MDE Product Development Team - Quarterly Report for April - June 2009

FY 2009

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(Compiled and edited by S. Benjamin and B. Johnson)

Executive Summary

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

- Continued evaluation of RUC and NAM, small May09 change to cloud analysis implemented into backup RUC, now affecting HRRR initial conditions also.

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

- Continued real-time feed of RR files to other AWRP RTs and Alaska Region NWS and getting feedback from them
- Improvements in WRF-RR: testing of WRFV3.1 and options in 1-h cycle, terrain detail, cycling of land-surface variables, bug-fixes to land-surface physics modifications for snow and ice cover,
- Serious file-system problems on ESRL supercomputer caused major disruption in testing of RR 1-h cycle
- Partial cycling design to be used for Rapid Refresh
- 2 papers on RR performance presented at AMS NWP/Weather Analysis/Forecasting conference in Omaha.

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

- RR GSI – completion for elevation correction for surface obs to match model value
- 4 papers related to GSI and its application to Rapid Refresh at AMS NWP/WAF conference

Task 09.5.6: Improve WRF model

- Version 3.1 released 9 April 2009 (NCAR). Version 3.1.1 will be released in late July.

Task 09.5.15: Develop methods for improved cloud/hydrometeor analysis in RR

- Discussions on GOES cloud data for full RR domain including Alaska (replacing CONUS GOES cloud data), not yet in test RR.

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

- Reconstruction of GSD RUC cycle (used for HRRR initial conditions) using grids from NCEP operational RUC after file-system problems.
- Continued evaluation of larger-domain HRRR over eastern 2/3 CONUS – consistently strong performance including 13 May case with strong convection across central US, VORTEX2 cases.
- Additional GSD progress on a time-lagged HRRR-based convective probability forecast
- Evaluation of new HRRR post-processing for additional storm parameters
- Two papers presented on HRRR at AMS NWP/WAF conference

Test 08.5.20 Probabilistic forecasts

- Initial VSREF framework developed by NCEP/EMC, additional discussions in May

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

GSD

Code modification for RUC analysis developed to avoid intermittent over-moistening in a certain combination of conditions. This situation occurs when satellite data shows cloud in lower troposphere in warm season and can result in an unstable vertical profile. It does not cause a crash in the RUC or subsequent HRRR due to use of the DFI. The changes have been implemented at GSD devRUC13 in April and into the backup RUC13 at GSD (improving HRRR also) in June. The changes are also ready to go for NCEP RUC but after discussion with NCEP (Geoff Manikin) were deemed non-critical for now. GSI interacted with WSI who initially pointed out this problem on 4 May (WSI uses RUC grids to initialize their high-resolution WRF run).

GSD also monitored the situation on NOAA-AirDAT negotiations on TAMDAR data and served on committees (Bill Moninger, Stan Benjamin). From April until early July, *TAMDAR reports were NOT assimilated into the operational RUC at NCEP at which point a new temporary agreement was reached.* (GSD has no role in the negotiations.) TAMDAR reports were continued to be assimilated into the GSD versions of the RUC over this period, and therefore were used in initializing the HRRR.

GSD evaluated the general accuracy for the Horizon Airlines TAMDAR aircraft reports, and found it to be of comparable accuracy to those of the other TAMDAR carriers, Mesaba (Northwest) and Republic/Chautauqua, for wind, temperature, and RH observations. Horizon Airlines provides data over the western US, but this data is not covered under the new NOAA/AirDAT contract and therefore, will not be used in the operational RUC or backup RUC and only in the devRUC at GSD.

GSD also re-evaluated accuracy of Canadian aircraft data and found it to be also fairly accurate now that turboprop data has been excluded.

NCEP

Subtasks

October 2008 through September 2009

09.5.1.1 Maintain hourly RUC runs and provide grids of SAV and AHP guidance products
There were no issues related to RUC performance this quarter, and the continuing NCO moratorium prevented us from testing anything. (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. (30 Sept 09)
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. 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. (30 Sept 09)
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 Since December 2008, this capability runs as part of the operational NCEP Production Suite, and is much more reliable since it is automatically switched with the rest of the suite when it is necessary to failover operations from one computer to another. (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:
See also CURRENT EFFORTS listed under Task 09.5.17.E1 below for issues related to code transition to new computer. The MADIS-to-GTS feed for NOAA Profiler Network wind and RASS data, both used by the RUC assimilation, is now the permanent replacement for the discontinued NWS-to-GTS feed. NCEP/NCO is investigating an invalid instrument type reported by some radiosonde sites. NESDIS hasn't yet responded to two problems with the GOES 1x1 field-of-view cloud data where a few random files begin with reports encoded with missing lat/lons and a bogus satellite ID and where GOES-East data arrives later. All sources of TAMDAR data were shut off on 7 April pending renewal of NWS' contract with AirDAT. Once these return (expected in July), work will continue on getting TAMDAR airframe type and airline code into the PrepBUFR file for ESRL's bias correction work. The NCO/EMC drop-out team discovered that the elevations for many radiosonde and surface sites are incorrectly reported in the NCEP station dictionaries. Efforts are underway to test elevation corrections. An updated version of the NCEP BUFR library software is being tested for implementation later this summer on the new computer. (Keyser)

PLANNED EFFORTS:
See also PLANNED EFFORTS listed under Task 09.5.17.E1 below for aircraft quality control issues. Complete RUC impact tests for TAMDAR wind data. Obtain all TAMDAR data from AirDAT and add airframe type and company code (for GSD) to improve bias corrections. Explore (with NCO) ways to keep experimental data that comes in on operational channels out of the operational analyses and update current upper-air and surface station dictionaries. Develop a platform-specific surface quality control module within the PrepBUFR processing framework. (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:
Disk space is short on P6.

INTERFACE WITH OTHER ORGANIZATIONS:
NCO.

UPDATES TO SCHEDULE: None.

09.5.1E2 (30 September 2009) (Manikin)
Perform configuration management for RUC, including thorough documentation, and respond promptly to any code malfunctions or performance issues.

CURRENT EFFORTS:

The transition to the new IBM Power-6 Based supercomputer (P6 for short) at NCEP continues, and output from all models has been scrutinized to make certain that the codes successfully run on the new machine. Geoff Manikin reports that the RUC output was examined throughout this quarter and compared to output from the older P5 machine, and the performance is satisfactory. The differences between the outputs are small, and the codes run reliably on the P6. (Manikin and ESRL)

PLANNED EFFORTS:
Prepare to push RUC forecast range to 18 hours with hourly output by Q4 FY2009 as promised to SPC and AWC. (Manikin)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:
The continuing NCO moratorium prevented us from testing anything.

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: None.

09.5.1E3 (30 September 2009) (Manikin, Keyser)
Monitor RUC performance, respond to any problems detected by ESRL, NCEP, or any RUC users, diagnose cause, develop solution to RUC software, test changes and coordinate with NCO on implementation.

CURRENT EFFORTS:

PLANNED EFFORTS: Continue monitoring efforts.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: None.

