Monthly Report for November 2008

FY 2009

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With contributions from Geoff DiMego and Mary Hart (NCEP/EMC);

Stan Benjamin, John Brown, Steve Weygandt (NOAA/ESRL/GSD);

Jordan Powers, Roy Rasmussen (NCAR);

And Ming Xue (OU/CAPS)

(Compiled and edited by S. Benjamin and B. Johnson)

Executive Summary

Task 09.5.1: Infrastructure support related to operational running of the RUC and NAM operational modeling systems.

- **RUC upgrade implementation at NCEP occurred on Monday 17 Nov 2008.**
  - RUC upgrade package code includes (radar reflectivity assimilation, longwave radiation, Grell/Devenyi upgrade). Improved precipitation, near-surface forecasts TAMDAR to be added likely on Tues 16 Dec 2008.
  - http://ruc.noaa.gov/ruc13_docs/RUC-upgrade.impl-prebrief.4nov08.pdf - RUC upgrade pre-implementation briefing includes new case studies and comparisons between old and new RUC versions.

Task 09.5.4 Develop, test, and implement Rapid Refresh configuration of the WRF modeling system.

- Two real-time parallel RR cycles running at GSD, currently being used to evaluate impact of radar DDFI-based radar assimilation

Task 09.5.5: Develop, test, and implement 3DVARs for RR and NAM

- Ongoing work to add inclusion of height difference (actual vs. model terrain) in GSI surface observation assimilation

Task 09.5.15: Develop, test, and implement 3DVARs for RR and NAM

- Evaluation of RR cloud analysis and comparison against RUC cloud analysis continuing

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

- Extensive verification and evaluation of summer 2008 HRRR forecasts completed and presented

RUC/RR progress/plan update at NCEP:

- NCEP presentation on RUC/Rapid Refresh/HRRR on Tues 9 Dec 2008 – Stan Benjamin and Steve Weygandt, Geoff DiMego on NCEP mesoscale plans (other than RUC/RR) See http://www.emc.ncep.noaa.gov/annualreviews/2008Review/index.html ; look up RUC/RR status for Tuesday. (Presentation also available by Geoff DiMego on non-RUC/RR mesoscale modeling

Task 09.5.1 Infrastructure Support Related to Operational running of the non-WRF Rapid Update Cycle System in NCEP Operations

GSD

Implementation of RUC upgrade occurred on Monday 17 Nov 2008. All changes implemented except that access to TAMDAR did not occur, since a RUC pre-analysis code was not updated as intended. That key feature of the upgrade is expected to be added on Tuesday 16 Dec 2008.

Final evaluations of RUC upgrade package and presentations to various RUC users

- Pre-implementation briefing to NCEP Director (Louis Uccellini) by Stan Benjamin and Geoff Manikin (NCEP/EMC) on Wed 5 November. Upgrade granted approval.
- Presentation developed and made available from http://ruc.noaa.gov at http://ruc.noaa.gov/ruc13_docs/RUC-upgrade.impl-prebrief.4nov08.pdf including a number of new case studies.
- Tele-training sessions on RUC upgrade to NWS Southern Regions.
- Some final improvements added to RUC post-processing for RTMA downscaling code as part of the RUC upgrade package, adding 5km output for potential temperature and local lapse rate.

Stan Benjamin and Steve Weygandt from ESRL/GSD gave a detailed presentation on RUC/Rapid Refresh status at the NCEP Production Suite Review meeting on Tuesday 9 Dec. This presentation is available under
http://www.emc.ncep.noaa.gov/annualreviews/2008Review/index.html

AWC and SPC and the NWS Eastern, Central, Southern, and Western Regions all made positive comments about the RUC upgrade in the NCEP review meeting. Alaska Region also spoke positively about access to experimental Rapid Refresh real-time products.

GSD also has worked on improving the retention of METAR ceiling observations in RUC 1-h forecasts (see Task 9.5.15).

NCEP

Dennis Keyser reports that the radiosonde complex QC program and its in-line intersonde (radiation) correction step were updated on 4 November to correct minor bugs in the codes and to account for the current set of radiosonde instrument types. WSR-88D Level II reflectivity data from all radar sites except San Juan are available for the 88D mosaics used in the RUC since 17 November. A change to include the San Juan data should be implemented in early December. NOAA Profiler Network wind and RASS data continue to be received via the GTS temporary patch while the NWS 90-day hardware outage continues. Multi-Agency Profiler wind and RASS data from an ESRL MADIS feed is again available as of 25 November. These data have not been available since April 2006 when the NWS cut their support. The RASS data are used by the RUC. NESDIS has been contacted on two problems with the “new science” GOES 1x1 field-of-view cloud data, where random files (2-4 daily) have 1-2 beginning reports encoded with missing lat/lons and a bogus satellite ID; and the later arrival of the GOES-East data. Parallel testing of TAMDAR aircraft temperature and wind data continues (it was inadvertently excluded from the 17 November RUC update - see below). At the request of ERSL/GSD, efforts are being made to get TAMDAR airframe type and company code (not currently available) for improved bias corrections. The 17 November RUC update now assimilates Mesonet winds based on a use-list.

