MODEL DEVELOPMENT AND ENHANCEMENT RESEARCH TEAM
Monthly Report for April 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.

- 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) now in hardened backup RUC cycle at GSD, ready for transfer 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 continues testing 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 showing much lower nighttime warm bias in experimental RUC versions at GSD with real-time surface verification. RRTM will now be included in the RUC change package.

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

- Convection suppression added to experimental RUC for radar no-echo regions in addition to previously developed latent heat specification for storm assimilation.
- Retrospective cycled tests of combined RUC/ARPS cloud analysis (assimilating METAR cloud and GOES-cloudtop data) within GSI-WRF framework.

Detailed report – MDE – April 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. The following new meso-networks were added to the mesonet feed received from NOAA/GSD MADIS: on 4 April a collection of mesonets under the provider name NJWxNet (New Jersey Mesonet, New Jersey Safetynet, and some Forest Service stations), on 12 April surface reports from GPS-IPW sites (under provider name DDMET), and on 24 April NERRS (National Estuarine Research Reserve System). An implementation on 17 April modified the data dump processing codes to use dynamic memory allocation, preventing future data overflow issues as new or expanded data platforms are added to the processing. POES and GOES data received from NESDIS were unavailable from 0600 through 1200 UTC on 06 April due to a NESDIS power outage. On 12 April, the GTS feed of GPW-IPW data was switched back on (after a six month interruption) allowing for redundancy between it and the existing NOAA/GSD LDM feed of these data. The data dump processing removes all duplicate observations.

Geoff Manikin reports that several bad 500 mb RUC analyses were observed in late April and traced to bad data from a particular aircraft. The quality control checks should have flagged these values, but it was determined that the code was written such that the temperature bias check would only be invoked if a fairly high number of observations was available from a single source in a given hour. Tests were made in which that threshold was lowered, and they resulted in elimination of the bad observations and significantly improved analyses. As a result, this code change was implemented as a crisis fix at 12Z 30 April.

Shun Liu has prepared codes to be JIF'ed in May to process Level II reflectivity data from WSR-88D Doppler radars. This effort includes three codes from NSSL: an upgraded quality control code which now deals simultaneously with both radial wind and reflectivity (instead of separate codes), code to transform the coordinate of the reflectivity data from local polar to uniform Cartesian and code to produce a 3D national mosaic of the reflectivity. A mosaic is required every hour for a future RUC upgrade package.

GSD

GSD tracked down an aircraft quality problem with RUC diagnostics and with the GSD AMDAR web page and monitoring system in late April (as mentioned under EMC above). GSD tested an initial fix and then worked with EMC for the final test. EMC worked with NCEP/NCO for the fix implementation on 30 April.

In April, GSD continued testing and final development for the 2007 change package for the RUC prior to its transfer to NCEP for pre-implementation testing.

This RUC analysis/model change package (implementation date now uncertain, possibly later in 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). Further changes were made in April, as shown in http://ruc.fsl.noaa.gov/13km_RUC.changelog.html (development RUC). To summarize the changes made in the development and backup RUC at GSD:

- Improved diabatic assimilation of 3-d radar reflectivity via diabatic digital filter initialization. Convection suppression added to remove parameterized convection during first hour in regions with no Further modifications made in April.
- Correction to RH observation errors for in-situ and precipitable water moisture observations, resulting in more accurate RH forecasts.
- Addition of 3 reflectivity producst in RUC post-processing (column max, 1-km, 4-km). The max reflectivity is now being shown in real-time products for both the devRUC13 and the backup RUC13 (now also including 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
- Other 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.

INTERFACE WITH OTHER ORGANIZATIONS:
Discussion between GSD and NCEP/EMC and NCEP/NCO 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.

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

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 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.

Discussions continued between GSD, NCEP/EMC, NCAR and the DTC regarding the RR core. The focus of these discussions was on conversion of WRF-ARW to run fully within the Earth System Modeling Framework at NCEP.

PLANNED EFFORTS: Complete the migration of the Rapid Refresh cycle from iJET to wJET, including 1) upgrade to WRF v2.2 model, and use of latest version of GSI, and increase the cycling frequency from once per 12 hours.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:
The /tg file system on the WJET computer at ESRL/GSD continues to be unreliable, despite continued strenuous efforts to diagnose and fix problems. Although we have made progress in the migration of WRF pre- and post-processing code to wJET, these problems render WJET essentially unusable for RR testing, for which extensive use of the file system is a requirement. Because of the size of the RR domain, the computational demands of frequent cycling require that WJET (rather than eJET or iJET) be used for the extensive and prolonged full-resolution testing of both GSI and WRF at GSD that is required prior to transfer of RR code to NCEP. Substantial further delay in fixing the wJET problems could therefore have serious impact on the current RR implementation schedule. Compounding this are numerous recent hardware outages on iJET, where most of GSD's experimental RUC and WRF runs (including the backup RUC13) are being run pending full availability of wJET . We will keep AWRP

management apprised of the situation.

