MDE Product Development Team
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Executive Summary

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

- Continued investigation of occasional crashes on RUC. In August, GSD found that an increase in sigma layer depths near surface solved the crash and made this change to the backup RUC in support of the HRRR in October. After meetings at NCEP last week, a change to the max sigma layer depth is now scheduled for the operational RUC this week. (Note: RR ran without problem in all of these cases.)

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

- *Start of RR EMC frozen evaluation is now set as 22 November.*
- *Anticipated RR implementation date at NCEP has now been moved back to* ***July 2011****.*
- After modifications to the WRF model for the rotated-lat-lon grid were tested and other modifications to WRF regarding initial moisture and hydrometeor fields, remaining gaps between RR and RUC forecast skill have been eliminated, i.e., the RR, including with the RLL grid, is now fully equal or better than the RUC for wind/temp at all levels.
- RR test cycle at NCEP continues to run in real-time with new rotated lat-lon (RLL) grid/domain covering all of the Aleutian Islands per requests from the Alaska Aviation Weather Unit (AAWU) and NWS Alaska Region.

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

- Additional tests were conducted with different configurations of background error covariance specification within GSI for RR to improve 6h RR forecast skill.

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

- Experiments revealed that modifications to hydrometeor or water vapor fields within WRF (as done in RUC) resulted in poorer RR forecasts.
- Revisions made to METAR-cloud-based RH pseudo-observations in variational humidity analysis in development RUC in October/November.

Task 11.5.24/19: Development/testing of HRRR

- Additional case study tests being conducted to evaluate different radar assimilation assumptions (in RUC) in comparing HRRR vs. HRRR-dev.
- HRRR reflectivity verification package running, being expanded to include VIL verification
- Parallel HRRR ("HRRR-dev") running every 3-h on shadow computer system, verification against HRRR

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

ESRL/GSD

ESRL conducted several tests on stability of the RUC forecast model (hybcst) for down slope wind forecast situations in October that resulted in crashes at NCEP and at ESRL. As a result, the maximum sigma layer thickness was changed from 10 hPa to 15 hPa in the backup RUC, resulting in successful runs without crashes and without any perceptible changes in output for non-crash cases. A similar change was made to the ESRL development RUC in August.

Similar tests were made at NCEP with improved stability. This has resulted in a recommendation from NCEP/EMC and ESRL/GSD to NCEP/NCO to make this modification to the operational RUC at NCEP. NCO agreed to this change, and this change will likely be made this week (16-19 Nov).

ESRL continues to monitor operational RUC (and two ESRL versions of RUC with some differences in radar and cloud assimilation). 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 at **http://ruc.noaa.gov/stats** -- no unexpected differences occurred during July. Reminder: the backup RUC at ESRL is used to initialize the HRRR (**http://rapidrefresh.noaa.gov/hrrr**), and the dev RUC is used to initialize the HRRR-dev.

In October, ESRL continued to run a modified version of the RUC with improved convective suppression and smaller latent heating from the radar reflectivity assimilation in the development RUC. The devRUC initial fields, in turn, are now used to initialize the development version of the HRRR.

NCEP

Testing is complete for a major upgrade to the NCEP BUFR library scheduled for implementation in FY2011/Q1, which is critical to all observational ingest and impacts both RUC and NAM. Work continues on issues like 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; and the NRL-based aircraft QC code. The Florida and Georgia DOT and Aberdeen PG mesonet providers have been down for several months. GOES-13 cloud and precipitable water retrievals have not been used since the switch from GOES-12 to GOES-13 in April 2010. An implementation on 19 October corrected an error which allowed surface pressure observations from 15 oil rig METAR reports (added last May) to be available for assimilation in the RUC and NAM. These were on the reject list due to their uncertain quality. (Dennis Keyser)

