MDE Product Development Team
April 2010 Monthly 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.

- RUC upgrade at NCEP started on 2 March 2010 not completed until 20 April
  - Poorer forecast skill between 2 March – 20 April
  - Discovered on 12 April that some of the corrected executables were not moved the right place on 2 March. NCEP corrected the problem on Tuesday 20 April.
  - Forecast skill recovered immediately starting 20 April.

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

- Main component updates now running at GSD in real-time RR: WRFv3.2, GSI from NCEP repository with RR changes
- RR implementation at NCEP making very good progress -

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

- ESRL RR cycle ported to faster nJET system, requiring some modification to GSI compiling
- RR GSI – updating complete to latest NCEP version (Q1FY10 version)
  - commits to NCEP repository from RR are now being made in April

Task 10.5.17: Infrastructure support for NAM, future RR, future HRRR, support for community WRF model

- WRFv3.2 released 2 April 2010. Contributions from NCAR to WRF model, especially on WRF physics, and from GSD on DFI and land-surface model. WRFv3.2 now being tested in HRRR and RR applications.

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.

Task 10.5.24/19: Development/testing of HRRR

- Hourly HRRR forecast length extended from 12-h to 15-h.
- All CONUS HRRR components (RUC and HRRR code and scripts) frozen and reliability improvements to hardware completed. Real-time HRRR system is stable and running with > 94% reliability.

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

ESRL/GSD

Upcoming RUC change package at NCEP – implemented 2 March 2010.

Preparation for the upcoming RUC change package at NCEP, including an extension to 18h, GSD is assisting EMC (Geoff Manikin) where the current parallel version was run from summer 2009 through implementation.

ESRL and NCEP discovered on 12 April that some of the corrected executables were not moved the right place on 2 March, causing poorer lower Tropospheric RUC forecasts since then. NCEP made the fix to this error on Tuesday 20 April.

- ESRL/GSD initially discovered that there must be some problem by comparing verification results between 2 versions of the RUC, the operational one at NCEP, and the "backup" RUC run at ESRL. The skill margin between the operational and backup RUC was sufficiently large to prompt ESRL to ask NCEP to re-check details on the final implementation. NCEP then discovered that some of the modified RUC executables were not properly installed to replace previous versions on 2 March. The result was that the RUC boundary condition code was using a different vertical coordinate from the RUC analysis and forecast model.
- A single RUC model crash occurred during this period (on 30 March) that was likely related to this mis-installation, but degraded forecasts throughout the period (2 March – 20 April) have occurred in the lower troposphere for wind, temperature, and relative humidity.

NCEP

Geoff Manikin reports that the RUC experienced a crash on 26 April due to a violation of CFL instability, associated with a mountain wave on the east side of the Sierra Mountains related to an intense Pacific trough coming onshore. NCEP Central Operations followed EMC's recommendation to immediately change the model time step from 20 to 18 seconds and no further crashes occurred. Problems have been encountered in other similar synoptic patterns, so it was decided to leave the time step at 18 seconds. This results in a slight delay to RUC products but no more than 3 minutes for an 18-hour forecast.

Dennis Keyser reports that work continues on radiosonde sites that report an invalid instrument type, late arrival of GOES 1x1 field-of-view cloud data, bringing in new SSM/IS data from DMSP F-16, F-17 and F-18 satellites to replace discontinued SSM/I products, use of TAMDAR data from AirDAT as a MADIS alternative, and the NRL-based aircraft QC code. A major upgrade to the NCEP BUFR library is being tested for implementation in FY2010. The Florida and Georgia DOT and Aberdeen PG mesonet providers have been down for several months. The Wisconsin DOT mesonet provider was down over the last half of April. GOES-13 replaced GOES-12 as the Eastern satellite on 14 April. GOES-13 winds are used, but GOES-13 cloud and precipitable water retrievals are currently not being used.

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 AHP 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 packed into GRIB2 format, see **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** . NCEP statistics can also be accessed via the ESRL/GSD site **http://www-ad.fsl.noaa.gov/users/loughe/projects/NCEP_verif/** (DiMego)

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

Excellent progress has been made in Rapid Refresh development during April toward upcoming implementation at NCEP. More information can be found under Task 5.4 report.