Geoff Manikin reports that the major RUC upgrade was implemented on 17 November. This version ingests hourly reflectivities mosaic files from which latent heat profiles are derived which are used in the forward step of the diabatic digital filter initialization to specify the 3-D profile of latent heating. Other changes include code for assimilation of mesonet wind (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. EMC and GSD recently discovered that the new version of the RUC analysis code is not yet properly receiving the TAMDAR data. An update to the getbufr code to correct this problem has been given to NCO for implementation on 16 December. A new procedure in the getbufr code to choose the surface ob closest to the analysis time (top of the hour) has exposed some bad pressure obs coming from a Canadian agricultural network coming in from AWS. Negotiations with MADIS (12-15 Dec) have resulted in flagging the SLP/altimeter data from these stations.

Subtasks

October 2008 through September 2009

09.5.1.1 Maintain hourly RUC runs and provide grids of SAV and AHP guidance products.

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

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

09.5.1.4 Maintain access to model verification data.

09.5.1.5 Working with NCEP/NCO and NCEP/EMC, complete the design, compilation, debugging, test runs and parallel testing of RUC codes on new CCS computer.

Deliverables

09.5.1.E1 Perform ingest, quality control and preparation of both existing and new observations in support of the operational RUC runs. (NCEP, GSD)

09.5.1.E2 Perform configuration management for RUC, including thorough documentation, and respond promptly to any code malfunctions or performance issues. (GSD, NCEP)

09.5.1.E3 Monitor RUC performance, respond to any problems detected by GSD, NCEP, or any RUC users, diagnose cause, develop solution to RUC software, test changes and coordinate with NCO on implementation. (GSD, NCEP)

Task 09.5.17 Infrastructure support for operational running of WRF-based modeling system in North American Mesoscale and HiResWindow at NCEP.

NCEP

Dennis Keyser reports that the radiosonde complex QC program and its in-line intersonde (radiation) correction step were updated on 4 November to correct minor bugs in the codes and to account for the current set of radiosonde instrument types. WSR-88D Level II reflectivity data from all radar sites except San Juan are available to the NAM-GSI. A change to include the San Juan data should be implemented in early December. NOAA Profiler Network wind and RASS data continue to be received via the GTS temporary patch while the NWS 90-day hardware outage continues. Multi-Agency Profiler wind (used by the NAM GSI) from an ESRL MADIS feed is again available as of 25 November. These data have not been available since April 2006 when the NWS cut their support. The RASS data are monitored by the GSI. AIRS radiance data counts have been lower than average since May due to late posting of files caused by hardware issues with NESDIS' AIRS processing. In mid-April the NAM-GSI stopped using AIRS AMSU-A radiances because channel 4 went bad. The NAM-GSI is being modified to allow the remaining AMSU-A channel data to be used. AIRS radiance and MODIS wind data were not available 4-5 November due to NESDIS hardware issues. Alaskan radiosonde data receipt has improved after NCEP contacted Alaska region, but there is still a need for some sites to move up their launch time so their data are received in time for the NAM-GSI. The following data types are now monitored by the NAM-GSI: RASS virtual temperature profiles, QuikSCAT 0.5 deg. scatterometer wind superobs, METOP-2 radiances (from AMSU-A, MHS and HIRS-4), TAMDAR (via ESRL MADIS feed) and Canadian AMDAR aircraft temperature and wind. The last three will be turned on in the NAM-GSI when the current NAM change package is implemented on 16 December. Ways to speed up the dump processing of NEXRAD Level II data are being explored.

Eric Rogers reports that NCEP's Central Operations has completed its 30-day real-time parallel test of the Fall 2008 NAM change package on 24 November. NCEP's service centers: Oceanic Prediction, Hydro-meteorological Prediction, Storm Prediction and Aviation Weather evaluated the real-time parallel runs and all gave a "thumbs-up" for the implementation to go forward. Geoff DiMego will brief NCEP Director on 12 December with a 16 December implementation targeted. A bug has been found in the land-surface model involving the use of the RESTART logical variable required when cycling or cold-starting. The origin of the bug was traced back to the incursion of the unified NOAH LSM which went into NAM operations in March 2008. Sadly, there was no regression test for this contingency and it was not detected until we started partial cycling. NCEP will monitor the impact (currently restricted to northern Alaska and Canada) by running a parallel with the bug fixed to run alongside the NAM after the bundle is implemented.

Subtasks

09.5.17.1 Maintain four-per-day North American Mesoscale runs and provide SAV and AHP guidance. (NCEP)

09.5.17.2 Maintain four-per-day HiResWindow runs and provide SAV and AHP guidance. (NCEP)

09.5.17.3 Provide vendors with gridded model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway. (NCEP)

09.5.17.4 Provide full grids from NAM, and HiResWindow on NCEP and NWS/OPS

servers. (NCEP)

09.5.17.4 Maintain access to model verification data. (NCEP)

09.5.17.5 Working with NCO, complete the design, compilation, debugging, test runs and parallel testing of RR, NAM and HiResWindow (and SREF) codes on new CCS computer.

