Quarterly Report for October – December 2008

FY 2009

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Executive Summary

Task 09.5.1: Infrastructure support related to operational running of the RUC and NAM operational modeling systems.

- **RUC upgrade implementation at NCEP occurred in 2 parts - 17 Nov, 16 Dec 2008**
  - Part 1 – 17 Nov 08 - RUC upgrade package code includes (radar reflectivity assimilation, longwave radiation, Grell/Devenyi upgrade). Improved precipitation, near-surface forecasts.
  - Part 2 – 16 Dec 08 - TAMDAR assimilation added, selection of mesonet reports closest to analysis time.
  - http://ruc.noaa.gov/ruc13_docs/RUC-upgrade.impl-prebrief.4nov08.pdf - RUC upgrade pre-implementation briefing includes new case studies and comparisons between old and new RUC versions.
- NAM upgrade implementation at NCEP – 16 Dec 2008

Task 09.5.4 Develop, test, and implement Rapid Refresh configuration of the WRF modeling system.

- Providing real-time feed of RR files to other AWRP RTs and Alaska Region NWS and getting feedback from them
- All RR components (GSI, WPS, ARW, WPP, scripts) under SVN code management

Task 09.5.5: Develop, test, and implement 3DVARs for RR and NAM

- Completed satellite retrospective experiment, indicating slight temperature improvement from the satellite radiance assimilation

Task 09.5.6: Improve WRF model

- Version 3.1 will be released in Spring 2009

Task 09.5.15: Develop, test, and implement 3DVARs for RR and NAM

- Modifications to WRFpost to provide better compatibility with RR cloud analysis

Task 08.5.24/19: Begin 3km High-Resolution Rapid Refresh testing / Improve radar assimilation

- GSD providing RUC radar-enhance initial condition and lateral boundary condition files to NCAR for HRRR experimental test work
- GSD completed preliminary work toward a prototype time-lagged HRRR-based convective probability forecast

RUC/RR progress/plan update at NCEP:

- NCEP presentation on RUC/Rapid Refresh/HRRR on Tues 9 Dec 2008 – Stan Benjamin and Steve Weygandt, Geoff DiMego on NCEP mesoscale plans (other than RUC/RR) See http://www.emc.ncep.noaa.gov/annualreviews/2008Review/index.html ; look up RUC/RR status for Tuesday. (Presentation is also available by Geoff DiMego on non-RUC/RR mesoscale

modeling).

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Task 09.5.1 Infrastructure Support Related to Operational running of the non-WRF Rapid Update Cycle System in NCEP Operations

GSD

Implementation of most of the RUC upgrade occurred on Monday 17 Nov 2008. All changes implemented except that access to TAMDAR did not occur, since a RUC pre-analysis code was not updated as intended. That key feature of the upgrade was added on Tuesday 16 Dec 2008.

Final evaluations of RUC upgrade package and presentations to various RUC users

- Pre-implementation briefing to NCEP Director (Louis Uccellini) by Stan Benjamin and Geoff Manikin (NCEP/EMC) on Wed 5 November. Upgrade granted approval.
- Presentation developed and made available from http://ruc.noaa.gov at http://ruc.noaa.gov/ruc13_docs/RUC-upgrade.impl-prebrief.4nov08.pdf including a number of new case studies.
- Tele-training sessions on RUC upgrade to NWS Southern Regions.
- Some final improvements added to RUC post-processing for RTMA downscaling code as part of the RUC upgrade package, adding 5km output for potential temperature and local lapse rate.

Stan Benjamin and Steve Weygandt from ESRL/GSD gave a detailed presentation on RUC/Rapid Refresh status at the NCEP Production Suite Review meeting on Tuesday 9 Dec. This presentation is available under http://www.emc.ncep.noaa.gov/annualreviews/2008Review/index.html

AWC and SPC and the NWS Eastern, Central, Southern, and Western Regions all made positive comments about the RUC upgrade in the NCEP review meeting. Alaska Region also spoke positively about access to experimental Rapid Refresh real-time products.

ESRL/GSD has worked on improving the retention of METAR ceiling observations in RUC 1-h forecasts (see Task 9.5.15).

ESRL/GSD has continued to monitor the real-time and overall performance of the operational RUC (and GSD experimental versions) for ceiling, visibility, precipitation, and upper-level observations of wind, temperature, and moisture from rawinsondes and aircraft. These RUC verification monitoring capabilities are available under http://ruc.fsl.noaa.gov/stats/.

NCEP

Subtasks

October 2008 through September 2009

09.5.1.1 Maintain hourly RUC runs and provide grids of SAV and AHP guidance products.
Problems with Canadian AWS mesonet pressure observations were diagnosed by ESRL and EMC in early December and after documentation by ESRL (RUC group), was solved on 15-16 December when MADIS (ESRL) set bad-quality flags on the bad pressure obs thus blocking their downstream use in the RUC (or NAM). (Manikin)

09.5.1.2 Provide vendors with gridded 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 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/PMB/Dataflow Group)

09.5.1.3 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 site at ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/ruc/prod/ and at the NWS/OPS site at ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/ in hourly directories named MT.ruc_CY.00 through MT.ruc_CY.23. This includes hourly BUFR soundings and output grids which undergo no interpolation and, as such, are on the models' computational grid (so-called native-native grids). Both sites now contain only grids packed into GRIB2 format, see http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml.
A limited set of fields from the RUC runs (and other NCEP models) can also be viewed at http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/. (EMC Team and NCO/PMB/Dataflow Group)

09.5.1.4 Maintain access to model verification data.
NCEP maintained its capability and provided access to routine verifications of the operational RUC analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch (MMB) website: http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html This capability was enhanced in December 2008 when Julia Zhu combined the various routine verification jobs and scripts and worked with NCO/PMB to have them added to the operational NCEP Production Suite. This combined processing will run more reliably in Production and will automatically be switched with the rest of the suite when it is necessary to switch operations from one computer to another. This used to have to be done manually when the verification jobs were run "over-the-counter" outside of Production. (EMC Team and NCO/PMB).

09.5.1.5 Working with NCEP/NCO and NCEP/EMC, complete the design, compilation, debugging, test runs and parallel testing of RUC codes on new CCS computer.

Deliverables

09.5.1. E1 Perform ingest, quality control and preparation of both existing and new observations in support of the operational RUC runs. (NCEP, GSD)

CURRENT EFFORTS: NCEP/NCO's new recombination code, which converts Build-10 WSR-88D Level II reflectivity (and radial wind) data to a Build-8 look-alike format, was implemented on 7 October. Level II reflectivity data from all radar sites except San Juan were once again available for the 88D mosaics, which the RUC started using on 17 November. A change to include San Juan was implemented on 9 December. (Liu) On 1 October, the NWS began a 90-day outage of NOAA Profiler Network wind and RASS data (used by RUC analysis) for hardware upgrades to improve security. On 27 October, these data became available via the GTS through an ESRL/GSD temporary patch. Multi-Agency Profiler wind and RASS data are again available as of 25 November, from an ESRL MADIS feed, for the first time since April 2006. The RASS data are used by the RUC. NCEP/NCO implemented an update to their upper-air dictionary on 7 October to correct obsolete default instrument types for many radiosonde sites. The radiosonde complex QC program and its in-line intersonde (radiation) correction step were updated on 4 November and again on 9 December, to correct minor bugs in the codes and to account for the current set of radiosonde instrument types. NESDIS has been contacted on two problems with the "new science" GOES 1x1 field-of-view cloud data, where random files (2-4 daily) have 1-2 beginning reports with missing lat/lons and a bogus satellite ID, and GOES-East data late arrival which reduces the obs counts in the RUC dump files for some cycles. On 17 November, the RUC was updated to assimilate mesonet wind data from a use-list. Beginning 15 December, GOES-13 replaced GOES-12 in the GOES-East schedule due to a GOES-12 thruster anomaly, which doesn't have a current return to service date. The RUC is now assimilating GOES-13 IR and WV imager (cloud-top) winds in place of GOES-12 winds, but it is not using GOES-13 layer PW and cloud data (it uses GOES-12 layer PW and cloud data). On 16 December, the RUC was updated to assimilate TAMDAR temperature and moisture data, but not wind data, and to now assimilate mesonet mass and wind data only from the site closest in time to the analysis time (when a site appears more than once in the input PREPBUFR file). Also, a change in the PREPBUFR processing corrected an error in the calculation of MDCRS and TAMDAR pressure-altitude above 226 mb. (Keyser)

