MODEL DEVELOPMENT AND ENHANCEMENT
RESEARCH TEAM
Monthly Report for October 2007
Submitted 15 November 2007

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Executive Summary

Task 08.5.1: Infrastructure support related to operational running of the RUC and North American Mesoscale (NAM) operational modeling systems.

- 1 Nov summary on RUC upgrade now available at http://ruc.noaa.gov/ruc13_docs/RUC-upgrade-early08.pdf . Lots of new verification, examples.
- Testing continues at NCEP for RUC upgrade package code, very good results (surface, convection, ceiling/vis, precip) evident for Sept-Nov. Implementation now planned for spring 2008. Change package includes mods to RUC analysis (including assimilation of radar reflectivity, mesonet winds, TAMDAR obs), model changes (RRTM longwave radiation and updated convection), and postprocessing enhancements (forecast radar reflectivity fields). All changes continue in real-time testing in hardened backup RUC cycle at ESRL/GSD. See 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.

- New Rapid Refresh summary at http://ruc.noaa.gov/rr/RR-TR-Oct07.pdf
- Hourly RR conventional observation files being created at NCEP and transferred to GSD

Task 08.5.6: Develop, test, and evaluate the performance of the nonhydrostatic WRF modeling system.

- Continued progress toward WRF version 3 planned for March 2008.

Task 08.5.8: Improve model physics for aviation forecasts.

- Non-local subsidence temperature tendencies tested in Grell-Devenyi scheme now producing a significant further improvement for convection forecasts in both NCEP parallel RUC and in GSD dev RUC13.

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

- Large improvements now forthcoming for complete use of METAR clouds in RUC and RR-GSI.

Task 08.5.17: Infrastructure support for running operational WRF model in North American Mesoscale and HiResWindow models at NCEP. (Rapid Refresh to be added in FY09)

- NAM upgrade implementation delayed until 2Q FY08.

Detailed report – MDE – October 2007

Task 08.5.1: Infrastructure Support Related to Operational Running of the RUC and North American Mesoscale (NAM) Systems

GSD

Lots of new progress on RUC upgrade, on documentation and performance itself.
New 44-slide summary of RUC upgrade at http://ruc.noaa.gov/ruc13_docs/RUC-upgrade-early08.pdf
New post to RUC forum on RUC upgrade at http://ruc.fsl.noaa.gov/forum/f2/Welcome.cgi/read/1713

In October, GSD has provided one last set of new code to NCEP, a variation to the Grell-Devenyi convection scheme, now using a non-local approach to subsidence warming. This adds further to the new RUC precipitation improvements shown in slides 39-40 in http://ruc.noaa.gov/ruc13_docs/RUC-upgrade-early08.pdf

Previous summary

This RUC analysis/model change package (implementation date now tentatively planned for spring 2008) is currently running in the NCEP parallel RUC (real-time product comparisons available at http://wwwt.emc.ncep.noaa.gov/mmb/ruc2/para/). The change package is also running and being evaluated in real- time in the 13km dev RUC (http://ruc.noaa.gov/pig.cgi?13km_D2) and the hardened 13km backup RUC (http://ruc.noaa.gov/pig.cgi?13km_BU). To summarize the changes made in the development and backup RUC at GSD:

- Assimilation
  - Hourly assimilation of 3-d radar reflectivity via diabatic digital filter initialization and convective suppression.
  - Assimilate mesonet winds using a new "mesonet provider uselist" augmented by an additional mesonet *station* uselist
  - Assimilate TAMDAR aircraft observations (available for NCEP operational use)
  - Differentiate wind observation error between GPS rawinsondes and non-GPS rawinsondes
  - Correction to RH observation errors for in-situ and precipitable water moisture observations, resulting in more accurate RH forecasts.
- Post-processing changes
  - Addition of three reflectivity products in RUC post-processing (column max, 1-km, 4-km) (all in RUC isobaric files – ruc_presm or pgrb)
  - Fix in ceiling diagnostic. Significantly improves false alarm by avoiding confusion with fog.
  - Fix to tropopause level problem identified in July 2007.
  - Additional new products in RUC isobaric/pgrib files - 500 hPa vorticity, total accumulated convective and non-convective precipitation from initial time, RH relative to precipitable water.
- Model changes
  - RRTM longwave radiation package replacing current Dudhia longwave package. This change improves nighttime forecasts over snow cover (cold-season) and especially a long-standing warm bias in particularly moist areas.
  - Land-surface model changes for improved 2m temperature over snow cover
  - Major improvements in Grell-Devenyi convective parameterization: 1) non-local application of subsidence-induced warming, 2) modifications in closure weighting for improved (decreased) areal coverage for light convective precipitation and improved coherence in mesoscale organization.

