MODEL DEVELOPMENT AND ENHANCEMENT RESEARCH TEAM

Monthly Report for May 2008
Submitted 15 June 2008

With contributions from Geoff DiMego and Mary Hart (NCEP/EMC);
Stan Benjamin, John Brown, Steve Weygandt (NOAA/ESRL/GSD);
Jordan Powers, Roy Rasmussen (NCAR);
Ming Xue (OU/CAPS)
(Compiled and edited by S. Benjamin and B. Johnson)

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 Part of Grell-Devenyi convection change withdrawn per March-May testing at GSD and NCEP and now producing better upper-level wind forecasts.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 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.

- Web-page comparing cold start and hourly cycled RR at http://rapidrefresh.noaa.gov .
- One-hour cycle testing using WRF version 3.0 and latest regional GSI version (March 2008) has been done with a new retrospective cycle period, and will soon be introduced to the real-time RR 1h cycle/forecasts.

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

- Rapid Refresh specific changes (mainly cloud/hydrometeor assimilation) incorporated into latest GSI version from NCEP (March 31, 2008)
- 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) has been tested in a 1-h cycle with the Rapid Refresh.

Task 08.5.24: Begin 3km High-Resolution Rapid Refresh testing

- HRRR changes in last month: Now running 1h earlier, also using DFI-output (showing large improvement), and being moved to different queue for better reliability.

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: 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), and implementation will likely occur in the next 2 weeks.

RUC upgrade for model, assimilation, and post-processing
After close scrutiny and testing over April and early May, GSD and EMC decided to rescind some of the Grell-Devenyi changes (specifically, using non-local subsidence), 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. The non-local subsidence design is still a good idea, and a corrected version of it will likely be used in the WRF model 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 last month's report 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, but that will not occur until fall.

Current planned implementation date – September 2008

NCEP

Dennis Keyser reports that the NCEP BUFR library was updated by NCEP/NCO on 28 May (several upgrades and enhancements were added). Tests of both "new science" GOES 1x1 field-of-view (f-o-v) cloud data and GOES 1x1 f-o-v PW data (replacing current 5x5 f-o-v

products) are underway. A change package which includes the GOES and the establishment of a Rapid Refresh data processing system has been submitted to NCEP/NCO and is waiting for implementation possibly in late June. Parallel testing of TAMDAR and Canadian AMDAR aircraft temperature and wind data is also currently underway. Cooperative Agency Profiler (CAP) and RASS data are not yet available through an alternate ESRL MADIS feed.

Geoff Manikin reports that last fall 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 has 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 of the snow component in the land-surface model to decrease excessively cold 2-meter temperatures over fresh snow at night, and a modification of the convective scheme to decrease widespread coverage of light precipitation. Daily comparisons of operational and parallel forecasts continue, and statistical evaluation of the new version of the model is underway. Implementation of this package is scheduled for early fall 2008.

In addition, an upgrade of the operational RUC is being prepared to switch to reading 1x1 GOES precipitable water radiances, as NESDIS is looking to shut off the current 5x5 data feed. The analysis code must be updated to handle a larger volume of GOES precipitable water data. An implementation has been coordinated with Dennis Keyser (see above).

Finally, SPC forecasters alerted EMC (in April) to a problem 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 initially appeared to be related to over fitting GPS precipitable water observations. However, no single, isolated code change eligible for a quicker crisis change has yet found to be effective (see GSD description above). Thus, the combined analysis and model code changes in the parallel RUC avoid the problems seen in the operational code, so while it is desirable to find a short-term fix the best option may be to wait for implementation of the parallel version in a few months.

Other users noticed a problem with a slight shift in the model coastline along the Great Lakes and oceans relative to the truth (also see GSD section above), and it was determined that the model topography and land-use files are indeed shifted slightly from truth. Replacement files were implemented on 11 June.

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

ESRL/GSD

Work continued to finalize the upgrade for 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). This version includes improvements to parameterizations used for the Rapid Refresh (including Grell-Devenyi convection, Thompson microphysics, and RUC-Smirnova land-surface model).

