MODEL DEVELOPMENT AND ENHANCEMENT RESEARCH TEAM
Quarterly Report for January-March 2007
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Executive Summary

Task 07.5.1: Infrastructure support related to operational running of the RUC and North American Mesoscale (NAM) operational modeling systems.

- Summer RUC change package -- RUC analysis (including mesonet winds, radar reflectivity), model changes (RRTM longwave radiation and updated convection), and postprocessing enhancements (forecast radar reflectivity fields) nearly ready to go to NCEP.

Task 07.5.4: Develop, test, and implement Rapid Refresh configuration of the WRF modeling system.

- Real-time WRF-RR 12-h cycle now running on full North American domain and CONUS domain (GSD)

Task 07.5.5: Develop, test, and implement improvements to the operational WRF 3DVARs for Rapid Refresh and North American Mesoscale runs.

- Good progress toward option to derive ensemble-based background error covariances for use in GSI (NCEP)
- Work continues on merging GSD and ARPS cloud/hydrometeor analyses and understanding sensitivity to microphysics scheme

Task 07.5.6: Develop, test, and evaluate the performance of the nonhydrostatic WRF modeling System.

- Progress toward correcting interactions between boundary-layer schemes and Ferrier microphysics

Task 07.5.8: Improve model physics for aviation forecasts

- RRTM longwave radiation implemented in development RUC with successful results for improving nighttime near-surface forecasts in warm and cold seasons. RRTM will now be included in the RUC summer change package.

Task 07.5.15: Develop improved methods of cloud and moisture analysis for use in the WRF Modeling System.

- Real-time cycled tests of radar-based latent heat nudging in RUC diabatic digital filter initialization substantially improve 0-6 h precipitation forecasts.
- Retrospective cycled tests of combined RUC/ARPS cloud analysis (assimilating METAR cloud and GOES-cloudtop data) within GSI-WRF framework.

Detailed report – MDE – 2nd Quarter 2007

Task 07.5.1: Infrastructure Support Related to Operational Running of the RUC and North American Mesoscale (NAM) Systems

NCEP

Dennis Keyser reports that Cooperative Agency Profiler (CAP) and RASS data are not yet available through an alternate ERSL MADIS feed. A new version of the BUFR archive library was implemented on 6 February. GOES-11 layer precipitable water retrievals and GOES-11 cloud-top pressure data were made available to the RUC assimilation on 6 February. GOES-12 satellite-derived wind quality was degraded from 20-21 February due to problems in the image calibration resulting from the activation of an anti-ice heater on the satellite. Three new subproviders (TELLURIDES, ABASINSA and ASPENSKICO) were added to the Colorado Avalanche Information Center (CAIC) mesonet on 14 February.

GSD

GSD efforts during the Jan-Mar quarter have focused mainly on finishing the 2007 change package for the RUC prior to its transfer to NCEP for pre-implementation testing.

This RUC analysis/model change package (planned for implementation at NCEP by summer 2007) is currently running in the 13km dev RUC (http://ruc.noaa.gov/pig.cgi?13km_D2) and as of 4 April, also running in the more-hardened 13km backup RUC (http://ruc.noaa.gov/pig.cgi?13km_BU). A number of changes have been developed and implemented in the devRUC13, including:

- Improved diabatic assimilation of 3-d radar reflectivity via diabatic digital filter initialization. Further modifications made in March.
- Correction to RH observation errors for in-situ and precipitable water moisture observations, resulting
- Addition of column-maximum (i.e., composite) reflectivity product in RUC post-processing. This is now being shown in real-time products for both the devRUC13 and the backup RUC13 (without radar reflectivity assimilation). Comparison of the radar-reflectivity from devRUC13 and backup RUC13 products has been especially effective in showing improvements from radar-reflectivity assimilation.
- Addition of lightning assimilation to complement the 3-d radar reflectivity assimilation. This adds building of convective areas where lightning strokes are evident and there is no 3-d radar reflectivity data (i.e. over oceans, outside of CONUS).
- 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 (warm season, discussed in the FY06Q4 MDE Report).
- Land-surface model changes for improved 2m temperature over snow cover
- Change to Grell-Devenyi convective parameterization with improved (decreased) areal coverage for light convective precipitation (see 07.5.8 on both topics).
- Analysis changes to:
    - Assimilate mesonet winds using a new "mesonet provider uselist"
    - Differentiate wind observation error between GPS rawinsondes and non-GPS rawinsondes
    - Assimilate TAMDAR aircraft observations, if they become available for operational use
- Post-processing changes – tropopause theta.

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. A new verification capability developed by Bill Moninger to verify RUC (and other) models against rawinsondes at 10-mb intervals instead of the usual mandatory-level intervals is increasingly utilized for monitoring these different RUC versions.

INTERFACE WITH OTHER ORGANIZATIONS:
Discussion between GSD and NCEP/EMC on upcoming RUC changes, NSSL on 3-d radar data, NCAR on radar assimilation, NCEP on radar data availability.

Discussions between GSD and RUC users in NWS and private sector on RUC performance.

Subtasks

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

The operational RUC has had no failures at NCEP during the quarter.