ESRL/GSD papers on RUC, Rapid Refresh, HRRR presented at 23rd WAF / 19th NWP Conference in Omaha:

Experiments with anisotropic background error correlations in the Rapid Refresh system
Dezso Devenyi, S. Weygandt, M. Hu, S. Benjamin
http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154308.htm

Monitoring observation-model differences in the real time Rapid Refresh System
Dezso Devenyi, W. R. Moninger, S. R. Sahm, M. Hu, S. G. Benjamin, and S. S. Weygandt
http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154298.htm

Adaptation and implementation of the Gridpoint Statistical Interpolation (GSI) for Rapid Refresh
Ming Hu, Devenyi, Weygandt, Benjamin -
http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154318.htm

Status report on Rapid Refresh development
Steve Weygandt, T. G. Smirnova, M. Hu, J. M. Brown, D. Dévényi, S. G. Benjamin, W. R. Moninger, S. E. Peckham, G. A. Grell, K. J. Brundage, B. D. Jamison, C. W. Harrop, and J. B. Olson
http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154330.htm

Implementation and testing of WRF Digital Filter Initialization (DFI) at NOAA/ESRL
Tatiana G. Smirnova, S. E. Peckham, S. G. Benjamin, and J. M. Brown
http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154325.htm

The High Resolution Rapid Refresh (HRRR): an hourly updated convection resolving model utilizing radar reflectivity assimilation from the RUC / RR
Steve Weygandt, T. G. Smirnova, S. G. Benjamin, K. J. Brundage, S. R. Sahm, C. R. Alexander, and B. E. Schwartz
http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154317.htm

Probabilistic thunderstorm guidance from a time-lagged ensemble of High Resolution Rapid Refresh (HRRR) forecasts
Curtis R. Alexander, D. A. Koch, S. S. Weygandt, T. G. Smirnova, S. G. Benjamin, and H. Yuan
http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154254.htm

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 aviation guidance grids. (30 Sept 09)
The real-time NAM parallel on the P6 computer continues to run, testing 4 minor bug fixes in the WRF-NMM dynamics/physics and a change in the cloud microphysics that leads to more realistic GOES brightness temperature lookalike output from the NAM post-processor. Also, several observation types not yet being assimilated in the NDAS/NAM are being monitored in the parallel, including IASI radiance data, ASCAT scatterometer winds, and WindSat scatterometer winds. Construction began on an NDAS system using the NEMS/NMMB model, the NEMS Preprocessing System (NPS), the NMMB version of the GSI analysis, and the unified NCEP post-processor. (Rogers, Ferrier)

09.5.17.2 Maintain four-per-day HiRes Window runs and provide aviation guidance grids. (30 Sept 09)
NCEP continues to make 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 - Eastern CONUS (00z & 12z), Western CONUS (06z) and Alaska (18z), and two small domains - Hawaii (00z & 12z) and Puerto Rico (06z &18z). For most of this quarter, the HiResWindow runs were made since there were few tropical systems to cause preemption. 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, Zhou and NCO)

09.5.17.3 Provide vendors with gridded NAM model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway. (30 Sept 09)
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 the HiRes Window on NCEP and NWS/OPS servers. Maintain access to model verification data. (30 Sept 09)
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. All NCEP steps to make HRW output available to the Silver Spring distribution center for AWIPS-SBN and NOAAPORT were completed in this year's 1st quarter. Actual transmission is awaiting a bandwidth audit by NWS/OPS. The data should become available to NWS forecast offices with the full deployment of AWIPS Build 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)

09.5.17.5 Working with NCO, complete the design, compilation, debugging, test runs and parallel testing of NAM and HRW (and SREF) codes on new CCS computer. (30 Sept 09)

Fine-tuning (with NCO) on the HiResWindow model task counts on the new CCS has been completed. (Pyle) NAM and NDAS have been stable. (Rogers, Keyser)
The second half of NCEP's new computer system in Gaithersburg, MD (known as stratus) was accepted by the government on June 29th after a full 30-day acceptance test. Because of the length of the test period, the NCO moratorium that was scheduled to last until late July (Quarter 4 of FY2009) has been extended until at least mid-August. (Hart)

Deliverables

09.5.17.E1 30 September 2009 **EMC** (Rogers, Pyle, Keyser, Liu)
Perform ingest, quality control and preparation of both existing and new observations in support of the operational WRF runs.

CURRENT EFFORTS:
The MADIS-to-GTS feed for NOAA Profiler Network wind and RASS data is now the permanent replacement for the discontinued NWS-to-GTS feed. The NAM-GSI uses profiler winds and monitors RASS temperatures. NCEP/NCO is investigating an invalid instrument type reported by some radiosonde sites. AIRS radiance data counts, below average since May 2008 due to file gaps and late posting of files, should be much more reliable now that NESDIS has moved their processing to a new Linux machine on 17 May (despite an outage 17- 22 May due to file format issues after the hardware change). There were also outages on 12-13 April, 20-22 April, 3-4 May and 9-11 May (these also affected MODIS winds). The mesonet wind uselist was found to contain errors in some provider listings. These errors keep over 600 sites out of the NAM-GSI. A uselist correction will be submitted in July. GOES-11 06Z radiance data counts were depressed for most of March and early April during eclipse season. NOAA-16 AMSU-B radiance quality has been gradually degrading and NESDIS declared channel 4 unfit for use in mid-April, so NAM-GSI stopped using all NOAA-16 AMSU-B radiances on 17 April. NOAA-18 MHS was not usable on 19-20 April due to satellite problems. A Request for Change was submitted on 26 May to add NOAA-19 1B HIRS-4, AMSU-A and MHS radiances to the 1B ingest and dumps. NOAA-19 became operational on 2 June. The following data types are monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), QuikSCAT 0.5 deg. scatterometer wind superobs, Mesonet mass data, and MDCRS moisture data. Work continues with NCO/PMB to transition observation ingest, dump and quality control and processing codes and scripts to the new computer. Runs are generating NAM/NDAS and RTMA PrepBUFR files with 50 km ASCAT and WindSat scatterometer wind data (both non-superobed), and NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and (since 21 April) SBUV-2 data. These changes to obs monitoring plus several NMM bug-fixes are being tested in Eric Rogers' real-time parallel NDAS/NAM. Efforts have begun to remove a legacy restriction that surface data must have a pressure report to be processed into the PrepBUFR files. This will allow many new surface observations (land, marine and Mesonet) to be assimilated in the RTMA. Some Alaskan radiosonde sites still need to move up their launch time so the NAM-GSI can use their data. Methods to speed up dump processing of NEXRAD Level II data are being explored. The NCO/EMC drop-out team discovered that elevations for many radiosonde and surface sites reported in the NCEP station dictionaries are incorrect. Efforts are underway to test elevation corrections. An updated version of the NCEP BUFR library software is being tested for implementation later this summer on the new computer. (Keyser)

PLANNED EFFORTS:
Use AIRS AMSU-A radiances in the next NAM-GSI update (assimilation stopped in April 2008 when channel 4 went bad). Add a new aircraft quality control module from NRL, as soon as run times improve. This code is now being tested in daily real-time parallel runs and being evaluated by NCO. 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; GOES 3.9 micron and visible satellite winds; WindSat and ASCAT scatterometer wind data; METOP IASI radiances; ozone from NOAA-series SBUV-2 and METOP GOME-2; GPS radio occultation data; SSM/I and TRMM/TMI rain rate; METEOSAT-9 IR and visible satellite winds; NOAA-19 AMSU-A, MHS and HIRS-4 radiances. Coordinate with the field to speed up more Alaskan RAOB processing for the NAM dumps. Maximize Alaska data retrievals (especially mesonet, aircraft and coastal surface). Add GSI events to the NAM PrepBUFR files. Let GSI use 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 a use-list to keep experimental data arriving on operational channels out of the operational analyses. Develop a platform-specific surface quality control module within the PrepBUFR processing framework. Work with NCO to bring in new sources of radar data (e.g., TDWR, Tail Doppler Radar from hurricane hunter P3 aircraft, Canadian, CASA). (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:
Lack of disk space on cirrus & stratus P6 machines.

INTERFACE WITH OTHER ORGANIZATIONS: GSD & NCO.

UPDATES TO SCHEDULE:

09.5.17.E2 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: No requests from other RT's were received during the second quarter.