PLANNED EFFORTS: See PLANNED EFFORTS listed under Task 09.5.17.E1 below for code transition to new computer and aircraft quality control issues. Complete RUC impact tests for Canadian AMDAR temperature and wind data, TAMDAR wind data (obtaining all TAMDAR data from AirDAT and adding (for GSD) airframe type and company code for improved bias corrections), 6-minute wind profilers, mesonet roadway data, new mesonet data feeds (including "hydro", "snow", modernized COOP and UrbaNet and late-arriving mesonet data), MDCRS aircraft moisture, MAP profiler winds, and lightning data. Explore (with NCO) ways to restrict experimental data [coming in via operational channels] from being used inadvertently in the operational analyses. Develop a platform-specific surface quality control module within the PREPBUFR processing framework. (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.
INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: None.

09.5.1. E2 Perform configuration management for RUC, including thorough documentation, and respond promptly to any code malfunctions or performance issues. (GSD, NCEP)

CURRENT EFFORTS: Code and scripts for the major RUC upgrade were turned over to NCEP Central Operations (NCO/PMB) in July, but with Critical Weather Days (CWD) due to extremely active tropical weather in August and September, the start of the 30-day outside RUC evaluation was delayed. This evaluation was completed in late October, and EMC/NCO received favorable feedback from forecasters at both the Storm Prediction Center (SPC) and Aviation Weather Center (AWC). NCEP Director was briefed on 28 October and the implementation was scheduled for 12 November. A power failure at the backup facility in Fairmont, WV on the 12th and subsequent CWD for a space shuttle launch on 13th caused the RUC implementation to be re-scheduled. The major RUC upgrade was finally implemented on 17 November. This version ingests National mosaics of reflectivity each hour from which a 3-dimensional field of latent heating is derived which is used in the forward step of the diabatic digital filter initialization. Other changes include the assimilation of mesonet wind (from a list of approved providers) and TAMDAR data, a change in the longwave radiation scheme from Dudhia to RRTM, a modification to the snow component of the land-surface model to decrease excessively cold 2-meter temperatures over fresh snow at night, another change to the snow model to allow for warmer temperatures during warm advection events over snow cover, and a modification to the convective scheme to decrease widespread coverage of light precipitation. EMC and GSD discovered soon after the implementation that the new version of the RUC analysis code was not yet properly receiving the TAMDAR data. An update to the getbufr code to correct this problem was given to NCO and it was implemented on 16 December. A new procedure in that getbufr code to chose the surface ob closest to the analysis time (top of the hour) exposed some bad pressure obs coming from a Canadian agricultural network recently added to the AWS feed. See subtask 09.5.1.1 & deliverable **09.5.1E3** for its resolution. (Manikin and NCO/PMB)

PLANNED EFFORTS: Work with NCO/PMB to transition RUC codes and scripts to the new computer. Prepare for pushing RUC forecast range to 18 hours with hourly output promised to SPC and AWC by Q4 FY2009.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: Lack of disk space on the new computer.

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: None.

09.5.1.E3 Monitor RUC performance, respond to any problems detected by GSD, NCEP, or any RUC users, diagnose cause, develop solution to RUC software, test changes and coordinate with NCO on implementation. (GSD, NCEP)

CURRENT EFFORTS: A problem was discovered by EMC in early December and linked by ESRL to a Canadian agricultural mesonet data network in Alberta and Saskatchewan providing bad surface

pressure data which had a negative impact on analyses in that region. MADIS, which provides the data to NCEP, was alerted to this issue, and began adding quality control flags to this data set starting 15 December. (Manikin)

PLANNED EFFORTS: Continue monitoring efforts.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: None.

Task 09.5.17 Infrastructure support for operational running of WRF-based modeling system in North American Mesoscale and HiResWindow at NCEP.

NCEP

Subtasks

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

Code and scripts for the major NAM/NDAS upgrade were turned over to NCEP Central Operations (NCO/PMB) in late August and the 30-day outside evaluation was begun 14 October. A mid-stream correction of a fixed-field initialization problem required the evaluation be extended an extra 2 week delayed. This evaluation was completed in late November, and EMC/NCO received favorable feedback from forecasters at Hydro-meteorological Prediction Center (HPC), SPC) and AWC. NCEP Director was briefed on 12 December. On 16 December the major NAM/NDAS upgrade package was implemented into NCEP operations. Changes to the WRF-NMM model physics/dynamics include: vertical mixing and diffusion are applied to each individual hydrometeor species (as opposed to just the total condensate field), absorption coefficients for cloud water/ice in the radiation parameterization are doubled and changes to the land-surface physics to improve forecasts of cold season (snow covered or frozen soil) near-surface fields. (Rogers and NCO/PMB)

09.5.17.2 Maintain four-per-day HiResWindow runs and provide SAV and AHP guidance. (NCEP)

NCEP runs 4/day runs of WRF-NMM at 4 km and WRF-ARW at 5 km when there are no hurricane runs. Five domains are run with three large domains being Eastern CONUS (00z & 12z), Western CONUS (06z) and Alaska (18z) and two small domains being Hawaii (00z & 12z) and Puerto Rico (06z &18z). Most of this quarter, the HiResWindow runs have been made since there have been few tropical systems to cause preemption by hurricane runs. A couple of Alaskan ARW failures occurred in December. Matt Pyle filed an RFC to correct the initialization issue and the fix is scheduled for implementation which NCEP also maintains twice-per-day runs of six WRF-based members (3 running NMM and 3 running ARW) of the Short Range Ensemble Forecast (SREF) system with aviation guidance available from http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html which now includes specific output for Alaska and Hawaii (eastern Pacific). (Pyle, Du and NCO)

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

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). Higher resolution grids (40-km grid #212 and 12-km grd #218) are also made available to FOS (and NOAAPORT) users. (EMC Team and NCO)

09.5.17.4 Provide full grids from NAM, and HiResWindow on NCEP and NWS/OPS servers.

(NCEP)

NCEP maintained real-time availability of full resolution gridded data from the operational 4/day NAM and HiResWindow (HRW) suite of WRF-NMM and WRF-ARW runs via anonymous ftp access via the NCEP server site at ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/nam/prod/ (on numerous grids) and at the NWS/OPS site at ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/. At the NWS/OPS site, the NAM data are in 4/day directories named MT.nam_CY.*hh* where *hh*=00,06,12 or 18; while the HRW data are in 4/day directories named MT.hires_MR.*mmm*_CY.*hh* where *mmm*=arw or nmm and *hh*=00,06,12 or 18. This includes hourly BUFR soundings (NAM only) and output grids which undergo little or no interpolation. Both sites now contain only grids packed into GRIB2 format, see http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml. HRW outputs are scheduled to be added to NOAAPORT feed with AWIPS OP9. A limited set of fields from the NAM and HiResWindow (HRW) runs (and other NCEP models) can also be viewed at http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/. (EMC Team and NCO/PMB/Dataflow Group)

New scripts and codes have been developed to convert the hourly national 3D reflectivity mosaics in binary format to GRIB and run this processing in a real-time parallel. This will be used as truth in [grid-versus-grid] verification of the simulated reflectivity products produced by NAM and HiResWindow runs. (Shun Liu, Matt Pyle and Binbin Zhou)

09.5.17.4 Maintain access to model verification data. (NCEP)

09.5.17.5 Working with NCO, complete the design, compilation, debugging, test runs and parallel testing of RR, NAM and HiResWindow (and SREF) codes on new CCS computer.
The first half of NCEP's new computer system was installed in Fairmont, WV in Oct-Nov and acceptance tested in Nov-Dec. This machine (known as cirrus) will be the one used to conduct all operational code/script conversion primarily during the next quarter. A moratorium on changes to the Production Suite will be in effect until this conversion is completed and the second half of the new computer system is installed and accepted in Gaithersburg, MD. NCO has produced a highly detailed plan for the conversion and it is expected that most of EMC will be engaged in this effort for at least the next three months. Due to power limitations there, the Gaithersburg machine will have to be handled in phases. For this reason, it is possible that the moratorium will last well into FY2009. Contractually, full acceptance of both halves must occur prior to 1 October 2009.

