MDE Product Development Team
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With contributions from **Geoff DiMego** and **Mary Hart** (NCEP/EMC);
Stan Benjamin, **John Brown**, and **Steve Weygandt** (NOAA/ESRL/GSD);
Jordan Powers and **Roy Rasmussen** (NCAR); and **Ming Xue** and **Xuguang Wang** (OU/CAPS)

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

Executive Summary

Task 11.5.1: Infrastructure support related to operational running of the RUC and NAM operational modeling systems.

- NCEP-RUC – continues running at 100% reliability since coordinate fix on 11/17/2010

Task 11.5.4 Develop, test, and implement Rapid Refresh configuration of the WRF modeling system.

- *The RR run at ESRL/GSD and the real-time parallel RR at EMC continue to show strong improvement in February over RUC for wind, temperature, RH, and height*
- *Precipitation verification indicates improvement for GSD RR over operational RUC at all thresholds.*
- *RUC-look-alike files from the RR are being produced, which should result in easy transition from the RUC to the RR.*
- *ftp access continues for these grids from RR running at NCEP-EMC, evaluation of RR-NCEP-EMC continues.*
- *Planned date for RR implementation at NCEP - Aug-Sept 2011.*

Task 11.5.5: Develop, test, and implement 3DVARs for RR and NAM

- Additional data sources now being used in GSI for RR (radial velocity from WSR-88D radars, TAMDAR moisture, WVSS aircraft moisture)
- RR cycling with binary format files benchmarked against netcdf cycling at GSD, changes ported to EMC parallel RR.
- Work continues to evaluate value added from radiance assimilation in RR (via GSI) including assessment of bias correction by channel for AMSU data.

Task 11.5.15: Develop methods for improved cloud/hydrometeor analysis in RR

- RR using frozen version of GSI cloud analysis yielding significant improvement in short-range ceiling and visibility forecasts.
- Testing continued with WRF with variations on specification of hydrometeors

Task 11.5.24: Development/testing of HRRR

- HRRR 15-min grib2 files created and distributed to downstream users
- Many experiments completed from extensive 10-day July 2010 HRRR retrospective case study period with quantitative verification and qualitative assessment. Results indicate switch to RR as HRRR parent (with "strong" latent heating in DFI-radar assimilation) will improve HRRR forecasts.
- Tests of 3-km DFI-radar assimilation in HRRR indicate forecast improvement for first few hours.
- Analysis of HRRR Convective Probability Forecasts (HCPF) from July 2020 period and creation of HRRR/HCPF overlay display concepts.

Task 11.5.1 Infrastructure Support Related to Operational running of the non-WRF Rapid Update Cycle System in NCEP Operations

ESRL/GSD
Operational RUC at NCEP has continued to run at 100% reliability since coordinate fix on 17 Nov 2010.

ESRL is now testing a modification to the radar-DFI assimilation in which a cold pool effect is included by forcing cooling near the surface proportional to the maximum radar reflectivity in the column and also proportional to the degree of sub-saturation. This version is running in the RUC-dev since 3 March.

ESRL continues to monitor operational RUC (and two ESRL versions of RUC with some differences in radar and cloud assimilation such as that described in the previous paragraph). Performance of the operational RUC is monitored at both ESRL and NCEP verification websites (see **http://ruc.noaa.gov/stats**). Inter-comparison of verification between the NCEP and ESRL versions of the RUC continue to be monitored by ESRL, also at **http://ruc.noaa.gov/stats**. Reminder: the backup RUC at ESRL is still currently used to initialize the HRRR (**http://rapidrefresh.noaa.gov/hrrr**), although the HRRR parent is on plan to be switched from the backup RUC to the ESRL Rapid Refresh in early April.

ESRL and NCEP/EMC also both tested use of a combined RUC/Rapid Refresh observational (prepBUFR) files, both successfully running the RUC pre-analysis program. These tests are preparing for eliminating one of the NCEP prepBUFR "dumps".

NCEP
Work continues on final preparations for the NRL-based aircraft QC code implementation; three radiosonde sites that report an invalid instrument type (we are in contact with some of the sites); late arrival of GOES 1x1 field-of-view cloud data; bringing in new SSM/IS data from DMSP F-16, F-17 and F-18 satellites to replace discontinued SSM/I products; use of TAMDAR data from AirDAT as a MADIS alternative. There was an NPN profiler outage on 22 February. The Florida and Georgia DOT and Aberdeen PG mesonet providers remained down. Edwards AFB was added as a Mesonet provider on 7 February. There are 14 sites in this unrestricted network. GOES-13 cloud and precipitable water retrievals have not been used since the switch to GOES-13 in April 2010. On 14 February more than 160 new (mostly North American) METAR sites began being decoded as the station table list was updated to agree with the MADIS list. (Dennis Keyser)

February (like January and December) was free of RUC CFL crashes. (Manikin)

Task 11.5.17 Infrastructure support for operational running of Rapid Refresh, North American Mesoscale, and HiResWindow (and future HRRR) at NCEP, including support for community WRF model

ESRL/GSD
Progress in Rapid Refresh development toward operational implementation at NCEP can be found under Task 5.4 report.

Regarding the WRF model, ESRL is testing variations to the MYNN PBL scheme inserting the alternative Bougeault-LaCarrere mixing length formulation, including discussions with the MYNN scheme developers. It is likely that this will be submitted to the WRF repository in the next few months.

