MDE Product Development Team
April Monthly Report – FY 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 (RAP)

- **RAP implementation at NCEP occurred on 1 May.   The RAP has replaced the RUC.**
- RAP version 2 running at GSD, yielding improved moisture and precipitation forecasts, and ready for transfer to NCEP EMC,
- Further changes have been made to the development (not primary) ESRL RAP including data assimilation and modeling improvements.   All of these will be included in final Rapid Refresh v2 (RAPv2) with implementation at NCEP, proposed for early FY13.
- GSI ported to the new NOAA research high performance computing system, ZEUS, with testing for 13-km RAP, 3-km HRRR, and 2D RTMA application.

Task 12.5.5: Develop/test/implement improvements to operational data assimilation supporting RAP/NAM

- RAPv2 changes have all been successfully been transferred to the GSI trunk at NCEP except one set of code for soil temperature/moisture adjustment
- Development and initial retrospective testing of an hourly updated 40-member, 13-km RAP EnKF/hybrid data assimilation system on ZEUS
- Tests of 3-km GSI cloud analysis on both the ESRL JET supercomputer and the ZEUS supercomputer.
- Continuing work to run RTMA 2DVAR using 3-km HRRR CONUS grid as input (ESRL and NCEP)

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.
- Updated Thompson v3.3.1 microphysics and MYJ boundary layer and RUC land-surface schemes implemented in RAP-primary at ESRL on 15 Feb.
- ESRL RAP updated to use MODIS land-use and fractional sub-grid-scale data – 15 Feb.
- Testing continues of GSD/Olson version of MYNN PBL scheme with some excellent results but testing was insufficient to include MYNN PBL in the frozen summer 2012 RAP/HRRR system.

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

- HRRR system ported to Zeus, hourly 3-km runs initialized from RAP with additional 3D 3-km GSI-based loud analysis.
- Continued testing full GSI at 3-km for initializing HRRR and use of hourly pre-forecast radar data assimilation cycle (with use of radar data every 15 min.) to reduce HRRR spin-up period.
- 9-day June 2011 RAP retrospective run nearly complete on ZEUS. Work to run June 2011 HRRR cases on ZEUS ongoing.
- Good real-time reliability and performance for HRRR since 9 March code freeze
- (From last month) 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.

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 RAP 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 RAP.   The changes and problem areas listed below involved such cross-component investigation and testing.

Rapid Refresh implemented operationally at NCEP at 12z on Tuesday 1 May 2012.
After a successful completion of the 4-week field test with the corrected NCO scripts to correctly include use of the 3-d mosaic radar reflectivity in the diabatic digital filter initialization of the Rapid Refresh (RAP), and subsequent approval by the Storm Prediction Center (SPC), Aviation Weather Center (AWC), and Hydrometeorological Prediction Centers of NCEP for RAP to go into operations, operational implementation of the RAP occurred without incident at 1200UTC Tuesday 1 May. This was to the great joy and relief of those from GSD, EMC, NCAR and NCO, whose collaboration (in the case of the first 3 organizations) over a period of several years overcame many challenges to bring this about, and with gratitude to the FAA's Aviation Weather Research Program for providing crucial financial and administrative support to make this possible.

To repeat from the FY12Q2 report, slides from the 11 March 2012 evaluation review are available at **http://ruc.noaa.gov/pdf/RAPbrief.NCEP-Dir-20Mar2012.pdf**. Aside from concerns expressed by the SPC that the surface dew points in the RAP over the central US have been running a bit *dry* during the afternoons, we have had no significant concerns expressed from RAP users about RAP performance.

Work continues toward further enhancements to the RAP2, looking toward operational implementation in late 2012 or, more likely, 2013. The GSD RAP primary cycle on Jet, which feeds initial and lateral boundary conditions to the HRRR, was frozen for the 2012 CoSPA summer exercise (See FY12Q2 Task 4 report for details of this configuration). Work on additional RAP version 2 enhancements continues:
- Improvements to the GSI cloud analysis to take into account partial cloudiness by distinguishing between SCT, BKN and OVC in METAR obs and restoration of full use of satellite cloud observations (RUC-dev cycle at GSD; see Task 5),
- Evaluation of impact of the Vaisala GLD360 lightning product used as a proxy for radar reflectivity in the RAP radar assimilation (GSD-RAP-dev1 cycle on Jet; see task 5),
- Continued development and testing of the WRF MYNN boundary-layer scheme (GSD RAP-dev2 cycle on Jet; see Task 8).

We are also continuing the process of setting up RAP cycles on the new NOAA Environmental Security Computing Center Linux cluster, ZEUS (see FY12Q2 report, Task 4, for more details on ZEUS). What we are calling RAPdev1 on ZEUS is a clone of the RR-primary. Once this cycle is confirmed to be working fully and reliably, we will set up other development cycles on ZEUS.

12.5.4.1 Ongoing   (NCEP, GSD)
Maintain hourly RAP runs and provide grids of SAV and AHP guidance products.

NCEP
The Rapid Refresh evaluation period in March - April went smoothly and with no problems with any code or output, implementation occurred as planned on 1 May. All FAA RUC users were able to make a smooth transition, along with other RUC users. The RUC was discontinued at the exact moment that the RAP began. (Geoff Manikin)

LaRC GOES cloud data was out for 92 hours ending 14z 9 April due to LaRC's switch to a backup server. The primary server did not go down, so NCEP's system failed to switch. NCEP will modify its system to detect this situation in future and make the proper switch. (Dennis Keyser)

GSD
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 from GSD during April and from the oper RAP beginning 12Z 1 May.

