MODEL DEVELOPMENT AND ENHANCEMENT RESEARCH TEAM

Quarterly Report for April, May, June 2008
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Executive Summary

Task 08.5.1: Infrastructure support related to operational running of the RUC and NAM operational modeling systems.

- Testing continues at NCEP for RUC upgrade package code (radar reflectivity assimilation, TAMDAR, radiation, Grell/Devenyi upgrade). Part of Grell-Devenyi convection change withdrawn per March-May testing at GSD and NCEP and now producing better upper-level wind forecasts. Implementation planned for fall 2008. Real-time comparisons continue in http://wwwt.emc.ncep.noaa.gov/mmb/ruc2/para .

Task 08.5.4: Develop, test, and implement Rapid Refresh configuration of the WRF modeling system.

- Updated web-page with hourly cycled RR at http://rapidrefresh.noaa.gov .
- One-hour cycle using WRF version 3.0, DFI, and latest regional GSI version (March 2008) now running reliably at GSD and without severe daytime cold bias seen earlier.

Task 08.5.5: Develop, test, and implement 3DVARs for RR and NAM

- Further modifications incorporated in June into RR version GSI
- (from May) Rapid Refresh specific changes (mainly cloud/hydrometeor assimilation) incorporated into latest GSI version from NCEP (31 March 2008)
- (from May) GSI code placed under an SVN (Subversion) revision control system at GSD to carefully track GSD-introduced changes.

Task 08.5.15: Develop improved methods of cloud and moisture analysis for use in the WRF modeling system.

- Cloud analysis for GSI incorporating METAR cloud and GOES cloud-top data (similar to the RUC cloud analysis) now running regularly in a 1-h cycle with the Rapid Refresh.

Task 08.5.24/19: Begin 3km High-Resolution Rapid Refresh testing / Improve radar assimilation

- HRRR changes in last quarter: Now running 1h earlier, also using DFI-output (showing large improvement), and being moved to different queue for better reliability.
- 15-min VIL output from hourly HRRR available at http://ruc.noaa.gov/hrrr/vil

Task 08.5.1: Infrastructure Support for Operational Running of the RUC at NCEP

GSD

Updates on two change packages:
June change package and larger upgrade (September) change packages to RUC

GSD and EMC completed work toward a change on 11 June to the RUC to correct land-surface fields. A slight horizontal (~5km) shift in its land-surface fixed fields (vegetation type, soil type) was needed correct these fields, and making them more accurate especially near coastlines. A post was made to the RUC forum: http://ruc.fsl.noaa.gov/forum/f2/Welcome.cgi/read/1799, including a link to a comparison over southern Lake Michigan (http://www.emc.ncep.noaa.gov/mmb/ruc2/test/ruc2mtmi_2008060912f000.gif).

A second near-term change will also soon happen (still true on 16 July): NESDIS is waiting for a RUC change to cease production of 3x3 field-of-view (FOV) precipitable water data, which the operational RUC currently assimilates. Thus, the second near-term change will be for modifications to the RUC analysis to allow use of the much denser 1x1 FOV PW data. NCO is now working on these changes (developed previously at GSD and tested there and at EMC).

RUC upgrade for model, assimilation, and post-processing
After close scrutiny and testing over April and early May, GSD and EMC decided to rescind inclusion of some of the Grell-Devenyi changes (specifically, using non-local subsidence) in the RUC upgrade, since experiments showed that this code was causing a degradation in upper-level wind forecasts. With this change, the parallel RUC (and similar GSD backup RUC) now is showing upper-level wind forecast skill fully comparable to that from the operational RUC and better in the lower troposphere. The non-local subsidence design is still a good idea, and a corrected version of it is now in testing with the WRF model configuration for the Rapid Refresh.

The RUC upgrade continues in parallel testing at NCEP. Real-time comparisons continue to be available at http://wwwt.emc.ncep.noaa.gov/mmb/ruc2/para. Both GSD and NCEP/EMC have used this web site on a daily basis to compare forecasts between the operational RUC and parallel RUC (with upgrade). As reported in previous months and below in the NCEP contribution on Task 5.1, an investigation continued regarding moisture profiles in the southern Midwest, after being alerted by NCEP's Storm Prediction Center. It was found that operational RUC soundings sometimes had excessively deep moist layers, but in almost all cases, the parallel RUC did not have this problem and showed much more realistic soundings. GSD and EMC ran experiments testing individual components of the fall RUC change with the existing operational RUC analysis code, but since none of these tests removed the moisture profile problem, we attribute the success of the parallel RUC in this area in part to its model changes, which are too significant to include in a quick crisis change. So the best bet is to simply get the overall RUC upgrade in as soon as possible.

Current planned implementation date – September 2008

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: NCO implementation of radar reflectivity processing with super-hi-res data is expected by mid-August. If this is delayed, this could cause a delay in the RUC upgrade implementation

NCEP
Task 08.5.1: Infrastructure Support for Operational Running of the RUC at NCEP

Subtasks

08.5.1.1 Maintain hourly RUC runs and provide grids of SAV and AIV guidance products.

A new radar reflectivity QC and SRC (Single Radar Cartesian) package was implemented on June 17. With this implementation, an SRC tank will be generated in operations and the Level II reflectivity mosaic package can generate a 3D mosaic from the files in this SRC tank for testing the RUC upgrade. The 3D reflectivity mosaic codes have been RFC'ed (RFC = request for change) and this package is under parallel testing at NCO. (Liu)

During the fall of 2007, EMC began running a parallel version of the RUC model, with the primary feature of this code being the assimilation of radar reflectivity data. Geoff Manikin worked with Shun Liu to generate hourly reflectivity mosaic files to be ingested by the RUC, and the assimilation of the mosaic data is linked to the digital filter initialization to specify the 3-d profile of latent heating. Other changes include the assimilation of mesonet wind data from a list of approved providers and TAMDAR data, a change in the longwave radiative scheme from Dudhia to RRTM, a modification to the snow component of the land-surface model to decrease excessively cold 2-meter temperatures over fresh snow at night, another change to the snow model to allow for warmer temperatures during warm advection events over snow cover, and a modification to the convective scheme to decrease widespread coverage of light precipitation. Daily comparison of operational and parallel forecasts continues, and statistical evaluation of the new version of the model is underway. Code will be turned over to NCO for final parallel testing in mid-July, and implementation of this package is scheduled for September 2008.

In addition, an upgrade to the operational RUC was prepared and RFC'ed to read 1x1 GOES precipitable water retrievals instead of the current 5x5 values, as NESDIS is looking to shut off the 5x5 data feed. With help from Dennis Keyser, the analysis code is being updated to handle a larger volume of GOES precipitable water data. An August implementation is likely.

This spring a user noticed a problem with a slight shift of the model coastline along the Great Lakes relative to the truth, and it was determined that the model topography and land-use files were indeed shifted slightly from truth. Corrected files were put into operations on 11 June.

Finally, SPC forecasters alerted EMC to a problem this spring with the RUC generating near-saturated layers near the top of the PBL over the southern plains in southerly flow, leading to extreme erroneous values of elevated cape. The problem appears to be caused by over-fitting GPS precipitable water observations, and a fix was sought for a possible crisis implementation. The parallel version of the model (to be implemented in September) showed a much-improved handling of these events, but the parts of the code that directly lead to this impact could not be isolated. As a result, no crisis change was made; we will wait for the full implementation in September to address the problem. (Manikin)

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

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). (EMC Team and NCO)

08.5.1.3 Provide full grids from RUC runs on NCEP and NWS/OPS servers.

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/ . This includes hourly BUFR soundings, output grids which undergo no interpolation and, as such, are on the models' computational grid (so-called native-native grids). These now contain grids packed into GRIB2 format, see http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml , and an index for each file is also provided. A limited set of fields from the RUC (and other NCEP models) can also be viewed at http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/ (EMC Team and NCO)

08.5.1.4 Maintain access to model verification data.

NCEP maintained its capability and provided access to routine verifications performed at NCEP of the operational RUC system forecasts. These include grid-to-station verifications (versus rawinsonde, surface, aircraft, Profiler, and VAD data) scores computed periodically at NCEP. Routine verifications have been performed and are accessible from NCEP's Mesoscale Branch's website: http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html (Rogers, Manikin, Keyser)

GSD has also continued its verification monitoring of both operational and experimental versions of the RUC against rawinsondes and METAR data (http://ruc.noaa.gov/stats).