(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 filter initialization. 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 has been 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 Linux cluster and inclusion of cloud analysis.

The fully updated RR system (with updated GSI and WRF) is undergoing final checkout using the recently developed RR retrospective cycle capability and will replace the current real-time cycle at GSD shortly. The ~10 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.

PLANNED EFFORTS: Replace current real-time RR 1-h cycle at GSD with an upgraded version that uses the latest WRF model (version 3) and latest regional GSI (March 31 version), with modification to include the generalized cloud analysis package.

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 JIF'ed 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.

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. We are waiting for a more reliable 1-h cycle (see 08.5.4 text above) before encouraging full ftp'ing of experimental RR grids. Two efforts to improve reliability of RR PrepBUFR files from NCEP and set aside processors on the GSD supercomputer are now being implemented.

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.

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.

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 now has FIM running within a very rudimentary ESMF version at GSD, and will convert this to run under NCEP's version of ESMF version 3.1 as soon as it becomes available from NCEP. 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 WRF post 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. 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, quantitative statistical validation is beginning. These statistics will become more meaningful once conversion of the 1-h cycle to run using WRF version 3 is complete (see subtask 5.4.1). 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.

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.

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.

GSD

Ming Hu completed work to 1) adapt the latest GSI version (March 31, 2008) to run on the GSD Linux supercomputers and 2) introduce the generalized cloud analysis into this GSI version. Dezso Devenyi completed work to make the normalized RH control variable (Q option 2) work correctly for the Eulerian mass (ARW) core option within GSI. The GSI code at GSD has been placed under an SVN revision control system to help manage the various modifications between different GSI versions.

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.

(Reported in May, but still notable). The most recent statistical comparison of the RR 1-h cycle vs. the operational RUC upper-level winds (over the matched CONUS radiosonde 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. Near-surface temperature verification shows some significant biases in the cycled RR, and we hope to solve this problem in June, since we are fairly confident this is not a fundamental problem in the WRF-ARW or RR physics code.

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 (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.

08.5.6 NCAR/MMM*
NCAR has been organizing with 9th WRF Users' Workshop, scheduled for June 23-27. The first day will feature WRF working group meetings, while the body of the workshop will be in the following three days. The final day will offer mini-tutorials in selected WRF-related capabilities. The workshop will be held at NCAR's Center Green facility in Boulder.

NCAR has been working on an updated ARW technical note, in following the release of WRF Version 3 in April. This will describe the ARW Version 3, and it is scheduled to be released during the 9th WRF Users' Workshop.

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 performed testing of it in stable boundary layer cases in one-dimensional mode. In microphysics work, Dudhia made fixes to the 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.

Lastly, a number of improvements to the nested RCM (NRCM) version of WRF were produced, and the NRCM was brought up to date wtih V3.0. The enhancements include: adding accumulated radiation and flux diagnostics and fixing their functionality for V3.0; improving accumulations of precipitation and of radiation fluxes for long-period simulations by adding bucket arrays to help prevent round-off effects; incorporating diurnal sea-surface temperature changes; adding a time-varying CO2 capability; and adding a time-varying deep soil temperature capability.

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 (planning for which was noted in the MDE RT report for April) of the impact of changing the vertical distribution of vertical levels in the WRF-ARW is underway in a collaborative effort between GSD and DTC. The particular impacts to be 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).

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.

Initial qualitative and quantitative evaluation of the RR cycled runs is underway, revealing specific issues that are being addressed. 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)

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 in was completed and tested on various cases. A number of bugs were identified and fixed. 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.

Deliverables

08.5.8E3 May 2008: (COMPLETE)

Improved microphysics scheme to ESRL for evaluation in WRF Rapid Refresh. (NCAR)

See text above under 08.5.8.3.

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 underway of vertical resolution in WRF. These tests will be 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 will be described in a paper by Steven Peckham, Tanya Smirnova, Stan Benjamin, John Brown (all from ESRL/GSD), and NCAR/MMM colleagues at the WRF Workshop in late June.