In addition to the work on the RUC change package, GSD continued to monitor real-time RUC performance among the operational NCEP version and 4 different experimental GSD versions, using observations from rawinsondes, surface stations, GPS precipitable water, and precipitation.

INTERFACE WITH OTHER ORGANIZATIONS:

Discussion between GSD and NCEP/EMC and NCEP/NCO on RUC changes, NSSL on 3-d radar data, NCAR on radar assimilation, NCEP on radar data availability.

NCEP

Dennis Keyser reports that on 2 October, ARINC corrected their BUFR encoding of MDCRS-ACARS mixing ratio (it had been one order of magnitude too large). Since then, moisture statistics generated by NCEP/NCO have shown good agreement with the guess. A study completed this month shows that the 13 August increase in the number of satellite ingest jobs run daily has indeed provided more of these data for the early-cutoff RUC dumps. Since the early October GSD/MADIS hardware upgrade, designed to speed up data flow, the amount of mesonet data available to the RUC assimilation has increased markedly. The following new mesonet providers/subproviders were added by GSD/MADIS: subprovider "SUPERAWOS" (in provider "NonFedAWOS") and subprovider "XCEL" (in provider "INTERNET") on 16 October, provider "NCECONet" on 17 October, and provider "MISC" (containing subproviders "Archbold" and "WxFlow") on 30 October. 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 random cycles where all of the "new science" cloud data have missing latitude and longitude. NESDIS is investigating this problem. Surface marine (ship, buoy, C-MAN, tide gauge) data have not had the benefit of NCEP/OPC interactive quality control since 18 June due to a file permission problem that was discovered in late October. This was corrected on 2 November. There was a 12-hour outage of GOES sounding and wind data on 3 October due to a DNS issue on the NCEP CCS. Cooperative Agency Profiler (CAP) and RASS data are not yet available through an alternate ERSL MADIS feed.

Geoff Manikin reports that EMC continues to run 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 as well as a list of reliable observation sites, 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, and a modification to the convective scheme to decrease widespread coverage of light precipitation. These changes have been running in parallel at EMC since the middle of September and will be evaluated throughout the fall and winter. Retrospective testing on warm season cases will then be run to examine performance during the more active convective season. If the statistical and user evaluations are positive, implementation will occur during the spring or summer of 2008.

Shun Liu tested the updated radar quality control (QC) and reflectivity mosaic package in parallel. An MPI-version of decoding code for reflectivity mosaic product was developed and run in parallel for GSD. Reflectivity mosaic products are generated hourly for RUC parallel experiments. He is also working with NCO to build a new radar data decoding and QC package so that the package can easily handle both current Level II data and the upcoming super-resolution Level II data. Radar data volume ID and scan ID information are being added to BUFR decoder. The ingest codes and GSI codes were modified to use them. After this update, the radar volume scan can be reconstructed using Level II BUFR.

Subtasks

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

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

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

08.5.1.4 Maintain access to model verification data.

Deliverables

08.5.1.E1 1 October 2007 - 30 September 2008 EMC (NCEP, GSD)
Perform observation ingest, quality control, and preparation of both existing and new observations in support of the operational RUC runs.

08.5.1.E2 1 October 2007 - 30 September 2008 (GSD)
Perform configuration management for RUC, including thorough documentation, and respond promptly to any code malfunctions or performance issues.

08.5.1.E3 1 October 2007 - 30 September 2008 (GSD, NCEP)
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.

