MDE Product Development Team
December FY11 1st Quarterly Report – FY 2011
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Executive Summary

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

- NCEP-RUC – now running at 100% reliability since fix - Restoration to larger sigma-layer depths on 17 November (15z) after coordination between ESRL, NCEP/EMC, and NCEP/NCO. This was a response to intermittent crashes in the RUC from April-early November before the change. ESRL made same change to backupRUC (initializing HRRR) and development-RUC on 25 October. 100% reliability of backupRUC and RUC-NCEP since the change. Note: RR ran without problem in all RUC crash cases in 2010 related to this issue.

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

- *RR showing strong improvement over RUC for wind, temperature, RH, height.*
- *Final problems with Rapid Refresh (background error, WRF mass variable consistency, height diagnostic, others) solved in October, November, and December.*
- *Updated versions of Thompson microphysics and MYJ boundary layer scheme implemented, shallow convection (through Grell scheme) now invoked, full switch to rotated lat-lon grid (better for Aleutians and future NCEP-NEMS) after WRF fix introduced*
- *Evaluation of RR-NCEP-EMC is underway.*
- *Anticipated RR implementation date at NCEP has now been moved back to July-August 2011.*

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

- Frozen version of GSI for RR including use of modified GFS background error covariance specification.
- Experiments continue to evaluate impact of including re-interpolation in the vertical and vertical re-integration following the GSI analysis (either at the end of the GSI program or in the beginning of the ARW model).
- Initial work 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

- Modification made to GSI cloud analysis in December to improve mid- to upper-tropospheric RH forecasts.
- RR using frozen version of GSI cloud analysis yielding significant improvement in short-range ceiling and visibility forecasts.
- Further revisions made to METAR-cloud-based RH pseudo-observations in variational humidity analysis in development RUC in November.

Task 11.5.24: Development/testing of HRRR

- June 2010 RUC / HRRR retro 8-day experiments nearly complete to evaluate impact of variations in strength of radar DFI on HRRR forecast skill.
- Similar 10-day July 2010 HRRR retrospective case study experiments underway. The July period better captures weakly forced mid-summer convection.
- Work complete on RUC / RR / HRRR radar reflectivity verification system including two new helpful websites (one for individual case verification graphics and one for aggregate and analysis of verification statistics).

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

ESRL/GSD

NCEP-RUC – Change:
Restoration was done to larger sigma-layer depths on 17 November (15z) after coordination between ESRL, NCEP/EMC, and NCEP/NCO. This was a response to intermittent crashes in the RUC from April-early November before the change. ESRL made same change to backupRUC (initializing HRRR) on 25 October. There is 100% reliability of NCEP-RUC and backupRUC since their respective changes on 17 Nov and 25 Oct. Note: RR ran without problem in all RUC crash cases in 2010 related to this issue.

> Background information on RUC change/crashes extracted from October 2010 report:
> ESRL conducted several tests on stability of the RUC forecast model (hybcst) for downslope 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.
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> 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 was made on 17 November.

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).

NCEP
Testing is complete for a major upgrade to the NCEP BUFR library that is critical to all observational ingests which impacts both the RUC and the NAM. A full 2-cycle production test on the development CCS machine was scheduled for 1 December and implementation was scheduled to occur on 14 December if the test is successful. 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 NRL-based aircraft QC code implementation preparation. 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. (Dennis Keyser)
The operational RUC experienced more CFL violation failures during the first two weeks of November. A time step reduction implemented in late October has not prevented more failures, so in mid-November it was decided to replace the code that defines the model vertical coordinate with the pre-March 2010 version. The March change was made in response to January crashes associated with an extreme trough over the Pacific Ocean; this change has made the model more susceptible to crashes associated with mountain wave events in the western U.S. Since the January event was a rare extreme event, it was decided to return to the old code and this code was implemented on November 17. This allows the model time step to again be set to 18 seconds and frees up extra resources that had to be devoted to the RUC in late October. No RUC crashes have occurred since 17 November. (Geoff Manikin)

Subtasks

11.5.1.1 Maintain hourly RUC runs and provide grids of SAV and AHP guidance products. (30 Sept 11)

The operational RUC experienced several CFL failures on 24 and 25 October. Per EMC instructions, NCEP Central Operations each time reset the model time step from 18 to 16 seconds and obtained a successful rerun.

After several additional failed cycles requiring a time step change, EMC authorized an emergency change to run all cycles with a 16-sec time step. After a failure with the 16-sec time step, the value was further reduced to 15 sec on 25 October. The reduced time step caused a delay of RUC products of up to 4 minutes, so NCEP Central Operations began running the RUC forecast job with an extra node on 27 October to make up the time. The operational RUC experienced more CFL violation failures during the first two weeks of November. Permanently reducing the time step further was deemed not desirable, so on 17 November, after offline testing by EMC, the code that defines the model vertical coordinate was replaced with the pre-March 2010 version. That March change was made in response to January 2010 crashes associated with a rare event extreme trough over the Pacific Ocean; this change has made the model more susceptible to crashes associated with mountain wave events in the western U.S. The November change allows the model time step to again be set to 18 sec and frees up the extra node that had to be devoted to the RUC in late October. No RUC crashes have occurred since 17 November. (Manikin)

11.5.1.2 Provide vendors with gridded model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway. (30 Sept 10)

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 the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (DiMego)

11.5.1.3 Provide full grids from RUC runs on NCEP and NWS/OPS servers. (30 Sept 10)

NCEP maintained real-time availability of full resolution gridded data from the operational RUC runs via anonymous ftp access via the NCEP server site at ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/ruc/prod/ and at the NWS/OPS site at ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/ in hourly directories named MT.ruc_CY.00 through MT.ruc_CY.23. This includes hourly BUFR soundings and output grids, which undergo no interpolation. Both sites now contain only grids in GRIB2 format http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml. A limited set of fields from the RUC runs (and other NCEP models) can also be viewed at http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/. (DiMego)

11.5.1.4 Maintain access to model verification data. (30 Sept 10)

NCEP maintained its capability and provided access to routine verifications of the operational RUC analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch (MMB) website: http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html (DiMego)

Deliverables

11.5.1E1 (30 September 2011) (Keyser, Liu)
Perform ingest, quality control and preparation of both existing and new observations in support of the operational RUC runs.

CURRENT EFFORTS: Testing is complete for a major upgrade to the NCEP BUFR library scheduled for implementation in January 2011. The Florida and Georgia DOT and Aberdeen PG mesonet providers remained down. 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 oilrig METAR reports (added last May but moved to the reject list) to be available for assimilation in the RUC and NAM. (Keyser)
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 and/or Rapid Refresh. (Liu)

PLANNED EFFORTS: See also PLANNED EFFORTS listed under Task 10.5.17.E1 below for aircraft quality control issues. Implement new BUFRLIB and NRL quality control package. Obtain all TAMDAR data from AirDAT as alternate to MADIS feed and add airframe type and company code to allow improved bias corrections to be developed. Continue work to resolve issues like three radiosonde sites that report an invalid instrument type; late

arrival of GOES 1x1 field-of-view cloud data; and bringing in new SSM/IS data from DMSP F-16, F-17 and F-18 satellites to replace discontinued SSM/I products (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A severe backlog has developed in the implementation schedule on the NCEP computers.

INTERFACE WITH OTHER ORGANIZATIONS: NCO, NSSL.

UPDATES TO SCHEDULE: None.

11.5.1E2 (30 September 2011) (Manikin, ESRL)
Perform configuration management for RUC, including thorough documentation, and respond promptly to any code malfunctions or performance issues.

CURRENT EFFORTS: Model time steps and number of nodes used were adjusted when the RUC experienced CFL crashes. The model time step was set back to the original 18 seconds after the 17 November CFL crash fix and extra nodes that had to be devoted to the RUC in late October were released. Standard NCEP change management protocol was followed. (Manikin, IBM and ESRL)

PLANNED EFFORTS: Monitor RUC performance.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: NCO & ESRL.

UPDATES TO SCHEDULE: None.

11.5.1E3 (30 September 2011) (Manikin, ESRL)
Monitor RUC performance, respond to any problems detected by ESRL, NCEP, or any RUC users, diagnose cause, and develop solution to RUC software, test changes and coordinate with NCO on implementation.

