MDE Product Development Team
3rd Quarter (April-June) Report – FY 2011
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(Compiled and edited by S. Benjamin and B. Johnson)

Executive Summary

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

- No problems with operational RUC in the quarter, final testing toward NAM upgrade planned for Jul 2011.

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

- *The RR run at ESRL/GSD and the real-time parallel RR at EMC continue to show improvement for the May period over RUC for precipitation, reflectivity, wind, temperature, and height, RH about even.*
- *ftp access continues for these grids from RR running at NCEP-EMC, evaluation of RR-NCEP-EMC continues. Some difficulties with system issues for RR-NCEP in May and early June causing intermittent interruptions.*
- ***Planned date for RR implementation at NCEP – mid-late Oct 2011, due to additional delays now anticipated with the NAM implementation in July.***

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

- GSI modifications to use PBL-based pseudo-residuals were introduced into the ESRL RR-primary version at 00 UTC 7 July. This follows a 3-week coupled RR-dev / HRRR-dev evaluation (against the RR-primary and real-time HRRR.
- Continued development and testing work toward GSI improvements for the 2nd version of the Rapid Refresh (expected implementation in spring 2012).
- Eight AMB staff members participated in the DTC GSI tutorial and workshop, with a presentation by Mariusz Pagowski (air chemistry assimilation with GSI hybrid) and Stan Benjamin (other ESRL GSI activities) and presentations by and much coordination of the tutorial by Ming Hu.
- Further testing of radial winds (with level-II data) in a parallel RR cycle at ESRL (RR-dev) showed very little degradation, encouraging for continued testing, but not enough to quite warrant inclusion in the ESRL or NCEP versions of the Rapid Refresh during summer 2011.
- Work continues to evaluate value added from radiance assimilation in RR (via GSI) including assessment of bias correction by channel for AMSU data.

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

- Intercomparisons of GOES-related cloud building between RUC-NCEP, RUC-backup-ESRL, and RUC-dev-ESRL toward improved initial cloud field in Rapid Refresh in RR2 in 2012. The ESRL RUC-dev now includes a new version of GOES-based cloud building designed to avoid moist bias problems found in the previous method in RUC and RR tests.
- RR using GSI cloud analysis yielding significant improvement in short-range ceiling and visibility forecasts over those from the RUC.
- Testing continued with the RR with variations on specification of hydrometeors; one result was a correction to the reflectivity-snow algorithm used in GSI radar processing. This version was implemented into the ESRL Rapid Refresh earlier in the quarter.

Task 11.5.24: Development/testing of HRRR

- Switch to use of RR primary as parent model for HRRR on 14 April, based on extension retrospective testing and evaluation during Spring 2010.
- Summer experiment started June 1, with HRRR running with > 95% reliability (for outages > 3h), strong coordination with NCAR/RAL and MIT/LL
- Extensive evaluation of impact on HRRR-dev from inclusion of boundary layer pseudo-obs in RR-dev. Based on results, switch made to RR primary (parent for primary HRRR) on 00 UTC 7 July 2011.

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

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

The ESRL development RUC was modified to test re-introducing GOES cloud data over the lowest 2km to improve cloud forecasts without causing an increase in RH error, as found in December 2010 with full troposphere use of GOES-based cloud building. (More under 5.15.)

ESRL continues to monitor operational RUC (and two ESRL versions of RUC with differences cloud assimilation). This evaluation is now especially important since it allows a benchmark for the parallel Rapid Refresh comparisons. Performance of the operational RUC is monitored at both ESRL and NCEP verification websites (see **http://ruc.noaa.gov/stats**). Inter-comparison of verification between the NCEP and ESRL versions of the RUC continue to be monitored by ESRL, also at **http://ruc.noaa.gov/stats**.

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

NCEP

Subtasks

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

NCEP maintained the hourly runs of RUC through the quarter. No RUC crashes have occurred since 17 November 2010. (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 AHP (aka 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://mag.ncep.noaa.gov/NCOMAGWEB/appcontroller**. (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: The Florida and Georgia DOT mesonet providers remained down. The Wisconsin DOT mesonet provider was down for the first half of April. The Aberdeen PG mesonet provider was down from 24 April until early May. The Kansas DOT mesonet provider went down 22 June. There was a five-hour outage of all mesonet data on 20 April due to a line problem. The GOES-13 cloud and precipitable water retrievals have not been used since the switch to GOES-13 in April 2010. The NRL-based aircraft QC code package is scheduled from implementation later in 2011. This includes quality controlled high vertical-resolution aircraft profile data near airports, with the nearest METAR report providing the surface level. Earlier memory issues in the code have been corrected and the code has also been revised to run five times faster than previously. The final step is to update it to properly handle TAMDAR reports. (Keyser)

Efforts were made to verify if Canadian radar data are correct. Elevation angle information turned out to be missing from some of radar stations and this was reported to NCO to be fixed. Efforts were also made to match reflectivity and radial wind data from Canadian radar but these data will have to be recast in a volume- scan look-alike form in order to apply the NSSL quality control. The level2.5 BUFR was checked again, and in the level2.5 data observation heights from some sites are found to be lower than the associated station elevation probably due to a failure to convert from feet to meters – to be fixed next quarter. Station IDs in the level2.5 data are incorrect in the "radwnd" BUFR file. NCO is investigating this now. (Liu)

PLANNED EFFORTS: See also PLANNED EFFORTS listed under Task 11.5.17.E1 below for aircraft quality control issues. Implement NRL QC package. Obtain all TAMDAR data from AirDAT as alternate to MADIS feed and add airframe type and company code to allow the development of improved bias corrections. Continue work to resolve issues like 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) Continue work on Canadian radar data to allow its use in the analysis, e.g. remap data to look like volume scans. Work with NCO to fix level2.5 data problems. (Liu)

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: No RUC configuration changes were needed during the quarter. (Manikin, IBM, ESRL)

PLANNED EFFORTS: Continue monitoring of 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: No RUC crashes have occurred since the 17 November 2010 fix was implemented. (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 toward operational implementation at NCEP planned for Oct 2011 can be found under Task 5.4 report.