Deliverables

09.5.17.E1 Perform ingest, quality control and preparation of both existing and new observations in support of the operational WRF runs. (NCEP)

09.5.17.E2 As requested by other RTs, incorporate new AHP calculations into Operational WRF Model post-processor and product generator (NCEP).

Task 09.5.4 Develop, test, and implement the Rapid Refresh.

NCEP
No NCEP activity to report.

Subtasks

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

GSD
As of late October 2008, two parallel full hourly cycled versions of the Rapid Refresh are running at GSD, with files going to many users (including AWR RTs), verification and web-based plots.

Verification of standard atmospheric variables (temp, RH, wind) continues to indicate the experimental Rapid Refresh is competitive with the RUC at most forecast lengths and output times. We recently discovered a minor bug in the application of our precipitation verification package to RR fields (an incorrect assumption about the accumulation period in a precipitation field) that was causing inaccurate precipitation skill scores. This is being corrected and we will have precipitation verification scores to report soon. A fairly detailed qualitative assessment of RR vs. RUC precipitation was completed for the NCEP Production Suite Review meeting. The resulted indicated a very good qualitative agreement between the RR and the RUC. The real-time runs are complemented by a retrospective capability that has been used to evaluate different background error covariance specifications in the GSI and is now being used to evaluate 2 different boundary layer schemes in the WRF model. We have also just completed 2 retrospective tests to evaluate the impact of satellite radiance assimilation on the RR forecast. Results from these retrospective tests are still pending.

Joe Olson, an NRC postdoc at GSD, is now beginning to examine RR performance specifically over Alaska with the aid of the Meteorological Evaluation Tool (MET) software being developed by the Developmental Testbed Center. This time of year, characterized by very cold surface temperature at some locations and highly stable lapse rates in the lower atmosphere, is a

particularly challenging time for NWP models. We intend for this evaluation to complement evaluations we receive from Alaska forecasters (see next subtask).

GSD is also actively modifying the NCEP version of WRFpost, originally written by NCEP/EMC to postprocess the WRF-NMM. GSD modifications are toward introducing the RUC postprocessing algorithms into the post, particularly those for ceiling, visibility and radar reflectivity. The latter algorithm is more consistent with the NCAR microphysics used in RR than is the present WRFpost algorithm, which is based on the Ferrier microphysics used in NAM.

09.5.4.2 1 Nov 2008 (GSD, NCEP)
Continue to solicit input from Inflight Icing, Turbulence, National Ceiling/Visibility, and Convective Weather RTs and NWS forecasters in Alaska and Puerto Rico, as well as AWRP RTs, on performance of pre-implementation Rapid Refresh. Arrange to have GSD RR grids available to examine and solicit feedback on RR performance.

(GSD)
GSD group has made many different types of RR files available to users (AWR RTs, NWS) and worked to assist them to access, process and display RR grids within various workstation environments. We are currently producing 4 flavors of RR files (native level, pressure level, surface field, and precip fields) for each 3 grids (full RR, Alaska 249, CONUS) and grib1 and grib2. So far, most of the interaction with outside groups has been focused on answering technical details about the grids and fields, but RTs and Alaska NWS now have the grids processed and more detailed evaluation are commencing. Correspondence continues with George Trojan at Alaska Region NWS to answer some additional questions about fields. George has ported RR grids to the AWIPS workstation and forecasters at ANC and FAI and the AWU are now viewing them.

09.5.4.3 30 May 2009 (GSD, NCEP, NCAR)
Updated report on status of tactical planning for making RR-WRF ARW model code for 2012 in compliance with Earth System Modeling Framework (ESMF) in agreement with the Sept 2007 Rapid Refresh MOU between NCEP and GSD.

09.5.4.4 30 Sept 2009 (GSD, NCEP)
Complete pre-JIF evaluation of Rapid Refresh in accordance with NCEP pre-implementation checklist for major implementations. Respond to evaluation questions, present information on Rapid Refresh pre-implementation testing and evaluation results in various forums, as required.

09.5.4.6 30 Sept 2009 (GSD and NCEP)
Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit Rapid Refresh software to NCO.

Deliverables

09.5.4.E1 20 Dec 2008 (GSD)
Report on Rapid Refresh testing at annual NCEP Production Suite Review meeting.

Collection of real-time verification statistics and case study plots in preparation for NCEP suite review is underway. A presentation summarizing the RR testing and refinement was given by Steve Weygandt at the NCEP (see PPT slides for RUC/RR presentation under http://www.emc.ncep.noaa.gov/annualreviews/2008Review/index.html

09.5.4.E2 1 September 2009 (GSD, NCEP)
Complete documentation (in Technical Procedures Bulletin-like document) of Rapid Refresh system.

09.5.4.E3 30 September 2009 (GSD, NCEP)
Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit Rapid Refresh software to NCO.

Task 09.5.5 Develop, test, and implement improvements to the operational 3DVARs for Rapid Refresh and North American Mesoscale runs.