NCEP

Since many obs-processing activities listed under Task 10.5.1 and 10.5.4 also pertain to the NAM, they are not duplicated here. For the NAM specifically, Dennis Keyser reports that some Alaskan radiosonde sites still need to move up their launch time so the NAM-GSI can use their data. The Level 2 88D decoder was updated on 6 April to include an improved radial wind QC package. GOES-13 replaced GOES-12 as the Eastern satellite on 14 April. GOES-13 winds are now used but GOES-13 radiances will be monitored until fall. The spring temperature patch was applied to GOES sounder radiances by NESDIS on 7 April, and is expected to increase the radiance biases. AIRS radiances and MODIS winds were not available for 15 hours on 6-7 April due to NASA/GSFC hardware problems. We are investigating the effect of removing U.S. (including Alaska) synoptic surface data from the GFS-GSI. Many of these sites have incorrect elevations and thus erroneous surface pressure calculations. Most U.S. synoptic sites are coincident with METAR sites having correct surface pressures. This investigation also involves updating the latitude, longitude and elevation for many Canadian and U.S. METAR sites and many Canadian synoptic sites based on the latest METAR and synoptic dictionaries. The following data types are monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), Mesonet mass data, and MDCRS moisture data. NOAA-19 1b radiances will soon be monitored. Reduced Level 2 88D radar data dump counts on the IBM P6 (vs. the P5) are being investigated. NAM/NDAS and RTMA PrepBUFR files are being generated in parallel with 50 km ASCAT and WindSat scatterometer wind data (both non-superob) and production NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and SBUV-2 data are being created. These changes to obs monitoring are being tested in Eric Rogers' real-time parallel NDAS/NAM. Replacing the current synthetic wind data bogus with the GFS tropical cyclone relocation procedure (for medium to strong tropical cyclones) to update the global first guess fields input to the t-12 hour NDAS is being tested. A legacy restriction (that only surface data with a reported pressure is processed) will be removed to allow many new surface observations (land, marine and Mesonet) to be assimilated in the RTMA and possibly NAM/NDAS. The parallel RTMA for Guam is using the expanded set of observations generated from a geographical domain which includes the region around

Guam. It is also testing the use of low-level satellite-derived winds. The lat/lon for METAR site PGUM (Guam) was corrected on 1 April so it is no longer rejected for being over water.

Yali Mao completed the transition of the RUC-based FIP source code from C/C++ to FORTRAN for eventual inclusion in NCEP's product generation suite. She compared the outputs to NCAR's and the plots matched very well. A little bit more effort on verification is still needed. Documentation and code completion for ingesting GRIB 2 and WRF-RR data will be taken care of later. Work has begun on the CIP source code transition.

Subtasks

10.5.17.1 Maintain hourly RR and four/day North American Mesoscale runs and provide aviation guidance grids. (30 Sept 10)

Four-per-day NAM runs have been maintained. Parallel tests of the NEMS/NMMB model in the EMC NAM parallel system continue on the CCS. Two NMMB parallels are now being run, the one a control run and the other an experimental run with model and/or analysis changes for inclusion in the control run. In January the Eulerian passive tracer advection of scalars was turned on in the control run, and the experimental run has concentrated on tests of radiation parameterization changes: 1) halving the absorption coefficients for water and ice to 800 and 500, respectively, and 2) changes to the radiation code to remove bugs that were causing unrealistic vertical profiles of longwave and shortwave heating rates. The changes led to a reduction in the NMMB's forecast cold bias in surface and lower Tropospheric temperatures. All radiation changes were put into the control run on 30 March. (Rogers)

Work has begun on building the infrastructure (pre- and post-processing) to make a high-resolution one-way NMMB nested run inside the North American parent domain on one of the NMMB parallels. Initial tests will be made of a 4 km CONUS nest forecast from 0-60 h inside the 12-km parent run either once or twice per day. (Rogers)

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

Four-per-day HRW runs have been maintained and none were preempted this quarter for hurricane runs. Digital filtering was added to the NCEP WRF-NMM dynamical core (it was already in place for the WRF-ARW core) for potential use with high frequency data assimilation. The filtered solution demonstrates significantly less noise over the first 3+ hours of the forecast, and appears to have little impact on the forecast at longer forecast ranges. Both of these test results are in line with the literature for digital filtering, and give confidence that it is working properly within the WRF-NMM. Preliminary examination of the impact of digital filtering in the assimilation of radar radial winds has begun. (Pyle/Liu)

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) 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://wwwt.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 & NCO)

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 packed into GRIB2 format, see **http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml**. HRW output was added to NOAAPORT feed this quarter and 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** . NCEP statistics can also be accessed via the ESRL/GSD site **http://www-ad.fsl.noaa.gov/users/loughe/projects/NCEP_verif/** . (DiMego)

10.5.17.6 Provide assistance to Inflight Icing, Turbulence, Convective Weather, Ceiling and Visibility and Oceanic Weather PDTs when their algorithms and product generation systems are ready to transition into NCEP's operational Production suite and/or unified model post-processor.