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). (EMC and NCO)

12.5.4.3   Ongoing   (NCEP, GSD)
Provide full grids from RAP runs on NCEP and NWS/OPS servers.

The RAPv1 implementation occurred on 1 May, so NCEP maintained real-time availability through April 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**. (EMC and NCO)

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/** (Note: RAP-NCEP is designated as "RRrapx" in the GSD statistics.   Statistics are also available from the three GSD RAP real-time cycles and will soon be available for the new cycles being set up on ZEUS. Verification of the NCO pre-operational RAP from late December 2011 through April 2012 is also available at this web site ("RRrapx" also during that period). As of 12Z 1 May, the "RRrapx" verification is for the NCEP operational RAPv1.

The RAPv1 implementation occurred on 1 May, so NCEP maintained its capability and provided access to routine verifications of the operational RUC analyses and forecasts through April. 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   (EMC/MMB)

12.5.4.5   Ongoing   (GSD, NCEP)
Ongoing evaluation of performance of real-time and retrospective runs of RAP system for SAVs, AHPs

RAP implementation occurred on 1 May. (Manikin)

12.5.4.6   1 Aug 2012   (ESRL, NCEP)
Initial software for RAPv2 changes ready for porting to EMC.

RAP implementation occurred on 1 May. (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 nearly equivalent to the RAPv2 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)**

ESRL-GSD
Start design of NARRE ARW and NMM model ensembles. Use of ensemble/hybrid data assimilation, likely augmented by different physics suites provides variability for the ARW and for the NMMB. Work at ESRL, CAPS and EMC on regional ensemble data assimilation (see 5.5) is critical for improved deterministic and probabilistic forecasts from the NARRE. Part of this subtask will be to do the experiments necessary to decide which of these alternatives gives the more useful ensemble diversity for aviation application, by means of real-time and retrospective testing on the RAP domain. (31 May 12)

NCEP
The initial version of North American Rapid Refresh Ensemble Time Lagged (NARRE-TL) has been constructed using the 6 most recent RAP forecasts plus the 4 most recent NAM forecasts. It extends to 12 hours and is updated every hour. The NARRE-TL website, including a link to one covering Alaska, is at **http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/NARRE/web_site/html/refl.html** The NARRE-TL system was implemented along with RAP on 1 May 2012. (BinBin Zhou and Jun Du)

12.5.4.9   12 Dec 2012   (ESRL, NCEP)
Complete testing at EMC of RAPv2 code, pending NCEP readiness.

Delays in the initial RAPv1 implementation will delay the RAPv2 upgrade until just before or possibly after the moratorium, which would be no sooner than May 2013. (Manikin)

12.5.4.9a Submit Request for Change (RFC) and modified codes for RAPv2 from EMC to NCO, pending NCEP readiness. **(15 Dec 12)**

Delays in the initial RAPv1 implementation will likely delay the RAPv2 upgrade until after the moratorium, likely no sooner than May 2013. (Manikin)

12.5.4.10 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. (1 Jul 12)

Work on this project will begin after RAPv1 model is implemented at NCEP. (Tom Black)

12.5.4.11 Present improved plan for bringing ARW model code into compliance with then current version of NEMS. (30 Sep 12)

ESRL continues to work primarily on bringing the FIM global model into NEMS compliance and working with NCEP to make further modifications to NEMS.   NEMS design for the global model will set the direction for making ARW NEMS-compatible. (S. Benjamin)

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 RAP / HRRR status at this review, held 6-7 December at NCEP.

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: COMPLETE.

The RAP website (**http://rapidrefresh.noaa.gov**) has been updated further, consistent with the RAP implementation on 1 May.   A new website describing diagnostic methods for RAP output fields is now available at **http://ruc.noaa.gov/rr/RAP_var_diagnosis.html**.

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/tin11-53ructorap.htm**. The document contains an overview of the model and explanation of the differences between the RUC and RAPv1. (Manikin)

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 on RAPv2 after the RAPv1 is implemented in May 2012. (Manikin)

GSD – RAPv2 code is essentially now ready for testing at EMC. Discussion has taken place about the possibility of starting some testing of RAPv2 at NCEP this summer.

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: Delays in the initial RAPv1 implementation will delay the RAPv2 upgrade until after the moratorium, likely no sooner than May 2013. Discussions continue on whether it may be possible to implement RAPv2 before or after the moratorium.   The argument to do so earlier is because RAPv2 code is already essentially frozen (for summer CoSPA HRRR) and ready to go.

12.5.4.E4   30 March 2012   (ESRL)
Report on testing of RAP assimilation/model improvements toward planned RAPv2 upgrade.

COMPLETE.   Extensive testing complete or underway for frozen RAPv2 for summer 2012 CoSPA/HRRR.

12.5.4.E5   31 Dec 2012   (ESRL, NCEP)
Pending computer resource availability, complete EMC testing of Rapid Refresh 2 changes for operational RAP at NCEP.

