MDE Product Development Team
September FY10 4th Quarter Report – FY 2010
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(Compiled and edited by S. Benjamin and B. Johnson)

Executive Summary

Task 10.5.1: Infrastructure support related to operational running of the RUC and NAM operational modeling systems.

- Investigation of occasional crashes on RUC warmed up again in August after a crash case. GSD found that an increase in sigma layer depths near surface solved the crash. No changes made yet in operational RUC, but this test provides a strategy if required by NCEP/NCO. (Note: RR ran without problem in all of these cases.)

Task 10.5.4 Develop, test, and implement Rapid Refresh configuration of the WRF modeling system.

- *Completion of start of RR EMC frozen evaluation has been slipped to 1 December.*
- *Anticipated RR implementation date at NCEP has now been moved back to* ***July 2011****.*
- RR test cycle at NCEP continues to run in real-time with new rotated lat-lon (RLL) grid/domain covering all of the Aleutian Islands per requests from the Alaska Aviation Weather Unit (AAWU) and NWS Alaska Region.
    - RUC-130 CONUS grids (same as current RUC grids) now being produced successfully from RLL version of RR.
- Major computer transition at ESRL required major rewrites to all RR scripts and significant testing in Aug-early Sept.
- Speed of ARW model increased significantly at NCEP, guaranteeing equal speed in Rapid Refresh as for current RUC.
- UNIPOST updated with RUC code for option to derive RUC-like aviation-impact variables (e.g., CIG, VIS)

Task 10.5.5: Develop, test, and implement 3DVARs for RR and NAM

- Code modifications for RR GSI with binary I/O complete and submitted back to NCEP
- Extensive testing to optimize background error covariance specification within GSI for RR to improve 6h RR forecast skill.

Task 10.5.15: Develop methods for improved cloud/hydrometeor analysis in RR

- Modifications to GSI for ingest of background hydrometeor fields and new observations accepted in NCEP GSI SVN repository
- Testing of METAR-cloud-based RH observations in variational humidity analysis in development RUC.
- Corrected issue with cloud analysis spuriously removing hydrometeors

Task 10.5.24/19: Development/testing of HRRR

- Additional case study tests being conducted to evaluate HRRR MCS propagation issues, including initial tests of 1km nest inside HRRR and mid-level moistening
- Continuing very good HRRR reliability since start of CoSPA evaluation
- Installation of computer resources for a HRRR partial shadow system has been completed at GSD
- HRRR reflectivity verification package running, being expanded to include VIL verification
- Parallel HRRR ("HRRR-dev") running every 3-h on shadow computer system, verification against HRRR

Task 10.5.1 Infrastructure Support Related to Operational running of the non-WRF Rapid Update Cycle System in NCEP Operations

ESRL/GSD
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). Intercomparison 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. No RUC performance problems occurred in the quarter at ESRL (of special interest since the backup RUC at ESRL is used to initialize the HRRR (http://rapidrefresh.noaa.gov/hrrr).

As of late September, ESRL is now running a modified version of the RUC with improved convective suppression and smaller latent heating from the radar reflectivity assimilation in the development RUC. The devRUC initial fields, in turn, are now used to initialize the development version of the HRRR (see more under 5.19).

After two August crash cases with the RUC model at NCEP in a down slope wind case, ESRL worked with NCEP-EMC to test variations in the vertical coordinate. A modest increase in the maximum sigma thickness specification in the RUC hybrid coordinate from 10 hPa back up to 12 hPa (or to 15 hPa) was successful to avoid the crash in this case. While these crashes are rare, ESRL and EMC now have a likely strategy to take if required by NCEP/NCO should additional crashes occur in RUC before the RR implementation. (Note: The Rapid Refresh has been rock-solid in all of these cases – no crashes at all.)

NCEP
10.5.1.1 Maintain hourly RUC runs and provide aviation guidance grids. (30 Sept 10) The operational RUC experienced several failures caused by violations of CFL instability during this quarter. The code is now running with a time step of 18 seconds, which results in a slight (~3 minute) delay in the 18-hour forecast products but makes the system less vulnerable to these crashes. NCEP Central Operations personnel have the option of running any future cycle that fails for this reason with a 16 second time step. (Manikin)

10.5.1.2 Provide vendors with gridded model data via Family of Services (FOS), and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (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)

10.5.1.3 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)

10.5.1.4 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

10.5.1E1 (30 September 2010) (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 nearly complete for a major upgrade to the NCEP BUFR library scheduled for implementation in FY2011/Q1. On 14 September, MAP (surface reports from Multi-Agency Profiler sites) was added to the list of mesonet providers that are decoded by NCO. The Florida and Georgia DOT and Aberdeen PG mesonet providers remained down. The Florida mesonet was down 17-23 September. The LSU-JSU provider was down 26 July through 29 August and again on 18-20 September. There was a 15-hour mesonet outage on 6 September due to MADIS issues. GOES-13 cloud and precipitable water retrievals have not been used since the switch from GOES-12 to GOES-13 in April 2010. Surface pressure observations from 15 oil rig METAR reports added since last May continue to be available for assimilation in the RUC and NAM even though they are on the reject list due to their uncertain quality. An RFC has been submitted to correct this error. (Keyser)

The REF2GRB package was modified by EMC to use Grib2 format and implemented by NCO on July 29, 2010. The new VAD wind process cannot generate enough VAD profiles during the precipitation scan mode. This bug was fixed and tested in parallel. (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 on issues like 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)

Canadian radar data will be examined and tested to see if current the WSR-88D Level-II data QC package can be applied. (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.

10.5.1E2 (30 September 2010) (Manikin, ESRL)
Perform configuration management for RUC, including thorough documentation, and respond promptly to any code malfunctions or performance issues.

CURRENT EFFORTS: The cause of the RUC cycles that "hung" prior to completion in May and June has not yet been found (no RUC model crashes occur on the ESRL compute with the same initial conditions), but work was done with IBM and NCO to have the code generate a clean exit instead of a hang in such an event. This allows NCO to notice the problem much sooner and initiate the rerun. This code was implemented on 24 August. (Manikin, IBM and ESRL)

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: NCO & ESRL.

UPDATES TO SCHEDULE: None.

10.5.1E3 (30 September 2010) (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 operational-NCEP RUC model experienced several failures caused by violations of CFL instability during this quarter. ESRL has rerun these cases on its computer with the NCEP initial conditions, and has been unable to reproduce the RUC model crash with either 18s or 20s time steps. The code is now running at NCEP with a time step of 18 seconds, which results in a slight (~3 minute) delay in the 18-hour forecast products but makes the system less vulnerable to these crashes. NCEP Central Operations personnel have the option of running any future cycle that fails for this reason with a 16 second time step. (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 10.5.17 Infrastructure support for operational running of Rapid Refresh, North American Mesoscale, and HiResWindow (and future HRRR) at NCEP, including support for community WRF model

ESRL/GSD

Progress in Rapid Refresh development during May toward operational implementation at NCEP can be found under Task 5.4 report.

NCEP

Parallel tests of the NEMS/NMMB model in the EMC NAM parallel system continue on the CCS. Two NMMB parallels are being run; a control run plus an experimental run with model and/or analysis changes for inclusion in the control run. During this quarter twice a day runs of all four nested domains (CONUS, Alaska, Hawaii, Puerto Rico) began in the experimental NMMB parallel. Other changes that have been implemented in both NMMB runs (including nests) include the modified 60 level vertical level distribution, (doubling from 8 to 15 the number of vertical levels above 200 mb), use of a dynamic reject list from the RTMA for mesonet data in the GSI analysis, and changes to various microphysics parameters to improve simulated radar reflectivity. Changes specific to the nests include expanding the Puerto Rico domain to cover all of Hispaniola, using an experimental version of the BMJ convection with moister profiles (in an attempt to induce behavior like the regular BMJ shallow convection), and turning on gravity wave drag/mountain blocking in the 6 km Alaska domain. Currently, MODIS IGBP land-use classification is being tested in the experimental NMMB parallel and all nests. (Rogers)

10.5.17.2 Maintain four/day HRW runs and provide aviation guidance grids. (30 Sept 10)

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 (Jan-Feb 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)

10.5.17.3 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 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)

10.5.17.4 Provide full grids from RR, NAM, and the HRW on NCEP and NWS/OPS servers. Maintain access to model verification data. (30 Sept 10)

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)

10.5.17.5 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

10.5.17.E1 30 September 2010 (Keyser, Liu)
Perform ingest, quality control and preparation of both existing and new observations in support of the operational RR, NAM & HRW WRF runs.

CURRENT EFFORTS: See also the obs related items reported under Task 10.5.1 especially Deliverable E1. Since the RR has an extended domain including Alaska and much more ocean areas, most of the following also applies to the Rapid Refresh. Since 1 August, nearly half of the Canadian radiosonde stations no longer provide wind information, as sites now alternate between using Loran and GPS navigation signals and only GPS signals are used to generate wind data. MTSAT-2 replaced MTSAT-1R for JMA satellite-derived winds on 11 August, with an unintended glitch in NCEP processing which led to no JMA data being available to the NAM-GSI until an emergency fix was implemented on 30 September. GOES-13 radiances are monitored but will not be used until the next NAM update (a result of the April 2010 switch to GOES-13). Due to fall eclipse season, there are 0600 UTC gaps in GOES data. NESDIS applied a fall temperature patch to GOES sounder radiances on 8 September (for GOES-11) and again on 17 September (for GOES-13). This should decrease the radiance biases in the NAM-GSI. There was a 7-hr loss of polar satellite data on 25 August. A 19-hr data outage from all instruments on NOAA-15 - NOAA-19 and on JASON-2 occurred 3 September from the effects of Hurricane Earl at Wallops. METOP 1B radiance data were not available for five hours on 9 July, for 4 hours on 20 August and for 5 hours on 17 September due to transmission problems. NOAA-18 has on-going gyro issues that could lead to the demise of the gyros and unusable products within 6 months. NESDIS engineers conducted 24-hour tests (10 Aug, 17-18 Aug) where the corrupted navigation data will not be sent to NCEP. After the second test, NOAA-18 MHS data was not available for another 20 hours due to problems related to the test. Increasing the amount of Level 2 88D radar data received by adding a 5th hourly ingest run is being discussed with NCO. The following data types are monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), Mesonet mass data, AIRS AMSU-A radiances 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-superobed), and production NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and SBUV-2 data are being created. These

changes to obs monitoring, with the exception of RASS, 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 pseudo surface pressure increment at the storm center (derived from the global guess and max wind information in the tcvitals file) along with a saturated moisture profile is now available for tested in the parallel. The RTMA update to dump and process observations in and around Guam was implemented on 29 September. As a result, the Guam RTMA is now assimilating some low-level satellite-derived winds. ESRL is concerned about missing ASCAT data and the low number of WindSAT data in a private ESRL directory on the NCEP ftp server.

