MODEL DEVELOPMENT AND ENHANCEMENT RESEARCH TEAM

Monthly Report for January 2008
Submitted 15 February 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 North American Mesoscale (NAM) operational modeling systems.

- RUC cloud analysis revised for improved use of METAR cloud data, crisis change implemented on 8 Jan 2008, see http://ruc.noaa.gov/gif/ruc13/RUC-crisis-change-Jan08-summary.pdf .
- Testing continues at NCEP for RUC upgrade package code (radar reflectivity assimilation, TAMDAR, radiation, Grell/Devenyi upgrade), very good results (surface, convection, ceiling/vis, precip) evident for Jan. Implementation now planned for May-June 2008. See real-time comparisons in http://wwwt.emc.ncep.noaa.gov/mmb/ruc2/para . Summary from AMS Conference (late Jan) available here: Implementation of the radar-enhanced RUC.

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

- New Rapid Refresh summary at http://rapid.refresh.noaa.gov .
- Web-page comparing cold start and hourly cycled RR at http://rapidrefresh.noaa.gov .
- Papers presented at AMS conference on Rapid Refresh progress.

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

- Continued progress toward WRF version 3.0 planned for spring 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. This important modification to the Grell-Devenyi convective scheme will also be included in WRFv3.0.

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.

Detailed report – MDE – January 2008

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

GSD

RUC upgrade continues in parallel testing at NCEP through January. Some problems surfaced with availability of radar reflectivity observations to parallel RUC at NCEP. GSD (Steve Weygandt, Stan Benjamin) and NCEP (Geoff Manikin, Shun Liu) are working together to diagnose problems with observation availability and to correct them, with some success already.

BACKGROUND on RUC upgrade:
Please see the October report for more details on RUC upgrade. Key components:

- Assimilation of new observations: radar reflectivity, TAMDAR aircraft, mesonet winds
- Model physics changes – RRTM radiation (new), Grell-Devenyi convection with non-local subsidence warming, snow density in land-surface model.

Effect of changes:

- Much improved precipitation, new reflectivity products.
- Elimination of 2m temp warm bias in summer and cold bias in winter.
- Improved lower tropospheric temps, winds, RH, clouds (TAMDAR, physics)

A new update on the RUC upgrade is available from the 11 Dec 2007 presentation at http://www.emc.ncep.noaa.gov/research/NCEP-EMCModelReview2007/RUC-NCEP-OperReview-Dec07-RRb.pdf

A 44-slide summary of RUC upgrade at http://ruc.noaa.gov/ruc13_docs/RUC-upgrade-early08.pdf and a November post to the RUC forum on RUC upgrade available at http://ruc.fsl.noaa.gov/forum/f2/Welcome.cgi/read/1713

January 2008 Crisis change:
GSD also developed improved processing of the RUC cloud analysis to ensure assimilation of METAR cloud observations failing to meet criteria for inclusion. Previous criteria in the cloud analysis were well-intentioned but found to be removing up to 30% of all METAR cloud observations. Using the new modified RUC cloud analysis code, a much higher percentage of METAR cloud obs are now captured in the RUC cloud analysis. A figure shown below depicts the CSI for 0h (analysis) and 1h forecast for 1000-ft ceiling over the RUC domain for the operational RUC and the development RUC13 (using the new cloud analysis). The accurate of both (analysis, short-range forecasts) is now much improved. Change implemented to NCEP oper RUC on 8 Jan 08 12z. See http://ruc.noaa.gov/gif/ruc13/RUC-crisis-change-Jan08-summary.pdf for more details.