NCEP
CURRENT EFFORTS: Work at NCEP will begin on RAPv2 after the RAPv1 is implemented in May 2012.   Work at ESRL has been well underway throughout 2011 and especially during the Oct11-Mar12 period.

PLANNED EFFORTS: Code is now ready to go to EMC for initial testing now that the

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: Delays in the initial RAPv1 implementation will delay the RAPv2 upgrade until after the moratorium, likely no sooner than May 2013. Move this deadline to 1 June 2013.

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 (RAPv1) codes and scripts were submitted to NCO during the last week of October 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: Implementation of the RAPv2 will likely have to wait until after the moratorium during which all of NCEP Production has to be moved to the new computer system. The moratorium is expected to last from September 2012 through at least the end of May 2013.

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 RAP users, Diagnose cause; develop solution to RR software, test changes and coordinate with NCO on implementation.

ESRL and NCEP
CURRENT EFFORTS: RAP implemented on 1 May.   Performance of real-time operational RAP has commenced.

PLANNED EFFORTS: Convert RAPv1 to new computer, and then bring in RAPv2 for testing and implementation in FY13.   This should be easier than for all other NCEP models since RAP usually runs on Linux supercomputers like the new NCEP computer.

UPDATES TO SCHEDULE: None.

12.5.4.E8   30 Nov 2012   (ESRL/GSD)
                Report on overall planned changes for the FY13 upgrade to the Rapid Refresh.

This date was further delayed a bit given the likely RAPv2 NCEP implementation schedule, although the already-completed RAPv2 reports for the summer 2012 HRRR constitute a preliminary report.
UPDATES TO SCHEDULE: Changed from previous 30 Sept to 30 Nov.

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

ESRL/GSD
In April, GSD data assimilation work focused on 5 main areas: 1) migration of GSI (as part of RAP package) to the new NOAA HPC system, ZEUS (mostly by Ming Hu), 2) updating the GSI subversion trunk code at NCEP with RAPv2 changes with the exception of the soil moisture/temp adjustment code, 3) initial work to test a 13-km RAP hybrid / EnKF system on ZEUS (Ming Hu in collaboration with OU/CAPS), 4) work to test (on ZEUS) use of a HRRR 3-km background for the RTMA 2DVAR analysis (Patrick Hofmann in collaboration with Manuel Pondeca), and 5) running of the full GSI 3DVAR (and just the cloud analysis portion of the GSI) for the HRRR 3-km domain. Other work included continued testing evaluation of improvements to the RAP cloud analysis (treatment for partial cloudiness, etc.), retrospective testing of assimilation of AIRS satellite retrievals and satellite radiance data (Haidao Lin) and testing and evaluation of lightning data assimilation in the RAP and sat-cast convective initiation indicator data in the RUC.

The migration to ZEUS went quickly and we now have two parallel real-time RAP cycles and a real-time HRRR running on ZEUS. Then, with assistance from OU/CAPS, Ming Hu was able to prepare and run a 4-day retrospective test of a 40 member 13-km RAP hybrid / EnKF data assimilation system. Initial assessment indicates less skillful performance than for the current GSD parallel (3DVAR) RAP and spread among members that is too small. Factors that may have caused this are being investigated and additional testing is ongoing, Patrick has made good progress on adapting Manual's special 2DVAR version of GSI for use with 3-km HRRR fields and Ming has successfully run the full GSI over the full 3-km and is currently running the GSI cloud analysis prior to the ZEUS real-time HRRR-dev runs. David Dowell is also utilizing this 3-km HRRR capability to test 3-km radar data assimilation for the HRRR-dev (see task 5.24). Haidao Lin continued his satellite assimilation work, porting his RAP retrospective test system over to the ZEUS supercomputer. As part of a separate project, Haidao and Steve Weygandt presented two posters at the GOES-R science week (one on AIRS retrieval assimilation and one on assimilation of extended coverage (over large oceanic regions) lightning data assimilation and sat-cast data assimilation.

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.   Some further bird-QC refinement may yet be needed – will report more next month.

12.5.5.1a   30 Oct 2012   (ESRL, NCEP)
Complete preparation of initial GSI changes for RAPv2 changes ported to EMC.

ESRL
Work on RAPv2 was delayed, due to delays in implementation of RAPv1 (completed May 1, 2012). Considerable work on this occurred during Oct 11 – Mar 12 at GSD. A nearly complete version 2 of the RAP was frozen at GSD in March for the 2012 CoSPA season (parent to the HRRR). This version includes many improvements to the analysis (use of pseudo-innovations for surface moisture, soil temperature and moisture adjustment based on surface innovations, conservation of virtual potential temperature in moistening associated with cloud building, limits of precipitable water innovations) that have resulted in better precipitation and moisture forecasts.   ESRL's new estimated date: 30 Aug 2012.
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 the AIRS data from the selective channel removal are being shown in retrospective tests. RAP retrospective system ported to ZEUS supercomputer system.