The ASCAT issue is the result of a change from two to four wind solutions in the upstream processing on 14 September (NCEP's processing must be modified to handle this). The WindSAT issue can only be corrected by moving the dump time back 30 minutes. RR dumps of Level 2 and expanded (time-window) Level 2.5/3 88D radial wind data and hourly lightning data 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. Hourly dumps of GOES single-pixel cloud data from NASA/Langley (which cover Alaska) from the developmental BUFR database began in July and are copied to a public ftp directory for RR parallel testing. ESRL reported in August that the Langley cloud data from NCEP covered a much smaller geographical area than expected. NCEP discovered a (latitude) decoder problem that was corrected on 17 September. An outage of the Langley data processed at NCEP on 27-29 September was due to a server problem. 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, because it's the only available radial wind data for the Alaska portion of the expanded RR domain. Level 2 data from 8 DOD CONUS sites are expected to become available in November 2010. (Keyser)

PLANNED EFFORTS: Since the Shemya radiosonde (70414) still has a launch time that is too late for the NAM-GSI or RR-GSI; we will contact Alaska Region to get more information on this issue. 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 "use list" to control what incoming data is 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 COOP, UrbaNet, wind energy and late-arriving mesonet data); MDCRS aircraft moisture (including WVSSII instrument on Southwest aircraft); NPN and MAP and European RASS virtual temperature profiles; JMA, Hong Kong, European, Canadian, MAP, and 6-minute NPN profiler winds; GOES 3.9 micron, GOES visible, and AVHRR POES satellite winds; 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 II 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). 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)

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: Complete

10.5.17.E2 30 September 2010 (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.

10.5.17.E3 30 September 2010 (Manikin, 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: No RR problems were detected during the last quarter.

10.5.17.E4 30 September 2010 (DiMego Manikin, Chuang)
As requested by other RT's, incorporate new AHP calculations into Operational WRF Model post-processor and product generator.

CURRENT EFFORTS: No requests from other RT's were received during the last quarter.

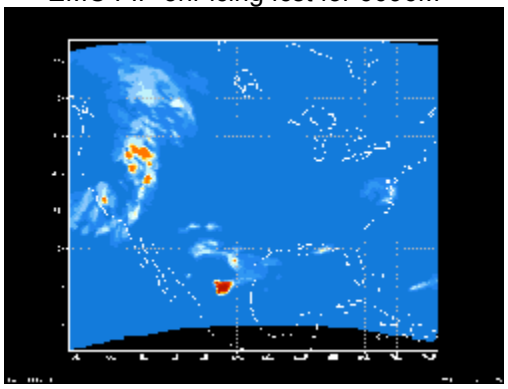
CIP Translation from AWC to NCEP CCS: Out of the six data sets fed to CIP, the data ingestion code for PIREP and RUC model data has been finished. Work just began on ingestion of GOES imager data in GINI format. FIP code adapted to the GFS was received from Frank McDonough. (Mao)

FIP Translation from AWC to NCEP CCS: This is complete. See figure comparison below. (Mao)

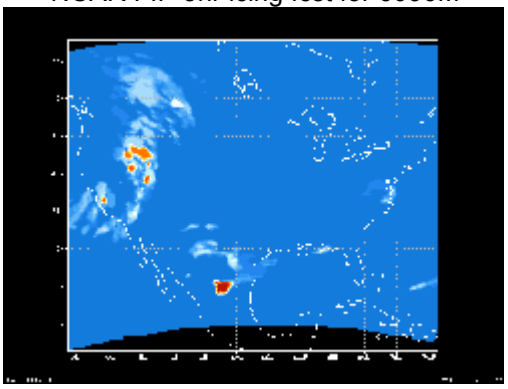
PLANNED EFFORTS: Respond to requests as received. Complete work on GOES imager data ingest in GINI format. (Mao)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: There is no GOES imager data available at NCEP in proper format. NCO will solve this by adding the WMO headers to the TNC feed to grab GINI format data through NOAAPort.

EMC FIP 3hr icing fcst for 6096M



NCAR FIP 3hr icing fcst for 6096M



INTERFACE WITH OTHER ORGANIZATIONS: NCAR, AWC.

UPDATES TO SCHEDULE: None

NCAR
CURRENT EFFORTS:

NCAR organized and conducted a WRF tutorial and assisted with related tutorials, held July 26–August 6. The first week featured the main WRF tutorial, while the second covered WRFDA, WRF-Chem, and MET. Attendance for the WRF tutorial was over 60.

NCAR prepared and issued a minor WRF release, Version 3.2.1. Released on August 18th, this contains bug fixes and miscellaneous improvements. Jimy Dudhia of NCAR/MMM contributed to the following fixes: (i) a minor YSU PBL scheme correction to a V3.2 modification in the Prandtl number calculation; (ii) reversion to the RRTMG longwave package from V3.1 while errors in the V3.2 package are investigated; and (iii) a minor fix to initialize a variable in the BEP urban model option. Details of V3.2.1 may be found at http://www.mmm.ucar.edu/wrf/users/wrfv3.2/updates-3.2.1.html.

Dudhia of NCAR/MMM worked on various WRF physics issues. In cumulus physics he obtained code from Pacific Northwest Nat'l Laboratory (Bill Gustafson and Jerome Fast) that adds CCSM physics options for deep and shallow convection into the WRF physics framework. The shallow scheme is one by Park and Bretherton (Univ. of Washington), and the deep scheme is a Zhang-McFarland scheme, as modified by Rich Neale (NCAR/CGD). These are also being prepared for the next major WRF release, V3.3 (2011).

Dudhia worked with Changhai Liu (NCAR/MMM) on modifications to the YSU PBL scheme and on determining the effect of sub-grid vertical fluxes on resolved fluxes in 1-km idealized PBL growth tests. This was motivated by the YSU scheme's allowing resolved large eddies to develop, while the MYJ PBL does not, with the MYJ behavior being preferable. The modifications made the YSU PBL behavior more reasonable. Dudhia also worked with John Michalakes (NREL) on adding physics related to surface wind fields in WRF. This includes allowing the ARW to advect the turbulent kinetic energy associated with some of its PBL options. Up until now this was not advected (except in NMM). This work is also in collaboration with Julie Lundquist (Colorado University).

On work on the model's surface-layer, Dudhia is finalizing work with Pedro Jimenez (CIEMAT Center, Spain) on improving the consistency of the surface-layer scheme in WRF with theory and evaluating it on an extensive surface dataset in Spain. This has led to a scheme that is improved in several details of its parameterization of the surface exchange coefficients in stable and unstable conditions.

With microphysics, Dudhia began work on adopting the Heymsfield and Schmitt (NCAR/MMM) formulas for particle fall speed and particle mass-size relations. These are based on the most recent observational datasets including corrections for known problems in past datasets that were the previous bases for such formulas. These changes will ultimately be implemented in the new WSM6 scheme.

NCAR/MMM hosted graduate student Marcela Ulate (U. Miami), who worked on the sensitivity of the MJO to model physics in tropical channel WRF simulations. The runs included the nudging of water vapor in order to obtain an MJO. This is being investigated in terms of the physics required to produce an MJO, particularly deep and shallow convection.

Lastly, Dudhia resolved a problem in WRF V3.2 RRTMG longwave radiation scheme. This was due to not updating the RRTMG data files when the V3.2 code was added. He added a fix for the new RRTMG scheme to the repository for the next release and made a code clean-up change in the coriolis calculation to comment unused lines.

Dudhia visited Numtech Co. in France to collaborate with Julien Pergaud, who is working with others to merge the QNSE stable boundary layer method with the eddy-diffusivity/mass-flux (EDMF) sub-grid scheme for unstable conditions. The latter scheme is used at Meteo-France. The merger of the two schemes is progressing and may become part of WRF V3.3.

Lastly, NCAR/MMM hosted visitor Fernando de Sales (UCLA), who delivered a preliminary version of the SSiB land-surface model. This LSM may eventually go into V3.3.

PLANNED EFFORTS: The development and implementation of new physics will continue in FY11.

UPDATES TO SCHEDULE: None

Task 10.5.4 Develop, test, implement, and improve the Rapid Refresh.

ESRL/GSD

Intensive effort continued during FY10Q4 toward the RR implementation at NCEP, with concentration on meeting specific NCEP requirements for the RR and also toward addressing matters of analysis and forecast performance that have appeared over the past few months. Tasks completed during the quarter are

- Expansion of the RR domain slightly to include all of Alaska including the entire Aleutian chain, and to convert to the rotated latitude-longitude grid/domain (see Fig. 1 below). The NCEP RR cycle ("RAPx") is has been running on the rotated lat-lon domain shown on this figure for much of the quarter.
- GRIB grid #83 has been designated for the Rapid Refresh using this rotated latitude-longitude domain.
- Speed-up of ARW model at NCEP – after help from NCEP/IBM consultants, the run-time was decreased by over 2x, and now is running in the same run-time currently being used by the RUC at NCEP.
- Upgrading GSI to the latest top-of-trunk version: significant effort was made to get this working correctly on n/hJet at GSD.
- Replacing NetCDF with binary formats for all input/output and intermediate files needed for the RR cycling.
- Upgrading of UniPost to produce 13 additional 2-d fields available from the RUC, but not heretofore available from UniPost.
- Generalization of the EMC programs *prdgen* and *copygb* to produce products on specified AWIPS grids from the rotated lat-lon grid in the RR.
- Finding and correcting a bug in the Grell shallow-convection scheme that was causing crashes on the NCEP IBM (but nowhere else).
- Completion of an effort with NCEP and NASA Langley (LaRC) to ensure that the Langley multispectral cloud diagnostics product is reliably available and suitably preprocessed at NCEP over the RR domain.

In addition, at GSD Rapid Refresh primary and dev 1-h cycles were shifted to run on hJet (a major effort). A major operating-system change for hJet/nJet late in July necessitated recompiling and some reconfiguring of WRF and GSI on these systems. With the decommissioning of wJet in early September, all the Boulder High-Performance computing systems are now using essentially the same operating system.

Close communication with NCEP was maintained via regularly scheduled weekly (and frequent additional unscheduled) telecons between the GSD RR developers and Geoff Manikin at NCEP to review current progress, examine forecast performance, both at GSD and EMC, and to define remaining tasks necessary toward the implementation. The principal remaining issues to be resolved before formal NCEP/EMC evaluation can begin involve improving the near surface analysis through more effective and complete use of *in situ* surface data (e.g., METAR, mesonets) in GSI and the proper settings for the background error, particularly to improve the wind analysis at upper levels.