NCEP

Subtasks

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

The parallel test of the NEMS/NMMB model in the NAM parallel system continues on the CCS. The run consists of a 12 km parent domain (same as current NAM) with all model and analysis changes that will be implemented into operations. Inside the 12 km parent domain are four high-resolution nested domains (4 km CONUS, 6 km Alaska, 3 km Hawaii, 3 km Puerto Rico) that will run from 0-60 h, and a movable fire weather nest nested inside the CONUS or Alaska nest at 1.33 km or 1.5 km resolution that will run from 0-36 h. Implementation progress and documentation can be tracked at **http://www.emc.ncep.noaa.gov/implementation-docs/impDoc.html**. (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 four times-per-day runs of ten WRF-based members (5 NMM and 5 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). HRW- and SREF-based High-Resolution Ensemble Forecast (HREF) products are now available online at **http://www.emc.ncep.noaa.gov/mmb/SREF/SREF.html** for the western (06z) and eastern (00 and 12z) CONUS. The SREF ensemble product generator was upgraded to include the following new features: minimum, maximum, mode, and 10/25/50/75/90 percentiles of many aviation related variables. Two clustering algorithms have been tested for use in the SREF and future NARRE and HRRRE. (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://mag.ncep.noaa.gov/NCOMAGWEB/appcontroller** (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)

During this quarter, final changes were made to the NAM parallel to add output fields needed for downstream applications and NCEP Service Centers. Working with Julia Zhu, during April the codes and scripts were optimized for use in production and the entire package was handed over to NCO. When NCO began running the 4x/day NAM parallel (with all nests) routinely in early June, the EMC parallel run was turned off and all parallel verification and web graphics jobs were changed to use the NCO parallel. NCO began the 30-day real-time parallel NAM test for evaluation by NCEP Service Centers and NWS regions on June 21. (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 items reported under Task 11.5.1.E1. Since the RR has an extended domain including Alaska and some ocean areas, most of the following also apply. Several erroneous AIREP aircraft waypoint locations were found and corrected, and this change is ready for implementation. The number of assimilated MDCRS-ACARS reports over North America increased by 1/3 on 8 April from Alaska Airlines after ARINC removed problematic lowest level reports that caused them to be rejected by NCEP. EUMETSAT added McMurdo, Antarctica on 10 June as a downlink station to process ½ orbit granules for METOP products. Splitting the downlink using a second station results in a 50-min reduction in latency for these data and an increased number of METOP radiances and products (e.g., ASCAT) are now available to the early-cutoff NAM and RR dumps. GOES-13 radiances are monitored until the NAM implementation in Q4 of FY2011. An instrument problem caused a loss of all METOP-2 polar satellite data for seven hours on 1 April. A software problem caused the loss of MODIS POES wind data for 14 hours on 6 May. The set points in the sounder/imager patch for GOES-12 and GOES-13 were changed by NESDIS in April, which increases their bias in the GSI. NCEP

stopped pulling bad NOAA-15 AMSU-B data from NESDIS DDS server 14 June. NOAA-18 has on-going gyro issues that could lead to unusable products. On 16-17 April, NESDIS engineers conducted the last 24-h test where the corrupted navigation data was not sent to NCEP. An implementation on 3 May added 50 km ASCAT and WindSat scatterometer wind data (both non-superobbed) into the operational NAM/NDAS dumps and PrepBUFR files, in preparation for the NAM upgrade now scheduled for August. The following data types are monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), MAP wind profiles below 400 mb, Mesonet mass data, AIRS AMSU-A radiances, NOAA-19 HIRS-4/AMSU-A/MHS radiances, METOP IASI radiances, ASCAT and WindSAT winds, and MDCRS moisture data. All but RASS of these are being tested in the NAM parallel. NAM/NDAS PrepBUFR parallel files use the new NRL-based aircraft QC code. RTMA PrepBUFR files are being generated in parallel with 50 km ASCAT and WindSat scatterometer wind data (both non-superob) and these now include surface land, marine and Mesonet reports with missing pressure. These missing pressure surface reports are now being tested in the RTMA. Production NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and SBUV-2 data are being created and dumps of RARS 1c radiances are being created in parallel. (Keyser)

NCEP generates experimental Rapid Refresh (RR) PrepBUFR files containing WindSat data (non-superob) and 50 km ASCAT for ESRL and EMC testing. These PrepBUFR files are now generated using the new NRL-based aircraft QC code and no longer flag (reject) MDCRS and TAMDAR moisture. 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 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, and GOES single-pixel cloud data from NASA/Langley (covering Alaska) are also being copied to a public ftp directory. These, along with early parallel dumps for 0000 and 1200 UTC, are being tested in ESRL's experimental RR runs and the EMC RR parallel. In June the 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 Alaska. Adding a 5th hourly ingest run for Level 2 88D radar data is being discussed with NCO. (Keyser)

Reflectivity assimilation work continues but suspicions about a bug in treatment of height of obs are first being investigated. Forecast experiments were conducted with modifying temperature with latent heat using both GSD's and NRL's cloud analysis method. The hourly cycle is set up and more experiments will be performed. Digital filter became available for HiRes NMMB. Data assimilation scripts for HiRes domain were updated to include the changes. The scripts and GSI code were modified several times to fix wrong time tag when use DFI and restart mode. Strong constraint in GSI is being tested in HiRes initialization again after the bug in calculating geopotential height was fixed. (Liu)

CIP transition work continues. The coding was completed and NCEP's results showed a positive match to AWC's when using the same datasets as AWC. More work is needed to ingest similar (but not identical) datasets processed routinely at NCEP in place of the ones processed on site at AWC by the CIP/FIP processing. An issue with the WAFS code needs to be addressed, where the GFS doesn't provide a corresponding product for gravity wave stress. Though gravity wave drag acceleration is available in GFS, the stress can't be simply calculated from the acceleration. More work is needed to solve this issue. (Mao)

PLANNED EFFORTS:
Add the use of AIRS AMSU-A radiances to the next NAM-GSI update. Implement NRL quality control package. Change PrepBUFR processing to add report sub-type information for development of bias corrections. Develop a "master use/reject-list" for incoming data. 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 on Southwest aircraft); new sources of mobile synoptic surface reports (Greenland); TAMDAR aircraft moisture; NPN and MAP and European RASS virtual temperature profiles; JMA, Hong Kong, European, Canadian, MAP, DOE and 6-minute NPN profiler winds; GOES 3.9 micron, GOES visible, and AVHRR POES satellite winds; hourly GOES IR and water vapor winds; WindSat and ASCAT scatterometer wind data (with later transition to new-science WindSat data); METOP IASI, and for the 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 gaps in NESDIS 1b ATOVS); 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; and for the NAM, filling in rawinsonde profiles between significant levels. Maximize Alaska data retrievals (mesonet, aircraft and coastal surface). Add GSI events to NAM PrepBUFR files. Let GSI use the actual or estimated anemometer, barometer and thermometer heights on ships. Work with NCO to bring in new radar data sources (TDWR, Hurricane Hunter Tail Doppler Radar, Canadian, CASA, additional DOD sites). Examine possible use of mixed-satellite (Aqua and Terra) MODIS winds for better coverage and timeliness than the current MODIS winds. Obtain Wildfire Automated Biomass Burning Algorithm (WFABBA) products for NAM Fire Weather runs. (Keyser) Strong constrains and DFI will used together to improve HiRes initialization. (Liu) Work on debugging CIP algorithm, now that dataset debugging is finished. (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. Implementation progress and documentation can be tracked at **http://www.emc.ncep.noaa.gov/implementation-docs/impDoc.html** . (Manikin)

11.5.17.E3 30 September 2011 (Manikin, Pyle, Rogers, ESRL/GSD)
Monitor RR, NAM & HiResWindow 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: Two problematic output fields were identified in the HiResWindow system after the March 2011 implementation. Both problems only impacted WRF-NMM output. The first problem field was instantaneous simulated radar reflectivity, where an inconsistency in the maximum raindrop size in the microphysics processing code used by the model and by the post processor created a slight reduction in simulated reflectivity in regions of intense precipitation. The second problem field was visibility, where the absence of convective precipitation rate in the model output was filled with a large "special" value when ingested into the post processor. The code computing the visibility didn't respect the "special" value, using the implied intense convective precipitation to generate unrealistically small values of visibility. Requests for Change forms were filed with NCO in May, and the fix is scheduled to be implemented on 12 July. (Pyle)

PLANNED EFFORTS: Monitor performance of the upgraded HiresW.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: None.