Deliverables

08.5.1.E1 1 October 2007 - 30 September 2008 **EMC** (Rogers, Manikin, Keyser)
Perform observation ingest, quality control, and preparation in support of the operational RUC runs.

CURRENT EFFORTS: The new radar data processing package has been tested and was implemented after the results from the code at NCO were compared to the development parallel. This package includes new job scripts, a new data decoder, updated radar radial wind quality control (QC), reflectivity QC and interpolation of reflectivity from polar to Cartesian coordinates (SRC file generation). (Liu)

From 1800 UTC 9 April through 2000 UTC 11 April NPN wind profiler data were not available because they were reporting longitude in degrees east instead of degrees west. The NCEP BUFR library was updated by NCEP/NCO on 28 May (several upgrades and enhancements were added). There was a 10 (17) hour outage of NESDIS-fed POES (GOES) satellite data on 1 June due to Storage Area Network drive hardware failures on the various NESDIS servers. This led to a failure in the 1500 UTC 1 June RUC as the Global first guess valid at 1500 UTC (used in the platform-specific observation quality control processing) had an incorrect internal date (a result of NCEP/NCO attempts to work around the satellite outage issue). There have been subsequent sporadic short outages of NESDIS data, again due to server issues (the most significant being 21-23 June when some GOES and POES counts were less than 50% of normal and 27 June when some GOES counts were zero). A change to handle radiosonde instrument types greater than 99 (now approved by the WMO BUFR committee) was implemented on 3 June. A national radar mosaic package based on quality controlled WSR-88D reflectivity was implemented on 24 June. Since the beginning of April, Level II reflectivity (and radial wind) data from an increasing number (at least 90) WSR-88D radar sites are unavailable due to their switch from Build 8 to Build 10 software. NCEP/NCO (Krishna Kumar &

Shucai Guan) is working on a recombination code in order to ingest these data and convert them back to a Build-8 look-alike format. Tests of both "new science" GOES 1x1 f-o-v cloud data and GOES 1x1 f-o-v PW data (replacing current 5x5 f-o-v products) are underway. There are still random files (2-4 per day) where NESDIS encodes 1 or 2 reports at the beginning with missing lat/lon and a bogus satellite id (NESDIS has been contacted). A change package that includes the 1x1 GOES and the establishment of a joint RUC/Rapid Refresh data processing system has been submitted to NCEP/NCO and is waiting for implementation possibly in late July. Parallel testing of TAMDAR and Canadian AMDAR aircraft temperature and wind data is also currently underway. At the request of ERSL/GSD, efforts are being made to get TAMDAR airframe type and company code (currently not provided in either the ERSL MADIS or AirDAT feed) to allow for improved bias corrections. Cooperative Agency Profiler (CAP) and RASS data are not yet available through an alternate ESRL MADIS feed. (Keyser)

PLANNED EFFORTS: After the NCEP/NCO recombination codes start running in operation, examine the full radar data processing flow to make sure the QC package and mosaic package work correctly, and check the NCEP's legacy resolution data against NSSL's. (Liu)

Add a new aircraft quality control module based on code from Naval Research Lab. This code was recently updated to run more efficiently and to fix some bugs, however, work still needs to be done to improve run times when profiles are generated. This code is now being checked out in daily real-time parallel runs for the GFS. Increase the time window for aircraft data to improve track checking. Change PREPBUFR processing to add report sub-type information so the analysis can use different obs errors and develop bias corrections based on data sub-types (airframes and ascent/descent tags, mesonet providers and sub-providers, radiosonde instrument type and on-site correction indicators). Complete RUC impact tests for new data types Canadian AMDAR and TAMDAR (from AirDAT vs. current ESRL MADIS feed), hourly WSR-88D 3-D reflectivity, 6-minute wind profilers, mesonet wind and roadway data, and new mesonet data feeds (including "hydro", "snow", modernized COOP and UrbaNet). (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: GSD & NCO.

UPDATES TO SCHEDULE: None.

Task 08.5.4: Develop, test, and implement Rapid Refresh configuration of the WRF modeling system.

ESRL/GSD
Work continued on the Rapid Refresh (RR) cycle with major upgrades to both the WRF model component and GSI analysis component of the real-time hourly cycled RR at GSD.

The WRF model upgrade is to version 3 (model and associated WPS pre-processing), released by NCAR in April. This version includes GSD-generated improvements to parameterizations used for the Rapid Refresh previously developed by GSD (Grell-Devenyi convection, Thompson microphysics, and RUC-Smirnova land-surface model). This upgrade will continue using the Mellor-Yamada-Janjic (MYJ) planetary boundary layer (PBL) scheme, also used in the operational NAM, the Dudhia short-wave radiation scheme and the Rapid Radiative Transfer Model (RRTM) long-wave radiation scheme.

(Note: WRFv3.0 also includes enhancements for initializing the WRF model with RUC native vertical grid data, including 5 types of hydrometeors and for doing the diabatic digital filters initialization necessary for 1-h cycling for the RR. These capabilities were previously added to WRF version 2 by AMB, but now have been permanently included in v3. This will allow WRF users to easily use initial cloud/hydrometeor fields, available only through RUC native grids.)

The GSI upgrade is to the regional NCEP-operational version (March 2008) with inclusion of the RR-specific cloud analysis module. In order to maintain a robust quality control on the code version evolution, this work is now being managed within the Subversion (SVN) version control system, with specific revision numbers for a) the March 2008 GSI as it runs at NCEP, b) March 2008 GSI with modifications needed to run in GSD Linux cluster, and c) GSI with modification for the GSD Linux cluster and inclusion of cloud analysis.

The fully updated RR system (with updated GSI and WRF) underwent final checkout using the recently developed RR retrospective cycle capability and replaced the previous real-time cycle at GSD during June. The ~7 day cycled retrospective capability (with verification) has been developed for the RR system and used to evaluate the optimality of various RR components, including the GSI background error specification and the cloud analysis package.

Once the 1-h RR cycle was updated to the new model components in June, comparison of its 12-h forecasts from the 0000 and 1200 UTC initial times were made with the GFS-initialized GSD "cold-start" runs that have been running at GSD for close to a year. (These runs had been switched early in Q3-FY08 to WRFv3 with identical physics as the 1-h cycle.) This comparison revealed a severe cold bias in the 1-h cycle runs. By turning off the soil moisture cycling, this was traced to a bug in the coupling between GSI and the ARW flavor of WRF for the cycling of soil moisture, in which the land-sea mask (with values of 1 over land areas) was being substituted for the top-layer soil moisture. As of about 1 July, daytime temperatures from the cycled RR now compare well with those from the GFS-initialized "cold-start" runs.

As part of the ongoing Rapid Refresh “shakedown” effort, other issues have been identified and resolved. These include occasional model blowups in the adiabatic backwards portion of the DFI due to computational (CFL) instability, and a periodic problem with the lateral boundary condition files used for the DFI. The former problem is being addressed by introducing a capability to run with a different (shorter) time step in the DFI than in the free forecast, and the latter has been fixed using a temporary work-around using separately read-in lateral boundary condition files every third hour when the pathology occurs. A permanent fix is being investigated by GSD and NCAR as a possible WPS bug.

In addition, the wall execution time of the model was sped up considerably through use of the quilting I/O option available in WRF through the namelist—this dedicates a specified number of nodes for I/O purposes and allows I/O on these nodes whilst the other nodes are doing model execution. Thanks to Tom Henderson of GSD for helping with this important enhancement.

Together, these changes have made the 1-h cycle run much more reliably on wJET. A 12h forecast on wJET is now usually completed in about 3200s using 128 processors (120 for the model, 8 for the “quilted” I/O). The GSI, usually takes about 720s using 64 processors.

PLANNED EFFORTS: Work toward permanent fixes for the soil moisture cycling, lateral boundary and DFI stability problems. Continue to closely monitor RR forecast performance and continue to experiment with procedures to speed up execution of both the GSI and the model.