Deliverables

09.5.17.E1 Perform ingest, quality control and preparation of both existing and new observations in support of the operational WRF runs. (NCEP)
CURRENT EFFORTS: A set of (00Z) WRF-launcher runs were performed using the operational NAM domain and 12 km grid-spacing to examine the impact of improved radial wind analysis on forecasts. Preliminary results indicate positive impacts were produced. NCEP/NCO's new recombination code, which converts Build-10 WSR-88D Level II reflectivity (and radial wind) data to a Build-8 look-alike format, was implemented on 7 October. Level II radial wind data from all radar sites except San Juan were once again available to the NAM-GSI. A change to include San Juan was implemented on 9 December. (Liu)
On 1 October, the NWS began a 90-day outage of NOAA Profiler Network wind and RASS data for hardware upgrades to improve security. The NAM-GSI uses profiler winds and monitors RASS temperatures. On 27 October, these data became available via the GTS through a temporary patch by ERSL/GSD. Multi-Agency Profiler wind and RASS data are again available as of 25 November, from a MADIS feed for the first time since April 2006. The RASS data are monitored by the NAM-GSI.
NCEP/NCO implemented an update to their upper-air dictionary on 7 October to correct obsolete default instrument types for many radiosonde sites. The radiosonde complex QC program and its in-line intersonde (radiation) correction step were updated on 4 November and again on 9 December, to correct minor bugs in the codes and to account for the current set of radiosonde instrument types. AIRS radiance data counts have been below average since May due to late posting of files (NESDIS' AIRS processing hardware issues). In mid-April the NAM-GSI stopped using AIRS AMSU-A radiances when AMSU-A channel 4 went bad. The NAM-GSI was modified on 16 December to allow monitoring of the

remaining AMSU-A channels (in preparation for their use in the next NAM-GSI update in late 2009). AIRS radiance and MODIS wind data were not available 6–9 October and again on 4-5 November due to NESDIS hardware issues. EUMETSAT replaced METEOSAT-9 with METEOSAT-8 for 1-9 December while MSG-9 underwent routine spacecraft decontamination. NCEP did not receive METEOSAT-8 wind data due to a problem in NCO which was later corrected. MSG winds are only monitored by the NAM-GSI so this was not critical. Beginning 15 December, GOES-13 replaced GOES-12 in the GOES-East schedule due to a GOES-12 thruster anomaly, which doesn't have a current return to service date. The NAM-GSI now assimilates GOES-13 IR and WV imager (cloud-top) winds in place of GOES-12 winds, but only monitors GOES-13 sounder radiances (GOES-12 radiances used). On 16 December the NAM-GSI was updated to assimilate TAMDAR temperature, wind and moisture data; Canadian AMDAR temperature and wind data; and METOP-2 HIRS-4, AMSU-A and MHS 1B radiances. Also, a change in the PREPBUFR processing corrected an error in the calculation of MDCRS and TAMDAR pressure-altitude above 226 mb. Alaskan radiosonde data receipt has improved after NCEP contacted Alaska region, but there is still a need for some sites to move up their launch time for the NAM-GSI. Ways to speed up the dump processing of NEXRAD Level II data are being explored. (Keyser)

PLANNED EFFORTS: Work with NCO/PMB to transition RUC codes and scripts to the new computer. 12Z test cases will be run to further examine the effect of improved radar wind analysis on the forecast. (Liu) Work with NCO/PMB to transition all observation dump and quality control and processing codes and scripts to the new computer. Add a new aircraft quality control module from Naval Research Lab, as soon as run times are improved for when profiles are generated. This code is now being tested in daily real-time Regional and Global parallel runs. Change PREPBUFR processing to add report sub-type information so the analysis can use different obs errors and develop bias corrections based on data sub-types (airframes and ascent/descent tags, mesonet providers and sub-providers, radiosonde instrument type and on-site correction indicators). Complete impact tests in NAM for several new data types: TAMDAR (from AirDAT feed); QuikSCAT 0.5 deg. scatterometer wind superobs (eventually using "new science" QuikSCAT); mesonet mass and roadway data, and new mesonet data feeds (including "hydro", "snow", modernized COOP, UrbaNet and late-arriving mesonet data); MDCRS aircraft moisture; NPN and MAP RASS virtual temperature profiles; JMA, European and MAP profiler winds; 3.9 micron and visible satellite winds; WindSat and ASCAT scatterometer wind data; GPS radio occultation data; and METEOSAT-9 IR and visible satellite winds. Coordinate with the field to speed up more Alaskan RAOB processing for the NAM dumps. Try to retrieve as much data as possible over Alaska (especially mesonet, aircraft and coastal surface). Add GSI events to the NAM PREPBUFR files. Make use in the GSI of the actual or estimated anemometer, barometer and thermometer heights on ships. Generate and QC high vertical-resolution aircraft profile data near airports. Explore (with NCO) the possibility of incorporating a use-list in order to keep experimental data coming in via operational channels out of the operational analyses. Develop a platform-specific surface quality control module within the PREPBUFR processing framework. (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: GSD & NCO.

UPDATES TO SCHEDULE:

09.5.17.E2 As requested by other RTs, incorporate new AHP calculations into Operational WRF Model post-processor and product generator (NCEP). 30 September 2009 **EMC** (Rogers, Pyle, Keyser)

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

CURRENT EFFORTS: AWC had requested a change in the procedure for calculating Freezing Level Height in both the NAM and GFS. The NCEP Post-processor was upgraded to use the 2m temperature instead of the surface (skin) temperature when looking for the height of the lowest freezing level. Operational versions of both NAM (16 December) and GFS (9 December) were upgraded. (EMC Team and NCO)

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None

INTERFACE WITH OTHER ORGANIZATIONS: NCO

UPDATES TO SCHEDULE: None

Task 09.5.4 Develop, test, and implement the Rapid Refresh.
NCEP
No NCEP activity to report.

Subtasks

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

GSD
Starting in late October 2008, two parallel full hourly cycled versions of the Rapid Refresh have been running at GSD, with files from the primary RR going to many users (including AWR RTs), verification and web-based plots.

Verification of standard atmospheric variables (temp, RH, wind) continues to indicate the experimental Rapid Refresh is competitive with the RUC at most forecast lengths and output times. Upper level wind RMS errors are almost an exact match to the RUC, except near the tropopause where scores are a bit worse. We are examining possible causes for this result.

A recently discovered minor bug in precipitation verification package (resulting in an incorrect summing of the precipitation accumulations just got corrected and we are beginning to compile statistics (summing the 12-h accumulated precipitation from two RUC forecast separated by 12 h). The bug was related to a difference in the accumulated precipitation files between the RUC and RR (RR has hourly and run-total precipitation, RUC has hourly and 3-hourly), Because of this difference, additional minor changes (coding underway) are need to the precipitation verification package to computer 6-hourly verification statistics. Qualitative comparisons of RR vs. RUC precipitation continue to show very good qualitative agreement. The real-time runs are complemented by a retrospective capability that has been used to evaluate different background error covariance specifications in the GSI and was also used to evaluate 2 different boundary layer schemes in the WRF model (see task 8 below). We also completed 2 retrospective tests to evaluate the impact of satellite radiance assimilation on the RR forecast. Results from this experiment indicate a slight improvement in mid-level temperatures and winds with near neutral results for other variables and levels.