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

GSD
The conversion of the Rapid Refresh to run Version 3.1 of WRF (released 9 April 2009), including merging with the recent ESRL-developed changes to the RR-WRF, is essentially complete. This includes the WRF Preprocessing System (WPS), the WRF ARW model and the WRFpost, although our focus at present is on WPS and the model.

The revision of the cycling of land-surface variables during April seems to be working well. This allows for

snow-cover trimming in the RR cycles as is done in the RUC (3/31/09 change package to operational NCEP RUC, see 15 April Q2 MDE report) when the daily NESDIS snow-cover and sea-ice product detects no snow cover, but snow cover is present in the RUC 1h forecast, and certain other criteria are met. Daily updating of sea ice is also now accomplished through use of this product, which is available through NCEP and also used by the NAM. (Formerly, sea ice in the RR was only updated upon cold starts from the GFS.) The cycling of land-surface variables was also redesigned to be more robust in order to better ensure continuity of cycling of soil properties and snow variables in the event of missed RR cycles.

A decision has been made by ESRL and NCEP/EMC in June to implement a "partial cycling" design for the Rapid Refresh, similar to that implemented for the operational NAM in December 2008. In the partial cycling design, the atmospheric fields will be rederived in a catch-up hourly update cycle once or twice daily, starting from GFS (likely due to pressure top) or NAM grids. The land-surface and cloud/hydrometeor fields will be fully cycled. This partial cycling design takes advantage of the improved data assimilation for longer waves from the global GSI than found possible for the regional GSI used in the NAM and RR. The components for the partial cycling RR already exist but new scripts and testing will be developed in August-September.

The persistent problem of WRF-RR-model crashes along the lateral boundaries once every few days has not yet been fully solved. More information recapping this investigation over the last 3 months and other matters are summarized below.

- New retrospective run capability with 1-h cycling was developed in April, and a new 7-day retrospective period encompassing a powerful spring storm in the central CONUS has been constructed. It covers the period 1800 UTC 15 through 1800 UTC 22 April 2009.
- RR retro run reproduced RR boundary crash, experiments underway for likely remedy(ies), including application of WRFv3.1.
- We are satisfied that the GSI is properly handling the sigma coordinate of the background WRF-ARW 1-h forecasts, and that this is not the source of crashing.
- Partial cycling design for the RR will remove any interruptions in the RR, although we still consider a diagnosis through the retro testing essential.
- Heavy usage of the ESRL supercomputer and a major file-system crash in late May (discussed further below) have been causing many dropped cycles on the GSD primary version of the RR and have forced us to turn off the dev RR entirely for most of the quarter. The numerous dropped cycles of the primary RR cycle have complicated efforts to diagnose and solve this periodic model-crashing problem, and have seriously hampered our overall evaluation of RR performance.
- A mechanism for reserving cores for regularly scheduled jobs such as the RR is now available on the ESRL supercomputer. However, the system folks have told us that migrating the RR cycle to this reservation system is not feasible at this time, due to the load on the computer. (The HRRR is already running under this reservation system.)
- Despite these file-system and heavy load problems, we discovered some remaining issues with the recently added (March-April) capability to predict temperature in sea ice and to predict the accumulation and ablation of snow on top of sea ice, with its attendant impact on albedo of the ice (see Task 8). Tests confirmed that the recent changes were successful, with too warm skin temperatures over the ice during daytime no longer present. A bug involving albedo was found to be causing excessive cooling and crashes in the LSM; this has been fixed.
- We also experienced a crash not on the boundary. This was tracked to buildup of strong vertical velocity in humid, mountainous tropical areas that is being carried over into successive runs. Increasing the 6th-order diffusion is being investigated for its efficacy in reducing this vertical velocity to magnitudes that the model numerics can tolerate.

Our strategy for diagnosing the crashes on the boundary will emphasize use of the retro period, to avoid the complications resulting from so many missed cycles with the real-time RR. Once we have isolated and remedied the sources of crashing in the retro period, we will introduce the change into the RR cycles.

GSD also introduced several additional severe-storm indices into the NCEP version of WRFpost during

April and early May. This was done at the request of the Storm Prediction Center, primarily for HRRR output. These include vertical shear of the horizontal wind, echo top, total column rainwater and snow, as well as a number of variables for which the output is the maximum value during the previous hour (updraft-helicity, updraft, downdraft, 10m wind gust speed, total column graupel, and composite reflectivity).

The largest and most advanced file system (Lustre File System, /lfs0) on the wJET/hJET computer became subject to significant slowdowns and hangs, the latter necessitating occasional manual restarts, during late April and early May, contributing to too many missed RR cycles. An upgrade to the Luster server software that was touted by the vendor as the cure to these problems was installed on 18 May. This, however, only exacerbated the problems. Subsequent attempts to reinstall the upgrade resulted in the loss of many files on /lfs0 and it was shut down entirely for over a week while attempts were made to recover these files (lfs0 is not routinely backed up). Fortunately, GSD/AMB has been careful about making sure that critical source code, scripts, etc., are on a file system that is backed up, and we have become more aggressive about moving large data files to the Mass Store, so losses were less than for most other users. However, the data and boundary-condition files needed to run the new RR 1-h retro period noted in the April 2009 MDE report were lost and are currently being reconstructed. We estimate that during May we lost close to 3 weeks of development time due to the /lfs0 problems and the efforts that have been put in to try to work around them. During June there were further outages, both related to efforts to recover files on /lfs0 and also in preparation for the arrival and acceptance testing of nJet, a large (~3000 processor) addition to ESRL's computational capability, as well as an upgrade to faster processors on hJet. Although most of nJet will be dedicated to the work of the Hurricane Forecast Improvement Project, the HRRR will also be run on this new machine (see Task 24), once it becomes available, which should be during Q4FY09. This should alleviate, at least temporarily, some of the burden on wJet and hJet, hopefully allowing the primary RR1h cycle to be put under the core reservation system. There has been close communication and collaboration with the Raytheon systems people during all of this and we acknowledge their strenuous efforts to deal with these matters.

GSD has also developed a possible replacement domain for the Rapid Refresh using the rotated lat-lon grid for its WRF-ARW dynamic core. The rotated lat-lon grid may result in more stable integrations than the Lambert conformal grid currently used in the RR. Testing will occur in late July and August. The rotated lat-lon projection is already used with the WRF-NMM dynamic core and became available for the ARW core in the last few months.

ESRL/GSD papers on Rapid Refresh presented at 23rd WAF / 19th NWP Conference in Omaha:

Status report on Rapid Refresh development
Steve Weygandt, T. G. Smirnova, M. Hu, J. M. Brown, D. Dévényi, S. G. Benjamin, W. R. Moninger, S. E. Peckham, G. A. Grell, K. J. Brundage, B. D. Jamison, C. W. Harrop, and J. B. Olson
http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154330.htm

Implementation and testing of WRF Digital Filter Initialization (DFI) at NOAA/ESRL
Tatiana G. Smirnova, S. E. Peckham, S. G. Benjamin, and J. M. Brown
http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154325.htm

Subtasks

09.5.4.1 Ongoing evaluation of performance of real-time and retrospective runs of RR system.

GSD
Starting in late October 2008 (but subject to the recent serious interruptions discussed above) 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), also with verification and web-based plots.

Verification of standard atmospheric variables (temp, RH, wind) through early March over the RUC

verification domain continued to indicate the experimental Rapid Refresh is competitive with the RUC at most forecast lengths and output times. Upper level wind RMS errors were almost an exact match to the RUC, except near the tropopause where scores were a bit worse. Beginning in mid-late March, however, performance of the RR has been intermittently worse, particularly for winds and temperature near the tropopause. That aircraft reports were not being used in the GSI during part of this period contributed, but is not the full explanation. This is of considerable concern, and a full evaluation will be undertaken once the computing environment is more stable.