There were no requests for assistance this quarter. Yali Mao has been asking clarification questions of Gary Cunning who is the NCAR point of contact for her on the FIP – see below.

Deliverables

NCAR/MMM

CURRENT EFFORTS:
NCAR has been planning the 11th WRF Users' Workshop. This will be held at NCAR from June 21–25. The workshop notice has been distributed and posted to the web page, and abstracts have been received. The organizing committee is currently arranging and scheduling the sessions.

NCAR issued this year's major release of WRF, Version 3.2. This was released on April 2, 2010. The preparation involved leading the WRF Release Committee, code testing and implementation, and preparing new documentation.

Jimy Dudhia is modifying the Goddard shortwave radiation scheme to allow for clear-sky scattering, as the scheme is currently ignoring aerosol effects unless provided by WRF-Chem.
A simple method of specifying a scattering parameter via the namelist is being tested.

Dudhia has obtained code from Yuqing Wang (U. Hawaii) to allow the SAS cumulus parameterization to work with the ARW and is working on its implementation. He is also adding the new Tiedtke cumulus scheme as an option for V3.2.

PLANNED EFFORTS: The preparation of the 11th WRF Users' Workshop will continue. The development and implementation of new ARW physics for availability to the Rapid Refresh will continue.

UPDATES TO SCHEDULE: NONE

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

ESRL/GSD
Progress continues toward the RR implementation at NCEP. The RR continues performing better than the RUC for most forecast fields, and the RR code continues to run in a test 6h cycle (soon to be hourly) at NCEP.
Rapid Refresh primary and dev 1-h cycles continue to run on wJet/hJet at GSD, and we are working toward a 1-h RR cycle on Cirrus at NCEP before the end of FY10Q3.

Upgrade to WRF model: During April 2010, we introduced WRFV3.2 into RR cold-start HRRR and HRRR-Chem runs at GSD. Comparisons indicate WRFV3.2 produces very similar results to the WRFV3.1.1 that we have been using (with upgrades) since summer 2009.

Upgrades to RR cycles at GSD: During the month, testing was begun of top-of-trunk version of GSI-FY10 (plus cloud analysis code not yet in GSI NCEP repository) coupled with WRFV3.2 in special 3-h test cycle at GSD in preparation for moving this to RR 1-h development cycle at GSD. At this writing, RRdev cycle is now running with WRFV3.2 and newest version of GSI, including generalized cloud analysis. Once this is established to be working properly, this configuration will be moved to the RR 1-h primary cycle.

GSI upgrades: Upgrading GSI version of Generalized Cloud Analysis is continuing. This is necessary to bring this code to conformity with latest version of RUC cloud analysis, for example, to ensure that areas identified as cloudy are saturated (the RUC dev13 cycle at GSD continues to be the development platform for this code because of greater ease of testing in the RUC environment). We have also modified definition of saturation to be water saturation at temperatures > -10C, transitioning to fully ice saturation at temperatures < - 22C, based on proportion of ice and water hydrometeors typically seen in Thompson microphysics. The GSI generalized cloud analysis upgrades probably account for some reduction in large upper Tropospheric relative humidity bias noted in FY10Q2 MDE report.
Discussions are underway with NCEP (John Derber) toward further code modifications necessary for putting the Generalized Cloud Analysis fully into the GSI repository (e.g., routines currently in a library unique to the generalized cloud analysis, distributing METAR obs amongst different processors for efficiency).

RR at NCEP: We are continuing to work with Geoff Manikin toward upgrading the current 6-h cycle running at NCEP without GSI to first run with an older version of GSI to iron out any cycling issues, and then to upgrade to the RR primary cycle at GSD. Geoff Manikin is planning to come to GSD the first week of June to work with Steve Weygandt and others at GSD to accomplish this latter task.

RR Post-processing: UniPost upgrades developed at GSD during FY10Q2 have been passed on to NCEP for testing and eventual inclusion into the NCEP repository. Geoff DiMego recommends strongly that in the interest of efficiency we follow the NAM in using the EMC program *prdgen* to generate smoothed 2-d output fields (e.g., sea-level pressure and 3-d fields, such as 500mb height, interpolated to constant pressure levels) instead of generating these directly (but less efficiently) in the UniPost. (Native-grid output and unsmoothed derived quantities such as CAPE would continue to be generated by UniPost.) We will be working with NCEP to introduce this change in tactics as part of setting up the 1-h cycling RR at EMC.