Continue to work toward implementation of the RUC radar initialization procedure into the 1-h cycle (Task 15).

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: Unreliability of the real-time RR PrepBUFR observation data feed from NCEP continues to cause sporadic missed cycles for the real-time RR cycle at GSD. Once the operational RUC switches over to this data feed (changes passed to NCO already, expected soon), this PrepBUFR file will be available on the NCEP FTP site for GSD, and this problem will be resolved

INTERFACE WITH OTHER ORGANIZATIONS: DTC, NCEP, NCAR

UPDATES TO SCHEDULE: None.

NCEP

NCEP has established a retrospective NAM Data Assimilation System (NDAS) test system using GSI and WRF-NMM for the full NAM domain at 32 km on the NCEP node of the NOAA R&D computer (known as haze). This month (June) a replacement system (vapor) is now being used. Accounts are being setup on vapor for GSD Rapid Refresh developers so they can use this system as a template and adapt it to perform hourly updates and digital filter and transition it to use WRF-ARW for rapid prototyping of the Rapid Refresh at and with NCEP.

Subtasks

08.5.4.1 30 December 2007 (GSD, NCEP) COMPLETE
Begin real-time hourly cycling of RR model with GSI over RR domain with availability at GSD of hourly prepBUFR files from NCEP having begun on 12 October 07.

CURRENT WORK:
See discussion above for description of ongoing development of the Rapid Refresh real-time 1-h cycle at GSD.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: PrepBUFR availability from NCEP, discussed above.

INTERFACE WITH OTHER ORGANIZATIONS: NCEP, NCAR

UPDATES TO SCHEDULE: None

08.5.4.2 1 March 2008 (GSD) [COMPLETE]
Begin collaborative evaluation with planned NOAA Rapid Refresh users, including AWC, SPC, NWS in Alaska and Puerto Rico. Arrange to have GSD RR grids available to examine and solicit feedback on RR performance.

We have made sample RR files available to Alaska NWS users, which have been downloaded. With the improved reliability of the RR 1-h cycle (see discussion above), we have contacted NWS-Alaska Region and other experimental RR users again to encourage full ftp'ing of experimental RR grids.

08.5.4.3 1 March 2008 (GSD) [COMPLETE]

Begin collaborative evaluation of Rapid Refresh with Inflight Icing, Turbulence, National Ceiling/Visibility, and Convective Weather RTs. Arrange to have GSD RR grids available to examine and solicit feedback on RR performance.

Test grids from the RR 1-h cycle have been made available via the GSD ftp site and initial feedback from RTs on data format issues have been received. Work to establish real-time file transfer has progressed well. One aspect of this work was development at GSD (Kevin Brundage) for a new automated procedure to rename the files from WRF convention to the RUC convention and transfer them to GSD ITS branch for ftp availability. In addition, we have been working with the other RTs to resolve some grib domain parameter settings that have been causing downstream processing issues. With this and the improved reliability of the RR 1-h cycle (see discussion above), we are now ready for users to begin full ftp'ing of experimental RR grids.

08.5.4.4 30 May 2008 (GSD, NCAR, NCEP)
Report on status of tactical planning for making RR-WRF code for 2012 in compliance with Earth System Modeling Framework (ESMF) as specified in the Sept 2007 Rapid Refresh MOU between NCEP and GSD.

Under separate funding, Tom Henderson (formerly NCAR, now with ESRL/GSD) continued his work toward putting the ESRL FIM (Flow-following Icosahedral Model, under development, test and evaluation within GSD) into the ESMF framework, a necessary step if it is to contribute members to NCEP's Global Ensemble. In the process of doing this, Tom is working closely with Tom Black of EMC. Tom Henderson has FIM running within a rudimentary ESMF version at GSD, and converted this to run under NCEP's version of ESMF version 3.1 in June. Experience gained with this effort will strongly facilitate the process of putting the RR (and ARW dynamic core) under ESMF in the 2010-11 time period.

08.5.4.5 Ongoing (GSD)
Further enhancement to WRFpost version for Rapid Refresh application, including modifications for generation of RUC-specific fields.

Output from the RR 1-h cycle at GSD, as well as that from the full-domain cold-start and run continue to be available. The Alaska window real-time products continues to be available from the cold-start run. We have recently begun creating Alaska window grib file from the RR 1-h cycle and will be disseminating the files and creating graphics soon. Also, a refinement of the presentation style (e.g., color tables) of these plots has been made to facilitate comparison with output from the various RUC hourly cycles running at GSD and NCEP. As noted under subtask 2 above, a separate display (based on AWIPS grid #249) is available to facilitate evaluation of RR over Alaska. Visibility, ceiling, and cloud-top height plots have proven helpful in evaluating the cloud-analysis performance (see tasks 08.5.5 and 08.5.15).

08.5.4.6 Ongoing (GSD, DTC later)
Ongoing evaluation of performance of real-time and retrospective runs of RR system for SAVs, AHPs.
Now that the 1-h cycle is running more consistently on wJET using version 3 of WPS and WRF and the March 2008 version of GSI, quantitative statistical validation is underway. These statistics confirmed a serious cold bias in the 1-h cycled runs (see summary discussion above) and helped to verify that it has been mostly resolved. Real-time products in the web displays noted above continue to permit qualitative evaluation.

Now that the 1-h cycle is running more consistently on wJET using version 3 of WPS and WRF and the March 2008 version of GSI, quantitative statistical validation is underway. These statistics confirmed a serious cold bias in the 1-h cycled runs (see summary discussion above). Real-time products in the web displays noted above continue to permit qualitative evaluation.

Deliverables

08.5.4.E1 30 Aug 2008 (GSD)
Have available for delivery to NCEP initial 'experimental level' WRF Rapid Refresh code for start of EMC testing toward 2009 Rapid Refresh implementation.

Work to improve the RR 1-h cycle on the GSD supercomputer has been complemented by collaborative work with EMC to facilitate a rapid transfer of code and scripts to the NCEP supercomputing environment. Toward that end, EMC scientist Yoshi Sato has generously provided his NAM retrospective infrastructure (code, scripts, etc.), which will provide a reference framework for the NCEP computing environment. Also, Several GSD scientists have obtained accounts on the new NCEP research computer (vapor), where initial NCEP testing of the RR will occur.

PROBLEMS: More reliable availability of Rapid Refresh PrepBUFR files awaits an implementation of a change to the GOES 1x1 data for the operational RUC at NCEP (see 5.4 text). After that change, the same PrepBUFR files can be used for the operational RUC and the experimental Rapid Refresh. This is important, since NCEP makes ftp availability only for operational PrepBUFR files.

Task 08.5.5 Develop, test, and implement improvements to the operational 3DVAR for WRF Rapid Refresh and WRF NAM.

GSD
Significant progress has been made in this area leading to an improved and more reliable RR 1-h cycle. A key development was the upgrade from the July 2007 version of GSI to the March 2008 (complete by Ming Hu with assistance from Dezso Devenyi and some consultation with EMC scientists). This work required 1) adapting the latest GSI version (March 31, 2008) to run on the GSD Linux supercomputers and 2) introducing the generalized cloud analysis into this GSI version, 3) completing work to make the normalized RH control variable (Q option 2) work correctly for the Eulerian mass (ARW) core option within GSI. This option significantly reduces the number and magnitude of negative water-vapor mixing ratio values coming out of the analysis. The GSI code at GSD has been placed under an SVN revision control system to help manage the various modifications between different GSI versions. This was especially helpful for maintaining a record of the changes needed for introducing the generalized cloud analysis package into the new GSI version. Four GSD scientists visited NCEP in mid June and discussed various aspects of the Rapid-Refresh application of GSI with EMC scientists, including receiving guidance on minor code structure modifications to make the general cloud analysis package suitable for inclusion in the NCEP repository version of GSI.

NCEP
Wan-Shu Wu adapted and tested the latest version of GSI in regional mode. The most important upgrade (besides some bug fixes) was a new version of the Community Radiative

Transfer Model (CRTM) used for the satellite radiance data. This upgrade changed the differences between the first guess and observations for all satellite instruments by changing the first guess, and consequently the analysis results. This upgrade is necessary in order to use the METOP data. This version was tested in a full resolution full domain parallel data assimilation system. Preliminary results show a small positive impact in all variables. She also worked on the low resolution system to generate an NDAS experiment that used the average of the global and regional forecasts as a first guess. The regional forecasts were the results of this partial cycle. The system is running midway through the month as a long test.