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

NCEP maintained real-time availability of SAV and AIV guidance to all vendors from the operational hourly RUC via the NWS Family of Services (FOS) data feed and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (EMC Team and NCO)

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

NCEP maintained real-time availability of full resolution gridded data from the operational RUC runs via anonymous ftp access via the NCEP server sites. This includes hourly BUFR soundings, and output grids which undergo no interpolation and, as such, are on the models' computational grids (so-called native-native grids). NCEP provides anonymous ftp access on ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/ . (EMC Team and NCO)

07.5.1.4 Maintain access to model verification data.

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

Deliverables

07.5.1.E1 1 October 2006 - 30 September 2007 EMC (Rogers, Manikin, Keyser)
Perform observation ingest, quality control, and preparation in support of the operational RUC runs.
CURRENT EFFORTS: On 8-9 January, NESDIS made an unscheduled change in its GOES satellite wind processing which led to corrupted BUFR files and no data availability. The Colorado Avalanche Information Center (CAIC) was added to the sources of Mesonet data assimilated by the RUC on 11 January (with three additional new sub-providers, TELLURIDES, ABASINSA and ASPENSKICO, added to CAIC on 14 February). A new version of the BUFR archive library was implemented on 6 February. GOES-11 layer precipitable water retrievals and GOES-11 cloud-top pressure data were made available to the RUC assimilation on 6 February. GOES-12 satellite-derived wind quality was degraded from 20-21 February due to problems in the image calibration resulting from the activation of an anti-ice heater on the satellite. Cooperative Agency Profiler (CAP) and RASS data are not yet available through an alternate ESRL MADIS feed. (Keyser)

PLANNED EFFORTS: EMC is preparing to test updates to the Rapid Update Cycle during the spring and summer of 2007. The analysis code will be updated to assimilate radar reflectivity with potential to improve precipitation and moisture forecasts. Changes will also be made to improve quality control of mesonet observations, particularly winds. The snow model code in the forecast will be revised to improve nighttime treatment of temperatures over fresh snow; the model currently contains a significant cold bias in these situations. A few radiative changes will also be made to deal with both the bias of cold temperatures over fresh snow and a warm nighttime bias in the warm season. A few minor changes to the convective scheme will also be made to handle capped environments. Parallel testing should begin in late April, and retrospective tests on cold season cases will be run during the summer. (Manikin)

Add a new aircraft quality control module based on code developed at Naval Research Lab. Increase time window for aircraft data in order to improve track checking. Change PREPBUFR processing to add report sub-type

information so analysis can use different obs errors and develop bias corrections based on data sub-types (e.g., airframes and ascent/descent tag for aircraft data, providers and sub-providers for mesonet data, instrument type and on-site correction indicator for radiosonde data). Do impact tests in RUC for several new data types: TAMDAR and Canadian AMDAR aircraft, hourly WSR-88D 3-dimensional reflectivity. (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: GSD & NCO.

UPDATES TO SCHEDULE: Complete 30 September 2007.

Task 07.5.4: Develop, test, and implement Rapid Refresh configuration of the WRF modeling system.

NCEP
NCEP has no scientific activity to report. Much discussion has taken place between NCEP and GSD concerning the RR Core testing and WRF core selection for the RR.

GSD

GSD, NCAR and the DTC reviewed and discussed documents (Requirements for Maintenance, Enhancement and Transition to Operations for the Rapid Refresh System in the context of the more general document Requirements for Maintenance, Enhancement and Transition to Operations at the NCEP Environmental Modeling Center) provided by NCEP and appended to the January report. Much further discussion took place between NCEP and GSD.

GSD continues to run and verify WRF forecasts initialized with RUC over the CONUS domain and cycled with GSI over the RR domain; see details below. A focus of activity during the last half of the quarter was to convert to use of the latest version of GSI and WRF v2.2, including the new WRF Preprocessing System and the v. 2.2 WRFpost on the new ESRL computer WJET.

Three abstracts dealing with various aspects of work toward the RR (overall review of RR status, the RR Core Test results, and GSI progress) were submitted to the American Meteorological Society Conference on Weather Analysis and Forecasting/Numerical Weather Prediction scheduled for June at Park City UT. An additional paper dealing with diabatic initialization using radar/lightning data in RUC (but having RR application) was also submitted.

PLANNED EFFORTS: Complete the migration of the Rapid Refresh cycle from iJET to wJET, including 1) upgrade to WRF v2.2 for (model, pre and post processing software), use on latest version of GSI.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: DTC, NCEP, NCAR

UPDATES TO SCHEDULE: None.

Subtasks

07.5.4.1 15 Nov 2006 (original due date), deferred to 15 Jan 2007. COMPLETE as of 10 Dec 2006. (GSD)

Begin real-time cycling of the RR model with GSI over RR domain at degraded resolution.

CURRENT WORK: The Rapid-Refresh real-time cycle, which has been running on iJET is being migrated to the new ESRL supercomputer (wJET). Several updates are being wrapped into this transition, including 1) upgrade to latest version 2.2 of the WRF code (including changes to model and pre- and post-processing software, 2) upgrade to lastest version of GSI. The last few endian-related issues with GSI on WJET were overcome through the joint efforts of Dezso Devenyi, Jacques Middlecoff and the computer staff. The new WRF Preprocessing System (WPS) runs much faster than the old WRFSI pre-processing software, but there remain some issues for cycling with WPS on WJET. Those and a few wJET WRFpost 2.2 issues are being addressed as part of the migration to wJET. WJET

will provide increased capacity compared to IJET, so once remaining problems are overcome we can increase the cycle frequency from the current once per 12h.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: Delayed task is now completed

INTERFACE WITH OTHER ORGANIZATIONS: NCEP

UPDATES TO SCHEDULE: This task for which we previously requested a 2-month delay (from 15 Nov 2006 to 15 Jan 2006) is now complete.

07.5.4.2 15 Jan 2007 (GSD, DTC) – Completed 5 Jan 2007

Build retrospective period capability including different seasons for testing of RR with cycling.

CURRENT WORK: The retrospective period chosen is the 10-day period 26 November to 6 December 2006. This period includes a good variety of weather, including a severe snow/ice storm and severe weather on 29-30 November over the Plains and Midwest. This retrospective period is being used very productively for testing impact of TAMDAR observations under non-MD&E funding. It is also available for testing the summer-2007 RUC change package, if needed.