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

New detailed PPT on Rapid Refresh status as of 1 Nov now available here
http://ruc.noaa.gov/rr/RR-TR-Oct07.pdf

Background from previous report.
An agreement was signed by GSD, EMC in early September 2007 to work together to implement the Rapid Refresh in 2 phases. In Phase 1, to be ready for NCEP implementation by September 2009, and toward which GSD has been working since 2004, the initial RR operational implementation will use the WRF-ARW under the WRF infrastructure, together with GSD physics and GSI-based data assimilation including diabatic Digital Filter Initialization (DFI). In Phase 2, to be implemented in 2012, an ensemble-based RR capability will operate under the NCEP Earth System Modeling Framework (ESMF) Modeling System, or NEMS, currently under development by EMC. The RR ensemble will include, depending on the available computing, members with NMM and ARW dynamics and various combinations of EMC and GSD physics as well as perturbed initial conditions. Phase 2 will feature advanced data assimilation techniques to provide digitally filtered background and forecast fields, the ability to ingest and analyze time-varying (at least hourly) surface, aircraft and Doppler radar observations and an ensemble initialization technique. The Phase 2 RR will be built on a NAM-based hourly assimilation cycle under ESMF, totally independent of the WRF code architecture.

GSD

In late October, GSD was successful in getting a 6-h cycle running on the full Rapid Refresh domain at 13km horizontal resolution on the faster wJET/TG file system of GSD's high performance computing system (duplicating an earlier cycle that ran on iJET). This was the culmination of several months of work, and benefited from diligent work by the ESRL JET management team to overcome significant I/O issues that arose in early Aug. due to the required installation on wJET of a NOAA security patch. The cycling RR, including GSI, the new WRF-ARW version 2.2 and the new WRF Pre-processing System is running under the GSD-developed Workflow Manager designed to facilitate efficient, reliable running of such cycles. A similarly-configured 3-h cycle on a smaller CONUS domain is also running on wJET. A cold-start version of the WRF-ARW, with the diabatic digital filter initialization (DDFI, reported on last quarter) is also running over the large RR domain every 12-h. and we plan to switch the cycled runs over to the DDFI version of the WRF ARW soon.

Radiosonde verification of the cycled and cold start RR forecasts has recently been added and a new RR web site is being developed for access to graphical output from these cycles and to provide access to RR grid parameters and static files (lat/lon of grid locations, terrain elevation, etc.)

PLANNED EFFORTS: Increase the cycling frequency to 1-h.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: DTC, NCEP, NCAR

UPDATES TO SCHEDULE: None.

Subtasks

08.5.4.1 30 December 2007 (GSD, NCEP)
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: As noted above, two RR cycles are now running at GSD on the wJET computer. Work is underway to upgrade these to 1-h cycling using the newly available NCEP hourly prepBUFR files and to add the satellite radiance assimilation. Additional work is underway to switch the internal I/O format from netcdf to binary (final output files will continue to be grib). Some computer issues with the MPI2 parallel I/O on the wJET computer have been encountered and are being investigated.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: NCEP, NCAR

UPDATES TO SCHEDULE: None

08.5.4.2 1 March 2008 (GSD)
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.

GSD is preparing to make information available (domain, map-projection parameters, lat/lon of grid points, terrain elevation, land use, procedures for accessing analysis and forecast grids, etc.) at a new RR web site under construction.

08.5.4.3 1 March 2008 (GSD)
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.

GSD is making information available to these RTs so that they can commence specific code and script preparations for obtaining and processing RR-domain output from GSD.

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) [in agreement with => as specified in?] the Sept 2007 Rapid Refresh MOU between NCEP and GSD.

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

Plots of analysis and forecast output from the new wJET RR cycles are now being generated for web access (http://www-frd.fsl.noaa.gov/mab/wrfrr13arw/) on a routine basis . Refinement of the presentation style (e.g., color tables) of these plots is being made to facilitate comparison with output from the various RUC hourly cycles running at GSD and NCEP.

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

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.

Task 08.5.5: Develop, test, and implement improvements to the operational WRF 3DVARs for Rapid Refresh and North American Mesoscale runs.