Rotated lat-lon projection for RR: This transition is next in priority to upgrades in the generalized cloud analysis for GSI and satisfactory performance in RR1-h cycles at GSD. The UniPost incorporates recently developed NCEP enhancements to post process wrfout files from the ARW when the ARW is run using the rotated lat-lon grid option. These were tested at GSD on output from the cold-start RR, but full implementation of the lat-lon grid awaits GSI changes to accommodate the lat-lon wrfout files as model-background input to the GSI.

NCEP

Dennis Keyser reports that experimental Rapid Refresh (RR) PrepBUFR files containing 50 km ASCAT, and WindSat data (non-superob) are being generated at NCEP and 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 and hourly lightning data are also being copied to a public ftp directory. These are being tested in ESRL's experimental RR runs, along with early (T+0:26 minute) parallel dumps for 0000 and 1200 UTC. Future data tests will include Multi-Agency Profiler winds and METOP-2 radiances. EMC and GSD have requested the ROC start their hourly processing of Level 2.5 88D data 10 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. Alaska Region is working to provide NCEP with their Level 2 full resolution data. Level 2 data from 4 DOD Hawaiian radars was added to the BUFR database as part of the 6 April decoder update.

Geoff Manikin reports that GSD is building the Rapid Refresh system and is in the process of transporting some of the codes to EMC for the eventual construction of an NCEP parallel system. EMC hopes to have a parallel Rapid Refresh system running by the middle of June.

Subtasks:

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

NCEP

Nothing to report. (Manikin)

GSD

The partial cycling primary RR cycle continues to show performance that is equivalent to or better than the backup RUC running at GSD for wind and temperature when measured against rawinsondes. RMS vector wind errors at all levels at 3 and 12h from the RR primary 1-h cycle continue to be equivalent or consistently better than the backup RUC. We have determined that the upper-level wind forecast skill is dependent on how many cycles have taken place since the last GFS partial cycling, with lower error when partial cycling was invoked most recently (09z, 21z).

We are still seeing periods of systematically too high near-surface mixing ratio over the eastern US for RR forecasts initiated during daylight hours. We will continue to monitor this situation, particularly as we evaluate the procedure for introduction of latent heating based on radar reflectivity in the diabatic digital filter initialization.

10.5.4.2 1 Nov 2009 (GSD, NCEP)

Continue to solicit input from Inflight Icing, Turbulence, National Ceiling/Visibility, and Convective Weather RTs and NWS forecasters in Alaska and Puerto Rico, as well as AWRP RTs, on performance of pre-implementation Rapid Refresh.

GSD continues to make many different types of RR files available to users (AWR RTs, NWS). We are currently producing 4 flavors of RR files (native level, pressure level, surface, and precip fields) for each of 3 grids (full RR, Alaska 249, and CONUS). Only grib2 files are now available. Per a NWS Aviation Testbed meeting in November 2010 in Kansas City, the RR will produce two primary output files:

1) native level 3-d files plus all 2-d fields (land-surface, precip, others), including 2-d diagnostic fields
2) pressure level 3-d files plus all of the same 2-d fields

It was agreed (NWS, NCEP, AWRP PDTs) that these RR files will meet all known requirements.

Coordination between GSD and AWC to facilitate transfer of experimental RR grids to AWC is nearly complete and AWC has begun examining RR grids.

10.5.4.3 30 July 2010 (GSD, NCEP, NCAR)

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/GSD continues to prepare its new global FIM model (**http://fim.noaa.gov**) using ESMF and the NCEP configuration for ESMF, NEMS, with initial testing at NCEP planned by August. This has provided valuable experience for ESRL software engineers in use of NEMS and is even helping to design its 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.

10.5.4.4 31 Mar 2010 (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.

An NCEP Charter document for the Rapid Refresh implementation was completed on 10 Dec 2009 and submitted to NCO via Geoff DiMego. An update to the RR Charter was written on 14 May and sent to Geoff DiMego.

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 (30 September 2010) NCEP

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

CURRENT EFFORTS: Recommendations are pending since system testing isn't complete yet.

PLANNED EFFORTS:

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

Ming Hu worked with Mike Lueken at NCEP got cloud analysis-related enhancements included in the NCEP GSI SVN repository. These enhancements include the hydrometeor background field I/O code (cloud water, cloud ice, rain, snow, and graupel) and code to ingest new observations needed for the cloud analysis (radar data, METAR cloud observations, satellite cloud observations). In addition, Ming iterated with NCEP personnel to add a more optimized method for searching among METAR observations for the cloud analysis. Ming then ported the latest NCEP version of GSI (FY10 - top of the trunk including the cloud analysis enhancements) back to ESRL and has worked with Curtis Alexander to get it integrated into an updated RR real-time system (this work completed in early May). As part of this and in conjunction with DTC, Ming greatly streamlined the GSI compiling procedure. Some adjustments were also made to the GSI run scripts. Ming also continued his work with Geoff Manikin to get a full RR system running on Cirrus at EMC (see additional details under 5.4).