NCEP
Wan-Shu Wu worked on incorporating a digital filter coded by Dave Parrish in her NDAS test system to run after each 3D-Var step. The necessary changes to the boundary code were done by Matt Pyle. The scripts were changed to restart the forecasts after the digital filter step. The code for merging the filter results back into the WRF restart file was modified to work with the IJK WRF/NMM. The whole system with the digital filter is now functional and impact experiments have been started.

Dave Parrish reports that it appears the main problem with all the regional TLNMC formulations (including the current Briere version and the computationally impractical global spectral Temperton version when applied to the regional domain) is how the boundary value forcing is extended beyond the regional domain. The balance solution is strongly dependent on the extended domain mean value of the forcing. On the sphere, the mean must be zero, but this is not a necessary condition for a regional domain. After some trial and error, the most robust solution was obtained by adding a single halo row of constant forcing just outside the regional domain and zero everywhere else in the extended domain. The extra forcing value is chosen so that the total domain (regional + extended) mean of the forcing is zero. This means that a much simpler multigrid scheme, based on a simple extension of the regional domain to an infinite flat plane, should work just as well as the global multigrid scheme most recently tested. Based on preliminary results, it appears that the new scheme can also be applied to the full background and possibly greatly reduce the domain scale oscillations that are observed in height field, and are especially large after a cold start from the global forecast.

Shun Liu has an algorithm (obtained from NSSL) coded up to estimate mixing-layer height from radar reflectivity observations. This algorithm needs to be further optimized based on other mixing-layer height observations. Shun Liu has also started to merge vertical velocity assimilation codes from the January 2008 version of the GSI into the latest version. Bugs have been found and fixed in the new GSI version.

GSD
Four GSD scientists (Dezso Devenyi, Ming Hu, Steve Weygandt, Stan Benjamin) visited NCEP on Dec. 8-9 to discuss various aspects of the GSI development for RR applications, including finalizing the inclusion of the GSD cloud analysis package to the NCEP GSI repository, surface assimilation issues, balancing and cycling issues, and NCEP scripting issues.

Work by GSD continues on refining the GSI for Rapid Refresh. In collaboration with colleagues at NCEP EMC, Dezso Devenyi is working to optimize the anisotropic covariance modeling as follows. NCEP has a fix for a possible bug in anisotropic code in the vertical. It manifested in the fact that isolines of observation impact did not follow the isolines of virtual potential

temperature. Since that code has been fixed by Yoshiaki Sato of NCEP. Fixed code and option of controlling strength of anisotropy may allow GSD to resolve the difficulties encountered in specifying the PBL height as parameter in surface data assimilation.

Additional progress in surface data assimilation at GSD includes modification of the original GSI code to accommodate observations which have a surface pressure which is greater than that of the associated background field point. This is accomplished by extrapolating surface values of variables back up to the interpolated grid point terrain at the observation point. Also, surface observations are checked according to surrounding water/land grid point indicator values. The code is largely ready, testing and graphical issues are still ahead.

In addition, as the GSI code and run configuration have stabilized more, we have begun to use the RR retrospective capability quite a bit more. Two parallel runs are performed with/without satellite data have recently been completed (results pending) and we plan a series of systematic data denials to verify the expected observation impacts.

Subtasks

09.5.5.1 31 December 2008 (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.

09.5.5.2 31 December 2008 (NCEP)
Establish hourly cycled NAM assimilation system on NOAA R&D computer at NCEP (machine called “haze”) using GSI and WRF-NMM to be adapted to ARW-based RR by GSD.

09.5.5.3 31 January 2009 (CAPS and GSD)
Testing of and refinement to the radial velocity analysis component of GSI for Rapid Refresh configuration, together with the cloud analysis.

Testing and evaluation for tropical cyclone case ongoing using RUC background fields

09.5.5.4 28 February 2009 (GSD)
Report on preliminary statistical evaluation of Rapid Refresh forecasts initialized with the GSI, including examination of upper-level winds, surface fields, and precipitation.

09.5.5.5 31 July 2009 (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. strong constraint, improved satellite channel bias correction, improved use of WSR-88D radial wind and/or satellite radiances and/or retuned co-variances to the GSI for FY2009 change package to the NAM.

Deliverables

09.5.5.E1 30 March 2009 (NCEP)
Subject to NCEP Director approval implement upgrades (e.g., partial cycling, TAMDAR) to GSI used in NAM/NDAS.

09.5.5.E2 30 September 2009 (GSD, NCEP)
Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit GSI code as part of Rapid Refresh software to NCO.

09.5.5.E3 30 September 2009 (CAPS and GSD)
Finalize enhancement package for radial velocity data analysis to begin testing at GSD toward future implementation for Rapid Refresh.

09.5.5.E4 30 August 2009 (GSD, NCEP)
Complete report on Rapid Refresh performance, including that from the GSI component of the RR, in comparison with the operational RUC.

Task 09.5.8 Improve physics in the WRF model, especially that bearing on prediction of aircraft icing.

Subtasks

09.5.8.1 31 July 2009 (GSD)
Complete systematic GSD evaluation of physics performance in GSD 1-hour RR cycles for initial RR implementation.