NCEP
Wan-Shu Wu tested the impact of using larger horizontal diffusion during data assimilation with her off line parallel on the full NAM domain. The results showed that with higher horizontal diffusion the system produced better first guess fit to the data. The version of the forecast model with some adjustment from the sigma level to the constant pressure level for temperature and humidity for horizontal diffusion produced better scores than that with horizontal diffusion on sigma level. Limitations on the adjustment from the sigma level to the pressure level were imposed in order to overcome some numerical problems associated with the thin model layers near the lower boundary. She also worked on a new forward model to assimilate wind direction. The tests showed that the solution was unbounded if the information of the wind direction was assimilated alone. For MESONET winds, which have a known negative speed bias, in order to make use of the directional information, the speed has to be assimilated also but with large ob error.

Manuel Pondeca has developed a module that computes ensemble-based background error covariances in the GSI. The module is undergoing testing by Yoshiaki Sato, a visiting scientist from JMA. Preliminary forecast scores from cycling experiments that used the global and regional ensemble to define the GSI background error covariances have shown promise. Manuel Pondeca also reports that he has developed the Lanczos-based estimation of the analysis error covariance matrix for the GSI. The method has already been implemented in the GSI-2DVar, which is used with the Real Time Mesoscale Analysis, and is being tested for the global GSI.

Shun Liu and Duk-Jin Won continue to examine the impact of vertical velocity as a control variable and (or) a diagnostic variable from vertical velocity equation in GSI to improve the assimilation of Level II 88-D radial wind observations. An effort was made to include these modifications to new version of GSI.

GSD
Subtasks

08.5.5.1 31 December 2007 (GSD and CAPS)
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.

Coding to parallelize the general cloud analysis is complete and it is being tested to verify the solution match with the serial code version. Further evaluation of this awaits completion of switch from netcdf I/O to binary I/O. Recent evaluation of the cloud analysis package within the RUC has revealed a condition that is preventing some METAR cloud observations from being used. A solution for this will be available soon and will be transferred to the cloud analysis code in the RUC and into GSI for Rapid Refresh.

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 decorrelation 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.

Radiosonde verification of the cold start and cycled RR runs has recently been added.

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 covariances) 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.

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

NCAR/MMM
Jimy Dudhia of NCAR worked with visitor Guenther Zaengl (University of Munich) on implementing several new features into WRF. These include a generalized vertical coordinate, modifications to stabilize and improve diffusion, and modifications to allow for terrain slope and shadowing in the solar radiation scheme. Dudhia also worked with visitor Veniamin Perov (SMHI, Sweden) on implementing a new PBL option into WRF, the QNSE PBL scheme (from Galperin et al.). Joe Klemp and Dudhia also updated and tested the new upper Rayleigh-w boundary condition.

Dudhia and Wei Wang of NCAR prepared minor release 2.2.1. This involved adding bug-fixes to V2.2 in preparation of a new tar file. Dudhia also added miscellaneous fixes to the WRF repository addressing model physics and numerics: (a) allowing for radiation to be called every timestep; (b) improving the hydrostatic pressure computation; (c) preventing the zero-out in the lowest layer of stress terms for w in a diffusion option; and (d) correction of a sign error for the curvature effect on v.

Subtasks

08.5.6.1 15 May 2008 (NCEP)
Commit to WRF Repository the changes embodied in operational WRF codes used in NAM upgrade package of March 2008.

08.5.6.3 30 July 2008 (NCEP)
Maintain and further develop WRF Preprocessing System (WPS) and Land-Surface Model static fields, including

updates to all documentation, in response to community requirements.

08.5.6.5 1 September 2008 (NCEP)
Maintain and further develop WRF Post-processing system including necessary RUC capabilities and updates to all documentation, in response to community requirements.

08.5.6.6 30 June 2008 (NCAR/MMM and DTC)
Deliver a WRF Users' Workshop and a tutorial on the ARW core (NCAR) and a tutorial on the NMM core (DTC) for the user community.

Deliverables

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

08.5.6.E2 30 September 2008 (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 08.5.8: Improve physics in the WRF model, especially that bearing on prediction of aircraft icing.