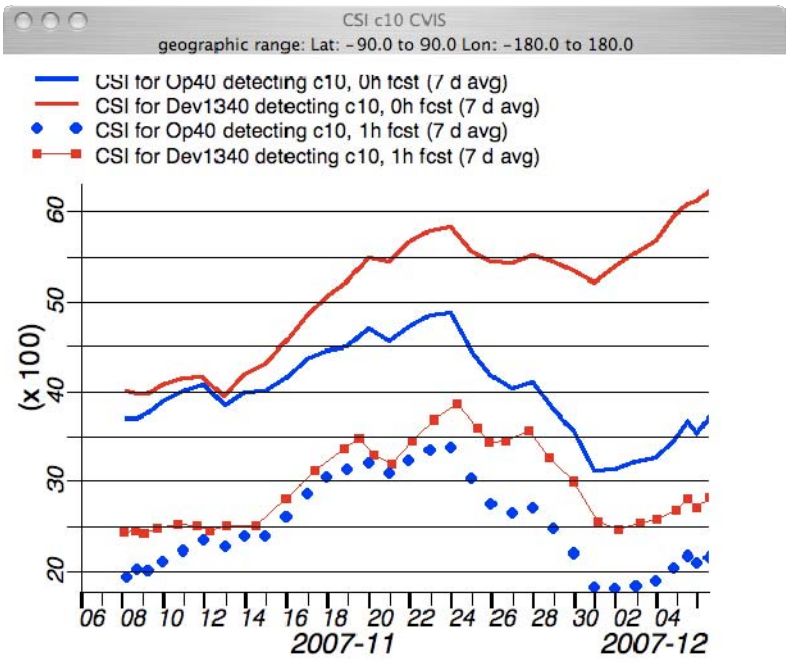

Figure 1. CSI for IFR (1000-ft) ceiling for 0h (analysis) and 1h forecast for the operational RUC and the development RUC13 (using the new cloud analysis) during testing period (Nov-Dec 2007).

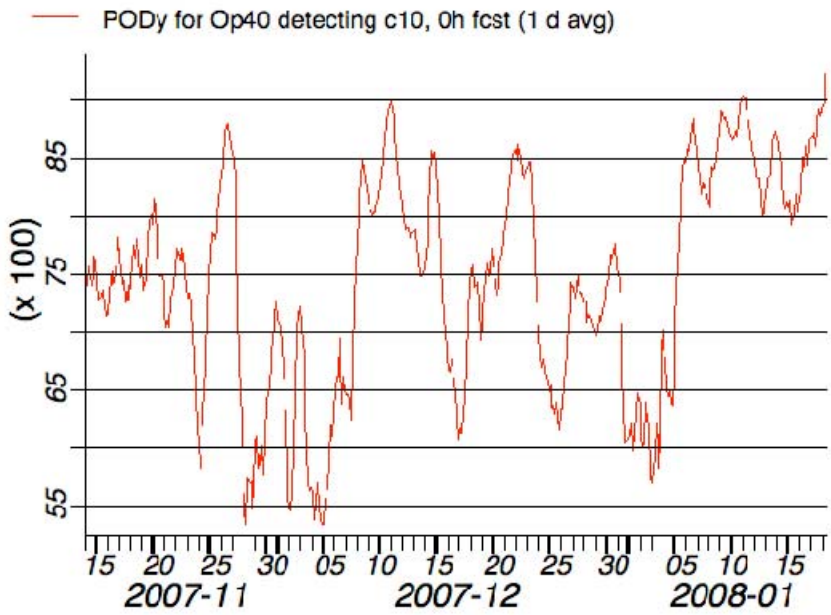

Figure 2. Probability of detection (yes) for IFR (1000 ft) ceiling from operational RUC analyses from 15 Nov 2007 to 18 Jan 2008. Change made on 8 Jan 2008. (Note: Verification here uses 40km output grids, resulting in some degradation.)

The crisis change implementation was submitted to NCEP/NCO by GSD and NCEP/EMC in December 2007 and implementation occurred on 8 January 2008.

Information on both RUC change package and ceiling/vis crisis change:
Paper presented at AMS Aviation, Range, and Aerospace Forecasting Conference, Jan 2008, New Orleans:

Stan Benjamin, NOAA/ESRL, Boulder, CO; and S. Weygandt, J. M. Brown, T. Smirnova, D. Devenyi, K. Brundage, G. Grell, S. Peckham, T. W. Schlatter, T. L. Smith, and G. S. Manikin, Implementation of the radar-enhanced RUC. Paper 6.2

INTERFACE WITH OTHER ORGANIZATIONS:
Extensive interactions with NCEP and NOAA/MDL.

NCEP

Dennis Keyser reports that a mesonet decoder implementation on 15 January increased the upper limit for handling reports in a single file from 50K to 100K reports. This has resulted in a small increase in the number of reports available for assimilation. Tests of both the "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. Parallel testing of TAMDAR aircraft data is also currently underway. Cooperative Agency Profiler (CAP) and RASS data are not yet available through an alternate NOAA/ESRL MADIS feed.

During the 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 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. Daily comparison of operational and parallel forecasts continues, and statistical evaluation of the new version of the model is underway.