The operational RUC experienced several CFL violation failures on 24 and 25 October. Each time NCEP Central Operations staff reset the model time step from 18 to 16 seconds, and obtained a successful rerun. After a few failed cycles, EMC authorized an emergency change to run all cycles at 16 seconds. After another failure even with the reduced time step, the time step was changed from 16 to 15 seconds on 25 October. This change to 15 caused a delay of products up to 4 minutes, so on 27 October NCEP Central Operations began using an extra node to run the RUC forecast job. This causes the 15 second time step model configuration to finish in the same amount of time as the original 18 second time step configuration. No more failures have occurred in late October, but it has failed again in early November. NCO has now approved a change to the parameter for sigma-layer thickness in the RUC, as tested by GSD and EMC. This change will be implemented in the 16-19 Nov period. (Geoff Manikin)

RFCs for a set of scripts for the archival of raw radar Level-II data have been submitted to NCO for implementation. This will allow retrospective runs of RUC, NAM or Rapid Refresh. (Shun Liu)

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 during May toward operational implementation at NCEP can be found under Task 5.4 report.

NCEP

Parallel tests of the NEMS/NMMB model in the EMC NAM parallel system continue on the CCS. Two NMMB parallels are being run: a 12 km control run and a 12 km experimental run with model and/or analysis changes for inclusion in the control run. The experimental parallel is running all four nested domains (CONUS at 4km, Alaska at 6 km, and Hawaii & Puerto Rico at 3 km). During October, the test of the MODIS-based IGBP land use definitions continued in the experimental parallel, with one additional change to alleviate isolated regions of abnormally low dew point temperatures. Several changes were also made to both parallels: 1) the GSI analysis was changed to use new observation errors and retuned background errors, assimilate new observations (RASS virtual temperatures, MAP winds, ASCAT winds), and to use an new version of the GSI code which runs faster with 2 parallel threads; and 2) begin using the 1/12th degree lat/lon high-resolution Real-Time Global SST analysis (RTG_SST_HR). (Eric Rogers)

NCEP continues to generate experimental Rapid Refresh (RR) PrepBUFR files (see Task 11.5.4) containing WindSat data (non-superob) and 50 km ASCAT for a private ESRL directory on the NCEP ftp server. RR dumps of Level II 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 copied to a public ftp directory. These and early (T+0:26 minute) parallel dumps for 0000 and 1200 UTC, are being tested in ESRL's experimental RR runs. ESRL is concerned about missing ASCAT data and the low number of WindSAT data caused by a change in the upstream processing on 14 September. NCEP is scheduled to correct its processing of ASCAT data in early November. The WindSAT and ASCAT data dump time windows were both moved back 30 minutes to try to obtain more data. There are many unavoidable gaps in the WindSAT data from problems upstream of NCEP. Langley cloud data was unavailable for 9-10 hours on 18 October and on 20 October due to NASA server issues. EMC and GSD requested the Radar Operations Center start their hourly processing of Level 2.5 88D data 25-30 minutes earlier so more data will arrive before the RR cutoff, because it's the only available radial wind data for the Alaska portion of the expanded RR domain. This process is expected to begin in November but will be gradual over time. Adding a 5th hourly ingest run to increase Level 2 88D radar data receipts is being discussed with NCO. Level II data from 8 DOD CONUS sites are expected to become available in November 2010. (Dennis Keyser)

For the NAM, NCEP will contact Alaska Region about the radiosonde at Shemya, AK, which launches too late for the NAM-GSI. There was a 12-hour loss of METOP-2 polar satellite data (all instruments) on 15 October. METOP-2 MHS radiances were unavailable on 3-6 October due to an instrument anomaly. AQUA AIRS and AQUA MODIS data were out for 10 hours on 7 October due to ground station problems. GOES-13 radiances are monitored but will not be used until the next NAM updates (a result of the April 2010 switch from GOES-12 to GOES-13). NOAA-18 has ongoing gyro issues that could lead to unusable products within 6 months. In late fall NESDIS engineers will conduct the final 24 hour test where the corrupted navigation data will not be sent to NCEP. JMA was forced to switch its cloud-derived wind production from MTSAT-2 to MTSAT-1R on 7 October due to a failure in the MTSAT-2 ground data processing system. A switch back to MTSAT-2 is not expected until late December. The following data types are monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), Mesonet mass data, AIRS AMSU-A radiances, NOAA-19 HIRS-4/AMSU-A/MHS radiances, ASCAT winds, and MDCRS moisture data. All but RASS of these are being tested in Eric Rogers' parallel. NAM/NDAS and RTMA PrepBUFR files are being generated in parallel with 50 km ASCAT and WindSat scatterometer wind data (both non-superob) and production NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and SBUV-2 data are being created. 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 the parallel as an alternative