NCAR/MMM
CURRENT EFFORTS:
NCAR released WRF Version 3.3. This contains many new features, parameterizations, and bugfixes. A full description of the release and its features may be found at **http://www.mmm.ucar.edu/wrf/users/wrfv3.3/updates-3.3.html**. WRFDA V3.3 was also released.

NCAR hosted the 12th WRF Users' Workshop, held June 20-24, 2011 at NCAR. The attendance was approximately 230. Day one offered the model fundamentals lecture series begun last year, with the topic being PBL and land surface modeling. The core of the workshop featured modeling topic areas during the week, and the final day presented instructional lectures.

[ESRL/GSD note: 4 talks at the WRF Workshop were given by ESRL/GSD scientists:

- Rapid Refresh application of WRF (John Brown)
- HRRR application of WRF (Curtis Alexander)
- RUC land-surface model development in WRF for RR and HRRR (Tanya Smirnova)
- Development of WRF-chem (and testing in RR-chem and HRRR-chem (Georg Grell)]

NCAR will put on the next WRF tutorial July 11–22. The first week will feature the basic WRF, while the second will cover WRFDA and WRF-Chem. During this quarter, NCAR gave a tutorial in Korea the week of April 11th as part of the 5th East Asia WRF Workshop and Tutorial. It also delivered one in Cyprus in the first week of May. This was part of the "Weather Research and Forecasting Model in the Middle East" workshop.

In PBL physics work, Jimy Dudhia of MMM hosted visitor Julien Pergaud (Numtech, France) who is working on a mass-flux/eddy diffusivity PBL scheme to combine with the QNSE PBL. This will be added to WRF. Dudhia also continued to work with Boris Galperin (Univ. of South Florida). Both of these collaborations are related to combining other day-time PBL schemes with Galperin's stable-regime QNSE scheme.

Dudhia is hosting visitor Hailey Shin (Yonsei Univ., Korea) who is working on new version of the YSU PBL scheme that is a hybrid TKE scheme. YSU is using its own daytime non-local mixing scheme, but will diagnose TKE in the day and predict it as in the QNSE scheme at night.

Dudhia investigated a problem with the MYNN PBL scheme in collaboration with Ming Chen (NCAR/MMM) and Joe Olson (NOAA). It was found that instabilities may arise in using the scheme, with the problem being related to TKE advection. Corrections are currently being explored.

NCAR continued to host visitors Pedro Jimenez (CIEMAT, Spain) and Anna Fitch (Univ. of Bergen, Norway) on wind-energy and wind-farm related work addressing conditions in the surface layer and PBL. Also a new short-term visitor Jorge Navarro (CIEMAT, Spain) is testing WRF LES capabilities in complex terrain.

Dudhia worked on adding regional climate diagnostics, such as outputting maximum daily surface temperature fields. Collaborator Ruby Leung of PNNL provided the code, which may be included in the next minor release of WRF, V3.1.1.

Dudhia also worked with Wei Wang (NCAR/MMM) and Ming Chen on comparison studies of the eight cumulus schemes in WRF V3.3. Preliminary results were presented in a seminar to the NCAR Convection Working Group. The new cumulus schemes include those currently operational in HWRF (Hurricane WRF), the GFS (global) model, and the CESM (climate) model. The NCAR testing involved a 12-km US grid and a 27-km tropical western Pacific grid.

PLANNED EFFORTS: The development and implementation of new physics for WRF will continue through FY11Q4.

UPDATES TO SCHEDULE: NONE

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

ESRL/GSD

Progress through the quarter has been steady toward a fall 2011 operational implementation of the RR at NCEP. However, there is a dependency on the earlier NAM implementation now planned for late July or early August.

Now, with some delays in the NAM implementation, the RR implementation is scheduled for mid-late October since NCEP/NCO personnel must complete the NAM implementation before being able to work full-time on the RR implementation.

After a critical early-April bug fix to the WRF Digital Filter Initialization (DFI) described in the FY11Q2 report, efforts early in the quarter were mainly toward continued evaluation of RR performance, both at GSD and at NCEP. These led to some minor adjustments in the GSI cloud analysis to improve consistency in the impact of radar observations on the introduction or clearing of snow hydrometeors. These were passed on to NCEP in April. Subsequently, no changes have been made to the RR at NCEP, and development and testing is now toward the next version of the Rapid Refresh (RR2) in spring 2012.

Motivated in part by the appearance of a positive bias in RR precipitation amounts during this spring's active severe storm season, the RUC procedure to more effectively spread the surface temperature and dew point observation innovations vertically into the mixed layer, if one exists in the 1-h forecast background, was introduced into the GSI by Ming Hu and Stan Benjamin and was successfully tested in June using the RRdev 1-h cycle. In both the RR-dev and subsequent HRRR-dev runs every 3h, some improvement was shown in reducing too widespread convection in comparing both the RR-dev with RR, and the HRRR-dev with the HRRR. This addition of PBL-based pseudo-residuals derived from surface-observation residuals is now running in both the RR 1-hour cycles at GSD, and, as of 00 UTC 7 July 2011 began being used to initialize the regular hourly runs of the HRRR. This modification will not be in the initial RR implementation, but is certain to be part of RR2, with further enhancements a possibility.

We anticipate implementation of the RR2 upgrade will be a much less arduous process than the initial RR implementation that we hope will finally come in October. Nevertheless, we anticipate at least minor changes in all aspects of the RR, including various aspects of GSI (including moving the cloud analysis a bit closer to a variational framework), the Diabatic Digital Filter Initialization and the model (using a later WRF release, upgrades to the present physics suite (Thompson microphysics, RUC/Smirnova land-surface, Grell convection), perhaps changing the boundary-layer scheme from MYJ to the GSD version of the MYNN).

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

A recent evaluation comparing the RR to the RUC shows that precipitation forecasts in May were clearly superior from the RR (Fig.1). The upper-level wind forecasts from the RR also continue to show improvement over the RUC in May (Fig.2). RH forecasts from the RR do not show in the warm season the same improvement evident in the cold season (Fig.3), but a continued improvement is still evident in RR temperature forecasts (Fig.4).