EMC implemented a small change package of corrections in early January. NCO alerted EMC to an issue with some forecasts pushing up against memory limits in December 2007, so the number of processors used to run the model was slightly reduced, with only a very slight increase in run time, an increase that does not impact time requirements for delivery of RUC products. In addition, a few errors with the assimilation of METAR data as well as a bug in the post processing of the precipitation rate were corrected.

The operational RUC experienced a few incomplete cycles scattered throughout the month of January. In each case, there was no crash; the code simply exited during integration prior to completion. IBM has determined that the incomplete runs all occurred on the same two computer nodes, so the initial hypothesis is that this is a computer issue and not a model code issue, but further investigation will occur.

Shun Liu was working with NCO to build new level II data decoder and figure out the problems of radar QC package when NCO tests the new decoder.

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.
CURRENT EFFORTS: Ongoing for both NCEP and ESRL/GSD.

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.
CURRENT EFFORTS: Ongoing for both NCEP and ESRL/GSD.

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.
CURRENT EFFORTS: Ongoing for both NCEP and ESRL/GSD.

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

ESRL/GSD

The Rapid Refresh home page (http://rapidrefresh.noaa.gov) contains current information about the RR as well as access to real-time RR runs. A summary of RR status as of December 2007 is included in the RUC Rapid Refresh update presentation at the NCEP model review on 11-12 Dec 2007 -- http://www.emc.ncep.noaa.gov/research/NCEP-EMCModelReview2007/RUC-NCEP-OperReview-Dec07-RRb.pdf

Two 6-h cycles and an experimental 1-h cycle (all on the full RR domain) continue to run on GSD's wJET computer. Graphical and image output from the primary 6-h real-time cycle is available off the RR home page (the 13-km-Rapid-Refresh left side of page). Additional fields can be viewed using the RUC grib viewer also linked off this page. In addition, a cold-start version of the WRF-ARW, with the diabatic digital filter initialization (DDFI, reported on last quarter) also continues to run over the large RR domain every 12-h. Rawinsonde verification for the RR forecasts (cold start and primary 6-h cycle) was introduced in October and continues. The secondary 6-h cycle is being used to introducing new features (full satellite radiance assimilation package with bias correction) and trouble-shooting performance issues (sea-ice updating). The 1-h cycle has been running, but disk I/O slowdowns on the wjet /tg file system have sometimes caused the cycle not to complete within the hour (see additional details in

Subtask 08.5.4.1).

The following papers concerning the Rapid Refresh were presented at the 13th AMS Conference on Aviation, Range and Aerospace Meteorology in New Orleans, 20-24 January 2008, by GSD authors:

Stan Benjamin, NOAA/ESRL, Boulder, CO; and J. Brown and S. S. Weygandt
High-frequency updating of weather model prediction in the NextGen era, Paper 5.3.

John M. Brown, NOAA/ESRL, Boulder, CO; and T. G. Smirnova, S. G. Benjamin, B. Jamison, and S. S. Weygandt: Rapid-refresh testing: examples of forecast performance, Paper 7.1.

Ming Hu, NOAA/ESRL, and S. Weygandt, S. Benjamin, and M. Xue: Ongoing development and testing of generalized cloud analysis package within GSI for initializing Rapid Refresh, Paper 7.4.

This paper was presented in the AMS IOAS-AOLS Conference:
Steve Weygandt, NOAA/ESRL, and S. Benjamin, T. Smirnova, and J.M. Brown: Assimilation of radar reflectivity data using a diabatic digital filter within the Rapid Update Cycle, Paper 8.4 – IOAS-AOLS.

And this paper was presented in the AMS 3rd Conf. on Meteorological Applications of Lightning Data:
Steve Weygandt, NOAA/ESRL, and S. Benjamin, M. Hu, T. Smirnova, and J.M. Brown: Use of lightning data to enhance radar assimilation within the RUC and Rapid Refresh models. Paper 8.4

NCEP

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

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: See discussion under subtask 4.1 below.

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: The 1-h cycle has been running, but disk I/O slowdowns on the wjet /tg file system have sometimes caused the cycle not to complete within the hour, leading to breaks in the cycle. We and the supercomputer experts are actively pursuing several tasks to make the 1-h cycle more robust including 1) testing different methods for the parallel I/O, 2) using different disks for the I/O, 3) setting aside a partition of 112 nodes to be dedicated to the RR 1-h cycle on wJET and 4) running the RR 1-h cycle on ESRL's eJET computer (that does not require using the /tg file system) and doing only the forecasts on wJET. In addition we are modifying the scripts to handle dropped cycles and restarts more effectively. These issues should be temporary as an upgraded file system is planned for this spring.