NCEP

Dave Parrish reports that a limitation of the hybrid ensemble option in GSI is that the localization scale is currently constant in the horizontal and vertical, independent of the background state. This is a particular problem for hurricane assimilation, where the best localization scale is small in the vicinity of the hurricane, but much larger elsewhere. The anisotropic filter, currently used operationally only in the RTMA GSI, is now being upgraded to apply to localization for the hybrid ensemble GSI. The primary task is the installation of a new filter normalization code (see Purser, NCEP Office Notes 456, 457), which is now underway. This will also benefit the RTMA, which currently uses pre-computed non-adaptive anisotropic filters.

Wan-Shu Wu worked on regional ozone analysis. In the NDAS, the observational error of SBUV ozone data was adjusted to account for the representativeness error from the regional vertical grid. To prevent a negative mixing ratio caused by an over-adjustment of the ozone fields, ozone background error variances were set to be 10% of the zonal mean values of the forecasts. The horizontal scales were set to 400km below 350mb and increased to 800km at the model top. Since mixing ratio (instead of layer ozone) was used as the analysis variable, the vertical scales were set to a small value (0.6 of grid spacing). The ozone analysis worked properly and the code was merged to a version of the trunk. After the regression tests, the code will be submitted to the GSI_SVN trunk.

Subtasks

A new type of virtual temperature observations (RASS) was evaluated in preparation for being used in NAM/NDAS. The statistics of the data fit to the first guess were collected and the adaptive tuning method used to evaluate the amplitude of the observational error, which is inversely proportional to the quality of the data. The data with very large RMS fit to the first guess showed up routinely in the rejected and monitored statistics. The statistics also showed that the RASS data that passed all the QC steps still have a significant bias and large RMS

to the forecast fields. The biases are also very different from those of the radiosondes. However, with tighter gross check bounds that exclude about 20% of the stations, the adaptive tuning results show that the rest of the data are of sufficiently good quality. (Wu)

Deliverables:

10.5.5.E3 16 Sept 2010 (revised date, previously requested) (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.
On schedule. The updated GSI (version FY10+ with cloud analysis) running at GSD and compiled at NCEP. Geoff Manikin will visit GSD on June 7-11 to finalize his RR test system. Plan to begin full real-time parallel RR testing at NCEP by 1 July.

10.5.5.E4 30 Sep 2010 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)

appears to be very good, with the RR model 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 will be conducted up to the transfer of RR code to NCEP/NCO, but these results including the physics now appear adequate.
WRFv3.2 official code release was made by NCAR on 2 April 2010. WRFv3.2 includes improvements in efficiency in generation of lookup tables for the Thompson microphysics (from NCAR) and prediction of temperature in sea ice and accumulation and ablation of snow on sea ice in the RUC land-surface model (from GSD). An RR retrospective test of the MYNN vertical mixing (boundary-layer) scheme with enhancements to the mixing-length formulation is still planned. We are looking particularly for evidence of beneficial impacts on prediction of low level wind and temperature, and amplitude of the diurnal cycle of temperature, as compared to the MYJ currently used in all the GSD RR cycles.

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)
Test and evaluate upgrades of RUCLSM to handle sea ice and snow cover on sea ice under wintertime conditions for FY11 Rapid Refresh upgrade.
The new version of the RUCLSM with the explicit prediction of sea ice temperature and its effects on sea ice albedo, as well as accumulation and ablation of snow on the sea ice, continues to run in the RR at GSD. Performance remains satisfactory. These enhancements were included in of the WRF v3.2 release on 2 April 2010. Tanya Smirnova presented a poster on the RUC LSM including these sea-ice enhancements at the CIRES (Cooperative Institute for Research in the Environmental Sciences) Rendezvous in Mid-April. She, along with Curtis Alexander and Ming Hu received CIRES Science Awards at the Rendezvous for their contributions to development and implementation of the RUC diabatic radar initialization and being used also in the RR.