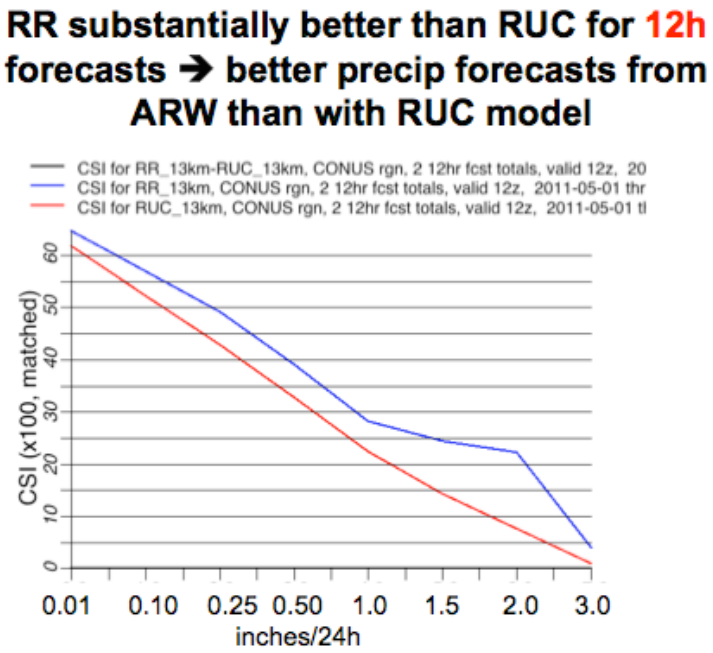


Figure 1. Precipitation forecast skill for 2 12h periods summed to 24h period from the RUC (red) vs. the Rapid Refresh (blue) for 1 May through 8 June 2011. Critical Success Index (CSI) measures skill at different accumulation thresholds from 0.01" to 3.0".

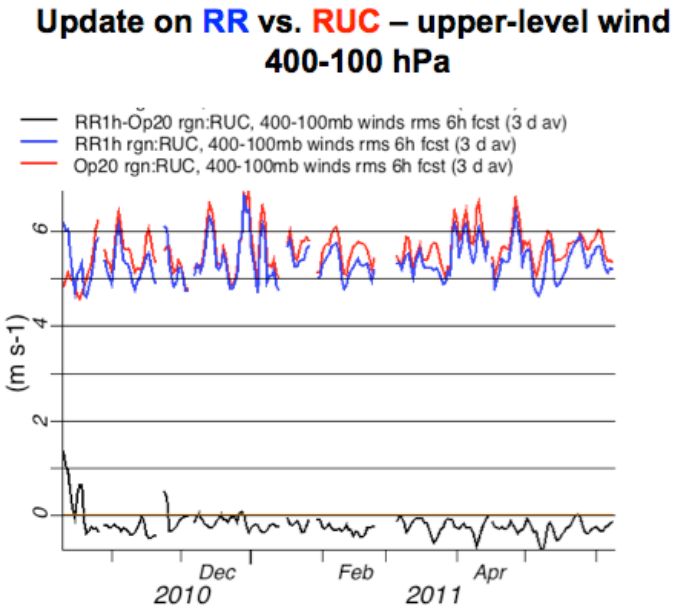


Figure 2. 6h forecast error (vs. raobs) for 400-100 hPa winds from RUC (red) vs. Rapid Refresh (blue) for the period from October 2010 until early June 2011.

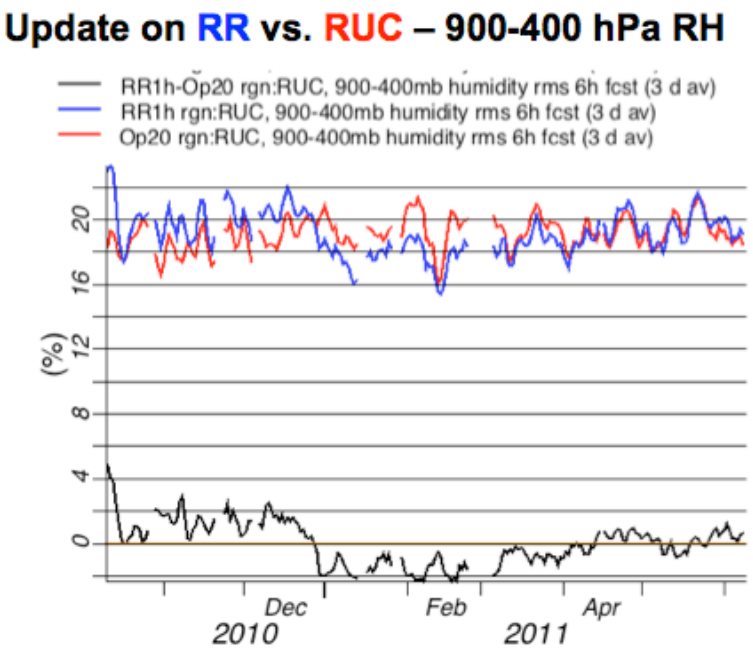


Figure 3. Same as Fig. 2, but for relative humidity forecasts averaged between 900-400 hPa.

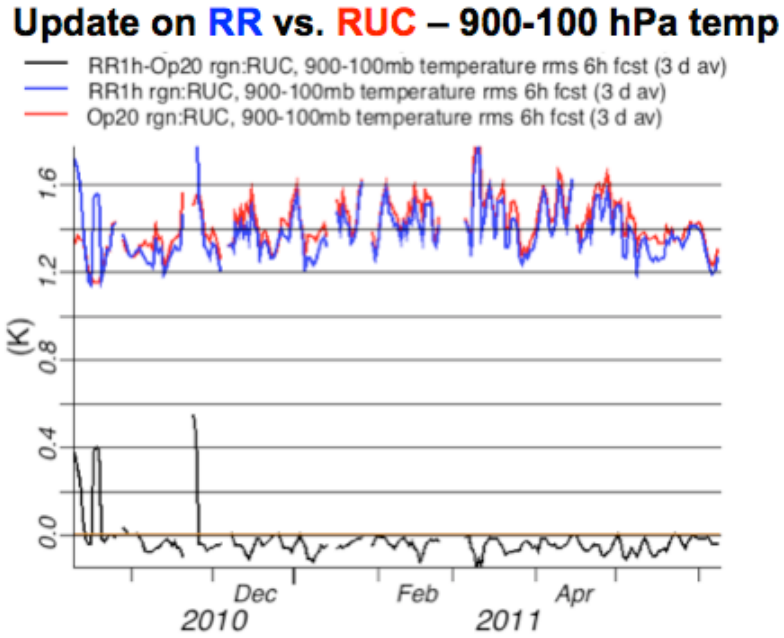


Figure 4. Same as Fig. 2, but for temperature forecasts averaged between 900-100 hPa (through most of the troposphere into the lower stratosphere).

NCEP

Subtasks

11.5.4.1 Ongoing evaluation of performance of real-time and retrospective runs of RR system for SAVs, AHPs. (30 Sept 2011)

The Rapid Refresh (RR) has been running stably in an EMC parallel environment since December. The code has been frozen since changes made in April to improve model handling of snow cover. Statistical evaluation has shown that the Rapid Refresh is now at least comparable to the RUC for most parameters, with significant improvement shown for upper level wind and height fields. Grib1 and Grib2 as well as station time series BUFR data files have been made available to the FAA, the NCEP service centers, and other RUC users on an FTP site, and informal evaluation of the model analyses and forecasts is underway. Special test files were provided to several FAA groups to ensure a seamless transition when the RR replaces the RUC. NCO will start their RR parallel for a formal evaluation after the NAM implementation in August, and RR implementation is currently scheduled for October. (Manikin)

11.5.4.2 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. Some discussion between EMC's Bill Lapenta and GSD took place 20 June. The possibility of not putting ARW into NEMS was broached but a final official decision by management has not yet been made. (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)

The initial condition perturbation scheme for the upcoming SREF implementation has been initially tested within the new NMMB members of the SREF. Various alternative physics packages/schemes such as GFS physics were tested (by Weiguo Wang and Brad Ferrier) using the WRF version 3.3 release (ARW core) to increase forecast diversity within an ensemble. Work was also done (by Dusan Jovic, Jamie Wolff of DTC and Brad Ferrier) concerning the Rapid Refresh physics options to be used in SREF. The results from these tests will be applied to the future NARRE and HRRRE construction. The Time-Lagged North-America Rapid Refresh Ensemble (NARRE-TL) system and products are under development and were presented at the 5th NOAA/NCEP ensemble user workshop in May. (Du)

Deliverables

11.5.4E1 (28 February 2010) (Manikin)
Update documentation for operational Rapid Refresh.

CURRENT EFFORTS: A kickoff meeting has been held between EMC and NCO. Implementation progress and documentation can be tracked at **http://www.emc.ncep.noaa.gov/implementation-docs/impDoc.html**. An informal evaluation of the Rapid Refresh model analyses and forecasts is underway. Special test files were provided to several FAA groups to ensure a seamless transition when the RR replaces the RUC. NCO will start their RR parallel for a formal evaluation after the NAM implementation in August. (Manikin)

PLANNED EFFORTS: Begin the official NCEP RR parallel and evaluation once there is space on the CCS.

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: The Rapid Refresh (RR) has been running stably in an EMC parallel environment since December. The code has been frozen since changes made in April to improve model handling of snow cover. Statistical evaluation has shown that the Rapid Refresh is now at least comparable to the RUC for most parameters, with significant improvement shown for upper level wind and height fields. (Manikin)

PLANNED EFFORTS: File Requests for Change (RFCs) for the RR bundle and continue to run the RR in an EMC parallel environment until it is implemented in October. (Manikin)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: ESRL.

UPDATES TO SCHEDULE:

Subtasks

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

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.

ESRL continues to hold RR-status telecons for FAA and AWC colleagues every 4-5 weeks (last on 6/9/2011). All feedback from the other PDTs has been positive. This evaluation has been made possible by the availability of pgrb, sgrb and bgrb files for the RR in GRIB1 from the EMC test RR cycle output.

The Storm Prediction Center has begun to evaluate BUFR sounding output from the EMC RR test cycle (from both analyses and forecasts) as compared to the RUC. The SPC forecasters use both analysis and forecast soundings extensively as part of their decision process on whether developing weather conditions warrant issuing severe thunderstorm and tornado watches.

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

ESRL/GSD
In May and early June, as reported under 5.4, a change was developed in GSI to allow extra pseudo-observations to be created from surface observations based on background (1h forecast) planetary boundary-layer (PBL) height. Beginning in mid-June, this change was implemented in the RR-dev and its GSI version at ESRL and controlled comparison against the ESRL RR-primary was begun. Results indicated that the RR-dev with this change is producing more accurate dew-point predictions for runs initialized during the daytime and not degrading other fields. Based on these results (and related HRRR-deb results showing an improvement in the HRRR-dev -- initialized from the RRdev – compared to the primary HRRR), this change was implemented in the ESRL RR primary at 00 UTC 7 July 2011. This change was enabled by work done in April (reported in May) to diagnose PBL height within GSI. Again, these changes will be part of the code change for the RR2 upgrade in late 2012. Similar work within GSI is ongoing to increase the fit of the RR analysis to the rawinsondes, which is important for users such as the SPC and may further improve HRRR forecasts of convective initiation.
Beginning in mid-June, Haidao Lin continued his satellite data assimilation work, and has obtained some modest improvement in a test with AIRS radiance data added to just conventional observations. Haidao presented a summary of this work at the JCSDA Satellite Data Assimilation workshop in College Park, MD in May. In late June, eight AMB branch members participated in the DTC GSI tutorial and workshop. Among these was Ming

Hu, who within his dual appointment with DTC played a key role in organizing many aspects of the tutorial and workshop including many of the presentations and the hands-on computer applications.

GSD also conducted an additional observation impact test of several days for radial wind data with the height processing correction suggested by NCEP (see NCEP's section below). For this new period, radial wind continued to produce a small negative impact, especially on lower troposphere forecasts of 3h to 6h duration. Subsequently, GSD also conducted yet another radial wind experiment period using level-II data instead of the previous level-2.5 data. For this test, the result was closer to neutral, with only a very small negative impact. GSD has decided to still withhold radial wind assimilation from the RR until the 2012 RR upgrade and when additional improvements are developed in radial wind processing and possibly with QC. Beginning in April, a large number of additional aircraft observations became available, especially over Alaska, and ingest of this data into the RR began, with an impressive increase of 25% in aircraft observations within the full RR domain.

CAPS

Our earlier tests showed that the 3-hour wind forecast errors were larger at higher levels, especially when verified against sounding. We hypothesized that this was because the fix inflation was applied every assimilation step (3 hourly) while soundings are only available and assimilated every 12 hours. Therefore, two more experiments were conducted to evaluate the impact of the configurations of the fix inflation: 1) none fix inflation; 2) ten percent fix inflation, in addition to the original experiment with a twenty percent fix inflation. In the first run, the fix inflation was not adopted, and only adaptive inflation was applied. Without the fix inflation, spread decreased sharply, and the 3-hour forecast error was increased compared to the experiment with twenty percent fixed inflation. This result suggested the fix inflation was necessary. In the second experiment, when the fix inflation was reduced from twenty percent to ten percent, the spread again was reduced. However, encouragingly, the 3-hour forecast was improved as compared to using the twenty percent fix inflation.

In addition to tuning the inflation factor, we also further tuned the localization in the EnKF. To deal with different temporal and spatial observational density, in the previous experiment, we assigned different localization scale to different observation type according to the observation density. For example, the localization scale given to the sounding was larger than the surface observation. We conducted two more experiments where the localization scale was also a function of height. In the first experiment, the localization scale increased linearly from 1020hPa to 200hPa and was fixed beyond 200hPa. Using this localization function, the 3-hour ensemble spread was enlarged at low level, and decreased at high level. The 3-hour forecast was improved. In the second experiment, we further adjusted the localization function. A nonlinear function as shown in Fig. 5 was used. The latest experiment using this nonlinear localization function and the ten percent fix inflation showed that 3-hour forecast initialized by the EnKF when verified against sounding was better than the GSI, except around 200 hPa. Forecasts error verified against the profiler was reduced using this new configuration of the inflation and the localization function for the EnKF, although it was still larger than the GSI. These results using the new configuration of the inflation factor and the localization function are encouraging and suggest that systematic methods to tune the inflation factor and the localization function are needed.

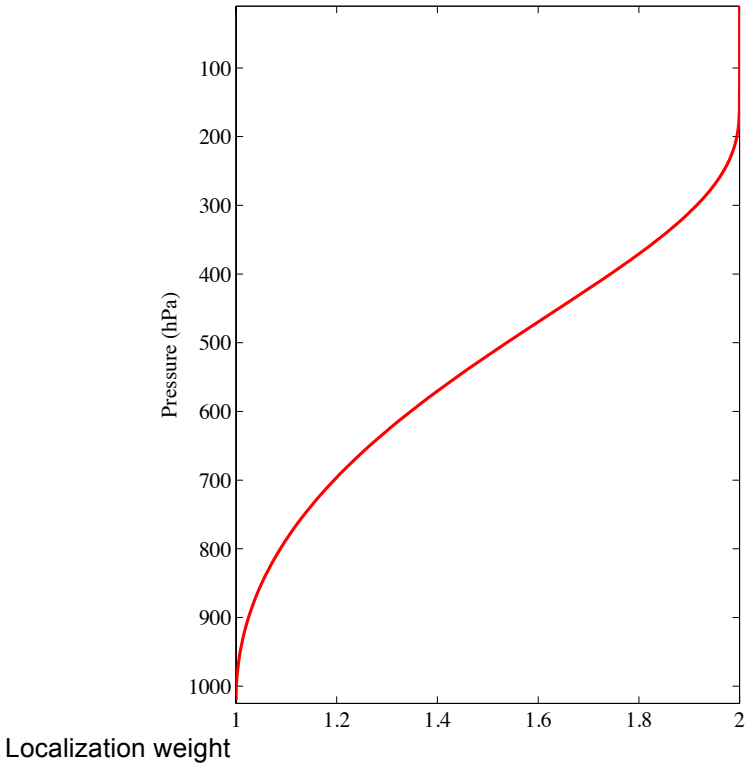


Figure 5. The localization weight at different pressure level

NCEP
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)

After finding the bug for Level 2 radar radial wind, the reported height of level-2.5 and level-3 data was also checked, and they all report a height above sea level. The RMS and bias between the radial wind and guess have been checked, and both are improved after the bug fix and more observations have become available at low altitudes. (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)

A 1.5-km resolution RTMA for Juneau-Alaska has been built in response to a request from NWS/Alaska forecasters, who pointed out that the current Alaska RTMA failed to adequately account for the topographic complexity of Juneau. A 2.5-km resolution extended CONUS RTMA has also been built by extending the NDFD domain northward from 51N to 56N. The analysis from that system will be disseminated in two separate GRIB2 files, one for the true NDFD domain and the other for the NWRFC domain. This arrangement eliminates the need to develop a separate RTMA system for the NWRFC domain. A replacement of the current operational CONUS RTMA with the extended CONUS RTMA is tentatively scheduled for Q1 of FY12. (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)

The effectiveness of adaptive tuning techniques was studied. It was found that for the types of observation with a large amount of locally dominant data the technique was less effective. For example, the method was less effective in determining the observational error variance of MESONET data, which are dominated by the amount of data near the surface. The tuning results should thus be judged subjectively. (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)

Reflectivity assimilation work continues but suspicions about a bug in treatment of height of obs are first being investigated. Forecast experiments were conducted with modifying temperature with latent heat using both GSD's and NRL's cloud analysis method. The hourly cycle is set up and more experiments will be performed. Digital filtering became available for the HiRes NMMB. Data assimilation scripts for HiRes domain were updated to include the changes. (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)

Work on the regional 3dvar-ensemble hybrid continued. An error in ensemble wind perturbation was found and fixed, where the GSI needs rotated wind perturbations but earth wind perturbations were provided. An option was added to use the perturbation based on the regional first guess instead of the global ensemble mean. The code was also cleaned up and unused arrays deleted to save memory. Preliminary results showed that the hybrid variational-ensemble analysis produced a positive impact in the middle section of the atmosphere and negative near the upper and lower boundaries. To minimize the negative impact, a vertically varying decomposition between the static background error co-variances and the ensemble was introduced. The ensemble contribution to the surface pressure analysis depended only on the first layer alpha, which has a negative effect on the forecasts. Vertically integrated alpha for the surface pressure contribution was added in an attempt to minimize the negative impact. Jim Jung found spurious sensitivities in the upper layers from using the satellite data in NDAS. A similar problem previously in the GDAS was solved by artificially dividing the upper layers into sub layers when fed into the CRTM. Jim looked into the problem and suggested some changes, which are being tested in an off-line parallel. Work continues on identifying Radiosonde layers within which it is justifiable to generate intermediate levels; i.e. there are significant levels reported to bracket the layer. (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: After finding a bug for Level 2 radar radial wind, the reported height of level-2.5 and level-3 data was also checked, and they all report a height above sea level. All codes related to height calculation in GSI code are being checked and the method of converting geopotential height to geometric height is examined in detail. The RMS and bias between the radial wind and guess have been checked, and both are improved after the bug fix and more observations have become available at low altitudes. (Liu)

PLANNED EFFORTS: Continue checking the differences between radar level-2 data, level-2.5 data and level-3 data. Compare the old level-3 data against the new (high resolution) level-3 data. (Liu)

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: A significant error was found in the height assignment of radar radial wind observations in the GSI. In the GSI, 3D fields of pressure and geopotential height are computed before any observations are processed. Then a vertical interpolation of model fields to the observations is done for height or pressure depending on how the observation is reported. For radar radial winds, the height above sea level is computed for each observation. In the subroutine setuprw.f90, the 3D geopotential height was assumed to be height with respect to sea level, but it is actually height above the model surface. Therefore, all radar radial winds have been misplaced too high in the vertical by the amount of the local surface elevation, a major error. This bug has been fixed in NAM parallel and merged to the GSI Subversion trunk. (Liu, Wu, Parrish)

Work continued on using surface observations with no reported pressure or height, and those data files were tested in GSI to make sure the GSI could handle these extra observations without degradation. It was necessary to modify the GSI code to use these data. In checking the new data, it was found that the TAMDAR data: temperature, humidity and wind, were not used in the regional parallel system. Dennis Keyser found that the new NRL aircraft QC flagged the data for rejection. This problem will be fixed prior to implementation of the package. The NAM parallel was changed to point at the operational TAMDAR obs. (Wu)

No work was done this quarter on the strong constraint. Work continued with Jacob Carley on the hybrid ensemble GSI application to radar reflectivity assimilation using 1.33km NMMB nest. Work continued with Wan-Shu Wu on modifications to the hybrid ensemble GSI to use the operational global ensemble as part of background error for the 12km NAM. (Parrish)

Reflectivity assimilation work continues but suspicions about a bug in treatment of height of obs are first being investigated. Forecast experiments were conducted with modifying temperature with latent heat using both GSD's and NRL's cloud analysis method. The hourly cycle is set up and more experiments will be performed. Digital filtering became available for the HiRes NMMB. (Liu)

PLANNED EFFORTS: Modify GSI to accept MESONET, SFCSHP, METAR and SYNOP data with missing observational pressure. Cooperate with the data group to complete work on using the radiosonde significant levels to improve the analysis profiles. Fix bug where mesonet obs with a crude estimate of pressure are used in the pressure analysis. (Wu) Complete generalized control variable change for hybrid ensemble part of GSI. Fix adjoint bug in dual resolution capability to reduce run time. (Parrish). Continue assistance to Jacob Carley to add NMMB generated ensemble input to the NMMB hybrid GSI, initially for use in assimilation of radar reflectivity at storm scale resolution. (Parrish) Run forecast experiments with modified temperatures based GSD's cloud analysis or NRL's reflectivity analysis. (Liu)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: 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

Modifications to the RR version of the RUC LSM reported in the FY11Q2 report continue to be working well. Tanya Smirnova also recently upgraded the RUC LSM to render it capable of using the more recent (and more accurate) MODIS land-use data. This upgrade, together with these earlier modifications to treatment of melting of snow and albedo when partial snow cover is suspected, and use of surface parameters that are weighted according to the proportion of occurrence of various land-use categories in a grid box rather being based only on the dominant land use, are all being prepared for submission to the NCAR WRF repository after the upcoming WRFv3.3.1 bug fix release.

Following on to work reported in the FY11Q2 report, limited experimentation continued toward comparing the various versions of the Thompson microphysics. As noted in the FY11Q2 report, we decided to use the v3.2 version of Thompson with known bugs removed, rather than switching to Thompson v3.3 at this time, for both the RR and the HRRR. However, we will consider upgrading to a later version of Thompson for the RR2 upgrade in late FY12. We have just received the most recent version of the scheme from Greg Thompson that is intended to change the size distribution of graupel in convective clouds in high-resolution, cloud-allowing forecasts such as HRRR. Because we are very satisfied with the performance of the present scheme for winter storms, we will be cautious about making any changes in microphysics for RR2 without extensive testing on winter precipitation cases.

Work on the MYNN planetary-boundary-layer (PBL) scheme continued, with further testing of modifications to keep the turbulence kinetic energy predicted by the scheme positive semi-definite. These are being tested using the new version of the surface layer developed earlier in the year in which both the roughness length specification and the stability functions have been reformulated. Latest results for individual cases continue to be encouraging vis-à-vis MYJ for 2-m temperature and dew point and 10-m wind, and also prediction of low-cloud coverage. This version of the MYNN scheme is being considered for the RR2 in FY12. It is also being considered for eventual application in the HRRR.

NCAR/RAL

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.
Deliverable
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.

CURRENT EFFORTS:
Trude Eidhammer continued testing the combined CCN and IN version of module_mp_thompson.F. She specifically focused on the 2 dimensional hill case to determine which ice freezing processes are important and if they make physical sense. She also used these simulations to check the new wet deposition (washout) mechanism that is included for both dust and sulfate aerosols. Finally, she is re-running the winter storm case

from April 2010, in which large amounts of dust from southwest were transported to Colorado, and deposited with the snow. She is conducting these reruns because vertical mixing of dust in the boundary layer is now better accounted than in the previous runs.

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

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED:
None

INTERFACE WITH OTHER ORGANIZATIONS:
GSD

UPDATES TO SCHEDULE:
None

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

GSD
In April, an important fix was made to the RR radar-DFI code in the WRF model to allow the original relative humidity and hydrometeors to be retained without upsetting the balance in the model.

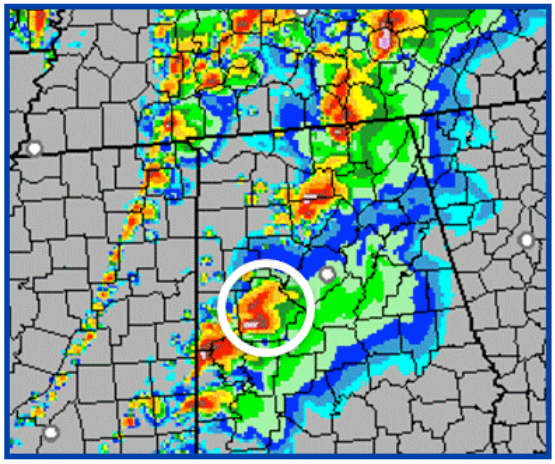
Stan Benjamin introduced new code changes into the RUC-dev code to re-introduce cloud building from GOES cloud retrieval data, but only for within 1500m of the surface. The goal is to improve low-level cloud cover while avoiding the RH bias discovered in December 2010, leading to removal of cloud building in the RR at that point. If this new treatment is successful, this change will also be a candidate for the RR2 upgrade in spring 2012.

Preliminary work continues to code a capability to do nudging of skin temperature, based on the lowest model level air temperature increment.

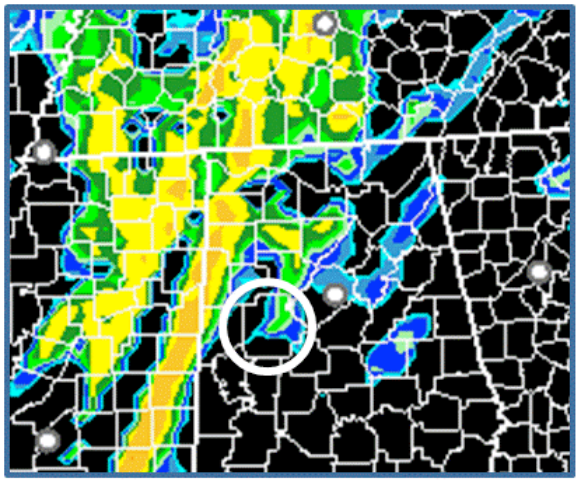
Task 11.5.24 Develop, test, and improve the 3-km WRF-based High-Resolution Rapid Refresh