Other work has focused on implementing the satellite bias correction code (provide by EMC), which is needed to properly use the satellite radiance assimilation package. In porting the code form NCEP to the ESRL Linux supercomputers, a number of platform related problems were encountered. First, GSI code

had to be modified at several points in order to generate 'little endian' satellite diagnostic files. This was necessary because the angle bias correction code uses derived data types and 'endian conversion' is not supported for derived data types by the Intel compiler. Then the code 'global_angupdate' was slightly modified to include some open and close for the namelist file. A script was then developed to perform test computations with the combined GSI and satellite angle bias correction system. It worked according to expectations. Testing is now complete and we are working to add the satellite radiance assimilation into the 6-h RR cycle, then 1-h cycle.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: See description above for minor issues related to wJET I/O on the /tg disk.

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.

Stan Benjamin briefed the NWS Alaska Region Science and Operations Officers (SOOs) and other NWS Alaska Region staff on 15-16 Jan 2008 in Anchorage on Rapid Refresh status and progress (and TAMDAR impact studies with RUC) and encouraged feedback from the NWS offices on RR performance over Alaska once output from the hourly cycle becomes available. The Rapid Refresh web site now offers an Alaska-window (based on AWIPS grid 249) display to facilitate evaluation of RR products over that area, and beneficial feedback has already been received from Alaska Region forecasters.

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 has made the necessary information available to these AWRP-RTs (see FY08Q1 report) 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) as specified in the Sept 2007 Rapid Refresh MOU between NCEP and GSD.

The design of the digital filter initialization (DFI) code in the WRF-ARW for the Rapid Refresh includes much code *above* the level of the particular dynamic core. This design has been accepted as the DFI framework for WRF version 3, scheduled for release in March 2008. This simplifies application of DFI to the NMM dynamic core, possibly a component of the 2012 RR ensemble.

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

Output from the full-domain RR 6-h cycle, as well as that from the full-domain cold-start runs continue to be available. 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 Alaska window display (based on AWIPS grid #249) has been added 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.

The availability of the web displays noted above is now facilitating this evaluation. This enabled recognition that skin temperature was being initialized to 271K in areas of sea ice coverage by the module that sets the initial fields in WRF. A fix to this problem has been proposed by GSD to the NCAR WRF developers and has been implemented into the GSD cold start runs and is being testing in the RR cycle runs.

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 TAMDAR and AMDAR data with an off line parallel system using the full-resolution, full-domain regional parallel as a control. The wind, temperature, and humidity observations were tested separately before all the data were used together. Adaptive tuning was used to assign the observational error for the data during the first period. The following period was then used to evaluate the data impact. A small positive impact in all the variables was found. (Similar to ESRL/GSD results included in their paper, Implementation of the radar-enhanced RUC.) With a low-resolution system the impact of using a background error covariance suitable for the first guess field from the global system in the NDAS was tested and an improvement to the forecasts was found. She also studied an adaptive regression based on a simple Kalman filter approach. A possible application of this method is as a post processor or to correct the model bias.

Shun Liu was working with David Parrish to merge GSI codes related radar data assimilation to latest version of GSI. A set of new scripts have been developed to run radar data assimilation and forecast in a small domain in near real-time. Efforts were made to set up a verification package for the small domain.

GSD

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.

At ESRL/GSD, Ming Hu's work to fully incorporate the updated and parallelized cloud analysis into the latest version of GSI that is being used for the cycling Rapid Refresh runs is complete. Real-time cycled runs with the cloud analysis are ongoing on the GSD wJET computer. Analysis of results is ongoing and has revealed issues that have been corrected. Recently, visibility, ceiling, and cloud-top height plots have been added for the RR cycled runs and have proven helpful in the evaluation of the cloud analysis performance. A progress report on the cloud analysis was presented at the AMS ARAM conference and can be found at: http://ruc.noaa.gov/GSI_cloud_analysis_report.pdf

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 was added during Quarter 1 and indicates reasonable agreement of model forecasts with observations. Detailed statistical evaluation awaits improved reliability of the hourly cycle and the full satellite assimilation.

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.

CURRENT EFFORTS:

PLANNED EFFORTS:

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.