to the current use of synthetic wind data bogus, but only at the t-12 hour start time of the NDAS. A legacy restriction (that only surface data with a reported pressure is processed) will be removed to allow many new surface observations (land, marine and Mesonet) to be assimilated in the RTMA and possibly NAM/NDAS. This testing has just started in the RTMA. (Dennis Keyser)
As part of the transition effort for CIP, code to read and remap GINI satellite imager data has been completed. Acquiring GINI data remains an issue at NCEP/EMC despite its availability operationally at AWC. NCO's data flow group is working this. Coding to derive the data calculation and merging is in progress. (Yali Mao)

NCAR
NCAR has set the dates of the next WRF tutorial as Jan. 31-Feb. 8, 2011. The tutorial will cover both WRF structure and operation, as well as related model components, such the Metgrid verification tool.

NCAR has begun preparations for WRF major release V3.3. At this time code is being accepted for inclusion, with a current target date of spring 2011. 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**

Jimy Dudhia of NCAR/MMM worked on various WRF physics issues. For inclusion in the WSM6 microphysics scheme, he adopted formulas of Andy Heymsfield and Carl Schmitt (NCAR/MMM) for fall speed and particle mass-size relations. The new fall speed for ice and snow has been tested and was presented at the DOE Atmospheric System Research workshop in Boulder. The new fall speeds were added to the WSM6 microphysics scheme as a first phase of modifying it for new size distributions to represent snow and ice particles.

Dudhia is working with NCAR/MMM visitor Thara Prabhakaran (Indian Institute of Tropical Meteorology) to evaluate how bulk and bin microphysics schemes compare with aircraft observations of clouds affected by aerosols. In radiation physics, Dudhia obtained a UCLA radiation scheme (Fu, Liou, and Gu) for the next WRF release. He also obtained the new Total Energy Mass Flux (TEMF) PBL scheme from Wayne Angevine (NOAA/ESRL).

Lastly, Dudhia is working to evaluate surface wind biases in 2-km simulations in a large, multi-year northern Spain dataset from NCAR/MMM visitor Pedro Jimenez. They are identifying potential areas for improvement.

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
Intensive effort continues toward freezing the Rapid Refresh code for several weeks of testing by EMC prior to submission of the Request For Change to NCO for the RR to replace the RUC. The main emphasis is on making sure the RR performed at least as well as the backup RUC at GSD, a necessary condition for operational implementation. We continued to have nearly daily coordination telecons with Geoff Manikin of EMC. At this writing we are close (days away, we think) to having a configuration available for EMC testing. The excellent reliability of both the primary and developmental RR cycles, plus the capability of making short retrospective runs and the highly responsive verification tools available to the RR development team have been crucial to overcoming the numerous issues that have arisen in the past few months. A change log on the primary RR 1h cycle is maintained at **http://ruc.noaa.gov/internal/RR_runs/RR_1h_info.txt**. Major issues dealt with during the month include

- Fixing a problem with deficient areal coverage of NASA Langley (LaRC) cloud data for use in GSI
- Testing of variants of background error and observation error configurations in GSI;
- Discovering and fixing a major bug in the "curvature term" in the WRF model code when the Rotated Lat-Lon (RLL) option is used;

- Discovery of a serious problem that arises in WRF from use of the RUC treatment of moisture and hydrometeors after application the digital filter initialization (DFI); workarounds in testing currently;
- Fixing a bug in the Grell shallow convection scheme;
- Addressing various post processing issues at NCEP.

More details are included below on specific changes.

LaRC cloud data problem at NCEP

The LaRC cloud preprocessing problem was successfully addressed in collaboration with NCEP by accounting for the larger RR domain in the pre-GSI processing of the data at NCEP. NCO and EMC did an excellent job in solving this problem after GSD documented its existence to them.