NCEP
Parallel tests of the NEMS/NMMB model in the EMC NAM parallel system continue on the CCS during February. Two NMMB parallels are running, one a 12 km control run and the other a 12 km experimental run with model and/or analysis changes for inclusion in the control run. The experimental parallel runs all four nested domains (CONUS, Alaska, Hawaii, Puerto Rico) and a movable fire weather nest over either the CONUS or Alaska. During EMC parallel testing, the fire weather nest is moved to different regions with interesting weather. (Eric Rogers)

In February two significant bugs were found in the NAM parallels. First, it was discovered that the NEMS-NMMB model code was not reading in the base (snow free) albedo at the start of the NDAS. It was instead reading the dynamic albedo and using it as the base albedo. This led to an erroneously high albedo over shallow/patchy snow cover, which led to a cold bias over regions with shallow/patchy snow cover. Also, a cold bias in soil temperatures was seen that worsens over time. It was discovered that this bias started when the parallel NDAS began running a digital filter initialization (DFI). It was determined that the physics state before the filter was run was not restored after the filter was finished, which led to colder soil temperatures. Because of this finding, the DFI was tuned off in the parallels and the cycled NDAS land states were restarted from the operational NDAS. (Eric Rogers)

NCEP generates experimental Rapid Refresh (RR) PrepBUFR files containing WindSat data (non-superob) and 50 km ASCAT, which are copied to a private ESRL directory on the NCEP ftpprd server. RR dumps of Level 2 and expanded (time-window) Level 2.5/3 88D radial wind data, hourly lightning data, and GOES single-pixel cloud data from NASA/Langley (covering Alaska) are also copied to a public ftp directory. These, along with early (T+0:26 minute) parallel dumps for 0000 and 1200 UTC are being tested in ESRL's experimental RR runs and the RR parallel being run at NCEP. There are many unavoidable gaps in the WindSAT data due to problems upstream of NCEP. NAM data impact tests have been performed (Wan-Shu Wu) on Multi-Agency Profiler winds and METOP-2. Future data tests will include the new VAD winds from Shun Liu's processing, RARS radiances (RARS parallel dumps are being generated) as well as "tcvitals" records for tropical cyclones. EMC and GSD requested the Radar Operations Center (ROC) start their hourly processing of Level 2.5 88D data 25-30 minutes earlier so more data will arrive before the RR cutoff, as it's the only available radial wind data for the Alaska portion of the expanded RR domain. Adding a 5th hourly ingest run for Level 2 88D radar data is being discussed with NCO. The ROC has been contacted because there is strong evidence that the amount of Level 2 and Level 2.5 (locally-generated superobs) data being processed at NCEP has significantly decreased over the past three months, even after seasonal trends are taken into account. The Level 2.5 data are only being collected at 26 sites right now due to software build changes on-site. The Level 2 data are only being collected at 140 sites for reasons still not known. This is under investigation. (Dennis Keyser)

Most of the issues in 11.5.1 also affect the NAM. For the NAM specifically, the problem with the too-late Shemya radiosonde (70414) launch time appears to have been corrected by folks in Alaska based on a limited review of receipt times in February. The problem of the NDAS not being able to process the complete set of APRX WeatherNet mesonet data due to a large number of duplicate reports coming from MADIS was corrected on 22 February with an NCO decoder change to process fewer incoming raw files. All of the data still come in but with many fewer duplicate reports after the change. METOP-2 polar satellite data (all instruments) was lost for several hours on 25 February due to a server failure at EUMETSAT. Due to spring eclipse season, which began on 9 February, there may be gaps in GOES data around 0600 UTC. GOES-13 radiances are monitored but will not be used until the next NAM update. NOAA-18 has on-going gyro issues that could lead to unusable products. NESDIS engineers still need to conduct the last of three 24-hour tests where the corrupted navigation data will not be sent to NCEP. The following data types are monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), MAP wind profiles below 400 mb, Mesonet mass data, AIRS AMSU-A radiances, NOAA-19 HIRS-4/AMSU-A/MHS radiances, METOP IASI radiances, ASCAT and WindSAT winds, and MDCRS moisture data. All but RASS of these are being tested in Eric Rogers' NAM parallel. Ten meter wind speed from JASON-1 and -2 altimetry data will soon be monitored. NAM/NDAS and RTMA PrepBUFR files are being generated in parallel with 50 km ASCAT and WindSat scatterometer wind data (both non-superob). The NAM/NDAS PrepBUFR files are generated using the new NRL-based aircraft QC code. Production NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and SBUV-2 data are being created and dumps of RARS 1c radiances are being created in parallel. Use of the GFS tropical cyclone relocation procedure (for medium to strong tropical cyclones) to update the global first guess fields input to NDAS is also being tested in parallel. A legacy restriction (that only surface data with a reported pressure is processed) will be removed to allow additional surface

observations (land, marine and Mesonet) to be assimilated in the RTMA and possibly the NAM/NDAS. This is now being tested in the RTMA. (Dennis Keyser)

Coordination with NCO was completed on two items to get new HiResWindow data out to the forecasting community. The first item was to get the appropriate NOAA Operational Model Archive Distribution System (NOMADS) processing in place for several new products that will be included in the upcoming HiResWindow implementation. Several of these items are newly defined in NCEP's local GRIB2 tables, which made the task more difficult. The second item was to submit an RFC adding some of these same new forecast products into the GEMPAK processing for HiResWindow grids that get distributed to the field over dB NET. Many of these new fields were added at the request of SPC, so they were eager to receive them to aid in their evaluation of the 30-day HiResWindow parallel. (Matt Pyle)

Basic debugging of CIP was completed, but the result was not satisfactory so more debugging is required. Work on the WAFS has started. The code to add Mountain Waves as a turbulence factor was finished. (Yali Mao)

NCAR

CURRENT EFFORTS:
NCAR began planning for the next WRF Users' Workshop. This will be held June 20-24, 2011 in Boulder at NCAR. The workshop will feature the usual modeling topic areas during the week and instructional lectures on the final day.