CURRENT EFFORTS:

PLANNED EFFORTS:

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

NCAR/MMM
NCAR conducted the first WRF tutorial of the year January 14-18, 2008, with approximately 60 people attending. The tutorial covered model structure, preprocessing, operation, and data assimilation, and practical sessions provided opportunities to run components and make simulations. The tutorial was held jointly with the DTC.

NCAR is working on the preparation of release of WRF Version 3.0. The WRF repository is frozen to new features until after the release, planned for Spring 2008.

WRF physics work was done by Jimy Dudhia of NCAR/MMM. He added slope and shading effects, supplied by Guenther Zaengl (Univ. Munich), to the Dudhia shortwave radiation option. The radiation schemes in WRF previously neglected these terrain effects. For the Goddard shortwave radiation scheme, a minor fix was added to the repository. This was provided by the developers at NASA Goddard.

A new Goddard microphysics options from NASA Goddard was added to the repository after testing. Some hurricane physics changes were also added, including a mixed-layer ocean model.

Dudhia collaborated with Beth Weekley (Developmental Testbed Center) in adding changes to allow the YSU PBL scheme to run with the NMM core. Testing is still needed at the DTC before this is considered a supported option, however. In other PBL work, the ACM2 PBL scheme was added as an option after some testing and minor fixes.

In land surface modeling, the unified Noah LSM was split into two modules to make it easier for the LSM group to maintain it with the off-line version. An improvement to its urban land-use category was also added. For the Urban Canopy Model available to Noah an anthropogenic heat source capability, developed by Mukul Tewari (NCAR) and others, was added. Lastly, the Pleim-Xiu LSM scheme (from the EPA) was added as an option in the repository code.

A rigid lid upper boundary option, developed by Joe Klemp of NCAR, was added for idealized applications. An exponential function was added as an option for the lateral boundary zone's strength function. This is useful for the broader boundary zones often used in regional climate applications. The use of isotropic versus anisotropic horizontal and vertical diffusion coefficients was improved based on problems found by Ligia Bernardet (NOAA) and recommendations from Joe Klemp and Bill Skamarock (NCAR).

ESRL/GSD
ESRL/GSD has also worked with MMM toward WRF v3.0 to introduce the digital filter initialization, similar to that used in the RUC model, for the WRF ARW code (see additional info under 5.15). The accumulation process and application of the digital filter weighting are applied *above* the dynamic core (solve*.F), so application to other dynamic cores in the future will be greatly simplified. GSD also contributed improved versions of the Grell-Devenyi scheme, the RUC/Smirnova land-surface scheme.

GSD has also contributed improvements to the WRF Real program (working with NCAR/MMM) to allow community use of RUC native-grid initial conditions including hydrometeors.

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.
CURRENT EFFORTS:

PLANNED EFFORTS: The WRF users' workshop will be in June 2008.

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

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.

Initial qualitative and quantitative evaluation of the RR cycled runs has begun, revealing specific issues that are being addressed, including a fix for the update of Arctic Ocean sea-ice.

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 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.

Observational cases in support of the above development continue to be developed. Work also continues on expanding the current scheme to two moments and adding an aerosol variable.

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 remains concerned about the performance of both RUC and RR in situations of strong low-level warm advection of air at temperatures well above freezing (e.g., 10 deg C) over snow-covered areas. Under such conditions the forecast of 2m temperature tends to verify much colder than observed. We think a contributor to this error is the way the surface energy budget is used to infer the rate of melting of snow. In effect, the temperature at the ground surface is constrained to not rise above 0C when snow is present, with any excess heat being used to melt the snow. There are constraints on the rate of snow melt that can in principle allow the surface temperature to be above freezing and that are not taken into account in the RUC-LSM. Tanya Smirnova is looking into this matter in detail, and we expect to soon test changes to the formulation of the surface energy budget in regard to snow melt.
Initial testing will likely be using RUC given the possibility that promising changes might be included in the RUC 2008 change bundle.

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.

NCAR
Test and evaluate current stratocumulus parameterizations for the prediction of icing and if necessary develop a new parameterization for the formation of icing including freezing drizzle in stratocumulus clouds. This will involve comparison to observations of well observed cases such as January 31 case from Cleveland, Ohio as part of the NASA/Glenn in-flight icing field studies and the use of LES modeling with WRF to simulate the processes forming super-cooled liquid water and drizzle. This task

will be linked to the aerosol task due to the finding that CCN concentration often plays a dominant role in the formation of drizzle in these types of clouds.

