MODEL DEVELOPMENT AND ENHANCEMENT
PRODUCT DEVELOPMENT TEAM
Quarterly Report for October-December 2006
Submitted 15 January 2007

With contributions from Geoff DiMego and Mary Hart (NCEP/EMC);
Stan Benjamin, John Brown, Steve Weygandt (NOAA/ESRL/GSD);
Jordan Powers, Roy Rasmussen, and Bill Hall (NCAR);
Ming Xue (OU/CAPS)
Compiled and edited by Stan Benjamin and Holly Palm

Executive Summary

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

- NCEP/EMC and ESRL/GSD collaboration on remedy for RUC crashes due to NAM boundary conditions, other improvements made to the operational RUC.
- NCEP/EMC implements change package to NAM – 19 December 2006

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 (GSD)

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

- Report on testing of RUC-like surface observation assimilation complete (subtask 07.5.5.7)
- Report on testing of RUC-like cloud/hydrometeor assimilation complete (subtask 07.5.5.1)

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

- Version 2.2 release of WRF by NCAR with significant help from GSD, including much improved interoperability of physics in ARW and NMM (outcome of Rapid Refresh core test).

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

- CAPS and GSD finish development of initial version of the generalized cloud analysis package

Detailed report – MDE – July FY06

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

GSD

GSD and NCEP coordinated to switch the GPS precipitable water data to a separate feed from GSD on 30 October (more detail in the NCEP report below).

GSD continued to monitor real-time RUC performance among the operational NCEP version and 4 different experimental GSD versions. The GSD versions are run for testing new analysis/forecast techniques, but also are very helpful in diagnosing problems with the operational RUC at NCEP. Three such situations occurred in November:

- Freezing of inland lakes (solution in collaboration with NCEP; see above). Since there is no current operational information available for water temperature on smaller lakes resolved in the 13km RUC (mostly in Minnesota and Canada), an estimate is made using nearby larger bodies of water. This treatment was found to have a problem in the situation for ice cover (see above), and a new technique was developed, tested, and implemented on 1 December at NCEP. This change has a slight effect on the atmospheric fields and cycling in the operational RUC in these areas only for the freeze-over and thawing seasons. Subsequent monitoring in December showed that this strategy has worked well.

- 5-km RTMA downscaling. After comments from the NWS field forecast offices, new software was developed and tested at GSD and also tested at NCEP to improve the accuracy of coastlines in the 5-km downscaled RUC data (part of the RUC postprocessing). Now, the land-use information from both 13km and 5km resolution is used, and the new technique forces contiguity of 5-km coastline and lakes with the water features resolved at 13-km resolution. This new code was also implemented on 1 December. This change only affects 5-km downscaled RUC output. In addition, a paper for the January 2007 AMS meeting was completed on the RUC-RTMA 5-km downscaling method (Benjamin, Brown, Manikin, Mann).

- RUC lateral boundary conditions. A crash occurred in the operational RUC (see NCEP, above) on 21 November that was linked through an investigation to very noisy NAM boundary conditions for a very deep upper-level trough over Florida reaching down into the Caribbean. GSD developed and tested a fix by smoothing NAM fields. This prevented the crash for this case and improved lateral boundary conditions overall, making for a slightly quieter (less short-time-scale fluctuations) RUC forecast. This fix was implemented at NCEP on 12 December.

On 6 December, NCEP/AWC noted noise in the RUC height fields over Kansas. GSD was able to link this to erroneous temperature observations from the RASS site at Haviland, KS. The NOAA Profiler Hub fixed this problem that day. GSD developed a new QC treatment for RASS temperatures to more carefully flag such data, now that this certain error mode is understood. Previous changes in the QC for the RUC on 11 July as part of the 13-km RUC change package had detected most of these RASS problems (and similar aircraft temperature problems). The new code has not yet been implemented and will be bundled with other future changes to the RUC.

Work is underway at GSD to test an upcoming RUC analysis/model change package (expected at NCEP by spring/summer 2007), currently running in the 13km dev RUC (http://ruc.noaa.gov/pig.cgi?13km_D2). This package will include model changes for improved 2m temperature over snow cover and improved (decreased) areal coverage for light convective precipitation (see 07.5.8 on both topics). It will also include analysis changes to include mesonet winds for a "mesonet provider uselist", to differentiate between GPS rawinsondes and non-GPS rawinsondes (for wind observation error), and will be ready to use TAMDAR aircraft observations, if they become available for operational use (already assimilated in the 13km dev RUC (http://ruc.noaa.gov/pig.cgi?13km_D2) and 20km dev2 RUC (http://ruc.noaa.gov/pig.cgi?20km_D2).