10.5.8.4 1 Aug 2010 (GSD)
Continue exploring possibilities for enhancing treatment of sea ice and tundra (including albedo changes and spring-time ponding) in Rapid Refresh domain toward a FY11 Rapid Refresh upgrade.
Discussions have commenced 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 than water clouds. Ice clouds have much lower emissivity in the infrared wavelengths than water clouds. They 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.
Deliverables:

10.5.8.E2 1 May 2010 (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:
Trude presented updates on the WRF dust-ice scheme in a NCAR/NOAA/PNNL small workshop about Aerosols and bulk microphysics in WRF and WRFchem. She received updated global model output from the GOCART model (7 years of simulations). She also continued her analysis of the El-Paso case (high level dust event).

PLANNED EFFORTS:
Continue 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
GSD continues to monitor performance of the cloud analysis within both the RUC and Rapid Refresh. RR GSI cloud analysis components have also been ported to EMC GSI SVN repository (see Task 5.5).
Subtasks

10.5.15.E2 16 Sept 2010 (revised date, previously requested) (GSD)
Complete testing of GSI generalized cloud analysis for Rapid Refresh and deliver code to NCEP as part of Rapid Refresh package delivered to EMC, pending availability of NCEP testing capability.
The hydrometeor background field ingest code and special observation ingest code in now part of the NCEP GSI repository. Ming Hu has now compiled and is running the latest version of the GSI with the cloud analysis at NCEP and coordinating with Geoff Manikin to transfer the code to Geoff's test RR cycle.

10.5.15.E3 30 Aug 2010 (GSD)
Complete testing of revised cloud analysis for part of FY11 change package to Rapid Refresh
Initial testing of ideas for this, including use of cloud residuals to create relative humidity innovations, are currently being testing in the development RUC at ESRL and will be moved over to a test version of the RR over the next few months. This capability will require substantial modifications in GSI (much in the RUC 3dVAR), and will be deferred to the FY11 change package for the RR.

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

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.

Reliability – now much higher, 100% for last 2 weeks (allowing gaps of up to 3h)

A request for new funding for computer resources for the shadow HRRR in order to perform many needed retrospective experiments with different data assimilation variations is forth coming.

(Below from previous report but still relevant)
There was a major effort by GSD personnel, working in conjunction with CoSPA partners (NCAT, MIT/LL) And QAPDT, to test, evaluate and refine HRRR components, leading to numerous enhancements. This has including moving the HRRR to dedicated nodes with quick failover procedures for most of the most common computer issues (leading to an improved reliability -- (~92% for all runs, ~98% with outages of 2 hours or less, which still allows delivery of a complete CoSPA product). A number of enhancements have been completed, including breaking up the 15-min VIL file (previously a single file with all output times from the entire 12-h HRRR run) into a series of 3-h files. This reduces the latency in the delivery of the VIL fields for the shorter hour forecast hours and also allows for transfer of at least some of the HRRR output in the event that the HRRR runs does not complete fully (as can happen when with slow I/O on one of the jet cores). An additional benefit is the ability to add extra surface fields to the 15-min output files. These fields will assist with high time and space resolution frontal and boundary detection.

The Rapid Refresh has also been ported over to the faster (and also fully dedicated) nJET cores and we are conducting retrospective experiments of HRRRs running nested within the RR, as a prelude to a switchover to run the HRRR nested within the RR. This changeover required quite a bit of detailed work by Ming Hu to resolve some issues related the specific architecture of the Nehalem chip. Work is nearly complete to create a set of operator procedures for quickly reacting to any HRRR outages during the summer demonstration. Most recently, an upgrade has been made WRF v3.2 using tiled output, which significantly decreases the runtime allowing for the possibility the HRRR may be able to be run out to 15 hours. As part of this upgrade, GSD personnel worked with Scott Dembek at NSSL to make changes to his code that saves hourly maximum values for key variables.

In addition, a large amount of work was completed to test various enhanced options for initializing the HRRR, including:

1) Running the HRRR within the RR,
2) Adding a 2nd pass of the radar reflectivity-based temperature tendency specification (through use of 3-km versions of the GSI cloud analysis and ARW model diabatic DFI), and
3) Reducing the strength of the reflectivity-based latent-heat temperature tendency in the RUC diabatic DFI.

This work required considerable effort to run a large number of RUC and HRRR retrospective experiments, and included running a 12-hourly parallel HRRR (run off of the real-time GSD RR), and was completed in coordination with NCAR, MIT/LL and QA PDT, who have been valuable in evaluating the various HRRR and downstream CoSPA forecasts. As part of that effort, Curtis Alexander modified the RR scripting and execution to trim nearly 15 minutes out of the hourly cycle, allowing the need RR files to be available with the same latency as the RUC files. Based on extensive testing, we have reached a decision (on 14 April) to maintain the current HRRR system

during summer 2010 (initializing the 3-km HRRR from the RUC with use of the same radar-reflectivity based temperature tendency as used in 2009).