GSI Testing

GSI testing continued through the month and in parallel with progress on other model and DFI issues. The result has been greatly improved understanding of GSI limitations in the context of the RR's hourly updating, as well as the effect of various combinations of GSD analysis settings (e.g., background error). Both NAM and GFS background error configurations (both available) have been extensively tested, and each has its unique set of strengths and weaknesses. We are close to a final configuration. We have also adapted GSI to make fuller use of surface data, particularly over the western CONUS, Alaska and the Appalachians by sharply reducing the inflated observation error assigned to stations that report station pressures that are not within a few hPa of the model surface pressure at the Gridpoint location.

Modifications to DFI

Because the WRF is a fully compressible non-hydrostatic model, failure to ensure hydrostatic balance at the end of the GSI or at the beginning of the free forecast after the DFI apparently produces mixed Rossby-gravity wave modes that can substantially degrade the forecast winds and temperatures. Because most users of WRF do not cycle and do not initialize with non-zero hydrometeor fields, this has not been fully appreciated heretofore. The exact mechanisms of the hydrostatic adjustment process in the WRF-ARW need more clarification. At the beginning of October, in an attempt to improve forecasts of cloud ceiling, instead of using the DFI-filtered values of water vapor and hydrometeors in initialization of the free forecast, we reverted to the RUC procedure of excluding the water vapor and hydrometeors from the time filtering of the DFI and restoring the relative humidity and cloud hydrometeors produced originally analysis step (done to minimize loss of cloud information introduced during the GSI) at the conclusion of the forward part of the DFI. To our surprise, serious degradation of the wind and temperature forecasts resulted. Performing a hydrostatic balance at the end of the GSI, followed by regridding of the model to accommodate any resulting changes in the dry mass of the grid columns, improved verification, but not as much as expected. (This process had not been done previously.) Code has now been developed to include the hydrometeors in the hydrostatic balancing at end of GSI, and to also ensure hydrostatic balance, using the relative humidity at the end of the DFI. Tests will be conducted to determine if these enhancements are effective in bringing the model performance back to acceptable levels.

Rotated lat-lon bug fix in WRF

Our testing of the GSI background error and also the DFI changes during the first half of the month suggested that there might still be an issue with the RLL forecasts, as objective verification of upper wind forecasts seemed to be systematically worse for our RRdev runs conducted on the RLL domain (see Fig. 1 in the FY10Q4 MDE report) as compared with the RR primary runs using the Lambert Conformal domain. This prompted initiating a careful comparison between RR forecasts on the Lambert Conformal and RLL grids, using both the real time cycles and short-retrospective-period runs. This revealed a significantly larger mean bias error in the wind forecast on the RLL grid, peaking near 250hPa, i.e., near the level of maximum winds. After verifying that fixed fields such as map-scale factors and Coriolis were correct and that there was not a problem with our verification when using RLL, we consulted with our NCAR colleagues on this and were referred to an NCAR WRF repository commit on 6 August for the RLL curvature terms in the WRF-ARW model code. We repeated our comparisons with this fix to the RLL and found very close agreement between the RLL and Lambert for wind verification, as well as for other fields. With this success, we have now (as of 4 November) both the RR primary and RR dev running at GSD using the RLL domain. The NCEP RR has been running with the RLL domain since midsummer.

Grell shallow convection

The bug in the Grell shallow convective scheme turns out to have affected only the NCEP runs, where the compiler handles uninitialized variables differently than on the jet system at GSD. This has now been fixed, and allows the RR to run at NCEP with the shallow convection active.

RR post processing

Work continued during the month to ensure that UniPost was producing RUC look-alike grids on CONUS grid #130 for the *sgrb* and *pgrb* files. It appears that this goal had been achieved by the end of October. The *bgrb* files, with the concurrence of the Inflight Icing and Turbulence PDTs will not (at least initially) contain certain fields (e.g., drip from canopy) output in the current operational RUC *bgrb* files. Unfortunately, the rotated lat-lon grid option continues to be unrecognized by *wgrib2*, so that RLL grib2 output is not currently usable by the other PDTs. Fortunately, the other PDTs are using #130 grids from the RR. Geoff Manikin will be consulting with Wes Ebisuzaki at NCEP on this matter.