CURRENT EFFORTS: The RUC CFL crashes were finally solved on 17 November by replacing the code that defines the model vertical coordinate with the pre-March 2010 version. The March change was made in response to January crashes associated with a rare event extreme trough over the Pacific Ocean; this change has made the model more susceptible to crashes associated with mountain wave events in the western U.S. No RUC crashes have occurred since 17 November. (Manikin and NCO/PMB)

PLANNED EFFORTS: Continue monitoring.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: All tasks and milestone/deliverables are complete.

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 - 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 is running all four nested domains (CONUS, Alaska, Hawaii, Puerto Rico). During November, the MODIS-IGBP land use definitions were implemented in the control NMMB parallel. Enhanced diffusion for specific humidity and cloud water was tested in the experimental parallel and implemented in the control parallel in November. Also, the experimental parallel began a test of microphysics and radiation changes that will reduce NAM total cloud fractions by reducing unrealistically high amounts of cirrus clouds. (Eric Rogers, Brad Ferrier)

Several changes to the nested runs were made in November to eliminate problems. First, two changes suggested by Zavisa Janjic and Matt Pyle were made to eliminate CFL-like noise that was seen in the CONUS nest runs during early November: 1) the divergence damping constant for the nested runs was increased by 33%, and 2) slight off-centering was turned back on in the Crank-Nicholson vertical advection scheme. This was accidentally turned off in the parallels in June 2010. Second, at the recommendation of NEMS code developer Tom Black, the number of boundary blending rows in the Alaska nest was reduced from 5 to 3 to eliminate code hangs since with 5 blending rows, a 2:1 grid space ratio for the Alaska nest to the parent, and only 2 halo rows for the parent task, the blending region was too wide. When Alaska has its northern boundary extremely close to the northern boundary of a parent task then Alaska's blending region can completely cross from one parent tasks' integration region through that parent task's halo and into the next parent task's integration region, causing the code to hang. (Eric Rogers)

NCEP continues to generate 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 being 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 now Geoff Manikin's RR parallel being run at NCEP. ESRL has been concerned about missing ASCAT data and the low number of WindSAT data. NCEP corrected its ASCAT processing on 9 November to handle a 14 September upstream processing change in wind solutions. The WindSAT and ASCAT data dump time windows have both been moved back 30 minutes to try to obtain more data for the RR. The AQUA AIRS and NOAA/METOP AMSU-A, AMSU-B, HIRS-3/4 and MHS, radiance dump time windows were moved from back 1 hour (to 3 hours prior to cycle time) to try to obtain more data for the RR. There are many unavoidable gaps in the WindSAT data due to problems upstream of NCEP. Future data tests will include Multi-Agency Profiler winds and METOP-2 and RARS radiances as well as "tcvitals" records for tropical cyclones. The NWS is increasing the resolution of the raw Level 3 ("NIDS") radial wind data in January so NCEP/NCO will need to modify the Level 3 decoder to maintain the processing of these data. 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. This process began in November but the changeover is gradual over time. Adding a 5th hourly ingest run to increase the receipt of Level 2 88D radar data is being discussed with NCO. Level 2 data from 8 DOD CONUS sites are expected to become available soon. (Dennis Keyser)

For the NAM specifically, we are contacting Alaska Region to discuss the radiosonde at Shemya, AK (70414) that still launches too late for the NAM-GSI. AQUA AIRS data were either very low or unavailable for 40 hours on 2-3 November due to late posting of files on the NESDIS server. 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 the demise of the gyros and unusable products within 6 months. NESDIS engineers still need to conduct the last of three 24-hour tests where the corrupted navigation data will not be sent to NCEP. JMA continues to produce cloud-derived winds with MTSAT-1R due to a failure in the MTSAT-2 ground data processing system. The 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. 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) 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 Eric's parallel as an alternative to the current use of synthetic wind data bogus but this can only be done 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)

A single case retrospective test was made using the NEMS/NMMB with a 12 h NDAS, both with and without digital filter initialization (DFI). Running the DFI in the NDAS required a code modification to avoid doing precipitation adjustments while the model was in a filtering state. There were some indications of better fits of first guess surface pressure within the analysis and improved geopotential height errors and wind errors at longer-range forecasts, but generally the differences were quite small (expected with the three hourly analysis updates) and not always positive. This code has been provided to Eric Rogers for extended parallel testing. (Pyle)
The code to ingest GINI satellite imager data into NCEP's Fortran version of CIP algorithm has been completed. Coding work has started to ingest lightning data from US National lightning network. Coding work for the last dataset of CIP, the radar data ingest, will begin as soon as the work on lightning data is complete. (Mao)

Subtasks

11.5.17.1 Maintain hourly RR and four/day North American Mesoscale runs and provide SAV and AHP guidance. (30 Sep 11)

Parallel tests of the NEMS/NMMB model in the EMC NAM parallel system continue on the CCS. A cchronology of major changes in the NMMB real-time parallel control run and the experimental and nested parallel runs can be found here. 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, Alaska, Hawaii, Puerto Rico). During this quarter numerous changes were implemented into the control run: 1) replace USGS land-use with MODIS-IGBP land-use definitions, 2) change the GSI analysis 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 3) begin use of the 1/12th degree lat/lon high-resolution Real-Time Global SST analysis (RTG_SST_HR). In December several changes were made to the dynamics/physics, including enhancing the diffusion of cloud water and specific humidity 4x over its previous value. Changes were made to the microphysics to reduce grid-scale cloud fractions (Fc) by estimating Fc as a simple function of the cloud water and ice mixing ratios. The experimental parallel is testing the use of digital filter initialization in the NDAS forecast, using a +/1 40-minute integration window. (Rogers)

Several changes to the NAM parallel nested runs were made to eliminate problems. First, two changes (suggested by Zavisa Janjic and Matt Pyle) were made to eliminate CFL-like noise that was seen in the CONUS nest runs during early November: a) the divergence damping constant for the nested runs was increased by 33%, and b) slight off-centering was turned back on in the Crank-Nicholson vertical advection scheme. Second, at the recommendation of NEMS code developer Tom Black, the number of boundary blending rows in the Alaska nest was reduced from 5 to 3 to eliminate code hangs, since with 5 blending rows, a 2:1 grid space ratio for the Alaska nest to the parent and only 2 halo rows for the parent task, the blending region was too wide. When Alaska has its northern boundary extremely close to the northern boundary of a parent task then Alaska's blending region can completely cross from one parent task's integration region through that parent task's halo and into the next parent task's integration region, causing the code to hang. Routine daily runs of the movable on-call "fire weather" nest were also added to the experimental parallel. This nest will run to 360-h at 1.33 km resolution (if in CONUS) or 1.5 km resolution (if in Alaska). (Rogers)

11.5.17.2 Maintain four/day HRW runs and provide SAV and AHP guidance. (30 Sep 11)

NCEP maintains 4/day runs of WRF-NMM at 4 km and WRF-ARW at 5 km when there are no hurricane runs. Five domains are run with three large domains – East-Central CONUS (00z & 12z), West-Central CONUS (06z)

and Alaska (18z), and two small domains - Hawaii (00z & 12z) and Puerto Rico (06z &18z). (Pyle and NCO) A major upgrade to the HRW has been prepared and tested but is not scheduled for implementation until Q2 FY2011 (Mar 2011).

NCEP also maintains twice-per-day runs of six WRF-based members (3 running NMM and 3 running ARW) within the Short Range Ensemble Forecast (SREF) system. Aviation guidance prepared from the SREF is available from http://www.emc.ncep.noaa.gov/mmb/SREF/SREF.html, which now includes specific output for Alaska and Hawaii (eastern Pacific). (Du, Zhou)

11.5.17.3 Provide vendors with gridded model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway. (30 Sep 11)

NCEP maintained real-time availability of SAV and AIV guidance to all vendors from the operational 4/day NAM on pressure surfaces on the 80-km AWIPS grid #211 via the NWS Family of Services (FOS) data feed and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). Higher resolution grids (40-km grid #212 and 12-km grid #218) are also made available to FOS (and NOAAPORT) users. (DiMego)

11.5.17.4 Provide full grids from RR, NAM, and the HRW on NCEP and NWS/OPS servers. (30 Sept 11)

NCEP maintained real-time availability of full resolution gridded data from the operational 4/day NAM and HiResWindow (HRW) suite of WRF-NMM and WRF-ARW runs via anonymous ftp access via the NCEP server site at ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/nam/prod/ (on numerous grids) and at the NWS/OPS site at ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/. At the NWS/OPS site, the NAM data are in 4/day directories named MT.nam_CY.*hh* where *hh*=00,06,12 or 18; while the HRW data are in 4/day directories named MT.hires_MR.*mmm*_CY.*hh* where *mmm*=arw or nmm and *hh*=00,06,12 or 18. This includes hourly BUFR soundings (NAM only) and output grids, which undergo little or no interpolation. Both sites now contain only grids in GRIB2 format see http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml. HRW output will become available to NWS forecast offices with AWIPS OP9. A limited set of fields from the NAM and HiResWindow (HRW) runs (and other NCEP models) can also be viewed at http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/ (DiMego)