NCAR continued the preparations for WRF major release V3.3. This month a second friendly user version made available for outside testing. Code regression and other testing at NCAR, at the DTC, and with contributors continues. The Release Committee is now meeting weekly. Information on the release and a list of candidate features may be found at **http://www.mmm.ucar.edu/wrf/users/release_3.3.html**. The release will be made by the first week in April.

Jimy Dudhia of NCAR/MMM worked on various facets WRF physics development. In preparation of the V3.3 release, this included the following: (i) helping Wayne Angevine (NOAA ESRL) to resolve an instability issue with his new TEMF PBL scheme; (ii) adding the PBL height diagnostic for the Bougeault-Lacarrere PBL scheme (received from Alberto Martilli, CIEMAT, Spain); (iii) fixing the seasonal roughness length variation and run-off diagnostic in the Noah PBL (with the NCAR Noah team); (iv) ensuring that CESM physics works with nesting; (v) adding a fix from NCEP (Brad Ferrier) to enable Eta microphysics to use cloud tendencies from cumulus schemes; (vi) implementing code from Greg Thompson (NCAR RAL) to correctly initialize microphysics budget arrays for DFI applications; and (vii) working with Ming Chen (NCAR MMM) to solve restart and OpenMP problems seen with the Grell shallow cumulus option. All of these tasks were completed this month.

Dudhia continued working with Pedro Jimenez (Univ. Complutense Madrid, Spain; MMM visitor) to evaluate WRF surface wind biases in a large, multi-year 2-km WRF simulation dataset. He finished work with Jimenez to correct surface wind biases in WRF. They also developed a new method, based on topographic characteristics, to improve wind climatology using WRF in complex terrain.

Dudhia developed prototype code to allow CO_2 to vary over the year in certain radiation schemes (RRTM longwave and Goddard shortwave). He also consulted with Stan Benjamin's group (NOAA ESRL) on how to force new moisture/cloud fields in their DFI applications where they affect model balance that can degrade forecast winds.

Lastly, Dudhia continued collaborating with visitor Anna Fitch (Univ. of Bergen) on testing the effects of wind farms with WRF simulations. This is associated with the inclusion of a new wind farm parameterization in WRF V3.3.

PLANNED EFFORTS: The development and implementation of new physics for WRF will continue through FY11Q1.

UPDATES TO SCHEDULE: NONE

Task 11.5.4 Develop, test, implement, and improve the Rapid Refresh

ESRL/GSD
The implementation of the RR at ESRL continues to be planned to occur in August-September 2011.

Rapid Refresh pre-implementation testing continues both at GSD and at EMC. The RR performance continues to be quite strongly superior to the RUC (See Figs. 1-3 below). The matter of deficient snow cover (and consequent warm 2-m temperature bias in areas that are snow-covered in reality, but not in the RR) discussed in last month's report continues to be intensively pursued with some good progress and a reasonably good solution. We did confirm that our problem is a unique "feature" of WRF in that post-DFI modification to any fields result in mass/wind imbalance. Thus, the design with modifications to hydrometeors and water vapor as done with the RUC model (to force consistency with the 3-d cloud/hydrometeor analysis) is not possible with WRF. Nevertheless, 4 other strategies have been successful to improve 0-1h snow accumulation in the RR-WRF (the key for evolving snow cover). These include use of 3h (instead of 1h) snow forecasts, and addition of radar-sensed snow hydrometeors when available. We also found it very helpful to replace the RR land surface fields, including particularly snow height and snow water equivalent, with the RUC fields valid at the same time. Tanya Smirnova performed this "snow surgery" successfully, and Jimy Dudhia from NCAR was very helpful in discussing this issue. Haidao Lin performed 4 retrospective period tests with the RR to test different theories, and Tanya and Ming Hu also did a great number of case studies. A group of 6 of us met twice weekly to discuss ideas and tests.

The capability for use of binary (instead of NetCDF) output files from the model and GSI is now complete and successfully tested at GSD and transferred to NCEP.

Radial winds continue to be assimilated into the RR, after the change back on 20 January when these observations became available sufficiently timely for inclusion in the RR 1-h cycles running at GSD.

A change log on the ESRL primary RR 1h cycle is maintained at
http://ruc.noaa.gov/internal/RR_runs/RR_1h_info.txt.

Subtasks

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

GSD:
The RR 1-h cycle at GSD and the real-time 1-h RR parallel cycle running at EMC continue to verify consistently better than the operational RUC upper-level variables (see Figs. 1 and 2). Also recent precipitation verification indicates improvement at all thresholds for the GSD RR compared to the operational RUC (see Fig. 3).
The substantial mid-upper troposphere moist bias noted in December has been largely removed in late December by eliminating building of cloud based on satellite observations in the GSI cloud analysis. In fact, RR forecasts are now showing a substantial improvement over the operational RUC for mid-upper troposphere RH. The GSD RR-primary 2-m temperature verification is satisfactory and generally as good or better than RUC except for being too warm in areas of deficient snow cover. Dew point at 2m is tending to run a little high except in dry areas of the interior Southwest, where dew points are running too dry.