Verification over Alaska continues, but seriously impaired by the computer issues. We saw some very large errors in 925mb wind forecasts at Anchorage during a strong low-level easterly flow situation with a deep low pressure in the Gulf of Alaska. The next paragraph may provide a partial explanation.

Using less smooth terrain (implemented in Feb) improved the response to surface data, since the GSI observational error of METAR stations is related to the difference between the station elevation and the model elevation at the station location. However, in April we found an inconsistency in the terrain file we have been using for the mass points (more detailed) and those used for the u and the v velocity-component points in the WRF model. This has since corrected.

NCEP
Experimental RR PrepBUFR files containing 50 km ASCAT, WindSat data (non-superob) and expanded (time-window) QuikSCAT data (0.5 deg lat/lon superobs) are being copied to a private ESRL directory on the NCEP ftpprd server. RR dumps of expanded (time-window) Level 2.5/3 NEXRAD radial wind data are also being copied to a public ftp directory. These and hourly lightning data are being tested in ESRL's experimental RR runs. ESRL plans to test other new data types present in the production RR PrepBUFR and dump files, including Multi-Agency Profiler winds, Canadian AMDAR data, QuikSCAT data (up to 2 hours old) and METOP-2 radiances. EMC and GSD are requesting that the ROC move up their hourly processing of Level 2.5 NEXRAD data by 10 minutes in order to allow more data to make the RR data cutoff time. (Keyser)

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 continues to make many different types of RR files available to users (AWR RTs, NWS). 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. George Trojan at Alaska Region NWS is porting RR grids to the AWIPS workstation and forecasters at ANC and FAI and the AAWU have now had a few months to evaluate them. We reported on the major concerns expressed by the Alaska forecasters in the FY09Q2 report.

PPT presentations (from the Alaskan Weather Symposium from 10-12 March in Fairbanks, AK). Summarizing the most recent Rapid Refresh verification can be viewed at:
http://ruc.noaa.gov/pdf/RR-AK-Wx-Symp-Mar09-pt1.pdf and
http://ruc.noaa.gov/pdf/RR-AK-Wx-Symp-Mar09-pt2.pdf

As a result of discussions with Alaska forecasters late last year, NASA Langley initiated an effort to produce GOES-based cloud products over most of the Rapid Refresh domain (more under 09.5.15). ESRL and NASA Langley are working to set up the real-time feed for this data, which is expected around mid-June (ESRL heavy job-load for IT services).

Various AWRP RTs at NCAR have also been accessing the RR grids and are evaluating the performance of their algorithms on this data. The Icing RT makes revealing displays comparing the hydrometeor fields from the RR vs. RUC.

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.

Related to the 2012-planned use of ESMF in the Rapid Refresh:
Tom Henderson of GSD has been working with Tom Black of NCEP on making necessary changes to the Flow-following, finite-volume Icosahedral Model (FIM, the global model developed and now under testing at ESRL) to make it compatible with the NOAA Environmental Modeling System (NEMS) flavor of ESMF. Under this architecture, there will be two ESMF "components" for models such as the RR: a "dynamics" (i.e., dynamical core) and a "physics" component. Roughly how this will work at each model time step is as follows. An "output state" will be generated in the dynamics component after the dynamics for a given time step is completed. This will consist of variables (e.g., temperature, horizontal wind, vertical motion, hydrometeors) required as inputs for any physics routines that are to be called at that time step (since all physics routines are not called at every time step, provision will be made for this in the output state if computation efficiency dictates). The physics routines inside the physics component then generate time tendencies for their particular physical processes to be applied to the dependent variables. This output state is passed back as an input state to the dynamics where the tendencies are applied. Although this is simple in concept, there are many details that arise in implementation, for example, where to put (dynamics or physics) computation of certain online model diagnostics that need to appear in stdout model log files. Henderson and Black are wrestling with these matters in consultation with model developers and are keeping other applications (such as the ensemble RR) in view.

The object of this work is to preserve the generality that ESMF allows (e.g., the physics and dynamics components could in principle operate on a separate horizontal grid), without compromising model run time. Maintaining simplicity for easier code maintenance is also an important design consideration. In the application envisioned for FIM as an ensemble member within the Global Ensemble Modeling System (GEMS) at NCEP, both FIM and GFS will be operating under the NEMS, possibly with different physics suites. The situation is therefore analogous to that envisioned for the Rapid Refresh in 2012: both the ARW and the NMM dynamical cores and with possibly different physics suites (e.g., the RR and the NAM physics suites) will be run under NEMS. Though the details of how GEMS will work under NEMS are not yet fully fleshed out, the GEMS work is well along. It is anticipated that the RR design for running under NEMS will closely follow that for GEMS wherever possible. Serious work on the RR design will commence once the GEMS design is far enough along to allow prototype testing with FIM or the NMMB global model (under development at NCEP).

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 30 Sept 2009 **(previously extended to Q2 FY10 @ Jan09 AWRP meeting – DiMego and Benjamin)** (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 **(previously extended to Q2 FY10 @ Jan09 AWRP meeting – DiMego and Benjamin)** (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
Dezso Devenyi has completed his work on a set of modifications to map the surface observations from the actual terrain to the model terrain (using a local lapse rate from the background field). By providing for a more accurate innovation, an improved fit to the surface observation should be obtained. Without this change, surface observations for which there is a significant height difference between the actual and the model would just be down-weighted, resulting in a less close analysis fit to these observations. Following Dezso's successful off-line testing, Ming Hu has merged these changes into a GSI snapshot pulled from the GSD operational RR cycle (Boulder GSI SVN revision #69, based on the NAM March 2008 version with GSD RR-specific modifications). These changes will be tested in the RR retro system (currently being used to diagnose the periodic crashing -- see task 5.4), then introduced into the GSD operational RR.

Continuing his work with the 1QFY09 version of GSI, Ming Hu has added in the code needed to do the radar reflectivity processing (completing all the changes needed to make this version RR-enabled). Following successful off-line tests, Ming is introducing this GSI version into the parallel real-time RR cycle (both the GSD operational RR and the GSD parallel RR are already using WRF version 3.1). Curtis Alexander continues to work on tracking down the build-up of errors along the boundaries and resultant crash of the RR every few days, using the RR retrospective capability. Following the initial experiment in which the failure mode seen in the GSD operational RR cycle was duplicated in the retro (using WRF version 3.0), a second test using version 3.1 has just reproduced the crash. This continues under active investigation.

Dezso continues his work with Bill Moninger on creating a web-based utility for tracking O-B and O-A statistics. The prototype is up and running and will be extremely helpful for diagnosing observation using including QC issues etc. Dezso gave presentations on both the surface assimilation and observations monitoring work at the recent NWP and WAF conferences, respectively.

09.5.5 30 May 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.

CAPS has completed a series of radial velocity assimilation experiments using GSI focusing on high-resolution predictions of Tropical Storm Erin (Aug 2007) and begun experiments at 13-km. These experiments have been complemented by GSI radial velocity assimilation tests conducted at GSD, using the level 2.5 radial velocity feed from NCEP. These latter experiments have uncovered data feed latency issues with the NCEP feed that are now being addressed as discussed below.
Stan Benjamin and Steve Weygandt have continued to work with Dennis Keyser at NCEP (with help from Geoff DiMego and others) to access suitable level 2.5 radial velocity files from NCEP and begin evaluation of them within the GSI for Rapid Refresh. Level 2.5 radial velocity files are now being transferred from NCEP to GSD; however, due to upstream issues with the data cutoff time, these files

contain radial velocity data that is from the previous hour. This is because the initial processing (super-obbing, done at the radar sites) to create the level 2.5 data and feed it to NCEP does not complete until +:35 to +:55 minutes after each hour, which is well after the RUC/RR data cutoff time (+:26 min after the hour). While we continue to pursue options to solve this data latency issue, Yi Yang of CAPS has been working in conjunction with GSD scientists to complete a supplementary retrospective test using NCEP level 2.5 data that has been transferred to GSD.