07.5.4.3 Build graphics and web viewing capability for display of ESRL RR real-time and retrospective runs.

07.5.4.4 Further enhancement of WRF-post version for Rapid Refresh application, including modifications to generation of RUC-specific fields.

Build graphics and web viewing capability for display of GSD RR real-time and retrospective runs.

CURRENT WORK: Web-viewing capability became available for real-time RR cycled runs over the CONUS domain in October, and is being extended to cover the full North American domain. Images and graphics from this can be viewed at http://www-frd.fsl.noaa.gov/mab/wrfruc. Limited objective verification became available over the CONUS during the quarter.

07.5.4.5 Ongoing (GSD)

Further enhancement to WRFpost version for Rapid Refresh application, including modifications to generation of RUC-specific fields.

CURRENT WORK: Tanya Smirnova has begun modifying the 2.1.2 version of WRFpost used in the RR Core Test last year so it can be used to generate grib output over the full RR domain.

07.5.4.6 Ongoing (GSD, NCAR later)
Ongoing evaluation of real-time and retrospective runs of RR system for SAVs and AIVs

Deliverables
None.

07.5.4.7 1 Nov 2006 (GSD) - ongoing

Start to solicit input from other AWRP Research Teams and NWS forecasters in Alaska and Puerto Rico regarding how they wish to use the RR and particular forecast challenges for which the RR might be able to provide guidance.

CURRENT WORK: Follow-up contacts have continued and resulted in an invitation from James Partain, Chief of the NWS Alaska Region Scientific Services Division, to Stan Benjamin to discuss RR current development and plans with NWS forecasters and others at the Great Alaska Weather Modeling Symposium in Fairbanks in March. In addition to NWS, participants in the symposium included university researchers and interested parties from the

University of Alaska.

This visit proved very educational regarding forecast challenges of the Arctic and shortcomings of models in Alaska. Discussions included use of satellite and radar data for hydrometeor analysis, the problem of initializing and predicting Arctic stratus clouds, Alaska modelers' experiences with both the Noah and RUC LSMs for surface fluxes and shelter temperature prediction under wintertime conditions (RUC LSM 2-layer snow preferred by some), and desired coverage of Alaska for the RR domain (forecasters would like a slight extension north and west to get the boundaries slightly farther from Barrow (northern Alaska) and to include Dutch Harbor (54.0N/166.5W) in the Aleutians in the RR domain.

INTERFACE WITH OTHER ORGANIZATIONS: NWS--Alaska Region

Deliverables

07.5.4.E1 15 October 2006 (GSD)
Complete a technical report describing the GSD preliminary real-time and retrospective testing of the WRF Rapid Refresh system.

Completed 1 September 2006. GSD report was sent to NCEP (see FAA-AWRP MD&E FY06 Q4 report) and made available on the web at http://ruc.fsl.noaa.gov/coretest2 /

07.5.4.E2 15 July 2007 (GSD)
Deliver report to NCEP on progress with WRF Rapid Refresh code toward FY09 Rapid Refresh implementation.

Task 07.5.5: Develop, test, and implement improvements to the operational WRF 3DVARs for Rapid Refresh and North American Mesoscale runs.

NCEP

Manuel Pondeca has made substantial progress in adding the option to generate ensemble-based background error covariances to the GSI-regional. The input ensemble fields, which can come either from the regional or the global ensemble system, are used to prescribe the local aspect tensor of the anisotropic component of the error covariances.

Wan-Shu Wu did some experiments in an attempt to reduce the impact of satellite radiances on moisture analysis. As reported last month, much of the NAM spindown appears to be associated with satellite data with the sign of the moisture increment opposite to that from conventional observations. To reduce the impact, conventional observation and background moisture error were decreased, since it was not obvious how to change the error of satellite radiances to achieve the same effect. Results of tests were neutral to slightly negative. Sensitivity tests to fine tune the magnitude of divergence damping in the model are also ongoing. While a value of 5x was used in the December crisis change bundle, forecasts are degraded when values less than 5x are used and seem optimal at 6x.

Dave Parrish reports that the regional strong dynamic constraint was introduced into the NAMX parallel for comparison against the operational NAM. Results after 3 weeks are mixed. There is general improvement in RMS height out to 48 hrs, but degradation by 84hrs. RMS winds are neutral to slightly positive over the entire range of forecasts. RMS temperatures are neutral to slightly worse, but always better at 100mb. Threat scores and bias degrade somewhat for heavy amounts. One consistent result appears to be that 10m winds are improved significantly over the western US, but slightly degraded over the east. The threat scores are also neutral to slightly improved for heavy precip over western US, but the opposite over the east. The current strong dynamic constraint is adiabatic. Over the western US, the constraint yields a net improvement because orographic effects are dominant and accurately included in the constraint. However, in the eastern US surface mixing may be dominant over orographic effects. A surface parameterization has been tested with GSI in global mode (M. Rancic), and we plan to introduce this in the regional mode constraint.

GSD

07.5.5.1 15 Oct 2006 (GSD and CAPS) – Completed 15 Oct 06
Report on testing of RUC-like cloud/hydrometeor assimilation (including GOES cloud-top data and METAR cloud/visibility/weather data) within WRF-GSI on the full Rapid-Refresh domain.

Report was completed 15 October 2006 and is available at http://ruc.noaa.gov/pdf/Verification_RUC_ARPS.pdf (Note that this is a 24Mb document; loading is very slow.)

Collaborative work continues between GSD and Ming Hu of CAPS to combine the ARPS and RUC cloud analysis and further test it within the RR-GSI CONUS environment, using Chris Harrop's workflow manager. Ming Hu has recently completed an experiment with Lin microphysics scheme and compared it with the Thompson. He found that the Lin scheme produced higher reflectivities, especially in the stratiform region. He is currently examining the hydrometeor to reflectivity conversion for the Lin and Thompson scheme. The Thompson scheme is more complicated and for the cloud analysis, we are exploring the possibility of using a look-up table for mapping reflectivity to hydrometeors.