A retrospective RR 3-h cycle run for 4-11 March 2008 to test the Mellor-Yamada Nikinishi-Niino sub-grid-vertical-mixing scheme in the RR has been completed. This scheme had previously been implemented in WRFV3 by Mariusz Pagowski of GSD. Evaluation of the performance of this scheme relative to the Mellor-Yamada Janjic scheme (currently used in RR real-time testing at GSD) in this retrospective test, is underway.

Atmospheric and Environmental Research (AER), Inc. reported that the RRTM longwave radiation scheme (developed at AER) had an error in the WRF model implementation, with the ozone climatology vertical profile being inverted from what should have been. Jimy Dudhia has made a change to the WRF model. It turns out that the implementation of RRTM into the RUC (part of the RUC upgrade package) was done correctly. The modification will also be made for the Rapid Refresh version of WRF.

09.5.8.3 30 July 2009 (NCAR)
Research and testing on addition of the new explicit aerosol variable(s) in initiating cloud water and ice. Computer storage and run time considerations will be considered as a constraint on the development. (NCAR task)

Trude Eidheimer is coming up to speed on WRF and is investigating various options for the implementation of an aerosol scheme into the microphysical model. Her focus will be the implementation of methods to predict Cloud Condensation Nuclei and Ice Nuclei.

09.5.8.5 1 December 2008 (DTC, GSD)
Report on FY07-funded GSD-DTC RR retrospective testing of the impact of different thickness of vertical model layers close to the surface and, as appropriate, other physics.
A draft report has been written by the DTC and GSD has provided comments on this draft.

09.5.8.6 1 August 2009 (GSD)
Begin to explore possibilities for enhancing treatment of sea ice and tundra (including spring-time pooling) in Rapid Refresh domain toward FY11 Rapid Refresh upgrade.

Preparations are being made to make available for evaluation for forecasters at Environment Canada's Arctic Weather Center at Edmonton the real-time RR1-h cycle running at GSD.

Deliverables

09.5.8.E2 30 Sept 2009 (GSD, NCEP)
Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit upgraded WRF model physics code as part of Rapid Refresh software to NCO.

09.5.8.3 Jul '09: Report on research and testing on addition of the new explicit aerosol variable(s) in initiating cloud water and ice. Computer storage and run time considerations will be considered as a constraint on the development. (NCAR task)

09.5.8.5 Dec '09: Report on FY07-funded ESRL-NCAR RR retrospective testing of the impact of different thickness of vertical model layers close to the surface and, as appropriate, other physics. (Joint NCAR and ESRL task)

09.5.8E2 Sep '09: Provide an improved microphysics scheme to ESRL for evaluation toward FY11 Rapid Refresh upgrade. (NCAR)

09.5.8E3 Aug '09: Complete physics improvement for icing, C&V, turbulence and convective forecasts. (NCAR)

Task 09.5.15 Develop improved methods of cloud and moisture analysis for use in the WRF Modeling System.

Subtasks

09.5.15.2 5 Jan 2009 (GSD and CAPS)
Continue 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.

GSD
Work by GSD continues on refining the GSI cloud analysis for Rapid Refresh. Comparison of RUC and RR analyzed ceiling statistics indicates slightly worse scores for the Rapid Refresh. We are investigating the cloud analysis to track down these issues. Improvements have also been made to the lightning assimilation module, including using a better relationship between lightning flash rate and maximum reflectivity.

Stan Benjamin, with help from Steve Weygandt, Bill Moninger, and others, has been developing and testing variations to the RUC analysis and model to improve retention of layers of cloud water, especially in the 1000-3000 ft layer (from IFR to MVFR). GSD verification against METAR ceiling observations and extensive has shown that cloud water in these layers will evaporate in the first hour of the model for both the RUC and WRF Rapid Refresh models. Bill Moninger has developed initial ceiling/visibility verification for the Rapid Refresh. Improvements for the RUC developed from this testing will be transferred to the Rapid Refresh code also (analysis and/or model, as is necessary). This work is also associated with separately funded NASA ASAP work for assimilating NASA Langley GOES cloud products into the RUC and Rapid Refresh.

In early Nov. 2008, an experimental version of the RUC began assimilating experimental satellite derived integrated water path fields (created by NASA Langley). These observations are added within the RUC cloud analysis and this code will be ported to the RR cloud analysis soon. One immediate benefit from these observations is extended coverage further into Southern Canada. Detailed testing and evaluation during the coding to use these products has continued to indicate a loss of RUC (and RR) low-level clouds during the first hour of the RUC forecast. A number of factors have been identified, most importantly the position of the call to the cloud analysis subroutine within the larger RUC analysis code. The current order allows sub saturation to occur in 3-d grid volumes where clouds were identified from METAR and GOES data, allowing immediate evaporation of non-zero hydrometeors set in the cloud analysis subroutine. Work in this area continues, and results will be applied to the Rapid Refresh as well as in the RUC (if changes are allowed at NCEP).

Work has continued with colleagues at NCEP on a number of GSI-related issues and Dezso Devenyi, Ming Hu, Steve Weygandt and Stan Benjamin travel to NCEP and discussed these issues in early Dec. Issues discussed included finalizing the inclusion of the RR cloud analysis package within the official NCEP GSI repository version.

