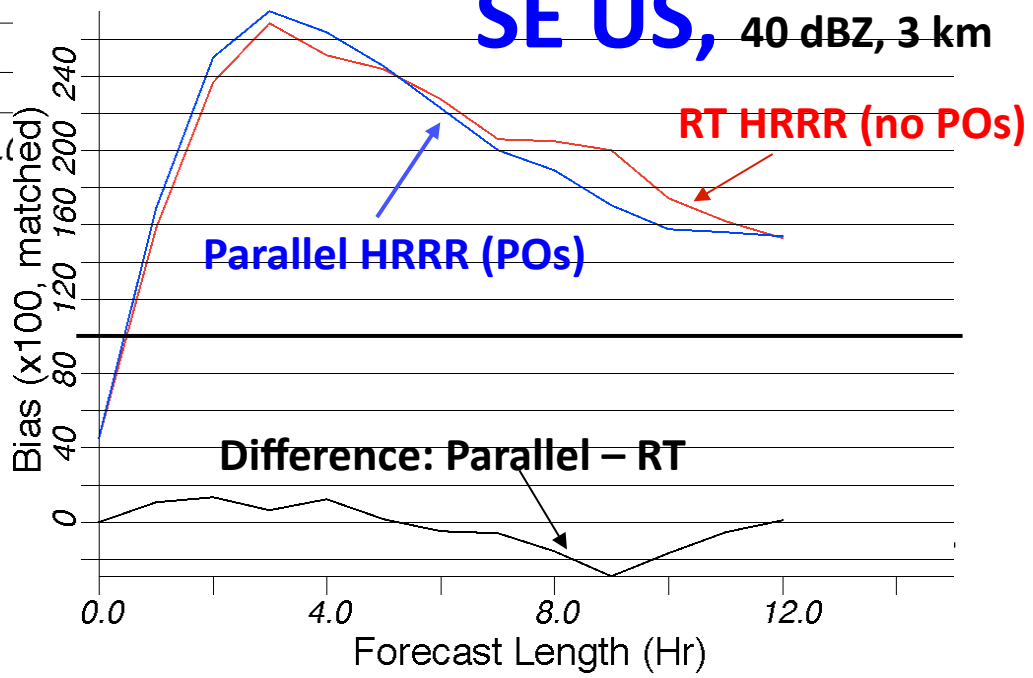
BIAS, All Issuance Times

June 19 – June 22

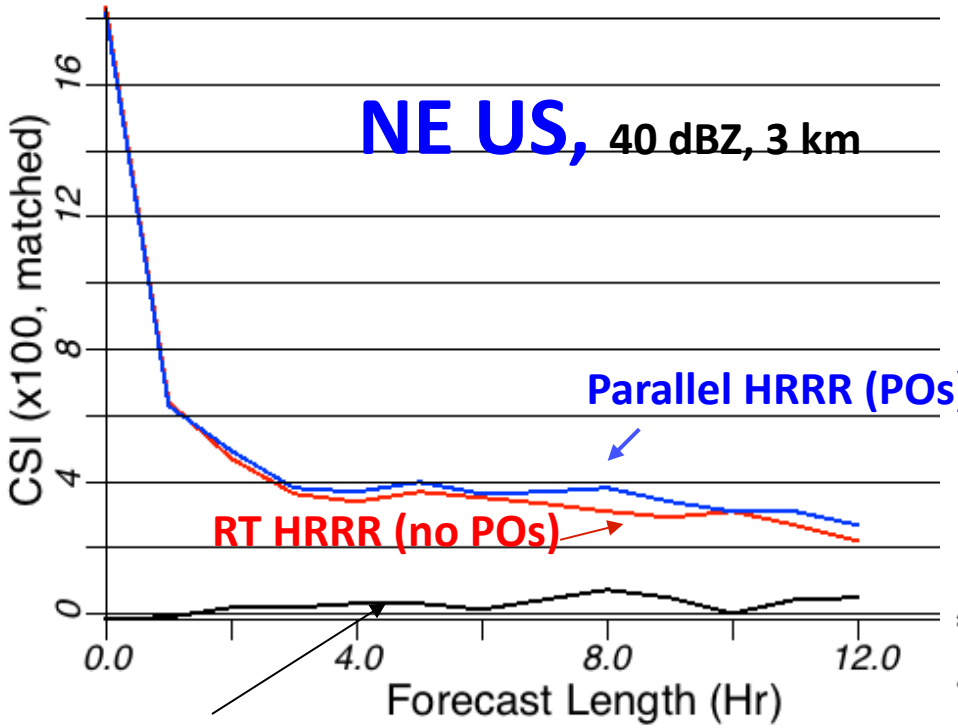


In Northeast, minor Bias reduction between 3 and 9 hour leads

In Southeast, minor Bias reduction between 5 and 12 hour leads