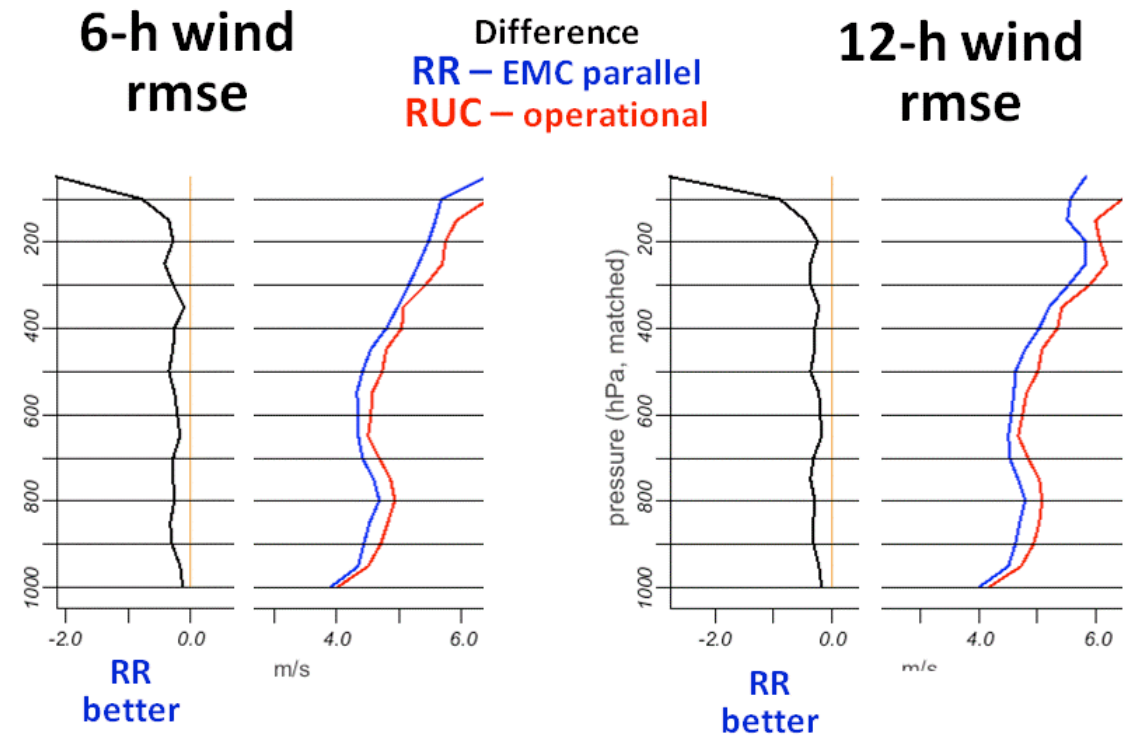

Figure 1. Verification of EMC real-time parallel Rapid Refresh vs. RUC (operational at NCEP) for 1 Feb 2011 – 10 Mar 2011 as a function of pressure level for 6-h wind (left), 12-h wind (right).

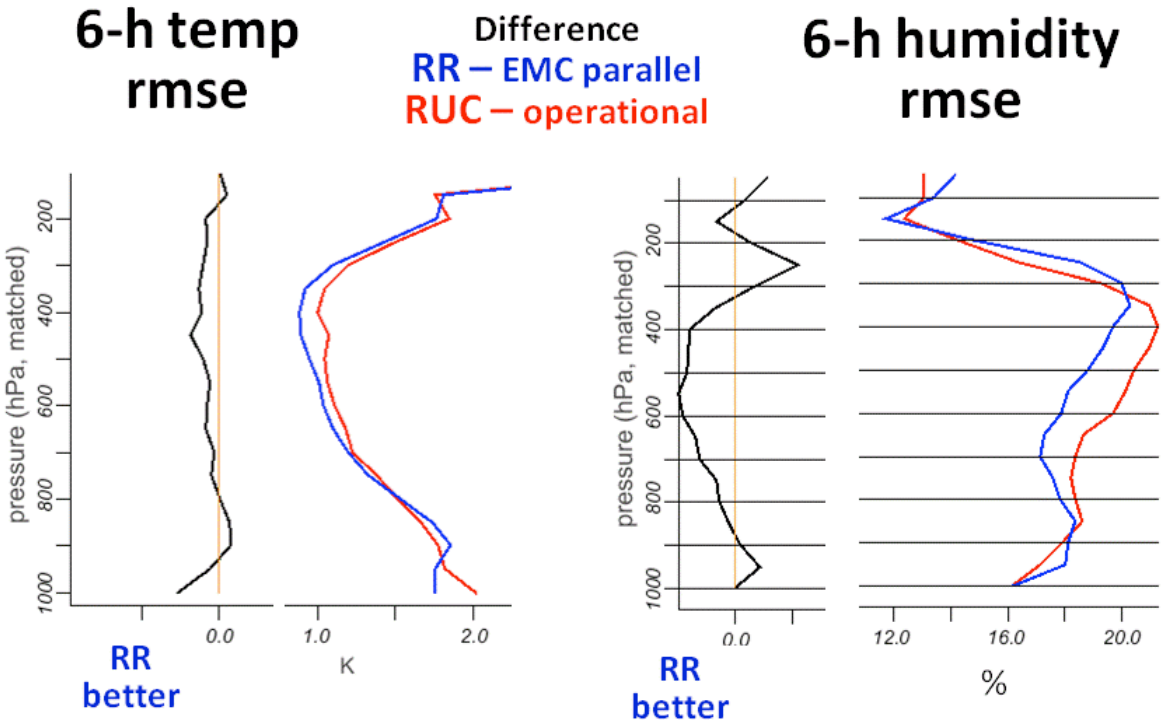

Figure 2. Verification of EMC real-time parallel Rapid Refresh vs. RUC (operational at NCEP) for 1 Feb 2011 – 10 Mar 2011 as a function of pressure level for 6-h temperature (left), 6-h relative humidity (right).