The RR at GSD continues performing similarly or slightly better than the RUC for most forecast fields at 3h and 12h duration, but with slightly poorer results for upper-level winds at 6h forecast duration (more under Task 5.5). The mid-level warm bias noted in the FY10Q3 report has been reduced significantly by enabling shallow convection (via a name list option in WRF) within the G3 (3d Grell-Devenyi) convective scheme. We performed limited testing toward lessening the earlier low-level warm bias (see Task 8).

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

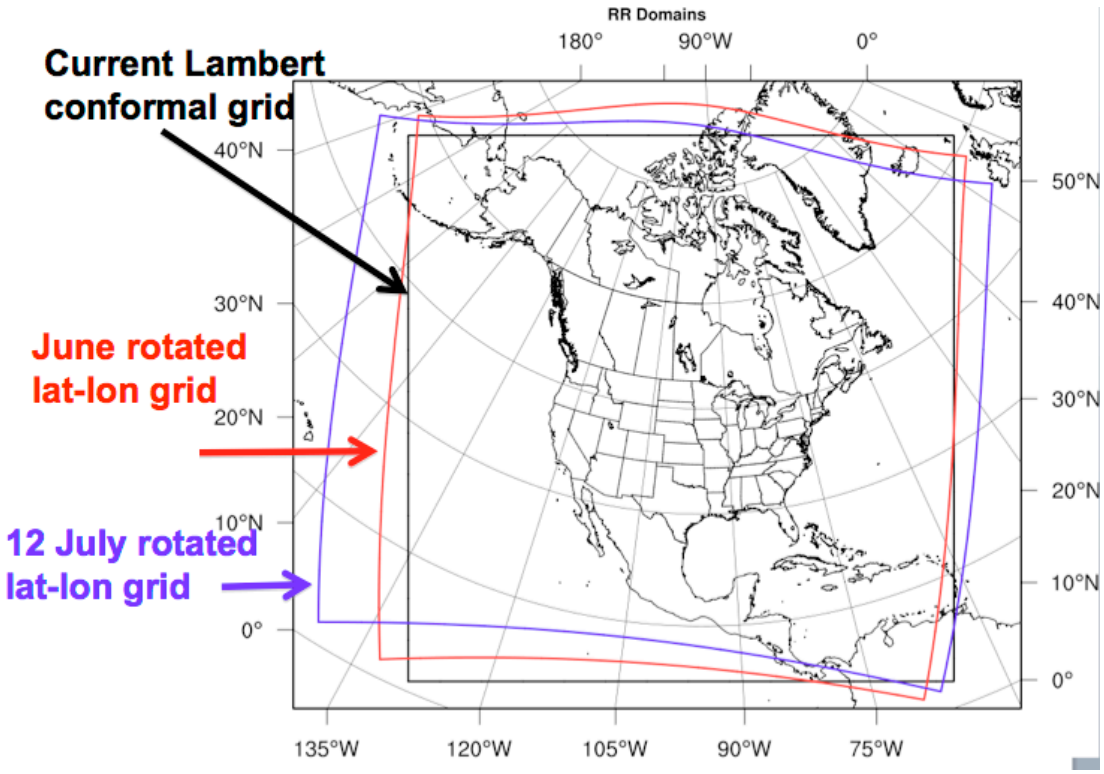


Fig.1. Rapid Refresh domain – old Lambert conformal (black) and future (purple) rotated lat-lon version. The red grid was an initial rotated lat-lon grid proposed in June before the Alaskan request to include all of the Aleutians in the RR domain.

More details below on specific changes:

Binary I/O in place of NetCDF:
A major effort in July was replacing NetCDF format files with flat binary files for model output and for output from the WRF Preprocessing System used in the RR partial cycling. A major component of this was the adaptation of the NCAR routine *update_bc* to permit use of binary files for input and output from this code instead of NetCDF. All this was a requirement for NCEP implementation. A benefit of this change is that reading and writing files now takes about half as long as before. We have been running with the binary I/O in the RRdev much of the quarter, but have held off putting this into the RRprimary at GSD because of the greater ease of inspecting the NetCDF wrfout files as compared with the binary WRF output. Geoff Manikin is putting these changes in place at NCEP.

Rotated lat-lon projection for RR:
Based on the groundwork laid in Q3FY10, and having received a final word from various functionaries in the National Weather Service, and particularly from the Alaska Aviation Weather Unit (AAWU), the Anchorage NWS WFO, and the Aviation Weather Center (AWC) in Kansas City concerning the desired domain coverage by the Rapid Refresh, we made the final decision in July to switch to the rotated latitude-longitude (RLL) horizontal grid early in July. Figure 1 (above, repeated from the Q3FY10 MDE report) shows the old Lambert conformal domain (in black) and the now final (purple) RLL grid. The purple RLL grid contains about 2.5% more grid points over a slightly bigger domain than the previous Lambert conformal grid that had been used at GSD for the past 20+ months, but at the same nominal 13km horizontal grid spacing. This grid (or, more precisely, the de-staggered A-grid instantiation of this grid, which is used by UniPost for output on the horizontal native grid) has been assigned

as AWIPS Grid # 83. (Parameters for this grid can be found at http://rapidrefresh.noaa.gov/RR.rlldomain.txt.) The UniPost incorporates recently developed NCEP enhancements to post-process binary files from the ARW when the ARW is run using the rotated lat-lon grid option. Heeding advice from EMC, for grids that require interpolation from the native RR horizontal Grid 83 to specialized domains (e.g., to Grid 130, the current native RUC horizontal 13km grid), at EMC we are using their *prdgen* code rather than *copygb*. This is more efficient (pre-calculation of interpolation weights from one grid to another) and much faster, than *copygb*. Considerable effort was required to port *prdgen* and a new version of *copygb* (needed to interface with the Developmental Testbed Center's MET verification software that we have been using to verify RR surface forecasts) to GSD's Linux clusters.

RR Post-processing:
UniPost upgrades developed at GSD during the past 3 quarters, including 13 new fields added in August and more in September, were passed on to NCEP and have been incorporated into the EMC RR by Geoff Manikin working closely with GSD to ensure these fields are being computed correctly and identically to RUC. These upgrades now successfully produce RUC look-alike isobaric (*pgrb*) and surface (*sgrb*) files on the CONUS 13km grid #130 having a complete set of RUC-like fields. Post-processing of GSD primary and dev 1-h cycles has used the UniPost (with earlier extensive GSD enhancements for RUC look-alike fields) for the past several months. A small glitch in generation of the 3-d native grid fields was fixed in early July; the UniPost has been generating output grids on the native sigma surfaces of the WRF instead of on isentropic (theta) levels since then. The level type in the RR GRIB output will be "hybrid levels", meaning only the vertical level, same as the RUC has been and same as that used for native-level output for the NAM and GFS.

Subtasks

10.5.4.1 Ongoing evaluation of performance of real-time and retrospective runs of RR system. (30 Sept 2010)

GSD
Overall, GSD RR performance continues to about equal or is better than that of the GSD RUC backup for most variables for 3h and 12h forecasts, slightly worse for jet-level winds for 6h forecasts (GSI work underway – see Task 5.5). Warm temperature biases at mid levels noted in the Q3 report were significantly reduced but not eliminated by activating the shallow convection option in the Grell convective parameterization. This decreased the overall cloud cover, presumably enhancing long-wave radiative cooling at middle levels.

Some warm and moist bias continues at the surface. Our immediate avenue for reducing this bias is toward more complete and effective use of surface data in the GSI through including surface stations that have a station pressure higher than the model surface pressure at that location, and by reducing the amount of 1h precipitation by modifying the radar assimilation in the RR/GSI to reduce soil moisture.

An experiment was performed (see Task 5.8) on whether a small physics change could reduce a warm bias at low levels over the eastern CONUS.

NCEP
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. ESRL reports that the Langley cloud data from NCEP cover a much smaller geographical area than expected, so NCEP is investigating. Future data tests will include Multi-Agency Profiler winds and METOP-2

radiances as well as “tcvitals” records for tropical cyclones. EMC and GSD have requested the Radar Operations Center to initiate radar sites’ hourly processing of Level 2.5 88D data 15-30 minutes earlier so more data will arrive before the RR cutoff. This is critical for the Alaska portion of the expanded RR domain, where the only source of radial wind data is the Level 2.5/3 because of no funding for Alaskan Level 2 data. Level 2 data from 8 DOD CONUS sites are expected to become available in November 2010. (Dennis Keyser)
The hourly Rapid Refresh cycle is now running at NCEP, although some updates to the code are still needed. Code has been written to develop a product generator for the Rapid Refresh to interpolate the output to the existing RUC output grids, to maintain all of the grids/parameters currently available in the RUC to assist user transition to the new system. This has proven to be a difficult task, as the RUC generates different precipitation accumulation time periods than in the WRF code used by the Rapid Refresh. (Geoff Manikin)
Subtasks

10.5.4.3
Testing of the Rapid Refresh continues. EMC has a stable parallel system running since the middle of August and is making evaluation graphics available on a web site. GRIB files are not being sent to the field for evaluation due to poor verification scores. There are ongoing issues related to the GSI analysis code and cycling of surface fields in the parallel RR, which must be resolved. (Manikin)

Deliverables

10.5.4E3 1 Feb 2010 (Manikin) (new request, consistent with 14 Oct RR status telecon)
Pending EMC, and NCEP Center initial recommendations, Request for Change (RFC) forms are filed to submit Rapid Refresh software to NCO.

CURRENT EFFORTS: Rapid progress in RR testing/development as described in the rest of Task 5.4.

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:
The NCEP computer issue reported in the Aug report has not been a problem since about 20 Sept, good news.

INTERFACE WITH OTHER ORGANIZATIONS: ESRL.

10.5.4E3 1 Feb 2011 (Manikin)
Pending EMC, and NCEP Center initial recommendations, Request For Change (RFC) forms are filed to submit Rapid Refresh software to NCO.

UPDATES TO SCHEDULE: This deliverable must carry over to FY2011.

Subtasks:

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

GSD
Overall, GSD RR performance continues to about equal or is better than that of the GSD RUC backup for most variables. Warm temperature biases at mid levels noted in the Q3 report were significantly reduced but not eliminated by activating the shallow convection option in the Grell convective parameterization.

10.5.4.2 Continue to solicit input from In-flight Icing, Turbulence, National Ceiling/Visibility, and Convective Weather PDTs and NWS forecasters in Alaska and Puerto Rico, on performance of pre-implementation Rapid Refresh. (ESRL, NCEP)

During July, discussions with the Alaska Aviation Weather Unit (AAWU) and the Anchorage NWS WFO concerning the desired domain coverage by the Rapid Refresh disclosed that the Alaska folks wanted to see the *entire* Alaska portion of the Aleutian Island chain included within the RR domain. This resulted in the purple domain on the rotated lat-lon grid shown in Fig. 1, and was approved by the Aviation Weather Center (AWC) in Kansas City in early July. To partially compensate for the westward extension necessary to include the Aleutians, the south boundary of the domain was moved slightly north. In order to display the full extent of the new Rotated lat-lon grid in Alaska localization, the AAWU and Anchorage NWS WFO asked that we produce products on AWIPS grid #242, which encompasses the entire Aleutian chain, instead of #249.

10.5.4.3 Updated report on status of tactical planning for making RR-WRF ARW model code for 2013 in compliance with Earth System Modeling Framework (ESMF) in agreement with the Sept 2007 Rapid Refresh MOU between NCEP and GSD. Work in this area will commence in FY11 (ESRL, NCEP, NCAR)

ESRL has had meetings with NCEP and DTC about future application of NEMS for the ARW core. ESRL/GSD continues to prepare its global FIM model (http://fim.noaa.gov) for becoming part of the Global Ensemble Forecast System at NCEP using ESMF and the NCEP configuration for ESMF, NEMS. Initial testing of FIM running under NEMS at NCEP was conducted earlier this year. The process of putting FIM under NEMS has entailed close collaboration between GSD software engineers and the NEMS developers at NCEP. This has provided valuable experience for ESRL software engineers in use of NEMS and GSD software engineers have even contributed substantially to the design of the NEMS configuration at NCEP. The FIM experience for NEMS prepares ESRL well for the upcoming adaptation of the WRF-ARW dynamic core toward NEMS in the 2013 version of the Rapid Refresh. Work specifically toward putting the ARW core under NEMS will commence in 2011.

10.5.4.4 1 Feb 2011 (GSD, NCEP)
Complete pre-RFC evaluation of Rapid Refresh in accordance with NCEP pre-implementation checklist for major implementations. Respond to evaluation questions; present information on Rapid Refresh pre-implementation testing and evaluation results in various forums, as required.

GSD
1 Feb 2011 is now our best current estimate for completion of the pre-RFC evaluation.

NCEP
Work has been done to generate RUC "look-alike" grids in the Rapid Refresh. Geoff Manikin has worked with GSD personnel to add all parameters to the post processor and has written 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. (Manikin)

Deliverables:

10.5.4.E1 20 Dec 2009 (GSD)
Report on Rapid Refresh testing at annual NCEP Production Suite Review meeting.
Stan Benjamin, Steve Weygandt and Ming Hu attended the NCEP Production Suite Review 8-10 December and gave an update on RR progress. This presentation can be found at
http://www.emc.ncep.noaa.gov/annualreviews/2009Review/presentations/Benjamin-Weygandt-RUC_C.ppt

10.5.4E3 1 Feb 2011 NCEP
(Manikin)
Pending EMC, and NCEP Center initial recommendations, Request for Change (RFC) forms are filed to submit Rapid Refresh software to NCO.

New estimated date – 1 Feb 2011 after EMC evaluation period is complete.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A schedule backlog has developed for implementations on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: ESRL.

UPDATES TO SCHEDULE: None.

Task 10.5.5 Develop, test, and implement improvements to the operational data assimilation supporting Rapid Refresh and North American Mesoscale runs.

ESRL/GSD
Significant effort continued during FY10Q4 toward obtaining a frozen code version of the GSI portion of the RR, for implementation at NCEP. One major accomplishment was completing the transfer and testing of all RR-related GSI changes to NCEP and inclusion of them in the NCEP SVN repository, allowing an NCEP SVN repository tagged GSI version (NCEP r9374, community r223) to be used for the Rapid Refresh. The main concentration has been on addressing matters of analysis and forecast performance that have appeared over the past few months. IN particular, recent RR GSI work been on tuning of the background error covariance specification. The real-time RR test cycles have used the NAM background error covariance file and settings and this has yielded rawinsonde-based forecast performance scores nearly equal to those from the RUC, for 3-h and 12-h forecasts (the ones closest in time to the 9z and 21z introduction of GFS atmospheric fields via the partial cycling). The 9-h and especially the 6-h RR forecasts (more distant in time from the introduction of GFS fields) have been more problematic, and work during this quarter has focused on tests using the GFS background error covariance file, allowing for variations in the amplitude of the background error variance. Extensive testing (single observation tests and two parallel cycle tests with evaluation of analysis increments and skill scores) has lead to progress in specification of the background error covariance, but not yet produced 6-h and 9-h forecasts superior to those from the RUC. Active work continues in this area (also using retrospective test cases) and we anticipate resolution of this key implementation issue within the next few weeks.

Other GSI-related work has included resolving several issues. 1) Switch moisture analysis from Q-option 1 to Q-option 2. 2) Work with NCEP and NASA Langley to resolve issues related to the Langley data, yielding ingest of the fields with correct data coverage for the expanded rotated lat-lon domain. 3) Fixing a GSI problem to facilitate the use of surface observations with a pressure level larger than the corresponding model surface pressure. Before this fix, a significant fraction of surface observations were not being used in the analysis. 4) Fixing a radar data pre-processing issue that was causing spurious clearing of the background hydrometeors in portions of the domain.

NCEP
Subtasks

10.5.5.1 Refine the radial velocity analysis component of GSI and determine the optimal de-correlation scales for different analysis passes. (30 Nov 09)

The 7 December 2009 precipitation case was rerun with and without assimilating radar radial wind and with a refined analysis scheme. After examining the results, it appears that short-term forecast in storm scale was improved with refined radial wind assimilation. However, the improvement on forecast score is slight. The radar radial wind will be assimilated three times with hourly intervals in future version. Completed.

10.5.5.3 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 10)

RFCs were submitted to NCO to implement a slight shift of the Hawaii-RTMA domain as requested by NWS Pacific Region. The 5km-resolution CONUS-RTMA datasets were added to the NOMADS server. In the CONUS

parallel, improvements were made to the algorithm that blends the RTMA first guess winds with the HWRF winds in the vicinity of tropical storms. (Pondeca, Manikin) Completed.

The 2.5 km CONUS RTMA, the Guam RTMA, and the domain re-alignment for Hawaii RTMA were successfully implemented in operations on September 28, 2010. All the work needed to add the 2.5 km CONUS RTMA to the operational NOMADS server was also concluded. Work on configuring the RTMA system to run for a new, small domain that extends northward of the CONUS domain, into British Columbia, Canada was initiated. The new RTMA domain is intended for supporting Operations at the Northwest River Forecast Center (Pondeca, Manikin, Keyser, J. Zhu).

10.5.5.4 Establish hourly cycled NDAS-like assimilation system on NOAA R&D computer at NCEP (machine called "vapor") using GSI and NMMB within NEMS to be adapted to a NEMS- and ARW-based RR by ESRL/GSD. (30 Jun 10)

The hourly cycled assimilation system has been built and is functional. This system was the basis for GSD's building of RR in a way, which is compatible with NCEP Production Suite. For EMC's use, the digital filter option in NMMB is nearing completion and is essential in light of the lack of a strong constraint in the GSI. (Rogers, Wu, Pyle) Completed.

10.5.5.5 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 10)

While the work reported in 10.5.5.1 was marginally positive, it has not been possible to complete integration of the refined radar radial wind version of the GSI into an initialization option for the HiResWindow at this time although work is progressing (Liu). The HiResWindow upgrade (without a GSI component) is now scheduled for implementation in Q2 FY2011 (Jan-Feb 2011).

10.5.5.6 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 covariance to the GSI for FY2011 change package to the NAM. (31 Jul 10)

RASS virtual temperatures and MAP winds were tested in the NDAS. Some stations report every 10 minutes and others report every hour, but only the data nearest to the analysis time were used. Since large biases were found, gross check limits were set to tighten the quality control. The adaptive tuning of the observational error was applied to the data after these QC adjustments and the parallel tests showed almost neutral (improved from previously negative) impacts on the forecasts. Satellite bias corrections were spun up in support of the official parallel test using the GFS coefficients to produce cold start files in the NDAS. The simultaneous GSI analyses for official NMMB parallel nests were also checked. Work was done with the regional land-surface and CRTM radiation groups to include the new IGBP vegetation types in the regional analysis. These changes were reviewed and committed to the GSI trunk repository. All GSI changes are being tested in Eric Rogers' NAM parallels, but the schedule for delivering code to NCO is now January 2011 for a Q3 implementation of the NAM upgrade package. (Wu)

Deliverables

10.5.5.E3 28 Feb 2010 (Manikin)
Pending EMC, and NCEP Center initial recommendations, Request For Change forms (RFC's) are filed to submit GSI code as part of Rapid Refresh software to NCO.

CURRENT EFFORTS: Geoff Manikin of EMC visited GSD in Boulder during the week of June 7 to work on the RR. As a result, the boundary condition and partial cycling jobs of the Rapid Refresh are now running routinely in the EMC parallel environment. (Manikin) Changes are still being made to the RR GSI. Once the GSI and ARW

changes are finished, a period of robust testing of will have to follow plus retrospective testing for the off-season before there can be a Change Control Board meeting for the NCO and EMC directors.

PLANNED EFFORTS: Get the full hourly RR cycle running stably by November. (Manikin)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO

UPDATES TO SCHEDULE: DELAYED INTO 2011.

10.5.5.E5 31 Aug 2010 (Wu, 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: Down weighting for collocated radiances were removed and the inclusions of uniform (high resolution) thinning for satellite radiances were added to a package tested in an NDAS parallel. The package includes a new GSI version that improves CPU consumption, new observational and background error covariance, and the use of new observations (RASS virtual temperatures, MAP winds and ASCAT winds). (Wu)

No additional work done this quarter on strong constraint. Wind rotation error, which occurs when northernmost point of domain is < 37°N, has been fixed and will be installed shortly in the subversion GSI trunk. (Parrish)

PLANNED EFFORTS: Apply and test the hybrid ensemble analysis in our regional system. (Wu)

Determine why regional strong constraint impact is always negative and test impact of different analysis grid with the global dual resolution code, which has been developed for more efficient hybrid ensemble and 4dvar applications. New strong constraint is not ready to implement in Sept. 2010. Analysis grid differs from models; generic tangent linear model differs too much from WRF/NAM and NMMB. (Parrish)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: Noisiness in the analysis increments and complications in the hybrid method localization adjustments. (Wu) Backlog of implementations in NCO.

INTERFACE WITH OTHER ORGANIZATIONS: GSD, NCO

UPDATES TO SCHEDULE: NAM upgrade to use NEMS/NMMB and improved GSI scheduled implementation slipped to Q3 FY2011 (~May 2011)

Additional progress has been made towards a regional application of the hybrid ensemble (hybens) option in GSI. First, an addition to the GSI by Arthur Mizzi (NCAR-MMM) allows ensemble perturbations of the ARW model to be used. His changes were transmitted to the NCEP machines and merged with the current GSI trunk, and a test case he provided was successfully run. Second, the random internal ensemble perturbation generator that wasn't working properly for the regional hybens application was fixed. Finally, some progress was made in reading global ensemble sigma files directly into the NMMB GSI, in preparation for the 1st series of regional tests with hybens using the parallel NMMB over the NAM domain. A temporary fix was provided for an error that appeared in the rotation of wind observations from the earth to model grid in the high resolution Hawaii and Puerto Rico nests, so Eric Rogers could continue with a parallel test running GSI simultaneously for the 4 high-resolution nests alongside that of the NAM parent. Work is underway on a permanent fix. (Dave Parrish)
Radio Acoustic Sounding System (RASS) virtual temperatures from the NOAA Profiler Network and Multi-Agency Profiler (MAP) Network and MAP winds were tested in the NDAS. While some stations report every 10 minutes and others report every hour, only the data nearest to the analysis time were used. Since large biases were found, gross check limits were set to tighten the quality control. The adaptive tuning of observational error was applied to the data after these QC adjustments and the parallel tests showed almost neutral (improved from previously negative) impacts on the forecasts. Satellite bias corrections were spun up in support of the official parallel test using the GFS coefficients to produce cold start files in the NDAS. The simultaneous GSI analyses for

Eric's NMMB parallel nests were also checked. Work was done with the regional land-surface and CRTM radiation groups to include the new IGBP vegetation types in the regional analysis. These changes were reviewed and committed to the GSI trunk repository. (Wan-Shu Wu)

Deliverables

10.5.5.E3
New requested date: 1 Feb 2011 (Manikin)
Pending EMC, and NCEP Center initial recommendations, Request for Change forms (RFCs) is filed to submit GSI code as part of Rapid Refresh software to NCO.

CURRENT EFFORTS:
Ongoing work to finalize background error covariance specification for code freezes of GSI portion of RR system.

PLANNED EFFORTS: Continue real-time and retrospective testing, planned code freeze by 1 Dec.

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO

UPDATES TO SCHEDULE: DELAYED INTO FY2011.

10.5.5.E5 31 Aug 2010 (Wu, 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: Testing the RTMA station reject-lists and use lists in NDAS. A new version of GSI that uses the latest satellite radiative code is also re-evaluated after a bug fix in the CRTM. (Wu)
Preliminary coding started at the end of June on test to see impact of different resolution on regional strong constraint. (Parrish)

PLANNED EFFORTS: Revise the background error and observational error covariance in NDAS. Apply the launcher tool on analysis related impact study. (Wu)

Determine why regional strong constraint impact is always negative and test impact of different analysis grid with the global dual resolution code, which has been developed for more efficient hybrid ensemble and 4dvar applications. New strong constraint is not ready to implement in Sept. 2010. (Parrish)

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED: The analysis grid is different from model and the generic tangent linear model differs too much from WRF/NAM and NMMB.

INTERFACE WITH OTHER ORGANIZATIONS: GSD, NCO, ESRL (on possible use of the HRRR for RTMA background)

UPDATES TO SCHEDULE: NAM upgrade to use have NEMS/NMMB and improved GSI scheduled implementation is now Q2 FY2011 (~March 2011)

Deliverables:

10.5.5.E3 New requested date: 1 Feb 2011 (GSD, NCEP)
Pending EMC, and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit GSI code as part of Rapid Refresh software to NCO.

See discussion above on final modifications (rotated lat-lon domain, binary I/O, upgrade to latest NCEP GSI version with "bundle" structures for analysis variables being completed.

10.5.5.E4 30 Sep 2010 – deferred to FY2011 in previous reports - NCEP (Wu, 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: Upgraded the GSI code to a latest SVN trunk version. The new features of the GSI include importing ozone field in NAM/NDAS from the global system for use in radiance assimilation via the CRTM, updating the 10m winds, 2m T, and 2m q fields in the NEMS/NMMB. Test the impact of the latest version and turn on GPS RO (Radio-Occultation) data on the short-term forecasts. Small positive impact on temperature and humidity fields was observed from the GPS RO data. (Wu)

PLANNED EFFORTS: Work on ozone analysis in NAM/NDAS and fixing the negative ozone-mixing ratio imported from the global system. (Wu) Test sensitivity of results to differences between the analysis grid and the model grid and between the regional models (WRF/NAM and NEMS-NMMB) and the generic tangent linear model using global dual resolution GSI code which has been developed for more efficient hybrid ensemble and 4dvar applications. (Parrish)

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED: A schedule backlog has developed for implementations on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: GSD

UPDATES TO SCHEDULE: Due to issues with slow progress on strong constraint and NMMB physics tuning and due to implementation schedule backlog, we must request this milestone be moved into FY2011.

Task 10.5.8 Improve physical processes in the WRF (RR and HRRR) and NAM models, especially including those that affect aircraft icing.

Subtasks:

10.5.8.1 30 Nov 2009 (GSD)
Complete systematic GSD evaluation of physics performance in GSD 1-hour RR cycles for initial RR implementation.
The overall performance of the RR WRF physics configuration was completed as part of the November (GSD Tech Review) and December (NCEP model review) meetings. The behavior of the physics (a critical component of the RR) appears to overall be very good, with the RR model through the fall, winter and early spring producing at least equal results to the RUC in key areas (upper-level wind/temp – better, surface wind/temp/Td – about equal overall, precipitation – better for CSI, perhaps too high for bias, ceiling – better for MVFR and IFR conditions). Additional evaluations, such as the examination of a warm temperature bias at mid levels that developed during May, will continue up to the transfer of RR code to NCEP/NCO, but these results including the physics now appear adequate. Regarding this warm bias at midlevels, we believe that this was caused by excessive middle and high cloudiness preventing sufficient longwave radiation cooling. The bias is reduced, but not eliminated, by activating the shallow convection in the Grell scheme, which decreases the cloud cover. Until activated this June, RR forecasts had been made with this option turned off. Fixing of a bug that affected only the NCEP IBM machines (and was only discovered when RR code testing began at NCEP) recently enabled the shallow convective scheme to be turned on in the EMC RR cycle.

During July, a test was initiated to examine a low-level afternoon warm bias that seems most pronounced over grassland areas. In the WRFV3.2 release of 2 April 2010, an option was added to the MYJ surface layer scheme to reduce the strength of coupling between the land and atmosphere over grassland and increase coupling over forested areas. We tested this option (iz0tlnd=1) in the development RR1h cycle between 20 July and 6 August, comparing against the primary RR1h cycle, and found no discernable benefit toward reducing the warm bias.

GSD has been interacting with the NCAR folks concerning possible problems with the WRFV3.2 version of the Thompson microphysics. These have been noted in conjunction with the common failure of the HRRR to properly maintain long-lived leading-line / trailing stratiform convective systems.

10.5.8.2 30 July 2010 (NCAR/RAL)
Report on research and testing on addition of the new explicit aerosol variable(s) in initiating cloud water and ice. Computer storage and run time considerations will be considered as a constraint on the development.

10.5.8.3 1 April 2010 (GSD) **COMPLETE**
Test and evaluate upgrades of RUCLSM to handle sea ice and snow cover on sea ice under wintertime conditions for FY11 Rapid Refresh upgrade.
These upgrades have continued to perform well in the RR.

10.5.8.4 1 Aug 2010 (GSD)
Discussions have been held with Ola Persson and other Arctic experts in ESRL's Physical Sciences Division. They point out that the major uncertainty in the surface energy budget over snow in the Arctic is the emissivity of low clouds. Ice clouds have much lower emissivity in the infrared wavelengths than water clouds. These investigators have collected high-quality data that may be of use to us in diagnosing model issues in the far north. To incorporate these effects will require enhancements to the existing coupling between microphysics and radiation in the RR, and will not be incorporated in the initial RR implementation.

10.5.8.5 30 July 2010 (NCAR-RAL)
Evaluate the new aerosol based ice initiation scheme that was implemented into WRF during the previous year using available case studies, including ICE-L and IMPROVE II.

10.5.8.6 30 Aug 2010 (NCAR-RAL)
Develop a scheme to explicitly predict the number of cloud droplets based on an assumed aerosol/CCN spectrum. This includes testing various droplet activation schemes in the recent literature based on updraft, general turbulence characteristics, super saturation, and aerosol properties. These changes will enable improved prediction of the size distribution of water droplets, including when freezing drizzle will occur.

10.5.8.10 30 Sept 2010 (GSD, NCAR)
Begin testing at GSD of latest version of microphysics for Rapid Refresh upgrade in FY2011.
GSD testing has been delayed until after approval by NCEP of the Request For Change for the RR implementation.

Deliverables:

10.5.8.E2 Now 1 Feb 2011 (GSD)
Pending EMC, and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit upgraded WRF model physics code as part of Rapid Refresh software to NCO.

10.5.8.E3 30 July 2010 (NCAR-RAL)
Provide an improved microphysics scheme to GSD for evaluation toward the FY11 Rapid Refresh upgrade.

CURRENT EFFORTS: A report was delivered on July 30 to Stan Benjamin (available under http://ruc.noaa.gov/faa-mde/10.5.8.E3_aerosols.pdf) regarding current progress on the new aerosol scheme in the NCAR microphysics scheme. Trude is preparing to combine the dust modules (emission, deposition and ice nucleation scheme) with the aerosol/CCN activation modules developed by Greg Thompson. The emission and deposition modules are mostly modified modules from the WRF-Chem model.

CURRENT EFFORTS:

The problem with low wet deposition rate, mentioned in last month's report seems to be related to model resolution issues. Trude ran 3 nested grid simulations to compare with a 1-domain simulation. The higher resolution domain shows a higher wet deposition rate compared to the low-resolution case. She is currently working on a fix for this problem.

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

NCEP
CURRENT EFFORTS: A report was delivered on July 30 to Stan Benjamin (available under http://ruc.noaa.gov/faa-mde/10.5.8.E3_aerosols.pdf) regarding current progress on the new aerosol scheme in the NCAR microphysics scheme. Trude is preparing to combine the dust modules (emission, deposition and ice nucleation scheme) with the aerosol/CCN activation modules developed by Greg Thompson. The emission and deposition modules are mostly modified modules from the WRF-Chem model.

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

GSD
During this quarter, all elements for the initial RR cloud analysis package were submitted to the NCEP SVN repository and approved. Ming Hu also coded additional modification for binary I/O of the cloud hydrometeor fields and submitted them to the NCEP SVN repository. Two data processing issues were also resolved (see task 10.5.5), one related to spurious hydrometeor clearing and one related to getting correct NASA Langley cloud files for the rotated lat-lon version of the RR.

An issue related to the treatment of moisture in the DFI was uncovered. In the RUC, the water vapor field is adjusted after the DFI to preserve the original (pre-DFI) relative humidity accounting for the modified temperature (from the DFI). For the RUC, this is important for maintaining in the forecast, the clouds specified in the cloud analysis. Addition of this change within the RR DFI resulted in significant degradation to all upper-level verification (high moisture bias, worse temperature and wind RMS errors). Based on this result, and the fact that even without the post-DFI moisture adjustment in the RR, the RR ceiling scores are very good, a decision was made to forego this change for now.

Variational moisture based on METAR-cloud RH innovations from ceiling observations developed in spring 2010 continues to run in the development RUC at ESRL. This technique will be evaluated further and revised toward a 2011 update to the Rapid Refresh.

Task 10.5.24 Develop, test, and improve the 3-km WRF-based High-Resolution Rapid Refresh

The HRRR continued to have excellent reliability, with all operational evaluation reliability metrics well exceeded. Real-time HRRR runs with the frozen code and scripts have continued following the end of the formal evaluation period. With the addition of the new shadow system (512 additional cores) in early Sept., a number of upgrades have been made. First, the GSD "backup" RUC, which provides the initial conditions and lateral boundary conditions for the HRRR was moved to a dedicated environment on the new system (completed before the old system was disabled on 13 Sept.). Second, the new nodes were used for some retrospective HRRR test runs to further evaluate issues related to the propagation of MCS, noted as a deficiency in the Summer 2010 HRRR runs (See discussion below of some 1-km tests results). Third, a real-time parallel HRRR cycle ("HRRR-dev") was initiated on the shadow system. The HRRR-dev runs every third hour using 256 cores. Initial testing with the HRRRdev has focused on examining the strength of the latent heating-based temperature tendency in the DFI-based radar assimilation of the parent RUC model. Patrick Hoffman has completed coding and scripting for scale-dependent reflectivity verification and has also added the HRRRdev, allowing us to begin evaluating the impact of this crucial aspect of the RUC radar assimilation on the HRRR forecast skill.

Curtis Alexander has created a work plan to update the HRRR 15-min VIL files from netcdf to grib2. We will switch from outputting the 15-min netcdf VIL file directly from the model to now output WRF history files every 15 min. Two flavors of the "Unipost" package will then be run: 1) an hourly version to create the standard grib2 native, pressure, and surface files, 2) a 15-min. version to output grib2 VIL files. Four 15-min grib2 VIL files will be concatenated to create hourly grib2 15-min VIL files that will be sent to CoSPA and other users. An advantage of this approach is that other 15-min fields (reflectivity, updraft helicity, surface fields can easily be added to the 15 min. files. Sample files for the downstream users will be available in Nov. with a switchover planned for Jan 2011.

Curtis Alexander and Eric James have completed additional case study work on case of poor HRRR performance in the propagation of mesoscale convective systems. Encouraging results have been obtained by running a 2-way interactive 1-km nest over a portion of the HRRR domain. See Fig. 2.

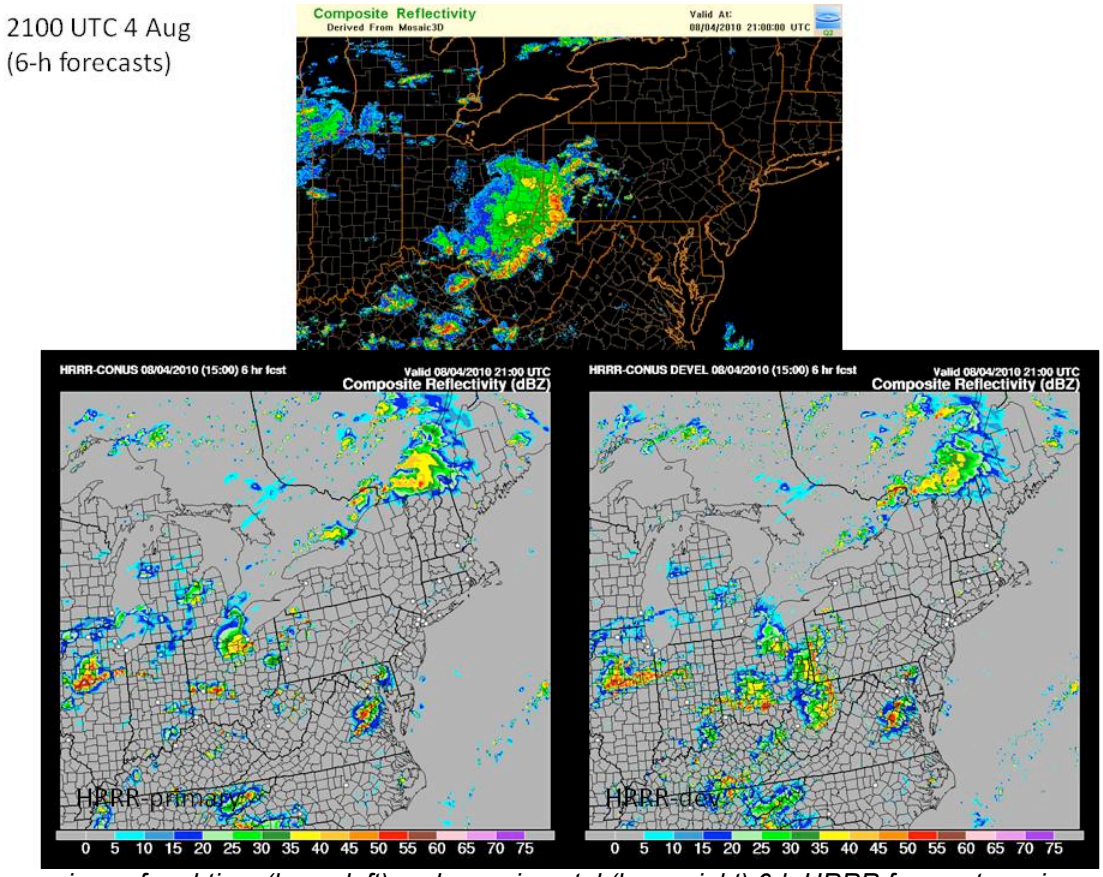


Fig. 2 Comparison of real-time (lower left) and experimental (lower right) 6-h HRRR forecast maximum reflectivity valid 2100 UTC 4 August 2010 with verification radar mosaic. Experimental HRRR includes a 2-way interactive 1-km nest.

Subtasks:

10.5.24.1 15 Jan 2010 (GSD, NCAR/RAL, NCAR/MMM)
Design the assimilation/modeling configuration for the HRRR during the 2010 summer convection forecasting (CoSPA) exercise.
Complete with frozen code since May 14, 2010

Task 10.5.24 Evaluate convection permitting forecasting by the ARW core for ultimate application in the HRRR

NCAR
CURRENT EFFORTS: In spring 2010, NCAR/MMM carried out 3-km ARW simulations initialized with radar-enhanced, 13-km Rapid Refresh grids from NOAA/ESRL. Jimy Dudhia worked with Morris Weisman (MMM) to evaluate the model spin-up in the ARW runs. The MMM work involves analyzing the effect of changes to the Thompson microphysics scheme that were presented at the meeting. These changes showed some degradation from the version used in last year's forecast experiment.
Dudhia also worked with Greg Thompson (NCAR/RAL) to investigate causes of reflectivity differences seen between the old Thompson scheme (used 2009) and the new WRF V3.2 version used in 2010. The primary differences include less developed leading lines of simulated echoes, weaker downdraft outflows, and larger areas of light precipitation leading to high bias for weaker thresholds, with low bias for strong thresholds of accumulated surface precipitation. The work is converging on code changes that specifically led to this new behavior. Dudhia is completing a report on the analysis.

PLANNED EFFORTS: Provision of final report.

UPDATES TO SCHEDULE: None
A detailed report including a summary of NCAR work under this task is available at:
http://ruc.noaa.gov/faa-mde/MDE_Report_NCAR_20101001.pdf

PLANNED EFFORTS: The analysis of the convection-permitting forecasts will through the end of this quarter.

UPDATES TO SCHEDULE: NONE

Deliverables:

10.5.24.E1 30 Sept 2010 (GSD)
Complete FY10 test (likely with full CONUS domain) with 3-km High-Resolution Rapid Refresh running every 1 h.

- Conduct real-time summer 2010 HRRR forecasts using 3-km WRF initialized with radar-enhanced Rapid Refresh over full CONUS domain, monitor performance, modify code/scripts as needed, maintain high reliability working with ESRL computer facility
- Coordinate with other AWRP users and other collaborators, including coordination of HRRR grid transfers
- Provide project management
- Lead writing of report on summer 2010 HRRR experiments

GSD HRRR personnel continue maintain the HRRR for the 2010 CoSPA evaluation, including real-time hourly HRRR run generation, file-transfer, outage notification, and interaction with co-developers and users. Interest in the HRRR continues to grow, with numerous requests for products.

On Oct. 12, Curtis Alexander presented a summary of the HRRR at the Severe Local Storms Conference in Denver. The PPT is available at: http://ruc.noaa.gov/faa-mde/Alexander-SLS2010.pdf

INTERACTIONS: ESRL/GSD scientists Curtis Alexander and John Brown have visited SPC to participate in the Spring Program, evaluating HRRR performance for aviation, severe weather, and hydro-meteorological applications. ESRL and NCAR scientists continue to meet every 2-4 weeks (most recently on Thurs 22 July 2010) to discuss issues related to HRRR and HRRR-like convection resolving simulations and share results of different sensitivity experiments designed to find improved formulations.

Task 10.5.19 Develop and refine techniques to assimilate radar radial velocity and reflectivity data through GSI and Rapid Refresh toward the HRRR.