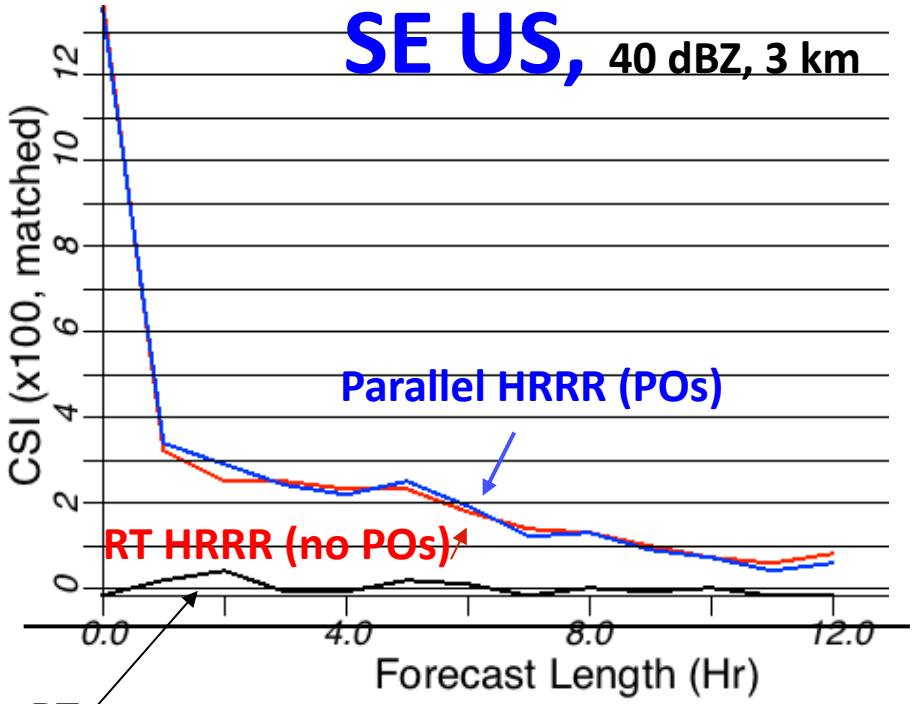
Forecast Skill, CSI
All Issuance Times
June 19 – July 5 (16 days)



Difference: Parallel – RT

In Northeast, minor increase in skill for 2-12 hour leads

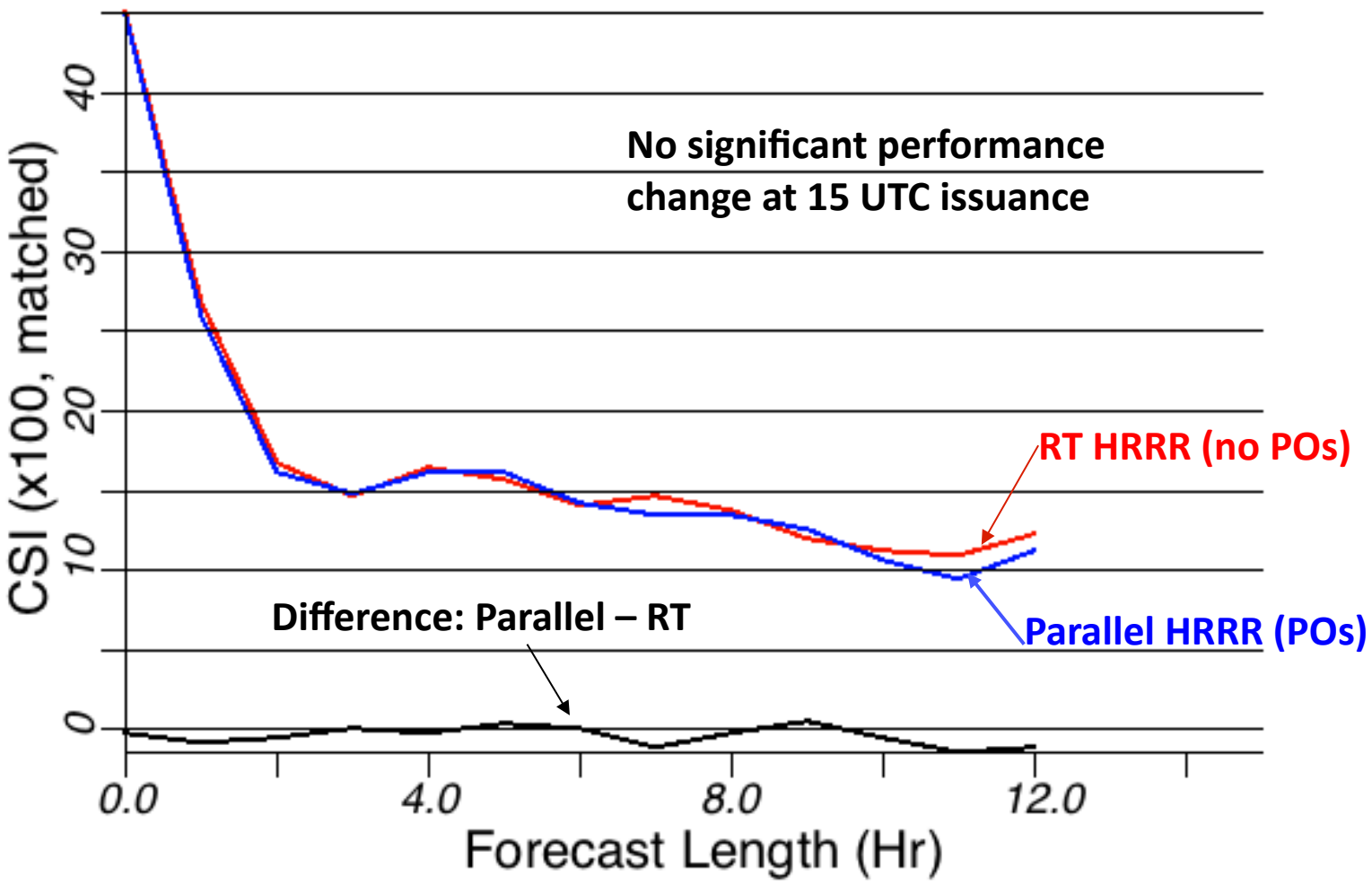
In Southeast, minor skill increase between 1-6 hr leads