09.5.15.3 30 Jan 2009 (GSD)
Develop and evaluate performance of diabatic digital filter initialization (DDFI) in the 13-km RR WRF model including assimilation of radar reflectivity data

GSD
We have the DDFI-based radar assimilation coded and running in one of our two real-time RR cycles. We have been evaluating difference between the RR cycles with and without the radar assimilation and comparing them with similar differences in the RUC. Based on a limited qualitative assessment, the signal from the DDFI radar assimilation in the RR looks similar to that from the RUC radar assimilation, but the difference between the with radar and without radar in the RR looks weaker than in the RUC.
A strong summer convective test case has been re-run with RR, including the radar assimilation package. A matched RUC re-run is pending, which will facilitate detailed comparisons of the radar assimilation performance for both the RIC and RR.

09.5.15.4 30 March 2009 (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.

09.5.15.6 30 Mar 2009 (GSD)
Include radar reflectivity-based latent heating within diabatic digital filter initialization (DDFI) in the RR WRF model

Deliverables

09.5.15.E2 30 Sept 2009 (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 09.5.6 Develop, test, and evaluate the performance of the nonhydrostatic WRF modeling system.

NCAR/MMM
Preparations of the next release of WRF continued at NCAR. The release committee has been meeting regularly to oversee the release of WRF V3.1, scheduled for Spring 2009. Prospective features include new physics options, including PBL and microphysics scheme modifications, and other upgrades.

Jimy Dudhia of NCAR had been working with QNSE PBL scheme developers in investigating issues in the behavior of the scheme in stable and unstable regimes. Solutions resolving the issues have been found and the code is close to being added to the WRF repository.

A minor change to the YSU PBL scheme obtained from Song-You Hong (Yonsei University), adding a new array, was added to the WRF repository. This version of the YSU scheme will appear in the V3.1 release.

Dudhia worked with Wei Wang and Josh Hacker of NCAR to add Hacker's single-column option to WRF. This was put into to the repository. Dudhia is also working with Wei Wang to add spectral nudging code from Gonzalo Miguez-Macho (Spain) into WRF.

In physics for WRF NRCM use, a set of changes was added to the repository for the V3.1 release. These included: (i) SST skin temperature prediction, (ii) deep soil temperature prediction, (iii) bucket accumulation arrays for water and energy budget accuracy, (iv) ability for time-varying CO2 in the CAM radiation scheme, and (v) leap-years made optional.

Subtasks

09.5.6.3 1 September 2009 (NCEP)
Maintain and further develop WRF Post-processing system including necessary RR capabilities and updates to all documentation, in response to community requirements.

09.5.6.4 30 June 2009 (NCAR/MMM)
Deliver a WRF Users' Workshop and a WRF tutorial for the user community.

09.5.6.5 30 Sept 2009 (NCAR/MMM)
Incorporate physics improvements from the WRF user community, GSD, and NCEP into the WRF software infrastructure for use in the Rapid Refresh model. Perform code testing to permit implementation into WRF repository. In collaboration with GSD, assist in the evaluation of those physics schemes for the RR that may be tested using the ARW.

Deliverables

09.5.6.E1 30 June 2009 (NCAR/MMM)
Deliver a WRF Users' Workshop and a WRF tutorial for the user community

09.5.6.E2 30 September 2009 (NCAR/MMM)
Incorporate physics improvements from the user community, GSD, and NCEP into the WRF software infrastructure for use in the Rapid Refresh model. Perform code testing to permit

implementation into WRF repository. In collaboration with GSD, assist in the evaluation of those physics schemes for the RR that may be tested using the ARW.

Task 09.5.24 Test WRF Rapid Refresh model at 3-km resolution toward High-Resolution Rapid Refresh

GSD
GSD presented summer 2008 HRRR statistical verification, as well as case study examples, at the NCEP Production Suite Review (Dec. 9-11). In addition, several NWS entities (SPC, regions) expressed a desire for further development and implementation of the HRRR (with the hourly radar updating via the RUC / RR). In addition, Stan Benjamin and Steve Weygandt have participated in meetings to discuss the evaluation of the 2008 CoSPA forecasts as well as plan the summer 2009 evaluation effort.

The GSD group has performed extensive verification and evaluation of the summer 2008 HRRR forecasts and worked with NCAR and MIT/LL to evaluate the combined CoSPA product. GSD HRRR reflectivity verification (at 3-h intervals) indicates 6-h HRRR forecasts with radar assimilation are better than 3-h HRRR forecast without radar assimilation at all times of the day. GSD has further evaluated the relative strengths of the HRRR and RCPF as a function of the diurnal cycle of convection. The RCPF does quite well at identifying mesoscale areas of convective initiation. The HRRR appears to have similar skill for convective initiation (based on verification of HRRR forecasts that have been up-scaled to a 13-km grid). As expected, HRRR improvements from the RUC radar assimilation increase as the initial time convective coverage increases.

Subtasks
09.5.24.1 15 Feb 2009 (GSD, NCAR/RAL, NCAR/MMM, CAPS, MIT/LL)
Design the assimilation/modeling configuration for the HRRR during the 2009 summer convection forecasting (CoSPA) exercise.