07.5.5.2 Oct 2006 (NCEP/EMC) - Delivered Oct 2006
Based on parallel testing and refinement of the experimental code, deliver a "pre-implementation" version of WRF-GSI for 2007 upgrade to NAM /NDAS.

At the beginning of this quarter, the strong dynamic constraint, already well tested with the GSI in global mode, was introduced into the regional mode of GSI. Two months of testing in the "pre-implementation" NAMX parallel show essentially neutral results, with some positive impact on geopotential. This will be part of the 2007 upgrade to NAM/NDAS. (Parrish)

07.5.5.3 Dec 2006 (NCEP/EMC) – Delivered Dec 2006
Report on testing of 2DVAR WRF-GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 5km resolution and higher.

In collaboration with Sei-Young Park and Jim Purser, Manuel Pondeca has added the capability to generate 'space-filling Hilbert curve'-based subsets of data for cross-validation to the GSI. The subsets are not overlapping and tend to be more evenly distributed in space than the complete data set. (Pondeca)

07.5.5.4 15 January 2007 (CAPS/ NCEP)
Further refine the radial velocity analysis component of GSI in response to model resolution changes. Consider issues on data quality, super-obbing, and optimal decorrelation scales.

07.5.5.5 15 May 2007 (NCEP/EMC)
Development efforts will produce a "research quality" code for an upgrade package (improved covariance and use of WSR-88D, satellite radiances and covariances) to the WRF-GSI.

Manuel Pondeca has made substantial progress in adding the option to generate ensemble-based background error covariances to the regional GSI. The input ensemble fields, which can come either from the regional or the global ensemble system, are used to prescribe the local aspect tensor of the anisotropic component of the error covariances. The impact of such situation-dependent covariances on the model analysis and forecast skill scores is currently being tested. Manuel Pondeca has also developed an algorithm that generates dynamic 'rejectlists' of surface observations that systematically fail a user-defined acceptance criterion. The lists for the current analysis are constructed from the GSI diagnostic files from previous analyses. The number of past diagnostic files used as well as the "severity" of the rejection criterion are conveniently specified by a set of namelist variables. Dynamic rejectlists for temperature, specific humidity and wind are already in use within the parallel RTMA. (Pondeca)

07.5.5.6 July 2007 (NCEP/GSD)
Based on case-study testing and refinement of the research quality code, deliver
resulting an "experimental" code for an upgrade package (improved covariance and use of WSR-88D, satellite radiances and covariances) to the WRF-GSI for the March 2008 change package to the NAM-WRF. (Jul '07)

NCEP
During March, testing began on two additional GSI features. The first is FGAT (First Guess at Appropriate Time), where the background at multiple time levels is used to interpolate the background to the time of each observation. This has been used in global mode for a long time and is just now being tested in regional mode. The second, a new feature, is simplified 4dvar (s4dvar), in which the analysis increment tendencies needed for the strong constraint, are also used to linearly extrapolate the analysis increment in time to the time of the observation. Both of these features add no significant additional cost to the GSI. For FGAT, the model forecast must be extended from 3 hours to 4.5 hours between each analysis update in the NDAS to provide background fields which cover the time window of the observations. The above features, plus the ability to read any mix of IJK/IKJ grid ordering from either the NMM or ARW core, will be incorporated in the April release of GSI. (Parrish)

GSD
Dezso Devenyi continues work on the anisotropic aspect of the Sept. 2006 version of GSI, in collaboration with Manuel Pondeca and Jim Purser of NCEP. He has incorporated the PBL height (computed as in the RUC) into the parameterization of the vertical correlation scale for the surface observation assimilation (to prevent intrusion of surface observation effects above the PBL). The anisotropic version of the GSI requires a computationally expensive Monte Carlo normalization, which can be offset by applying the recursive filters on a coarse grid. Working on eJET, Dezso has conducted a series of experiments to evaluate the timing characteristics for this anisotropic form of the GSI. He has found that a grid coarsening factor of four allows for a normalization parameter value of 200, yielding a quality analysis with approximately the same computational cost as the isotropic analysis.

Jacques Middlecoff isolated and resolved the last few computer problems (endian-related issues in GSI libraries) that were preventing GSI from running on the new ESRL supercomputer (wJET). Using this version of the GSI, Dezso is conducting similar timing tests on wJET as part of our migration of the RR cycle from iJET to wJET (see 07.5.5.8 below).

Dezso Devenyi and Tom Schlatter presented a poster entitled: "Adaptations of the Gridpoint Statistical Interpolation for the Rapid Refresh System" at the University of Colorado – Cooperative Institute for Research in Environmental Science 2nd Annual Science Symposium.

07.5.5.7 15 Dec 2006 (ESRL) Completed 15 Dec 2006
Report on testing of RUC-like surface observation assimilation (including use of inferred PBL depth, terrain and land mask constraints, and soil temperature/moisture adjustment) within WRF-GSI on the full Rapid-Refresh domain.

Dezso Devenyi continues work on the anisotropic aspect of the Sept. 2006 version of GSI, in collaboration with Manuel Pondeca and Jim Purser of NCEP. He is incorporating the PBL height (computed as in the RUC) into the parameterization of the vertical correlation scale for the surface observation assimilation. This method will prevent intrusion of surface observation effects above the PBL. Dezso is also investigating the Monte Carlo based normalization applied in the GSI filter package. Due to the increased computation cost for the anisotropic filter package, all experiments are being done with a grid coarsening factor of four.