11.5.17.5 Maintain access to model verification data. (30 Sep 11)

NCEP maintained its capability and provided access to routine verifications of the operational RUC analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch (MMB) website: http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html (DiMego)

For the NAM paralel and seasonal forecast-vs.-observation statistics (operational NAM versus NMMB control run, started with 1 June 2010 since the change with the biggest impact [multiple boundary rows] was put into the control run on 5/17/2010. Online summaries can be found by clicking June-August 2010 and September-November 2010 . Seasonal statistics for nests (operational NAM vs. NMMB parent vs. CONUS/Alaska nests), end date is when we switched from purely explicit convection to BMJ_DEV (light amount) can be found by clicking 12 July - 30 August 2010 . (Rogers, DiMego)

Deliverables

11.5.17.E1 30 September 2011 (Keyser, Liu)
Perform ingest, quality control and preparation of both existing and new observations in support of the operational RR, NAM, and HiResWindow runs.

CURRENT EFFORTS: See also the obs related items reported under Task 11.5.1 especially Deliverable E1. Since the RR has an extended domain including Alaska and some ocean areas, most of the following also apply to the Rapid Refresh. Alaska Region was contacted about Shemya radiosonde (70414) whose launch time is too late for the NAM-GSI and RR, but we have no response to date. JMA was forced to switch its cloud-derived wind production from MTSAT-2 to MTSAT-1R from 7 October to 22 December due to a failure in the MTSAT-2 ground

data processing system. GOES-13 radiances are monitored but will not be used until the next NAM update. METOP-2 polar satellite data (all instruments) was lost for 12 hours on 15 October, 3 hours on 2 December, 7 hours on 4-5 December, 4 hours on 18 December, 14 hours on 22 December and 13 hours on 23-24 December. 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. AQUA AIRS data were very low or unavailable on 2-3 November due to late posting of files on the NESDIS server. NOAA-18 has on-going gyro issues that could lead to the demise of the gyros and unusable products within 6 months. NESDIS engineers still need to conduct the last of three 24-hour tests where the corrupted navigation data will not be sent to NCEP. NCEP corrected its ASCAT processing on 9 November to handle a 14 September upstream processing change in wind solutions. 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, ASCAT winds, and MDCRS moisture data. NAM/NDAS and RTMA PrepBUFR files are being generated in parallel with 50 km ASCAT and WindSat scatterometer wind data (both non-superob) and NAM/NDAS dumps of METOP IASI radiances, GPS radio occultation data and SBUV-2 data are being created. All of these are being tested in Eric Rogers' real-time parallel NDAS/NAM. 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 Eric's parallel as an alternative to the current use of synthetic wind data bogus but this can only be done at the t-12 hour start time of the NDAS. A legacy restriction (that only surface data with a reported pressure are processed) is 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.

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. ASCAT and WindSAT data dump time windows have been moved back 30 minutes to try to obtain more data for the RR. The AQUA AIRS and NOAA/METOP AMSU-A, AMSU-B, HIRS-3/4 and MHS, radiance dump time windows were moved from back 1 hour (to 3 hours prior to cycle time) to try to obtain more data for the RR. 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 being 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 Geoff Manikin's RR parallel being run at NCEP. Langley cloud data was unavailable on 18 and 20 October, 6-8 November and 24 December due to NASA server issues and from 17-21 December due to planned power outage at Langley. In November, Radar Operations Center (ROC) started 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 to increase the receipt of Level 2 88D radar data is being discussed with NCO. Level 2 data from 8 DOD CONUS sites are expected to become available soon. (Keyser)

CIP transition work continues. Two more of the six data sets fed into CIP are now done as the data ingest codes for GINI satellite imager data and lightning data have been finished. The code for Unisys radar basic reflectivity data ingest (the last data set) is almost done. (Mao)

PLANNED EFFORTS: Follow up with Alaska Region about Shemya radiosonde (70414) launch time. Add the use of AIRS AMSU-A radiances to the next NAM-GSI update. Add a new NRL aircraft quality control module after NCO BUFRLIB is updated. Change PrepBUFR processing to add report sub-type information for development of bias corrections. Develop a "master use/reject-list" to control what incoming data are assimilated. Complete NAM and RR impact tests for TAMDAR (AirDAT feed); mesonet mass and roadway data, and new mesonet data feeds (including "hydro", "snow", modernized and SHEF COOP, UrbaNet, wind energy and late-arriving mesonet data); MDCRS aircraft moisture (including WVSSII instrument on Southwest aircraft); TAMDAR aircraft moisture; NPN and MAP and European RASS virtual temperature profiles; JMA, Hong Kong, European, Canadian, MAP (below 400 mb), and 6-minute NPN profiler winds; GOES 3.9 micron, GOES visible, and AVHRR POES satellite winds; hourly GOES IR and water vapor winds (replacing currentl3-hour time frequency); WindSat and ASCAT scatterometer wind data; METOP IASI, and in the case of RR, METOP 1b, radiances; ozone from NOAA-series SBUV-2 and METOP GOME-2; GPS radio occultation data; SSM/IS wind speed and total precipitable water products; SSM/IS and TRMM/TMI rain rate; METEOSAT-9 IR and visible satellite winds; NOAA-19 AMSU-A, MHS and HIRS-4 radiances; RARS 1c radiances (to fill in gaps in NESDIS 1b ATOVS radiances); VAD winds from QC'd NEXRAD Level 2 data; GOES-13 and -14 radiances and winds; 10 meter wind speed from JASON-1

and -2 satellite altimetry data; lightning data from BLM network over Alaska and W. Canada; "tcvitals" records for tropical cyclones. Coordinate with the field to speed up more Alaskan RAOB processing. Maximize Alaska data retrievals (especially mesonet, aircraft and coastal surface including reports in SHEF format). Add GSI events to NAM PrepBUFR files. Let GSI use the actual or estimated anemometer, barometer and thermometer heights on ships. Generate and QC high vertical-resolution aircraft profile data near airports. Work with NCO to bring in new radar data sources (TDWR, Tail Doppler Radar from hurricane hunter P3 aircraft, Canadian, CASA, additional DOD sites). Examine possible use of mixed-satellite (Aqua and Terra) MODIS winds, which have better coverage and timeliness than the current single-satellite MODIS winds. (Keyser) Continue working on CIP and WAFS, start Mountain Wave work. (Mao)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A severe backlog has developed in the implementation schedule on the NCEP computers.

INTERFACE WITH OTHER ORGANIZATIONS: ESRL/GSD & NCEP/NCO & NWS/Alaska Region & NESDIS

UPDATES TO SCHEDULE:

11.5.17.E2 30 September 2011 (Manikin, ESRL/GSD)
Perform configuration management for RR, including thorough documentation, and respond promptly to any code malfunctions or performance issues.

CURRENT EFFORTS: RR is not yet running in NCEP Production. No problems were detected during parallel testing this last quarter.

11.5.17.E3 30 September 2011 (Manikin, Pyle, Rogers, ESRL/GSD)
Monitor RR, NAM & HRW performance, respond to any problems detected by ESRL/GSD, NCEP, or any users, diagnose source/cause of the problem, develop solution, test changes and coordinate with NCO on implementation.

CURRENT EFFORTS: A significant change package for the HRW was handed off to NCO on 12/14 with a targeted implementation in FY11Q2 (March 2011). The package includes an upgrade to the version of the WRF forecast model from v2.2 to v3.2, with the ARW and NMM cores each now using their version of more conservative moisture advection. Forecast BUFR soundings are also reintroduced to the HRW, and a new hybrid ensemble system will generate high-resolution probabilistic guidance. Several new GRIB products of interest to severe weather, air quality, fire weather, and wind energy meteorologists are being added as well. The grid spacing remains unchanged at 4.0 km for the WRF-NMM and 5.15 km for the WRF-ARW, and the domains remain the same with the exception of Puerto Rico (expanded by about 50% to cover Hispaniola) and the addition of a new domain for Guam. (Pyle)

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE:

NCAR

CURRENT EFFORTS:
During this quarter NCAR/MMM planned the next WRF tutorial, which will be Jan. 31–Feb. 8, 2011. The tutorial will cover both WRF structure and operation and the MET (Model Evaluation Tool) verification package.