PLANNED EFFORTS: Continued monitoring, efforts toward new observing systems for both RUC and NAM.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: Frequent interaction between GSD and NCEP, also including GSD Information Technology Services (ITS) and NCEP Computing Office (NCO).

Presentation on RUC/Rapid Refresh by Stan Benjamin to NCEP Production Suite Review meeting
http://www.emc.ncep.noaa.gov/research/NCEP-EMCModelReview2006/RUC-NCEP-OperReview-Dec06.ppt

Presentation on Mesoscale Modeling Branch by Geoff DiMego to same meeting
http://www.emc.ncep.noaa.gov/research/NCEP-EMCModelReview2006/EMC-MMB-ProdSuiteRev.Dec06.ppt

NCEP
Subtasks

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

Geoff Manikin reports the operational RUC experienced 2 failed cycles on 21 November. The problem was traced to excessively noisy fields in the operational NAM model (which provides the boundary conditions for the RUC) associated with an unusual southward push of polar air to the southern boundary. Tests indicated that the problem could be prevented by adding some simple smoothing to the processing of the NAM fields in the code that generates the boundary conditions, and this updated code was implemented on 12 December.

Users also pointed out a problem with 2-meter temperatures over lakes in Minnesota that were running far too cold for late November. This problem was traced to code that was implemented earlier this fall to deal with lake temperature problems. Data for these Minnesota lakes, which are unresolved in current water temperature data sets, are now borrowed from nearby reliable points on Lake Winnipeg. The late November problem was that Lake Winnipeg was frozen with an arctic air mass in place over Manitoba, while actual Minnesota air and water temperatures were well above freezing. The code was applying the cold air temperatures over Lake Winnipeg to the Minnesota lakes; during most of the year, if Lake Winnipeg is frozen, the lakes over northern Minnesota will also be frozen, but there are periods in fall and spring when this may not be the case. The correction is to add a check to see whether the Lake Winnipeg points are frozen; if they are, then the ambient air temperature over Minnesota is used to determine the temperature over the lakes there. This fix was also implemented on 12 December.
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 on pressure surfaces on the 80-km AWIPS grid #211 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, 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 30 October a CRISIS change was made in order to obtain GPS Integrated Precipitable Water data over a direct GSD LDM feed. These data are no longer available on the NWS-TOC due to a cut in funding at GSD. In addition, the surface component of these data are no longer available as part of the GSD mesonet feed so they are not available for assimilation. Alaska Mesonet has been added to the mesonet data assimilated by the RUC. Cooperative Agency Profiler (CAP) and RASS data are not yet available through an alternate ERSL MADIS feed. (Keyser)

PLANNED EFFORTS: 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). Turn on GOES-11 layer precipitable water retrievals and cloud-top pressure data. (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

Much discussion has taken place here internally and with other organizations on the RR Core Testing Report.

GSD

Additional timing tests were conducted for the Phase 2 (RUC-like) physics configuration used in the RR Core Test reported on in FY06 Quarter 4 (see deliverable 07.5.4.E1). These indicated that the running time of the 2 cores was about equal with non-radiation physics in the NMM called every 3 time steps (i.e., every 90s) and advection of scalars every other time step, and when non-radiation physics and scalar advection was done every large time step (72s) in the ARW. (Radiation was called every 30min in both cores.) The use of positive-definite advection of scalar variables in the NMM, but not in ARW, may have resulted in as much as a 10 to 15% timing penalty for the NMM. (Positive definite advection is advantageous, particularly for cloud and precipitation hydrometeors, and will be used in the operational RR regardless of which core is chosen, but requires some extra logic and arithmetic in the code.) Nevertheless, after accounting for this penalty the timing advantage for the NMM in the GSD RR Core-test Report appears to have been overestimated. We now believe it is at most 15% for this frequency of calling the RUC look-alike phase 2 physics. Other issues discussed with NCEP during the quarter included how, if ARW were chosen, GSD would maintain the operational ARW code for the RR. The conclusion was that this would be handled similarly to the current RUC; the ARW and ancillary codes and scripts needed to cycle using GSI would be maintained by GSD with assistance from NCAR or the DTC as needed. The role of the DTC in RR development and testing, regardless of which core is chosen, was also discussed.

PLANNED EFFORTS: NCEP will decide on which dynamical core to use for the RR using recommendation and subsequent discussions from GSD.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: DTC, NCEP

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 RR model with GSI over RR domain at degraded resolution.