Joe Olson, an NRC postdoc at GSD, is now beginning to examine RR performance specifically over Alaska with the aid of the Meteorological Evaluation Tool (MET) software being developed by the Developmental Testbed Center. Joe pointed out some problems with the MET software to the developers and has worked with the MET developers to correct them. This time of year, characterized by very cold surface temperature at some locations and highly stable lapse rates in the lower atmosphere, is a particularly challenging time for NWP models. We intend for this evaluation to complement evaluations we receive from Alaska forecasters (see subtask 4.2 below).

GSD is also actively modifying the NCEP version of WRFpost, originally written by NCEP/EMC to postprocess the WRF-NMM. RUC post-processing algorithms for ceiling, visibility and radar reflectivity have been introduced into the post, and results are being examined for accuracy and overall consistency with RUC behavior (of course, identical behavior is not to be expected since the models are different).

The RUC reflectivity algorithm is more consistent with the NCAR microphysics used in RR than is the present default WRFpost algorithm, which is based on the Ferrier microphysics used in NAM.

Also, all codes and scripts associated with the Rapid Refresh real-time cycle have now been brought into a "Subversion" ("SVN", a commonly used revision control system) repository, which will provide detailed tracking of all system changes and greatly assist efforts to synchronize GSI developments at GSD and NCEP. Note, the recent addition of the RR version of the ARW model, WPS pre-processing, and the WPP post-processing software to the SVN repository complements the previously completed inclusion of the GSI code.

09.5.4.2 1 Nov 2008 (GSD, NCEP)
Continue to solicit input from Inflight Icing, Turbulence, National Ceiling/Visibility, and Convective Weather RTs and NWS forecasters in Alaska and Puerto Rico, as well as AWRP RTs, on performance of pre-implementation Rapid Refresh. Arrange to have GSD RR grids available to examine and solicit feedback on RR performance.

(ESRL/GSD)
GSD has made many different types of RR files available to users (AWR RTs, NWS) and worked to assist them to access, process and display RR grids within various workstation environments. We are currently producing 4 flavors of RR files (native level, pressure level, surface field, and precip fields) for each of 3 grids (full RR, Alaska 249, CONUS) and in grib1 and grib2 formats. During October and November, most of the interaction with outside groups was focused on answering technical details about the grids and fields. Now that the RTs and Alaska NWS now have the grids processed, more detailed evaluation has begun. George Trojan at Alaska Region NWS has ported RR grids to the AWIPS workstation and forecasters at ANC and FAI and the AWU are now viewing them.

Members of the RR development group at GSD and NWS Alaska Region Science and Operation Officers met by telcon on 17 December to discuss RR issues, including very preliminary assessment of RR performance. The Alaska folks noted the following performance concerns

- Too much low-level cloudiness (this was before the RUC modifications to ceiling diagnosis became available, but also may be worsened by the lack of polar-orbiter satellite data going into the cloud analysis)
- Too warm at night in low-lying inland areas that are typically very cold this time of year (also seen in GSD's verification using MET—this will be addressed further once we are confident that RR cycling of snow and soil temperature and moisture are correct)
- Too much east wind at Anchorage in certain situations (this likely results from coarse resolution of the terrain in the Anchorage vicinity, but will be investigated further).

The Alaska-Region forecasters would also like a partial cloudiness product and BUFR soundings for Alaska and adjacent areas. They also encouraged us to do everything we can to ensure that available buoy and ship data and NASA QuikSCAT surface winds are used in the analysis in order to better forecast landfalling storms. This may require allowance for large latency on some of this data. As a result, NASA Langley initiated an effort to produce GOES-based cloud products over most of the Rapid Refresh domain (more under 09.5.15).

Various AWRP RTs at NCAR have also been accessing the RR grids and beginning to use evaluate them with respect to their algorithms. In particular, the Icing RT has begun making displays comparing the hydrometeor fields from the RR vs. RUC. This processing has helped uncover a minor grid issue (apparently in the grib1 to grib2 conversion). We are working to resolve it.

09.5.4.3 30 May 2009 (GSD, NCEP, NCAR)
Updated report on status of tactical planning for making RR-WRF ARW model code for 2012 in compliance with Earth System Modeling Framework (ESMF) in agreement with the Sept 2007 Rapid Refresh MOU between NCEP and GSD.

09.5.4.4 30 Sept 2009 (GSD, NCEP)
Complete pre-JIF evaluation of Rapid Refresh in accordance with NCEP pre-implementation checklist for major implementations. Respond to evaluation questions, present information on Rapid Refresh pre-implementation testing and evaluation results in various forums, as required.

09.5.4.6 30 Sept 2009 (GSD and NCEP)
Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit Rapid Refresh software to NCO.

Deliverables

09.5.4.E1 20 Dec 2008 (GSD)
Report on Rapid Refresh testing at annual NCEP Production Suite Review meeting.

A presentation summarizing the RR testing and refinement was given by Steve Weygandt at the NCEP Annual Product Review (see PPT slides for RUC/RR presentation under
http://www.emc.ncep.noaa.gov/annualreviews/2008Review/index.html

09.5.4.E2 1 September 2009 (GSD, NCEP)
Complete documentation (in Technical Procedures Bulletin-like document) of Rapid Refresh system.

09.5.4.E3 30 September 2009 (GSD, NCEP)
Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit Rapid Refresh software to NCO.

Task 09.5.5 Develop, test, and implement improvements to the operational 3DVARs for Rapid Refresh and North American Mesoscale runs.

NCEP

GSD
Four GSD scientists (Dezso Devenyi, Ming Hu, Steve Weygandt, and Stan Benjamin) visited NCEP on Dec. 8-9 to discuss various aspects of the GSI development for RR applications, including finalizing the inclusion of the GSD cloud analysis package to the NCEP GSI repository, surface assimilation issues, balancing and cycling issues, and NCEP scripting issues. Based on feedback from GSI code managers at NCEP, Ming Hu has been working complete additional minor coding changes to bring the inclusion cloud analysis into full compliance with the GSI coding standards.

Work by GSD continues on refining the GSI for Rapid Refresh. In collaboration with colleagues at NCEP EMC, Dezso Devenyi is working to optimize the anisotropic covariance modeling as follows. NCEP has a fix for a possible bug in anisotropic code in the vertical. It manifested in the fact that isolines of observation impact did not follow the isolines of virtual potential temperature. This code has since been fixed by Yoshiaki Sato of NCEP. The corrected code and an option to control the strength of the anisotropy may allow GSD to resolve the difficulties encountered in specifying the PBL height as parameter in surface data assimilation.

Additional progress in surface data assimilation at GSD includes modification of the original GSI code to accommodate observations which have a surface pressure which is greater than that of the associated background field point. This is accomplished by extrapolating surface values of variables back up to the interpolated grid point terrain at the observation point. Also, surface observations are checked according to surrounding water/land grid point indicator values. The code is largely ready; testing and graphical issues are still ahead.

In addition, as the GSI code and run configuration have stabilized more, we have begun to use the RR

retrospective capability quite a bit more. Two parallel runs performed with/without satellite data have recently been completed indicating slightly improved upper level wind and temperature forecasts from the satellite radiance data.

09.5.5 31 January 2009 (CAPS and GSD)
Testing and refinement to the radial velocity analysis component of the GSI for Rapid Refresh configuration together with the cloud analysis.