RR verification

After many changes over the past several weeks, it appears that we have a version of RR at GSD on the Rotated Lat-Lon domain that verifies at least as well for RMSVE winds and RMS temperatures aloft as the backup RUC at GSD. Mid-level (near 500mb) RH still verifies a little worse. The 850mb height fields are showing a low bias, at both GSD and in Geoff Manikin's RR cycle at NCEP, but such bias is not evident at upper levels.
No egregious problems exist in surface verification. However, there are a number of nagging concerns. The 2-m temperature biases at GSD show a suppressed diurnal cycle in parts of the eastern CONUS, with too high dew points in the midday hours in the same areas. This pattern is often symptomatic of excess soil moisture, but more testing will be required to convincingly establish that this is in fact the case here. Forecast dew points over the interior West from morning initializations often drop well below the observed by afternoon when skies are clear. Verification of IFR ceilings (< 1,000ft) is a bit better than the backup RUC at GSD.

NCEP

Work continues on the Rapid Refresh development. As of 7 Nov, statistical skill scores indicate that the model is not yet performing well enough for the formal evaluation to begin. GSD, however, has found several errors in the GSI and an error in the formulation of the native rotated lat/lon grid, and it is hoped that correcting these errors will soon lead to improved performance. Work has been done to make sure that all parameters and accumulation periods available in the RUC pressure level files and most of the parameters in the RUC native level files will be available in the Rapid Refresh grids. These are the so-called RUC-look-alike grids which have been promised to users. (Geoff Manikin)
See extensive observation processing work by EMC's Dennis Keyser in support of RR under Task 11.5.17.

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

ESRL/GSD

Work continued to obtain a final frozen version of the GSI for the NCEP operational implementation now expected Q4 2011. GSI-related work has focused on the possible need for a vertical interpolation following the 3DVAR analysis step, because once the surface pressure is modified in the analysis, the pressure level of the sigma surfaces is slightly adjusted. Investigation of the issue arose because of elevated noise during the beginning of the backward time integration of the diabatic digital filter initialization in the WRF ARW compared to the RUC. Discussions with NCAR personnel indicated a possible sensitivity for the WRF-ARW without this step, which is not present in the GSI (the RUC 3DVAR includes a similar step at the end of the analysis). Ming Hu has coded a vertical integration and it is being tested in the GSI. Single run experiments showed only very small changes to the fields based on the vertical integration and only a slight reduction in the DFI noise. A controlled 5-day retrospective test run has been completed by Haidao Lin and is currently being verified to evaluate forecast impact. An additional change was made to check for and remove super saturation at the end of the GSI cloud analysis.
A second area of testing has focused on evaluation of variations in the background error covariance (BEC) specification. The work has involved extensive single-observation tests by Ming Hu and comparisons between

the real-time RR cycles running at ESRL/GSD, the “primary” and “developmental” RRs. The primary RR is using the NAM BEC formulation and is giving very good results (comparable to the RUC). Comparison experiments (including uses of the GFS BEC file and variations in the amplitude of the weights) have been conducted to see if a more optimal BEC specification for the RR can be obtained. Ming’s single-observation experiments have shown that the GFS BEC produces large analysis increments with stronger cross-variable correlations. Used as is in the RR cycle, the GFS BEC has yielded larger RR forecast errors than the NAM BEC. More recent tests with changes to reduce amplitude of the observation innovations have yielded improvements in the GFS BEC-based RR forecast, and related experiments are ongoing this week.

Two changes were made to improve the use of surface observations in GSI. First a linear ramp of the weighting (based on the observation vs. model pressure level difference) was added for surface observations below the model surface. Second, a bug, which only allowed the terrain matching pre-processing to be applied during the first outer loop (as oppose to all outer loops) was found and fixed.

CAPS

A new branch for regional EnKF has been created in the DTC GSI Repository and the regional EnKF package created by CAPS was checked in. This version is based on the latest version of GSI, obtained in September from Ming Hu of GSD, and WRF version 3.2. During October, CAPS continued to test the EnKF system and compare the results with those of GSI, using the May 8 to 16, 2010 testing period. In the experiments reported on last month, the EnKF assimilation experiments were crashing during the WRF integration after first few days of cycled analysis. It was found to be caused by the steep terrain near the southeast boundary. A new domain of 207x207 grid points is now used which is 10 grids fewer at each boundary. The new domain is a little smaller than that of RR but still covers the entire North America.