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 migration of the Rapid-Refresh real-time cycle to the new ESRL supercomputer (wJET) has been delayed by persistent problems with the wJET I/O involving the Terragrid /tg disks. Intermittent job failures have recently been linked to a problem in I/O on the /tg disks for some of the wJet nodes (introduction of errors during the reads). The problem is most severe for the GSI, because it has extensive parallel internal I/O. The problem appears to be close to resolution. Despite these issues, Tanya Smirnova successfully configured WRF version 2.2 (including the WRF Preprocessing System, the WRF model and the WRFpost) for the Rapid refresh domain on wJET. The new WRF Preprocessing System (WPS) runs much faster than the old WRFSI pre-processing software. Cold start RR runs have been completed on wJet, but the addition of the new GSI to the workflow cycle awaits the resolution on the wJet Terragrid I/O issues.

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 chosen retrospective period (see FY07 Q2 report) continues to be 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.

CURRENT WORK: As noted above, v2.2.1 of WRFpost can now be run successfully on wJET to produce GRIB output.

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

The NCEP Verification System is now running on iJET and is being used to verify GSD's WRF and WRFRUC runs.

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

Wan-Shu Wu prepared and tested a package for the next implementation of regional data assimilation in the NAM and its NDAS. The package included the latest GSI code that can take first guess files with either IJK or IKJ format (the next upgrade to WRF-NMM in NAM will include a change to using IJK for array storage and loop order). The strong constraint was turned on and the following new data were included: AIRS, GOES 1x1 radiances, MODIS and EUMETSAT winds, MESONET humidity and winds (only those on a USELIST provided by ESRL/GSD), and QUIKSCAT. To use this new satellite data, the bias correction files were expanded and spun up. Tests revealed that little of the new satellite data was used when runs were done in the extended NAM domain. This problem was solved by fixing a bug in the data thinning program. She also fixed the code to assimilate GPS refractivity in the regional mode but found the majority of the data were being rejected for too large Ob-Guess differences such that further tuning and data checking are required before the data can be used operationally. ACARS moisture was also tested for this change package but could not be included due to very poor guess fit and, more importantly, very large bias (often above 50% and of opposite sign of the mean rawinsonde guess fit). Finally, MESONET temperatures and surface pressures were tested and also found to have too large guess fit at this time.

Dave Parrish reports that a large difference was noticed between the strong constraint balance numbers based on the current operational GSI, updated with the strong constraint routines, and the latest GSI. While debugging the code, he discovered that the difference was entirely due to a change of surface pressure variable from log(sfcp) in the operational to sfcp in the latest version. Most of the contribution to the balance numbers is at the smallest horizontal scales and largest vertical scale. Near the grid scale, there is a large difference due to a discretization error between derivatives of log(sfcp) converted to sfcp and derivatives of sfcp directly. This seems to have no significant impact on the results but was essential to understand and diagnose.

Experiments continue with FGAT (first guess at appropriate time) and S4DVAR (simplified 4DVAR). The results from 24hrs of assimilation followed by an 84hr forecast for a fixed case have been disappointing so far. A bug was found that causes an improper time extrapolation for both FGAT and S4DVAR when the strong constraint is turned on in diagnostic mode only - not actually used in the analysis. Reruns will be done once the code is fixed.

Preliminary tests were conducted with a simple form of digital filter, digital finalization, in which the forecast is run forward only and time averaging is done centered around the analysis time to create a time smoothed background. Initially this was done externally from the WRF NMM, by writing out restart files every 4 minutes and averaging in a separate code. While very wasteful of resources, the results of a 24 hr assimilation were significantly improved with the time smoothed background.

A successful test was completed in late April of a subroutine installed at the lowest level of WRF NMM to do the digital finalization much more efficiently and write out time averaged fields in a simple fashion, bypassing the WRF infrastructure and registry.

Other work involved fixing a bug in the IKJ/IJK feature of GSI which failed with a coldstart file, and creating a square root of the background operator for use in a full weak constraint 4DVAR extension of GSI being created by Yannick Tremolet, during a 1 year visit to GMAO. This work should make full weak constraint 4DVAR experiments with WRF NMM possible by mid FY08.

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.