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.

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 (currently being upgraded to latest GSI version). Testing and refinement of DDFI within 1-h cycle and of various cloud analysis options (including reflectivity assimilation) continue.

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

Dennis Keyser reports that the NCEP BUFR library was updated by NCEP/NCO on 28 May (several upgrades and enhancements were added). There appears to be an improvement in the receipt of some of the Alaskan radiosonde data as sites like 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. During the past month, AIRS radiance data counts have been lower than average due to hardware issues with NESDIS' server. This should be corrected in June when NESDIS ports their AIRS system to Linux machines. AIRS AMSU-A radiances have not been available to the NAM-GSI since mid-April when AMSU-A channel 4 went bad. Efforts are underway 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.

Dave Parrish reports that his attempt was unsuccessful in trying to improve the GSI tangent linear normal mode constraint (TLNMC) for regional application by blending a large-scale part from the global TLNMC with small scales with the existing regional TLNMC. The assumption of constant f and map factor that was made for the regional version has a significant impact regardless of scale. This was verified by using the same small-scale test function for regional and global TLNMC and comparing the balance correction results. The patterns agree qualitatively, but the amplitude of the wind, for example, is still incorrect for the regional solution compared to the global, which is known to be correct. A new version of the regional TLNMC based on Temperton, "Implicit Normal Mode Initialization" (MWR 1988) is now under development. This was not tried before because it involves an iterative solution of variable coefficient Helmholtz equations and seemed too difficult to implement. But by using an extension to a doubly periodic domain, it turns out that these equations can be solved efficiently using FFTs. Because the global/regional blending strategy involved the development of a smooth extension of fields from regional to global domains, very similar software can be used for the double periodic extension. This has been completed and initial testing of the Helmholtz solver indicates that it may be practical to use.

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.

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 (over Oklahoma in August 2007) continued. 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 are being performed at 3-km grid resolution. One evaluates the impact of radial velocity alone and evaluates the combined impact of radial velocity and reflectivity.

Initial results with 30-min cycles for up to 4.5 hours 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. More assimilation cycles will be completed and experiments with reflectivity or radial velocity data only will be performed. The forecast results will be verification in more details and quantitatively, including direct verification against radial velocity and reflectivity observations. Our current experiments use NAM 12-km gridded data as the initial analysis background and boundary condition. Later, we will test RUC grids for such purposes, to be more consistent with the target HRRR configurations. The following figure compares the 5.5-hour 3-km WRF ARW forecast against observed reflectivity. Nine 30-min assimilation cycles were used. The spiral rain band and the ‘eye’ structure of the tropical cyclone are captured in the prediction (left).