GSD
The ESRL computer upgrade including the shadow system for the HRRR (512 new dedicated cores) was installed in early Sept. and we began running a parallel HRRR every 3rd hour on 256 cores in early Oct. Comparison testing (with radar reflectivity verification) of HRRR runs from RUCs with the standard amount of latent heating (the real-time HRRR) with parallel HRRR runs from RUC with a reduced amount of latent heating (The HRRR-dev) are underway. Further testing of the radar assimilation capability for the HRRR forecast system would continue using real-time runs and retrospective cases from the Summer 2010 Op Eval period.
The focus will be on: 1) variations in the strength of the radar reflectivity-based latent heat temperature tendency, 2) further comparison of HRRR forecasts initialized from RR vs. RUC (including the radar assimilation), 3) impact from the addition of 3-km radar assimilation to the RUC/RR 13-km assimilation. An updated version of the GSI, incorporating the latest NCEP modifications is essential for this testing, and is being updated for RR use. This GSI version will also be used for the 3-km tests (in conjunction with the DFI package in the WRF-ARW run at 3-km resolution).

NCEP
A set of subroutines were completed that read old VAD wind BUFR files, new VAD wind bufr files and the PREPBUFR file. Efforts were also made to convert the new VAD wind BUFR file to the new format and append it

to the PREPBUFR file. Subroutines were also completed to co-locate the old VAD wind observations in temporal and spatial dimensions to compare the two observations. Wind profiles were generated for the two observations at all co-located stations. An examination of the impact of assimilating radial wind on NMMB forecast was completed, with mixed results. A positive impact was found for large-scale precipitation ETS skill; however, a slightly negative impact was found in the upper air verification. Work continues with John Derber and Russ Treadon to fix a bug in GSI where the initial penalties of radial wind are different with different MPI tasks. (Shun Liu)

Deliverables

10.5.19.E2 30 September 2010 (Liu, Pyle, Parrish)
Report on the design and initial development of hybrid ensemble-3DVAR system

CURRENT EFFORTS: All work on the hybrid ensemble option this quarter was focused on maintaining existing capability while massive changes were introduced to GSI to allow nearly complete generalization of state and control variables. (Parrish)

PLANNED EFFORTS: Add interface to read existing regional ensemble perturbations from SREF. (Parrish)

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED: This is a new and relatively immature capability so expectations should be tempered.

INTERFACE WITH OTHER ORGANIZATIONS: CAPS, ESRL/GSD

UPDATES TO SCHEDULE: None.

10.5.19.E4 15 September 2010 (Liu, Pyle, Parrish)
Demonstrate mini-NDAS data assimilation system using HRRR-like design constructed to precede HiResWindow runs or Matt Pyle's SPC runs using hourly updates with GSI.
CURRENT EFFORTS: The NEMS/NMMB digital filtering was extended to work properly for nested domain runs. There is a requirement that the filtering specifics be identical for the parent and all nests, keeping the entire model on the same timeline and providing proper boundary conditions to each nest. This code has yet to be committed to the NCEP/EMC code repository, which has prevented it from being tested with the nested NMMB-based NAM system that currently is being run in parallel by Rogers. However, that code commit and subsequent testing should begin within the next six weeks. (Pyle)

Performance experiments with the new VAD wind have begun. A set of codes was written to read old VAD wind bufr files, new VAD wind bufr files and prepbufr files. Efforts were also made to convert VAD wind bufr files to new VAD wind bufr format and append them to prepbufr files. A set of subroutines were also coded to temporally and spatially co-locate old VAD wind observations to compare them with new observations, by generating wind profiles at all co-located stations. Hardwired observation types in the GSI codes were modified to handle the new VAD wind with its new type number. The new VAD wind and old VAD were compared with model guess field, and the new VAD wind has a smaller RMS error than the old VAD wind. A bug in the GSI was fixed to prevent initial penalties of radial wind from being different with different MPI tasks. The impacts of assimilating radial wind on NMMB forecast were examined in 10 DA-forecast experiments. Positive impact was still found in ETS skill for small precipitation thresholds. (Liu)

PLANNED EFFORTS: Examine the forecast performance of the new VAD winds with more cases. (Liu)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: GSD, University of Oklahoma

UPDATES TO SCHEDULE: Complete.

10.5.19.E5 15 Sept 2010 (CAPS, NCEP and GSD)

GSD

We continue with bi-weekly meetings involving ESRL GSD and PSD personnel and OU CAPS. Kefeng Zhu visited Boulder for the GSI tutorial and met in person with GSD and PSD personnel, for initial EnSRF filter experiments with 1 3-h forecast cycle. A case study period from Early May 2010 has been selected, data (observations, etc.) have been pulled from the archive and Jeff Whitaker has provided global ensemble files, and assimilation experiments have commenced.

CAPS

During last quarter, two software packages were developed: one for generating the initial ensemble and the perturbed lateral boundary conditions, by sampling the NMC-method-generated covariance using the random-cv method; one for carrying out the EnSRF hourly data assimilation and forecast cycle. The latest available GFS forecast is used to update the lateral boundary condition tendency files for WRF. The job management system in these software packages, were written in 'csh' and 'ksh'. WRF version 3.1 and an earlier GSI version were chosen for the test.

During this quarter, the job submission was updated by using the Workflow Management System (WMS) available on JET. The WMS has been used to manage the operational RUC and RR and it includes three basic languages: ruby, xml and ksh. One of the advantages of using the WMS is that it can automatically resubmit the job when the job failed due to some unexpected reasons. In addition, CAPS received a latest version of GSI package from Ming Hu of GSD. The regional EnKF system for RR application is now updated to work with WRF version 3.2 and latest GSI.

The May 8 to 16, 2010 testing period was selected for the updated EnKF system. This period features a wide variety of weather, including the May 10th OK tornado outbreak which is intriguing at the mesoscale also with a strong forcing and a strong cap), a difficult MCS case at the night of the 11th that was significantly mishandled by RUC/HRRR, a cold season type Front Range upslope event, and some southeast propagating MCSs across Texas. A key characteristic for this period is the existence of propagating baroclinic disturbances and associated surface phenomena. This period is also within 2010 Spring Experiment period. During the Spring Experiment, storm-scale ensemble forecasts with 26 4-km members and one 1-km member over the CONUS domain were produced by CAPS in real time, which provides an opportunity for inter-comparison.

Two experiments, one use the GSI alone and one use the EnKF were conducted for this test period. Both used almost the same configuration as operation RR except that the horizontal grid spacing was coarser ~40km and 'dfi_radar' option was turned off. The GSI 3 hourly cycles were started from 00UTC may 8, 2010 and stopped at 21UTC May 16, 2010. The EnKF was tested using different control variables: P (pressure), T (potential temperature), U, V, Q (water vapor mixing ratio) or with P replaced by surface pressure. For the GSI experiments, it was found that the update of the lateral boundary condition after each analysis cycle was necessary, and otherwise, the GSI cycle crashed during the WRF integration at 21UTC May 15, 2010. For the EnKF experiments, while the first few cycles were successfully carried out, the cycle crashed during the WRF integration at 18UTC May 12, 2010. Several EnKF cycles starting from different initial times (0800, 0803 and 0815) were tried and the problem remained the same. The reason was still under investigation. One of the possible reasons is the steep terrain near the southeast boundary. And the other reason may be that the 'random cv' led to too much increment in the initial step. Fig.3 below shows forecast rmse against all the observation of the set of experiments. The RMSE of GSI is stable: the average value of variable 'T' is 1.6306 K, 'Q' is 0.1266 g/kg, 'U' is 3.0536 m/s and 'V' is 3.0757 m/s. The forecast rmse of EnKF goes up rapidly in the first few cycles and begin to decrease after about 4 days cycling. More experiments are being conducted to diagnose the filter divergence symptom in the EnKF.

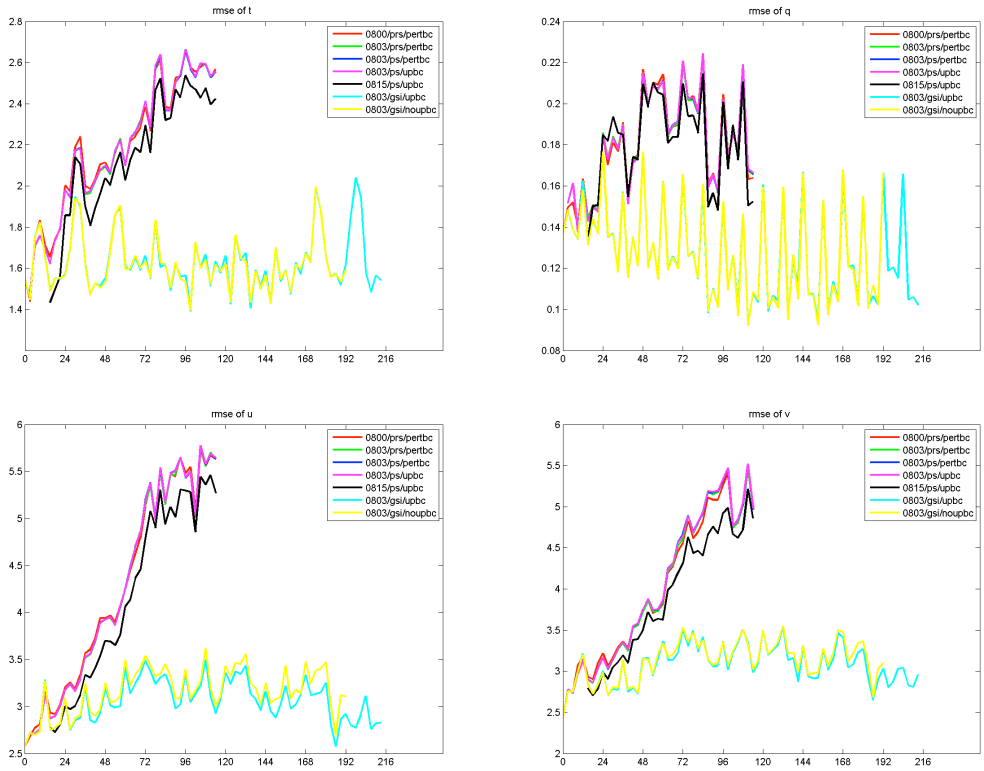


Fig.3. Forecast rmse of EnKF and GSI analysis: (a) potential temperature (b) water vapor mixing ratio (c) U and (d) V. The first four digits are start time of 'ddhh'. And 'prs' represents control variable pressure. And 'ps' represents control variable surface pressure. Both were using the EnKF analysis method. 'gsi' means using GSI analysis. 'Pertbc' means the boundary condition was perturbed by 'random cv' method. 'Upbc' was using the WRFDA utilities 'da_update_bc.exe' after each analysis cycle. 'Noupbc' means directly use of boundary condition.

NCEP
10.5.19.E5 30 September 2010 (Liu, Pyle, Parrish)
Report on the design and initial development of hybrid ensemble-3DVAR system

CURRENT EFFORTS: Basic infrastructure for hybrid ensemble GSI is complete. This used internally generated ensembles for testing. For real data testing, code development is well underway to allow direct use of NCEP operational Global Ensemble Forecast System (GEFS) members in hybrid ensemble GSI analysis for NAM NMMB. (Parrish)

PLANNED EFFORTS: Run tests using GEFS based hybrid ensemble using the NEMS launcher and experimental NDAS and present results at AMS NWP/WAF conference in January in Seattle. (Parrish, Wu)
PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: This is a new and relatively immature capability so expectations should be tempered.

INTERFACE WITH OTHER ORGANIZATIONS: CAPS, ESRL/GSD. Code written by Arthur Mizzi (MMM-NCAR) added to NCEP subversion GSI trunk, to read ARW ensemble perturbations for regional hybrid ensemble GSI.

UPDATES TO SCHEDULE: None.

Task 10.5.20 Develop ensemble-based probabilistic products for aviation users.

GSD

Curtis Alexander resolved issues with the HCPF scripts, restoring real-time production of HCPF probability files. These issues arose from work to add a logistic regression-based weighting procedure for the HRRR Convective Probability Forecast (HCPF) that ensures statistical reliability. There have been on going discussion with MIT/LL on time-lagged ensemble strategies and probabilistic display concepts.

GSD group members Steve Weygandt, Curtis Alexander, and Eric James have obtained VSREF code from Binbin Zhou (NCEP EMC), who has created the VSREF. This follows previous discussions in June on collaboration and ways to further incorporate GSD strategies into the VSREF. Binbin supplied a VSREF Tarball to GSD and provided a code walkthrough to the GSD group in a subsequent telecon. Eric James is partway through porting the HCPF code to Fortran90, which will greatly facilitate inclusion of HCPF concepts into a collaborative VSREF system.

NCEP

Work on bias correction for the SREF precipitation forecasts continues. Three presentations were prepared: one for the AMS Summer Community meeting on how to communicate and use forecast uncertainty information; two others for the DTC Ensemble Testbed Mesoscale Ensemble Workshop, with one on SREF status and plans (an oral presentation given by Geoff DiMego) and a poster presentation on the Very Short Range (VSREF) and High Resolution (HREF) Ensemble Forecast Systems at EMC. (Jun Du)
The VSREF web site is maintained daily. Precipitation probability products have now been added to the VSREF. Work was completed to help Central Region WFOs display most of the VSREF products within AWIPS. A cron job is being prepared to routinely send VSREF GRIB2 data to EMC's anonymous FTP site to be used by Central Region WFOs and other future users of VSREF. (Binbin Zhou)
Subtasks

10.5.20.1 Complete 'research quality' version of upgrade to SREF for consideration in November 2010 SREF upgrade package. (15 Jan 10)

A research quality version of the SREF has been constructed and work begins to put it through its paces as it matures for next year's major upgrade. The 'research quality' version reflects a change in strategy as we move towards a strictly NEMS-based suite of runs for SREF and everything else in NCEP's Production Suite, to reduce the number of models at NCEP. While we are depending on a multi-model approach to achieve success in the short range, EMC has decided to drop the two legacy models used in the SREF, namely the 6 Eta members and the 5 Regional Spectral Model (RSM) members. 2 additional WRF-ARW members and WRF-NMM plus 7 NEMS-NMMB members will replace these 11 members. Dusan Jovic wrote the code necessary to perform the NEMS-NMMB control member breeding cycle. Jun Du tested the codes in an ensemble framework, incorporated NEMS ensemble run into the current WRF ensemble job structure and verified the NEMS-NMMB model performance. The research quality version will continue to have 21 members with 7 each coming from the three models. A major upgrade in resolution is also planned with the horizontal spacing moving from the current 32-35 km to 22-25 km. This will completely fill SREF run slot on the current P6 computer platform. (DiMego and Du) Completed.
Due to the NCEP schedule delay of the November 2010 SREF package (see the next item), new work on bias correction for the SREF precipitation forecasts has been started. (Du)
A performance-ranking method has been developed for predicting an individual ensemble member's relative performance, which might potentially improve ensemble mean and probabilistic forecasts via improved post-processing. The method has been documented as a journal manuscript, which will be submitted to Monthly Weather Review. (Du and Zhou)

10.5.20.2 Visit AWC to conduct continued training and education on SREF applications, receive feedback on existing guidance, and to acquire new requirements, if funding available. (15 Feb 10)

Jun Du, BinBin Zhou, Geoff DiMego and Yali Mao visited AWC on 16-19 November to discuss SREF aviation products. Geoff DiMego attended the AWC Testbed meeting on R2O Issues. Completed.

10.5.20.4 Based on case study testing and refinement of the research-quality code, deliver the upgrade SREF codes to NCO for November 2010 SREF upgrade package. (30 Apr 10)

A 4km hybrid ensemble system was set up. The production standard scripts were written and tested. It will be implemented at NCEP production as part of the Hires-Window package later this year. The system will have 44 members, hourly output for the first 36hrs then 3-hourly to 48hrs, output includes individual members, mean, spread and probabilities for three domains - east CONUS, west CONUS, and Alaska in grib1-2 formats. (Du) Completed
The November 2010 target for this implementation slipped into Q4 FY2011 along with many other 2010 implementations because of a backlog in NCO. (DiMego)
10.5.20.5 Improve preliminary (developed in FY09) procedure appropriate for aviation users from Very Short-Range Ensemble Forecast (VSREF) system using high-resolution RR and NAM existing runs toward a future High-Frequency Probabilistic Forecast (HFProb) generator to be used in NextGen, including common post-processor, obs-based statistical post-processing, optimized member weighting. (31 Mar 10)
Many Central Region WFO forecasters now use the experimental VSREF web site as an additional source of guidance for aviation weather (icing, CAT, visibility, ceiling, fog, surface wind/jet stream, convection, reflectivity, precip type, freezing level, and accumulated precip):
http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/VSREF/web_site/html/conv.html
The VSREF package developed at EMC has been delivered to GSD for cooperative research and improvements, particularly in the convection product. (Zhou) Completed

The November 2010 target for this implementation slipped along with many other 2010 implementations because of a backlog in NCO. (DiMego)

10.5.20.5 Improve preliminary (developed in FY09) procedure appropriate for aviation users from Very Short-Range Ensemble Forecast (VSREF) system using high-resolution RR and NAM existing runs toward a future High-Frequency Probabilistic Forecast (HFProb) generator to be used in NextGen, including common post-processor, obs-based statistical post-processing, optimized member weighting.
(31 Mar 10)

Working with Thomas Hultquist (NWS Science and Operations Officer) and the forecasters at the Chanhassen, MN, WFO and Central Region, VSREF data was added into AWIPS so forecasters can access VSREF output for their local airport responsibilities, which includes Chicago O'Hare. A 2-member ensemble made up of the High-Res NMM and ARW models was generated. The comparisons show that an ensemble mean of just two members does indeed yield better forecasts than either of the individual members (Zhou).

Many WFO forecasters now use the experimental VSREF web site as an additional source of guidance for aviation weather:
http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/VSREF/web_site/html/conv.html
Positive feedback was received from several WFOs related to VSREF forecast timing and location of a June fog event in the NE panhandle and several cases of improved TAF forecasts when using the VSREF guidance. (DiMego and Zhou)

The VSREF package developed at EMC has been delivered to GSD for cooperative research and improvements, particularly in the convection product. (Zhou)

10.5.20.6 Further calibrate probabilities and potential echo-top (improve statistical reliability) ensemble cumulus information. (1 Jul 10)

A grid-to-grid verification of simulated reflectivity from the RUC, NAM, operational Hires NMM, and Hires ARW against the MOSAIC radar dataset was built. The whole package is finished and is being readied for implementation. Results from the Grid-to-Grid verification of echo-tops and reflectivity from both the old and new

SREF versions show that the scores of both the control NMM and ARW in the new SREF for echo tops and reflectivity significantly increased, to an almost 100% increase in Equitable Threat Score (ETS). The new SREF ensemble probability scores for both echo tops and reflectivity are also significantly improved over all the ensemble probability thresholds (Zhou). Completed.
Three presentations were prepared and presented at meetings: one for the AMS Summer Community meeting on how to communicate and use forecast uncertainty information; two others for the DTC Ensemble Testbed Mesoscale Ensemble Workshop, with one on SREF status and plans (an oral presentation given by Geoff DiMego) and a poster presentation on the Very Short Range (VSREF) and High Resolution (HREF) Ensemble Forecast Systems at EMC. (Du)

Deliverables

10.5.20.E1 30 June 2010 (Du, Zhou, Mao)
Subject to NCEP Director approval, implement initial VSREF product generation as part of 2010 RUC/RR upgrade package [products not operational but generated routinely within the RUC script as part of NCEP's Production Suite].

CURRENT EFFORTS: The probabilistic verification of SREF composite reflectivity and echo-tops using Shun Liu's implementation of NSSL's 88D national mosaics continues. (Zhou)

PLANNED EFFORTS: Complete the work on VSREF convection products by adopting GSD's convection code. Add an echo-top ensemble product as well as other aviation and convection products using the ensemble product generator. (Du, Zhou)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: The November 2010 target for this SREF implementation slipped to Q4FY11 because of a backlog in NCO. Due to the next NAM's upgrade using a new NMMB model to replace the NMM, the NAM2Eta conversion code needs to be replaced too by a new NMMB2Eta capability that must be created.

INTERFACE WITH OTHER ORGANIZATIONS: AWS, GSD

UPDATES TO SCHEDULE: Delayed. VSREF implementation is going to occur with either the RR or SREF implementations whichever one comes first in FY2011.

10.5.20.E2 30 August 2010 (Du, Zhou, Mao)
Demonstrate products from experimental VSREF probabilistic forecasts updated hourly.

CURRENT EFFORTS: An experimental VSREF is now running and is updated hourly. Results can be seen at (http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/VSREF/web_site/html/vsref.html). (Zhou)

PLANNED EFFORTS: SPC convection products such as Probability of Thunderstorm (also requested by AFWA), fire weather parameters and 80m AGL parameters such as wind will be added into the SREF ensemble product generator as resources become available. (Du, Zhou)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: No ceiling/cloud amount is available from ARW SREF members, and no reflectivity is available from the Eta members and some RSM members.

INTERFACE WITH OTHER ORGANIZATIONS: AWS, GSD

UPDATES TO SCHEDULE: Complete.