Overall efforts in this area, including work by Dezso Devenyi, Tom Schlatter and Steve Weygandt were summarized in the following report, available at http://ruc.fsl.noaa.gov/pdf/RR-GSI_sfc_assim_dec06.pdf:

Devenyi, D., T. Schlatter, S. Weygandt, and S. Benjamin, 2006: "Assimilation of surface data in the PBL for Rapid Refresh within the GSI analysis system", 11 pp.

07.5.5.8 15 Feb 2007 (ESRL/GSD) Completed 15 Feb 2007
Development efforts produce an 'experimental' version of the GSI suitable for Rapid Refresh application (e.g.

includes RR-specific modifications for cloud hydrometeor and surface observation assimilation).

Experimental versions of the combined RUC/ARPS cloud analysis and the anisotropic surface observation assimilation have both been included in an experimental version of the GSI and testing and refinement continues. Ming Hu of CAPS continues work on the cloud analysis and Dezso Devenyi is doing additional tests with the anisotropic surface observation assimilation. These tests demonstrate that this milestone for this experimental version of GSI is complete, but further development will continue to refine these techniques. Work is ongoing to migrate this experimental version of GSI and the ongoing real-time RR cycle from iJET to wJET.

Deliverables

07.5.5E1 30 March 2007 delayed to 30 September (NCEP/**EMC)** (March 2007)
Subject to NCEP Director approval, implement WRF-GSI in NAM/NDAS.

CURRENT EFFORTS: NCEP management (EMC and NCO directors) have decided to move the NAM/NDAS upgrade into 4th Quarter due to delays with GFS/GSI implementation and the need to implement it, HYCOM and Hurricane-WRF before doing the NAM/NDAS upgrade. NCEP Director will not approve NAM/NDAS upgrade until both EMC & NCO Directors also approve. Consequently, this deliverable will be delayed until 30 September.

The impact of using the aircraft (WVSS-II) humidity observations in the NDAS were tested. On the short (3-hour) forecasts, the effect from using the aircraft humidity was small. It was found that the analysis increments of humidity from the satellite data were of the opposite sign to the aircraft observations. A separate NDAS cycling system set up to test the impact of reducing the influence of satellite data on the humidity analysis showed that the precipitation spin down after each analysis was decreased by 20% and the first guess fit to the conventional data was improved for all variables. Because of the NCEP CCS upgrade the code and scripts were moved to the new IBM machine and various node-task combinations for optimal computational efficiency were tested on the new machine. Efforts were made to use of or to monitor all the data currently available to the operational system. The amount of divergence damping used in the data assimilation cycling was tuned for the optimal forecast performance. (Wu)

PLANNED EFFORTS: Updating the GSI to the latest version by the analysis group which includes the use of surface pressure instead of logarithmic of pressure as analysis variable, use of CRTM as radiance forward model, MPI_IO capability on more data and variational QC capability.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE:

07.5.5E2 15 July 2007 (ESRL)
Based on real-time parallel and retrospective testing and refinement of the experimental code, report to NCEP on progress toward a 'pre-implementation' version of WRF-GSI suitable for Rapid-Refresh application (to replace RUC 3DVAR in FY09).

Work continues on testing and refinement of Rapid-Refresh specific aspects of the GSI package (See 07.5.5.1 and 07.5.5.7). Resolution of the wJET-related endian issues for the latest version of GSI, has allowed us to move forward with migrating the real-time RR cycle from iJET to wJET. Tanya Smirnova successfully adapted the WRFPOST version 2.1.2 for use on the full RR domain and we are now producing a variety of RR output grib files. Bill Moninger is adding these RR output grib files to his verification database. Also, within the RR test cycle on iJET, we have switched the conventional observation feed to use the NAM observation file and have done some initial testing toward installing a 6-h cycle.

Task 07.5.6: Develop, test, and evaluate the performance of the nonhydrostatic WRF modeling System.

GSD, in collaboration with NCAR/MMM and NCEP/EMC

WRF v2.2 was completed as reported in January. A version of WRF-Chem compatible with WRF v2.2 and developed under other-agency funding is now ready to be introduced to the WRF repository (Grell and Peckham).

NCAR

07.5.6 30 September 2007 (NCAR/MMM)
Incorporate physics improvements into the WRF software infrastructure.

CURRENT EFFORTS: In light of a high surface moisture bias over snow cover seen in forecasts (produced by AFWA), Dudhia of NCAR worked with Mukul Tewari (NCAR/RAL) on identifying a fix. The approach modifies the Noah LSM's treatment of evaporation over snow cover as the ground temperature reaches the freezing point under conditions of strong solar forcing. The fix helps to eliminate the bias, and it will be refined prior to incorporation in the repository.

A way to update sea-ice cover during model runs has been developed. This involves the reading of specified sea-ice inputs, and may be helpful for runs including high-latitude areas, as envisioned in RR applications. It will also benefit longer runs.

Dudhia added the Outgoing Longwave Radiation diagnostic to the RRTM longwave scheme for inclusion in the repository. This can be used for analysis of OLR for analysis of climate-type simulations or in generating simulated satellite-type imagery in RR forecasting.

During the quarter, Dudhia improved PBL vertical mixing of ice clouds in the MRF and GFS PBL options, where previously it had been ignored. In addition, Ferrier microphysics-MYJ PBL scheme interaction code was incorporated in the ARW. NCAR finalized code to fix the interaction of the PBL ice mixing and the microphysics (both in ARW and NMM).

Dudhia also helped to develop a minor bugfix for the Grell-Devenyi cumulus scheme and put a bugfix for the Thompson microphysics into the repository. In separate work, development was begun on a simplified parameterization as part of the WRF-Var simplified physics suite.

PLANNED EFFORTS: Work will continue at NCAR on model physics capabilities and improvements, at a level supported by the budget reduction for '07.