GSD

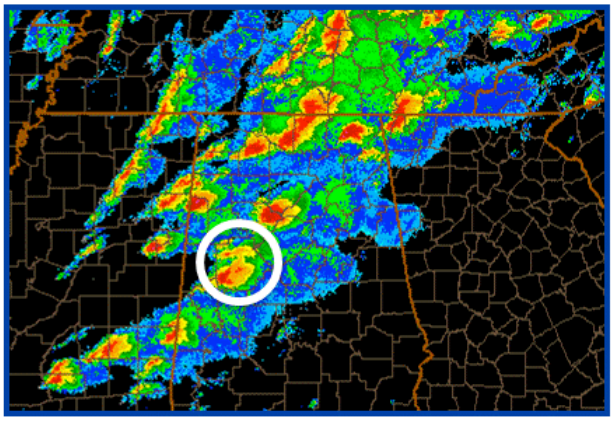
A key milestone was achieved on April 14th, 2011, when the HRRR was switched to run nested within the Rapid Refresh. Prior to this time (and since the inception of the HRRR in 2007) it had always run as nest within the RUC using RUC-based initial conditions. A very significant amount of work preceded this important switchover. First, work to bring the RR to an NCEP operationally ready level was completed, including numerous code updates and fixes (including introduction of partial cycling, resolving issues with the rotated lat lon coordinate, and resolving issues related to DFI balance and hydrometeor reset after the DFI. Next, an extensive set of RUC-HRRR and CW PDT colleagues at NCAR completed RR-HRRR tests on summer 2010 high impact weather periods with detailed analysis of results here at GSD and. Based on this modification were made to the RR radar-DFI assimilation and changes made to the HRRR, resulting in RR-HRRR results that are generally superior to the RUC-HRRR. This work and this accomplishment would have been extremely difficult without the HRRR shadow computer system on jet and the in-house verification package developed by Patrick Hofmann. The RR-based HRRR has been running in real-time with high reliability (and latency trimmed from ~3h last year to ~2h this year) through all the recent severe weather. Shown below is a comparison of HRRR and RUC 9-h forecasts for the April 27th Southeast U.S severe weather outbreak day (this day was also one with very significant aviation impact). As can be seen the HRRR does very well in capturing the overall character of the convection (clusters of super cells ahead of a thin squall-line). It also reproduced certain storms down to a county scale, including the devastating Tuscaloosa tornado storm indicated by the white circles.



3km HRRR 9-h forecast of thunderstorms for 27 April 2011, valid 5pm Eastern Time.



13km RUC 9-h forecast of thunderstorms for 27 April 2011, valid 5pm Eastern Time.



Observed thunderstorms for 27 April 2011, valid 5pm Eastern Time. The **Tuscaloosa, AL tornadic storm cell** is indicated by the white circle.

A careful evaluation of the HRRR continued during May 2011. The HRRR did an excellent job in showing an outbreak of severe rotating thunderstorms for the Joplin, Missouri tornado on 5/22/2011. Some cases have been found with too high areal coverage of convection in the HRRR, more so with the onset of summer in the month of June. Associated with this has been the development of an assimilation modification for testing, creation of PBL-based pseudo-observations, as discussed under Tasks 5.4 and 5.5. With the additional processors funded by the FAA, a real-time (every 3rd hour) developmental HRRR forecast was run for a period of three weeks. The results of the comparison of HRRR-dev vs. HRRR, indicated improved performance (especially during the afternoon) for the HRRR-dev (initialized off of the RR-dev). See Fig. 6 below showing the improvement for the HRRR forecasts initialized at 21 UTC. Based on the results from this extensive testing, these changes were introduced into the real-time HRRR (used for CoSPA) on 00z 7 July. Following this change, the HRRR-dev (shadow system) has been used to conduct experiments to further optimize the WRF model time step. Results indicate that the HRRR WRF model time step can be increased from (15s/20s – dynamic time step) to 18s/24s, with no degradation of the forecast (indicated by verification of near real-time HRRR-dev runs vs. HRRR primary).

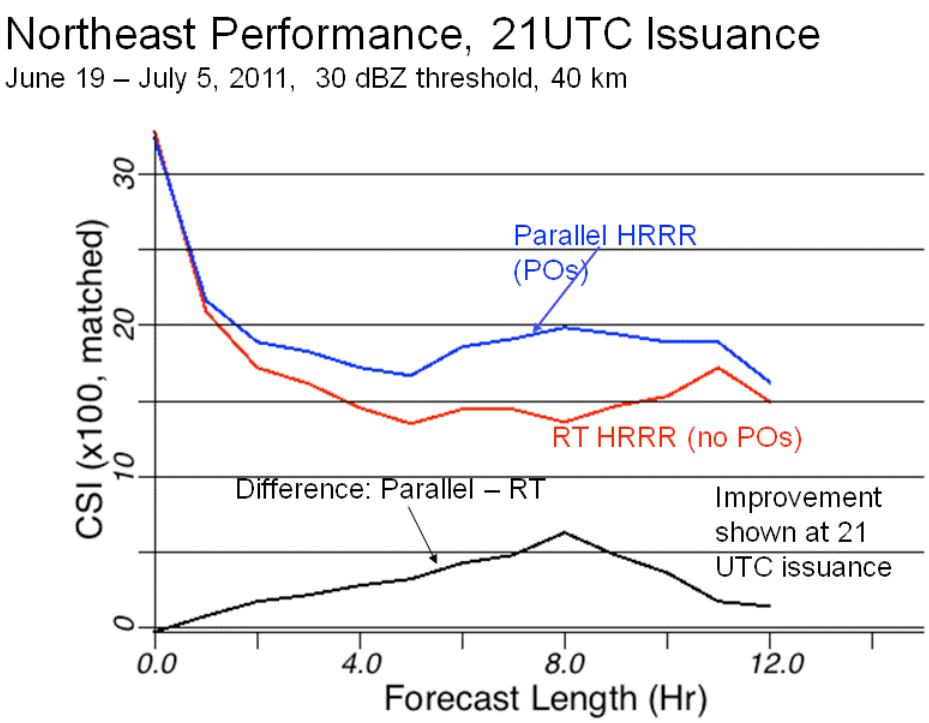


Fig. 6. Comparison of 30-dBZ reflectivity 40-km CSI scores for HRRR-dev (based on RR-dev with boundary-layer-based pseudo-observations – blue) vs. HRRR (based on RR-primary without pseudo-observations).

NCAR/MMM

CURRENT EFFORTS: NCAR/MMM and GSD agreed that NCAR will run the ARW for selected cases from the current season, based on cases seen in the HRRR runs that are being done. NCAR will simulate and analyze up to four cases, running the ARW at 3-km using the HRRR for ICs and BCs. Sensitivity tests would be done as appropriate.

NCAR reviewed real-time HRRR forecasts to help select cases for further study, with Spring 2011 turning out to be very active. NCAR performed initial sample test runs with WRF at 4 km in preparation for these HRRR study cases. More recently, NCAR has increased the resolution of its ARW runs to 3 km to be fully consistent with the HRRR resolution.

PLANNED EFFORTS: NCAR will continue to review the real-time forecast output, will collaborate with GSD on case selection, and will begin chosen case analysis and re-simulation at 3 km.

UPDATES TO SCHEDULE: NONE