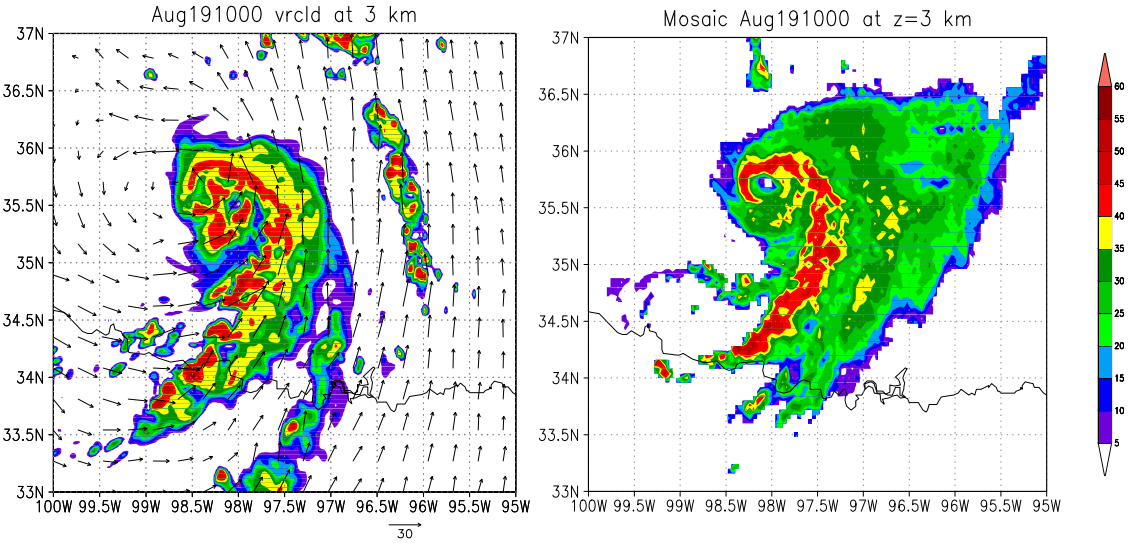

Fig.5.19.1. The 5.5-hour forecast field with the ninth cycle via cloud analysis (left) and NSSL Mosaic reflectivity (right) at 10UTC 19 August 2007.

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

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.

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.

A modification was made in early June to the HRRR initialization from the RUC, now directly using the DFI-initialized grids. This was possible only after a redesign of the RUC post-processing and scripts (see 5.19.E1 text). A comparison of 1h HRRR reflectivity forecasts before (lower right) and after (upper right) is shown below.

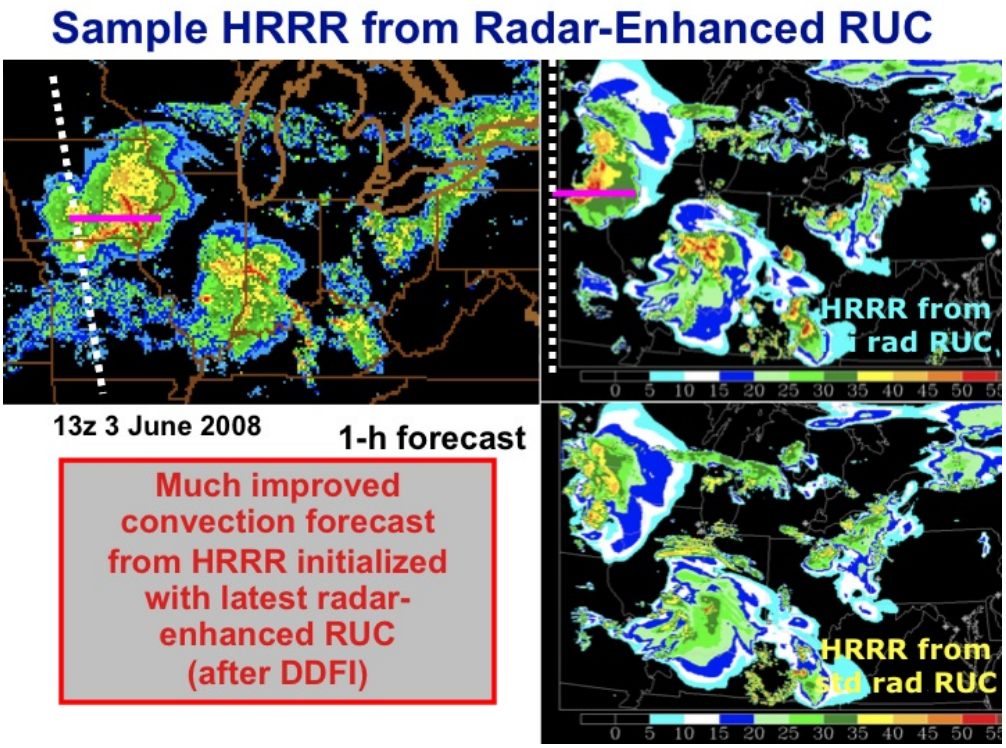

Fig 5.24.1. 1-h HRRR reflectivity forecasts compared to observed, all valid 13z 3 June 2008. From standard radar-DFI-RUC initial conditions (lower right), and new post-DFI radar-RUC initial conditions (upper right).

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. 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.

*Revised 06/17/2008 (per Jordan Powers – NCAR-MMM)