UPDATES TO SCHEDULE: None.

07.5.6 31 March 2007 (NCAR/MMM)
WRF for Rapid Refresh

CURRENT EFFORTS: NCAR delivered WRF V2.2 code to GSD for its use in RR testing. This included the latest enhancements and bugfixes for Thompson microphysics scheme, developed by MDE Research Team collaborator RAL, and NCAR worked with RAL scientists in that microphysics implementation. NCAR also provided (for RR applications) the WPS code. NCAR also delivered to GSD a written description of version features for its RR documentation base.

UPDATES TO SCHEDULE: None.

07.5.6.E1 30 June 2007 (NCAR/MMM, DTC)
Conduct a WRF Users' Workshop and tutorials on the ARW core (NCAR) and the NMM core (DTC) for the user community

CURRENT EFFORTS: NCAR hosted an ARW tutorial on January 22-26, 2007. The attendance was about 60 students, the maximum that could be accommodated. Topics included the WPS, physics, software framework, and

WRF-Var, and practicums were offered.

NCAR has begun planning the WRF Users' Workshop and another tutorial. The Users' Workshop will be June 11-14. The tutorial will be July 23-27, and the planning is being coordinated with the DTC.

UPDATES TO SCHEDULE: None.

NCAR Budget Expenditures, Quarter 2, FY2007

	Qtr	YTD
Salaries	$ 5,295	$11,285
Benefits	2,690	5,733
Matls & supplies	-	-
CSC	652	1,418
NCAR Indirect	4,128	8,798
UCAR Fee	146	1,873
TOTAL	$12,911	$29,107

Task 07.5.8: Improve physics in the WRF model, especially including those that affect aircraft icing.

GSD

In addition to the efforts on the Grell-Devenyi scheme discussed below, GSD has also continued to evaluate the real-time performance in both WRF and RUC of a revised version of the RUC-Smirnova 2-layer snow model planned for the summer RUC change bundle. This revised scheme reduces excessively cold nighttime temperatures over freshly fallen snow when temperatures are already cold. This is achieved by increasing the density of freshly fallen snow once it is on the ground from an unrealistically low value previously used.

In a reverse feed from WRF back to RUC, the RRTM used extensively in WRF is now in parallel RUC testing as a candidate to replace the old Dudhia lwrad scheme. See 07.5.1 for more discussion.

Subtasks

07.5.8.4 30 January 2007 (GSD) COMPLETE
Carefully evaluate candidate convective schemes and their interaction with other physics for RR application.

CURRENT WORK: Under other-agency funding Georg Grell led efforts to improve the ensemble weighting in the Grell-Devenyi ensemble convective scheme so as to improve the prediction of convective precipitation. Of particular concern in WRF was the excessive areal coverage of light precipitation from convection. The outcome of this work was a new, but not drastically changed, version of the Grell-Devenyi scheme. This new version now runs in the WRF RR cycles at GSD, and is under evaluation. Testing of the scheme at GSD in the different milieu of the RUC led to some unique further modifications for RUC. This RUC-modified version of the new scheme is planned to be part of the RUC change bundle discussed under task 07.5.1, pending the outcome of current testing in the devRUC13 cycle at GSD. The main effect of the change in RUC is also to reduce the areal coverage of light convective precipitation, and to delay the onset of convection in situations where it is initiated by daytime heating. This is accomplished primarily by requiring as a condition for the existence of convection in a grid column that candidate updraft air parcels reach their LFC at a pressure level closer to the level of their LCL than previously.

07.5.8.5 30 June 2007 (GSD)
Improve handling of moist processes in candidate PBL scheme for use in the RR-WRF.

As part of his responsibilities with the WRF Physics working group, John Brown is collaborating in evaluation of existing WRF boundary-layer schemes. Dudhia of NCAR (and also a member of the physics working group) has

been working toward making the existing WRF boundary-layer schemes more thermodynamically consistent under conditions of vapor saturation and in their feedbacks with the microphysics schemes.

07.5.8.6 1 August 2007 (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.

Stratocumulus modeling work with the January 31 case from Cleveland has shown that changes to the simulation of freezing drizzle and supercooled liquid water in this typical stratocumulus icing case is sensitive to details of the Planetary Boundary Layer scheme. Future work will focus on improving the PBL scheme in order to improve the simulation of icing in stratocumulus clouds. We will also identify other typical stratocumulus icing cases that performance simulations on those as well.

07.5.8.8 15 August 2007 (GSD, NCAR/RAL)
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
07.5.8.E2 15 June 2007 (GSD)
Report to NCEP and AWRP on testing of revised versions of microphysics and other physical parameterizations into WRF Rapid Refresh model

07.5.8.E3 30 June 2007 (GSD)
Report on overall performance of physics parameterizations in pre-implementation version of RR at annual WRF Workshop in Boulder, CO.

07.5.8.E4 30 September 2007 (NCAR)
Report on development of a predictive capability in the NCAR microphysics for aerosol concentration and mixing ratio that can be used to determine CCN and IN as a function of cloud updraft velocity, temperature, pressure, and background aerosol concentration. Sources and sinks of aerosol particles will need to be taken into account. This task will be closely linked to the stratocumulus task given above.

Task 07.5.15 Develop improved methods of cloud and moisture analysis for use in the WRF Modeling System.

Subtasks

07.5.15.2 15 May 2007 (GSD)
Develop and evaluate performance of diabatic digital filter initialization (DDFI) in the RR WRF model for initial cloud and hydrometeor fields.