In June, in order to evaluate the impact of additional radial velocity data for the Rapid Refresh (RR) configuration and test the modified RR workflow for running retrospective cases on the GSD machine, Yi Yang made test runs on the 13 km RR grid for the June 4 2009 case, assimilating NCEP-processed level-2.5 radial velocity sup-obs data at 1200 UTC June 4, on top of the existing procedure assimilating reflectivity data through latent heat forcing in DDFI (the latter a standard procedure of RR). The results showed that assimilating level-2.5 sup-obs only one time has little impact on the forecast for this case. The main purpose of the June 4th case is to test the modified workflow, in preparation for more systematic tests with other cases with carefully prepared data sets.

A new case from 15 June overnight into 16 June 2009 has recently been selected by Steve Weygandt at GSD for systematic test with RR configuration, and in particular for evaluating the impact of assimilating level-2.5 radial velocity data. This set of experiments will be performed in hourly-cycled mode, close to the planned operational configuration of RR, and be nested with GFS.

In addition to the standard procedure of planned RR, which assimilates reflectivity data through latent heat forcing with the forward step of DDFI, we will also compare its performance against several variations. One variation will use the temperature adjustment provided by the ARPS-based cloud analysis procedure (which is part of the generalized cloud analysis package in GSI) instead of the simple latent heating based procedure in DDFI. This temperature adjustment will be applied directly, as an add-on adjustment to temperature without turning off cumulus parameterization heating, or using in the same way as the current latent heating forcing in DDFI. Tests will also be performed to evaluate the impact of including cloud, moisture and hydrometeor adjustments provide by the generalized cloud analysis. For each of these configurations, the addition of radial velocity data through GSI will be evaluated.

This work is somewhat delayed by the need for prepared level-2.5 super-ob radial velocity data set for test cases from NCEP. Further testing and refinement will continue.

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.

The RTMA system has been built for the Guam NDFD grid, and its evaluation is underway. In addition, work has been performed on calibrating the background error covariance model of the 2.5 km resolution CONUS RTMA, which is to replace the current 5 km resolution system. (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.

The cycled assimilation system with the digital filter is functional on vapor. (Wu)

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.

Extensive evaluation of the RR in late February (in advance of our trip to Alaska to discuss RR with Alaska NWS folks) indicated satisfactory results in most verification statistics.

Details are included in the following PPTs, presented at the Alaska Weather Symposium: PPT presentations (from the Alaskan Weather Symposium from 10-12 March in Fairbanks, AK), summarizing the most recent Rapid Refresh verification can be viewed at:
http://ruc.noaa.gov/pdf/RR-AK-Wx-Symp-Mar09-pt1.pdf and
http://ruc.noaa.gov/pdf/RR-AK-Wx-Symp-Mar09-pt2.pdf

The computer disk outage in late May has greatly complicated efforts to evaluate and refine the Rapid Refresh cycle since that time. A change was made to the ARW damping coefficients in early May (just before the disk issues), that made the verification scores worse. This change was removed late in the month. Preliminary precipitation verification indicates improved CSI scores compared to the RUC, but slightly higher biases.

09.5.5.5 Based on case-study testing and refinement of the research quality code, deliver 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. (31 Jul 09)
(Pondeca, Yanqiu Zhu, Parrish)

The pieces of the 'experimental' code for the GSI upgrade are coming together in the Q1FY2010 version of the GSI repository. The observational error variances in the analysis system were re-evaluated with the DesRoziers and Ivanov adaptive tuning method. The results produced a slight negative impact on the low resolution test system. The observational error covariances of each observational type were again evaluated individually. The variances for the background error were also tuned. The work on the error statistics was both carried out and based on the performance of the low resolution NDAS system on the NOAA R&D computer at NCEP. On the new CCS supercomputer an off-line parallel of the full resolution system was set up for impact studies on the new GSI version (Q1FY2010) and new observations. The new version of GSI included two bug fixes which would affect use of conventional data in the upper layers. There were more rawinsonde data used in the top layer and the data in the upper layers were given more weight. The parallel tests showed a small positive impact on the short (three-hour) forecasts. (Wu)

A set of codes was developed to compare the estimated mixing-layer height from radar with other observations. With help from Matt Pyle, Shun Liu modified the HiRes forecast system so that the system can run in near-real-time or do a retrospective case study. The WRF-launcher's verification has been modified to verify the HiRes forecast in retrospective case study mode. An April precipitation case was used to test various options for assimilating radial velocity. Test results were encouraging, and the forecast composite reflectivity pattern was visibly better than the current HiRes's parallel's forecast. Experiments were also performed to determine how to thin data or form super-obs, how to decide the optimal background error de-correlation length, and how to set the parameters for strong constraints; these experiments showed a small impact on the forecast. Experiments using 3 hour precipitation, reflectivity and echo top verification for those forecasts are being set up. Estimated mixing-layer height from radar reflectivity for April - May was collected for comparison with heights estimated from ACARS and RAOBS. For daytime the mixing-layer height from radar is about 200 m lower than that from ACARS, while at night the mixing-layer height from radar is higher. The estimation algorithm for mixing-layer height was modified to improve its performance at night. VAD winds from WSR-88D radar QC package will be used to compare with current VAD wind product in operation – it is expected the VAD winds computed centrally after the winds have been QC'ed will be superior to the VAD winds computed onsite based on non-QC'ed data. Radar reflectivity will be used as a factor to define radial wind observation error and give more weight to radial wind observations when reflectivity is large. (Liu)

A NEMS NMMB interface was added to the operational NAM GSI. Small modifications were made as necessary at the request of Eric Rogers as he creates a new NMMB NDAS for the next major NAM implementation in late FY2010 or early FY2011. These include getting the correct skin temperature (results in large increase of accepted sat radiances), properly updating various forecast date info, and adding a parameter to leave restart date info unchanged (required for cycling with less than 3 hour

interval). The operational NAM GSI was compared to the latest trunk subversion GSI with help from Wan-Shu Wu. Differences are minor, but presumably better due to a bug fix for the vertical observation error modification added by John Derber, after being originally discovered by Wan-Shu Wu. The NEMS NMMB interface has been added to dparrish branch of subversion GSI, and is scheduled for addition to the subversion trunk GSI once all regression tests have been successfully completed. (Parrish)

Deliverables

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

CURRENT EFFORTS: The NAM/NDAS upgrade was implemented in December 2008 just prior to the NCO moratorium. (Wu, Rogers)

PLANNED EFFORTS: Continue preparations of the 'experimental' version of the next GSI upgrade package which, if it doesn't make it in as a possible late 2009 regional GSI minor upgrade, will be included in the next major NAM implementation. Continue checking the new TLNMC code. Run assimilation tests with the low-res WRF-NMM test bed comparing the no constraint, existing TLNMC, and new TLNMC. (Wu, Parrish)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO

UPDATES TO SCHEDULE: Completed December 2008.

09.5.5.E2 30 September 2009 **(previously extended to Q2 FY10 @ Jan09 AWRP meeting – DiMego and Benjamin)** (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.