Difference: Parallel – RT

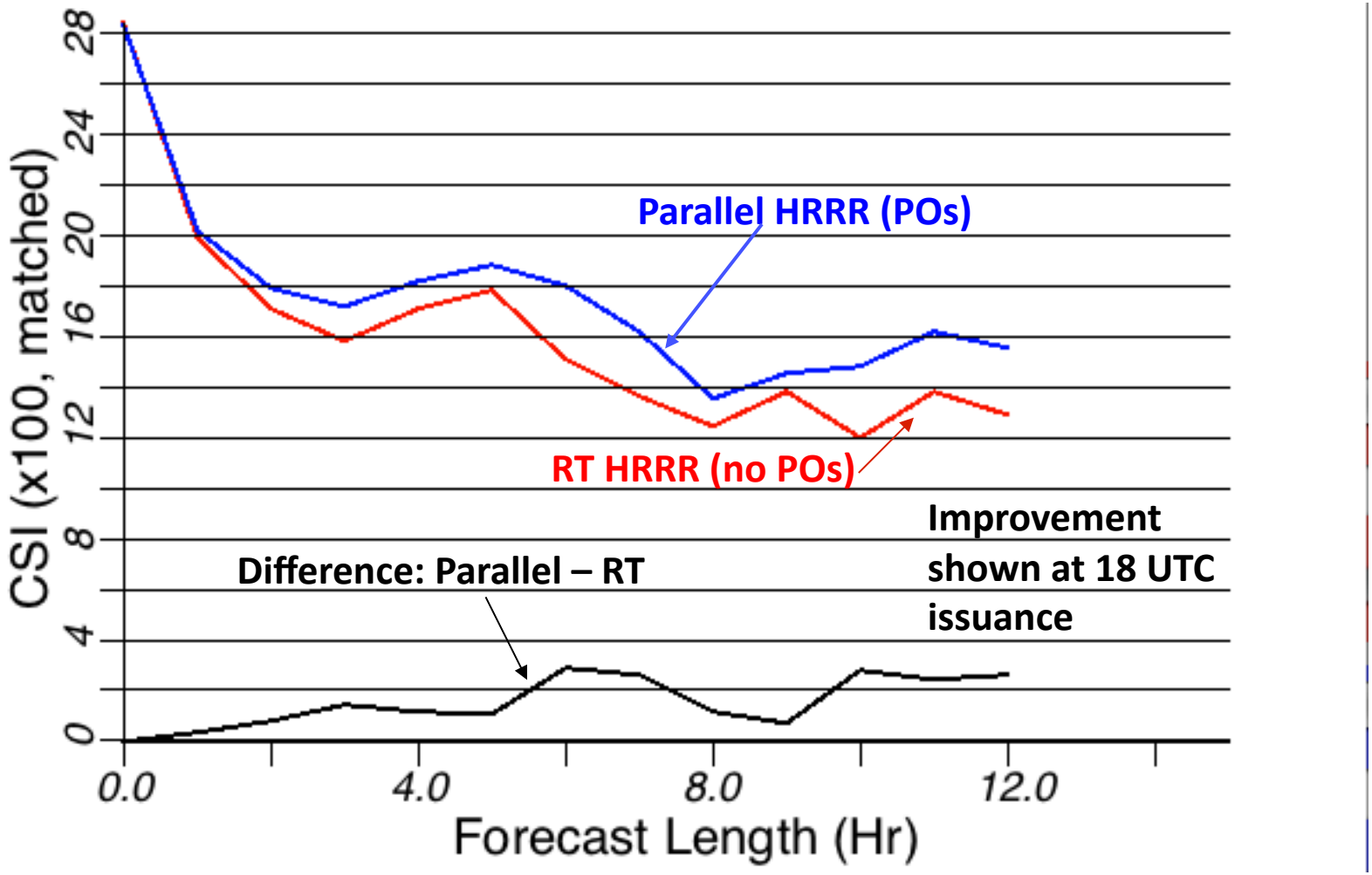
Northeast Performance, 15UTC Issuance

June 19 – July 5, 2011, 30 dBZ threshold, 40 km



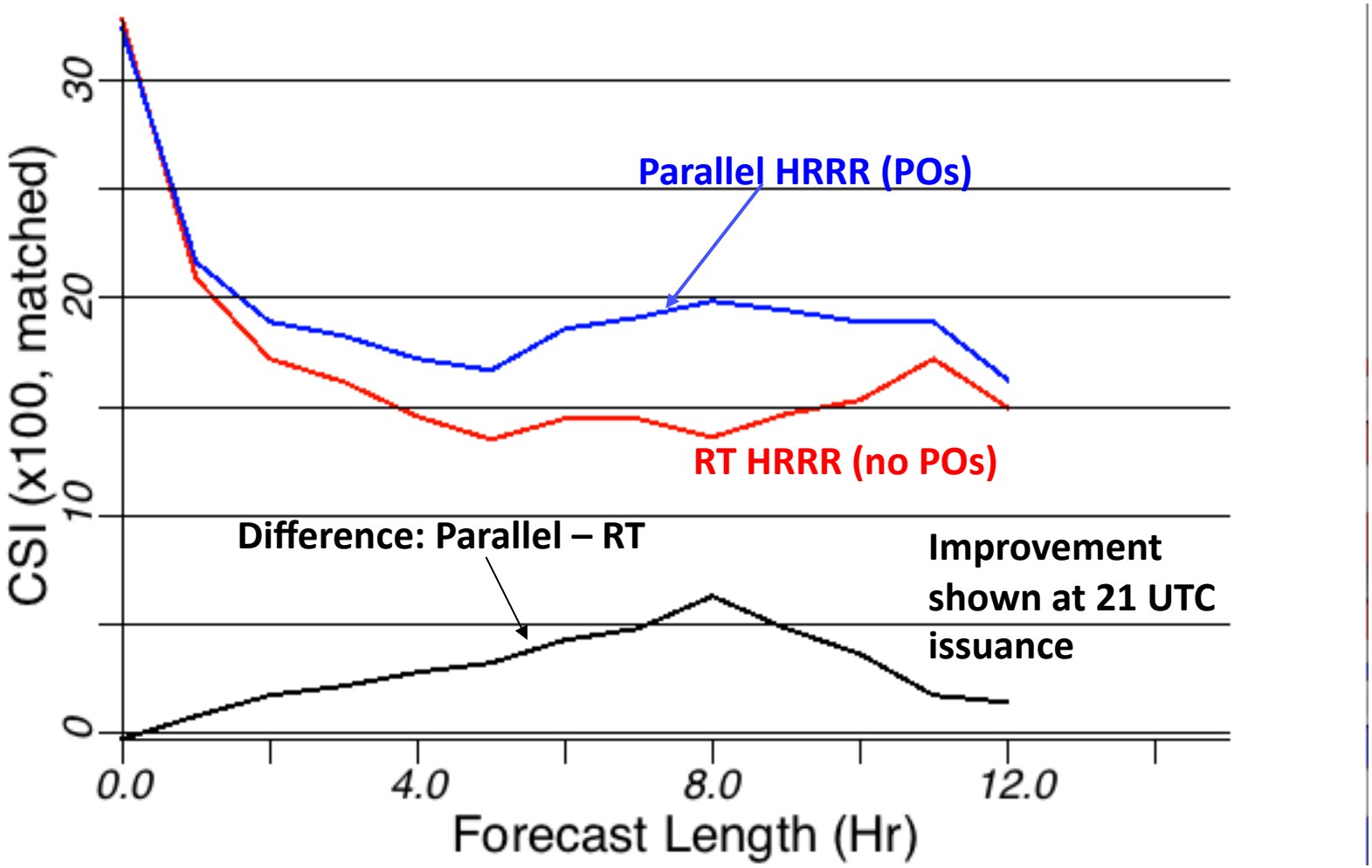