NCAR/MMM led the preparations for the next WRF major release, V3.3. Code for new features was accepted and integrated into the WRF repository. A pre-release version to friendly users will be made in the next quarter and testing will be conducted. The target date for the release is 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. Example of physics options added in this quarter are: (i) the new Goddard shortwave and longwave radiation schemes; (ii) the New Simplified Arakawa-Schubert (NSAS) deep convection scheme; and (iii) the Tiedtke deep convection scheme.

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.

Dudhia obtained the Lin-Colle (Stonybrook University) microphysics scheme. The code was tested and added to the WRF repository for the V3.3 release.

Dudhia worked with NCAR/MMM visitors Thara Prabhakaran and Dipu Sudhakar (Indian Institute of Tropical Meteorology) to evaluate how bulk and bin microphysics schemes compare with aircraft observations of clouds affected by aerosols. Work was also done using WRF-Chem to diagnose the effects of dust transport on radiative heating. In radiation physics, Dudhia obtained a UCLA radiation scheme (Fu, Liou, and Gu) for the next WRF release.

Dudhia evaluated surface wind biases in 2-km simulations in a large, multi-year northern Spain dataset from NCAR/MMM visitor Pedro Jimenez. The two identified ways to improve WRF surface wind output in complex terrain based on topographic properties.

Dudhia obtained the SSiB land-surface model from UCLA and evaluated the code's standards for WRF. Its addition to the WRF repository has been postponed. Dudhia also obtained an updated version of CLM3.5 land scheme in WRF V3.2.1. This scheme will be made available in a tar file supported by the developer (Jimimg Jin, Utah State) that will be separate from the V3.3 release.

In convective parameterizations, Dudhia obtained Wayne Angevine's (NOAA/ESRL) TEMF (Total Energy Mass Flux) PBL/shallow convection scheme. The code was tested and then added to the repository for the V3.3 release. Dudhia also added to the repository the CESM climate model's parameterizations for deep and shallow convection, as well as its PBL scheme. These were obtained from Bill Gustafson and Jerome Fast at PNNL. The deep convection option is the Zhang-McFarlane scheme, and the shallow convection and PBL schemes are the Bretherton and Park (Univ. of Washington) schemes.

Lastly, Dudhia worked with Steven Cavallo (NCAR/MMM) to add an ozone capability to the ARW. This would allow the ARW to ingest or initialize ozone analyses (instead of climatological ozone) and to interact with radiation. Work was also done to add an upper boundary radiation fix to the RRTMG scheme, matching the work done on the older RRTM scheme last year.

PLANNED EFFORTS: The development and implementation of new physics for WRF will continue through FY11Q2.

UPDATES TO SCHEDULE: NONE

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

ESRL/GSD

Through much of the quarter, an intensive effort was directed toward freezing the Rapid Refresh code in preparation for several weeks of testing by EMC. This testing got underway at EMC on 1 December and continues at this writing. This is necessary to verify that the RR test cycle at EMC performs at least as well as the operational RUC prior to submission of the Request For Change (RFC) to NCO for the RR to replace the RUC. Nearly daily coordination telecons between RR developers at GSD and Geoff Manikin of EMC occurred through much of the quarter. Work this quarter produced a Rapid Refresh configuration at GSD that is systematically

superior to both the backup RUC at GSD and to the operational RR-NCEP. This near-final configuration was moved to EMC in late November, although an important change to improve RH forecasts was added in late December.

Verification of the EMC test cycle in early December confirmed the presence of a high bias in mid-upper tropospheric relative humidity that we had seen at GSD, and subsequent retrospective and parallel testing at GSD confirmed it was related to the building of clouds from the GOES-based cloud data and related to uncertainty about the actual saturation water vapor in the -10 to -30C range.

Aside from this, no code changes for GSI or WRF have been made to the EMC Rapid Refresh since 1 Dec although some smaller mods have been made regarding post-processing and access to higher-resolution sea-surface temperature data.. The excellent reliability of both the primary and developmental RR cycles, plus the capability of making short retrospective runs and the quick verification tools available to the RR development team were crucial to overcoming the numerous issues that were unresolved at the beginning of the quarter, or arose during the early part of the quarter. Some of the major ones include

- Discovering and fixing a major bug in the "curvature term" in the WRF model code when the Rotated Lat-Lon (RLL) option is used;
- Change in background error covariance to that from GFS (instead of NAM) and change to GSI scale parameters after experiments to optimize these values for the Rapid Refresh;
- Encountering a serious forecast initialization problem that arose in WRF when, as in RUC, we initialized the free forecast with the water-vapor mixing ratio and hydrometeor fields coming directly from the analysis, rather than with the time filtered versions of these fields coming from the DFI. Until this problem is solved better in WRF (for “Rapid-Refresh-2”), we are using the time-filtered fields of all dependent variables to initialize the free forecast;
- Fixing a bug in the Grell shallow convection scheme;
- Addressing various post processing issues at NCEP.

More details on these can be found in Task 4 discussions in the FY11 October and November monthly reports. A change log on the ESRL primary RR 1h cycle is maintained at http://ruc.noaa.gov/internal/RR_runs/RR_1h_info.txt.

At the request of other AWRP PDTs we continued to add a few output variables to UniPost. Except for a lingering difficulty with producing GRIB2 files on the RR lat-lon grid at NCEP that is being addressed, we believe Rapid Refresh enhancements to UniPost are now complete.

Subtasks

11.5.4.1 Ongoing (GSD, NCEP)

Ongoing evaluation of performance of real-time and retrospective runs of RR system for SAVs, AHPs
ESRL: The RR 1-h cycles at GSD on the Rotated Lat-Lon domain now verify consistently better for RMSVE winds, RMS temperatures aloft and relative humidity than either the operational RUC or the backup RUC at GSD. Further, the EMC RR cycle (“RAPX”) is equivalent to or a bit better than the operational RUC. –Applying the analysis increment at the lowest model level to both 2-m temperature and skin temperature reduced a 2-m temperature bias at 00h noted early in the quarter. This improves the diurnal cycle of temperature overall, but we do still find that for certain land-use categories (e.g., deciduous forest) that the diurnal cycle is too suppressed. However, temperature verification scores show generally slightly better verification for the EMC RR cycle than the operational RUC.

EMC: Work was done during this quarter to address some of the problems noted during the fall, and statistical skill scores indicate that the model is now performing well enough for the formal evaluation to begin sometime in late January. The biggest issue had been a very low bias for upper level geopotential height fields, and an error in the code that reads in the moisture terms critical to the computation was found and corrected in December. Other issues were with the specification of the native grid and with tuning the GSI, and these have also been corrected. The most significant remaining issue is a moist bias in mid-level relative humidity. It is believed that

the building of cloud causes this during the assimilation, and tests in late December to limit this building were promising. (Manikin)

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.

As noted above, the RR was undergoing frequent updating through November, so coherent evaluation by users was not possible until December. However, pgrb, sgrb and bgrb files are now available in GRIB1 from the EMC test RR cycle output, and we expect to receive more feedback from the other PDTs during the next few weeks.

11.5.4.2a (EMC)
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)

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 in January 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: Work has been done to generate RUC "look-alike" grids in the Rapid Refresh. EMC worked with GSD to add all parameters to the post processor and write code to generate precipitation accumulation fields in the RR that match those from the RUC. All grids and parameters available in the pressure level output grids in the RUC will be available in the RR, although some of the fields may be in a different order. These “look-alike” files covering the CONUS are now available for ftp at ftp://ftp.emc.ncep.noaa.gov/mmb/mmbpll/rap. Coordination has also been done with the FAA to test Rapid Refresh versions of the special files with WMO headers currently used by the FAA. Initial testing in December revealed some issues that are being corrected, with full testing planned for late January. (Manikin)

PLANNED EFFORTS: Add files to cover the entire domain and those for Alaska to the server in January. At this time, the formal evaluation by RUC users will begin.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: NCO, ESRL & FAA.

UPDATES TO SCHEDULE:

11.5.4E2 (31 August 2010) (Manikin)

Code transferred to EMC for Rapid Refresh upgrade change package to be implemented in early FY12.