Shun Liu is continuing to test the 2008 version of radar radial wind QC package. When the package runs in interactive mode, there is no problem. However, when load-leveler jobs are submitted for parallel testing, the package just stopped running without giving any error information. After discussions with NSSL about current test results, NSSL will update the radial wind QC package. He has also collected radar wind observations and compared the observations with the model simulated radial wind. He found that there are some data QC problems when the radial wind magnitude is near zero after radial winds are QC'ed, and large biases were found when the observations are at low altitudes (low radar tilt angles). The GSI codes were modified to reject near-zero radial winds in assimilation, but a solution for the large radial wind bias at low altitudes is still under study. A WRF-launcher was also set up to examine the impact of radial winds on forecasts over the operational NAM domain.

The current radar processing codes deal only with Level II obs in Build 8 format. The 88D network is being upgraded and more and more sites are now sending Level II obs in Build 10 (super-res) format. Nearly a third of the sites over CONUS have been upgraded since April. These sites are being ingested but cannot be processed through the NSSL qc packages so the upgraded sites would have no Level II obs. Within the NAM 3DVAR, Level II.5 winds (superobs generated onsite and transmitted separately from Level II) would be used in the absence of Level II data. NCEP Central Operations (NCO) is working to get a UNIDATA code running which recombines the Build 10 data into Build 8 format.

Subtasks

08.5.5.2 Report on testing of 2DVAR WRF-GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 5-km or finer resolution. (31 Dec 07)

A new forward model to use the wind direction was introduced and tested in an effort to use the directional information of the low speed biased MESONET wind data. The tests showed that the solutions were unbounded (not converging) if the wind directions were assimilated without the wind speeds. It was also shown that adjusting the U/V observations proportionally, to maintain the first guess wind speed while fitting the observational wind direction, produced better 3dvar convergence than using the direction and the speed separately. **Complete.**

08.5.5.3 Further refine the radial velocity analysis component of GSI in response to model resolution changes. Examine data impact at higher assimilation frequencies and higher spatial resolutions. Consider issues on data quality, super-obbing, and optimal de-correlation scales. (31 Jan 08)

Radar wind observations have been compared to observations using model simulated radial wind, and there are problems when the radial wind magnitude is near zero after the radial wind QC while large biases are found for low-altitude observations. The GSI codes were modified to

reject near zero radial winds. With help from Brad Ferrier, the WRF-launcher was set up to run a case to examine the impact of radial wind on model forecasts. The result was encouraging in a full NAM domain test, with slight positive impacts on the forecast. More full NAM domain tests will be performed after the Level-II build 10 data become available. A cloud analysis package for reflectivity assimilation from GSD is in the process of being compiled on the NCEP IBM machine and will be modified so it can be tested with the WRF-NMM. (Liu)

08.5.5.5 Based on case-study testing and refinement of the research quality code, deliver result in an 'experimental' code for an upgrade package (e.g. improved use of WSR-88D data and satellite radiances and co-variances) to the WRF-GSI for FY2009 change package to the NAM-WRF. (31 Jul 08)

The adaptive tuning of observational error using the method by DesRoziers et al. (2001) was added as an option within the official GSI code, and is now available with each update of both the global and regional systems. The latest version of GSI were adapted and tested in regional mode with a real-time off line parallel. The most important upgrade (besides some bug fixes) was a new version of the community radiative transfer model (CRTM) used for the satellite radiance data. This upgrade changed the differences between the first guess and observations for all satellite instruments and consequently the analysis results. This upgrade was necessary in order to use the METOP data. The new version of the GSI with METOP data was tested in a full resolution full domain parallel data assimilation system. Preliminary results showed a small positive impact in all variables. TAMDAR, Canadian AMDAR and METOP (AMSUA, HIRS, MHS) radiances will be incorporated in the next package and are being used all the official NAM parallels. (Wu)

INTERFACE WITH OTHER ORGANIZATIONS: GSD visit with 4 scientists (Benjamin, Weygandt, Devenyi, Hu) to NCEP for 2 days in June – excellent discussions, planning on GSI, Rapid Refresh, and RUC.

Subtasks

08.5.5.1 31 December 2007 (GSD and CAPS) COMPLETE
Progress report on testing and evaluation of the generalized cloud/hydrometeor assimilation (including GOES cloud-top data and METAR cloud/visibility/weather data) within a cycled GSI on the full Rapid-Refresh domain.

Ming Hu has completed work to merge cloud analysis capability into latest regional GSI version. Also, an SVN (Subversion, a software change management tool) repository to systematically track the evolution of GSI versions and aid collaboration between GSI developers has been established.

08.5.5.2 31 December 2007 (NCEP and GSD)
Report on testing of 2DVAR GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 5-km or finer resolution.

08.5.5.3 31 January 2008 (NCEP and CAPS)
Further refine the radial velocity analysis component of GSI in response to model resolution changes. Examine data impact at higher assimilation frequencies and higher spatial resolutions. Consider issues on data quality, super-obbing, and optimal de-correlation scales.

08.5.5.4 28 February 2008 (GSD)

Report on statistical evaluation of Rapid Refresh forecasts initialized with the GSI, including examination of upper-level winds, surface fields, and precipitation.

The most recent statistical comparison of the RR 1-h cycle vs. the operational RUC upper-level winds (over the matched CONUS radiosondes stations) for a 6 week period from early March through late April indicates that for levels below ~400 mb, the wind RMS errors for the RR 1-h cycle are smaller than the current operational RUC for the +3h and +6h forecasts (very good news) and those for +9h and +12h forecast wind RMS errors were similar. As discussed earlier under Task 4, a serious cold bias near and at the surface in daytime temperature verification was traced to a bug in the soil moisture cycling within GSI.

08.5.5.5 31 July 2008 (NCEP)
Based on case-study testing and refinement of the research quality code, deliver result in an 'experimental' code for an upgrade package (e.g. improved use of WSR-88D data and satellite radiances and co-variances) to the WRF-GSI for FY2009 change package to the NAM-WRF.

Deliverables

08.5.5.E1 30 March 2008 **EMC** (Wu, Parrish, Pondeca, Liu)
Subject to NCEP Director approval implement upgrades to WRF-GSI used in NAM/NDAS.

CURRENT EFFORTS: The GSI changes implemented in the 31 March NAM upgrade included tightening the satellite QC over land, reordering of regional i/o arrays, direct assimilation of sensible temperatures without changing to virtual temperatures, extended MPI_IO capability to more data input, a new option to compute 10m wind factor using existing surface model, and the exclusion of ozone sensitivity from radiances in regional mode. It also included features in preparation for 4d-var like an extended assimilation time window, a redefined beginning of assimilation time, state and control vectors identified explicitly for 3d/4d-var, binned observations, and a control vector extended to 4 dimensions. An ESMF interface was added which is only functional in the presence of ESMF-related relevant libraries. A generalized vertical coordinate was added, and pressure is used instead of the log of pressure as an analysis variable. (Wu)

Work continues to improve the GSI tangent linear normal mode constraint (TLNMC). The problem has been that the existing version assumes constant coriolis parameter and map factor, which creates large scale errors that persist and grow with cycling. Significant effort was expended this quarter to blend the global TLNMC with the regional TLNMC but this approach in the end did not correct the problem. Another version of the TLNMC has been created based on Temperton, "Implicit Normal Mode Initialization" (MWR 1988). This involves an iterative solution of variable coefficient Helmholtz equations. However, this option is rather expensive and initial tests completed at the end of June indicate possible boundary condition problems. An alternative already available (from the attempt to blend global and regional TLNMC) is to just use the global TLNMC at sufficiently high resolution to resolve the analysis increment tendencies. This is too expensive for use in operations, but can provide a benchmark result for comparison with other schemes. (Parrish)

PLANNED EFFORTS: Continue work on the GSI tangent linear normal mode constraint. (Parrish)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

08.5.5.E3 30 September 2008 **EMC** (Liu)
Deliver enhancement package for radial velocity data analysis for further implementation testing.