12.5.5.3 Implement proper vertical covariance localization and test the hybrid DA system using EnKF covariance. (Completed 31 Jan 2012)

Scripts for off-line NDAS parallel tests were set up to compare 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 routinely in the global pre-implementation parallel tests. Due to resource constraints only 2 cycles per day were used. The results from the limited cases that ran to completion show that using the global ENKF ensemble improved the short term (3-hour) regional forecasts over using the GEFS ensemble and that the resulting hybrid variation-ensemble analysis significantly reduced the error of subsequent regional forecasts. Once the ENKF is implemented in the operational global in mid-May, this will be put into a NAM parallel. (Wu)

12.5.5.4   31 Aug 2012   (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 Aug 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 and is in the frozen code for the RAP that serves as the parent for the HRRR in the summer 2012 real-time evaluation. Most changes for RAPv2 are complete, but additional testing is ongoing to improve fit to rawinsonde vertical structures.

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). David Dowell continues to evaluate different strategies for 3-km radar data assimilation using GSI. Ming Hu is examining impact of 3-km cloud analysis on HRRR forecasts.

In late March, Stan Benjamin noted the absence of data from the Langley Hill radar from western Washington State getting into the RAP at NCEP or ESRL and getting into the HRRR.   The Langley Hill data was only installed last fall.   Stan started a sequence of emails started resulting in changes at NCEP (Shun Liu) and NSSL to accelerate moving Langley Hill data into full usage in the US radar mosaics and therefore, getting into the RAP and HRRR models by early April.

NCEP

New VAD wind testing continues. New and operational VAD winds are compared with both NAM and GFS backgrounds. Test runs 4 times a day for 11-30 April 2012 calculated the bias and RMS using the NAM background for both types of VAD wind. RMS and bias for VAD wind versus the GFS "best guess" were calculated for 3-24 April. The new VAD winds show better performance than operational VAD wind in both tests. A QC check for "bird contamination" was added to the new VAD wind in the GSI to reject bird contaminated radar observations. A bug in level2 data decoder for elevation angle was found and will be fixed. (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 and is in the frozen code for the RAP that serves as the parent for the HRRR in the summer 2012 real-time evaluation.

12.5.5.7   15 Dec 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 – note current estimated date.

NCEP
Work will begin on RAPv2 after the RAPv1 is implemented in May 2012. (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
Work continued on improving the visibility analysis in the RTMA to take into account the discontinuous character of its first guess. For low visibility observations next to a localized feature of low first guess visibility, a major challenge is to achieve a smooth merge of the observation increments with the first guess where the guess displays very large gradients. Initial experiments were also conducted on the use of a GLERL-type analysis for lake winds in the RTMA. This approach relies on the use of pseudo-observations and the prescription of background error covariances exhibiting a sharp gradient along the shoreline, to limit the influence of land (water) observations to land (water) bodies. Work continues on putting together the RFCs for the 2012 RTMA upgrade package. (Manuel Pondeca, Yanqiu Zhu, Steve Levine)

GSD
Manuel Pondeca has provided the 2DVAR configured GSI code, scripts, etc. to Patrick Hofmann, who has started to run the code on ZEUS and conduct 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.

GSD
With assistance from OU/CAPS, Ming Hu has built a 40-member 13-km RAP EnKF / hybrid data assimilation system on ZEUS and completed a 4 day retrospective test. Initial examination of results indicates too small a spread. Work ongoing by Ming Hu and Jeff Whitaker (ESRL) to resolve some outstanding issues.

NCEP
The scripts and fix files for testing hybrid analysis in the NAMX parallel were prepared and installed. The changes for hybrid variational and ensemble analysis were checked out of the repository and tested, and a neutral forecast impact was found. The hybrid analysis was then turned on in the off-line parallel to make sure things worked properly. The angle bias correction program had to also be updated to work with the new GSI. After the package was turned on in the official NAMX parallel Eric Rogers noticed timing issues with the global ENKF files. The scripts were corrected to use the forecasts with longer lead times and/or GEFS forecasts as a backup. The hybrid analysis is now being tested in NAMX and the preliminary results show a large positive impact on the Day 2 and Day 3 forecasts (see figure). (Wan-Shu Wu, Eric Rogers)