A set of sensitivity experiments for testing the parameters in the EnKF has been carried out in the new domain. Two experiments, one use the GSI alone and one use the EnKF were conducted for this test period. Both used almost the same configuration as operation RR except that the horizontal grid spacing was coarser ~40km and ‘dfi_radar’ option was turned off. These experiments involve 3 hourly GSI and EnKF data assimilation cycles starting from 00 UTC may 8, 2010 and ending at 21UTC May 16, 2010, and all were done at a 40 km resolution. The EnKF results are compared to the GSI results with the same domain setting in Fig. 1. The change of the domain size has little impact on the three-hour forecast innovation (root mean squared difference from observations). The differences between EnKF results with covariance inflation turned off (as in the first set of tests reported earlier) and with inflation turned on are obvious. The later have significantly reduced RMSEs. With extra adaptive inflation, the RMSEs are decreased slightly but in all cases the forecast errors using EnKF are still higher than GSI-based forecasts. Experiments with boundary conditions perturbed around the GFS forecast using the ‘random_cv’ method (labeled pertbc), and with effectively unperturbed boundary condition (labeled upbc) from GFS are also compared, the curves in the Fig. 1 suggested that the analysis results are not sensitive to the boundary perturbations used (not surprising because the forecasts are only 3 hour long). In addition, different horizontal covariance localization radii were tested. The 600 km radius performs better than 1000 km. We are looking at more diagnostics and analysis innovations in order to better understand the EnKF analyses, and the goal is to obtain error levels lower than those of GSI. We are using all available observations in the ‘PrepBUFR’ dumped out by GSI; we may perform experiments using subsets of observations to see if the higher error level of the EnKF is associated with particular data types.