CURRENT EFFORTS: Work was done to address some of the problems noted during the fall, and statistical skill scores indicate that the model is now performing well enough for the formal evaluation to begin sometime in late January. The biggest issue had been a very low bias for upper level geopotential height fields and an error in the code that reads in the moisture terms critical to the computation was found and corrected in December. Other issues were the specification of the native grid and tuning the GSI, and these have also been corrected. (Manikin)

PLANNED EFFORTS: The most significant remaining issue is a most bias in mid-level relative humidity. It's believed to be caused by the building of cloud during the assimilation, and tests in late December to limit this building were promising. (Manikin)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: ESRL.

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

Based on group work spearheaded by Ming Hu, a frozen version of the GSI for the Rapid Refresh implementation was obtained in November. The biggest change was to switch from use of a NAM-based background error covariance (BEC) file to a GFS-based BEC file. Based on detailed comparisons of single-observation analysis increments from GSI using the NAM and GFS BEC files, Ming made changes to the GFS BEC specification (changes to the amplitude and vertical correlation length scale) that resulted in equal or slightly superior RR forecasts from the GFS BEC compared to the NAM BEC. Rapid testing and evaluation of these changes was greatly facilitated by Haidao Lin's retrospective runs from a May 2010 5-day test case and application of Bill Moninger's radiosonde verification package. Additional testing and evaluation was completed using the two parallel real-time RR cycles at NCEP. Updated code was then passed to Geoff Manikin's real-time RR cycle running at NCEP.

Geoff Manikin's RR cycle has been running in a stable configuration since early Dec. with detailed quantitative and qualitative forecast evaluation ongoing. This evaluation has included statistical verification by Geoff as well as porting Geoff's files from Geoff's RR back to ESRL for ingest into Bill Moninger's (ESRL) upper air verification database. In addition, Geoff Manikin's real-time RR/RUC comparison webpage (with analysis increment and RR-RUC difference plots) has been extremely helpful in evaluating RR forecasts. One remaining item that emerged from this analysis was a high RR bias and larger RMS for mid- and upper-level moisture. Work by Ming Hu lead to a modification in the treatment of cloud top data that resolved this issue, leading to an improved mid- and upper-level moisture forecasts for the RR compared to the RUC. The change was to use a combination of NESDIS and NASA (larger coverage) products to just trim excess cloudiness in the Rapid Refresh background field. The change was made first in the GSD RR cycle, then transferred over to Geoff Manikin's EMC RR cycle on 29 Dec. 2010.

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. 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). Overall RR statistics continue to look quite good compared to the RUC and the Geoff Manikin's parallel evaluation continues.

OLD NEW

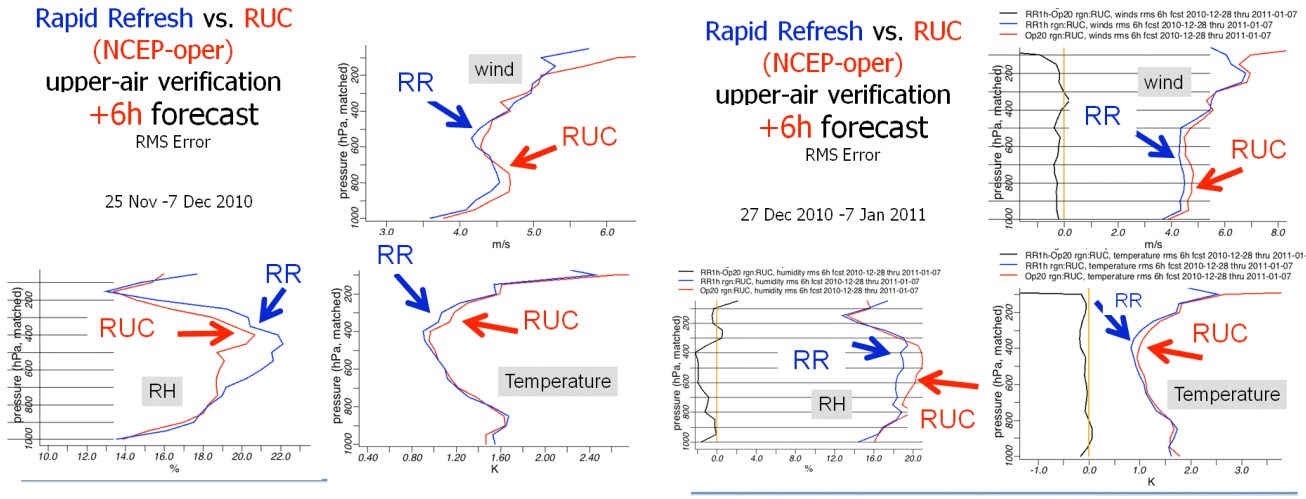

Fig. 1. Comparison of 6-h forecast Rapid Refresh (GSD) vs. NCEP-operational RUC upper-level verification for two periods, 25 Nov – 7 Dec 2010; and 27 Dec 2010 – 7 Jan 2011. Upper level wind and temperature RMS errors are smaller for the RR at both times, while the significant improvement in the RR upper-level RH forecast skill (relative to the RUC) from the first period to the 2nd is quite evident. This improvement is from the change made to the treatment of satellite cloud top information in the RR GSI cloud analysis.

Additional GSI-related work has focused on testing of a vertical interpolation and vertical re-integration following the 3DVAR analysis step to better preserve hydrostatic balance. Ming Hu implemented these adjustments in GSI and Haidao tested them in his retrospective experiments, but only found very slight impact. Haidao has also used his RR retrospective test period to evaluate the impact of satellite radiance (AMSU-A/B, HIRS, MHS) data on the RR forecast. Results from the first test showed near neutral impact. Analysis of the channel biases indicate sub-optimal performance of the bias correction scheme, which will be addressed in future experiments.

GSD personnel (Stan Benjamin, Ming Hu, Haidao Lin, Steve Weygandt) visited NCEP in early December for the Product Suite Review (presentation on RUC/RR/HRRR and discussions with NWS users). The presentation can be found at: http://www.emc.ncep.noaa.gov/annualreviews/2010Review/
GSD personnel also discussed various aspects of GSI for regional application with NCEP GSI researchers.

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

Over the past quarter, two parallel experiments, one using GSI analysis and the other using EnKF, have been conducted and successfully completed. The test domain contains 207x207 grid points, which uses the same configuration as RR except with reduced horizontal grid spacing of 40km. Both GSI and EnKF were run with a 3-hourly assimilation cycle for a test period over a week starting from May 8 2010. To better understand the EnKF configuration, a set of experiments using different parameters in EnKF have been run and the results were compared with GSI. It was found the forecast innovation were most sensitive to the inflation factor. With a fixed inflation of 1.2 plus an adaptive inflation factor a parameter of 20% were used to recover 20% of the first guess spread in the analysis spread), the EnKF's first guess errors (i.e., 3 hour forecasts) are comparable to that of GSI.

In October, a new branch for regional EnKF had been created in the DTC GSI Repository and the regional EnKF package (named as EnKFv1 below) was checked in. In December, we merged regional EnKF with the latest global EnKF, by moving codes specific to regional EnKF into a unified version (named as EnKFv2 below). And a new flag 'iflagreg' was added to control the regional analysis option. In this unified version, the variables updated during the regional EnKF assimilation were x-component wind (U), y-component wind (V), potential temperature (T), perturbation geopotential (PH, not used in the previous EnKF version), water vapor mixing ratio (Q) and dry mass surface pressure (Ps). These variables are the same as WRF atmosphere prognostic variables. Due to the coarse resolution and that only conventional data were assimilated, other WRF prognostic variables such as the microphysics variables, cloud water, ice and rain, snow, hail were not updated. In addition, satellite interface has been tested, and its correctness is still under examination.

A set of experiments with different parameters has been carried out using EnKFv2. As in EnKFv1, the 3-hour forecast error measured by the innovation of the first guess is most sensitive to the inflation approach. When only adaptive inflation methods was adopted, the spread of EnKF is too small and the 3-hour forecast error quickly diverge. At the end of analysis cycle (9 days), the 3-hour forecast error of EnKF is twice as big as GSI. With an extra fixed inflation, the 3hour forecast error of EnKF was stabilized as the GSI. However, the forecast error of EnKF is still a little higher than GSI. Fig.1 shows the vertical profiles of the averaged 3-hour forecast innovations of EnKF and GSI from May 8 to May 16 2010. In the experiments EnKFv2mu, we further used the column perturbation dry air mass (MU) instead of dry mass surface pressure (MU+MUB+ptop) as analysis variable. Slightly improvement has been found through this modification. Overall, GSI performs better than EnKF in the middle and upper level and their differences are small in the lower atmosphere. While these tests show regional EnKF codes work properly, we will be doing more tunings for the EnKF. We used 600km horizontal cut off radius in the EnKF analysis, which is likely, too small in current experiment configuration and the adaptive inflation coefficient of 0.2 is also subject to tuning.