NAM vs NAM parallels upper air stats vs raobs

Ops NAM = Solid ; NAMB (with Physics changes) = Dashed ; NAMX (with physics changes and using global EnKF in GSI) = Dash-Dot
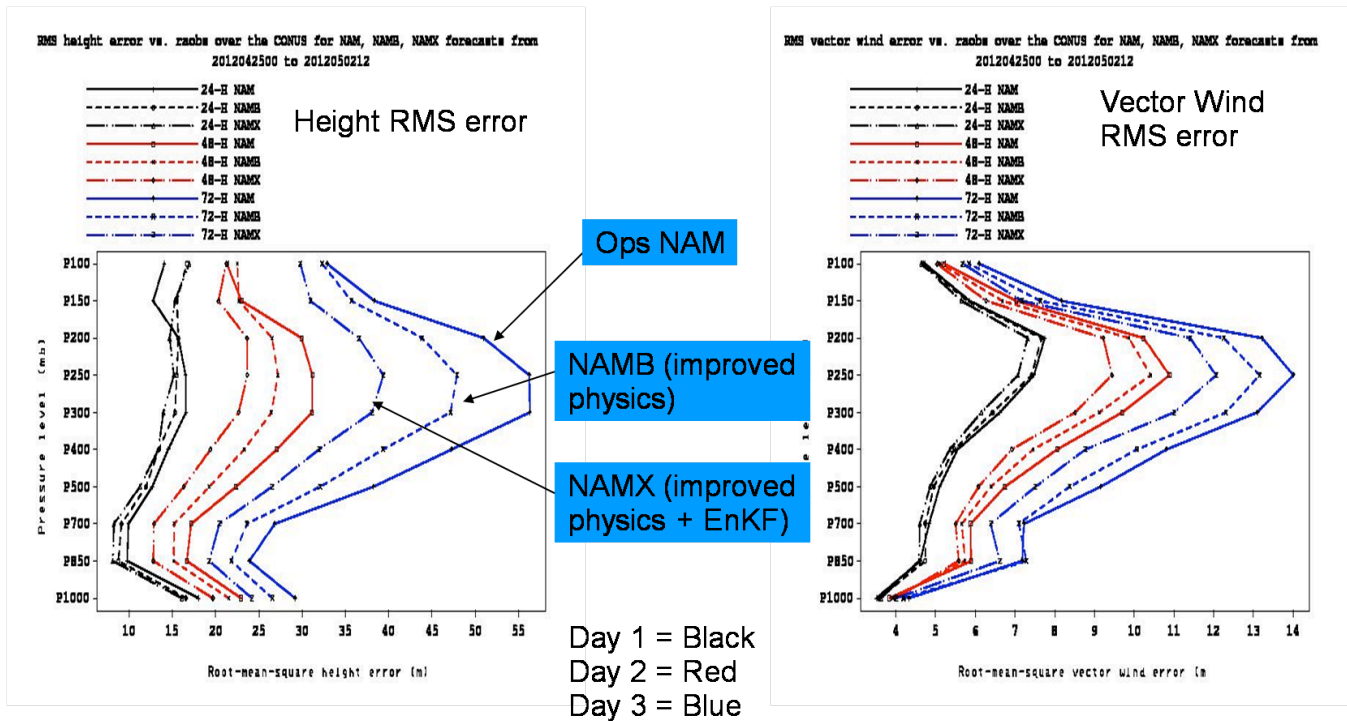
12.5.5.12   31 July 2012   (NCEP)
If authorized by NCEP Director, implement initialization of the convection-resolving NAM nests and HiResWindow runs using CAPS/Shun Liu improved techniques for radial velocity analysis in GSI together with Diabatic Digital Filter use of 88D reflectivity Mosaic.

NCEP
The cloud analysis package was debugged to determine why the reflectivity field became noisy after the analysis ran. The noise was found to be from a redistribution of total ice in the Ferrier scheme. (Shun Liu)

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 few changes in the hybrid analysis that were tested in the parallel NDAS were then added to a new GSI version: 1) level enhancement for radiosonde observations using the character of the significant levels, 2) using satellite winds from separate files instead of from PREPBUFR files, 3) a new data feed for AMSU-A radiance data. The data were created by a direct station read-out and collected more quickly than the standard data. Work was done to produce the regional background error statistics in little-endian format in preparation to move on to the new NCEP supercomputer. A GSI package, which included changes to the code and scripts to allow the GSI to work on various computer platforms, was reviewed before adding it to the repository. (Wan-Shu Wu)

While working on the new method to allow the use of GFS derived satellite bias correction coefficients directly in the NAM GSI, an error was discovered in the first guess moisture field in the NAM tm12 cold-start file. This had a substantial negative impact on the AMSU-B and MHS channels with the new radiance bias correction method, but the regional bias correction coefficients appear to compensate for the moisture error. The error in the cold-start file was corrected and tested in Eric Rogers' parallel. There was no significant impact from this change, but the utilization of AMSU-B and MHS channels improved with the new method. (Dave Parrish, Matt Pyle, Eric Rogers)

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 on this after the RAPv1 is implemented in May 2012. (Binbin Zhou & Wan-Shu Wu)

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
New VAD wind testing continues. New and operational VAD winds are compared with both NAM and GFS backgrounds. Test runs 4 times a day for 11-30 April 2012 calculated the bias and RMS using the NAM background for both types of VAD wind. RMS and bias for VAD wind versus the GFS "best guess" were calculated for 3-24 April. The new VAD winds show better performance than operational VAD wind in both tests. A QC check for "bird contamination" was added to the new VAD wind in the GSI to reject bird contaminated radar observations. A bug in level2 data decoder for elevation angle was found and will be fixed. (Shun Liu)

12.5.5.E1   1 April 2012   (GSD)
New version of GSI including revised radial wind assimilation ready for NCEP for RR upgrade.

COMPLETE: RAP retrospective tests with inclusion of level radial yielding neutral forecast impact, resulting in inclusion of these data in frozen version 2 of RAP. Code transfer to NCEP delayed to delay in NCEP implementation of RAP version 1.

12.5.5E3   1 October 2012   (ESRL)

Final GSI code transfer complete to EMC as part of Rapid Refresh v2 package to be implemented later in FY13

CURRENT EFFORTS: Work with ESRL/GSD will begin on RAPv2 after the RAPv1 is implemented in May 2012.

PLANNED EFFORTS: Implement the RAPv1 on 1 May 2012.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: Delays in the initial RAPv1 implementation will delay the RAPv2 upgrade until after the moratorium, likely no sooner than May 2013. Date changed to 1 Oct 2013.