GSD

The planned early 2008 RUC change bundle now in parallel testing at NCEP (see Task 08.5.1) includes replacement of the current Dudhia long-wave radiation scheme with the RRTM and incorporates changes in the Grell-Devenyi convection scheme. Both these changes are discussed in the FY07Q4 report. Revisions to the RUC LSM (discussed in FY07Q2 report) are also part of this change bundle. In comparisons with the oper RUC13, this change bundle has shown substantially improved Equitable Threat Scores and bias at all forecast times and for most precipitation amounts. Particularly for the 0-6h period, much of this improvement can be attributed to the hydrometeor assimilation. Nevertheless, the convective scheme is also contributing to this improvement. GSD continues to evaluate real-time performance of this scheme in both WRF and RUC, and further modifications are possible. See slide 40 in http://ruc.noaa.gov/ruc13_docs/RUC-upgrade-early08.pdf for RUC precipitation verification statistics for old and new versions.

Subtasks

All Option A unless noted otherwise.

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.

08.5.8.2 15 May 2008 (NCEP)
Development efforts produce a 'research quality' code of physics upgrades for consideration in the 2009 NAM-WRF change package.

08.5.8.3 1 July 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.

08.5.8.4 15 July 2008 (NCEP)
Based on case-study testing and refinement of the research quality code, deliver an "experimental" code of physics upgrades for the 2009 NAM-WRF change package.

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.

GSD is planning a case-study test of the effect of changes in the configuration of the WRF model layers on the behavior of the RUC LSM. Pending the outcome of these tests, additional testing will be considered.

08.5.8.6 1 August 2009 (GSD)
(NOTE: Gloria, Warren, this date should be Aug 2009.)
Begin to explore possibilities for enhancing treatment of sea ice and tundra (including spring- time pooling) in Rapid Refresh domain.

08.5.8.7 1 September 2008 (NCAR) Option B
Upgrade the microphysics and boundary layer scheme to appropriately simulate freezing drizzle and icing in stratocumulus clouds.

08.5.8.8 30 September 2008 (NCAR) Option C
Implement the above upgrades into the WRF model and test on IMPROVE, AIRS-II and stratocumulus case studies. The evaluation will include supercooled liquid water, freezing drizzle, as well as snowfall rate and precipitation type and ceiling and visibility.

Deliverables

08.5.8.E1 30 March 2008 (NCEP)
Subject to NCEP Director approval, the physics upgrades become Operational at NCEP as part of the 2008 change package for WRF-NMM. (Will supplement physics progress toward Rapid Refresh.)

08.5.8.E2 30 Aug 2008 (GSD, NCEP)
Have available for delivery to NCEP initial 'experimental level' WRF Rapid Refresh code, including physics routines, for start of EMC testing toward 2009 Rapid Refresh implementation.

08.5.8.E3 30 September 2008 (NCAR)
Provide an improved microphysics scheme to GSD for evaluation in WRF Rapid Refresh.

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)
Develop and evaluate performance of diabatic digital filter initialization (DDFI) in the RR WRF model without use of radar data

CURRENT WORK: As noted in the MDE FY07Q4 report under task 4, WRF model code has been successfully modified to allow backward-forward diabatic digital filter initialization in the WRF-ARW (Tanya Smirnova, Steven

Peckham, with consulting help from Stan Benjamin). This required a DFI section to be added to the namelist to control the beginning and ending times of the backward adiabatic and forward diabatic steps, as well as to input parameters that define the digital filter. Modifications to mediation-level code, as well as addition of DFI code, were necessary to have the DFI run as part of the same job stream instead of running as 3 separate jobs. This GSD-developed backwards-forward diabatic DFI for WRF-ARW, similar to that in the RUC model, is now integrated into the 13-km RR cold start runs at GSD and we will soon switch the cycled runs over to the DDFI version of the ARW model (Task 4). Tests of the effectiveness of the DDFI have been made over the RR grid using GFS data processed through the WRF preprocessing system (WPS) as input. The DDFI demonstrably reduces noise by over 50%, as measured by the time-step to time-step change in surface pressure, over simply starting the model with the initial state as it comes out of WPS without the DDFI. Some further tuning of the DDFI is anticipated to optimize its effectiveness, once more frequent cycling over the RR domain using WRF-ARW begins.