GSD continues to evaluate and refine the code for radar reflectivity assimilation into the diabatic digital filter initialization (DFI) within the 13-km RUC model (prototype for WRF-RR DDFI). An experimental version of this algorithm was introduced into a real-time RUC parallel cycle on 9 Feb. 2007 and recently ported to the real-time "backup" RUC, which runs on dedicated computer nodes. Qualitative assessment of the forecast fields and quantitative precipitation verification continue to indicate significant improvement in short-range precipitation forecasts and have led to a number of minor modifications to the algorithm. Some initial work is also underway toward developing a method for suppressing spurious model convection. Comparisons of model-derived forecast reflectivity (which was recently added to the RUC model post-processing) from cycles with and without the radar-

assimilation in the DDFI also suggest substantial improvement. GSD and NCEP are discussing including this technique in a summer 2007 upgrade to the operational RUC at NCEP and a formal requirement statement for the national radar mosaic data has been submitted to NCEP. This work will serve as the basis for the inclusion of a similar technique in the WRF-based Rapid Refresh.

07.5.15.4 15 July 2007 (GSD and CAPS)
Develop a revised version of the GSI cloud assimilation treatment of satellite and METAR cloud data in its cloud analysis.

Collaborative work continues between GSD and Ming Hu of CAPS to evaluate and further refine the generalized cloud analysis (created from the ARPS and RUC cloud analysis) within the RR-GSI CONUS environment, using Chris Harrop's workflow manager. Ming Hu has recently completed an experiment with Lin microphysics scheme and compared it with the Thompson. He found that the Lin scheme produced higher reflectivities, especially in the stratiform region. He is currently examining the hydrometeor to reflectivity conversion for the Lin and Thompson scheme. The Thompson scheme is more complicated and for the cloud analysis, we are exploring the possibility of using a look-up table for mapping reflectivity to hydrometeors.

Deliverables
07.5.15.E2 15 July 2007 (GSD)
Report on progress of GSI cloud analysis code to NCEP to be part of FY08 Rapid Refresh.
(see subtask 07.5.15.4. and 07.5.15.E3 for discussion of progress on cloud analysis in GSI for RR)

07.5.15.E3 15 September 2007 (GSD and CAPS)
GSD
Complete further revisions and testing of the generalized cloud analysis package within GSI for stratiform cloud (using GOES cloud top and METAR cloud data) and initial treatment for convective cloud at parameterized scale assimilating radar reflectivity.

CAPS
Complete further revisions and testing of the generalized cloud analysis package within GSI for stratiform cloud (using GOES cloud top and METAR cloud data) and initial treatment for convective cloud at parameterized scale assimilating radar reflectivity.

With the help of Steve Weygandt of GSD, Ming Hu of CAPS conducted 5 experiments with hourly assimilation cycles for the 13 March 2006 central US squall lines case to study the impacts of cloud analysis when used in RUC CONUS environment. The workflow of GSD is used to manage the assimilation cycles. The 5 experiments include one using regular GSI analysis with conventional observations (without cloud analysis), three using the RUC, ARPS, and generalized cloud analyses, respectively, in addition to the GSI analysis, and one repeating the experiment that uses the ARPS cloud analysis but using Lin instead of Thompson microphysics scheme in the WRF-ARW forecast.

Initial examination on the results shows that the cloud analysis is able to improve precipitation prediction by reducing spurious precipitation, building up part of the squall line, and enhancing cyclonic precipitation. The comparison of the experiments with the same cloud analysis scheme but different microphysics schemes indicates significant impacts of the microphysics scheme on the effect of the cloud analysis in the assimilation.

Ming Hu further studied the Lin and Thompson microphysics schemes in detail and derived the equations calculating the radar reflectivity factor from precipitation species based on the Thompson scheme used in RUC and WRF-ARW. Then, a Thompson-scheme-based precipitation species retrieval scheme was designed and has been built into the generalized cloud analysis package as a new option of precipitation retrievals. Its performance will be evaluated in the coming quarter.

Budget: CAPS funds for FY2007 has not arrived and it typically arrives in late spring. The FY2006 funds will be depleted by the end of June 2007, as planned. The later ending date is due to the late arrival of funds.

Task 07.5.17 Infrastructure support for running operational WRF model in Rapid Refresh, North American

Mesoscale and HiResWindow modes at NCEP.

NCEP

Dennis Keyser reports that in addition to work noted in Task 07.5.1 above, the full complement of NEXRAD Level 2 radial wind data were again available for assimilation on 6 February (these had not been processed since late September due to an upstream formatting change). Also, METEOSAT-5 visible winds were once again assimilated on 6 February (visible winds had not been used for over two-years due to TOC to NCEP communication line problems which were corrected last year). European AMDAR aircraft data were unavailable 12-20 February due to a decoding problem at NCEP resulting from the addition of moisture information to the incoming BUFR data. EUMETSAT replaced METEOSAT-5 with METEOSAT-7 as the operational "east" satellite on 13 February.

Subtasks

07.5.17.2 (NCEP/EMC and NCEP/NCO)
Maintain four-per-day North American Mesoscale runs and provide SAV and AIV guidance.
Due to a significant degradation in data quality, a crisis change was made to turn off the assimilation of NOAA-16 AMSU-A channel 4 satellite radiance data in the operational GSI analysis on 29 January 2007. To minimize any adverse impact from other NOAA-16 AMSU-A products, all of the NOAA-16 AMSU-A data was down-weighted relative to other AMSU-A data from other satellites. (Rogers)

07.5.17.3 (NCEP/EMC and NCEP/NCO)
Maintain four-per-day HiRes Window runs and provide SAV and AIV guidance.
NCEP maintained operational 4/day ~5 km nested runs of the HiResWindow (HRW) suite of both WRF-ARW and WRF-NMM configurations. When there are no hurricane runs, daily HiResWindow runs of both the WRF-NMM and the WRF-ARW are made on a daily basis for large domains covering Alaskan (00z) and western (06z), central (12z) and eastern (18z) CONUS plus small domains covering Hawaii (00&12z) and Puerto Rico (06&18z). In addition, NCEP has maintained twice-per-day runs of six WRF-based members in the Short Range Ensemble Forecast (SREF) system with specially designed aviation guidance available from http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html .