12.5.5.E4   15 Dec 2012   (GSD, NCEP)
Pending EMC, and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit GSI code as part of upgrade for Rapid Refresh v2 software to NCO, pending NCEP readiness.

ESRL
Progress with RAPv2 at ESRL is very promising and would allow this schedule, pending NCEP's readiness to start testing and NCEP's need to get in some other implementations with RAPv2 implementation not having occurred until 1 May 2012.

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

CURRENT EFFORTS: Work will begin on RAPv2 after the RAPv1 is implemented on 1 May 2012.

PLANNED EFFORTS: Implement the RAPv1 on 1 May 2012.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: Delays in the initial RAPv1 implementation will delay the RAPv2 upgrade until after the moratorium, likely no sooner than May 2013. Move this deadline to 15 Dec 12 but may need to be delayed further due to moratorium.

12.5.5.E5   15 Jan 2013   (ESRL, NCEP)
Pending computer resource availability, implementation of Rapid Refresh 2 changes to operational RAP 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 in earnest after the moratorium in 2013.

PLANNED EFFORTS: Implement the RAPv1 on 1 May 2012.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: Delays in the initial RAPv1 implementation will delay the RAPv2 upgrade until after the moratorium, likely no sooner than May 2013.

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

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

Encouraging results from OU/CAPS dual-resolution (40/13 km) test and good progress by Ming Hu on building 13-km test system.

NCEP
CURRENT EFFORTS: Work will begin after the RAPv1 is implemented in May 2012.

PLANNED EFFORTS: Implement the RAPv1 in May 2012.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: Delays in the initial RAPv1 implementation will delay the RAPv2 upgrade until after the moratorium, likely no sooner than May 2013.

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.

CURRENT EFFORTS: Porting of the GSI into NEMS has been put on hold while it completes its transition to EnKF especially for regional applications. Tests with hourly updated NAM will help determine of having model and GSI in a single executable will be worth the effort. Some feel having GSI in NEMS will be restrictive and too complicated. The savings in time due to greatly reduced data motion will have to be great to offset these negative aspects of moving GSI into NEMS. (DiMego, Rogers)

A new satellite data feed created by direct read-out stations and corrected more quickly than the standard feed were tested and included in the package for the next implementation. In order to use the GOES15 radiances in the analysis, a new version of GSI was checked out from the GSI trunk. The parallel tests indicated the new version produced slightly larger forecast error than the control. Work was done to find out the reason. (Wu)

PLANNED EFFORTS: Continue testing the hybrid variation-ensemble analysis and the new data, i.e., VAD winds, GPSRO bending angles, and surface observations without pressure. If the new components pass the parallel tests with at least a neutral impact, the components will be included in the package for official regional parallel. Move work to the NOAA R&D computer (ZEUS). (Wu)

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED: The development computer in NCEP is at its full capacity and the off-line parallel does not run to completion often.

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: None.

**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.

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.

We have noticed a slight improvement in the ability of the HRRR to develop leading-line / trailing stratiform mesoscale systems during its forecasts in 2012 as compared with 2011. We attribute this, in part at least, to use of the WRFV3.3.1 Thompson microphysics in place of V3.2.1, which was employed during the 2011 convection season. There were some notable busts in HRRR forecasts of mesoscale convective systems during April (insufficient mesoscale organization and longevity), so further improvement in this aspect of HRRR performance is still needed and will be pursued over the next several months.

NCAR/RAL

CURRENT EFFORTS: In April 2012, the NCAR-RAL MD&E team diagnosed and fixed a bug in the radar reflectivity code for the WDM5/6 schemes provided to NOAA/ESRL, OU-CAPS, and many other recipients. Additionally, Paul DeMott modified the prototype aerosol-aware Thompson et al microphysics scheme to use some recent modification for ice nucleation on dust/mineral aerosols.

PLANNED EFFORTS: The next 6 to 9 months will continue the testing and full implementation of the Thompson et al (2008) "aerosol-aware" microphysics scheme.

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED: No delays at this time.

INTERFACE WITH OTHER ORGANIZATIONS: Besides the direct interactions between NCAR-RAL and NOAA/ESRL/GSD, there were a number of interactions with collaborators at NSSL and OU, including Jack Kain, Fanyou Kong, and Scott Dembek. Additionally, the new radar reflectivity code was discussed and approved between G. Thompson and Song-you Hong (Yonsei University, Korea).

SUBTASKS:
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).

The MYNN PBL and surface-layer scheme continues to run in the RAP-development-2 cycle at GSD. Because this scheme gives wind forecasts that are no worse than the MYJ and often better, we persevere in addressing two other problem areas:
  • Near surface warm bias in late afternoon / early evening period, including the evening transition: this   is being addressed through modifications to the Yang (2002, *QJRMS*) surface-layer scheme and parameters that control the entrainment at top of the daytime mixed layer,
  • Too drastic decoupling of near-surface conditions from the free atmosphere when snow or ice cover is present, leading to extensive spurious nocturnal fog formation in these regions: we are addressing these by modifications to mixing-length formulation under very stable conditions and by more careful mixing of thermodynamically conserved variables (e.g., liquid-water potential temperature).

Despite these concerns, a version of the MYNN that is regarded as superior to the one released with v3.3.1 was submitted to NCAR earlier this year and is part of the WRFV3.4 release by NCAR on 6 April. Because we still consider the MYNN to have promise for improved boundary-layer performance in both RAP and HRRR, effort to refine the MYNN PBL by eliminating specific problem areas will continue.

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   Moved to Jan 2013   (GSD)
Based on RAP experience and recent WRF physics progress, begin development and testing of physics enhancements for RAPv3 implementation and for future versions of the HRRR.

12.5.8.13   30 July 2012   (NCAR/MMM)
Task 12.5.8.13 Deliver a WRF Users' Workshop and WRF Tutorial for the User Community

NCAR presented a WRF tutorial at the 6th Annual East Asia WRF Workshop and Tutorial in South Korea. Gave a workshop this covered the basic WRF system and attendance was about 70 people.

NCAR is organizing the 13th WRF Users' Workshop, to be held at NCAR's Center Green facility on June 25–29. The deadline for submitting abstracts has passed. The first day will provide lectures on a focused area of mesoscale modeling, and this year's topic is convective parameterization. On June 29th there will be mini-tutorials on visualization packages, regional climate modeling, and verification. The workshop web page may be found at: **http://www.mmm.ucar.edu/events/2012_wrfusers**.

PLANNED EFFORTS: NCAR will continue to organize the 13th WRF Users' Workshop and will host it on June 25–29. NCAR will host and deliver the next WRF tutorial July 16–20.

UPDATES TO SCHEDULE: NONE

12.5.8.14   30 Sept 2012   (NCAR/MMM)
Task 12.5.8.14 Incorporate Physics and Dynamics Improvements into WRF

NCAR released WRF Version 3.4 on April 6th. New physics scheme include the Noah-MP LSM, UCLA radiation, and Oklahoma microphysics. The new features are described at **http://www.mmm.ucar.edu/wrf/users/wrfv3.4/updates-3.4.html**.

Jimy Dudhia of NCAR/MMM tested convective-radiative equilibrium code, running to equilibrium after 20 days. The latest tests included a double-CO_2 case and adding 1°C to the SST to examine the effects on energy fluxes and the water cycle.

Dudhia continued to work with visitors Roanne Bakker (Wageningen University, Netherlands) and Pedro Jimenez (CIEMAT, Spain) to work on evaluating and testing WRF against CASES99 tower data for stable conditions. Tests are focusing on modifying the vertical mixing criteria and the nighttime surface temperature.

PLANNED EFFORTS: The development and incorporation of new physics and dynamics for WRF for the RR will continue through FY12Q3.

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).

As a result of an alert Florida National Weather Service forecaster noticing erroneous fog at Tampa in the RAP during the RAP field test in April, and querying Geoff Manikin about it, GSD discovered some spurious sea-ice points in the daily-updated 4-km resolution snow cover and sea ice product from NESDIS. This product is used daily for trimming areas of snow cover (over land) and ice cover (water) where snow and ice are present in the ongoing RAP cycles including at NCEP, but are absent in the NESDIS product. This required introducing, in collaboration with NCEP, additional quality-control safeguards against spurious ice points in this field. These safeguards are now in place for these fields being used in the operational RAP, as well as the RAP cycles run by GSD.

Deliverables

12.5.8.E1   1 October 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 Dec 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.E4   15 Jan 2013   (ESRL, NCEP)
Pending computer resource availability, implementation of Rapid Refresh 2 changes to operational RAP 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.

12.5.8E6   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.

This is already largely set as of March 2012 for the frozen ESRL RAP for summer-2012 CoSPA/HRRR.

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.

Real-time HRRR system continues to run in support of CoSPA project. April has focused on 1) building a parallel HRRR system (HRRR-dev) on the new ZEUS supercomputer, 2) ongoing retrospective testing of the RAP / HRRR system for the June 2011 period, and 3) testing and evaluation of different 3-km radar assimilation strategies. The HRRR-dev is running on ZEUS, with verification working, and some details to be resolved for transfer and web display of graphics. In this initial configuration a 3-km cloud analysis (within the GSI framework) is being applied
prior to launching the HRRR forecast. Work to complete the June 2011 RAP / HRRR retrospective was delayed by some initial computer issues on ZEUS, but is proceeding smoothly now. David Dowell continues to evaluate different 3-km radar data assimilation strategies. A likely short-term candidate that has been evaluated is to use a one hour pre-forecast period, with 4 cycles of radar data assimilation, prior to the HRRR forecast. This has shown promise at reducing the model spin-up period for the HRRR. We are also considering longer pre-forecast periods, but these require a full 3-km GSI using all available observation to avoid degradation to the mesoscale environmental fields. In separate work with significant promise for the longer term, David is evaluating storm-scale EnKF/hybrid techniques.

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. GSD real-time RAP / HRRR system with all these upgrades was frozen on March 9, 2012 for 2012 evaluation.

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

Exercise ongoing with very good overall HRRR performance and reduced false alarms compared to 2011 noted. Storm structure seems to be especially well predicted with this 2012 RAP/HRRR configuration.

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. Frozen on March 9, 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**

Real-time project ongoing with good results so far.

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.

With an experimental version of the RAP now running on ZEUS and HRRR case testing also running there, it appears that there will be a dual HRRR capability until the NCEP implementation.   We will report more on this next month.