Northeast Performance, 18UTC Issuance

June 19 – July 5, 2011, 30 dBZ threshold, 40 km



Northeast Performance, 21UTC Issuance

June 19 – July 5, 2011, 30 dBZ threshold, 40 km



Northeast Performance, 00UTC Issuance

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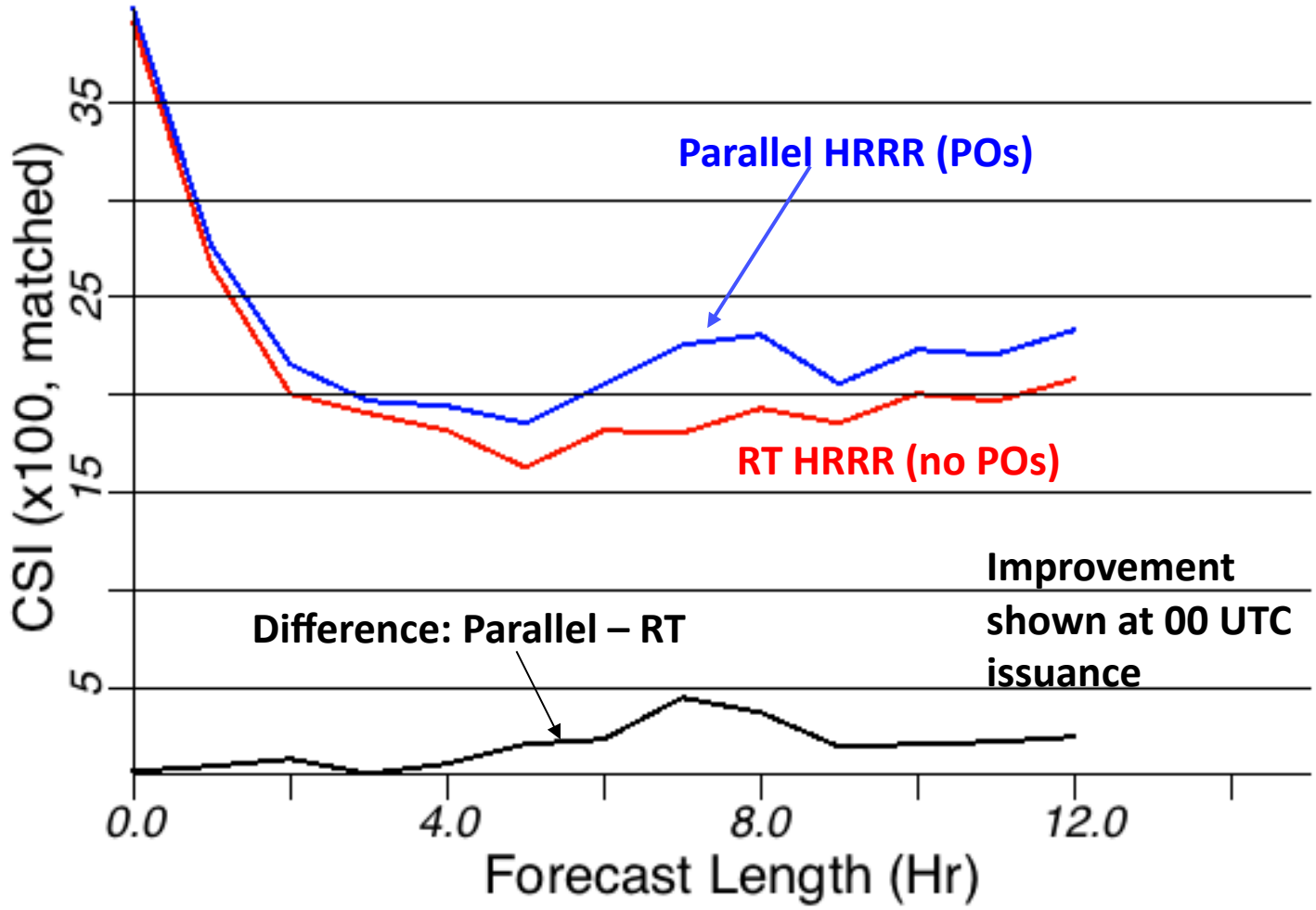
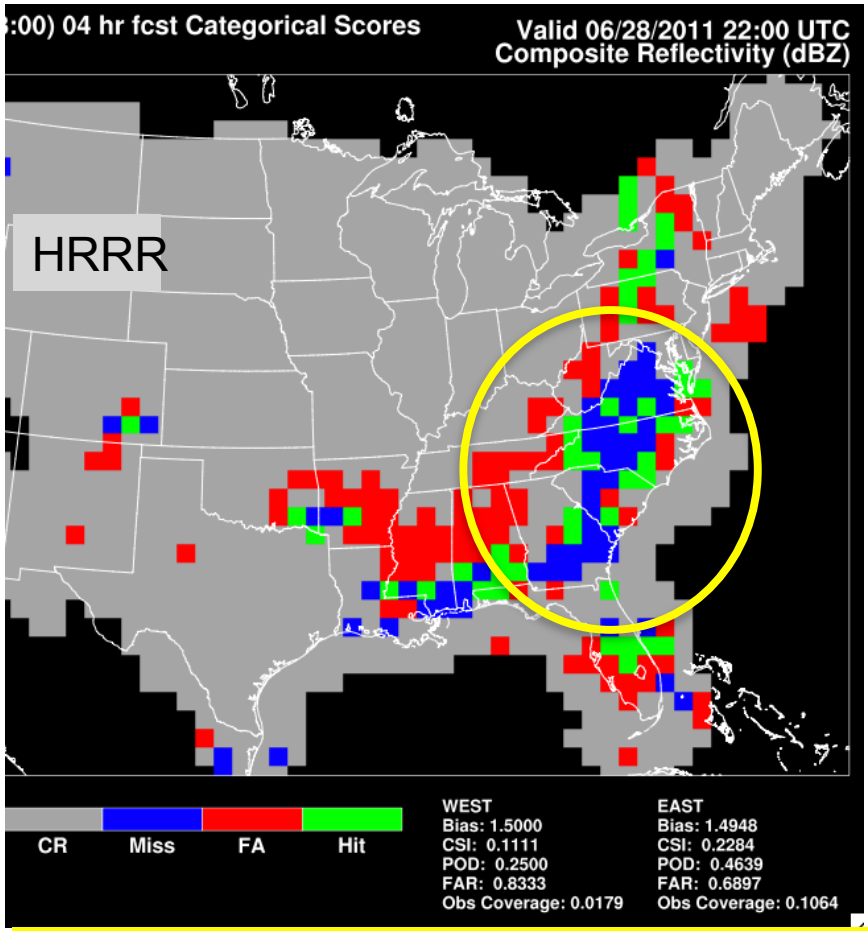
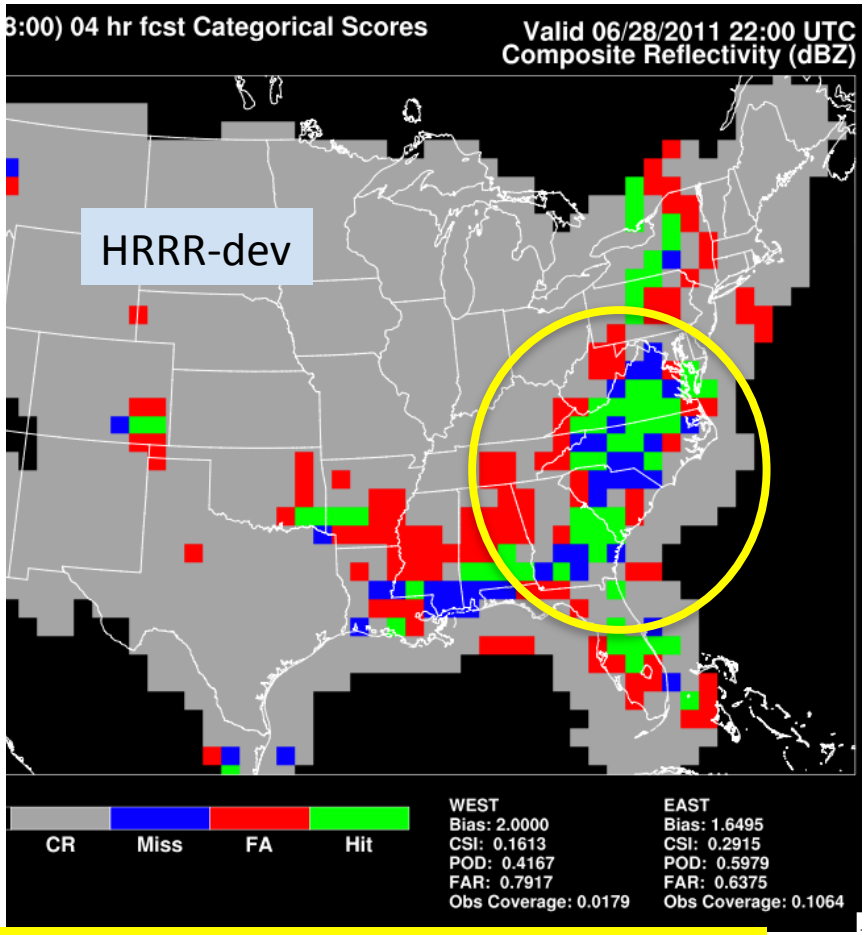