Subtasks

09.5.5.1 31 December 2008 (NCEP and GSD)
Report on testing of 2DVAR GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 5-km or finer resolution.
On 3 October, Real-Time Mesoscale Analysis (RTMA) of temperature and dew point at 2 m, wind at 10 m and surface pressure was implemented for Hawaii and Puerto Rico. These also include estimated analysis uncertainty fields. These grids are at the NWS' NDFD resolution of 2.5 km. On 9 December, the CONUS (5 km) and Alaska (~6 km) RTMA systems were upgraded to the identical version of RTMA that was put in place for Hawaii and Puerto Rico. The RTMA is now based on a unified set of software. (Pondeca)

09.5.5.2 31 December 2008 (NCEP)
Establish hourly cycled NAM assimilation system on NOAA R&D computer at NCEP (machine called "haze") using GSI and WRF-NMM to be adapted to ARW-based RR by GSD.
An hourly cycle requires having a digital filter capability as the RUC has shown. An initial version of a digital filter (from Parrish) was incorporated in a low resolution NDAS system on the R&D machine to run after each analysis step in preparation for the hourly cycling. The necessary changes to the boundary code were done and the scripts were changed to restart the forecasts after the digital filter step. The code for merging the filter results back into the WRF restart file was built and modified to work with the IJK WRF/NMM. The whole system with the digital filter is functional but the test experiments showed mixed impact on the forecasts. (Wu)

09.5.5.3 31 January 2009 (CAPS and GSD)
Testing of and refinement to the radial velocity analysis component of GSI for Rapid Refresh configuration, together with the cloud analysis.

Testing and evaluation for tropical cyclone case ongoing using RUC background fields.

09.5.5.4 28 February 2009 (GSD)
Report on preliminary statistical evaluation of Rapid Refresh forecasts initialized with the GSI, including examination of upper-level winds, surface fields, and precipitation.
09.5.5.5 31 July 2009 (NCEP)
Based on case-study testing and refinement of the research quality code, deliver results in an 'experimental' code for an upgrade package (e.g. strong constraint, improved satellite channel bias correction, improved use of WSR-88D radial wind and/or satellite radiances and/or retuned co-variances to the GSI for FY2009 change package to the NAM. (Pondeca, Yanqiu Zhu, Parrish)

The observational errors used in NAM were tuned after two bug fixes in GSI code ended up affecting the effective observational errors for rawinsonde, pibal and profiler data in the upper layers and the number of observations used in the uppermost layer. A low resolution experiment was set up to test the impact of the new observational errors, bug fixes and nonlinear quality control. Tests showed that the analysis code ran 20% slower with the nonlinear quality control on, and the analysis fit to the data was also worse. The changes resulted in gross check rejecting less data, which was compensated for by activating the variational quality control. After tuning the quality control and gross check parameters, studies showed only a small impact on the forecasts. (Wu)

EMC worked with NCO to test the radar Build-10 data decoder and super-resolution data recombination algorithm (see Keyser reports for Tasks 1 and 17). A bug in Level-II data decoder was found where the spectrum width was incorrect. This bug has no impact on the reflectivity, but radial wind QC in the GSI was impacted. This bug was fixed by NCO. Shun Liu has also an algorithm (from NSSL) coded to estimate mixing-layer height from radar reflectivity observations. Shun Liu has also started to merge vertical velocity assimilation codes from the January 2008 GSI version into the latest version. Bugs have been found and fixed in the new GSI. Efforts were made to compare the analysis from the old version with the new. (Liu)

A global scheme based on a method outlined in Barros et al., 1990, has been shown to work quite well to create a working multigrid scheme for use in an improved regional version of TLNMC (dynamic constraint). The main problem found so far with all the regional TLNMC formulations (including the current Briere version and the computationally impractical global spectral Temperton version when applied to the regional domain) is how the boundary value forcing is extended beyond the regional domain. The balance solution is strongly dependent on the extended domain mean value of the forcing. On the sphere, the mean must be zero, but this is not a necessary condition for a regional domain. After some trial and error, the most robust solution was obtained by adding a single halo row of constant forcing just outside the regional domain and zero everywhere else in the extended domain. The extra forcing value is chosen so that the total domain (regional + extended) mean of the forcing is zero. Based on preliminary results, it appears that the new scheme can also be applied to the full background and possibly greatly reduce the domain scale oscillations that are observed in height field, and are especially large after a cold start from the global forecast. (Parrish)

Deliverables

09.5.5.E1 31 March 2009 (NCEP) **EMC**
Subject to NCEP Director approval to implement upgrades (e.g., partial cycling, TAMDAR) to GSI used in NAM/NDAS. (Rogers, Wu, Parrish, Pondeca, Liu)

CURRENT EFFORTS: Effective Tuesday December 16, 2008, beginning with the 1200 UTC NAM run, a major set of upgrades to the GSI were implemented as part of a NAM system upgrade. Included in the changes was an upgrade to the most current GSI version which includes an improved Community Radiative Transfer Model (CRTM). The new NDAS utilizes partial cycling where atmospheric states from the GDAS are used instead of states from the previous NDAS. This was found to significantly reduce the larger synoptic-scale errors seen in later NAM forecast periods. The new WRF Pre-processing System (WPS) replace the older more cumbersome Standard Initialization (WRF-SI). With this change the NAM begins to assimilate METOP2 satellite radiances and winds and temperatures from both Canadian AMDAR and TAMDAR aircraft. See Task 09.5.17 for the NAM model changes included in this major package. (Rogers, Wu)

PLANNED EFFORTS: Work with NCO/PMB to transition NAM GSI codes and scripts to the new computer. Prepare for a possible late 2009 regional GSI upgrade. Build an hourly cycle on the new computer (cirrus). (Wu) The algorithm to estimate the mixing-layer height based on other mixing-layer height observations will be further optimized. After merging vertical velocity into the new version of GSI, the impact of radial wind assimilation on forecast will be examined further. (Liu) Complete work on building the new TLNMC scheme and begin testing. (Parrish)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE:

09.5.5.E2 30 September 2009 (GSD, NCEP)
Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit GSI code as part of Rapid Refresh software to NCO.

09.5.5.E3 30 September 2009 (CAPS and GSD)
Finalize enhancement package for radial velocity data analysis to begin testing at GSD toward future implementation for Rapid Refresh.

09.5.5.E4 30 August 2009 (GSD, NCEP)
Complete report on Rapid Refresh performance, including that from the GSI component of the RR, in comparison with the operational RUC.

Task 09.5.8 Improve physics in the WRF model, especially that bearing on prediction of aircraft icing.

Subtasks

09.5.8.1 31 July 2009 (GSD)
Complete systematic GSD evaluation of physics performance in GSD 1-hour RR cycles for initial RR implementation.

A retrospective RR 3-h cycle run for 4-11 March 2008 to test the Mellor-Yamada Nikinishi-Niino sub-grid-vertical-mixing scheme in the RR has been completed. This scheme had previously been implemented in WRFV3 by Mariusz Pagowski of GSD. Evaluation of the performance of this scheme relative to the Mellor-Yamada-Janjic scheme (currently used in RR real-time testing at GSD) in this retrospective test, is underway. Preliminary statistical assessment is that the MYNN scheme is competitive with MYJ in verification against rawinsonde wind, temperature and humidity, and the wall-clock time of the forecast is not appreciably longer when MYNN is used.

Atmospheric and Environmental Research (AER), Inc. reported that the RRTM longwave radiation scheme (developed at AER) had an error in the WRF model implementation, with the ozone climatology vertical profile being inverted from what should have been. Jimy Dudhia has made a change to the WRF model. It turns out that the implementation of RRTM into the RUC (part of the RUC upgrade package) was done correctly. The modification has been made for the Rapid Refresh version of WRF.

09.5.8.3 30 July 2009 (NCAR)
Research and testing on addition of the new explicit aerosol variable(s) in initiating cloud water and ice. Computer storage and run time considerations will be considered as a constraint on the development. (NCAR task)
Trude Eidheimer has implemented a new ice nucleation scheme into WRF that is based on the Meyers, Phillips, and DeMott schemes. The key aspect of this new scheme is that it is based on the size and number concentration of aerosol particles. She is also investigating various aerosol schemes for later inclusion.

Trude Eidheimer is coming up to speed on WRF and is investigating various options for the implementation of an aerosol scheme into the microphysical model. Her focus will be the implementation of methods to predict Cloud Condensation Nuclei and Ice Nuclei.