Status of MDE Deliverables – 15 May 2012

Legend: 🟩 Deliverable on schedule; ☑ Deliverable submitted; 🟥 Deliverable overdue

Deliverable and Related Task	Due Date	Status	Comment
12.5.4 Develop, test, implement, and improve the Rapid Refresh			All RAPv2 milestones are delayed until late FY12 or FY13, as noted below and in earlier monthly and quarterly reports.
12.5.4.1 Maintain hourly RAP runs and provide grids of SAV and AHP guidance products (ESRL, NCEP)	Ongoing	🟩	
12.5.4.E1 Report on Rapid Refresh Status (ESRL)	12/20/11	☑	
12.5.4.7 Complete testing and evaluation of new RAP capabilities (model physics and data assimilation) – RAPv1 (ESRL)	01/31/12	☑	
12.5.4.E2 Update documentation for operational Rapid Refresh (ESRL)	02/01/12	☑	
12.5.4.6 Initial software for RAPv2 changes ready for porting to EMC (ESRL)	08/01/12	🟩	
12.5.4.E4 Report on testing of RAP assimilation/model improvements (ESRL)	03/30/12	☑	
12.5.4.E3 Final code ready for transfer to EMC for Rapid Refresh v2 change package (ESRL)	10/01/12	🟩	
12.5.4.E5 Complete testing at EMC of RAPv2 code, pending NCEP readiness (NCEP, ESRL)	12/31/12	🟩	
12.5.4.E6 Perform config mgmt. for RAP (ESRL, NCEP)	Ongoing	🟩	
12.5.4.E7 Monitor RAP performance, respond to problems, diagnose causes, develop solutions. (ESRL, NCEP)	Ongoing	🟩	
12.5.4.E8 Report on overall planned changes for FY13 upgrade to Rapid Refresh (ESRL)	11/30/12	🟩	This task was originally for a RAPv3 but is now linked to RAPv2.
12.5.5 Develop, test, and implement improvements to the Rapid Refresh and the NAM data assimilation			
12.5.5.E1 New version of GSI including revised radial wind assimilation ready for FY13 RAPv2 upgrade (ESRL)	04/01/12	☑	Complete in that RAP-ESRL frozen for HRRR is essentially that planned for RAPv2 @NCEP.
12.5.5.E3 Finalize GSI code ready for transfer to EMC for RAPv2 (ESRL)	10/01/12	🟩	
12.5.5.E4 Pending EMC and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit GSI code for RAPv2 software to NCO, pending NCEP readiness (NCEP, ESRL)	12/15/12	🟩	
12.5.5.E5 Pending computer resources, implement RAPv2 at NCEP (NCEP, ESRL)	01/15/13	🟩	NCEP plans a moratorium that may delay this implementation, although ESRL and NCEP will try to implement RAPv2 before it since code is essentially ready as of spring 2012
12.5.5.E6 Report on results of EnKF and hybrid DA systems for the RAP configuration (CAPS, EMC, ESRL)	09/30/12	🟩	
12.5.5.E7 Subject to NCEP Director approval, implement NEMS/NMMB version of GSI in NAM/NDAS (NCEP)	09/30/12	🟩	

12.5.5.E8 Develop dual-resolution EnKF for RAP configuration (CAPS)	09/30/12	☐	
12.5.5.E9 Report on planned GSI changes for the RAPv2 upgrade to the Rapid Refresh (ESRL)	09/30/12	☐	
12.5.8 Improve physical processes in the WRF, especially including those that affect aircraft icing			
12.5.8.E1 Final model physics code transfer complete to EMC for RAPv2 upgrade change package to be implemented by early 2013 (ESRL)	10/01/12	☐	Essentially complete now in ESRL RAPv2 but will keep the door open for additional physics mods until fall.
12.5.8.E2 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 v2 software to NCO (ESRL, NCEP)	12/15/12	☐	
12.5.8.E4 Pending computer resources, implement RAPv2 at NCEP with new physics configuration (ESRL, NCEP))	01/15/13	☐	
12.5.8.E5 Transfer the coupled aerosol-microphysics scheme into a test version of HRRR (NCAR/RAL)	09/01/12	☐	
12.5.8.E6 Deliver WRF Users' Workshop and WRF tutorial (NCAR/MMM)	07/30/12	☐	
12.5.8.E7 Report on enhancements made to WRF model physics (NCAR/RAL)	09/15/12	☐	
12.5.8.E8 Report summarizing enhancements made to the model physics packages (ESRL)	09/30/12	☐	
12.5.8.E9 Incorporate physics improvements into WRF for future RAP and HRRR (NCAR/MMM)	09/30/12	☐	
12.5.24 Develop, test, implement and improve the 3-km WRF-based High Resolution Rapid Refresh			
12.5.24.1 Initial design for the assimilation/modeling configuration for the HRRR during the 2012 CoSPA Prototype Summer Operations	01/15/12	☑	
12.5.24.E1 Incorporate all assimilation and modeling changes into HRRR for Summer 2012	04/01/12	☑	
12.5.24.E2 Complete FY12 evaluation with revised 3-km HRRR running every 1 h. (ESRL) • 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	09/15/12	☐	
12.5.24.E2a 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 (NCEP, ESRL)	06/01/12	☐	