CURRENT EFFORTS: Testing continues on the 2008 version of radar radial wind QC package. The package runs well in interactive mode, however, when load-leveler jobs are submitted for parallel testing the package stops running with no error information. After discussions with NSSL about current test results, NSSL will update the radial wind QC package. Radar wind observations are being collected and compared the observations with the model simulated radial wind. (Liu)

PLANNED EFFORTS: Test the 2008 version of radar radial wind QC package after the level-II build 10 data become available at NCEP. (Liu)

Deliverables

08.5.5.E1 30 March 2008 (NCEP)
Subject to NCEP Director approval implement upgrades to WRF-GSI used in NAM/NDAS.

08.5.5.E2 30 August 2008 (GSD)
Rapid Refresh code delivery date to NCEP/EMC for initial testing of RR version of GSI.

08.5.5.E3 30 September 2008 (NCEP and CAPS)
Deliver enhancement package for radial velocity data analysis for further implementation testing.

Task 08.5.6 Develop, test, and evaluate the performance of the nonhydrostatic Weather Research and Forecasting (WRF) modeling system.

NCAR/MMM

NCAR/MMM Contributions to FAA MDE PDT
Third Quarter FY08 Report

Task 08.5.6 Develop the nonhydrostatic Weather Research and Forecasting (WRF) Model

Task 08.5.6.6 Deliverable
08.5.6.E1 Conduct a WRF Users' Workshop and tutorial on the ARW core (NCAR) and a tutorial on the NMM core (DTC) for the user community
30 June 2008 (NCAR/MMM, DTC)

CURRENT EFFORTS: The WRF Users' Workshop deliverable was completed. NCAR hosted the 9th WRF Users' Workshop on June 23-27 at its Center Green facility in Boulder, CO. Working group meetings on June 23 were followed by general sessions on June 24-26. On June 27 there were instructional sessions on new model-related utilities. Approximately 250 registered for the workshop.

Earlier this quarter, NCAR personnel put on a WRF tutorial at the 2nd East Asia WRF Workshop and Tutorial, held April 7-12 at Seoul National University in Seoul, Korea. Approximately 50 people attended the tutorial.

NCAR/MMM is preparing for the next WRF tutorial July 14-24. This year the first week will offer the standard WRF material, while the second week will feature WRF-Var and WRF-Chem tutorials. The WRF tutorial maximum of 60 registrants has been reached. The tutorial will be given at NCAR.

PLANNED EFFORTS: Second WRF tutorial, July 14-24, 2008.

UPDATES TO SCHEDULE: None.

Task 08.5.6 Milestone

Incorporate physics improvements into the WRF software infrastructure 30 September 2008 (NCAR/MMM)

CURRENT EFFORTS: NCAR released WRF Version 3.0 in April. This major release offered many new physics and capabilities, including a global ARW capability, a variable time step, an implicit upper boundary gravity-wave absorbing layer, digital filtering initialization (DFI), merged WRF and WRF-Var, and WRF-Chem. The new physics packages added included Morrison microphysics, Goddard microphysics, a new Grell cumulus scheme, the Unified Noah LSM, the Asymmetric Convection Model 2 PBL scheme, and the Pleim-Xiu LSM. NCAR also released documentation in the form of a technical note for the ARW V3.0.

Jimy Dudhia of NCAR worked with Semion Sukoriansky (Ben Gurion University) to complete an initial version of a new PBL scheme, the QNSE (quasi-normal scale elimination) scheme. They also tested it in stable boundary layer cases in one-dimensional mode and in a real-data case. In microphysics work, Dudhia made fixes to the both Morrison and Goddard schemes to allow them to work with OpenMP parallelization. Impacting the CAM radiation scheme, Dudhia fixed a problem with aerosols in the initialization of non-zero aerosol distributions. In model dynamics options, the diffusion upper damping layer profile was changed to a cosine squared function.

Improvements to the nested RCM (NRCM) version of WRF were produced, and the NRCM was brought up to date with WRF V3.0. NCAR worked on a number of bug fixes to the WRF code. One addressed the staggering of frictional terms in the LES PBL option, while another was made in constants used by the WSM microphysics options. Fixes related to cloud-water mixing ratio in certain combinations of PBL and microphysics were also made.

PLANNED EFFORTS: Work will continue at NCAR through FY08, in collaboration with various members of the WRF community, on adding physics capabilities and improvements and making fixes where necessary.

UPDATES TO SCHEDULE: None.

Task 08.5.8: Improve physics in the WRF model, especially that bearing on prediction of aircraft icing.

GSD

The planned 2008 RUC change bundle continues in parallel testing at NCEP (see discussion under Task 08.5.1).

GSD and DTC

The test of the impact of changing the vertical distribution of vertical levels in the WRF-ARW was planned and executed in a collaborative effort between GSD and DTC. The particular impacts examined are on forecasts of 2-m temperature and dew point and 10-m wind, as well as low ceiling and visibility. Of particular concern are situations having low-level warm advection over snow-covered ground, a condition that has caused systematic daytime cold biases in 2-m temperature forecasts (subtask 1, below). The hypothesis is that higher resolution in the lowest ~500m above ground will improve these forecasts beyond what has already been achieved by alterations to the RUC LSM (subtask 1). Results are currently being evaluated and will bear on the final RR configuration of model levels near the surface.

Subtasks

08.5.8.1 31 Dec 2007 (GSD)

Begin systematic GSD evaluation of physics performance in GSD 1-hour RR cycle and address issues that arise in preparation for 2009 RR implementation. Particular attention will be given to microphysics and interactions between microphysics and the other parameterized physical processes.

Code modifications and testing have begun by GSD to call the microphysics parameterization in the WRF-RR-ARW less frequently, at multiples of the dynamic time step. This will save some run time (estimated at least 5%) and should give similar results to calling microphysics at every dynamics time step. This capability has never been available previously with the WRF-ARW dynamic core, although it has been with the WRF-NNM dynamic core.

Initial qualitative and quantitative evaluation of the RR cycled runs for physics effects have been underway in Q3. Too cold temperature forecasts under conditions of strong advection over snow cover of air with much above freezing temperatures have been addressed by restricting the rate of snowmelt based on empirical snowmelt studies. This allows more of the downward turbulent heat flux toward the surface from aloft to increase the temperature at the lowest model level, reducing the cold temperature bias. This change, introduced both into the RUC and the RUC LSM version used in the RR, is part of the RUC change package scheduled for implementation later this year (see Task 1).

08.5.8.3 May 2008: (NCAR)

May ‘08: Expand the current one moment microphysical scheme to two moments and add a variable for aerosol particles in order to improve forecasts of freezing drizzle and icing. Computer storage and run time considerations will be considered as a constraint on the development. (NCAR)

A two moment scheme for rain was completed and tested on various cases. This improved scheme is available to ESRL for testing in the WRF Rapid Refresh. We plan to participate in the WMO Cloud Modeling Workshop this July in order to compare our results with other schemes.

In addition, work continues on the freezing drizzle cases from Cleveland. A paper summarizing these results is in preparation. These cases will be used to evaluate the improvements to the microphysical scheme. Plans are being formulated regarding the implementation of an aerosol particle variable into the scheme. We are currently reviewing existing schemes and will coordinate the selection of the candidate scheme with ESRL.

Deliverables
08.5.8E3 May '08: Improved microphysics scheme to ESRL for evaluation in WRF Rapid Refresh. (NCAR)

Deliverables
08.5.8E3 May 2008: (COMPLETE)
Improved microphysics scheme to ESRL for evaluation in WRF Rapid Refresh. (NCAR)

08.5.8.5 31 Mar 2008 (DTC, GSD)
Report on GSD-DTC RR retrospective testing of land-surface model formulations for snow, and, as appropriate, other physics.

See above discussion on the retrospective test of vertical resolution in WRF. These tests were done with a restriction to the rate of snow melt recently introduced into the RUC LSM. Tests with this modification in RUC have shown improved (though still with some cold bias) spring-season daytime temperature forecasts over snow cover

Task 08.5.15: Develop improved methods of cloud and moisture analysis for use in the WRF Modeling System.