09.5.8.5 1 December 2008 (DTC, GSD)
Report on FY07-funded GSD-DTC RR retrospective testing of the impact of different thickness of vertical model layers close to the surface and, as appropriate, other physics.
A draft report has been written by the DTC and GSD has provided comments on this draft.

09.5.8.6 1 August 2009 (GSD)
Begin to explore possibilities for enhancing treatment of sea ice and tundra (including spring-time pooling)

in Rapid Refresh domain toward FY11 Rapid Refresh upgrade.

Preparations are being made to make available for evaluation for forecasters at Environment Canada's Arctic Weather Center at Edmonton the real-time RR1-h cycle running at GSD.

Deliverables

09.5.8.E2 30 Sept 2009 (GSD, NCEP)
Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit upgraded WRF model physics code as part of Rapid Refresh software to NCO.

09.5.8.3 Jul '09: Report on research and testing on addition of the new explicit aerosol variable(s) in initiating cloud water and ice. Computer storage and run time considerations will be considered as a constraint on the development. (NCAR task)

09.5.8.5 Dec '09: Report on FY07-funded ESRL-NCAR RR retrospective testing of the impact of different thickness of vertical model layers close to the surface and, as appropriate, other physics. (Joint NCAR and ESRL task)

09.5.8E2 Sep '09: Provide an improved microphysics scheme to ESRL for evaluation toward FY11 Rapid Refresh upgrade. (NCAR)

09.5.8E3 Aug '09: Complete physics improvement for icing, C&V, turbulence and convective forecasts. (NCAR)

Task 09.5.15 Develop improved methods of cloud and moisture analysis for use in the WRF Modeling System.

Subtasks

09.5.15.2 5 Jan 2009 (GSD and CAPS)
Continue testing and evaluation of the generalized cloud/hydrometeor assimilation (including GOES cloud-top data and METAR cloud/visibility/weather data) within a cycled GSI on the full Rapid Refresh domain.

GSD
Work by GSD continues on refining the GSI cloud analysis for Rapid Refresh. Comparison of RUC and RR analyzed ceiling statistics indicates slightly worse scores for the Rapid Refresh. We are investigating the cloud analysis to track down these issues. Changes have also been made to WRFpost to bring the ceiling diagnosis into conformity with that used with the RUC.
One particular difference in the WRFpost (an inconsistency in WRFpost compared to the RUC post, which is compatible with the RUC cloud analysis), was causing very extensive low ceilings in the RR post-processed fields. This is fixed as of 10 January, 2009.

Improvements have also been made to the lightning assimilation module, including using a better relationship between lightning flash rate and maximum reflectivity.

Stan Benjamin, with help from Steve Weygandt, Bill Moninger, and others, has been developing and testing variations to the RUC analysis and model to improve retention of layers of cloud water, especially in the 1000-3000 ft layer (from IFR to MVFR). GSD verification against METAR ceiling observations and extensive has shown that cloud water in these layers will evaporate in the first hour of the model for both the RUC and WRF Rapid Refresh models. Bill Moninger has developed initial ceiling/visibility verification for the Rapid Refresh. Improvements for the RUC developed from this testing will be transferred to the Rapid Refresh code also (analysis and/or model, as is necessary). This work is also associated with separately funded NASA ASAP work for assimilating NASA Langley GOES cloud products into the RUC and Rapid Refresh.

In early Nov. 2008, an experimental version of the RUC began assimilating experimental satellite derived integrated water path fields (created by NASA Langley). These observations are added within the RUC cloud analysis and this code will be ported to the RR cloud analysis soon. One immediate benefit from these observations is extended coverage further into Southern Canada. Detailed testing and evaluation during the coding to use these products has continued to indicate a loss of RUC (and RR) low-level clouds during the first hour of the RUC forecast. A number of factors have been identified, most importantly the position of the call to the cloud analysis subroutine within the larger RUC analysis code. The current order allows sub saturation to occur in 3-d grid volumes where clouds were identified from METAR and GOES data, allowing immediate evaporation of non-zero hydrometeors set in the cloud analysis subroutine. Work in this area continues, and results will be applied to the Rapid Refresh as well as in the RUC (if changes are allowed at NCEP).

As of 14 Jan 2008, NASA Langley has produced an initial larger RR-domain GOES-based cloud-top field. Real-time products will be ftp'd from NASA Langley to ESRL/GSD by later this month. An advanced version of the RUC cloud-analysis module has already been developed for the development-RUC13, and this code will be transferred into the GSI for the Rapid Refresh.

Work has continued with colleagues at NCEP on a number of GSI-related issues and Dezso Devenyi, Ming Hu, Steve Weygandt and Stan Benjamin traveled to NCEP and discussed these issues in early Dec. Issues discussed included finalizing the inclusion of the RR cloud analysis package within the official NCEP GSI repository version.

09.5.15.3 30 Jan 2009 (GSD)
Develop and evaluate performance of diabatic digital filter initialization (DDFI) in the 13-km RR WRF model including assimilation of radar reflectivity data

GSD
We have the DDFI-based radar assimilation coded and running in one of our two real-time RR cycles. We have been evaluating difference between the RR cycles with and without the radar assimilation and comparing them with similar differences in the RUC. Based on a limited qualitative assessment, the signal from the DDFI radar assimilation in the RR looks similar to that from the RUC radar assimilation. But the difference between with radar and without radar in the RR looks weaker than in the RUC.
A strong summer convective test case has been re-run with RR, including the radar assimilation package. A matched RUC re-run is pending, which will facilitate detailed comparisons of the radar assimilation performance for both the RUC and RR.

09.5.15.4 30 May 2009 (GSD and CAPS)

REQUEST from Stan Benjamin and Ming Xue: DEFER due date from 30 March to 30 May

Further refine the generalized cloud analysis for the target RR resolution, model physics scheme and use of additional data. Perform forecast test evaluations to document the impact of the cloud analysis refinements.

09.5.15.6 30 Mar 2009 (GSD)
Include radar reflectivity-based latent heating within diabatic digital filter initialization (DDFI) in the RR WRF model

Deliverables

09.5.15.E2 30 Sept 2009 (GSD)
Complete testing of GSI generalized cloud analysis for Rapid Refresh and deliver code to NCEP as part of Rapid Refresh package delivered to EMC, pending availability of NCEP testing capability.

Task 09.5.6 Develop, test, and evaluate the performance of the nonhydrostatic WRF modeling system.

NCAR/MMM
CURRENT EFFORTS: In this quarter, preparations of the next major release of WRF began at NCAR. This release will be WRF V3.1 and is scheduled for Spring of 2009. V3.1 will provide many new features and capabilities, including:

- WRF-Fire code
- monotonic transport
- gravity wave drag
- spectral nudging
- operational NMM code physics and dynamics
- 4DVAR
- WRF-Var radiance data assimilation
- NRCM modifications
- polar modifications
- Noah LSM updates, and
- new physics packages for the ARW (see below).

NCAR prepared for the next WRF tutorials, which it will host January 26-February 5, 2009. The basic WRF tutorial will cover model structure, preprocessing, and operation, and practical sessions will provide opportunities to run model components. There will be a separate WRF-Var tutorial. In addition, there will be a separate tutorial on the MET (Model Evaluation Tools) verification package, presented by the DTC.

Over the quarter NCAR made various bug fixes to WRF physics and dynamics. These addressed: the Lin microphysics scheme to improve water conservation; the CAM radiation scheme to prevent out-of-bounds references; the ozone profile in the RRTM radiation scheme; and initialization of the Thompson microphysics scheme to prevent calls at each nest move. Jimy Dudhia of NCAR also conducted tests on the positive-definite advection (PDA) scheme on parallel platforms in idealized cases with periodic boundary conditions. A fix to the PDA scheme was implemented by NCAR.