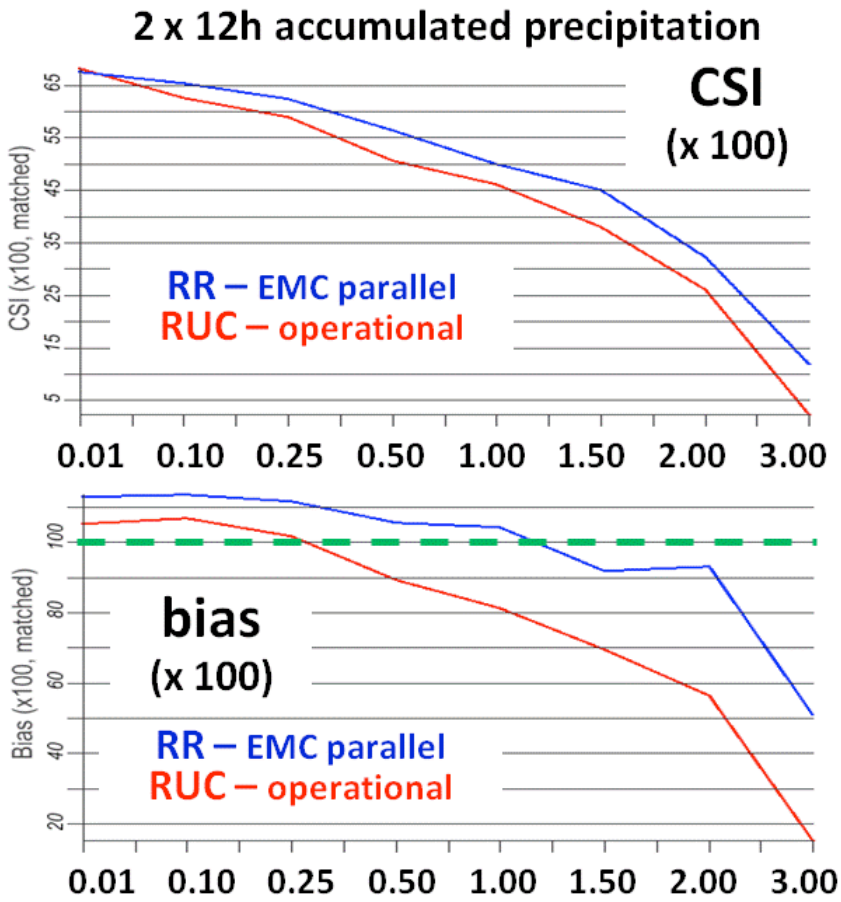

Figure 3. Verification of GSD real-time parallel Rapid Refresh vs. RUC (operational at NCEP) precipitation forecast skill for 25 Feb 2011 – 10 Mar 2011. Critical Success Index (x 100) in top panel and bias (x100) in bottom panel (2 x 12-h accumulations verified against 24-h CPC precipitation analysis.

NCEP

The Rapid Refresh (RR) has been running stably in an EMC parallel environment with no major code changes since December. Statistical evaluation has shown that the Rapid Refresh is now at least comparable to the RUC for most parameters. Grib1 and Grib2 files have been made available to the FAA, the NCEP service centers, and other RUC users on an ftp site, and informal evaluation of the model analyses and forecasts is underway. Special work has been done with several FAA groups to ensure a seamless transition when the RR replaces the RUC. RR implementation is currently scheduled for late summer. (Geoff Manikin)

See extensive observation processing work by EMC's Dennis Keyser in support of RR under Task 11.5.17.

11.5.4.2 1 Nov 2010 (GSD)

Solicit and respond to input from RR forecast users (e.g., FAA, AWC, SPC, NWS, other users), as well as AWRP RTs, on performance of Rapid Refresh.

pgrb, sgrb and bgrb files are now available in GRIB1 from the EMC test RR cycle output, and limited, though not unfavorable feedback has been received so far. Feedback from the other PDTs continues to be welcome.

Stan Benjamin, Tanya Smirnova and Joe Olson will attend the Alaska Weather Symposium in Fairbanks in March to update the National Weather Service Alaska Region Science and Operations Officers (SOOs) on status of the Rapid Refresh, and to discuss other issues of particular interest to Alaska forecasters. Significant outcomes of this meeting will be discussed in the FY11Q2 report.

11.5.4.2a (EMC, GSD)
Complete bringing ARW model code into compliance with than current version of NEMS, including successfully running forecasts and verifying integrity of ARW running under NEMS. (30 Sept 2011)

Work has not yet started. (Black, Manikin, GSD)

11.5.4.3 Start design of NARRE ARW physics ensembles. These will be derived either by varying parameters within the physics suite planned for the initial RR implementation, or by using different physics suites. 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 RR domain. (30 Sept 2011)

Work will begin on this subtask later in 2011. (Du, Manikin)

Deliverables

11.5.4.E1 20 Dec 2010 (GSD)
Report on Rapid Refresh status and plans to NCEP Operational Model Production Suite Review meeting.

Complete. Presentation available at **http://www.emc.ncep.noaa.gov/annualreviews/2010Review/**

11.5.4E1a (28 February 2010) (EMC - Manikin)
Update documentation for operational Rapid Refresh.

CURRENT EFFORTS:
Experimental Rapid Refresh grids from the EMC parallel run are now available at **ftp://ftp.emc.ncep.noaa.gov/mmb/mmbpll/rap**. Inside the directory for each date, you will find the following for each cycle:

13 km grids covering current RUC domain w/ data on native levels (awp130bgrb)*
20 km grids covering current RUC domain w/ data on native levels (awp252bgrb)
13 km grids covering current RUC domain w/ data on pressure levels (awp130pgrb)*
20 km grids covering current RUC domain w/ data on pressure levels (awp252pgrb)
11 km grids covering Alaska (awp242)
32 km grids covering the full domain (awip32)
* - Available in grib1 and grib2 (all others only in grib1)
We may make grib2 available for more of the files at a later time. Note that bufr output is not currently available but should be within the next month.

The files covering the current RUC domain will have the same parameters as the current operational RUC files, but the order of some fields will be different. The content of the Alaska and full domain files is subject to change, so do not run any scripts that expect a particular order of the records.