The HIRESW WRF-NMM and WRF-ARW forecasts are run the same version of the WRF infrastructure (V1.3) that was first implemented into NCEP operations in September 2004. When the HIRESW WRF-NMM model that was compiled on new NOAA/NWS Central Computing System (CCS, machines designated dew/mist) started running in NCEP operations in January 2007, the forecast QPF was been reduced by about one-half of what it was when it was running on previous (blue/white) CCS. When the HIRESW WRF-NMM model binary compiled on the blue/white system was retrieved from the NCEP run-history archive and run on the dew/mist system, the model QPF looked reasonable. Since the HIRESW WRF model codes compiled on the dew/mist system are suspect, the WRF-NMM and WRF-ARW HIRESW model binaries compiled on the blue/white system replaced those compiled on the current NOAA CCS computers on 26 March. (Rogers)

07.5.17.4 (EMC Team and NCO)
Provide vendors with gridded NAM model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway. NCEP maintained real-time availability of SAV and AIV guidance to all vendors from the operational 4/day NAM via the NWS Family of Services (FOS) data feed and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG).

07.5.17.5 (EMC Team and NCO)
Provide full grids from NAM, and the HiRes Window on NCEP and NWS/OPS servers.
NCEP maintained real-time availability of full resolution gridded data from the operational NAM (12 km) runs via anonymous ftp access on the NCEP server sites on ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/ . This includes hourly BUFR soundings and output grids which undergo no interpolation and, as such, are on the models' computational grids (so-called native-native grids). NCEP provides anonymous ftp access to GRIB and BUFR output HiResWindow (~5 km) suite of WRF-ARW and WRF-NMM on the NCEP ftp server (ftp://ftpprd.ncep.noaa.gov/mmb/mmbpll/ in the directories east08.t18z, central08.t12z, west08.t06z and alaska10.t00z). HRW run output remains on the standard 8 km Lambert grids #243-254. NWS FTP Services:

Both GRIB1 to GRIB2 data are currently available on the new gateway system (ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/). To conserve bandwidth, GRIB2 data is being transferred to tgftp and then converted to GRIB1. For that reason, GRIB2 data will be available one to two minutes earlier on average than GRIB1.

07.5.17.5 Maintain access to model verification data. (see subtask report under Task 07.5.1.4)

07.5.17.6 Provide assistance to In-Flight Icing, Turbulence, Convective Weather, C&V and Oceanic Weather MDE research team when their algorithms and product generation systems are ready to transition into NCEP's operational production suite. UNFUNDED under Option A

Deliverables

07.5.17.E1 1 October 2006 - 30 September 2007 EMC (Parrish, Derber, Wu, Keyser)
Perform observation ingest, quality control and preparation in support of the operational North American Mesoscale WRF runs.

CURRENT EFFORTS: In addition to work noted in Task 07.5.1 above, a CRISIS change was made on 8 January to correct an array overflow error that resulted in the failure to process Level 3 radial wind data. These data provide a backup to the primary Level 2.5 data (the Level 2 data were still not available at this time). The full compliment NEXRAD Level 2 radial wind data, which had not been processed since late September due to an upstream formatting change, again became available for assimilation on 6 February (an additional change on 20 March resulted in faster processing of the data ingest resulting in more data available for the on-time NAM dumps). Also, METEOSAT-5 visible winds were once again assimilated on 6 February (visible winds had not been used for over two-years due to TOC to NCEP communication line problems which were corrected last year). European AMDAR aircraft data were unavailable 12-20 February due to a decoding problem at NCEP resulting from the addition of moisture information to the incoming BUFR data. EUMETSAT replaced METEOSAT-5 with METEOSAT-7 as the operational "east" satellite on 13 February. (Keyser)

PLANNED EFFORTS: In addition to items noted in Task 07.5.1 above, do impact tests in NAM for several new data types: TAMDAR and Canadian AMDAR aircraft; aircraft moisture; mesonets (including new hydro, snow, modernized COOP and UrbaNet feeds; and roadway information in existing mesonet feed); RASS; JMA and CAP profiler winds; 3.9 micron and visible satellite winds; WindSat, ERS and QuikScat scatterometer wind data, AIRS every field-of-view radiances, GPS radio occultation data, POES MODIS and METEOSAT-8 satellite winds, and GOES (11 and 12) single field-of-view radiances. Tap into additional mesonet data from non-MADIS sources (e.g., LDAD and/or MesoWest). (Keyser, Wu)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: GSD & NCO.

UPDATES TO SCHEDULE:

7.5.17.E2 1 October 2006 - 30 September 2007 EMC (Parrish, Derber, Wu, Keyser)
As requested by other MDE research teams, incorporate new AIV calculations into Operational WRF Model post-processor and product generator.

CURRENT EFFORTS: No requests were made by other MDE RESEARCH TEAMs during this period. NWS Eastern Region and the NCEP Storm Prediction Center (SPC) have requested that simulated radar reflectivity be added to the NCEP model post-processor. This has been done and Ferrier has updated and corrected aspects for use in SPC/NSSL Spring Program. NCEP's AWC & HPC and NWS Eastern Region have requested the post generate satellite look-alike products. This has been done by adding the CRTM (radiative transfer model code from GSI) to the model post.

PLANNED EFFORTS: Implement unified post with reflectivity and satellite simulation capability. Refine forward model for simulated reflectivity.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None

INTERFACE WITH OTHER ORGANIZATIONS: GSD & NCO

UPDATES TO SCHEDULE: None