Dudhia collaborated with Georg Grell (NOAA ESRL/GSD) to add convective mass flux into the dynamics of the new Grell 3 cumulus scheme. Dudhia worked with Wei Wang of NCAR to prepare the WDM3 (WRF Double Moment 3) and WDM5 (WRF Double Moment 5) microphysics schemes (obtained from Song-You Hong of Yonsei University) for the V3.1 release; these both feature double-moment cloud and rain. Dudhia also worked with developers of the QNSE PBL scheme to investigate and correct its behavior in stable and unstable regimes. The QNSE scheme was added to the repository and will be in the V3.1 release. For the YSU PBL scheme, a new array was added (code obtained from Hong of Yonsei University) and the revised version put in the WRF repository. This will appear in WRF V3.1. New RRTM longwave and shortwave radiation packages were also added to the repository.

Dudhia, Wang, and Josh Hacker of NCAR added Hacker's single-column option to WRF. Dudhia also worked with Wang to add a spectral nudging capability into WRF. Surface analysis nudging code obtained from Penn State was also added. These features will be in V3.1.

Lastly, in physics for WRF NRCM, a set of changes was added for the V3.1 release. These included:

i. SST skin temperature prediction
ii. deep soil temperature prediction
iii. bucket accumulation arrays for water and energy budget accuracy
iv. time-varying CO2 in the CAM radiation scheme, and
v. leap-years made optional.

PROBLEMS/ISSUES/SCHEDULE CHANGES: None.

PLANNED EFFORTS: Integration of new physics and capabilities into the WRF system will continue in

FY09. The next major release of WRF, V3.1, is planned for the next quarter.

Subtasks

09.5.6.3 1 September 2009 (NCEP)
Maintain and further develop WRF Post-processing system including necessary RR capabilities and updates to all documentation, in response to community requirements.

GSD – Some improvements in WRF-Post described under 09.5.4, yet to be submitted to NCEP (Huiya Chuang). SVN repository set up for all ESRL changes to WRF-post.

09.5.6.4 30 June 2009 (NCAR/MMM)
Deliver a WRF Users' Workshop and a WRF tutorial for the user community.

09.5.6.5 30 Sept 2009 (NCAR/MMM)
Incorporate physics improvements from the WRF user community, GSD, and NCEP into the WRF software infrastructure for use in the Rapid Refresh model. Perform code testing to permit implementation into WRF repository. In collaboration with GSD, assist in the evaluation of those physics schemes for the RR that may be tested using the ARW.

Deliverables

09.5.6. E1 30 June 2009 (NCAR/MMM)
Deliver a WRF Users' Workshop and a WRF tutorial for the user community

09.5.6.E2 30 September 2009 (NCAR/MMM)
Incorporate physics improvements from the user community, GSD, and NCEP into the WRF software infrastructure for use in the Rapid Refresh model. Perform code testing to permit implementation into WRF repository. In collaboration with GSD, assist in the evaluation of those physics schemes for the RR that may be tested using the ARW.

Task 09.5.24 Test WRF Rapid Refresh model at 3-km resolution toward High-Resolution Rapid Refresh

GSD
GSD presented summer 2008 HRRR statistical verification, as well as case study examples, at the NCEP Production Suite Review (Dec. 9-11). In addition, several NWS entities (SPC, regions) expressed a desire for further development and implementation of the HRRR (with the hourly radar updating via the RUC / RR). In addition, Stan Benjamin and Steve Weygandt have participated in meetings to discuss the evaluation of the 2008 CoSPA forecasts as well as plan the summer 2009 evaluation effort.

The GSD group has performed extensive verification and evaluation of the summer 2008 HRRR forecasts and worked with NCAR and MIT/LL to evaluate the combined CoSPA product. GSD HRRR reflectivity verification (at 3-h intervals) indicates 6-h HRRR forecasts with radar assimilation are better than 3-h HRRR forecast without radar assimilation at all times of the day. GSD has further evaluated the relative strengths of the HRRR and RCPF as a function of the diurnal cycle of convection. The RCPF does quite well at identifying mesoscale areas of convective initiation. The HRRR appears to have similar skill for convective initiation (based on verification of HRRR forecasts that have been up-scaled to a 13-km grid). As expected, HRRR improvements from the RUC radar assimilation increase as the initial time convective coverage increases.

GSD has begun preliminary work toward creating a prototype time-lagged ensemble-based convective probability forecast product from the HRRR and NCAR has preliminary results from a statistical assessment of HRRR time-lagged forecasts.

Subtasks

09.5.24.1 15 Feb 2009 (GSD, NCAR/RAL, NCAR/MMM, CAPS, MIT/LL)
Design the assimilation/modeling configuration for the HRRR during the 2009 summer convection forecasting (CoSPA) exercise.

GSD

Tanya Smirnova has recently tested an expanded HRRR domain. The new domain, which extends west to the Rocky Mountains and south to the Gulf Coast, is rotated clockwise to minimize grid points over the Atlantic Ocean. There would be several advantages to this expanded HRRR domain: 1) expanded coverage for key hubs including Atlanta, Minneapolis, Dallas and Denver, 2) by placing the western domain edge well west of the mean dry-line position, the western boundary contamination (from large MCSs that are poorly represented in the parent model, entering the HRRR domain) would be greatly reduced. 3) Greater utility to all users, including NOAA operational forecast units. Initial tests indicated about 66 minutes for a 12-h forecast on 400 processors. We are looking into small changes to get the run time under an hour.

09.5.24.2 15 Aug 2009 (NCAR/MMM)
Evaluate techniques for convection-permitting (e.g., 3-km) forecasting by the ARW core in the HRRR configuration. In collaboration with GSD, perform and evaluate convection-permitting forecasts on test cases using radar-enhanced RUC or Rapid Refresh (13-km) grids from GSD for initial condition fields to identify strengths and weaknesses of HRRR-ARW forecasts. This will include a 2009 analysis on evolution of convective storm mode during first 1-3 hours of model transition from effective resolution 13-km to actual 3-km resolution. Perform fully-explicit tests and evaluate short-term forecast results. Submit summary of results and collaborate with other groups on consolidated summary of results from 2009 HRRR exercise and research results.

09.5.24.3 15 Sept 2009 (NCAR/MMM, GSD)
Collaborate on analysis of convection-permitting tests using HRRR cases. Draft and deliver summary of results.

09.5.24.4 30 Sept 2009 (GSD, NCAR/RAL)
Complete 2009 HRRR summer exercise using modeling and assimilation modifications determined in 2008 exercise. Collaborate on analysis of HRRR tests and deliver summary of results.

Deliverables

09.5.24.E1 15 August 2009 (NCAR/MMM)
Submit report on evaluation of HRRR-ARW forecasts.

09.5.24.E2 30 August 2009 (NOAA/ESRL/GSD)
Complete FY09 test in Northeast Corridor U.S. domain with 3-km High-Resolution Rapid Refresh running every 1 h.

- Conduct real-time summer 2009 HRRR forecasts using 3-km WRF initialized with radar-enhanced Rapid Refresh over Northeast US Corridor domain
- Coordinate with other AWRP users and other collaborators
- Provide project management
- Lead writing of report on summer 2009 HRRR experiments

09.5.24.E2 30 September 2009 (NCAR/RAP and NCAR/MMM)
Collaborate with GSD on analysis of 2009 results. Draft and deliver summary of results.
Evaluate techniques for convection-resolving (e.g., 3-km) forecasting by the Rapid Refresh (ARW core). Perform and evaluate HRRR convection-resolving forecasts on test cases using Rapid Refresh grids from GSD to identify strengths and weakness of model at high resolution. Perform 2009 experiments to re-evaluate effects of transition from 13-km parameterized convection to 3-km resolved convection in 0-3h

forecasts and in lateral boundary conditions from the RUC or Rapid Refresh using the Grell-Devenyi parameterization.

Task 09.5.19 Develop ability to assimilate WSR-88D radial velocity and reflectivity data through GSI and Rapid Refresh toward High-Resolution Rapid Refresh.

Subtasks

09.5.19.1 30 October 2008 (GSD, NCAR/RAL, CAPS)
Select initial case studies from summer 2008 for 3-km HRRR data assimilation case studies.