PROBLEMS / ISSUES ENCOUNTERED: Significant computer downtime due to major issues with the main GSD supercomputer disk system completely compromised the Rapid Refresh (and HRRR) real-time cycle during much of the month of May with sporadic outages continuing into July. GSD personal quickly transferred operations to other disks, but I/O was slower resulting in many missed runs. In addition, work to transfer GSI enhancements (such as the surface observations terrain matching code) to the real-time cycle was greatly hampered. The disk became available again in early June, but, as noted under Task 4, reliability continues inadequate for careful evaluation. We look for this situation to improve in Q4FY09 as the new nJet computer becomes available and processor upgrades are made to hJet.

CURRENT EFFORTS: Two parallel RR cycles, and a retrospective cycle are running at GSD and being used to evaluate RR / GSI enhancements, but efforts to finalize the system and obtain documentation of the forecast impact from the latest changes have been significantly hampered due to computer reliability issues (see PROBLEMS / ISSUES below). Intensive effort ongoing by the ESRL IT personnel to resolve lingering computer issues related to the major disk crash in late May 2009. This has involved sporadic

scheduled (and unscheduled) downtimes for the disk systems. We have coordinated with the IT personnel to automate procedures to failover RR cycles to secondary disk systems and handle other computers disruptions as much as possible.

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.

Several times during January and February, the RR Alaska verification revealed onshore flow in northwest Alaska as being too warm. We found this to be an issue common among models, not allowing sufficient surface radiative cooling when there is snow on ice. During February and March, Tanya Smirnova looked into what would be required to modify the RUC LSM to treat ice as a land surface, including the accumulation and ablation of snow on the ice and vertical heat diffusion within the ice, as well as cycling of snow and ice temperature, and also with temperature and snow-cover dependence for albedo (smaller albedo for temperatures approaching and above freezing when ponding on the ice may be present). We hypothesized that this enhancement would permit more realistic buildup and maintenance of cold air over the ice surface in winter through greater negative surface heat flux to the atmosphere. Tanya modified the RUC LSM accordingly and subsequent tests with this new version of the RUC LSM in the cold start RR indicated that, indeed, 2-m temperature forecasts along the northwest coast of Alaska were improved. Tanya has also made a number of other improvements to the RUC LSM. These include removal of a singularity that occasionally manifested itself as anomalously cold surface temperatures with very thin snow cover, loosening of the constraints on melting rate when air temperature is above freezing, and general code cleanup. These changes were introduced into the RR1h cycles in late April. Subsequent evaluation has revealed situations where temperature within the ice was erroneously rising above the melting point, leading to too warm skin temperatures. Restricting the temperature in the ice to be at or below freezing has alleviated this problem.

Joe Olson has been testing the new WRFV3.1 version of the Nakanishi-Niino-Mellor-Yamada boundary-layer scheme that was implemented by Mariusz Pagowski of GSD. He has isolated a problem with excessive mixing lengths above the boundary layer when the lapse rate approaches the dry adiabatic. He is in communication with Nakanishi about a more physically-based formulation that has promise. Further testing and evaluation of this scheme in RR is planned in the near future.

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 Eidhammer tested the new routine to account for dry deposition of dust due to turbulent transfer to the surface. This routine is also based on WRFchem GOCART module (as the emission and gravitational settling routines are), but an assumed size distribution is used instead of using size binning. Preparations for the July 09 report have begun.

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.

See subtask 8.1 for modifications already made for sea ice. Ftp arrangements were made to make RR grids 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 '08: 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 FY09 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 Rapid Refresh.

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. Extensive report on this task in last quarterly report. Main task this month *by Ming Hu) has been completion of porting the cloud analysis modifications to the new GSI version (1QFY09).

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

09.5.15.4 30 May 2009 (GSD and CAPS)
Request in February from Stan Benjamin and Ming Xue: DEFER due date from 30 March to 30 May. Assumed approved.

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

The DDFI-based radar assimilation continues to running in the GSD operational and now the parallel RR cycles. Springtime evaluation of difference between the RR cycles with and without the radar assimilation and comparing them with similar differences in the RUC indicated that the signal from the DDFI radar assimilation in the RR was similar to that from the RUC radar assimilation, with the exception that the RR produces larger areas of heavy convective precipitation (though this may be linked more to the model than the implementation of the radar assimilation procedure). Recent comparisons have been hampered by ongoing problems with the RR run reliability due to the GSD supercomputer stability issues.

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:

PLANNED EFFORTS

PROBLEMS/ISSUES/SCHEDULE CHANGES:

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.

CURRENT EFFORTS:
NCAR convened the 10th Annual WRF Users' Workshop on June 23-26. Approximately 270 people attended. The workshop featured both plenary and parallel sessions, including a developers' forum and a poster session. The final day had instructional presentations on model-related utilities.

Preparation for the next WRF tutorial is underway at NCAR. It will be held July 13-24. It will offer a basic WRF component, a WRF-Var tutorial, a WRF-Chem tutorial, and a MET (Model Evaluation Tools) tutorial.

PLANNED EFFORTS:
The next WRF tutorial is being held July 13-24, 2009 in Boulder at the NCAR Foothills Laboratory. Registration is closed.

UPDATES TO SCHEDULE: NONE

09.5.6.5 30 Sept 2009 (NCAR/MMM)
NCAR released WRF Version 3.1 in April 2009. Preliminary work involved completing testing and certification of the code for release.

CURRENT EFFORTS:
NCAR released WRF Version 3.1 in April 2009. Preliminary work involved completing testing and certification of the code for release. Both WRF 3.1 and WRF-Var 3.1 were provided. Release features have been summarized in previous reports. Jimy Dudhia of NCAR/MMM presented a talk on the new physics in the WRF V3.1 release at the 10th WRF Users' Workshop.

Since the release, code bug-fixes and improvements have been worked on. Dudhia added a minor fix in the surface w (vertical velocity) diagnostic that includes map-scale factors. The latter had previously been neglected. Dudhia worked with John Michalakes (NCAR/MMM) to resolve an OpenMP issue related to the use of a logical in the surface physics driver, where by strict FORTRAN standards it was set in an inappropriate part of the code. This was leading to some unpredictable behavior in OpenMP tests with certain PBL and land-surface combinations. A minor correction was also made to the QNSE (PBL scheme) surface moisture flux treatment as part of this correction.

A fix to the Pleim-Xiu LSM was made for a variable that was undefined in cases where surface nudging was turned off. This was found in WRF software engineering tests, but it did not cause noticeable problems with results. There were also minor fixes to the RUC LSM related to the accumulation budget for snow melt and related to allowing the use of a time-varying background albedo.

Dudhia completed changes to the Lin microphysics scheme, received from Peter Blossey (Univ. of Washington). These modifications provide for more accurate evaporation calculations. Dudhia addressed cleaning up the arrays needed by the Ferrier microphysics scheme to improve memory and disk space usage.

Dudhia worked with Penn State to distinguish grid-nudging for the stable mixing regime (regime 2). He also added a fix to the V3.1 repository to enable spectral nudging.

Dudhia diagnosed and resolved problems related to slope radiation effects, where these had been exaggerated due to a bug in the code. He worked with David Gochis and Ethan Gutmann (NCAR/RAL) to develop additional slope effect improvements in surface fluxes.

PLANNED EFFORTS:
A minor release, V3.1.1 will be issued in July. Physics testing and implementation will continue through the end of the FY.

UPDATES TO SCHEDULE: NONE

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.

<u>Task 09.5.24</u> Test WRF Rapid Refresh model at 3-km resolution toward High-Resolution Rapid Refresh

GSD

GSD has worked to optimize creation and dissemination of the grids for the 2009 larger-domain HRRR. Latency has been reduced to ~2-h for the 12-h HRRR forecast. This has included placing the HRRR runs within a computer job core reservation system and tuning the number of cores such that the HRRR run for a given hour finished in slightly less than 1 hour, allowing the same computer cores to be used for the next HRRR run. In addition, as part of the CoSPA collaboration, code supplied by NCAR/RAP to create 15-min output of VIL (calculated two ways) and forecast echo-top has been incorporated into the WRF-ARW version used for the HRRR. Finally file transfer procedures have been adjusted to maximize reliability and minimize delay.