While other formulations show much promise and were nearly ready for inclusion in the summer 2010 demonstration (experimental work will continue on them), the present formulation was found to be the most reliable method. In particular, use of the Rapid Refresh in place of the RUC yielded very encouraging results, but we cannot hold the RR code constant through the summer (because of ongoing refinements toward the NCEP operational implementation), as needed for the CoSPA demonstration.

10.5.24.2 15 Aug 2010 (NCAR/MMM, GSD)

In collaboration with GSD, NCAR/MMM will work to evaluate convection-permitting (e.g., 3-km) forecasting by the ARW core for ultimate application in the HRRR. It will perform and evaluate convection-permitting forecasts using the radar-enhanced RR (13-km) grids from GSD for initial conditions, in order to identify strengths and weaknesses of the model at high resolution. This will include analyses, for selected cases, of the evolution of convective storm mode during first 1–3 hours of model transition from 13-km resolution to 3-km resolution. NCAR will collaborate with GSD in the process and submit a summary of results.
This work is ongoing in conjunction with NCAR personnel (including David Dowell, Jenny Sun, Mei Xu, James Pinto, Jimy Dudhia), with monthly meetings to exchange information. Issues that have been examined include domain size, grid-resolution, and choice of background grids, microphysics options, and surface temperature biases (related to model post-processing). In additional, as part of the 2009 retrospective verification, GSD has re-run specific cases (09 through 15 UTC, 29,30,31 July) and transferred files to NCAR and MIT/LL for CoSPA retrospective processing. NCAR's initial evaluation of these results showed an improvement to CSI for VIL forecasts by 20-40% for 1-5h forecasts when radar reflectivity assimilation was included compared to the operational HRRR runs last summer without radar data.

10.5.24.4 30 May 2010 (NCAR/RAL) Conduct sensitivity runs... (Ken Stone)

We have been coordinating sensitivity runs between the Convective, Turbulence, and Icing PDTs to evaluate the impact of various model configurations on the diagnosis and prediction of convective storms, turbulence and in-flight icing. Four cases were selected for sensitivity experimentation: 6 February 2008, 4 June 2008, 9 October 2009, and 9 December 2009. All of these cases exhibit interesting convection, turbulence, and in-flight icing aspects. We are currently in the process of collecting the relevant datasets to initiate the sensitivity runs. The baseline runs will emulate the WRF-RR (13 km) and the HRRR (3 km) models. Several variations of model configuration and physics packages will be explored.

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

As of early May 2010, all HRRR related code, scripts, hardware in frozen state. No changes are expected, except minor fixes as needed. The configuration includes real-time RUC with digital-filter-based radar reflectivity assimilation running at GSD to supply initial and boundary conditions to the HRRR. HRRR (using WRF v3.2+) running on ~1000 fully dedicated cores producing a 15-h forecast each hour with ~ 2-h latency. Hardware

enhancements (besides the fully dedicated cores include redundant files systems, expanded capacity internal file transfer, and redundant ftp server for external file transfer.

INTERACTIONS:
Stan Benjamin from ESRL visited MIT/LL for a day (26 April) to present a seminar on the HRRR and discuss HRRR and CoSPA topics with MIT/LL scientists.

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

(Below reported in April but still relevant.)

Working in conjunction with our CoSPA partners and building upon previous work to rerun HRRR runs for the 29-31 July 2009 test period with the RUC radar assimilation turned on (requiring cycled retrospective runs of the RUC system), much work was done to test 3 key enhancements:

1) Running HRRR initialized by RR,
2) Running a 2nd pass 3-km reflectivity-based temperature tendency based DFI,
3) Reducing the strength of the reflectivity-based temperature tendency (in the RUC, but applicable to RUC, RR, or HRRR). See description of these experiments in task 5.19 and explanation of our decision to maintain the present formulation for the summer 2010 CoSPA demonstration.

This major and sustained testing effort required many coordinated retrospective runs amongst RUC, RR, and HRRR models, included use of parallel RR and HRRR real-time runs, suspension of the HRRR real-time cycle, nearly immediate transfer of HRRR output files to various downstream users (for blending and verification), but lead to significant enhancements to our understanding of the reflectivity assimilation procedure. In particular, real-time tests of the HRRR running within the RR yielded very encouraging results and we seriously considered using this formulation for the summer CoSPA demonstration. The requirement to have a code freeze for the system was not possible, as we need to continue to make modification to the GSD real-time RR system prior to the NCEP implementation. Much progress was also made on the 2nd pass 3-km option,
Also included was the testing of a 3-km GSI-based cloud analysis and several enhancements to the cloud analysis. Finally, a comparison of the strength of the temperature tendency in the RUC, shed light on how the HRRR responds to the RUC forcing. Parallel work on these enhancements to the radar assimilation procedure will continue.