Three Forecast Case Examples

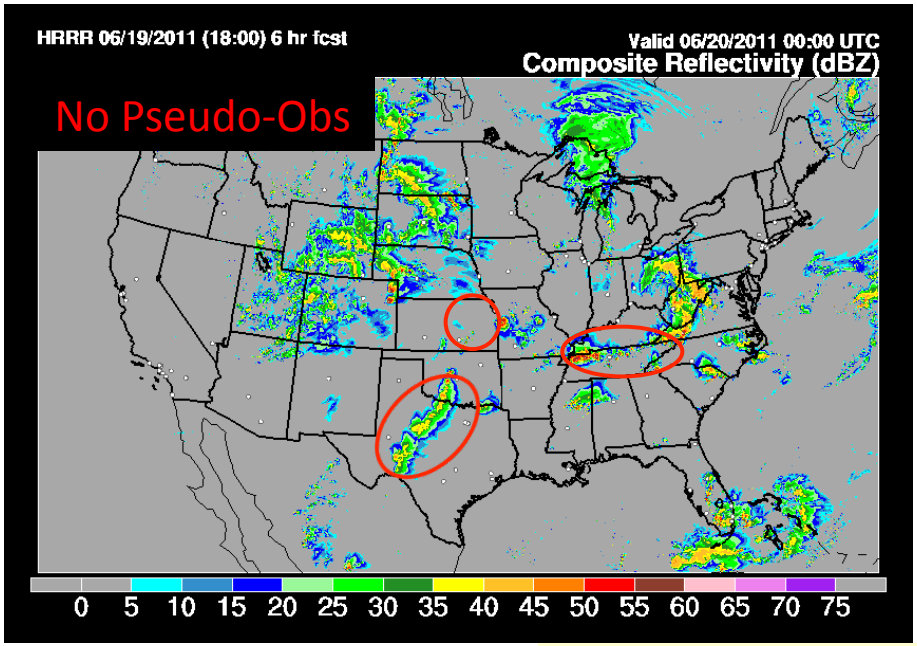
Case study – 6/28 – 4h forecasts initialized 18z, valid 22z