GSD
Tanya Smirnova has recently run test of an expanded HRRR domain that would provide additional coverage the west and south. The new domain, which extends west to the Rocky Mountains and south to the Gulf Coast, is rotated clockwise to minimize grid points over the Atlantic Ocean. There would be several advantages to this expanded HRRR domain: 1) expanded coverage for key hubs including Atlanta, Minneapolis, Dallas and Denver, 2) by placing the western domain edge well west of the mean dry-line, the western boundary contamination (from large MCSs that are poorly represented in the parent model, entering the HRRR domain) would be greatly reduced. 3) Greater utility to all users, including NOAA operation forecast units. Initial tests indicated about 66 minutes for a 12-h forecast on 400 processors. We are looking into small changes to get the run time under an hour.

09.5.24.2 15 Aug 2009 (NCAR/MMM)
Evaluate techniques for convection-permitting (e.g.,3-km) forecasting by the ARW core in the HRRR configuration. In collaboration with GSD, perform and evaluate convection-permitting forecasts on test cases using radar-enhanced RUC or Rapid Refresh (13-km) grids from GSD for initial condition fields to identify strengths and weaknesses of HRRR-ARW forecasts. This will include a 2009 analysis on evolution of convective storm mode during first 1-3 hours of model transition from effective resolution 13-km to actual 3-km resolution. Perform fully-explicit tests and evaluate short-term forecast results. Submit summary of results and collaborate with

other groups on consolidated summary of results from 2009 HRRR exercise and research results.

09.5.24.3 15 Sept 2009 (NCAR/MMM, GSD)
Collaborate on analysis of convection-permitting tests using HRRR cases. Draft and deliver summary of results.

09.5.24.4 30 Sept 2009 (GSD, NCAR/RAL)
Complete 2009 HRRR summer exercise using modeling and assimilation modifications determined in 2008 exercise. Collaborate on analysis of HRRR tests and deliver summary of results.

Deliverables

09.5.24.E1 15 August 2009 (NCAR/MMM)
Submit report on evaluation of HRRR-ARW forecasts.

09.5.24.E2 30 August 2009 (NOAA/ESRL/GSD)
Complete FY09 test with Northeast Corridor U.S. domain with 3-km High-Resolution Rapid Refresh running every 1 h.

- Conduct real-time summer 2009 HRRR forecasts using 3-km WRF initialized with radar-enhanced Rapid Refresh over Northeast US Corridor domain
- Coordinate with other AWRP users and other collaborators
- Provide project management
- Lead writing of report on summer 2009 HRRR experiments

09.5.24.E2 30 September 2009 (NCAR/RAP and NCAR/MMM)
Collaborate with GSD on analysis of 2009 results. Draft and deliver summary of results.
Evaluate techniques for convection-resolving (e.g., 3-km) forecasting by the Rapid Refresh (ARW core). Perform and evaluate HRRR convection-resolving forecasts on test cases using Rapid Refresh grids from GSD to identify strengths and weakness of model at high resolution. Perform 2009 experiments to re-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.

Task 09.5.19 Develop ability to assimilate WSR-88D radial velocity and reflectivity data through GSI and Rapid Refresh toward High-Resolution Rapid Refresh.

Subtasks

09.5.19.1 30 October 2008 (GSD, NCAR/RAL, CAPS)
Select initial case studies from summer 2008 for 3-km HRRR data assimilation case studies.

GSD
A set of 8 summer 2008 cases has been selected for coordinated GSD, NCAR, MIT/LL evaluation. These include 20, 27 July; 2, 8, 13, 15 Aug; 6 Sep. We are also looking at some other cases for specific HRRR analysis including 31 July and 13 Sept.

09.5.19.2 31 August 2009 (GSD, NCAR-RAL)

Run case studies from early 2009 using 3-km HRRR on GSD jet computer using different RR-based initial conditions

- Radar-DFI enhanced RR
- Radar-DFI RR using unsmoothed latent heating
- Test of 3-km radar-enhanced diabatic digital filter initialization (DDFI)

09.5.19.3 30 Sept 2009 (CAPS)
Complete new 3-km GSI data assimilation experiments toward improved assimilation of radial wind.

CAPS modified its radar pre-preprocessing program for GSI, 88d2gsi, to improve its efficiency and correct an elevation mapping error (not present in 88d2wrf program used earlier). The automatically QC'ed radial velocity (Vr) data were further run through interactive editing software Solo II from NCAR to correct any remaining unfolding problem with the data. New sets of experiments are being rerun using the better QC'ed data set. Also, Vr data up to the full 230 km range are now used instead of the 150 km range used earlier (done to avoid certain QC problems).

Results from one set of experiments using the newly QC'ed data are shown below, where the radar data were assimilated at 10 minute intervals between 00 and 02 UTC, September 2007, for the Erin case. Shown together are the low-level vortex center tracks determined from NAM analyses (green), the Oklahoma Mesonet and other surface observation data (red), and the official best track (black). It is believed that the 'best track' is not the 'best' because it matches the satellite imagery for precipitation centers better rather than ground-based *in situ* measurements, and precipitation regions are off the vortex center. We will use the surface-based track (called mesonet track) for further verification.