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.

At CAPS, two versions (of NCEP and GSD) of the GSI code were ported to OU's Linux cluster. The generalized cloud analysis package has been incorporated within to GSI codes and packages passed initial tests. Forecasting test is underway with WRF-ARW.

Continuing the work of September, the main efforts at CAPS were spent on resolving the crashing problem of the GSI code (NCEP web distributed version). After switching MVAPICH to MPICH-P4 in LSF platform options, the MPI run now works. Further work was done to test the correctness of the system with two test data sets, using NetCDF I/O. They are the 2004072722 data set from NCEP GSI web site and the squall line case of 13 March 2006. For the NCEP test case, the difference in horizontal wind fields is about 10^{-7}m/s between our output and that of the NCEP test.

Some missing sub-packages had to be added to the GSI packages during the porting. Currently, the GSD version with generalized cloud analysis package works correctly. With WRF-ARW, forecast experiments are ongoing to test the difference between two GSI versions and the impact of the cloud analysis by using GSD version with the 13 March 2006 case.

Assistance from Ming Hu, currently of GSD/DTC, is greatly appreciated.

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.

CURRENT WORK: The DDFI without radar-reflectivity-based latent heating is now included in the GSD's 13-km cold start WRF-RR runs and the cycled RR runs will soon be switched to the DDFI version of the ARW (see Task 4, above). This is a necessary step in preparation for upcoming work to complete this subtask.

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 operational running of WRF-based modeling system in North American Mesoscale and HiRes Window at NCEP.

NCEP

Dennis Keyser reports that on 02 October, ARINC corrected their BUFR encoding of MDCRS-ACARS mixing ratio (it had been one order of magnitude too large). Since then, moisture statistics generated by NCEP/NCO & EMC have shown much better agreement with the guess. A study completed this month shows that the 13 August increase in the number of satellite ingest jobs run each day has indeed provided more of these data for the early-cutoff NAM dumps. As of 16 October, all NAM observational data are now processed within the new, expanded NAM domain, using a mask developed by Eric Rogers (this mask allows only those observations within the exact domain to be selected for dumping). This change is in preparation for the FY08/Q2 NAM-GSI update and replaces a lat/lon domain which was a superset of the current NAM domain. In early October, a new source of Automatic Dependent Surveillance (ADS) aircraft reports was added to the AIREP aircraft data assimilated by the GSI. Since late October a key Alaskan radiosonde, Shemya (70414), became available to the early-cutoff NAM GSI after its launch time was moved back at the request of NCEP and NWS Alaska Region. Surface marine (ship, buoy, C-MAN, tide gauge) data have not had the benefit of NCEP/OPC interactive quality control since 18 June due to a file permission problem that was discovered in late October. This was corrected on 2 November. There was a 12-hour outage of GOES sounding and wind data on 3 October due to a DNS issue on the NCEP CCS. NCEP is in the process of switching its processing to high-resolution BUFR JMA winds, following a period of testing. Parallel testing of the following new data types is currently underway in preparation for the FY08/Q2 NAM-GSI update: GOES-11 and -12 single field-of-view radiances over water (replacing current 5x5 field-of-view GOES-12 radiances), AIRS every f-o-v radiances, QuikSCAT 0.5 deg. scatterometer wind superobs, mesonet winds filtered by provider via NOAA/GSD's "uselist", and MODIS IR and water vapor satellite winds. By late Fall 2007, dropwindsonde moisture from NOAA (P-3 and Gulf Stream) and USAF will start being used by the NAM GSI, and aircraft turbulence and icing data will be available for verification. Efforts to speed up the dump processing of NEXRAD Level II data are being explored.

The following activities continue throughout the year.

Subtasks

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

08.5.17.2 (NCEP)
Maintain four-per-day HiResWindow runs and provide SAV and AIV guidance.

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

08.5.17.4 (NCEP)
Provide full grids from NAM, and HiResWindow on NCEP and NWS/OPS servers.

08.5.17.4 (NCEP)

Maintain access to model verification data.

OPTION D ONLY
08.5.17.5 (NCEP)
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 (NCEP)
Perform ingest, quality control and preparation of both existing and new observations in support of the operational WRF runs.