Recent work by Ming Hu has overcome an important obstacle related to 3-km radar DFI assimilation within the HRRR. Previously, similar "2nd pass" 3-km assimilation experiments on the HRRR 2/3 CONUSD domain had yielded further impressive gains in HRRR prediction skill. Unfortunately, attempts to run the required simplified version of the GSI (using the cloud analysis to compute the latent heating temperature tendency, but with the variational solver turned off) were not successful. Ming tracked the problem down to a memory issue and has found a way around it, allowing us to begin similar tests, now on the full CONUS HRRR domain. Other work is ongoing to compare HRRR runs nested within radar assimilating RR runs vs., radar assimilating RUC runs for the 29 July 2009 test case.

Two recent GSD hires, Patrick Hofmann and Eric James, have begun working on HRRR-related activities. Patrick began on April 1 and has been streamlining our existing internal HRRR verification system, too allow more rapid and complete quantitative skill assessment of various HRRR forecasts. Eric began on May 1, and has been qualitatively evaluating HRRR forecasts. Both are also learning the RR / HRRR code, scripts, run and evaluation procedures.

NCEP
Shun Liu reports that the RFC for the REF2GRIB package was rejected and then further modified. Codes and scripts in the REF2GRIB package were separated from the 3D mosaic package. Codes in this package that generate three executables were merged to get a single executable in order to meet NCO's requirement. Shun finished tests of assimilating radar radial wind with the DFI version of WRF. In the HiRes initialization, the test (with some help from Matt Pyle) was to examine if a cross-relationship between wind and other model variables can be established through DFI. The temperature increment is found to be small after DFI and the moisture increment relatively large.

Deliverables:

10.5.19.E5 15 Sept 2010 (CAPS, NCEP and GSD)
Report on the design and initial development of EnKF data assimilation for Rapid Refresh scale
CAPS obtained a version of the global EnSRF code from Dr. Jeff Whitaker of ESRL and are now working on linking this EnSRF package with the regional GSI for RR application initially. Initially, this EnKF analysis will be performed at ~ 40 km resolution and the ensemble mean analysis will be used to initialize the 13-km RR forecast. Using a test domain of 227 x 227 grid points at ~40 km grid spacing that covers the entire RR domain, we have generated initial ensemble initial and boundary condition perturbations using WRFDA RANDCV option (using 'da_wrfvar.exe' and 'da_update_bc.exe' programs). The regional GSI is used to transform the background fields needed by EnSRF from NETCDF to binary format and to calculate the observation innovations for each ensemble member. Since the output from the EnSRF is binary, a data transform utility was written to update the analyzed state variables in the analysis background. The ensemble mean can then be obtained using WRFDA 'gen_be_ensmean.exe'. The 13 km RR resolution fields can finally be generated by grid interpolation utilities used by WRF grid nesting. An initial version of these capabilities has been developed and passed compilation, and will be tested for correctness. One of the remaining issues is that the control variables in the EnSRF system are not consistent with the current regional GSI output; these will require modifications to the EnSRF codes.

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

GSD
Doug Koch has coded a preliminary threshold adjustment procedure that ensures statistical reliability. Initial evaluation reveals that it reduces the maximum realized probabilities down to about 60%.
GSD (Curtis, Steve, Stan) has interacted with MIT/LL (Haig, Colleen) to produce a HCPF-like convective probabilistic forecast for CoSPA.

NCEP
Jun Du reports that work has been started to build a new NEMS-based ensemble component for the 2011 operational SREF system upgrade. The plan is to use the NEMS-NMMB model to replace the Eta and RSM models currently used in the SREF system. The new SREF system is expected to have 21 members, including 7 NEMS-NMMB, 7 WRF-NMM and 7 WRF-ARW members.

Binbin Zhou built a grid-to-grid verification of simulated reflectivity from RUC, NAM, operational Hires NMM, and Hires ARW against the MOSAIC radar dataset. The whole package has been 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 are significantly increased, to an almost 100% increase in ETS. The new SREF ensemble probability scores for both echo tops and reflectivity are also significantly improved over all the ensemble probability thresholds.