Collaborative work continues between GSD and Ming Hu of CAPS as reported in deliverable 07.5.15.E3. The present version of the generalized cloud analysis is not parallelized, necessitating that it be called after the variational solver in the GSI. Recent work has focused on scoping out the work needed to create a parallel version.

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.

Additional work on this subtask has been on hold, due to the intensive effort to isolate the wJet Terragrid disk I/O issues associated with GSI. See the discussion in subtask 07.5.5.8 for details

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).

Dezso Devenyi and Jacques Middlecoff made progress toward resolving additional problems they have encountered running GSI on wJet and its associated Terragrid file system. The first involves the parallel I/O and the GSI code structure which opens potentially non-existent files, causing zero-length files to be written. With the high speed Terragrid (/tg) system, a conflict occurs when many nodes try simultaneously access the non-existent file. This problem did not occur on wJet using the nfs disks because the I/O is much slower. Recently, a second intermittent problem involving the integrity of copies between nodes on wJet has been uncovered. While this second problem was causing all jobs to occasionally fail, the GSI program was especially vulnerable because of the extensive parallel I/O (including the writing and reading of many files) with to the program). As of 15 May, the second problem has been isolated and GSI testing on wJET using the Terragrid disks will begin again.

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 toward replacing the current RR-GSI cycle on ijet with an improved cycle on wJet has been slowed by persistent computer problems on wJET (see 07.5.5.8). Tanya Smirnova has configured WRFv2.2 for the Rapid

Refresh domain and conducted cold start tests using the new WRF version 2 system (including the WRF Pre-processing System as a replacement for WRFSI) on wJET, using Chris Harrop's work flow manager scripts. The addition of the new version of GSI to the workflow on wJet awaits the resolutuion of the wJet Terragrid I/O problems summarized above.

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

NCAR

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

NCAR is organizing the 8th WRF Users' Workshop, and the deadline for the submission of initial abstracts was April 20. MMM is working with the DTC in the organization of the Summer 2007 WRF tutorial, to be held July 23-27. For the first time this will cover both cores.

Dudhia of NCAR worked to improve on a high surface moisture bias over snow cover seen in WRF forecasts of the Air Force Weather Agency. Working with Mukul Tewari (RAL), he identified, and has implemented, a fix in the Noah LSM involving the treatment of evaporation over snow cover as the ground temperature reaches the freezing point. This was further improved to include snow-fraction regions, and it was committed to the repository in April.

Dudhia helped DTC staff to determine the reason for failures in the ARW when the GFDL radiation scheme was combined with Thompson microphysics. This was determined to be due to negative cloud amounts in the GFDL radiation. A fix was developed, and NCEP has implemented this safeguard in the GFDL scheme in the repository.

High-resolution hurricane work using the ARW continues at NCAR. A problem was found with unrealistically weak surface fluxes under the idealized calm-wind situation, and it was traced it to the Beljaars method of calculating a subgrid convective velocity. This calculation was improved by employing instead an MM5 method attributed to Wyngaard, which has no dependence of convective velocity on wind speed. This hurricane work is also providing a testbed for the TKE sub-grid turbulence scheme that Dudhia has coupled to the surface fluxes.

A team of NCAR/MMM scientists, in collaboration with Seoul National University, delivered an ARW tutorial in Korea. This was held April 18-21 at Seoul National University and was part of the East Asia WRF Workshop and Tutorial (http://weather.snu.ac.kr/wrf2007).

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: See general discussion above.

UPDATES TO SCHEDULE: None.

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: Performance of the upgrades to the Grell-Devenyi convection scheme introduced into the RUC and WRF runs in January and described in FY07 Q2 report are continuing to be monitored in GSD real-time runs.

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

While visiting the Storm Prediction Center, Norman OK, in late-April – early May, J. Brown had opportunity to compare boundary-layer structures from high-resolution (4km horizontal grid spacing) ensemble runs being performed by CAPS of WRF-ARW v2.2 that were identical except for the boundary-layer scheme, either the Yonsei University (YSU) scheme, or the Mellor-Yamada-Janjic (MYJ) scheme (used in the operational WRF-NAM). These comparisons, for afternoon mixed layers over the Midwest and Southeast, indicated the MYJ scheme tends to produce shallower, more well-mixed and moister conditions in the mixed layer. This is a result that has also been seen in idealized 1-d comparisons by others. Overall, based on a small sample of days, the results with the MYJ scheme most often (but not always) more accurately resembled the boundary-layer structure as revealed by verifying raobs.

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. Greg Thompson will be visiting Istvan Geresdi to further work on the detailed microphysics scheme used to verify the bulk scheme. One goal of this work is to simulate stratocumulus icing using the detailed microphysical scheme.