Subtasks

08.5.15.1 31 October 2007 (NCEP)
Based on parallel testing and refinement of the experimental code, deliver the 'pre-implementation' code to NCO including improved diabatic initialization (e.g. nudging to analyzed precipitation and GOES cloud-top) for the March 2008 NAM change package.

08.5.15.2 30 Jan 2008 (GSD) COMPLETE
Develop and evaluate performance of diabatic digital filter initialization (DDFI) in the RR WRF model without use of radar data

Although this was reported as complete in previous months, we note that this work (go to paper 1.3) was described in a paper by Steven Peckham, Tanya Smirnova, Stan Benjamin, John Brown (all from ESRL/GSD), and NCAR/MMM colleagues at the 9th Annual WRF Workshop in late June. An issue with the DDFI occasionally causing the RR 1-h cycle to crash was recently isolated and resolved, by shortening the time-step in the backward integration

08.5.15.3 30 March 2008 (GSD and CAPS)
Further refine the generalized cloud analysis for the target RR resolution, model physics scheme and use of additional data. Perform forecast test evaluations to document the impact of the cloud analysis refinements.
Ming Hu introduced the generalized cloud analysis into the latest GSI version (March 31, 2008) and has conducted systematic tests within the RR retrospective test environment. This version is now running in the RR 1-h cycle at GSD.

08.5.15.4 30 May 2008 (NCEP)
Based on development efforts, deliver 'research quality' diabatic initialization upgrades (e.g. initial use of Level II reflectivity) for consideration in the March 2009 change package for NAM.

08.5.15.5 30 Mar 2008 (GSD)
Include radar reflectivity-based latent heating within diabatic digital filter initialization (DDFI) in the RR WRF model.

The components for RR reflectivity assimilation are in place with the release of WRF version 3 including diabatic digital filter initialization and cloud analysis capability within GSI (upgraded to latest GSI version during the quarter). Testing and refinement of DDFI within 1-h cycle and of various cloud analysis options (including reflectivity assimilation) continue. An option to use a shorter time step during the DFI is being developed to prevent occasional crashes during the backward portion of the DFI (noted in Task 4).

08.5.15.6 30 July 2008 (NCEP)
Based on case-study testing and refinement of the research quality code, an 'experimental' WRF code is delivered with diabatic initialization upgrades (e.g. initial use of Level II reflectivity) for the March 2008 change package for NAM.

Deliverables

08.5.15.E1 30 March 2008 (NCEP)
Subject to NCEP Director approval, the WRF-NMM code with upgraded diabatic initialization capability (e.g. nudging to analyzed precipitation and GOES cloud-top) becomes operational at NCEP as part of the March 2008 change package to NAM.

08.5.15.E2 30 Aug 2008 (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.

Task 08.5.17 Infrastructure support for running operational WRF model in RR, North American Mesoscale and HiResWindow modes at NCEP.

NCEP

Subtasks

08.5.17.1 Maintain four-per-day North American Mesoscale runs and provide SAV and AIV guidance.

The assimilation of AIRS satellite radiance data in the NDAS/NAM GSI analysis, which was supposed to be implemented with the 31 March 2008 NAM change package, was not done on that date due to an error in the scripts provided to NCO. This error was fixed on 22 April 2008.

Parallel testing of the components of the Fall 2008 NAM change package is underway. Modifications being tested include changes to the GSI analysis (latest code release, assimilation of TAMDAR/AMDAR aircraft data and METOP-A radiance data), the NDAS (so-called "partial

cycling" option in which the GDAS atmospheric states are used as first guess to the NDAS analysis at the start of the 12-h NDAS run) and the WRF-NMM forecast model (modifications to the shallow convection parameterization, radiative response to clouds and the land-sfc physics). (Rogers)

A new radar reflectivity QC and SRC package was implemented on June 17. With this implementation, an SRC tank will be generated in operations and the Level II reflectivity mosaic package can generate a 3D mosaic from this SRC tank for testing the RUC upgrade. The 3D reflectivity mosaic package has also been JIFed and this package is under parallel testing at NCO. (Liu)

08.5.17.2 Maintain four-per-day HiRes Window runs and provide SAV and AIV guidance.

NCEP maintains four-per-day runs of HiResWindow - making runs of both WRF-NMM at 4 km and of WRF-ARW at 5 km for large domains covering Alaska (18z), Western& Central CONUS (06z) and Eastern & Central CONUS (00z & 12z) plus small domains for Hawaii (00z & 12z) and Puerto Rico (06z & 18z). (Matt Pyle and NCO)

During this period, Matt Pyle completed a minor upgrade to the HiResWindow runs. This upgrade involved a) coordinated changes with NCO to speed-up product generation within HiResWindow, b) changes to the post-processing code to properly generate precipitation type and total cloud field percentage within the WRF-ARW and c) changes to the product generator to specify the GRIB model/process id for NMM to 112 and for ARW to 116 so the two models' output could be distinguished. Because HiResWindows don't run when HWRF runs, Matt continues to make his once daily run at 00z for SPC's use and to provide BUFR soundings which are not yet included in HiResWindow runs in operations.

In addition, NCEP maintains four-per-day runs of six WRF-based members (3 running NMM and 3 running ARW) of the Short Range Ensemble Forecast (SREF) system with aviation guidance available from http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html which now includes Alaska and Hawaii (eastern Pacific). (EMC and NCO)

08.5.17.3 Provide vendors with gridded NAM model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway.

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). (EMC Team and NCO)

07.5.17.4 Provide full grids from NAM, and the HiRes Window on NCEP and NWS/OPS servers.

NCEP maintained real-time availability of full resolution gridded data from the operational 4/day NAM and the HiResWindow (HRW) suite of WRF-NMM and WRF-ARW runs via anonymous ftp access via the NCEP server site ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com. For NAM, this includes hourly BUFR soundings and output grids which undergo no interpolation and, as such, are on the models' computational grids (so-called native-native grids). HRW run output is mapped to 5 km output grids packed into GRIB2 format, see http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml ; and is now being distributed over AWIPS SBN and NOAAPORT. A limited set of fields from the NAM, HRW runs (and other

NCEP models) can also be viewed at http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/ (EMC Team and NCO)

08.5.17.5 Maintain access to model verification data. (see subtask report under Task 08.5.1.4)

08.5.17.6 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.

Deliverables

08.5.17.E1 1 October 2007 - 30 September 2008 **EMC** (Parrish, Derber, Wu, Keyser) Perform observation ingest, quality control and preparation in support of the operational North American Mesoscale WRF runs.

CURRENT EFFORTS: There appears to be an improvement in the receipt of some of the Alaskan radiosonde data as sites such as Shemya (70414) are now usually available before the NAM data cutoff. NCEP contacted Alaska in late winter about this issue, but there is still a need for some sites to move their launch time so that their data can be received in time for the NAM-GSI. Since early May, AIRS radiance data counts have been lower than average due to late posting of files associated with hardware issues with NESDIS' AIRS processing machines. This should improve later this year when NESDIS ports their AIRS system to new Linux machines. In mid-April AIRS AMSU-A radiances stopped being available to the NAM-GSI when AMSU-A channel 4 went bad. Efforts are underway to modify the GSI to allow the remaining AMSU-A channel data to be used. The following data types are now monitored by the NAM-GSI: RASS virtual temperature profiles, QuikSCAT 0.5 deg. scatterometer wind superobs, TAMDAR (via ESRL MADIS feed) and Canadian AMDAR aircraft temperature and wind. Efforts to speed up the dump processing of NEXRAD Level II data are being explored. Cooperative Agency Profiler (CAP) and RASS data are not yet available through an alternate ESRL MADIS feed. (Keyser)

Testing continues on the 2008 version of radar radial wind QC package. The package runs well in interactive mode, however, when load-leveler jobs are submitted for parallel testing the package stops running with no error information. After discussions with NSSL about current test results, NSSL will update the radial wind QC package. Radar wind observations are being collected and compared the observations with the model simulated radial wind. (Liu)

PLANNED EFFORTS: Complete impact tests in NAM for several new data types: TAMDAR (direct from AirDAT vs. current ERSL MADIS feed, former to eventually include Alaskan PenAir data) and Canadian AMDAR aircraft; QuikSCAT 0.5 deg. scatterometer wind superobs (eventually using "new science" QuikSCAT); mesonet mass and roadway data, and new mesonet data feeds (including "hydro", "snow", modernized COOP, UrbaNet and late-arriving mesonet data); METOP-2 1B HIRS-4, AMSU-A and MHS radiances; aircraft moisture; RASS temperatures; JMA, European and CAP profiler winds; 3.9 micron and visible satellite winds; WindSat scatterometer wind data; GPS radio occultation data; and METEOSAT-9 IR and visible satellite winds. Coordinate with the field to continue to speed up Alaskan RAOB processing so that they arrive in time for the NAM dumps. Attempt to retrieve as much data as possible over Alaska (especially mesonet, aircraft and coastal surface). Add GSI events to the NAM PREPBUFR files. In the GSI, make use of the actual or estimated anemometer, barometer and thermometer heights on ships. Generate and QC high vertical-resolution aircraft profile data near airports. (Keyser)

The 2008 version of radar radial wind QC package will be tested after the level-II build 10 data become available at NCEP. (Liu)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: GSD & NCO.