Significant computer down time do to major issues with the main GSD supercomputer disk system in late May has lead to sporadic missed HRRR runs and a few longer periods of HRRR downtime. GSD personal quickly transferred operations to other disks, but I/O was slower resulting in many missed runs. An intensive effort by the ESRL IT personnel to resolve lingering computer issues related to the major disk crash in late May 2009 is ongoing. This has involved sporadic scheduled (and unscheduled) downtimes for the disk systems. We have coordinated with the IT personnel to automate procedures to failover RR cycles to secondary disk systems and handle other computers disruptions as much as possible.

This work has been supplemented by real-time case study evaluation of the new larger-domain HRRR in May and June. Some excellent case studies have occurred, including the central US squall line case on 13 May with unusual (but well-forecast by HRRR) convective mode. This can be seen in the Fig. showing an 11-h HRRR forecast of maximum reflectivity and the accompanying NSSL verifying reflectivity mosaic. Barry Schwartz has completed coding and scripting to verify HRRR reflectivity forecast against the NSSL reflectivity mosaic and is working on procedures to verify HRRR precipitation forecasts. Without question, however, simple qualitative assessments clearly indicate much better HRRR forecasts (compared to 2008) are now regularly available from Iowa-Illinois into the Chicago area and from Missouri toward St. Louis with the larger HRRR domain.

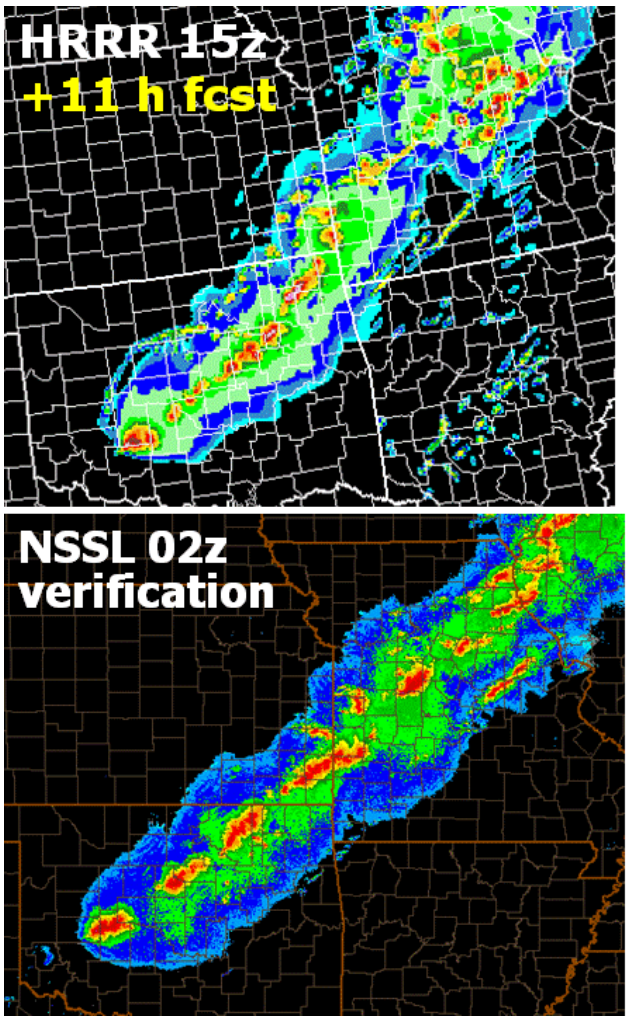

Fig. 1 (Top) HRRR 11-h forecast simulated maximum reflectivity valid 0200 UTC, 14 May 2009. (Bottom) NSSL maximum reflectivity mosaic used as validation.

Ongoing evaluation of real-time HRRR runs has continued through May and June and has re-enforced this favorable impression. The HRRR has produced quite realistic storm structure (often correctly forecasting regions of super cells, multi-cells, bow-echoes and multi-cell storms. In addition, the HRRR has been quite good at indicating locations of significant convection, often to within a couple of counties. This skill has been seen not only for HRRR runs initialized with ongoing storms (via the RUC DFI-based radar assimilation), but also for longer lead time morning HRRR runs (initialized before convective initiation). In addition to the HRRR evaluation conducted by NSSL/SPC as part of their spring program, the HRRR guidance has been used extensively by the VORTEX-2 field project forecasters, to the point that by the end of the project the HRRR was considered critical to project operations. At the recent NWP conference in Omaha, NE, Steve Weygandt gave a talk summarizing improvements to the HRRR for the 2009 season and results so far.

GSD has conducted a series of tests with different WRF namelist parameters for diffusion, advection, and forward differencing options, as suggested by Lou Wicker at NSSL after Stan Benjamin's visit to NSSL/SPC in April. One set of changes for diffusion was implemented immediately into the real-time HRRR runs in late April, and other changes are possible.

In addition to Stan's visit to Norman in April for only 1.5 days, Steve Weygandt and John Brown visited SPC/NSSL for a full week each during May to participate in the Spring Forecast Experiment for

convective weather forecasting. The HRRR is now an important participant among the experimental NWP products being evaluated in this Experiment.

GSD has developed 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. As of early May, a HRRR Convective Probability Forecast (HCPF) product is being created and verified in real-time.

The HRRR products now available have been expanded after changes to WRFpost and HRRR ncl scripts for graphical products. This is now the list of products available hourly for the full HRRR domain, and each of 4 regional quadrants (NW, SW, NE, SE). See http://ruc.noaa.gov/rr/hrrrlargeq1/

1 km agl reflectivity
Reflectivity
max reflectivity
surface CAPE
surface CIN
most unstable CAPE
LCL
0-1 km shear
0-6 km shear
max updraft helicity
storm motion
max vert int graupel
10m wind
max 10m wind
skin temp
2m temp
2m temp - skin temp
2m dew point
precipitable water
1h acc precip
total acc precip
snow water equiv
precip type
850mb temp
850mb wind
850mb rh
850-500mb mean rh
700mb temp
700mb vvel
mean vvel
max updraft
max downdraft
500mb temp
500mb vort
250mb wind
Visibility
cloud top height
Ceiling

ESRL/GSD papers on HRRR presented at 23rd WAF / 19th NWP Conference in Omaha:

Reports from AMS WAF/NWP Conference in Omaha, NE, 1-5 June 2009

The High Resolution Rapid Refresh (HRRR): an hourly updated convection resolving model utilizing radar reflectivity assimilation from the RUC / RR

Steve Weygandt, T. G. Smirnova, S. G. Benjamin, K. J. Brundage, S. R. Sahm, C. R. Alexander, and B. E. Schwartz

http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154317.htm

Probabilistic thunderstorm guidance from a time-lagged ensemble of High Resolution Rapid Refresh (HRRR) forecasts

Curtis R. Alexander, D. A. Koch, S. S. Weygandt, T. G. Smirnova, S. G. Benjamin, and H. Yuan

http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154254.htm

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.

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.

CURRENT EFFORTS: NCAR ran the ARW in real time at 3-km resolution twice-daily using 13-km Rapid Refresh grids for initial conditions. This was in support of the Storm Prediction Center's Spring Forecast Experiment (SFE). Two forecasts a day were run through the end of June (0000 and 1200 UTC initializations). Two cases from the SFE period are being chosen for evaluation, based on GSD input. These will be analyzed jointly by NCAR/MMM and GSD.