Having these grids now will allow all users to examine Rapid Refresh data for the ongoing cold season. Your assessments of the model performance (good and bad) will be appreciated and can be sent to **geoffrey.manikin@noaa.gov** and **stan.benjamin@noaa.gov** Operational implementation of the Rapid Refresh at NCEP is currently planned for late summer. The parallel model codes will still undergo a few minor changes over the next few months, but major changes to the codes are not currently expected.

If you are interested in examining output but do not want to download files, graphics are available at **http://www.emc.ncep.noaa.gov/mmb/gmanikin/rap/para**

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: NCO, ESRL & FAA.

UPDATES TO SCHEDULE:

Task 11.5.5 Develop, test, and implement improvements to the operational data assimilation supporting Rapid Refresh and North American Mesoscale runs

ESRL/GSD
Ming Hu completed tests to benchmark the performance of the GSD RR system cycling with binary I/O compared to netcdf I/O and is porting these changes to the EMC parallel RR.

Ming Hu made other enhancements to the RR GSI. First, he added in the use of two additional observation types (both used in the RUC) into the RR, now available in the RR/RUC prepBUFR observation files. These observations are TAMDAR/WVSS aircraft moisture and PBL profiler winds. In addition, Ming added code in the GSI to make use of an aircraft observation rejection list (generated based on average innovation statistics compiled by GSD) including modification of the code to check aircraft observation by tail number and MDCRS number (both can be used in the prepbufr file). More recently, improvements to the time availability of the radar radial velocity data have allowed these observations to be included in the GSI for RR at ESRL.

The testing of these same prepBUFR files with the RUC was reported under Task 5.1, again, with the purpose to those that both models can operate with the same set of prepBUFR files.

CAPS
Report on initial test results of implementing the EnSRF package for RR application.
In February, we generalized the EnKF analysis code for it to be able to handle variables on the Arakawa C grid. In the previous version, wind components U and V on the WRF C-grid are first interpolated to the A grid and the analysis increments are produced on the A grid then interpolated back to the C grid. It was suspected that the interpolating process might have caused the larger errors in U and V than other variables. When using a vertical localization length-scale factor of 1.1, the new version completed the weeklong run while some forecasts of some members crashed after 5 days. However, during the earlier cycles, no significant improvement was found when comparing the 3-h forecast innovations.

To further evaluate the impact of EnKF analyses on longer forecasts, we extended the deterministic forecasts starting from the ensemble mean to 24 hours. A standard verification procedure from GSD will be used for the verification and for that purpose we added a post-processing step to prepare the data. We have been using GSI diagnostic files for verification purpose.

Because of quality control within the GSI, different sets of observations may be involved in the verification of different analysis, leading to non-clear comparison between GSI and EnKF-based forecasts. To avoid this problem, we also plan on using the point-stat tools available within the MET (Model Evaluation Tools) packages.

Efforts continued in tuning the EnKF configurations to reduce the errors of ensuing forecasts. Two problems were found: one is that the spread at the lower levels is too small; the other is the EnKF-based forecasts are much more noisy than GSI-based when using the same DFI configuration. The DFI in the EnKF case is being tuned. Although the cycles didn't run to completion with our first test, reduced 3-hour forecast innovations are found. The surface pressure forecast errors, which used to be significantly higher than the GSI case is reduced, as is the noise level. The forecast innovations of other variables are improved, too.

In addition, 12-hour-long 13-km forecasts starting from the interpolated 00 and 12 UTC 40-km GSI and EnKF analyses were produced for the weeklong period. Figure 4 shows the GSS scores of precipitation forecasts against the NCEP Stage IV data. For a threshold of 0.1 mm, the GSS scores indicated that forecasts initialized from the EnKF analyses were clearly better than the ones from GSI analyses. For a threshold of 1.25 mm, the forecasts initialized from the GSI analyses were better in the first 8 hours of forecast but became worse afterwards.

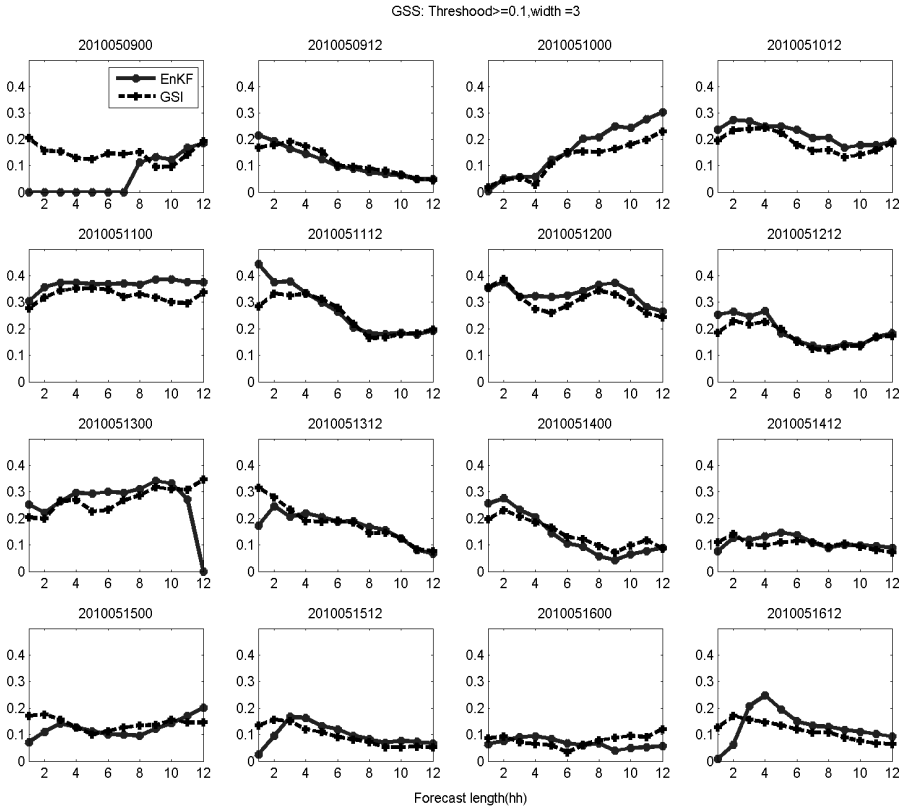

Fig.4. GSS scores of ~13 km precipitation forecasts initialized from EnKF and GSI analyses, verified against NCEP Stage IV precipitation data. RUC CONUS domain was used. The titles in each figure indicate the initial times of forecasts and the x coordinate is for the forecast lead times.

Work testing the GSI-based hybrid var-EnKF continued also for RR. We obtained the latest GSI package from the DTC GSI repository that contains the latest hybrid capabilities. Major work was focused on the hybrid single-observation testing. Meantime, effort is being made trying to improve the single-observation increment structure. Experiments aiming at examining parameters like the relative weight given to static background (beta1_in), the horizontal localization correlation length (s_ens_h) and the vertical localization correlation length (s_ens_v) have been conducted. Figure 5 shows the testing results employing GSI, hybrid EnKF and pure EnKF. All three used the 3-hour forecast from the EnKF ensemble mean analysis at 00 UTC May 14 2010, which was after 6 days of the EnKF cycles. For these experiments, we placed a single temperature observation with a 1˚C innovation at 700 hPa over Norman. When beta1_in of 0.5 is used, the hybrid analysis increment has a pattern in-between those of GSI and pure EnKF. While the general pattern suggests that the hybrid seems to work, the hybrid-analyzed increments with beta1_in set to 0 are significantly smaller than those of pure EnKF. One possible reason is that the vertical localization radius specified in terms of the model level in the hybrid is inconsistent with that used by

the EnKF, which is based on ln(p). However, when ln(p) is used in the hybrid, the analysis program crashed. The code is being debugged.

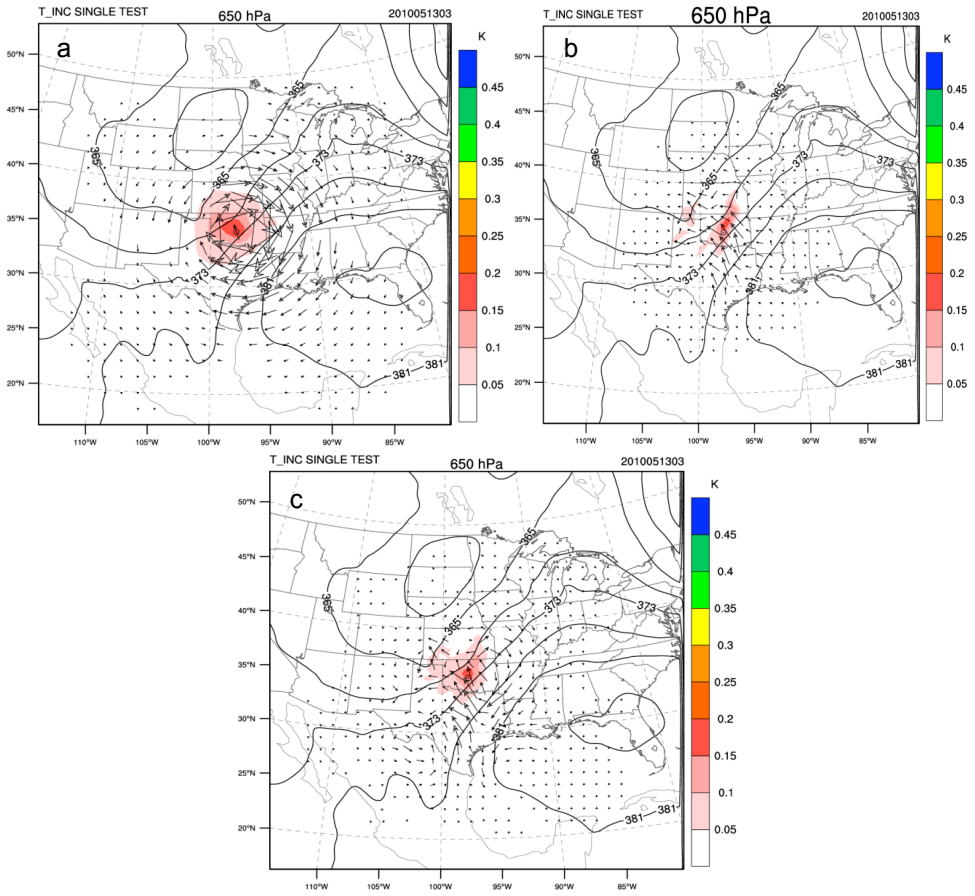

Fig. 5. Temperature (shaded) and wind analysis increments, together with the background geopotential height (contours) from single-observation experiments, using (a) GSI 3DVAR, (b) pure EnKF, and (c) the hybrid with beta1_in=0.5.

NCEP

Work continued on fixing the non-meteorological profiles occasionally generated by the NAM's GSI analysis. The worst profiles were those that are both saturated and unstable. The resulting spin-down in the model has a negative impact on the subsequent forecasts. The reason that these profiles exist was that the analysis increments were spread in the vertical without considering the structure of the background. This is exacerbated when the vertical separation between reporting levels in a radiosonde report is large. In order to adjust the background profiles toward the rawinsonde observations, intermediate 'reporting levels' were added between the reported levels for both temperature and humidity. This is entirely consistent with radiosonde reporting practices, which limits reporting to "significant levels" where the vertical trace of temperature and humidity deviates from a straight line on a tephigram (DiMego). This extra data did not slow down the 3DVAR convergence and had little effect on the analysis except in the local area where the data were added. As expected, with these extra data the analysis was closer to the rawinsonde and the non-meteorological profiles were less likely to occur. This work was presented at a recent branch meeting. (Wan-Shu Wu)

Work continues on the codes for reflectivity assimilation. The code for calculating simulated reflectivity in the WRF-post was adapted to the reflectivity analysis package. NRL's reflectivity assimilation codes together with the

reflectivity simulation codes were adapted too. A limited comparison between the simulated reflectivity from Ferrier's method and NRL's method was done. Reflectivity generated from Ferrier's method looks better than that generated from NRL's method based on just one case. Latent heat was calculated based on the reflectivity analysis and the adjusted temperature appeared reasonable based on the one case study. Shun Liu developed a set of codes and scripts to monitor radar data status and graphically display the status information. (Shun Liu)

Work on refining the Lanczos-based estimate of the GSI-2DVar analysis error with the help of cross-validation statistics continues. A 3-km resolution Alaska RTMA, which will replace the current 6-km system, has been built and tested. Work on building a 1.5-km resolution Juneau, Alaska RTMA system has resumed. Plans to run a Delayed Mesoscale Analysis have been resurrected. (Manuel Pondeca)

Task 11.5.8 Improve physical processes in the WRF (RR and HRRR) and NAM models, especially including those that affect aircraft icing.

GSD

Joe Olson continues testing of the Mellor-Yamada-Nakanishi-Niino PBL scheme. Emphasis in February was toward improving the MYNN surface layer by modifying treatment of the thermal roughness length and making other modifications. Overall, the mods to the MYNN continue to show good promise of improving MYNN wind forecasts in the boundary layer without degrading temperature forecasts and without causing poorer wind forecasts aloft in individual case studies. A retrospective RR test to compare performance of this scheme to the current MYJ is still planned.

The use of this modified version of the MYNN scheme is being considered for the Rapid Refresh *after* its initial implementation at NCEP later this year. It is also being considered for application into the HRRR.

NCAR

Subtasks:

11.5.8.1 Oct '10
Start to evaluate the relatively performance of new microphysics and PBL schemes used in the physics-perturbation-only 4-km CONUS-scale forecasts from CAPS spring forecast experiment.

11.5.8.2a Apr '11
Continue testing newly implemented coupled aerosol-microphysics scheme in case studies and perform sensitivity analyses.

11.5.8.2b May '11
Determine the best method for including aerosols into HRRR's initial analysis and boundary conditions so they are available to the microphysics scheme.

Deliverables

11.5.8E3 Sep '11
Deliver an improved ice nuclei tracking scheme in the two-moment microphysics scheme to ESRL for real-time testing in the WRF Rapid Refresh.

PLANNED EFFORTS: Continue developing and testing the new aerosol scheme.

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED: None

INTERFACE WITH OTHER ORGANIZATIONS: GSD

UPDATES TO SCHEDULE: None

Task 11.5.15 Develop improved methods of cloud and moisture analysis for use in the Rapid Refresh and NAM Modeling Systems.

GSD
In early February, Ming Hu re-tested the GSI for 3-km application on the CONUS HRRR domain. Previously (spring 2010), he had encountered memory issues on the jet chips, making this application difficult. The new chips have expanded memory, the tests were successful, allowing us to proceed using the GSI cloud analysis to generate a 3-km radar latent heating based temperature tendency field for use in testing 3-km DFI radar assimilation in the HRRR (see task 5.24).

Task 11.5.24 Develop, test, and improve the 3-km WRF-based High-Resolution Rapid Refresh

GSD
Curtis Alexander completed work to create sample grib2 HRRR 15-min output files for VIL and other fields, has made these files available to downstream users so they can make modifications to their own ingest software. Downstream users have not reported any issues with the new file format, and once they have completed their processing changes, GSD will produce files in both the old (netcdf) and new (grib2) formats for a short period to make sure there are no further issues encountered, then discontinue the netcdf format. The new grib2 format files contain many more fields than the old netcdf files, yet are still much smaller in size.

Significant additional HRRR retrospective test work was completed this month, including multi-day comparisons Of HRRR forecasts initialized from: 1) RUC with weak DFI-radar heating, 2) RUC with string DFI-radar heating (2010 real-time configuration), 3) RR with weak DFI-heating, 4) RR with strong DFI-heating, 5) several variations of 3-km DFI-radar assimilation. Results indicate that: 1) use of the RR (as opposed to the RUC) the parent model yields improved HRRR forecast skill from 4 hours on, 2) use of the strong latent heating (as opposed to the weak heating) in the DFI-radar assimilation yields improved forecast skill in the 0-3 hour range, 3) 3-km DFI-radar assimilation yields further improvement in the 0-3 hour forecast range. Based on these results, we anticipate switching to the use of the RR as the HRRR parent within the next month and use if the 3-km DFI-radar assimilation is fairly likely.

Other 2011 HRRR changes based on extensive retrospective experiments were reported last month and include removal of the 6th order diffusion (helps with the low bias problem in the southeast) and upgrading to the latest Thompson microphysics scheme. As part of the HRRR evaluation effort, Patrick Hofmann has created 2 additional HRRR reflectivity sub-domains (northeast and southeast).

NCAR

Task: Evaluate convection-permitting forecasting by the ARW core for ultimate application in the HRRR

CURRENT EFFORTS:

PLANNED EFFORTS: High-resolution ARW simulations from RR grids will be run beginning in April/May for the SPC's Spring Forecast Experiment. These will be done at NCAR and then analyzed in collaboration with ESRL.

UPDATES TO SCHEDULE: NONE

Task 11.5.19 Develop and refine techniques to assimilate radar radial velocity and reflectivity data through GSI and Rapid Refresh toward the HRRR

Not funded in FY11, an unfortunate slow-down to HRRR development.

Task 11.5.20 Develop ensemble-based probabilistic products for aviation users

Not funded in FY11.