UPDATES TO SCHEDULE:

08.5.17.E2 1 October 2007 - 30 September 2008 **EMC** (Parrish, Derber, Wu, Keyser)
As requested by other PDT's, incorporate new AIV calculations into Operational WRF Model post-processor and product generator.

CURRENT EFFORTS: No requests were made by other PDTs during this period.

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None

INTERFACE WITH OTHER ORGANIZATIONS: NESDIS, GSD & NCO

UPDATES TO SCHEDULE: None

Task 08.5.19: Develop ability to assimilate WSR-88D radial velocity and reflectivity data through GSI and Rapid Refresh toward High-Resolution Rapid Refresh.

GSD -
A modification was made in early June to the HRRR initialization from the RUC, now directly using the DFI-initialized grids. This change has significantly improved the effective radar reflectivity assimilation for the HRRR. This was possible only after a redesign of the RUC post-processing and scripts (see 5.19.E1 text). A set of cases was first tested by GSD with this change. A comparison of 1h HRRR reflectivity forecasts before (lower right) and after (upper right) is shown below. Subsequently, this change was implemented into the real-time HRRR processing.

Currently, the RUC-DFI data is only available from the GSD "development-13" experimental RUC, not the "backup-13" RUC generally made available to outside users. A transfer to the backup RUC has started but not completed for the code and script changes required for output of the RUC-DFI grids (also valid at 00h but requiring a number of changes to avoid confusion with the different RUC analysis grids, also valid at 00h).

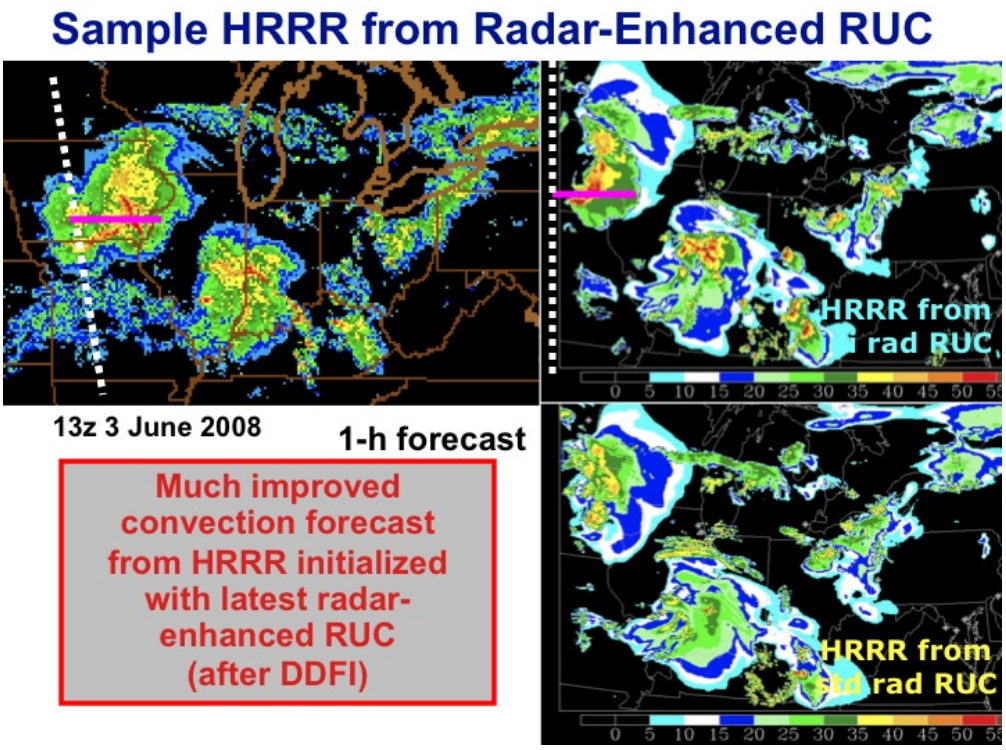

Fig 5.24.1. 1-h HRRR reflectivity forecasts compared to observed, all valid 13z 3 June 2008. From standard radar-DFI-RUC initial conditions (lower right), and new post-DFI radar-RUC initial conditions (upper right).

Subtasks

08.5.19.1 30 May 2008 (GSD, NCAR/RAL, CAPS)
Select initial case studies from 2007 and 2008 for 3-km HRRR data assimilation case studies.

Primary case study examined so far is 10 July 2007. In addition, GSD has conducted some exploratory HRRR re-runs for a few of the several interesting cases that occurred during the first week of June 2008.

08.5.19.2 31 August 2008 NCAR-RAL
Run case studies using 3km HRRR using different RUC-based initial conditions

- Run case studies from spring/summer 2008 using 3-km HRRR on GSD jet computer using different RUC-based initial conditions
  - Operational RUC (without radar reflectivity assimilation)
  - Radar-DFI enhanced RUC (probably from GSD)
  - Radar-DFI RUC using unsmoothed latent heating
  - Test of 3-km radar-DFI when code ready from GSD
- Use Northeast US Corridor domain for HRRR runs as used at GSD.
- Provide detailed report on case studies by 15 Sept 08

08.5.19.3 31 August 2008 (CAPS)
Complete 3-km GSI data assimilation experiments for potential application within the HRRR assimilating radial wind. Evaluate impact using 3-km HRRR-WRF model configuration as used

by GSD.

At CAPS, Assimilation and forecast experiments with tropical cyclone Erin were performed with WRF/ARW-GSI system. An ARPS radar data processing package was adopted to prepare radial velocity data for use directly in GSI. A verification package based on WRF2ARPS and ARPS Radar emulator RADAREMUL is adapted to allow for direct verification of model output against observed radial velocity and reflectivity.

Experiments were first performed to determine the effect of spatial correlation scales within GSI for radial velocity data on the wind analysis. Subsequently, radar radial velocity and reflectivity data from multiple WSR-88D radars are assimilated using GSI together with the generalized cloud analysis package, at 30 min intervals for up to 6 hours. Two sets of experiments were performed at 3-km grid resolution. One evaluates the impact of radial velocity alone and one evaluates the combined impact of radial velocity and reflectivity. NAM analysis grids were used for the analysis background at the initial time and for lateral boundary conditions.

Experiments with 30-min cycles are updated to 5.5 hours. The results show that the radar data improve the forecast of the tropical cyclone vortex as well as embedded spiral structures of precipitation bands. The vortex intensity is increased and the spiral structures are better captured with more cycles. The cloud analysis with reflectivity data helps establish the spiral rain bands. Verifying against the observed radial velocity, the structure of the simulated radial velocity is closer to the observations. The averaged correlation coefficient between the simulated and observed radial velocity over 14 elevations can reach 0.87. A comparison between the simulated and observed radial velocity fields at the 0.48 degree elevation is shown in the following figure. The May report of CAPS showed a comparison between model-predicted and observed reflectivity fields. The model is able to capture nicely the spiral rainband associated with the cyclone.

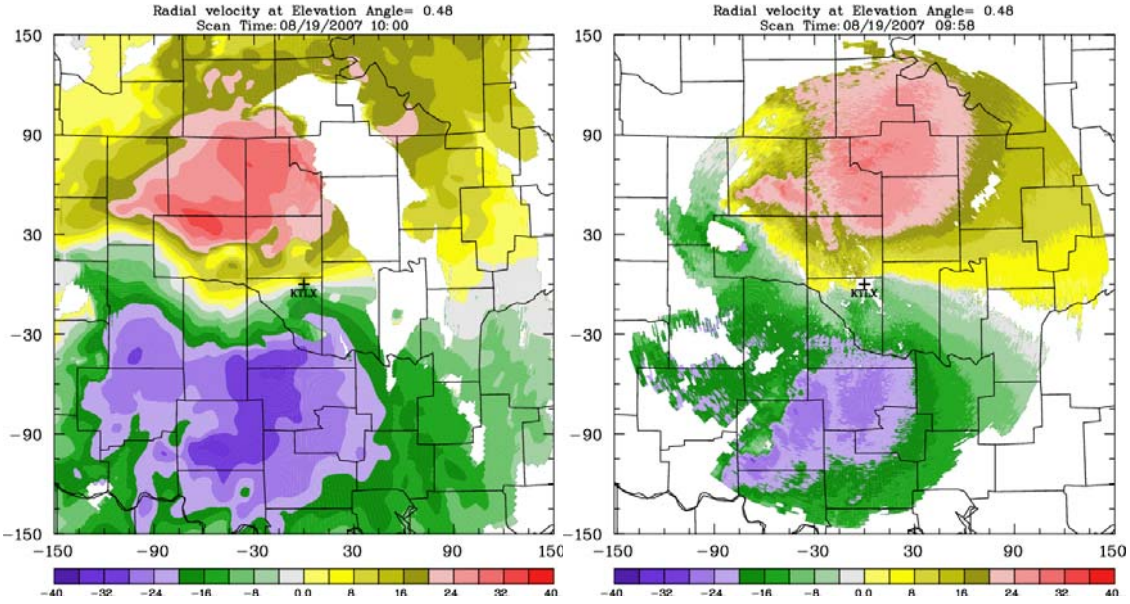

Fig.1 The simulated radial velocity at 1000 UTC August 19, 2007 viewed from Oklahoma City radar (left) and observed radial velocity at 0958 UTC August 19,2007 (right) at the lowest elevation (0.48°). Here the simulated radial velocity is calculated from the 4.5-hour forecast starting from the eleventh assimilation cycle in which both vr data and cloud analysis were

used.

Assimilation cycles up to 6 hours will be completed and more experiments with reflectivity and/or radial velocity data only will be performed. The forecast results will be further verified quantitatively. Later, we will test RUC grids for initial analysis background and lateral boundary conditions, to be more consistent with the target HRRR configurations. Efforts will also be made to port and implement the latest version of GSI and WRF from GSI at national supercomputing center.

A new visiting scientist, Yi Yang, started working at CAPS on July 7 on the FAA project.

Assistance from Shun Liu (NCEP) and Ming Hu (GSD/DTC) continues to be greatly appreciated.

The CAPS received $70,000 FY2007 funds in August 2007. In June, about $5000 (loaded) was spent on salary, with $15,420.0 remaining. The FY2008 funds have not arrived yet and a delay until October 2008 is expected because of continued negotiation for a MOU between FAA and NSSL.

08.5.19.4 30 Sept 2008 (GSD)

- Develop new stand-alone 3-km processor from raw 3-d reflectivity tiles to 3-km HRRR domain, similar to software developed for 13-km RUC
- Develop and test code at 3-km for assimilation of radar reflectivity using observation-based specification of latent heating within WRF-DFI.

Deliverable

08.5.19.E1 GSD, CAPS, NCAR-RAL 30 Sept 2008
Complete improved version of 13km/3km radar assimilation techniques for demonstration in FY09 exercises.

In the spring, GSD modified several components in the RUC processing to allow direct output and post-processing of DFI-initialized grids. While we do not advocate use of these grids as RUC analyzed fields for aviation and other user applications, it did allow tests to initialize the HRRR model with the DFI grids including the latest radar reflectivity instead of the RUC analyzed grids, which effectively does not. These tests were finally performed in early June and showed a significant improvement in 1h-6h forecasts in 3 different case studies. Based on these results, this variation in the HRRR (using RUC-DFI-radar initial conditions immediately after DFI) was implemented into the real-time HRRR runs. Thus, this new modification is now affecting HRRR grids ftp'd to NCAR and MIT/LL.

VIL output at 15-min frequency is now available from a real-time HRRR web site at http://ruc.noaa.gov/hrrr/vil. This is the first time that any RUC/RR/HRRR graphical products have been available at a 15-min output frequency.

Task 08.5.20: Develop ensemble-based probabilistic products for aviation users.
UNFUNDED

Task 08.5.24

Task 5.24 specifically treats development and testing of the 3-km HRRR model itself. Development and testing work on assimilation of radar data at the 3-km scale is under Task 5.19.

Subtasks
08.5.24.1 30 September 2008 (GSD, NCAR/RAL, NCAR/MMM)
Conduct HRRR summer exercise. Collaborate on analysis on HRRR tests. Draft and deliver summary of results.

Real-time ftp transfer of HRRR grids to NCAR and MIT/LL since mid April. VIL fields with 15-min output added to HRRR grids and also ftp'd to NCAR (accomplished in mid-May). Modification made to HRRR scripts to speed up processing time by 1 hour, resulting in improved HRRR guidance. In order to do this, the backup RUC was changed to run out to 13h (instead of 12h) on an hourly basis, so that each HRRR run can be started as soon as the new RUC analysis (or post-DFI) file is available, using lateral boundary conditions (BCs) from the *previous* RUC forecast. This trade-off in using older (less accurate) BCs was considered acceptable to get the new HRRR forecast out 45-60 min faster.

GSD interacts many times weekly with MIT/LL and NCAR on the HRRR contribution to the CoSPA real-time 0-6h forecasts. GSD keeps the CoSPA partners abreast of changes in HRRR processing and computer availability.

GSD worked carefully during Q3, including in June, with its own IT specialists to improve the reliability of the HRRR. Bad nodes and interconnects on the GSD supercomputer were identified and removed from the system.

Additional improvement to speed up processing of RUC radar assimilation fields used to drive the HRRR, resulting in further substantial improvement in the HRRR. Real-time verification of HRRR reflectivity forecasts is ongoing. Real-time monitoring of HRRR forecasts has revealed some issues related to the limited HRRR domain size and propagation of convective systems into the HRRR domain.

5.24.2 NCAR-MMM
Evaluate HRRR forecasts with different initializations using GSD HRRR runs

- Compare 3-km HRRR forecasts using initial conditions from 2 versions of the RUC: radar-enhanced RUC from GSD, no-radar RUC from NCEP.
- All HRRR runs performed at GSD, from spring/summer 2008
- Perform analysis of evolution of convective storm mode during first 1-3 hours of model transition from effective resolution 13-km to actual 3-km resolution.

Deliverables

08.5.24.E1 30 August 2008 (NOAA/ESRL/GSD)
Complete FY08 test with small Northeast U.S. domain with 3-km High-Resolution Rapid Refresh running every 1 h.

- Conduct real-time summer 2008 HRRR forecasts using 3-km WRF initialized with radar-enhanced RUC over Northeast US Corridor domain
- Coordinate with other AWRP users and other collaborators
- Provide project management
- Lead writing of report on summer 2008 HRRR experiments

(See subtask 08.5.24.1)

08.5.24.E2 30 September 2008 (NCAR/RAP and NCAR/MMM)
Collaborate with GSD on analysis of results. Draft and deliver summary of results. Evaluate techniques for convection-resolving (e.g., 3-km) forecasting by the Rapid Refresh (ARW core) in preparation for development of high-resolution RR (HRRR). Perform and evaluate RR convection-resolving forecasts on test cases using radar-enhanced RUC or Rapid Refresh grids from GSD to identify strengths and weakness of model at high resolution. Evaluate effects of transition from 13-km parameterized convection to 3-km resolved convection in 0-3h forecasts and in lateral boundary conditions from the RUC or Rapid Refresh using the Grell-Devenyi parameterization.