PLANNED EFFORTS: The analyses of the chosen RR-initialized forecasts will be completed in the next quarter. Summaries will be written of the analyses.

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.

Coordinated evaluation of specific case studies is ongoing with monthly meetings between GSD and NCAR. Sensitivities to grid resolution, model numerics, and microphysics have been examined. Other experiments have illustrated the benefit of using the RUC initial fields (with the DFI-based radar assimilation).

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.

A significant effort to make the HRRR production and file delivery system robust has been completed, including placing HRRR within the jet reservation system, adding new post-process variables, calibrating the number of cores to optimize the run time and working with user communities to achieve timely and reliable transfer of various output files. Additional work is ongoing to evaluate real-time HRRR runs, identify strengths and weaknesses, and resolve issues. One issue that we have identified is the presence of streamers in the vorticity field entering from the upstream boundary. This is likely due to inconsistencies in the WPS interpolation from the external native model grid. Tests using pressure level data from the external model have not shown this problem and we are actively investigating this problem.

Deliverables

09.5.24.E1 30 August 2009 (NCAR/MMM)
Submit report on evaluation of HRRR-ARW forecasts.

CURRENT EFFORTS: The forecast cases are being chosen in collaboration with GSD. The evaluation is occurring in this quarter, but the report has not been written yet.

PLANNED EFFORTS: The analyses of the chosen RR-initialized forecasts will be completed in this quarter, along with the report.

UPDATES TO SCHEDULE: None

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.

GSD and CAPS

We are continuing to examine how the convergence / divergence fields initialized in the HRRR (from the RUC radar reflectivity assimilation) evolve down-scale during the first 1-3 hours of the HRRR model run to yield 3-km-scale convective systems. Curtis Alexander has made plots of the HRRR initial (00-h from the 13-km RUC diabatic-DFI) and HRRR 1-h divergence fields, illustrating the scale-contraction and intensification of the low-level convergence. Analysis is ongoing for both cases were the convection has initiated within the first hour (DDFI reflectivity-based convergence is diagnosed for the first time within the RUC system) and for cases with ongoing convection (DDFI reflectivity-based convergence superimposed upon ongoing RUC convection from previous radar assimilation cycles).

Coordinated work with CAPS continues on a comprehensive set of experiments to further evaluate radial velocity assimilation both within the 13-km RR and the 3-km HRRR. All relevant data have been retrieved for a test case from 15-16 May 2009. Yi Yang is continuing his work with the radial velocity assimilation experiments using GSI. Initial experiments are focusing on 13-km application for the RR, which will be used as input for a 2nd pass at 3-km using the GSI with shorter correlation length scales.

Earlier experiments at CAPS at 3 km resolution targeted at HRRR, using RUC analysis background showed positive impacts of radar data for tropical storm Erin (2007) that intensified over Oklahoma, based on subjective evaluations. Quantitative evaluations have been performed against the radar reflectivity and radial velocity observation, NHC best track data, and NCEP stage IV precipitation observations. The data assimilation used GSI and the generalized cloud analysis combination, and tested

impacts of various combinations of data sources. These experiments used level-2 data directly, instead of the level 2.5 super-ob radial velocity data. The results have been summarized in a draft manuscript.

For more systematic quantitative evaluation of forecasts, the DTC Model Evaluation Tools (MET) has been updated to the version 2.0. The package includes a comprehensive set of field as well as object-based verification scores. NCEP Stage IV instead of Stage II precipitation data are now used for verification since the former was found to be more accurate when compared with Oklahoma Mesonet data. Further, using reflectivity as the field of verification, in a way similar to precipitation data, a data interface has been written for MET. Currently, MET has been applied for the inland tropical cyclone case Erin which reintensified Oklahoma between 00 UTC to 15 UTC in 19 August 2007. Experiments with different two-hour-long assimilation windows with 10-minute radar data assimilation cycles are evaluated, with correspond to the reorganization, re-intensifying and intensified stages of Erin. The periods are 00 to 02 UTC (A02), 02 to 04 UTC (A24) and 04 to 06 UTC (A46). Verification results show that A46 gives overall the lowest skill score, while the A02 performed the best. A24 have the best structure forecast, but because of its southward position errors, its quantitative skill scores are not as good as those of A02. The verification packages will be applied to other test cases aimed at RR and HRRR configurations.

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.

09.5.19.4 30 Sept 2009 (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.

GSD
Curtis Alexander and Doug Koch developed code to create and verify real-time HRRR Convective

Probability Forecasts (HCPF). Steve Weygandt supplied RCPF code to Binbin Zhou, who is utilizing time-lagged RUC ensemble members and other model grids to create a prototype Very Short Range Ensemble Forecast (VSREF). Curtis Alexander gave a presentation on preliminary HCPF results at the recent NWP conference in Omaha, NE.

ESRL/GSD paper on HRRR-based probabilistic forecasting presented at 23rd WAF / 19th NWP Conference in Omaha:

Probabilistic thunderstorm guidance from a time-lagged ensemble of High Resolution Rapid Refresh (HRRR) forecasts
Curtis R. Alexander, D. A. Koch, S. S. Weygandt, T. G. Smirnova, S. G. Benjamin, and H. Yuan
http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_154254.htm

NCEP

CAPS

Subtasks

09.5.20.1 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. (31 Jan 09)
In April the parallel SREF system had its complete set of RFCs submitted to NCO for a Quarter 4 implementation. Aviation related fields of cloud base, PBL height, Composite Radar Reflectivity and Echo Top height are now produced from most or all 21 members of the parallel SREF system (reflectivity & echo top can only be produced from WRF & RSM members at this time). In May the radar echo top product was added to the post (by Hui-Ya Chuang) and turned on in output from the parallel SREF in response to a request from FAA Command Center. The verification of the parallel SREF was completed based on daily runs from February through May 2009 and the results were presented at 23rd WAF / 19th NWP Conference in Omaha: http://ams.confex.com/ams/23WAF19NWP/techprogram/paper_153264.htm. In June a new effort to remove forecast bias from the model native grid (rather than from pgrb output from the model post as is done currently) was started to make probabilistic forecasts for all forecast fields (rather than a few selected fields) more reliable. To start, the work is focusing on the single NAM deterministic model instead of the SREF. With the help of RSM modelers, three types of problems (memory leaking, improper initialization and an array dimension being out of bound) have been fixed for the RSM model in the parallel SREF system to improve RSM performance (model integration is now more reliable). (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 Develop & deliver a new fog algorithm used in SREF product for aviation. (30 Apr 09)
A new fog algorithm was designed and developed in FY2007 and incorporated into the special ensembles NCEP ran in support of the Beijing Olympic Games in August 2008. A paper about the verification of a fog prediction method using part of the NCEP SREF system was written by Binbin Zhou and Jun Du and is under internal review prior to submission to Weather and Forecasting. (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:
Initial work on VSREF products based on the RUC and NAM forecasts, using the SREF ensemble product generator, and the general framework for the VSREF procedure was completed. These products include cloud base/top, visibility, turbulence, icing, low level wind shear, jet stream probability and reflectivity. These preliminary products are updated daily on the VSREF website http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/VSREF/web_site/html/vsref.html. (Zhou, Du)

PLANNED EFFORTS:
Work will continue on convection products in VSREF, by adopting GSD's convection code. An echo-top ensemble product will be added using the ensemble product generator. (Du, Zhou) turbulence, icing, low level wind shear and jet stream probability

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:
No ceiling/cloud amount is available from ARW SREF members, and no reflectivity is available from the Eta members and some RSM members.

INTERFACE WITH OTHER ORGANIZATIONS: AWS, GSD

UPDATES TO SCHEDULE: None.