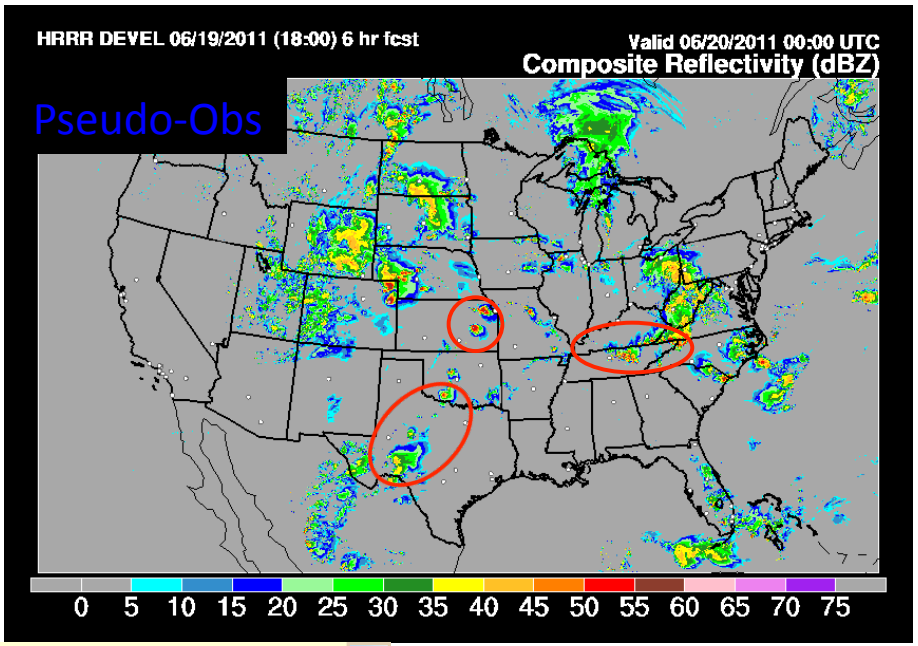




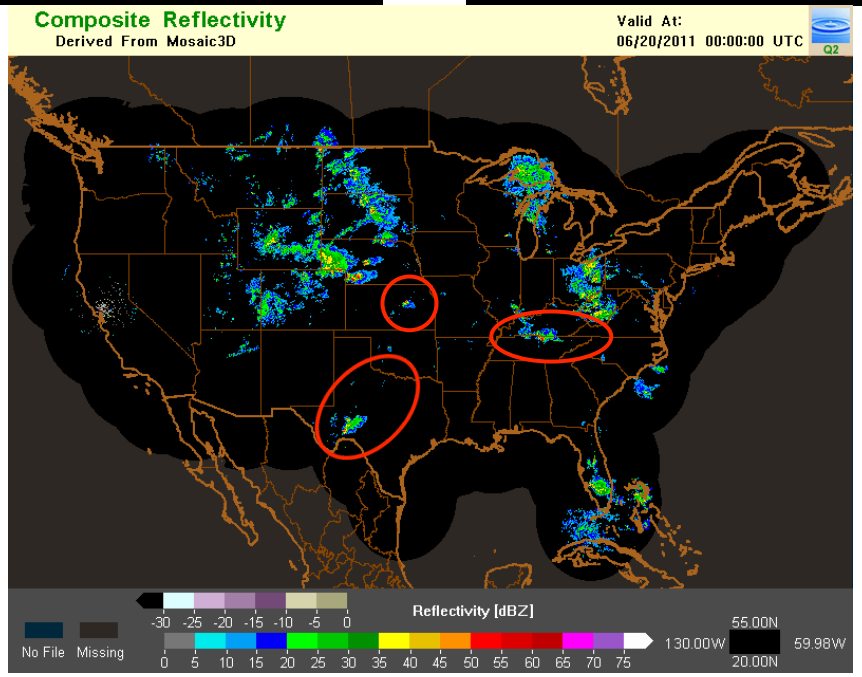
Improved forecast in southeastern and middle Atlantic states from HRRR-dev