The track of WRF forecast with GSI analysis of Vr data up to 150 km range is shown in magenta while the track with full-range radar data is in blue. It can be seen that the latter with full range radar data is closer to the mesonet track, although in both cases, the minimum sea-level pressure at the vortex center is over predicted compared to the mesonet observations. Further investigation will be performed on the intensity forecast. Our experiments using RUC as the initial analysis background and lateral boundary conditions tend to produce weaker vortices.

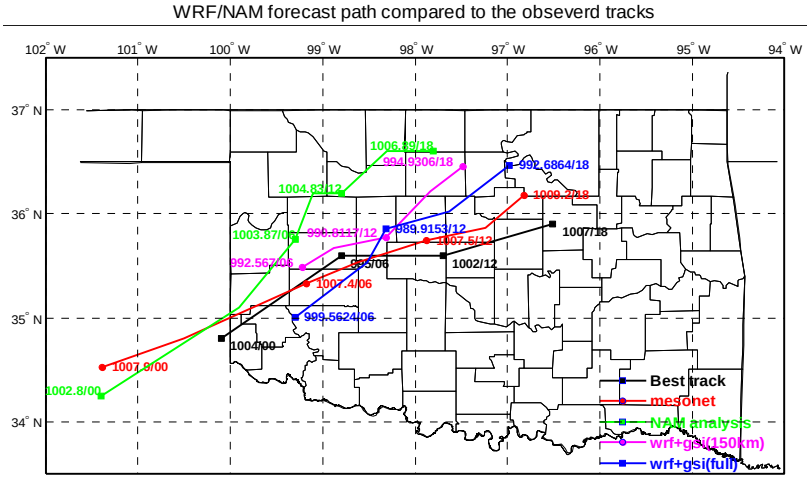

Fig.1 : Best track (black), OKC Mesonet-determined track (red), track based on NAM analyses (green) (00-18 UTC), and WRF forecast tracks assimilating reflectivity and radial velocity radar

up to 150 km range (magenta) and up to full 230 km range (06-18 UTC) for the low-level vortex center.

09.5.19.4 30 Sept 2008 (GSD)
Develop and test improved DFI assimilation of radar reflectivity at 3-km using observation-based specification of latent heating within WRF-DFI developed by GSD and NCAR in FY08.

Deliverables
09.5.19.E1 30 Sept 2009 (GSD, CAPS, NCAR/RAL)
Complete improved version of 13km/3km radar assimilation techniques for demonstration in FY09 exercises.

Task 09.5.20 Develop ensemble-based probabilistic products for aviation users.

NCEP
Jun Du reports that the work of adding stochastic forcing to a convective parameterization scheme has begun, to test if it can improve the diversity of an ensemble system. If it does improve the ensemble spread, it will be used in the future SREF system upgrades. The SREF upgrade package being tested throughout most of the first quarter of FY2009 encountered two failures (script instability due to shared working directories) and an initialization-related WRF member failure) late in its 30 day evaluation period. There was insufficient time to fix the problems and conduct even an abbreviated test & evaluation of the updated system before the start of NCO's moratorium (16 December) so the implementation was postponed until later in 2009 when the moratorium is lifted. The new testing of the canceled package on the P6 platform will restart in early 2009.

BinBin Zhou is working with the Alaska Aviation Forecast Unit to evaluate SREF ceiling and visibility forecasts over the Alaska region. Based on the evaluation and their suggestions, the "conditional mean" computation in ensemble product generator was modified, but this modification needs more data and more time to verify.

Shun Liu continues to work with Binbin Zhou on modifying scripts and codes to convert the binary format 3D reflectivity mosaic to GRIB format. The new package is running in parallel and will provide an hourly GRIB format 3D reflectivity mosaic product for use as 'truth' in the fcst-vs-grid verification package.

Subtasks

09.5.20.1 15 January 2009 (NCEP)
Complete 'research quality' version of upgrade to SREF (e.g. higher resolution, more WRF members and more physics diversity) for consideration in November 2010 SREF upgrade package.

09.5.20.2 15 February 2009 (NCEP)
NCEP visits AWC to conduct continued training and education on SREF applications, receive feedback on existing guidance, and to acquire new requirements (fully depending on FAA funding).

09.5.20.3 15 April 2009 (NCEP)
NCEP develops and delivers a new fog algorithm used in the SREF product for aviation (fully depending on FAA funding, $60K requested).

09.5.20.4 31 August 2009 (NCEP)
Based on case-study testing and refinement of the research-quality code, deliver the upgrade SREF codes to NCO for November 2010 SREF upgrade package.

09.5.20.5 31 March 2009 (GSD and NCEP)
Develop a preliminary procedure appropriate for aviation users from Very Short-Range Ensemble Forecast (VSREF) system using high-resolution RR and NAM existing runs.

09.5.20.6 1 July 2009 (GSD and NCEP)
Further calibrate probabilities and potential echo-top (improve statistical reliability) ensemble cumulus information.