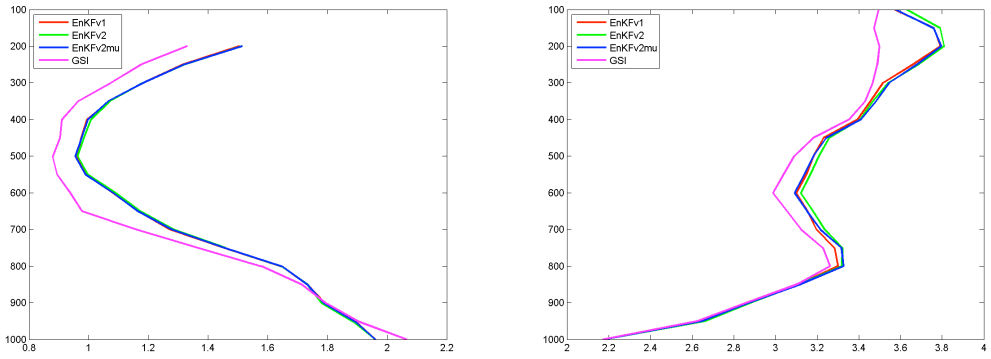

Fig.2. Vertical profiles of 3-hour forecast innovations against all the observations (a) potential temperature (b) x-component wind.

The CAPS team (Kefeng Zhu, Xuguang Wang and Ming Xue) welcomed a new post-doctoral Yujie Pan this quarter. She will be working on the hybrid GSI-EnKF for RR applications. Now she is conducting single observation increment experiment to further test the EnKF. Officially released single-point observation test module in GSI will erroneously pass the same innovation for each member to EnKF and lead no increment during the EnKF analysis. To solve this problem, program writing a real observation of a single point with a fixed observation value in prepbufr format has been developed. Compilation of GSI and the parallelization partition of EnKF were further adjusted to make the one observation test work. In the regional GSI for WRF ARW, the observation errors are forced to use an external static error table instead of using the observation error in the prepbufr file. In order to conduct the single observation test with a given observation error, we further modified the GSI code (gsimode.f90).

In this single-observation test, the ensemble mean 3-h forecast that was obtained after 2 days' data assimilation cycles was used as the background for both the EnKF and GSI. Fig.2 illustrates the resultant analysis increment for temperature and wind after assimilating a single temperature observation at 700 hPa at 35.23 $^\circ N$ and 262.56 $^\circ W$, with a 1K-observation increment and an observation error of 0.8K. The left two columns are

increments (analysis minus background) of the GSI, and the right two columns are increments of the EnKF. The increments are interpolated from terrain following coordination to height coordination. The distribution at low-level increment is contaminated by steep terrain near the southwest boundary. Note that, because of the flow-dependent cross-variable error covariance provided by the e EnKF, U from EnKF, with peak of 0.343 m/s, is almost four times of that from GSI. The same is true for V. The magnitude of temperature increment of EnKF is 0.25k, about half of GSI.

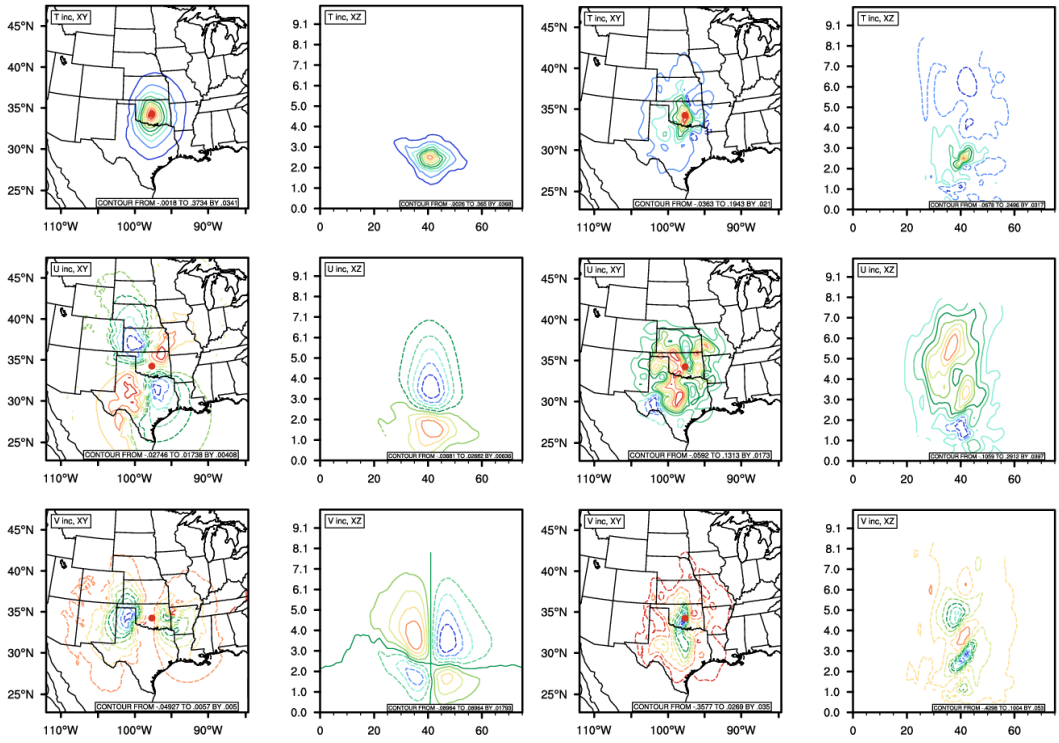

Fig.3. Distribution of increments (analysis minus background), left two columns are from GSI, while right two columns are from EnKF. The first and third columns are at 700 hPa, the second and forth are cross section. The first row is temperature increment, the second is U, and the third is V.

NCEP

Work continues on use of hybens GEFS NMMB GSI (hybrid ensemble GSI for NMMB using GEFS ensembles directly for the ensemble part of the background error). After much effort and help from Edward Colon and Brad Ferrier, successful runs were obtained with the NMMB-GSI launcher including the hybens GEFS NMMB GSI. Preliminary results from one case, 20100501 (Tennessee floods), show some sensitivity of forecasts to the inclusion of GEFS information. However, this is only one case and it isn't clear if the impact is positive. The hybens GEFS NMMB GSI has been run in a parallel by Wan-Shu, and shows a small but very consistent positive impact (compared to Eric Roger's NMMB NDAS parallel) for the NDAS for fits of 3 hour forecast winds to observations, especially at upper levels. There is also some improvement in the fit to moisture observations, while temperature is neutral and surface pressure has a consistently negative impact. No parameter tuning has been attempted yet. (Dave Parrish)

Studies continue on the impact of the analysis grid size and results show grid size can be doubled without degradation to the forecasts, which will help to reduce the computational requirements when we move to a hybrid-ensemble technique. MAP wind usage is being limited to levels below 400mb and the latest NEMSIO library has been tested with the GSI code. A failed GSI job was traced to the use of GPS data. Although ASCAT winds were turned on in GSI analysis, a QC flag in the prepbufr files prevented their use. The observational errors were provided to D. Keyser and the flag has been fixed and the code updated. D. Keyser also found an error in the observational error table that W. Wu fixed. The hybens GEFS NMMB GSI was incorporated into the off-line parallel and preliminary results were encouraging. (Wan-Shu Wu)

Work continues on the 20101027-precipitation case to examine the impact on the forecast from assimilating VAD wind and radial wind. A detailed analysis was also done to identify the improvement in PCP ETS score for low thresholds after assimilating radial winds. Work continues on full vector wind retrievals from radar radial wind to get a tangential wind. These retrieved winds are compared with VAD winds. Efforts continue to create an interface so that GSI can read in the retrieved wind. (Shun Liu)
Using cross-validation, the covariance models used with the Alaska RTMA parallel have been fine-tuned. Code that generates mesonet station use lists for the Alaska RTMA on a periodic basis was also developed. Bugs have been fixed that were introduced into the 2DVAR option of the GSI subversion code while adding the 'bundle coding format'. (Pondeca)

Subtasks

11.5.5.1 Refine the radial velocity analysis component of GSI and determine the optimal decorrelation scales for different analysis passes. (30 Nov 11)

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 temporally and spatially so that the observation numbers from both the new and old VAD winds are similar. The new VAD wind still shows a lower RMS compared with the guess field. Work continues with NSSL to 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 old/new VAD wind against the guess cannot determine the quality of new VAD wind since there is no ground truth. VAD winds from five locations were checked, and in most cases the new VAD winds are better than the old. (Liu)

11.5.5.3 Report on testing of 2DVAR GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 2.5-km resolution. (31 May 11)

The domain for the Northwest RFC-RTMA, which will support operations at the Northwest River Forecast Center, has been configured. The covariance models used with the Alaska RTMA parallel have been fine-tuned using the cross-validation technique as a means to improve the quality of the analysis, following feedback from forecasters. Work has also started to configure a separate high resolution RTMA for the Juneau-CWA, where topographic complexity represents a challenge for the RTMA-2DVar even at the double resolution of 3 km so the Juneau domain will run at 2 km. Work has been started on a stand-alone downscaling code that can be applied to any model to generate first guess fields for the RTMA. In particular, the code will be used to test the downscaling of the HRRR model fields. Code was developed to generate mesonet station-uselists for the RTMA on a periodic basis. Bugs introduced in the 2DVAR option of the GSI subversion code while adding the 'bundle-coding format' have been fixed. (Pondeca)

11.5.5.4 Adapt Desrozier et al. techniques to RR and apply to refine observational error and background error covariance estimates within the GSI. (30 Jun 11)

Not worked on this quarter. (Wu)

11.5.5.5 If authorized by NCEP Director, implement initialization of HiResWindow runs using CAPS/Shun Liu improved techniques for radial velocity analysis in GSI together with Diabatic Digital Filter use of 88D reflectivity Mosaic. (31 Jul 11)

Differences between radar level-2 data, level-2.5 data and level-3 data are being checked. GSI codes were modified to monitor the three data types. Differences between data in the radar volume scan are also being checked. Because codes have been frozen since 2009, the HiResWindow implementation will not include any new initialization. Testing will continue targeting 2012 upgrade. (Liu)

11.5.5.6 Based on case-study testing and refinement of the research quality code, deliver result in an 'experimental' code for an upgrade package (e.g. strong constraint, improved satellite channel bias

correction, improved use of WSR-88D radial wind and/or satellite radiances and/or retuned covariances to the GSI for FY2011 change package to the NAM. (31 Jul 11)

Studies on the impact of the analysis grid size show that the grid size can be doubled without degradation to the forecasts, which will help in reducing the computational requirements when running a hybrid-ensemble analysis. A failed GSI job was traced to the use of GPS data and a fix was added to the GSI. Although ASCAT winds were turned on in GSI analysis, a QC flag in the prepbufr files prevented their use. The observational errors were provided to Dennis Keyser and the flag has been fixed and the code updated. Keyser also found an error in the observational error table, which was fixed. The hybrid-ensemble GEFS NMMB GSI was incorporated into the off-line parallel and preliminary results were encouraging. A case study showed that the ensemble contribution incorporated the flow blocking effect on the analysis increments, which was not observed in the analysis with the traditional isotropic background error. The results of parallel NDAS test on the hybrid-ensemble GSI showed positive impact on the winds and humidity but negative on the surface pressure. (Wu)

Deliverables

11.5.5.E1 15 Sep 2011 (Manikin)
Pending EMC, and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit GSI code as part of late 2011 upgrade for Rapid Refresh software to NCO.

CURRENT EFFORTS: A comparison between the new and old VAD BUFR files is underway. Bugs introduced in the 2DVAR option of the GSI subversion code while adding the 'bundle-coding format' have been fixed. A failed GSI job was traced to the use of GPS data and a fix was added to the GSI. The hybrid-ensemble GEFS NMMB GSI was incorporated into the off-line parallel and preliminary results were encouraging.

PLANNED EFFORTS: Continue work with NSSL to identify the quality of new VAD wind by checking the differences between the new and old VAD. Check differences between radar level-2 data, level-2.5 data and level-3 data, and between data in the radar volume scan.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A severe backlog has developed in the implementation schedule on the NCEP computers.

INTERFACE WITH OTHER ORGANIZATIONS: NCO

UPDATES TO SCHEDULE: DELAYED INTO 2011. None.

11.5.5.E2 30 Sep 2011 (Wu, Parrish, Rogers)
Subject to NCEP Director approval implement NEMS/NMMB version of GSI (e.g. strong constraint, revised bkgs+obs errors) in NAM/NDAS.

CURRENT EFFORTS: The new analysis package, including a new GSI version that improves CPU consumption, new observational and background error covariance's, the use of new observations (RASS virtual temperatures, MAP winds and ASCAT winds) and uniform (high resolution) thinning for satellite radiances, has been tested in an official parallel in preparation for the implementation. An emergency fix preventing the use of GPS-RO data, limiting MAP wind usage to levels below 400mb and an upgrade to use the latest NEMSIO library were included. (Wu, Rogers)

Offline NDAS parallel tests of GEFS in the NMMB hybrid GSI show a consistent small improvement in 3 hour forecast fit to winds and relative humidity, with neutral results for temperature and a negative impact for surface pressure. Isolated NMMB/GSI launcher tests show no consistent improvement yet to free forecasts from the addition of ensemble information. A fix was made to adjust GEFS surface pressure perturbations from GEFS terrain to NMMB terrain. This had negligible impact in the offline parallel NDAS tests, and a still negative impact for 3 hour forecast fit to surface pressure observations. These results will be presented at the AMS NWP/WAF conference this January in Seattle. (Parrish)

Work continues on wind retrievals from radar radial wind to get a tangential wind. These retrieved winds are compared with VAD winds. An interface was created so that GSI can read in the retrieved wind and a forward model of tangential wind was built into GSI. Limited tests of assimilating tangential winds were finished and the bias of tangential wind is larger than expected. Work continues on the 20101027-precipitation case to examine the impact on the forecast from assimilating VAD and radial winds. A detailed analysis was also done to identify the improvement in precipitation ETS score for low thresholds after assimilating radial winds. Parallel experiments of radial wind assimilation for HRW ran over 60 days, and positive impacts were still found in PCP-ETS verification. The verifications were extended to UPAIR, SUFACE, and ANYAIR, but mixed results were found in those forecast scores. Small negative scores were found in UPAIR verification. Small improvements were found at lower levels (<500 hPa) in the ANYAIR verification. (Liu)

PLANNED EFFORTS: Adjust the usage of radar data among levels 2, 2.5 and 3. Check the verification scores of radial wind assimilation for HRW again after another 30 days. Begin work on reflectivity assimilation. (Liu, Wu, Rogers) Run tests in the NDAS parallel with full 84hr forecasts and verification. (Wu) Fix adjoint bug in dual resolution capability to reduce run time. Help Jacob Carley add NMMB generated ensemble input to the NMMB hybrid GSI, initially for use in assimilation of radar reflectivity at storm scale resolution. (Parrish)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: This is a new and relatively immature capability so expectations should be tempered. A severe backlog has developed in the implementation schedule on the NCEP computers.

INTERFACE WITH OTHER ORGANIZATIONS: GSD, NCO

UPDATES TO SCHEDULE:

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

GSD

In the course of setting up the EMC Rapid Refresh cycle, uninitialized variables were discovered in the shallow convection scheme that prohibited compilation on the NCEP IBM. Fixing this bug early in the quarter allowed this scheme to be run at EMC. During FY10Q4 it had been determined at GSD that activating the shallow convection scheme reduced a substantial high bias in mid-level temperatures by reducing upper-level cloud cover.

GSD received bug fixes from Greg Thompson of NCAR in November for the Thompson microphysics scheme, and implemented this new version at both GSD and EMC. These fixes, affecting mainly graupel production and rain evaporation, had little effect based on comparison tests on the RR domain, but were more important for higher resolution runs (e.g., HRRR). GSD also tested a new version from the WRF repository of the MYJ PBL (planetary boundary layer) scheme in the 5-day May 2010 retro period, where it showed small positive effects. It was also implemented in the test cycle at EMC during November.

Verification of 2-m temperature and dew point as a function of land-use category has shown surprisingly large systematic differences in forecast behavior as a function of land use. For example, in the fall season, deciduous forest areas demonstrated a markedly suppressed diurnal cycle in temperature over the observed. This contributed to our decision to apply the lowest-layer temperature increment from the GSI analysis to the 2-m and skin temperatures also, with the result of improving the diurnal cycle. We will continue to use this information about performance as function of land use as guidance for identifying problems in the land-surface and surface-layer/boundary-layer schemes.

Joe Olson continues testing of the Mellor-Yamada-Nakanishi-Niino PBL scheme on smaller RR and High-Resolution Rapid Refresh (HRRR) look-alike domains. An improved formulation for combining the mixing lengths appropriate to the surface layer and the free atmosphere has shown good promise of improving wind forecasts in the boundary layer without causing poorer wind forecasts aloft. A retrospective RR test to compare performance of this scheme to the current MYJ is planned.

NCAR

Trude Eidhammer presented a poster for the American Geophysical Union meeting entitled: “Modeling of dust impact on precipitation via heterogeneous ice nucleation”. This poster describes the impact of the new dust ice nucleation scheme on the April 2010 winter storm. This is a storm which dust was observed to be generated in the desert southwest and likely impacted the storm.

She has also been examining reasons for the production of unexpected precipitation in the model simulations in regions when dust ice nucleation was included. It seems that model induced gravity waves during the spin-up time is a likely source of the problem. This “model induced” precipitation difference then makes it difficult to determine the physical based differences in precipitation. A solution to this problem is being worked on.

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

The RR with the frozen GSI version (including the cloud analysis) is yielding good forecast skill for ceiling and visibility variables (see ceiling verification slide in the NCEP Product Suite Review presentation slides: http://www.emc.ncep.noaa.gov/annualreviews/2010Review/, even though we are not resetting the cloud and relative humidity fields to the pre-DFI values in observed cloudy regions following application of the DFI in the WRF ARW initialization. In the RUC system, these fields are reset, following the DFI to help retain (in the model forecast) the clouds information added during the cloud analysis. Within the Rapid Refresh system, this resetting was previously found to cause some imbalance within and degradation of the RR forecasts (winds and other fields). Given the high skill of the RR cloud forecasts even without this reset of the hydrometeor and relative humidity fields, this change was deemed not critical for the RR implementation. Determination of the cause of this

imbalance remains a priority, however, as resetting the fields may yield additional cloud forecast improvement in the RR and may be important for the HRRR 3-km radar reflectivity assimilation.

A fairly significant change was made to the cloud/hydrometeor analysis in both the RR and the RUC in December. As described under task 5.5, a high bias with larger RMS errors (compared to the RUC), were found in RR upper-level relative humidity forecasts. Work by Ming Hu lead to a modification in the treatment of cloud top data that resolved this issue, leading to improve mid- and upper-level moisture forecasts for the RR compared to the RUC. The change was to use a combination of NESDIS and NASA (larger coverage) products to just trim excess cloudiness in the Rapid Refresh background field. Previously, in addition to clearing of RR fields based on the cloud data, we had also been adding cloud water and ice in regions where the satellite data indicated the existence of clouds. We believe that the high relative humidity bias from this is tied to uncertainties in specification of both the cloud depth and the degree of grid box saturation and amount of cloud mixing ratio species in cloudy regions. This change to cloud clearing only from the satellite cloud top data was made first in the GSD RR cycle, then transferred over to Geoff Manikin's EMC RR cycle on 29 Dec. 2010 and has resulted in significant improvement in RR mid-level relative humidity forecast skill.

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

GSD

Curtis Alexander has completed script change to improve the HRRR latency. 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.

Curtis is currently working to switch the HRRR "15-min VIL" output files from the current netcdf format to grib2 format. Currently, the fields are computed and directly from the ARW model at 15-min intervals, stored internally and output every 3-h. Under the new system, complete model history files will be output every 15-min, and the two different UNIPOST utilities will be run. The first one will create the 15-min grib2 files (allowing for the inclusion of some additional fields and shifting some of the diagnostic calculation from the model to the post program). The model output files from the "non-hour" times will then be purged to keep disk space use within reasonable bounds. A second UNIPOST run will then create the usually hourly grib2 files. This work will be completed in January 2011, with sample files being distributed to downstream users prior to the switchover of the real-time HRRR system. By using a different compiler (and different compile options) on the GSD system, Curtis recently found a solution to a key hurdle in this task (that also was impacting the RR files produced at GSD). The "cnvgrb" program that converts from grib1 to grib2 was setting hydrometeor fields to 1 at levels where the entire field was zero (upper levels). With this now solved, work is proceeding to produce sample 15 min grib2 files.

Eric James has completed a 2-experiment RUC retrospective test from a June 2010 period. In this controlled environment test, the strength of the radar-based latent heating temperature tendency in the Diabatic DFI is being varied. Subsequent HRRR tests can then evaluate the impact on the HRRR forecast. This work will be expanded using a longer retrospective period from July 2010 that includes examples of key HRRR-related issues observed during the summer 2010 operational evaluation (including MCS propagation/maintenance, SE coverage, etc.). Eric has completed the RUC part of a 10-day July 2010 retrospective experiment and with help from Haidao Lin has an RR retrospective for the same period running. These two retrospective runs (RUC and RR) will be used for RUC-HRRR vs. RR-HRRR testing, which will commence shortly. Results from these HRRR runs will be fed into Patrick Hofmann's reflectivity verification software and RR-HRRR grids provided to NCAR/RAP and MIT/LL.

Patrick Hofmann has completed work on his real-time RUC / RR / HRRR scale-dependent radar reflectivity verification package and added to very helpful web page for accessing the verification information. The first webpage displays forecast and validation graphics (full fields and color coded categorical information). The second web page is patterned after Bill Moninger's verification pages and displays customizable time-series of statistical verification data. To create this page, Patrick ported the verification data to a database. A third web page will allow customizable display of aggregate verification statistics as a function of valid time of day. A sample from the statistical web page is shown below.

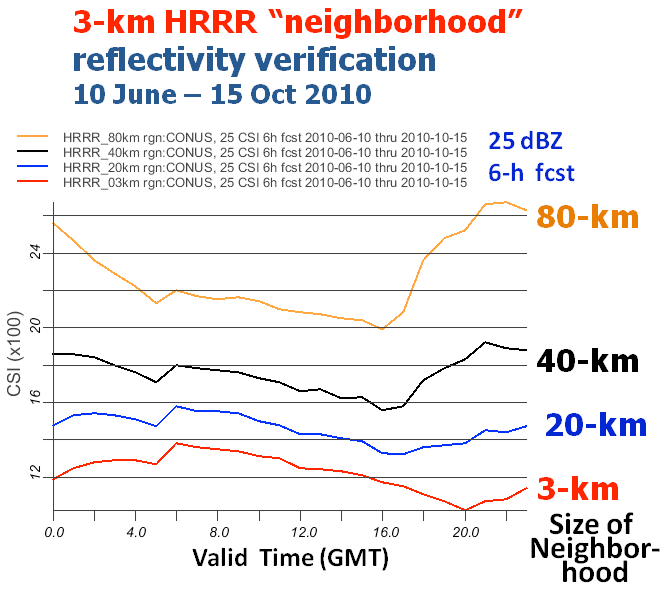

Fig. 4. A sample reflectivity of verification statistics from the database. Shown is the average CSI as a function of forecast valid time for all 6-h forecasts from the 3-km HRRR for the period from 10 June – 15 Oct. 2010. The CSI skill is shown for verification on small "neighborhood" (3-km) and for successive larger "neighborhoods" (20-km, 40-km, 80-km). Focusing on the convective initiation (CI) time of 1700-1900 GMT (1-3 PM EDT), one can see that although skill is low on the 3-km verification relative to other times, skill grows rapidly for verification over larger neighborhoods. This clearly indicates that while the HRRR does not pinpoint CI locations to within 3-km, it performs well at located CI within 40-km to 80-km.

NCAR

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

CURRENT EFFORTS: Jimy Dudhia of NCAR submitted a report on the 2010 convection-revolving ARW simulations for the Spring Forecasting Experiment. He worked with Greg Thompson (NCAR/RAL) to investigate the causes of reflectivity differences seen in the 3-km high-resolution ARW runs of the 2009 tests and the 2010 tests using different versions of the Thompson microphysics scheme. The work identified the main code changes, centered on graupel production, that were responsible for the performance differences.

PLANNED EFFORTS: New RR-initialized, high-resolutions will be planned and conducted in Spring 2011.

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.