18 UTC 19 June 2011 init: 6 hr forecast valid 00 UTC 20 June 2011

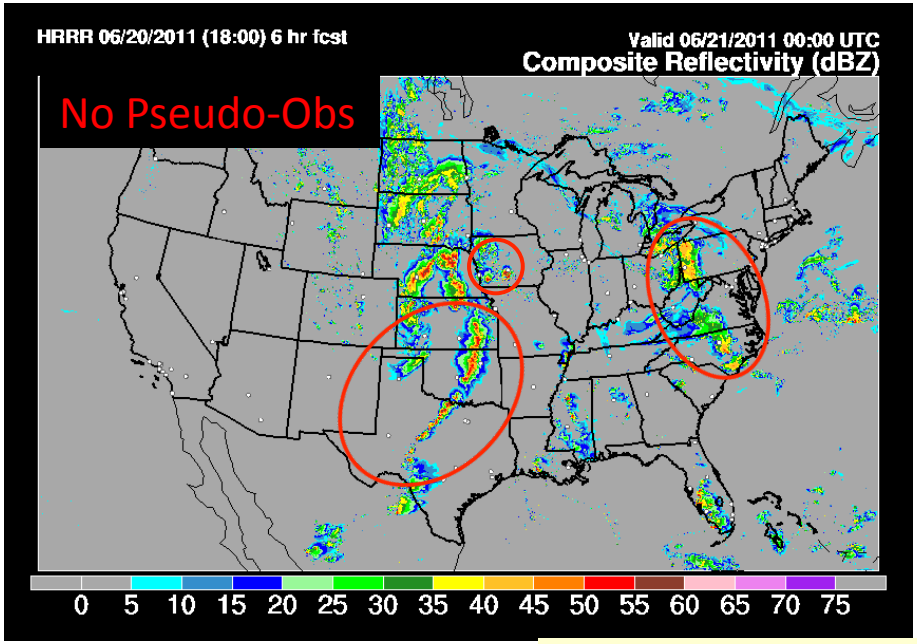


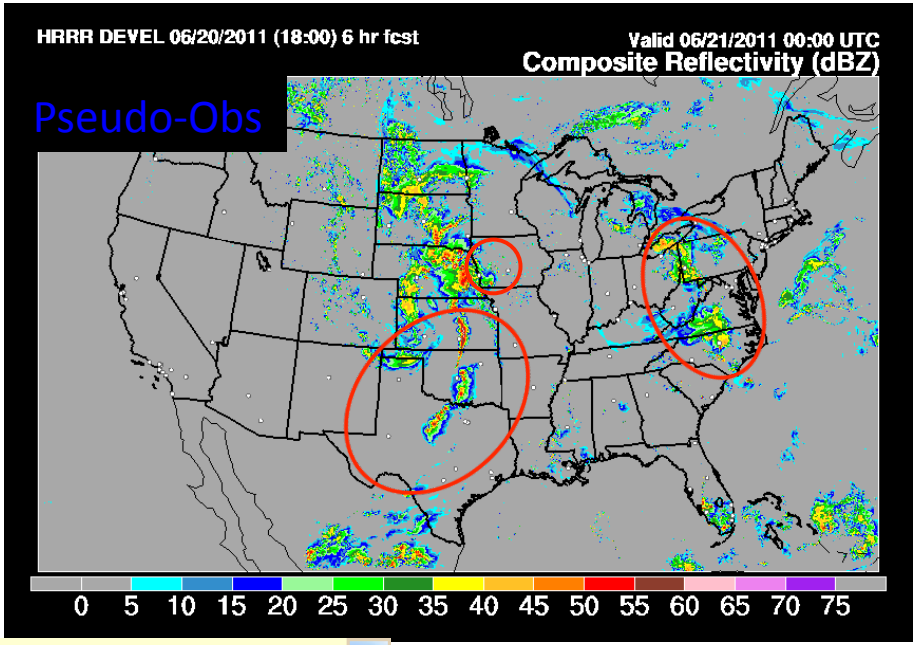


Observed Reflectivity

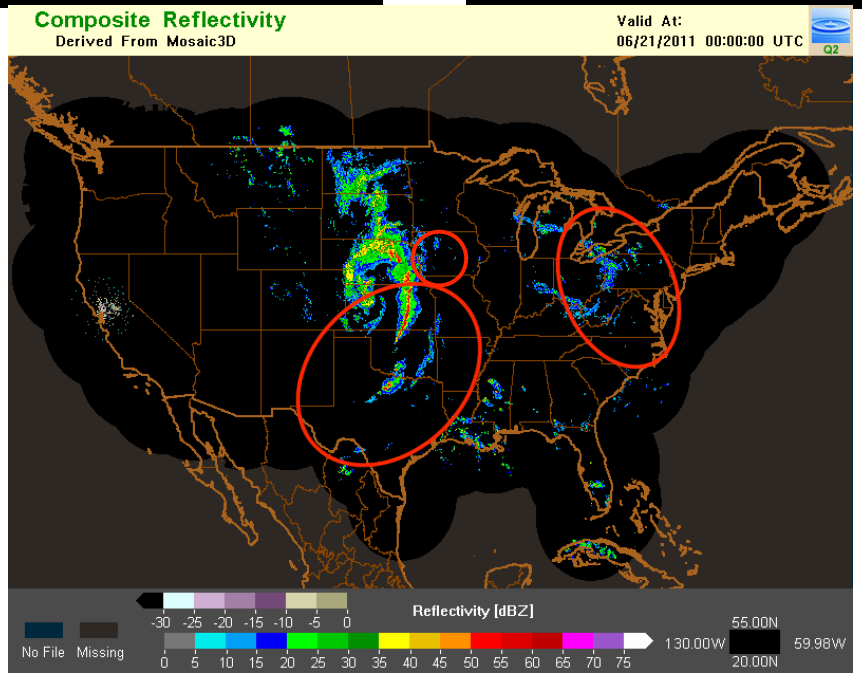


18 UTC 20 June 2011 init: 6 hr forecast valid 00 UTC 21 June 2011





Observed Reflectivity



General improvement of convective forecasts with fewer false alarms and more accurate evolution

Summary

- PBL-based observations were added to Rapid Refresh to improve initialization of the HRRR (primary)
- Parallel testing from 6/13 through 7/5 show clear improvement in thunderstorm forecasting for initial times from 18z through 00z from HRRR-dev (parallel HRRR with PBL-based pseudo-obs added to parallel development Rapid Refresh – RR-dev)
- Change made at 00z 7 July 2011 to RR-primary (which initializes the primary HRRR)