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.

NCAR
In collaboration with NCAR/RAL, investigate potential for RR application of existing physics schemes that combine PBL processes with prediction of PBL-driven stratocumulus or shallow cumulus.

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 May 2008 (NCAR)
Status of improved microphysics scheme to ESRL for evaluation in WRF Rapid Refresh.

07.5.8.E4 30 September 2007 (NCAR)
Report on the stratocumulus task given above.

The final report on this task was delivered on September 27, 2007.

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

CURRENT WORK: As noted way back in the MDE-RT FY07Q4 report under task 4, WRF model code was successfully modified to allow backward-forward diabatic digital filter initialization in the WRF-ARW. The GSD design of the DDFI was intended to impact the core-dependent (i.e., specific to either ARW or NMM) parts of the WRF code as little as possible. 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, in addition to the DFI code itself, 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, has been functioning well in the 13-km RR cold start runs at GSD for over 3 months. 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. We have been able to reduce the noise further by use of a newer, more effective low-pass filter code that will be part of WRF v3.0. We will soon switch the cycled runs over to the DDFI version of the ARW model (Task 4). Some further tuning of the DDFI may yet occur, including increasing the time interval for the backward and forward integrations to eliminate a larger portion of the gravity-wave frequency spectrum, once we have a chance to systematically evaluate the RR 1-h cycle.

08.5.15.3 30 March 2008 (GSD and CAPS)

FUTURE EFFORTS:
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, forecasting tests at the 4-km resolution are being performed with the WRF-GSI system. Conventional observations in PREPBUFR file and NSSL mosaic reflectivity data are used in GSI. Forecasting experiments aim at testing the effectiveness of the generalized cloud analysis package with WRF ARW model. Forecast experiments were performed using initial conditions obtained three different ways: 1) direct interpolation from NAM 12-km real-time analysis; 2) GSI analysis using conventional observations in PREPBUFR file only; 3) GSI analysis that includes additional reflectivity and other cloud observations via generalized cloud analysis scheme. Some semi-empirical parameters in the generalized cloud analysis were investigated. Three-hour forecasts starting from these initial conditions were performed with two different microphysics schemes (Thompson graupel and Lin schemes). For a March 2006 squall line case, all experiments were able to capture the main characteristic of the system, with the results include cloud analysis being the best. The impact of the cloud analysis does not seem to be very sensitive to the microphysics scheme used. The reflectivity formulas used in the cloud analysis are consistent with the specific microphysics scheme used in the prediction model. Quantitative evaluation of the forecasts is being performed, and experiments with more cases will be needed for reliable statistics. The latter will be carried out in collaboration with GSD.

Efforts are also being made to upgrade the WRF model to version WRF2.2 and link it with GSI.

Assistance from Ming Hu of GSD/DTC is greatly appreciated

The CAPS received $70,000 FY2007 funds in August 2007. In January, about $5000 (loaded) was spent on salary, with $40,420.0 remaining.

Testing of GSI cloud analysis in RR testing, revision of GSI cloud analysis with updates to RUC cloud analysis as reported under 08.5.1.

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 since an implementation on 4 December, the GSI is not calculating virtual temperature as expected for MDCRS ACARS reports (it is analyzing sensible temperature). This will be corrected in the FY08/Q2 NAM-GSI update. 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 all f-o-v radiances, mesonet winds filtered by provider via NOAA/GSD's "uselist", and MODIS IR and water vapor satellite winds. QuikSCAT 0.5 degree scatterometer wind superobs, as well as TAMDAR (via ESRL MADIS feed) and Canadian AMDAR aircraft data will both be monitored in the GSI after the FY08/Q2 NAM-GSI update. 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.

Starting late December, EMC began running a parallel test of the NDAS/NAM system using "partial" cycling, in which each NDAS cycle is initialized from GDAS atmospheric states and cycled NDAS land-

surface states. Eric Rogers reports that compared to the control NAM (in which the NDAS fully cycles on itself), parallel NAM forecast height, temperature, and vector wind RMS errors vs. rawinsonde data are reduced by up to 10%.

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.

08.5.17.6 Provide assistance to Inflight Icing, Turbulence, Convective Weather, Ceiling and Visibility and Oceanic Weather PDTs when their algorithms and product generation systems are ready to transition into NCEP's operational Production suite.

Deliverables

08.5.17.E1 (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.

UNFUNDED

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.

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.

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

UNFUNDED