08.5.17.E2 (NCEP).
As requested by other PDTs, incorporate new AIV calculations into Operational WRF Model post-processor and product generator

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

OPTION B.

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

08.5.19.2 28 Feb 2008 (GSD)
Develop and test 3-km version of radar-reflectivity-based diabatic digital filter initialization (DDFI) and perform initial tests on cases. Revise during FY09 based on GSD tests and associated testing to be performed by NCAR/RAL.

08.5.19.3 30 March 2008 (NCAR/RAL)
Provide wind/temperature/moisture profiles for HRRR case studies using VDRAS for case studies. Provide these profiles to CAPS for GSI data assimilation experiments for 3-km HRRR.

08.5.19.4 30 June 2008 (NCAR/RAL)
Complete case study tests using radar-DDFI-enhanced WRF-HRRR model at 3-km. Report on effect on 0-3h forecasts using 3-km radar-DDFI assimilation.

08.5.19.5 31 August 2008 (CAPS)
Complete 3-km GSI data assimilation experiments for potential application within the HRRR assimilating radial wind and RAL-provided VDRAS profiles. Evaluate impact using 3-km HRRR-WRF model configuration as used by GSD.

08.5.19.6 January 2008 (NCEP)
Prepare for the expected doubling of Level II data volume due to the modified and additional VCP strategies.

08.5.19.7 15 July 2008 (NCEP)
Report on progress towards incorporating Level II reflectivity through the GSI analysis into the WRF model runs.

Option C addition.

08.5.19 30 August 2008 (GSD, CAPS, NCAR/MMM)
Data assimilation development and testing as described in Option B2 are also conducted for winter cases to provide an improved data assimilation capability ready for real-time application by this date.

08.5.19 30 March, 30 Sept 2008 (GSD)
Develop two versions at each of these dates of radar reflectivity-based latent heating within diabatic digital filter initialization (DDFI) in initial test version of 3-km HRRR. The first version will be used for summer 2008 real-time experiments, and the second will be ready for winter 08-09 experiments and spring 2009 experiments.

08.5.19 30 September 2008 (GSD, CAPS)
Exploratory work on ensemble Kalman filter from time-lagged HRRR

08.5.19 15 September 2008 (NCEP)
Demonstrate mini-data assimilation system using HRRR design from 1 March plan constructed to precede HiResWindow runs using hourly updates with GSI.

Deliverables

OPTION B.
08.5.19.E1 31 August 2008 (GSD, CAPS, NCAR, MIT/LL)
Report on radar assimilation results for HRRR from summer 2008 test under the lead of GSD with contributions from each organization.

08.5.19.E2 30 March 2008 (NCEP)
Subject to NCEP Director approval, implement upgrade package to WRF-GSI (e.g. improved use of Level II radial velocity) in the NAM and NDAS runs.

OPTION C only.
08.5.19.E3 31 July 2008 (GSD, CAPS, NCAR, MIT/LL)
Provide additional report on radar assimilation results for HRRR from winter 2007-08 case studies under the lead of GSD with contributions from each organization.

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

OPTION C only.

Subtasks

08.5.20.1 15 January 2008 (NCEP)
Complete 'research quality' version of upgrade to SREF (e.g. higher resolution, more WRF members and more physics diversity) for consideration in November 2008 SREF upgrade package.

08.5.20.2 15 February 2008 (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).

08.5.20.3 15 April 2008 (NCEP)
NCEP develops and delivers a new fog algorithm used in the SREF product for aviation (fully depending on FAA funding, $60K requested).

08.5.20.4 31 August 2008 (NCEP)
Based on case-study testing and refinement of the research-quality code, deliver the upgrade SREF codes to NCO for November 2008 SREF upgrade package.

08.5.20.5 31 March 2008 (GSD and NCEP)
Develop a preliminary procedure appropriate for aviation users from Very Short-Range Ensemble Forecast (VSREF) system using high-resolution RUC and NAM existing runs.

08.5.20.6 1 July 2007 (GSD and NCEP)
Further calibrate probabilities and potential echo-top (improve statistical reliability) ensemble cumulus information.