CURRENT WORK: This has been GSD's most significant task toward the Rapid Refresh. Because the acceptance of the new ESRL supercomputer (wJET) was delayed into January 2006, a decision was made to fit a prototype 12-h RR cycle on the full North American domain onto the existing ESRL supercomputer (iJET). This was accomplished by running other developmental RUC/RR test cycles on fewer processors (increasing wall clock time), decreasing forecast lengths (48-h and 24-h to 24-h and 12-h) and staggering model start times. The RR cycle uses the Gridpoint Statistical Interpolation (GSI) analysis and the WRF-ARW (which includes a GSD-written Digital Filter Initialization) as the forecast model, WRFSI to supply boundary conditions from the GFS model, and a modified version of the REAL program to cycle the previous RR forecast. Testing of these components as configured for the full RR (North American) domain revealed a minor issue related to landuse definition amongst the various programs. This issue was resolved with assistance from Tanya Smirnova. Both the CONUS and full North American domain RR cycles are being run within XML workflow manager environment developed by Chris Harrop at ESRL/GSD. The environment allows users to easily specify various aspect of the model cycle (including run time, start time, file and task dependencies, error checking and restart, and processor specifications) and automatically monitors progress of the workflow, performing appropriate tasks.

As of 10 January 2007, both the CONUS and RR domain GSI-cycled WRF ARW runs have shown good reliability on iJET over the past few weeks (subject to some computer downtimes). In addition, portions of the RR workflow system have been ported over to wJET and preliminary testing is ongoing. The new RR cycle being built on wJET will include several changes and updates: 1) switch to WRFv2.2, 2) use of WRF NMM core, 3) use of NCEP pre-processing routines , 4) use of NAM data files being supplied by NCEP. Dezso Devenyi has performed initial work toward getting a GSI/NMM-based RR cycle running over a CONUS domain by completing a GSI run using NAM binary background fields and NAM prepbufr observations, and NAM satellite and radar data. In response to an ESRL/GSD request, NCEP has made available a real-time feed of NAM observations files, which are being transferred to ESRL.

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)

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 already being used for testing impact of TAMDAR observations under non-MD&E funding.

07.5.4.4 15 Nov 2006 (GSD) – Completed 15 Nov 2006.

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. Objective verification is expected to be available soon.

07.5.4.5 Ongoing (GSD)

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

07.5.4.6 Ongoing (GSD, NCAR later)

Ongoing evaluation of performance of real-time and retrospective runs of RR system for SAVs, AIVs.

07.5.4.7 1 Nov 2006 (GSD) - ongoing

Start to solicit input from other PDTs 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: A presentation concerning GSD's plans for the RR was given at the 4th Canadian Aviation Weather Workshop in Edmonton in October. Because the RR domain will cover all of Canada, there was considerable interest expressed by Canadian aviation forecasters in the RR. Important contacts were made with experts on the weather of the Far North at this meeting. Discussions with James Partain from the Alaska Region of National Weather Service (NWS) have been ongoing since the beginning of the RR implementation. A byproduct of these discussions was a teleconference between Rapid Refresh developers and various Alaska Region NWS personnel. GSD (Stan Benjamin) also had brief discussions with NWS Alaska (James Nelson, Amy Fish) at the NCEP Production Suite Model Review meeting (12-13 Dec 2006). Follow-up with these contacts will continue.

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/

Option A
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 worked on using the AIRS radiances in the NDAS. The analysis does not converge properly with the AIRS data even after the thinning was tuned to the resolution and the channels above the model domain were turned off. The forcing from the AIRS data to each of the variables was examined and it was the sensitivity to the ozone that caused the minimization to fail. Since the ozone analysis is not needed in the regional system, the sensitively to ozone was turned off and the analysis worked. She spun up the bias correction coefficients in an off line parallel for a week before the test was run in the official parallel. A positive impact on the forecast fit to conventional data and to the precipitation scores were found in the evaluations.

Dave Parrish reports that the strong dynamic constraint, previously introduced into GSI for global applications, has now been successfully extended to regional mode for use with the WRF NAM. The regional version is based on this paper: Briere, S., 1982: "Nonlinear Normal Mode Initialization of a Limited Area Model", Mon. Wea. Rev., 110, 1166-1186. Preliminary tests with an offline parallel to the operational WRF NDAS have just been started. The introduction of external mode divergence damping in the NAM model during NDAS runs has been tested in parallel for some time now and has shown dramatic improvements in assimilation and extended forecasts. Early results with the addition of the new strong constraint with also the model divergence damping indicate an additional significant

improvement in 3hr forecast surface pressure, but so far neutral for other variables. Due to the reduction in noise from both model damping and strong constraint, it is expected that a new definition of the background error will lead to further improvements.

Manuel Pondeca has started some work with the GSI to estimate the analysis error covariance using a variation of the Lanczos algorithm. It is based on work by Fisher, M. and Courtier, P., 1995: Estimating the covariance matrices of analysis and forecast error in variational data assimilation, ECMWF Tech. Memo. 220. An estimate of analysis error is required for the RTMA, which is the two dimensional surface analysis--also part of the GSI code. Also, the ensemble people would like an estimate of analysis error to improve the scaling of ensemble perturbations.

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.fsl.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 CONUS environment, using Chris Harrop's workflow manager (described in subtask 07.5.4.1). The initial testing was done using a simplified "framework" based on a 2005 version of the GSI. This has now been updated to use a full 2006 version of GSI. In addition to documenting the correct implementation of both the ARPS and RUC cloud modules within the GSI "framework:, the Oct. 2006 report (listed below), provided key comparisons information for ongoing discussions between Ming Hu and Steve Weygandt about optimal strategies for a generalized cloud analysis combining elements from both RUC and ARPS. As of 10 January 2007 Ming Hu has finished coding work for this generalized analysis within the GSI framework (updated to a newer release of the GSI) and begun cycled tests on a CONUS domain version of the Rapid-Refresh setup using the GSD workflow manager software environment (see 07.5.15.E3 for details).

The results of the initial testing are summarized in the following document, which includes results for both cold start (no background 3-d cloud fields) and cycled (background 3-d cloud fields) cases:

Ming H., S. Weygandt, M. Xue, and S. Benjamin, 2006: "*Verification of the implementation of RUC and ARPS Cloud Analysis Procedures in GSI with 13 March 2006 Central US Squall Line Case*", 26 pp

07.5.5.2 Based on parallel testing and refinement of the experimental code, deliver a "pre-implementation" version of WRF-GSI to replace Eta 3DVAR in NAM /NDAS (Oct '06)

The strong dynamic constraint previously introduced into GSI for global applications, has now been successfully extended to regional mode, for use with the WRF NAM. The regional version is based on the paper Briere, S., 1982: "Nonlinear Normal Mode Initialization of a Limited Area Model", MWR, 110, 1166-1186. The introduction of external mode divergence damping in the NAM model during NDAS runs has been tested in parallel for some time now and has shown dramatic improvements in assimilation and extended forecasts. A second parallel with the extra model damping and the addition of the strong dynamic constraint has been run for the month of December. The results show an additional 10% improvement in 3hr forecast surface pressure, and neutral results for other variables. (Parrish)

07.5.5.3 Report on testing of 2DVAR WRF-GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 5km resolution and higher. (15 Dec '05)

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. Manuel Pondeca has also continued work on estimating the analysis error covariance matrix via the connection between the conjugate-gradient method of the GSI and the Lanczos algorithm for solving large scale symmetric eigenvalue problems. (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.

Ming Xue of CAPS continues to collaborate with NCEP, in particular Shun Liu, in the testing and evaluating of the impact of radial velocity data on WRF-NMM forecasts through GSI. Ming Xue visited NCEP in late November to discuss radar data assimilation issues with NCEP scientists. CAPS hosted NCEP visitor Shun Liu in late November and December. Due to the reduction of FY2007 funding, CAPS direct contribution in this area of research will be limited, as the main emphasis will be placed on task 07.5.15E3.

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.

07.5.5.5 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. (15 May '07)

07.5.5.6 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).

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.

Overall efforts in this area, including work by Dezso Devenyi, Tom Schlatter and Steve Weygandt are 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.

The report includes:

1) An analysis of test results to assess the possibility of using the anisotropic error covariance formulation developed at NCEP to accomplish the RUC-like surface observation assimilation. The desired outcome for the anisotropic covariance formulation is analysis increments that adapt to the depth of the background planetary boundary layer. The anisotropic formulation would avoid the use of 'pseudo-observations' as is currently used in the RUC. With consultation from Manual Pondeca at NCEP, Dezso Devenyi completed a set of single-observation and full data experiments to illustrate the impact from 1) using the anisotropy and 2) imposing height dependent variations in the magnitude of the anisotropy. Results confirm the utility of this approach and documented the coupling between the horizontal and vertical scales. Based on these encouraging results, further tests are ongoing.

2) A comparison of observation minus background (O-B) values for simple interpolation and use of a similarity theory-based forward model for both the RUC and the GSI (completed by Tom Schlatter with assistance from Steve Weygandt). Tom Schlatter modified the RUC analysis code diagnostics to duplicate the diagnostics found in the GSI and a comparison case was completed for the two analysis packages. For the RUC and this particular test case (0000 UTC 15 July 2006), use of the more sophisticated similarity theory-based forward model reduced the O-B difference for surface temperature observations. For the GSI in which the similarity theory-based forward model is only utilized for the temperature field, O-B differences were somewhat larger for temperature. Also, mean O-B statistics indicated the background field was warmer than the observations on average. We are working to resolve a discrepancy in the number of observations in each layer, which has precluded a direct comparison of the GSI vs. RUC statistics.

07.5.5.8 15 May 2007 (GSD)
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).

Development and testing continues with 2 RR test cycled in place on ESRL iJETcomputer (CONUS and full North American domains). As of 10 January 2007 work is underway to port RR cycle software to new ESRL supercomputer (wJET). The new cycled systems will include: 1) switch to WRFv2.2, 2) use of WRF NMM core, 3) use of NCEP pre-processing routines , 4) use of NAM data files being supplied by NCEP. See subtask 07.5.4.1 for details.

Deliverables

07.5.5.E1 31 March 2007 **EMC**
Mar '07: Subject to NCEP Director approval, implement WRF-GSI in NAM/NDAS.

CURRENT EFFORTS: The background error covariances in GSI analysis were re-evaluated. The NMM model had had substantial changes since the error covariances was estimated. To reflect the current error characteristics of the first guess fields, the Monte Carlo method was used to generate the error statistics. The most significant difference from the previous background error statistics was that the vertical error structures were broader for the temperature and the humidity in the new statistics. She also worked on using the AIRS radiances in the NDAS. The analysis does not converge properly with the AIRS data even after the thinning was tuned to the resolution and the

channels above the model domain were turned off. The forcing from the AIRS data to each variable was examined and it was the sensitivity to the ozone that caused the minimization to fail. Since the ozone analysis is not needed in the regional system, the sensitively to ozone was turned off and the analysis worked. The AIRS data were tested in the official parallel. Positive impact on the forecast fit to conventional data and on the precipitation scores were found in the evaluations. The impact from using the aircraft humidity was also tested. (Wu)

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE:

07.5.5.8 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.

Overall efforts in this area, including work by Dezso Devenyi, Tom Schlatter and Steve Weygandt are 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.

The report includes:

1) An analysis of test results to assess the possibility of using the anisotropic error covariance formulation developed at NCEP to accomplish the RUC-like surface observation assimilation. The desired outcome for the anisotropic covariance formulation is analysis increments that adapt to the depth of the background planetary boundary layer. The anisotropic formulation would avoid the use of 'pseudo-observations' as is currently used in the RUC. With consultation from Manual Pondeca at NCEP, Dezso Devenyi completed a set of single-observation and full data experiments to illustrate the impact from 1) using the anisotropy and 2) imposing height dependent variations in the magnitude of the anisotropy. Results confirm the utility of this approach and documented the coupling between the horizontal and vertical scales. Based on these encouraging results, further tests are ongoing.

2) A comparison of observation minus background (O-B) values for simple interpolation and use of a similarity theory-based forward model for both the RUC and the GSI (completed by Tom Schlatter with assistance from Steve Weygandt). Tom Schlatter modified the RUC analysis code diagnostics to duplicate the diagnostics found in the GSI and a comparison case was completed for the two analysis packages. For the RUC and this particular test case (0000 UTC 15 July 2006), use of the more sophisticated similarity theory-based forward model reduced the O-B difference for surface temperature observations. For the GSI in which the similarity theory-based forward model is only utilized for the temperature field, O-B differences were somewhat larger for temperature. Also, mean O-B statistics indicated the background field was warmer than the observations on average. We are working to resolve a discrepancy in the number of observations in each layer, which has precluded a direct comparison of the GSI vs. RUC statistics.

07.5.5.8 15 May 2007 (GSD)
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).

Development and testing continues with 2 RR test cycled in place on iJETcomputer (CONUS and full North American domains). As of 10 January 2007 work is underway to port RR cycle software to new ESRL supercomputer (wJET). The new cycled systems will include: 1) switch to WRFv2.2, 2) use of WRF NMM core, 3) use of NCEP pre-processing routines , 4) use of NAM data files being supplied by NCEP. See subtask 07.5.4.1 for details.

Deliverables

07.5.5E1 30 March 2007 (NCEP)
Subject to NCEP Director approval implement upgrade to WRF-GSI used in NAM/NDAS.

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) and refinements to real-time test cycles running on ESRL computers (see 07.5.4.1)

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

NCAR/MMM. in collaboration with GSD and NCEP

CURRENT EFFORTS:
During this quarter, NCAR prepared and released WRF 2.2. WRF V2.2 features new capabilities such as the new WRF Preprocessing System (WPS), FDDA/nudging (both analysis and observation), numerous physics additions/modifications, new dynamics/diffusion/filter options, new software components (e.g., ESMF component support), and various bugfixes. The new physics routines include: the CAM long- and short-wave radiation scheme; an urban canopy model coupled with the Noah LSM; a new version of the Thompson microphysics scheme; modified YSU and MYJ PBL schemes; improved WSM-3,-5, and -6 microphysics schemes; an updated Ferrier micophysics scheme; and updated and improved Grell-Devenyi and BMJ cumulus schemes. GSD (G. Grell, T. Smirnova, and S. Peckham) contributed strongly to the final testing of WRF V2.2 (see also 07.5.8), especially for the interoperability of physical parameterizations, an outcome of the previous WRF Rapid Refresh core test.

The details of WRF V2.2 are described at:
http://www.mmm.ucar.edu/wrf/users/wrfv2/updates.html.

Dudhia of NCAR addressed microphysics interoperability issues for ARW and NMM, including adding separate snow and graupel surface diagnostics for use with NMM LSM. This applies to the WSM3, WSM5, and WSM6 schemes. In surface phyisics work, Dudhia worked with visitor Ratko Vasic (UCLA) on starting implementation of a potential new option for WRF, the simple SiB LSM.

NCAR in this quarter had begun collaboration with J.-W. Bao and E. Grell at NOAA/ESRL on the use of WRF's sub-grid turbulence, in place of a PBL scheme. Dudhia continued work on LES real-data applications with Brandon Storm (Texas Tech) and implemented the Bao-Grell code that so far handles sensible heat flux from the land surface.

PLANNED EFFORTS: Work will continue at NCAR on model physics capabilities and improvements, but with limited funding from the FAA.

UPDATES TO SCHEDULE: None.

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

CURRENT EFFORTS: NCAR will host an ARW tutorial on January 22-26, 2007.
Enrollment will be at about 60 students, and the course is full at this time.

UPDATES TO SCHEDULE: None.

NCAR Budget Expenditures, Quarter 1, FY2007

	Qtr	YTD
Salaries	$ 5,990	5,990
Benefits	3,043	3,043
Matls & supplies	-	-
CSC	766	766
NCAR Indirect	4,670	4,670
UCAR Fee	1,727	1,727
TOTAL	$16,196	$16,196

Subtasks

07.5.6.2 15 June 2007 (NCEP)
Commit to WRF Repository the changes embodied in operational WRF codes used in NAM upgrade package of March 2007.

07.5.6.5 30 May 2007 (NCEP)
Maintain and further develop WRF Standard Initialization (SI) and Land-Surface Model static fields, including updates to all documentation, in response to community requirements.

Deliverables

07.5.6.E1 30 June 2007 (NCAR/MMM)
Conduct a WRF Users' Workshop and a tutorial on the ARW core (NCAR) for the user community. Include descriptions and testing of Rapid Refresh as part of the workshop.

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

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

After considerable effort and testing, and in collaboration with WRF developers at NCAR and EMC, developers at GSD (Grell, Peckham, Smirnova) were able to successfully install a major set of modifications into the WRF repository in October, for *both* the WRF-ARW and NMM. These include the following:

- WRF Standard Initialization capability to initialize WRF with RUC initial conditions from the RUC native grid, including hydrometeors;
- Proper interaction between hydrometeors and GFDL radiation for microphysics schemes other than just Ferrier microphysics;
- New versions of the Grell-Devenyi convective scheme and the NCAR (Thompson) microphysics, the latter developed largely through FAA AWRP funding;
- New/updated WRF/Chem.

Tanya Smirnova is participating in an international evaluation of the performance of Land-Surface schemes (referred to as LSMs) in the mixed Boreal forest/grassland area of central Saskatchewan. This involves consideration of forest, frozen ground and snow cover. This evaluation as well as detection of a systematic nighttime cold bias in RUC operational forecasts in areas of fresh snow cover has resulted in changes to the RUC LSM which are now under testing at GSD. The cold bias in RUC was traced in part to the assumption of erroneously low density of snow on the ground at cold temperatures. Under clear nighttime conditions this led to very rapid cooling of the snow (and air in contact with it) because of the unrealistically low density and therefore low heat capacity of the snow. The heat conductivity of the snow was also increased (but kept within realistic range) to allow more heat transfer through the snow from the underlying soil. These enhancements will likely be part of a spring 2007 change bundle to the operational RUC.

Subtasks

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

CURRENT WORK: Under other-agency funding Georg Grell is leading efforts to improve the ensemble weighting in the Grell-Devenyi ensemble convective scheme so as to improve the prediction of convective precipitation. A particular goal is to reduce excessive areal coverage of light amounts of convective precipitation. . We expect the improvements resulting from this work will be tested for possible inclusion in a RUC change bundle later this year. Performance will also be examined in RR cycles at GSD.

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.

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.

An analysis of stratocumulus schemes from the NASA/Glenn in-flight icing project has been identified as a critical component of this task. Work on these cases will start next month. Available stratocumulus schemes are being identified for evaluation. Aerosol schemes are also being identified for inclusion in the testing and evaluation. An evaluation of a number of one moment and two moment schemes were done in order to evaluate whether two m moments are necessary for cloud to rain auto-conversion.

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.

CURRENT WORK: GSD developed and tested initial code for radar reflectivity assimilation into the DDFI within the 13-km RUC model. Latent heating was forced consistent with the hydrometeor increment from the observed radar data during the forward DDFI step. Some reasonable modifications to lower-tropospheric divergent wind fields around a squall line resulted in an initial test, but the surface wind modifications were too large. Work will continue on this.

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.

CURRENT WORK: GSD and CAPS have continued work toward testing the satellite/METAR cloud initialization. This particular component is primarily from the RUC hybcloud code modified by CAPS for GSI. The ARPS component for initialization of cloud water from radar will likely also be used in the GSI cloud analysis being developed toward the Rapid Refresh (see below).

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 07.5.5.1. and below)

07.5.15.E3 15 September 2007 (GSD and 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 further tested the ARPS and RUC cloud analysis packages within a simplified framework based on a 2005 version of the GSI using the 13 March 2006 central US squall lines case. The impacts of the cloud analysis on the forecast were studied for both cold start (no background 3-d cloud fields) and cycled (background 3-d cloud fields) cases. A report was prepared with GSD to document the verification of the implementation of both the ARPS and RUC cloud modules (see subtask 07.5.5.1).

Based on the previous work and collaborated with GSD, Ming Hu combined the main components of the ARPS and the RUC cloud analysis together and developed an initial version of the generalized cloud analysis package which combined the strengths of the two old packages. The new package is able to build a 3 dimensional cloud coverage with cloud types based on METAR data, NESDIS cloud products, and NSSL reflectivity mosaic. Further, it is able to calculate cloud water and cloud ice mixing ratios, to retrieve rain, snow, and hail mixing ratios from radar reflectivity, and to adjust in-cloud temperature based on latent heat or lifted moist adiabat.

Collaborating with Steve Weygandt of GSD, Ming Hu has updated all three cloud analysis packages to the Rapid Refresh CONUS environment, which includes a full 2006 version of GSI and WRF-ARW with RR CONUS settings. Both GSI and ARW are managed by workflow. The 13 March 2006 central US squall lines case was used again to conduct preliminary tests of the cloud analysis in the new environment. Several forecasting experiments using ARW starting from the GSI analysis with the cloud analysis were conducted and the results are being analyzed to evaluate the implements of all three cloud analysis modules in the RR CONUS environment. As of 10 January 2007, cold start runs have been completed and 1-h cycled experiments (to examine the cumulative effect of using the cloud analysis with each update) are underway.

Task 07.5.17 Infrastructure support for running operational WRF model in Rapid Refresh, North American Mesoscale and HiResWindow modes at NCEP.

NCEP

Subtasks

07.5.17.1 Maintain four-per-day North American Mesoscale runs and provide SAV and AIV guidance.

On 19 December 2006 several changes to the WRF-NMM were implemented in the North American Mesoscale Model to improve model performance. The divergence damping routine, which damps all gravity-inertia and external modes, is changed to increase damping of the external mode. During the NDAS, divergence damping is increased to 5x that used during the 84 hr NAM free forecast. Additionally, horizontal diffusion is turned on between neighboring grid points with a slope of less than or equal to 54 m / 12 km (9x that in previous operational NAM). (Rogers)

Numerous changes were made to the convective parameterization, including 1) Triggering of deep and shallow convection is considered only for grid points with positive cape throughout a parcel's ascent; the search for parcel instability is extended to include not only whether the most unstable (highest theta-e) parcel can support convection, but also whether parcels originating at higher levels become positively buoyant when lifted to their LCL. Convective adjustments are made with respect to the parcel associated with the greatest instability (largest CAPE), 2) the search for the most unstable parcel is extended from the lowest twenty percent of the atmosphere to the lowest 40 percent of the atmosphere, 3) water loading effects are now included in assessing the buoyant instability of parcels from which a revised (lower) cloud top is determined to be at the highest level of positive buoyancy, 4) the latent heat of vaporization used to calculate equivalent potential temperatures during model integration is made to be consistent with the value used in generating the initial lookup tables, 5) when a grid point fails the entropy check for deep convection but still has positive CAPE, changes in temperature and moisture by shallow convection are then considered at these so-called "swap" points. The first-guess estimate for the top of shallow convection is based on the highest level where the parcel remains positively buoyant (this is more restrictive than positive CAPE), and the vertical extent of shallow convection is not to exceed 0.2 times the atmospheric pressure depth (e.g., 200 hPa for a surface pressure of 1000 hPa). A final adjustment is made to the top of shallow convection in which it can extend to higher altitudes if the mean ambient relative humidity (RH) in the cloud layer exceeds a threshold RH while remaining positively buoyant (i.e. CAPE greater than 0). The threshold RH is based on the RH at cloud base that is consistent with a deficit saturation pressure of 25 mb (usually near 90%). The maximum cloud top height for shallow convection is limited to 450 hPa, and 6) the first-guess reference temperatures in the upper-half of shallow convective clouds are limited to be no more than 1 deg C colder than the ambient temperature. (Rogers)

Changes to the cloud microphysics include 1) during melting precipitation ice particles are assumed to have the same mean diameter (1 mm) as at the freezing level, and 2) two changes intended to increase the presence of supercooled liquid water and improve forecast products for use in aircraft icing algorithms: (a) The temperature at which small amounts of supercooled liquid water, if present, are assumed to be glaciated to ice was lowered from -30C to -40C. (b)The temperature at which ice nucleation is allowed to occur was lowered from -5C to -15C based on aircraft icing observations. (Rogers)

07.5.17.2 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. 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 (and ahead of schedule),NCEP has maintained twice-per-day runs of six WRF-based members of the Short Range Ensemble Forecast (SREF) system with aviation guidance available from http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html . (EMC and NCO)

07.5.17.3 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 on pressure surfaces on the 80-km AWIPS grid #211 via the NWS Family of Services (FOS) data feed and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (EMC Team and NCO)

07.5.17.4 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 4/day NAM and the 5 km nested runs of the HiResWindow (HRW) suite of WRF-ARW and WRF-NMM 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/. GRIB and BUFR output are sent to 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 (http://tgdata.nws.noaa.gov). To conserve bandwidth, GRIB2 data is being transferred to tgdata and then converted to GRIB1. For that reason, GRIB2 data will be available one to two minutes earlier on average than GRIB1. Both sets of data will remain on the TOC FTP server for a minimum of 180 days after the system is declared operational. (EMC Team and NCO)

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 PDT when their algorithms and product generation systems are ready to transition into NCEP's operational production suite.

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 30 October on the new Mist machine to point to the proper new directory path for TPC tropical cyclone records. These are used by the synthetic data bogusing program. Also, a CRISIS change occurred on 31 October to work around connectivity problems to NESDIS' new DDS server, where NCEP obtains most of its POES data. NEXRAD Level 2 radial wind data have not been processed since late September due to an upstream formatting change. The NAM continues to assimilate Level 2.5 and Level 3 radial wind superobs as a backup. This will be corrected soon in the pre-implementation runs on Mist. (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, 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)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: GSD & NCO.

UPDATES TO SCHEDULE:

0.5.17.E2 1 October 2006 - 30 September 2007 **EMC** (Parrish, Derber, Wu, Keyser)

As requested by other PDT's, incorporate new AIV calculations into Operational WRF Model post-processor and product generator.

CURRENT EFFORTS: No requests were made by other PDTs during this period. NWS Eastern Region and NCEP's Storm Prediction Center (SPC) have requested that simulated radar reflectivity be added to the WRF-post. This field was generated for the recent DTC Winter Forecast Experiment and for the SPC Spring 2005 program. Ferrier has updated and corrected aspects of the reflectivity simulation capability in the WRF post-processor.

PLANNED EFFORTS: Refine forward model for simulated reflectivity.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None

INTERFACE WITH OTHER ORGANIZATIONS: GSD & NCO

UPDATES TO SCHEDULE: None