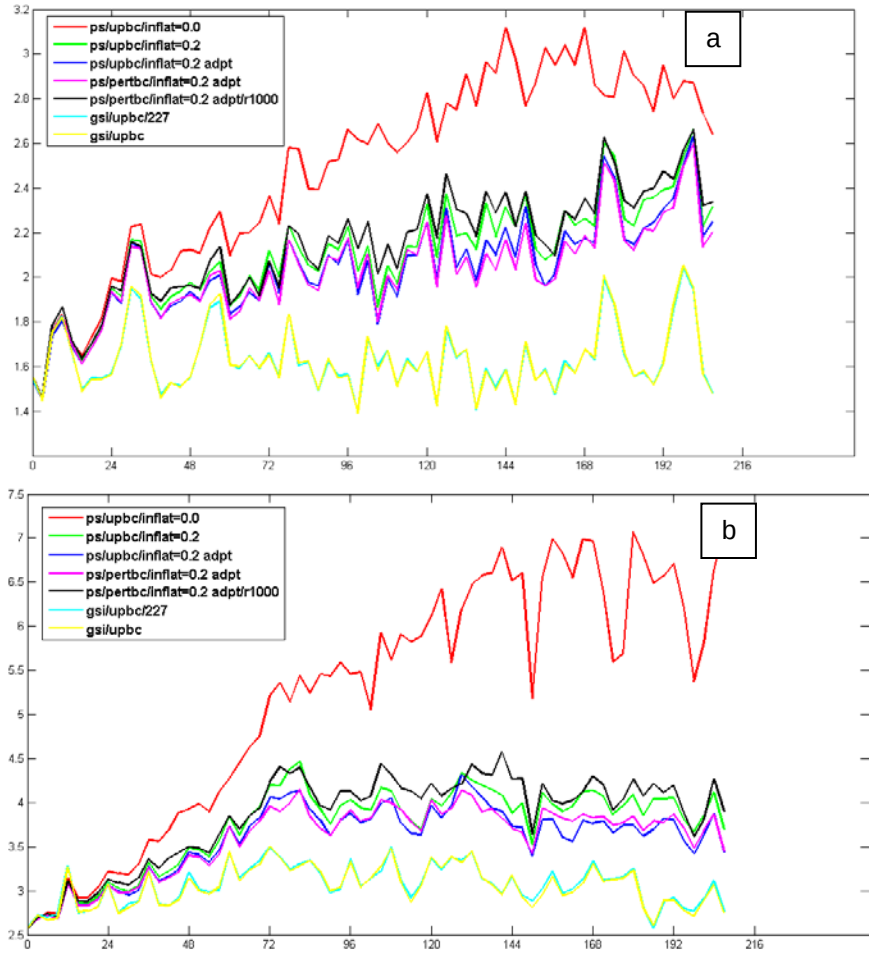

Fig.1 Three-hour forecast innovations of EnKF and GSI analyses for (a) potential temperature and (b) x component of velocity. The 'ps' represents control variable using surface pressure instead of pressure; 'pertbc' means the perturbed boundary conditions using the 'random cv' method while 'upbc' uses effectively unperturbed boundary conditions; 'adpt' referred to additional adaptive inflation; 'r1000' denotes the use of 100 km horizontal covariance localization radius while others used 600 km; 'gsi' means GSI analysis and others are for EnKF. '227' represents the old larger domain.

NCEP

Preparations continue for tests of the hybens GEFS NMMB GSI (hybrid ensemble GSI for NMMB in NAM directly using GEFS ensembles for the ensemble part of the background error). Codes and test scripts were provided to Wan-Shu Wu so she can evaluate hybens GEFS NMMB GSI performance in her version of the parallel NDAS. She has started running the parallel evaluation and is now collecting data for the initial results. The dual resolution feature of hybens GSI is not working yet for regional applications, resulting in a significant increase in the cost of running hybens GEFS GSI over the NAM domain. It was discovered that there is almost no impact, positive or negative, when using a coarser analysis grid. While the current NMMB GSI analysis grid resolution is 17 km, a value of 36 km also appears to work just as well, leading to the possibility of substantial savings of resources for both NMMB GSI and hybens GEFS NMMB GSI. With help from Edward Colon, the hybens GEFS GSI was introduced into the NMMB-GSI launcher. (Dave Parrish, Wan-Shu Wu)

A comparison between the new and old VAD BUFR files is underway. To make a fair comparison, the GSI code was modified to thin the new VAD wind in temporally and spatially so that the observation numbers from both new and old VAD wind are similar. The new VAD wind still shows a lower RMS compared with the guess field. Work continues with NSSL to further identify the quality of new VAD wind, by checking the differences between the new

and old VAD. If the difference is large, the raw Level-II data will be reprocessed with the QC package and plots of raw data versus data after QC will determine which VAD wind is more reasonable. The plots are needed because RMS comparisons between old and new VAD winds or of old and new VAD wind against guess field cannot determine the quality of new VAD wind since there is no ground truth. VAD winds from five locations were checked, and in most of cases the new VAD winds are better than the old. (Shun Liu)
Work continues on configuring the new Northwest RFC-RTMA and blending the analysis with that from the CONUS RTMA in the small overlapping geographical area. Work also continues to improve the variational quality control in the GSI. (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

- Bug fix for uninitialized variables was found necessary to allow the shallow convection to be turned on in the EMC RR cycle. Recall that the shallow convection was found helpful in reducing a warm mid-level temperature forecast bias (see FY2010Q4 MDE report for details).
- Joe Olson has set up verification of 2-m temperature and dew point based as a function of land-use category. This is showing substantial systematic differences in forecast behavior as a function of land use. For example, deciduous forest areas demonstrate a markedly suppressed diurnal cycle in temperature over the observed. We will be using this information as guidance for identifying problems in the land-surface and surface-layer/boundary-layer schemes.