GSD
A set of 8 summer 2008 cases has been selected for coordinated GSD, NCAR, and MIT/LL evaluation. These include 20, 27 July; 2, 8, 13, 15 Aug; 6 Sep. We are also looking at some other cases for specific HRRR analysis including 31 July, 13 Sept. and 5 Sept.

09.5.19.2 31 August 2009 (GSD, NCAR-RAL)
Run case studies from early 2009 using 3-km HRRR on GSD jet computer using different RR-based initial conditions

- Radar-DFI enhanced RR
- Radar-DFI RR using unsmoothed latent heating
- Test of 3-km radar-enhanced diabatic digital filter initialization (DDFI)

GSD has been providing, to NCAR, RUC lateral boundary and radar-enhanced initial condition (history file dump directly after the RUC diabatic DFI-based radar assimilation) files for experimental re-runs of selected test cases from the 2007 convective season. Initial work has focused on 5 Sept.

09.5.19.3 30 Sept 2009 (CAPS)
Complete new 3-km GSI data assimilation experiments toward improved assimilation of radial wind. CAPS modified its radar pre-preprocessing program for GSI, 88d2gsi, to improve its efficiency and correct an elevation mapping error (not present in 88d2wrf program used earlier). The automatically QC'ed radial velocity (Vr) data were further run through interactive editing software Solo II from NCAR to correct any remaining unfolding problem with the data. New sets of experiments are being rerun using the better QC'ed data set. Also, Vr data up to the full 230 km range are now used instead of the 150 km range used earlier (done to avoid certain QC problems).

Results from one set of experiments using the newly QC'ed data are shown below, where the radar data were assimilated at 10 minute intervals between 00 and 02 UTC, September 2007, for the Erin case. Shown together are the low-level vortex center tracks determined from NAM analyses (green), the Oklahoma Mesonet and other surface observation data (red), and the official best track (black). It is believed that the 'best track' is not the 'best' because it matches the satellite imagery for precipitation centers better rather than ground-based in-situ measurements, and precipitation regions are off the vortex center. We will use the surface-based track (called mesonet track) for further verification.

The track of WRF forecast with GSI analysis of Vr data up to 150 km range is shown in magenta while the track with full-range radar data is in blue. It can be seen that the latter with full range radar data is closer to the mesonet track, although in both cases; the minimum sea-level pressure at the vortex center is over predicted compared to the mesonet observations. Further investigation will be performed on the intensity forecast. Our experiments using RUC as the initial analysis background and lateral boundary conditions tend to produce weaker vortices.

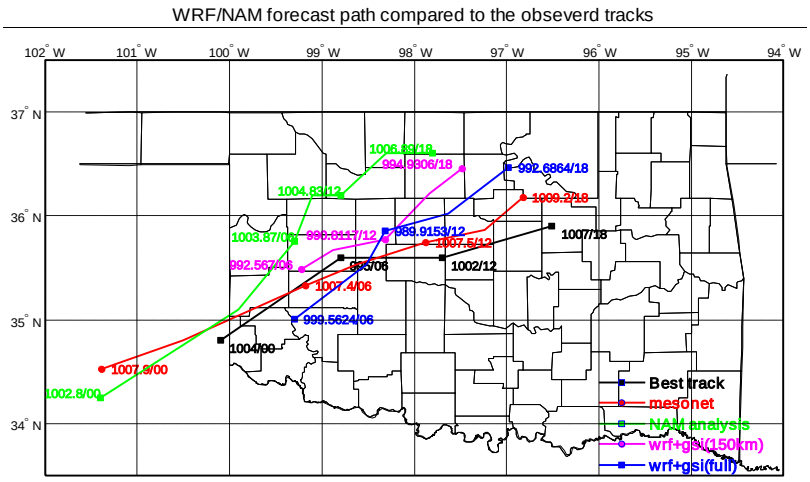

Fig.1 : Best track (black), OKC Mesonet-determined track (red), track based on NAM analyses (green) (00-18 UTC), and WRF forecast tracks assimilating reflectivity and radial velocity radar up to 150 km range (magenta) and up to full 230 km range (06-18 UTC) for the low-level vortex center.

09.5.19.4 30 Sept 2008 (GSD)
Develop and test improved DFI assimilation of radar reflectivity at 3-km using observation-based specification of latent heating within WRF-DFI developed by GSD and NCAR in FY08.

Deliverables
09.5.19.E1 30 Sept 2009 (GSD, CAPS, NCAR/RAL)
Complete improved version of 13km/3km radar assimilation techniques for demonstration in FY09 exercises.

<u>Task 09.5.20</u> Develop ensemble-based probabilistic products for aviation users.

NCEP

Subtasks

09.5.20.1 15 January 2009 (NCEP)
Complete 'research quality' version of upgrade to SREF (e.g. higher resolution, more WRF members and more physics diversity) for consideration in November 2010 SREF upgrade package.
Code and scripts for a major SREF upgrade [including higher resolution, more WRF members, more physics diversity, alternate initialization and hourly output] were turned over to NCEP Central Operations (NCO/PMB) in July, but a late request from SPC and AWC for hourly output plus the nearly overwhelming complexity of the SREF system coupled with new SPA personnel led to a very late start of the 30-day outside evaluation. This evaluation was completed in mid November, and EMC/NCO received favorable feedback from forecasters in State College, PA, HPC, SPC and AWC. Sadly, a couple of code/script failures occurred in the interim and the SREF upgrade had to be postponed (no time to restart & complete another 30 day period) until after the moratorium. SPC has expressed a strong desire for hourly output for two months prior to the 2009 convection season in order to have enough data to calibrate their guidance. In order to fill this need, EMC is working to establish a routine parallel run of the upgraded SREF system on the new machine before end of January and run it for SPC from February through March. Meanwhile, the current operational SREF must be the system converted (initially at least) to the new computer. (Du, Zhu) Candidate upgrades to SREF for the November 2010 package are being planned. Coding is complete for a stochastic convective parameterization experiment. One hurricane case has been tested and the result is quite encouraging. (Du)

09.5.20.2 15 February 2009 (NCEP)
NCEP visits AWC to conduct continued training and education on SREF applications, receive feedback on existing guidance, and to acquire new requirements (fully depending on FAA funding).

09.5.20.3 15 April 2009 (NCEP)
NCEP develops and delivers a new fog algorithm used in the SREF product for aviation (fully depending on FAA funding, $60K requested).
A new fog algorithm was designed and developed in FY2007. This algorithm was incorporated into the special ensembles NCEP ran in support of the Beijing Olympic forecast runs. (Zhou)

09.5.20.4 31 August 2009 (NCEP)
Based on case-study testing and refinement of the research-quality code, deliver the upgrade SREF codes to NCO for November 2010 SREF upgrade package.

09.5.20.5 31 March 2009 (GSD and NCEP)
Develop a preliminary procedure appropriate for aviation users from Very Short-Range Ensemble Forecast (VSREF) system using high-resolution RR and NAM existing runs.

GSD has identified a new scientist to work on the VSREF project with NCEP – more on this topic by next month's report.

09.5.20.6 1 July 2009 (GSD and NCEP)
Further calibrate probabilities and potential echo-top (improve statistical reliability) ensemble cumulus information.

Deliverables

09.5.20. E1 31 August 2009 **EMC** (Du, Zhou)
Demonstrate products from experimental VSREF probabilistic forecasts updated hourly.

CURRENT EFFORTS: SREF experimental runs for the aviation product are continuing. Coordination with Alaska Office's Aviation Unit has begun, to evaluate and improve SREF's ceiling ensemble mean forecast over the Alaska region. (Du, Zhou)
PLANNED EFFORTS: Transition SREF codes to the new CCS computer for further testing, new parallel running and final implementation. This work will begin in January 2009 and have the highest priority. Further tune the convective parameterization scheme and run more case studies. Construct initial VSREF system using the highly adaptable ensemble product generator. (Du, Zhou)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: AWS, GSD

UPDATES TO SCHEDULE: