

**MDE Product Development Team  
February Monthly Report – FY 2012  
Submitted 15 March 2012**

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*(Compiled and edited by S. Benjamin and B. Johnson)*

## **Executive Summary**

### **Task 12.5.4: Develop, test, implement and improve the Rapid Refresh (RR or RAP)**

- Continued progress toward RAP implementation at NCEP to replace the RUC, still planned for 20 March. A 30-day evaluation was completed with all evaluating parties recommending implementation, resulting in approval by the NCEP Director for the implementation.
- A presentation on the RAP implementation for a 3/12 briefing to NCEP management is available at <http://ruc.noaa.gov/pdf/RAPbrief.NCEP-Dir-20Mar2012.pdf>.
- **(Late 3/15 news: A delay of a few days beyond 20 March is now necessary to identify some new RAP issue at NCEP likely linked to a computer environment issue.)**
- Further upgrades to ESRL RAP implemented at ESRL in February through early March, including data assimilation and modeling improvements. All of these will be included in Rapid Refresh v2 (RAPv2) with implementation at NCEP, proposed for early FY13.

### **Task 12.5.5: Develop/test/implement improvements to operational data assimilation supporting RR / NAM**

- Recent short-range upper-air verification continues to show strong improvement of NCO parallel RAP over NOAA operational RUC, indicating good performance by the RAP GSI analysis package.
- Merge of ESRL/GSD GSI trunk with recent NCEP (r16882) / community (r719) version. Benchmarking of this updated GSI version, followed by use for all ESRL/GSD real-time runs. With this the RAPv2 inherits other GSI community improvements.
- Further enhancements to GSI cloud analysis added to the ESRL/GSD RAP version 2, including provision for partial cloud building and building of marine stratus at a level consistent with the background marine boundary layer.
- Addition of GLD360 lightning data to GSI analysis for real-time ESRL/GSD RAP cycle runs.
- Continued testing and evaluation of impact from assimilation of energy observations (nacelle, tower, sodar).

### **Task 12.5.8: Improve physical processes in WRF (RAP and HRRR) and NAM models, especially for icing**

- Updated version of WRFv3.3.1 implemented in RAP-primary at ESRL using options tested at ESRL for optimal RAP performance, especially for clouds.
- Thompson v3.3.1 microphysics and MYNN boundary layer and RUC land-surface schemes implemented in RAP-primary at ESRL on 15 Feb.
- ESRL RAP updated to use MODIS land-use data – 15 Feb.

### **Task 12.5.24: Develop / test / implement improved 3-km HRRR**

- HRRR Program Review presented at ESRL/GSD – see <http://ruc.noaa.gov/pdf/HRRRProgramReview-13mar2012.pdf>. This is an excellent summary of recent progress with the HRRR and the ESRL version of the Rapid Refresh from which the HRRR is initialized.
- Completed extensive real-time and retrospective testing / evaluation of numerous candidate changes for RAP/HRRR system arriving at substantially improved convection, surface, and precipitation forecasts from the now-frozen system for 2012 CoSPA real-time evaluation.
- Main RAP / HRRR enhancements for 2012 CoSPA evaluation include: 1) upgrade/code merge to recent community versions of both GSI (for RAP) and WRF for RAP and HRRR, 2) several enhancements to RAP analysis to reduce moist bias in RAP, 3) several WRF model enhancements for both ESRL/GSD RAP and HRRR, 3) upgrade to reflectivity diagnostic calculation that is consistent with the new Thompson microphysics (for both ESRL/GSD RAP and HRRR)
- Completion of 9-day retrospective test using frozen RAP version, followed by 5+ days of HRRR runs. Verification comparison to 2011 HRRR shows substantial reduction in high reflectivity bias in first few

- hours while maintaining similar CSI scores.
- Tests of 3-km GSI cloud analysis on both the ESRL JET supercomputer and the ZEUS supercomputer.

NOTE to all RUC/RAP users: **Now** is the overlap period with **both** RUC and RAP data available from NCEP for any users to sort out any transition issues. When the RAP changes status to operational, planned for 20 March or shortly thereafter, there will be no RUC grids available after this date.

#### **Task 12.5.4 Develop, test, implement, and improve the Rapid Refresh**

##### **ESRL/GSD**

*Task 5.4 involves the integrated testing and development of the model, assimilation, post-processing, and script components of the Rapid Refresh. While some changes in the RR may fall specifically with assimilation (Task 5.5) or model physical parameterizations (Task 5.8), under this task we consider the full-integrated effects of all components of the RR. The changes and problem areas listed below involved such cross-component investigation and testing.*

The Rapid Refresh (RAP) implementation is still scheduled for 20 March 2012. There were no further crashes of the NCO RAP since those reported last month, so the field test completed successfully. On Monday 11 March the Evaluation Review for the Rapid Refresh was held, led by Louis Uccellini, director of NCEP, with participation by personnel from the Aviation Weather Center, the Hydrometeorological Prediction Center and the Storm Prediction Center (SPC) and the National Weather Service Eastern Region, in addition to personnel from the Environmental Modeling Center (EMC). Stan Benjamin of GSD and Geoff Manikin of EMC made a presentation on RAP content and performance (available at <http://ruc.noaa.gov/pdf/RAPbrief.NCEP-Dir-20Mar2012.pdf>). These were well received, with the only reservations being expressed by the Storm Prediction Center out of concern that there haven't been enough severe weather episodes yet to fully evaluate the RAP, particularly its ability to describe and predict vertical sounding structures important for severe weather. (3/15 late breaking news: Implementation will be delayed by at least a few days beyond 3/20 due to an irreproducible issue that is likely related to a computer environment problem.)

The RAPv2 upgrade that has been the object of most RAP effort the past several months was brought to a point during February where retrospective testing on the August 2011 retro period was showing great improvement in alleviating the low level moist bias and the precipitation bias of summer 2011. Retrospective testing of the HRRR initialized with this version of the RAPv2 has since confirmed that these RAP changes also benefit the HRRR forecasts (see Task 5.24). The GSD RAP primary incorporating these enhancements is now frozen to support the HRRR for this warm season's CoSPA exercise. The following is a cursory list of the most important RAP2 enhancements now in the RAP primary cycle at GSD *beyond* the initial RAP code that will be implemented into NCEP operations later this month. These have all been noted in recent MDE reports.

- GSI analysis
  - Water-vapor pseudo-observations
  - Soil moisture/temperature adjustment from near-surface atmospheric assimilation fields.
  - Adjustment of integrated precipitable water vapor observations to account for model-observation ground height differences
  - Use of radar radial velocities as well as limited low-level wind data (available through a DOE project) in the analysis
  - Extensive upgrades to cloud analysis, including
    - Constrain addition of snow hydrometeors from radar reflectivity to prevent excessive 1h precipitation and overall moist bias from subsequent excessive soil moisture.
    - Restrict cloud building into dry layers having a steep lapse rate
    - Various other changes to reduce moistening related to cloud building
- WRF model
  - WRF version 3.3.1 (released August 2011) instead of version 3.2.1 (released August 2010)
    - V3.3.1 of Thompson microphysics

- Kept v3.2.1 of Grell G3 parameterized convection
  - 5<sup>th</sup> order accurate (replacing 3<sup>rd</sup> order) vertical advection—better retention of initial cloud layers in forecast
- UniPost
    - Radar reflectivity output now consistent with V3.3.1 Thompson microphysics

These other changes of slightly less but still notable importance for improving forecast skill have been in development and testing:

- The latest parallel testing on assimilation of radar radial winds has shown approximately neutral impacts, based on our objective verification.
- Other evaluation of physics behavior continues (Task 5.8).
- Assimilation of low-level winds from towers, wind-generator nacelles, and sodars. These proprietary data have been made available via NCEP through leveraging from the Department of Energy-funded Wind Forecast Improvement Project (WFIP). They are available in the upper Midwest of the US and some locations in Texas. Evaluation of the wind tower and nacelle data over the past 2 months has resulted in modification of the quality control for admitting use of the tower data and in deciding to use the wind speed only for the (superobbed) nacelle data. With these conditions, the wind tower and nacelle wind data are, along with the sodar data, are now being assimilated within GSI.
- Work to improve the analysis fit of rawinsonde temperature and humidity data through reducing the vertical error correlation and lower observation errors has been on hold whilst more pressing issues pertaining to the RAP-primary freeze for CoSPA were addressed. However, SPC concerns that RAP more faithfully replicate smaller-scale details of the temperature and moisture stratification that can be important for prediction of initiation of convection motivate this work to resume (see Task 5). Data collection for use in generating new background error covariances specific to the RAP continues.

## **NCEP**

### **Subtask 12.5.4.1**

Major progress towards implementation of the Rapid Refresh (RAP) to replace the RUC has been made. NCEP Central Operations has been running their parallel code, and the formal evaluation period completed about 3/7/2012. A couple of minor post processing issues were resolved during the evaluation, requiring a restart of the 30-day clock, but things have been stable through the end of February. The NCEP director was briefed on 3/12, where he approved implementation of the RAP toward the end of March. (Geoff Manikin, Dennis Keyser)

#### **12.5.4.1 Ongoing (NCEP, GSD)**

Maintain hourly RAP runs and provide grids of SAV and AHP guidance products.

GSD continues to make pgrb and bgrb files available from the ESRL/GSD RAP-primary real-time 1-h cycle available from its FTP site. RAP grids from the pre-operational NCEP/NCO cycle continued to be available during February.

#### **12.5.4.2 Ongoing (NCEP, GSD)**

Provide vendors with gridded model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway.

NCEP maintained real-time availability of SAV and AIV guidance to all vendors from the operational hourly RUC on pressure surfaces on the 80-km AWIPS grid #211 via the NWS Family of Services (FOS) data feed and via the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (30 Nov 12)  
(DiMego)

#### **12.5.4.3 Ongoing (NCEP, GSD)**

Provide full grids from RAP runs on NCEP and NWS/OPS servers.

The RAP implementation is now planned for March 2012, so NCEP maintained real-time availability of full resolution gridded data from the operational RUC runs via anonymous ftp access via the NCEP server site at <ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/ruc/prod/> and at the NWS/OPS site at <ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/> in hourly directories named MT.ruc\_CY.00 through MT.ruc\_CY.23. This includes hourly BUFR soundings and output grids, which undergo no interpolation. Both sites now contain only grids in GRIB2 format [http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1\\_to\\_GRIB2.shtml](http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml). A limited set of fields from the RUC runs (and other NCEP models) can also be viewed at <http://mag.ncep.noaa.gov/NCOMAGWEB/appcontroller>. (DiMego)

NOTE to all RUC/RAP users: **Now** is the overlap period with **both** RUC and RAP data available from NCEP for any users to sort out any transition issues. When the RAP changes status to operational planned for 20 March, there will be no RUC grids available after this date.

#### **12.5.4.4 Ongoing (NCEP, GSD)**

Maintain access to model verification data.

GSD maintains its verification web site for RAP and RUC versions at <http://ruc.noaa.gov/stats/> Statistics are available from the three RAP real-time cycles. Verification of the NCO pre-operational RAP is now available at this web site. This verification will continue with the official RAP implementation scheduled for 20 March.

The RAP implementation was delayed to Q2FY12, so NCEP maintained its capability and provided access to routine verifications of the operational RUC analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch (MMB) website:

<http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html> (DiMego)

#### **12.5.4.5 Ongoing (GSD, NCEP)**

Ongoing evaluation of performance of real-time and retrospective runs of RAP system for SAVs, AHPs

The NCEP/NCL pre-operational RAP cycle is equivalent to or outperforms the operational RUC for most variables at most altitudes. (See slides 27-40 in <http://ruc.noaa.gov/pdf/RAPbrief.NCEP-Dir-20Mar2012.pdf>). Lower troposphere humidity and temperature forecasts are showing further improvement in the ESRL RAP with changes implemented in November and December for soil adjustment and modification in assimilation of PBL-based pseudo-observations as well as the GSI version of the RUC cloud analysis.

#### **12.5.4.6 changed to June-Sept 2012 (ESRL, NCEP)**

Initial software for RAPv2 changes ready for porting to EMC.

Testing of the early RAPv2 code now frozen in the RAP-primary cycle at GSD argues that it would be advantageous to begin preliminary testing this code at NCEP as soon as logistics permit after the initial RAP implementation at NCEP.

Delays in the initial Rapid Refresh implementation will delay the Rapid Refresh upgrade to 2013. Move deadline to 1 Sep 12. (Manikin)

#### **12.5.4.7 31 Jan 2012 (ESRL)**

Complete testing and evaluation at ESRL of new Rapid Refresh capabilities in model physics (see 12.5.8) and data assimilation (see 12.5.5, 12.5.15) toward consideration in the upgrade to the RAP (RAP2) at NCEP near end of 2012.

COMPLETE - The configuration of the Rapid Refresh (RAP-primary at ESRL) for the summer 2012 is now fully set. This version of the RAP will be roughly equivalent to the RAP2 version envisioned for NCEP by late 2012.

We therefore call this task “complete”, but other smaller changes may yet be added at a later time before code for the RAPv2 is transferred to NCEP/EMC later in 2012.

**12.5.4.8 31 May 2012 (ESRL, NCEP)**  
Start design of NARRE ARW and NMM model ensembles.

The NARRE-TL system will be implemented along with the RAP near the end of March. Tests to fix a surface temperature cold bias problem in WRF\_NMM and WRF\_ARW were performed within the new 16km SREF. Based on the test results, physics options in the radiation and surface physics schemes were adjusted to reduce the cold bias in the SREF WRF\_NMM and WRF\_ARW members. (BinBin Zhou and Jun Du)

**NCEP**  
**Subtask 12.5.4.8**

The NARRE-TL system has been sent to NCEP Central Operations for operational implementation. It is expected to be implemented along with RAP near the end of March. Physics were adjusted for the NMMB members in the SREF to reduce its warm bias, while an investigation is going on to determine why ARW\_NCAR and ARW\_RAP members in the SREF show a cold bias in 2m temperatures. (BinBin Zhou and Jun Du)

**12.5.4.9 28 May 2012 (ESRL, NCEP)**  
Complete testing at EMC of RAPv2 code, pending NCEP readiness.  
Delays in the initial Rapid Refresh implementation will delay the Rapid Refresh 2 upgrade, possibly to 2013. Move deadline to 1 Jan 13. (Manikin)

**12.5.4.9a 15 June 2012 (NCEP, ESRL)**  
Submit Request for Change (RFC) and modified code for RAPv2 from EMC to NCO, pending NCEP readiness.

Delays in the initial Rapid Refresh implementation will delay the Rapid Refresh upgrade to 2013. Move deadline to 15 Jan 13. (Manikin)

**12.5.4.10 1 July 2012 (ESRL)**  
Commence work toward rendering RAP code, including potential physics suite options, operable within the NEMS (NOAA Environmental Modeling System, which is based on the Earth System Modeling Framework (ESMF), in compliance with the Sept 2007 Rapid Refresh MOU between NCEP and GSD.

Work on this project will begin after RAP model is implemented at NCEP. (Tom Black and ESRL)

**12.5.4.11 30 September 2012 (GSD, NCEP)**  
Present improved plan for bringing ARW model code into compliance with then current version of NEMS.

Under non-FAA funding, the Advanced Computing Group within GSD working in close collaboration with Tom Black at NCEP has mostly completed bringing the global Finite-volume flow-following Icosahedral Model (FIM) into the NEMS framework. It is expected that this experience will greatly facilitate converting the then current version of the RAP code into NEMS.

**Deliverables**  
**All Option A unless noted otherwise.**

**12.5.4.E1 20 Dec 2011 (ESRL)**  
Report on Rapid Refresh status and plans to NCEP Operational Model Production Suite Review meeting.

Complete. Stan Benjamin and Steve Weygandt made a joint presentation on the RR / HRRR status at this review, held 6-7 December at NCEP. Presentations will be made available on the web.

COMPLETE. Available at <http://www.emc.ncep.noaa.gov/GEFS/prod-review/NCEPmodelReview-2011.html>

**12.5.4.E2      1 Feb 2012      (ESRL, NCEP)**

Update documentation for operational Rapid Refresh.

NCEP and ESRL

CURRENT EFFORTS: A National Weather Service Technical Implementation Notice (TIN) concerning the RUC to Rapid Refresh transition was posted on 30 November 2011. It can be found at <http://www.nws.noaa.gov/os/notification/tin11-53ructoap.htm>. The document contains an overview of the model and explanation of the differences between the RUC and RAP.

The Rapid Refresh web page at <http://rapidrefresh.noaa.gov> continues to be updated with the latest information on the RAP. The RAP/RUC question/answer forum has been getting more active in recent months – see <http://ruc.noaa.gov/forum/eval>.

GSD presented a total 5 RAP tutorials via Go To Meeting to Storm Prediction Center forecasters in February. In addition, two tutorials open to NWS field offices and the other NCEP centers were presented on 22 and 29 February.

PLANNED EFFORTS: Implement the RAP in Q2FY12.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: None.

**12.5.4.E3      1 Oct 2012 (modified)      (ESRL, NCEP)**

Final code ready for transfer to EMC for Rapid Refresh 2 (RAPv2) package to be implemented in early FY13 (modified)

NCEP

CURRENT EFFORTS: Work will begin after the RAP is implemented in Q2FY12. (Manikin)

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: (requested in Jan 2012) *Move deadline to 1 Oct 12 because of delay in initial RAP implementation.*

**12.5.4.E4      30 March 2012      (ESRL)**

Report on testing of RAP assimilation/model improvements toward planned RAPv2 upgrade.

Extensive testing complete or underway ... see above.

**12.5.4.E5      31 July 2012 (request change to FY13)      (ESRL, NCEP)**

Pending computer resource availability, implementation of Rapid Refresh 2 changes to operational RAP at NCEP.

NCEP

CURRENT EFFORTS: Work will begin after the RAP is implemented in Q2FY12. (Manikin)

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: Move deadline to somewhere between Nov 12 to Feb 13 because of delay in RAP implementation.

**12.5.4.E6 Ongoing (ESRL, NCEP)**

Perform configuration management for Rapid Refresh, including thorough documentation, and respond promptly to any code malfunctions or performance issues.

NCEP

CURRENT EFFORTS: A total of 25 RFCs directly related to Rapid Refresh code were submitted to NCO during the last week of October 2011 in preparation for the implementation. Twenty additional RFCs covering related systems and verification codes were also submitted. A thorough documentation of the Rapid Refresh codes and downstream dependencies is found in the Technical Implementation Notice found at <http://www.nws.noaa.gov/os/notification/tin11-53ructorap.htm>. (Manikin)

PLANNED EFFORTS: Implement the RAP in Q2FY12.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: None.

**12.5.4.E7 Ongoing (ESRL, NCEP)**

Monitor Rapid Refresh performance; respond to any problems detected by ESRL, NCEP, or any RR users, Diagnose cause; develop solution to RR software, test changes and coordinate with NCO on implementation.

**ESRL and NCEP**

The ESRL and NCEP versions of the RAP have been evaluated by ESRL and NCEP/EMC on an almost daily basis, including validation against rawinsonde, surface, and precipitation observations available under <http://ruc.noaa.gov/stats>.

PLANNED EFFORTS: Implement the RAP in Q2FY12.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: None.

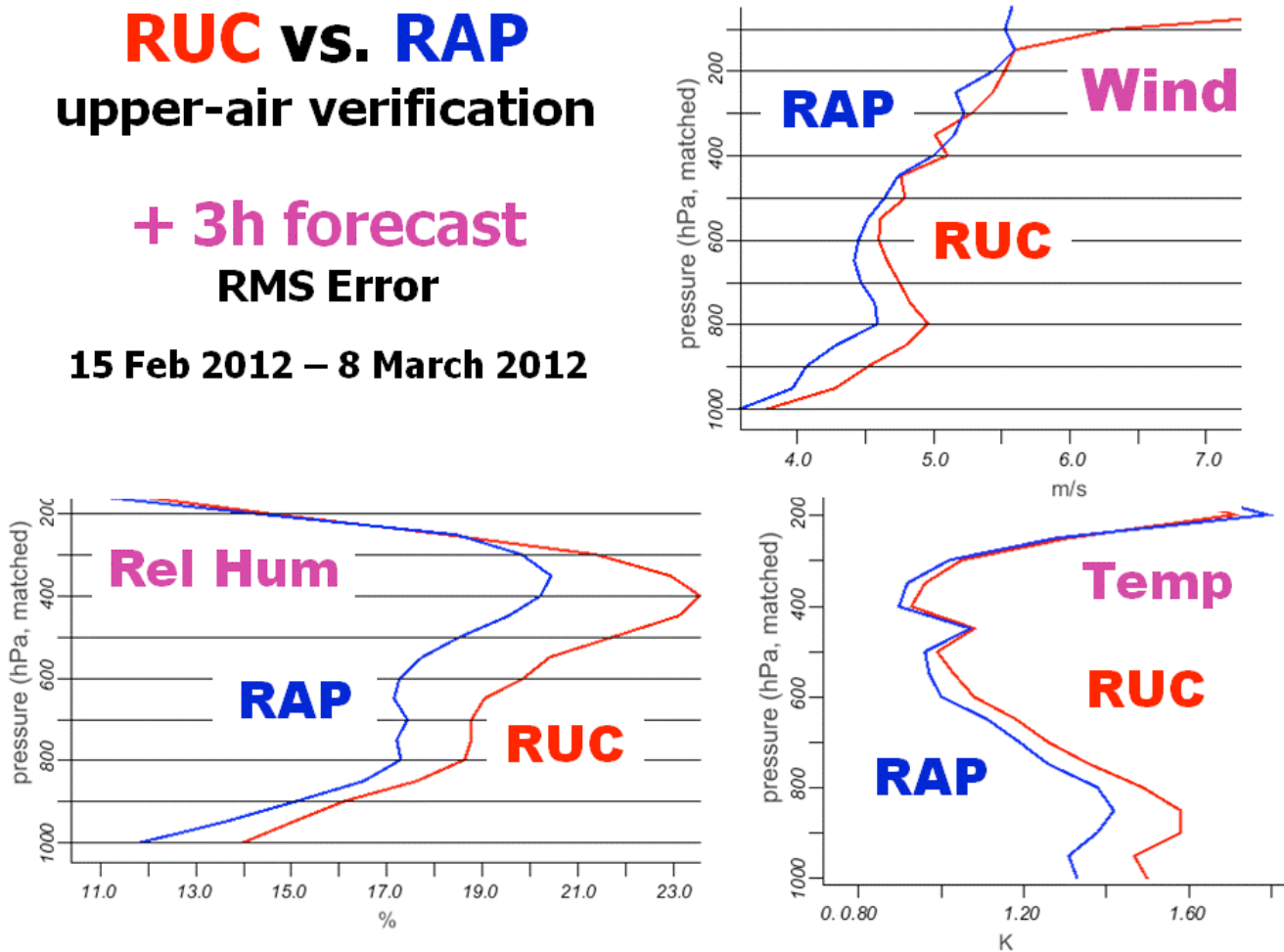
**12.5.4.E8 30 Sept 2012 (ESRL/GSD)**

Report on overall planned changes for the FY13 upgrade to the Rapid Refresh.

**Task 12.5.5 Develop, test, and implement improvements to the operational data assimilation supporting Rapid Refresh and North American Mesoscale runs.**

**ESRL/GSD**

NCEP operational implementation is now planned for late March 2012. Recent short-range (+3 hr) upper-air verification continues to show strong improvement for the NCO parallel RAP compared to the operational RUC, as indicated in Fig. 1. This indicates good performance by GSI analysis as configured for the RAP.



**Fig. 1. Vertical profile of +3h forecast RMS errors for the NCEP Central Operations (NCO) parallel version of the RAP vs. the NCAP operational RUC for wind, temperature and moisture.**

Work was completed to freeze a real-time ESRL/GSD version of the RAP to drive the HRRR for the 2012 CoSPA real-time evaluation. Additional changes beyond those implemented in Dec. / Jan. have included several items. 1) The treatment of cloud building was improved, so that the background cloud hydrometeor states of the individual grid columns within the search region of each observation are better preserved. The practical result of this enhancement is a reduction in the extent of artificial cloud “disks” from the cloud building. 2) The building of low-level marine cloudiness was modified to build at levels that are consistent with background marine boundary layer. 3) Assimilation of GLD360 extended range lightning data was added to the GSI, using a similar algorithm to that used for the NLDN lightning data (mapping the lightning to proxy reflectivity, use in the radar-DFI



technique). 4) Assimilation of energy sector related observations (nacelle, tower, and sodar) and monitoring of forecast impact.

The impact of these changes (along with earlier set of changes listed below) was evaluated in both real-time and a retrospective run (for the 11-18 Aug. high weather impact period). Results indicate improvement in nearly all aspects of the model forecast. Specifically, a reduction in the high precipitation bias in the first hour of the RAP, improved upper-level skill scores (likely due to the reduction of spurious parameterized convective precipitation systems), and improved surface dew point forecasts. These changes will be part next version of the RAP at NCEP (RAP-version2) and of the RAP version frozen in March 2012 for the CoSPA exercise.

Previous changes implemented in ESRL/GSD RAP v2 system in Dec. 2011 / Jan. 2012:

- (1) Added soil adjustment for moisture and temperature based upon near-surface temperature and moisture analysis increments
- (2) Switched planetary boundary layer pseudo-observations to moisture only (remove temperature pseudo-observations)
- (3) Modified GSI forward model for GPS-met PW observations to account for difference in terrain height between observations and model and to limit large PW innovations.
- (4) Modified GSI cloud analysis to reduce relative humidity for cloud clearing and to preserve virtual potential temperature when adjusting water vapor for cloud building/clearing
- (5) Incorporated new temperature-dependent specification of hydrometeor specification from 3-d radar reflectivity that significantly reduces excessive precipitation during first 1-2h of RAP model forecasts. This modified technique appears to be particularly important in reducing RAP and HRRR moist bias.

Work to evaluate impacts from real-time parallel testing of assimilation of low-level winds data from towers, wind-generator nacelles, and sodars is still ongoing. These data are available and being evaluated for RR assimilation through leveraging from the Department of Energy-funded Wind Forecast Improvement Project.

Ming Hu completed work to update the ESRL RAP-version 2 GSI to the latest EMC trunk (NCEP r16, 882, community r719).

Cloud analysis – new software was developed to re-introduce GOES cloud building but only within 1200m of surface. This software was tested first in the development RUC and then tested within the GSI for the RAP. Additional work will continue in this area both before and after the RAP freeze.

GSD contributors to RR/HRRR effort under FAA and NOAA funding: Ming Hu, Curtis Alexander, Stan Benjamin, John Brown, Tanya Smirnova, David Dowell, Haidao Lin, Joe Olson, Patrick Hofmann, Eric James, Brian Jamison, Xue Wei, and Bill Moninger.

### **Subtasks**

**12.5.5.1            31 Dec 2011            (GSD)**  
**Further refinement to the radial velocity analysis component of GSI for Rapid Refresh 2 configuration.**

Results from inclusion of radial velocity data assimilation in parallel versions of the RAP are still generally neutral, resulting in its inclusion in the early March frozen version of the RAP.

**12.5.5.1a            31 Jan 2012            (ESRL, NCEP)**  
**Complete preparation of initial GSI changes for RAPv2 changes ported to EMC.**

Weekly meetings are being held with AMB personnel to continually re-assess possible changes and prioritize testing and evaluation of them.

## **NCEP**

Delays in the initial Rapid Refresh implementation will delay the Rapid Refresh upgrade to 2013. Move deadline to 31 Jan 13. (Wu, Parrish)

### **12.5.5.1b      31 Dec 2011      (GSD)**

**Complete initial testing at ESRL of improved satellite radiance assimilation capability (bias correction, time windows, etc.) for RAPv2.**

Ongoing retrospective and real-time testing led by Haidao Lin in this area. Improvements for AIRS data from selective channel removal shown in retrospective tests.

### **12.5.5.4      1 April 2012 (change to 31 July)      (ESRL)**

**Complete testing of GSI changes for RR2 at ESRL.**

Delays in the initial Rapid Refresh implementation will delay the Rapid Refresh upgrade to FY2013. Move this deadline to 31 July 2012. A large set of changes to reduce the high bias in RAP moisture and precipitation forecasts has already been fully tested and included in all three ESRL GSD real-time parallel RAP runs.

### **12.5.5.5      1 Feb 2012      (GSD, NCEP)**

**Test version of GSI appropriate for 3-km High-Resolution Rapid Refresh (HRRR) configuration, including use of level-2 radar radial wind and reflectivity data.**

## **GSD**

Work continues to optimize the 3-km sub-hourly assimilation procedure for real-time application. In the system, a one-hour pre-forecast integration is completed, in which 4 application of the diabatic DFI-based radar assimilation is completed. The WRF ARW code has been modified to accomplish within a single model executable. At present, however, 4 separate application of the GSI (over the 3-km HRRR domain) are needed to create the radar reflectivity-based temperature tendency arrays. We are currently investigating needed changes to the GSI cloud analysis to allow all for the creation of all four of these temperature tendency arrays at a single time. The change would significantly reduce run-time for this pre-forecast spin-up period, increasing the likelihood that we can run it in real-time. It was decided to NOT include this in the operational version of the HRRR for spring/summer 2012.

Ming Hu has recently successfully run this 3-km GSI cloud analysis on both ESRL JET and ZEUS supercomputers, getting about 4 min. run times (64 cores on JET, 72 cores on ZEUS).

## **NCEP**

Checks on the new VAD wind dump continue, where the new VAD wind is compared with HiRes guess field. RMS of the new VAD wind is smaller than that of the operational VAD wind while the new VAD wind bias is larger than the operational VAD wind. (Shun Liu)

### **12.5.5.6      Moved to later in 2012 (GSD)**

**Complete testing of Rapid Refresh GSI modifications for RAPv2 at EMC, transfer code to NCO, pending NCEP readiness.**

Delays in the initial Rapid Refresh implementation will delay the Rapid Refresh upgrade to FY2013. Move this deadline to 31 December 2012. A large set of changes to reduce the high bias in RAP moisture and precipitation forecasts has already been fully tested and included in all three ESRL GSD real-time parallel RAP runs.

### **12.5.5.7      15 June 2012      (NCEP, ESRL)**

**Submit Request for Change (RFC) and modified GSI code for RAPv2 from EMC to NCO, pending NCEP readiness.**

Delays in the initial Rapid Refresh implementation will delay the Rapid Refresh upgrade to 2013.

## **NCEP**

Delays in the initial Rapid Refresh implementation will delay the Rapid Refresh upgrade to 2013. Move deadline to 15 Jan 13. (Manikin, Wu)

**12.5.5.9          31 May 2012                  (NCEP and GSD)**  
**Report on testing of 2DVAR GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 2.5-km or finer resolution and HRRR as background. (Possible 15-minute update for RTMA to support CoSPA, pending Convective Weather PDT support.)**

**NCEP**

The GSI code has been enhanced to handle the optional use of diurnal blacklists for surface temperature and moisture observations and direction-stratified accept lists for mesonet winds. A RTMA parallel has been set up to test the impact on the analysis from the added quality control of using such lists. (M. Pondeca, S. Levine)

**GSD**

Manuel Pondeca has provided the 2DVAR configured GSI code, scripts, etc. to Patrick Hofmann, who is beginning to examine the code and set up initial test runs toward evaluating use of the 3-km HRRR as a background for the RTMA

**12.5.5.10          1 July 2012                  (CAPS, ESRL)**  
**Develop dual-resolution capabilities of EnKF and test it for RR configurations.**

**12.5.5.11          31 July 2012                  (CAPS, EMC, ESRL)**  
**Complete initial comparison of 13km EnKF/hybrid results using background error covariance fields derived from a global model ensemble vs. those derived from a regional ensemble.**

**NCEP**

The benchmark tests related to the regional applications were performed when the branch with the hybrid ensemble-variation was changed. The package was ready to be included to the GSI trunk. Scripts were prepared for off-line NDAS parallel tests using the GEFS ensemble versus the EnKF ensemble in the regional hybrid analysis. The impact test could only be performed when the EnKF was produced in the global pre-implementation hybrid ensemble tests. In order for the jobs to run in the very full DEV machine, scripts were rewritten and only 2 cycles per day could be completed. (Wan-Shu Wu)

The hybrid ensemble upgrade package summarized in GSI subversion ticket #235 was sent out for final review after minor modifications and bug fixes were completed in response to an internal code review. (Dave Parrish, Wan-Shu Wu, Mingjing Tong, Jacob Carley, Daryl Kleist)

**12.5.5.12          31 July 2012                  (NCEP)**  
**If authorized by NCEP Director, implement initialization of the convection-resolving NAM nests and HiResWindow runs using CAPS/Shun Liu improved techniques for radial velocity analysis in GSI together with Diabatic Digital Filter use of 88D reflectivity Mosaic.**

**NCEP**

A bug in cloud analysis package when updating NMMB background was fixed. Cloud ice in cloud analysis package was modified to be small cloud ice crystals rather than total ice for the NMMB background. (Shun Liu)

Some corrections were made to the NMMB code's digital filtering to properly handle filtering of non-zero hour restart files. Previously in Shun Liu's radar assimilation work, his restarting of the model at 1 h to ingest more radar data would zero out the precipitation field and thus make the first 3 h precipitation total erroneously small. Adding the accumulated precipitation array to the list of physics fields to be restored to their pre-filtered state corrected the problem. Other changes were made to the logic deciding when boundary information needs to be read, as the wrong boundary information occasionally was read after filtering in the case of non-zero hour restarts. (Matt Pyle)

**12.5.5.13          31 July 2012                  (NCEP)**  
**Based on case-study testing and refinement of the research quality code, deliver result in an 'experimental' code for an upgrade package (e.g. improved satellite channel bias correction, improved**

**use of WSR-88D radial wind and/or satellite radiances and/or retuned covariance's to the GSI for FY2013 change package to the NAM.**

**NCEP**

A new version of the GSI was checked out from the trunk for upgrading the NDAS analysis package. The radiosonde-level enhancement, which was tested in the official NDAS parallel, was added to this version since the enhancement was still in review before being added to the trunk. A bug fix for the grid definition of the first guess fields was also included. This new version was tested with the off-line parallel and a neutral impact was found. This version was then used as the basis for new enhancements. The background error variance for the normalized relative humidity was tuned and tested. A bug in the assignment of GSI background error variances was also found and corrected. (Wan-Shu Wu)

Work continued on coding and debugging of the new method to allow use of GFS derived satellite bias correction coefficients directly in the NAM GSI. Coding is still in progress, with no results yet. (Dave Parrish)

**12.5.5.14a      1 August 2012            (CAPS, ESRL)**

**Explore the use of time-lagged ensemble for increasing the ensemble size within the EnKF and EnKF hybrid.**

**NCEP**

Work will begin after the RAP is implemented in Q2FY12. (Binbin Zhou)

**12.5.5.15      30 August 2012            (CAPS, GSD, NCEP)**

**Finalize the multi-scale multi-pass configuration for analyzing radial velocity and other data. Report initial results with RR and HRRR testing.**

**NCEP**

Checks on the new VAD wind dump continue, where the new VAD wind is compared with HiRes guess field. RMS of the new VAD wind is smaller than that of the operational VAD wind while the new VAD wind bias is larger than the operational VAD wind. (Shun Liu)

***Deliverables - All Option A unless noted otherwise.***

**12.5.5.E1      1 April 2012            (GSD)**

**New version of GSI including revised radial wind assimilation ready for NCEP for RR upgrade.**

**12.5.5E3      (28 Feb 12)            (NCEP)**

Final GSI code transfer complete to EMC for Rapid Refresh upgrade change package to be implemented in spring 2012. (Combined with 12.5.5E1) (Manikin, Wu)

CURRENT EFFORTS: Work will begin after the RAP is implemented in Q2FY12. A set of changes has been completed and is running in the ESRL/GSD real-time runs.

PLANNED EFFORTS: Implement the RAP in Q2FY12.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: Move deadline to 1 Oct 12 because of delay in initial RAP implementation.

**12.5.5.E4      15 June 2012            (GSD, NCEP)**

**Pending EMC, and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit GSI code as part of spring 2012 upgrade for Rapid Refresh 2 software to NCO, pending NCEP readiness.**

**ESRL**

**Request for change to early FY13.**

**NCEP**

Pending EMC, and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit GSI code as part of spring 2012 upgrade for Rapid Refresh 2 software to NCO, pending NCEP readiness.

CURRENT EFFORTS: Work will begin after the RAP is implemented in Q2FY12.

PLANNED EFFORTS: Implement the RAP in Q2FY12.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: Early FY13

**12.5.5.E5      31 July 2012      (ESRL, NCEP)**

**Pending computer resource availability, implementation of Rapid Refresh 2 changes to operational RR at NCEP.**

**ESRL**

Request for date change to early FY13.

**NCEP**

Pending computer resource availability, implementation of Rapid Refresh 2 changes to operational RAP at NCEP.

CURRENT EFFORTS: Work will begin after the RAP is implemented in Q2FY12.

PLANNED EFFORTS: Implement the RAP in Q2FY12.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: Early FY13.

**12.5.5.E6      30 Sept 2012      (CAPS, EMC, ESRL)**

**Report on the results of EnKF and hybrid DA systems for the RR configuration.**

**NCEP**

CURRENT EFFORTS: Work will begin after the RAP is implemented in Q2FY12.

PLANNED EFFORTS: Implement the RAP in Q2FY12.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: None.

**12.5.5.E7      30 Sept 2012      (NCEP)**

**Subject to NCEP Director approval, implement NEMS/NMMB version of GSI (e.g. strong constraint, revised bkg+obs errors) in NAM/NDAS.**

**12.5.5.E8      30 Sept 2012      (CAPS and GSD)**  
**Report on initial results of dual-resolution EnKF for RR configuration.**

**12.5.5.E9      30 Sept 2012      (ESRL/GSD)**  
**Report on planned GSI changes for the FY13 upgrade to the Rapid Refresh.**

UPDATE TO DELIVERABLE:  
Change to early FY13 due to late implementation of initial RAP.

**Task 12.5.8    Improve physical processes in the WRF (RR and HRRR) and NAM models, especially including those that affect aircraft icing.**

**GSD**

Improvements to radar and moisture assimilation in GSI finalized in January-February 2012 have greatly improved the WRF moist precipitation bias at least for RAPv2. We expect some continued moist precipitation bias in the NCEP RAP until the RAPv2 assimilation changes are implemented there.

**12.5.8.1                      1 Oct 2011      (GSD)**

Based on ongoing GSD RR evaluation and feedback from users of the newly operational RAP, including other AWRP PDTs, continue developing and begin testing a suite of upgraded or new physics packages using developmental RR real-time cycles and retrospective periods at GSD, in preparation for RAP upgrade (RAPv2).

Improved versions of the Thompson microphysics and RUC-Smirnova land-surface model were implemented into RAPv2 in February, resulting in improved precipitation, cloud, and near-surface forecasts. The RUC-Smirnova scheme now uses updated MODIS land-use information, and also uses fractional land-use within each RAP and HRRR grid area.

The MYNN PBL and surface-layer scheme has been running in the RAP-development-2 cycle at GSD since mid February. Although it improves upon the MYJ scheme running in parallel in the RAP-primary by some measures, it also leads to excessive fog and low cloud development over snow covered areas at night, and has not been consistently better for winds and temperatures, either at the surface or aloft. In particular, the Yang surface-layer scheme, part of the current MYNN package, has proved a bit problematic over forested areas in our RAP-development2 real-time parallel cycle. Accordingly, it was decided not to elevate the MYNN to the RAP-primary at this time or into the operational HRRR for spring/summer 2012, but to continue testing it on single cases and retrospectively, and as there is opportunity, continue running it in one of the GSD parallel cycles. Despite these concerns, a version of the MYNN that is regarded as superior to the one released with v3.3.1 was submitted earlier for release with WRFv3.4, scheduled near 1 April.

**12.5.8.3                      1 July 2012      (NCAR/RAL)**

Continue to increase the complexity and possible interactions between various aerosol constituents and microphysics. For example, the first version of the scheme uses a constant hygroscopicity value whereas different aerosol constituents have different values of this parameter. Also, as the grid spacing of HRRR decreases, NCAR and GSD will incorporate large urban sources of sulfates and other aerosols directly into the model.

**12.5.8.4                      1 July 2012      (NCAR/RAL)**

More closely couple/link the aerosols and cloud droplet/ice characteristics to the radiation scheme(s). Aerosols directly affect the radiation, but also indirectly affect radiation through changes in cloud characteristics. Both are essentially ignored at this time. Also, directly utilize model output variables of cloud species and aerosols to develop better ceiling & visibility forecasts.

**12.5.8.5                      1 July 2012      (NCAR/RAL)**

Assemble a series of well-known benchmark case studies pertaining to the new aerosol-microphysics package in order to evaluate future improvements as well as test its sensitivities. Cases will be picked from intensive operation periods of large field programs such as PacDEX, PLOWS, IMPROVE, VOCALs, etc.

**12.5.8.6**                      **1 Sept 2012**    **(GSD and NCAR/RAL)**

Transfer the NCAR coupled aerosol-microphysics scheme into test versions of RR and HRRR and begin testing on individual cases (including HRRR summertime Mesoscale Convective System cases) using climatological aerosol distributions.

**12.5.8.7**                      **1 July 2012**    **(GSD and NCAR/RAL)**

Begin coupling the NCAR aerosol-microphysics scheme with highly simplified version of the GOCART option in WRF-Chem being developed by GSD.

**12.5.8.8**                      **1 June 2012**    **(GSD)**

Based on RR experience and recent WRF physics progress, begin development and testing of physics enhancements for RR3 implementation planned for FY13 and for future versions of the HRRR.

**12.5.8.13**                     **30 July 2012**   **(NCAR/MMM)**

NCAR delivered a WRF tutorial January 24–28, and its next WRF tutorial will be in Seoul, Korea (ROK) in April. The next WRF tutorial at NCAR will be in July 2012.

NCAR has begun planning the 13<sup>th</sup> WRF Users' workshop. This will be at NCAR's Center Green facility the week of June 25<sup>th</sup>, 2012.

PLANNED EFFORTS: NCAR will host and deliver the next WRF Users' Workshop in FY12Q3 and the next tutorial in Boulder in FY12Q4.

UPDATES TO SCHEDULE: NONE

**12.5.8.14**                     **30 Sept 2012**   **(NCAR/MMM)**

NCAR continued overseeing and preparing the next major WRF release, WRF V3.4, which is targeted for April 2012. Candidate features include new/improved physics (including the Noah MP LSM, the UCLA SSiB LSM, and a new surface layer scheme), software framework improvements, and WRFDA parallel 4DVAR.

NCAR conducted regular Release Committee meetings and worked on the second friendly-user (beta) release. This will be issued in March. Information on the release may be found at: <http://www.wrf-model.org/users/release.php>

Jimy Dudhia of NCAR/MMM is working with Prof. Y. Xue and Dr. F. De Sales (UCLA) on finalizing changes to the new SSiB LSM for the V3.4 WRF release. Ming Chen (NCAR/MMM) is testing scheme robustness, and NCAR is collaborating with the UCLA developers in investigating stability problems related to ice cover.

Dudhia continued to assist in the addition of aerosol and ozone effects in WRF. Working in collaboration with Ryan Torn (SUNY Albany) and Wei Wang (NCAR/MMM), this is targeted to improving WRF hurricane forecasting.

Dudhia also began tests with Ming Chen on the Morrison-Gottelman microphysics scheme, from the CAM physics package. They are comparing CAM and WRF physics for ten 20 km North America convective season simulations to determine general scheme behavior.

PLANNED EFFORTS: The development and incorporation of new physics and dynamics for WRF for the RR will continue through FY12Q2.

UPDATES TO SCHEDULE: NONE

**12.5.8.15**                     **Ongoing**        **(GSD)**

Continue development of the RUC LSM for application to both RR (RR2 in FY12 and RR3 in FY13) and HRRR, based on feedback from users, with particular emphasis on improving treatment of snow, sea ice and tundra, and use of upgraded ground surface datasets now available through the V3.3 WRF Preprocessing System (e.g., MODIS vegetation, lake surface temperature for lakes other than the Great Lakes).

The cold start RR, initialized twice daily from the GFS, is using the MODIS 24-category land-use datasets available through the WPS. No problems have been encountered. A rigorous comparison with the corresponding 28-category land-use dataset currently being used in the RR will be made after other higher priority RR changes have been evaluated.

### ***Deliverables***

**12.5.8.E1                      28 Mar 2012 (defer to July 2012)                      (ESRL, NCEP)**

Final model physics code transfer complete to EMC for Rapid Refresh 2 upgrade change package.

UPDATE TO DELIVERABLE:

Change to early FY13 due to late implementation of initial RAP.

**12.5.8.E2                      15 June 2012 (defer to Nov 2012)                      (GSD, NCEP)**

Pending NCEP computer readiness and EMC and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit WRF physics code changes as part of upgrade for Rapid Refresh 2 software to NCO.

UPDATE TO DELIVERABLE:

Change to early FY13 due to late implementation of initial RAP.

**12.5.8.E3                      30 March 2012 (NCEP) (Option C)**

Subject to NCEP Directors' approval, implement in NCEP Operations the physics upgrades of the 2012 NEMS-NAM change package. (May contribute to FY12-13 physics progress within Rapid Refresh and adds to NEMS common physics layer)

**12.5.8.E4                      15 July 2012 (ESRL, NCEP)**

Pending computer resource availability, implementation of Rapid Refresh 2 changes to operational RR at NCEP.

UPDATE TO DELIVERABLE:

Change to early FY13 due to late implementation of initial RAP.

**12.5.8.E5                      1 Sept 2012 (NCAR/RAL and GSD)**

Transfer the coupled aerosol-microphysics scheme into a test version of HRRR.

**12.5.8.E6                      30 July 2012 (NCAR/MMM)**

Deliver a WRF Users' Workshop and a WRF tutorial for the user community.

**12.5.8.E7                      15 Sept 2012 (NCAR/RAL)**

A written report by mid September 2012 summarizing enhancements made to the model physics packages.

**12.5.8.E8                      30 Sept 2012 (ESRL/GSD)**

Report on overall planned model physics changes for the FY13 upgrade to the Rapid Refresh.

**12.5.8.E9                      30 Sept 2012 (NCAR/MMM)**

Incorporate physics and dynamics improvements from the user community, GSD, and NCEP into WRF for use in the Rapid Refresh system. In collaboration with GSD, assist in the evaluation of those physics schemes for the RR that may be tested using the ARW. Perform testing for code acceptance and implementation into WRF repository. Assist in the implementation of WRF bug fixes.



#### **Task 12.5.24**

**FY 2012, also Priority 7: Develop, test, implement and improve the 3-km WRF-based HRRR**

***Task 5.24 specifically treats development and testing of the 3-km HRRR model itself. Development and testing work on assimilation of radar data at the 3-km scale is under Task 5.19.***

Work has been completed on an extensive set of upgrades to the GSD/ESRL RAP/HRRR analysis/forecast system for the 2012 CoSPA real-time evaluation. The work included coding, testing, and evaluating a large number of candidate analysis and model upgrades, utilizing both real-time and retrospective test configurations and with rapid verification feedback for upper-air, surface, ceiling and visibility, precipitation and reflectivity. The overall goal was to improve the accuracy of HRRR forecasts, especially targeting the high reflectivity bias (especially in the +1-4 h forecast range) and occurrences of spurious convection noted in the 2011 CoSPA evaluation.

Several significant enhancements were made to the RAP data assimilation including:

1. Assimilation of surface moisture pseudo-obs in PBL,
2. Soil adjustment based on near-surface temperature / moisture increments
3. Elevation correction for precipitable water assimilation and limits to PW innovations
4. Conservation of virtual potential temperature for cloud building
5. Fractional cloudiness and improves marine stratus building
6. Building of low-level clouds from GOES data (without instruction of a moist bias)
7. Temperature-dependent hydrometeor specification from 3D radar reflectivity (less 1h precip bias)
8. Assimilation of tower/nacelle/sodar observations
9. Assimilation of GLD360 lightning observations
10. GSI merge with recent NCEP/EMC trunk

In addition several enhancements were made to the ARW model and post-processing (benefitting both RAP and HRRR) including:

1. Upgrade to WRFv3.3.1+ (+ indicates with RAP specific enhancements)
2. Enhancements to PBL, land-surface (MODIS land use, and Thompson microphysics (two moment rain), more frequent call to short-wave radiation)
3. Enhancements to model numeric (vertical velocity damping upper bound conditions, 5th-order vertical advection)
4. Improvements to model post-processing especially use of a new reflectivity diagnostic that is consistent with the new Thompson microphysics.

Extensive verification of real-time and retrospective RAP runs has confirmed the benefits of these changes to the RAP (see task 5.5). A key RAP improvement for the HRRR has been the reduction on the high bias for RAP forecast moisture and precipitation. Following the completion of a RAP retrospective run for the Aug. 11-18, 2011 period a series of HRRR forecasts were launched from this RAP retrospective. We have currently completed over 5 days of even hour HRRR runs (> 60 runs). Verification of these runs has confirmed that the RAP improvements have yielded a significant reduction in the high reflectivity bias during the first few hours of the HRRR runs. This can be seen in Fig. 2, HRRR CSI and bias plots from the few days of these HRRR.

An excellent summary of recent HRRR and related RAP progress was presented on 13 March 2012 at an ESRL/GSD program review, available at <http://ruc.noaa.gov/pdf/HRRRProgramReview-13mar2012.pdf>.

# 2011 vs. 2012 HRRR Reflectivity Verification

Eastern US, Reflectivity > 25 dBZ  
11-21 August 2011

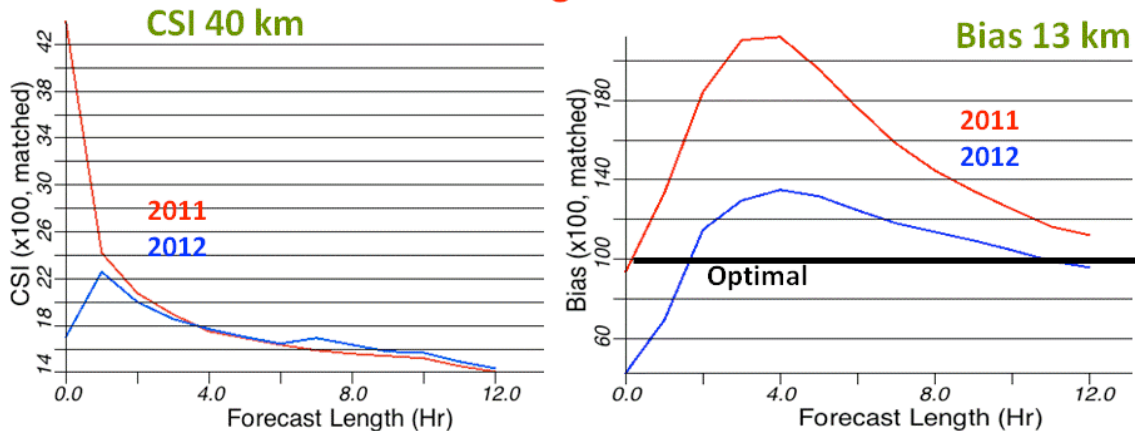
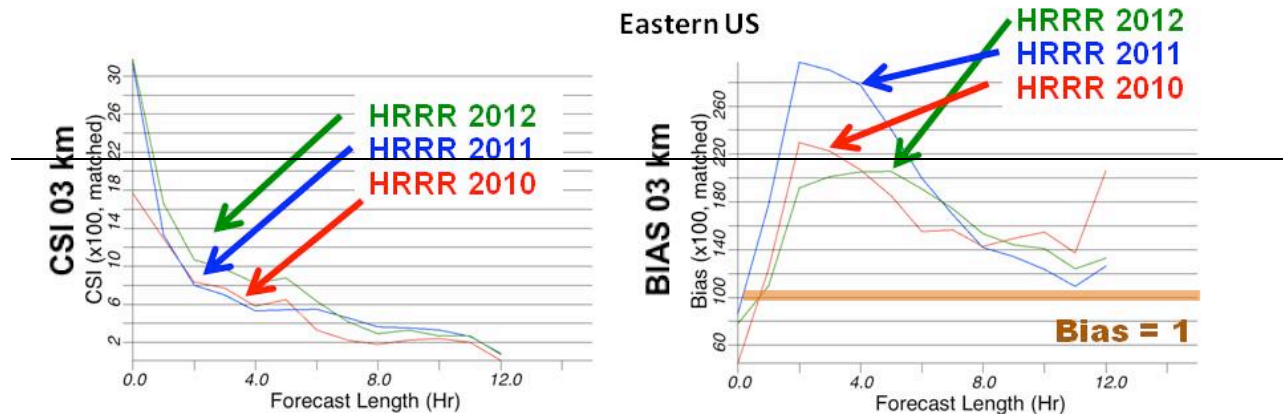


Fig. 2. Comparison of categorical skill scores for 5+ days of HRRRs (HRRR run for all even hours) run from the 11-21 August 2011 high impact weather period. Blue (2012) curves are for retrospective HRRRs run with all the analysis and model changes incorporated into the frozen code for the 2012 CoSPA evaluation. Red (2011) curves are from the 2011 real-time runs.

## HRRR Evaluation Reflectivity $\geq 35$ dBZ, 03 km Scale Select Cases 11-22 August 2011



HRRR 2012 – Improved CSI and reduced high bias in first 6 hours

Fig. 3. CSI and bias for reflectivity above for HRRR/RAP versions from 2010, 2011, and 2012 versions for a common testing period from 11-22 August 2011.  
Subtasks

**12.5.24.1      15 Jan 2012      (GSD, with assistance as needed from NCAR/RAL, NCAR/MMM, CAPS, MIT/LL)**

**Initial design for the assimilation/modeling configuration for the HRRR during the 2012 summer convection forecasting (CoSPA) exercise.**

As detailed above, extensive retrospective testing of the coupled RAP / HRRR data assimilation / forecast system for the August 11-21 period is complete. All changes to the RAP / HRRR system have been incorporated into the GSD runs and impact on HRRR-are very positive.

**12.5.24.3      30 Sept 2012      (GSD)**

**Complete 2012 HRRR summer evaluation using modeling and assimilation modifications determined in 2011 exercise. Collaborate on analysis of HRRR tests and deliver summary of results.**

**Deliverables**

**12.5.24.E1      1 April 2012      (ESRL/GSD)**

**Incorporate all assimilation and model changes that affect the HRRR into a frozen version of HRRR (and parent Rapid Refresh) for the summer 2012 exercise.**

As detailed above, work was completed on improvements to RAP / HRRR system for 2012 in advance of the freeze date in March 2012.

**12.5.24.E2      15 Sept 2012      (NOAA/ESRL/GSD)**

**Complete FY12 evaluation with revised 3-km HRRR running every 1 h.**

- **Conduct real-time summer 2012 HRRR forecasts using 3-km WRF initialized with radar-enhanced Rapid Refresh over full CONUS domain, monitor performance, modify code/scripts as needed, maintain high reliability working with ESRL computer facility**
- **Coordinate with other AWRP users and other collaborators, including coordination of HRRR grid transfers**
- **Provide project management**
- **Lead writing of report on summer 2012 HRRR experiments**

**12.5.24.E2a      1 June 2012      (NCEP, ESRL/GSD)**

**Report on computing resource status on NCEP CCS, NOAA R&D Site A and NOAA R&D Site B with regards to possible implementation of HRRR.**