NCAR
Trude Eidhammer has been examining the effect various dust concentration have on precipitation. For the case of April 28-29, 2010 she ran nested simulations with 3 domains (9, 3 and 1km), where the 1km domain (d03) was centered over Colorado. Cases were run with a control background dust concentration, and with 10xcontrol and 100xcontrol. For precipitation over Colorado, the increase in total domain precipitation from control to 100xcontrol is up to 20 % when looking at d03 domain. Considering the d01 domain (9km) over the same Colorado region, the increase of precipitation in the 100xcontrol case is up to 10 %. These results some that the results are resolution dependent, as identified by the recent paper by Ikeda et al. (2010).
When considering the north western part of the USA (Washington and Oregon), the difference in total precipitation between control and 100xcontrol is basically 0%. This difference in behavior is currently under investigation. We currently think that this may be due to differences in precipitation systems. Note that there are still local spatial differences in precipitation due to changes in dust concentration in both regions

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

GSD
GSD continued to test and evaluate possible RR modifications related to the balancing issue associated with resetting the hydrometeors to the original (from the GSI analysis) values following the diabatic DFI. These original hydrometeor values include the changes made in the GSI cloud analysis to better fit the surface and satellite cloud observations. Previous testing has revealed that resetting the hydrometeors after the DFI introduces noise into the resultant forecast and degrades the upper-level wind forecast skill. Tanya Smirnova is working on a rebalancing to be run after the DFI that would allow the hydrometeors to be reset, facilitating full retention of the cloud analysis information. This is considered to be a desirable, but not essential, inclusion for the RR refresh code freeze, as ongoing ceiling verification indicates good RR skill even without the post-DFI reset of the hydrometeors. During the month, GSD also made a fix to allow use of the NASA Langley cloud top data for both Lambert conformal (LC) and rotated lat-lon (RLL) map projections. A previous modification to allow use for

the RLL inadvertently prevented use for the LC. This did not affect the RR testing, as it is using the RLL map projection, but it is important to have data processing code that is not map projection specific.

GSD also continued its development of creating RH innovations from METAR ceiling observations. Code was developed to add sub saturation innovations for METAR reports indicating clear conditions if there were nearly saturated layers in the background. Moreover, corrections were made to the observation error inflation for these pseudo-observations, and to the elevation AGL criteria. These observations are now producing improvements both in ceiling and RH forecasts from the development RUC, where they are being assimilated.

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

GSD

Curtis Alexander has coded script change to improve the HRRR latency by ~ 30 minutes and is testing them in the "HRRR-dev" shadow system. We were already using the previous hour RUC for lateral boundary conditions (LBCs) to avoid needing to wait for the current hour RUC to complete an 18-h forecast before starting the WPS pre-processing to obtain the LBCs. Note, we use the current hour RUC post-DFI fields for the HRRR initial conditions (ICs) to get the latest radar data information into the HRRR). The improvement is accomplished by running the WPS pre-processing for the HRRR LBCs in a separate step, as soon as the previous hour RUC 18-h forecast is complete. Then a second WPS is run for the HRRR ICs as soon as the current hour RUC post-DFI file is available. While it requires running WPS twice, the IC specification version runs much faster than a version that also processes the lateral boundary conditions, thereby achieving the time savings. This will soon be moved over to the primary HRRR run.

Eric James is completing a RUC retrospective test. This controlled environment test will serves as a control experiment for additional runs, in which the which the strength of the radar-based latent heating temperature tendency in the diabatic DFI can be varied. Subsequent HRRR tests can then evaluate the impact on the HRRR forecast. A matched RR retrospective will then be completed, with associated HRRR runs, allowing for controlled comparisons of the RR-based HRRR and the RUC-based HRRR. Grids from these experiments will be provided to the other CoSPA teams for evaluation prior to switching the HRRR from the RUC to the RR. Patrick Hofmann has implemented real-time scale-dependent 24-h accumulated precipitation verification for the RUC, RR, and HRRR models. We have accumulated about 2 weeks of results and Patrick is coding statistical aggregation scripts.

NCAR

CURRENT EFFORTS: Jimy Dudhia of NCAR is currently finalizing a report on the 2010 simulations. He has worked with Greg Thompson (NCAR/RAL) to investigate the causes of reflectivity differences seen between the previous Thompson scheme and the V3.2 scheme used in 2010. The work has concluded with identifying the main code changes responsible for the performance differences that were centered on graupel production terms.

PLANNED EFFORTS: The report on the results of the high-resolution FY10 forecasts will be finalized.

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.

Task 11.5.20 Develop ensemble-based probabilistic products for aviation users.

Not funded in FY11.