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 RUC model in preparation for its subsequent implementation in the RR WRF model. (name change requested)

GSD
The radar reflectivity assimilation technique developed for the RUC added in April the second key component, convection suppression in areas where no reflectivity is observed. This was in addition to the previously reported (in 07.5.1 and 07.5.15) work for forcing convection in observed regions by specification of latent heating in the RUC model diabatic forward digital filter initialization component. The new convection suppression is accomplished by creating a new 2-d field from the observed radar reflectivity data indicating regions approximately 100km away from any observed reflectivity over 5 dbZ. Using this field, the RUC model convective inhibition (cap depth) is set such that no convection is allowed in these echo-free areas for the DDFI step and for the subsequent 30-min period. This code is now included in the backup RUC, ready for transfer to NCEP as part of the RUC change package.
GSD has further refined the radar reflectivity assimilation code within the 13-km RUC DDFI. This system is the prototype for the WRF Rapid Refresh DFI radar reflectivity assimilation system. The primary change during the past month is the addition of a convective suppression component to inhibit the development of spurious convection during the first 30 minutes of the model forecast. This is accomplished by creating a 2D map of regions with convection from the NSSL reflectivity mosaic. For regions with no convection, the cumulus parameterization is prevented from triggering during the first 30 minutes of the model integration. In addition to this change, a number of minor adjustments have been made to the radar assimilation algorithm. Monitoring of the forecasts with the radar assimilation continues. Objective precipitation verification and subjective evaluation of model predicted simulated reflectivity indicate an improvement in short-term forecasts from the radar assimilation. Discussions continue with NCEP concerning their work to make the radar reflectivity mosaic pre-processing software operational and coordinated work to begin parallel testing at NCEP of the RUC upgrade package.

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 (see subtask 07.5.15.E3 for additional details). The current version of the generalized cloud analysis runs on a single processor and recent work has focused on scoping out the work needed to create a parallel version of the cloud analysis.

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.
Verbal summary of progress provided during bi-weekly GSI telcons.

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.

Ming Hu of CAPS conducted a forecast starting from initial condition including the generalized cloud analysis with the Thompson-scheme-based precipitation species retrieval scheme. The forecast results are very similar to its counterpart forecast that uses original Lin-scheme-based precipitation retrieval scheme. Also, unreasonably large snow mixing ratios is found in the cloud analysis with Thompson scheme and is working on finding the cause.

Ming Hu has updated the cloud analysis packages to the September 2006 version of GSI on wJET and revised the report that documents the steps of incorporating the cloud analysis into GSI. The report also includes the information of coding and the cloud data ingesting and environment setup. Currently, the disk /p70 is used for the updating work on wJET to avoid the problems of GSI when running on /tg0 disk.

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 0600 and 1800 UTC t-00 NAM data cutoff times were both changed from T+1:19 to T+1:15 on 3 April to bring them into alignment with the 0000 and 1200 UTC t-00 NAM data cut-off times. The NEXRAD Level II data dump processing for the t-00 NAM runs at 0000, 0600, 1200 and 1800 UTC was moved back 5-minutes (from T+1:15 to T+1:10) on 10 April to account for an increase in Level II data resulting from both increased springtime convection and faster ingest of the data into the BUFR tanks (as a result of a 20 March implementation). This change was necessary to keep the overall NAM network run within its defined time limit. EUMETSAT replaced METEOSAT-8 with METEOSAT-9 as the operational "west" satellite on 11 April (these MSG winds are not yet assimilated).

Eric Rogers is preparing code to be JIF'ed in June for an upgrade package for the NAM and its NDAS. This package is running in real-time parallel mode on the development machine known as dew. The package includes upgrades to GSI (see above), expansion of the NAM domain (18%), upgrade of the WRF-NMM prediction code including use of IJK array storage and loop ordering (15% faster runtime), unified NOAH land-surface component, modified Zo formulation, modifications to limit surface moisture sources in evergreen & mixed forest areas and unified post-processing.

Matt Pyle is preparing code to be JIF'ed in May for a major upgrade package for the HiResWindow runs. Largely driven by a request from the Storm Prediction Center, this package includes a substantial expansion (more than doubling) of the domain coverage, an increase in horizontal resolution (WRF-NMM to run at 4 km and WRF-ARW to run at 5.1 km) plus the changes listed above for NAM. Simulated reflectivity will be turned on from these runs

where it has not been possible with the old version 1.3 codes and associated post-processor running there today. The schedule for the large nested domains will change to running the East-Central CONUS domain at both 00z and 12z, the West-Central domain at 06z and the Alaskan domain at 18z. The schedule for the small nested domains remains Hawaii at 00z & 12z and Puerto Rico at 06z & 18z.

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