MDE Product Development Team – September 2009

FY 2009 4th Quarter Report

Submitted 15 October 2009

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

Executive Summary

MDE report at AWR Program Mgmt Review (Sept 2009)

– http://ruc.noaa.gov/faa-mde/MDE-AWRP-PMR-Sep09.pdf

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

- Testing underway at NCEP for 18h RUC, also including adding Canadian aircraft (non-turboprop) reports, fix to cloud analysis for warm clouds, TAMDAR moisture data in NCEP RUC restored on 14 Oct.

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

- Changes made to WRF model and bug-fix to cloud analysis involving MPI improve RR robustness with 1-h cycling and eliminate spurious features in forecast reflectivity.
- New file system became available, greatly alleviating the serious file-system problems on ESRL supercomputer; RR 1-h cycle now much more reliable.
- Partial cycling for Rapid Refresh running in primary 1-h cycle at GSD, giving much improved results
- Improvements in WRF-RR: testing of WRFV3.1.1 and options in 1-h cycle
- Continued real-time feed of RR files to other AWRP RTs and Alaska Region NWS and getting feedback from them.

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

- Sept - GSI code change to upgrade to FY09 version (with all RR features added) and to move cloud analysis *after* variational solver and add removal of super saturation and negative moisture. Preliminary results for cloud analysis changes suggest improved short-term ceiling / visibility forecasts.
- RR GSI – completion of elevation correction for surface obs to match model value, retrospective test nearly complete; work underway on coastline regime-dependent background for assimilation of surface obs.
- Visit by GSD to NCEP in August - discussions between GSD and NCEP on GSI changes for RR cloud analysis after initial RR

Task 09.5.6: Improve WRF model

- WRF Version 3.1.1 released in July, changes underway toward next version

Task 09.5.8: Improve RR/RUC model physics

- 2nd moment Thompson microphysics implemented into primary RR (operRR) on 27 August.

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).
- NASA Langley cloud top data (covering almost all of the RR domain) now being used in parallel RR cycle at GSD.

Task 09.5.24/19: Begin 3km High-Resolution Rapid Refresh testing / Improve radar assimilation

- Continued evaluation of larger-domain HRRR over eastern 2/3 CONUS.
- HRRR moved to new file system – 17 August 2009 – reliability much improved.
- Initial test of CONUS-domain HRRR conducted on new, faster nJet computer.
- Three papers presented on HRRR at WSN09 symposium and 1 paper at AMS radar conference
- Completion of HRRR reflectivity verification at coarsened resolution confirms that scores just after convective initiation improve substantially when allowance is made for small phase errors
- Completion of initial 3-km radar assimilation experiment for a test case -- encouraging results.

Test 09.5.20 Probabilistic forecasts

- Initial VSREF framework developed by NCEP/EMC using code from RCPF for convective module
- Additional GSD progress on a time-lagged HRRR-based convective probability forecast

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

GSD

Testing of 18h RUC with changes at NCEP underway, conducted by NCEP/EMC with new code from ESRL/GSD. Key components:

- Extension of hourly RUC forecasts from 12h out to 18h every hour (i.e., new forecasts with hourly output to 18h to be produced in every RUC cycle 24x/day).
- Addition of Canadian aircraft data (see below), often over 1000 reports/hour. Previously, Canadian aircraft was from turboprop planes, with poor heading information and poor quality wind data. However, reports from those aircraft are now excluded (by Canada), leaving regional jet data of high quality.
- Correction to saturation of 3-d volumes with warm clouds. This problem was detected in late April after investigating a problem with RUC data reported by WSI. A fix was made to the GSD RUC versions at that time, and now is being added to the operational RUC at NCEP.
- As part of the RUC testing, it was found in early September that the TAMDAR moisture observations were not being used in the operational RUC (and NAM) even though they were properly assimilated back in November 2008 as part of the RUC upgrade. GSD and NCEP investigated this issue, found that it was related to a metadata change made to TAMDAR data, and a fix was implemented on 14 October, restoring it to the operational RUC and NAM.

GSD modifications to experimental ESRL RUC for the July-Sept period

- Assimilation of Canadian aircraft data. Obs-background differences were re-examined for these data and found to now be of good quality. Canadian aircraft contribute a large number of observations, over 1000 reports/hour. Therefore, Canadian aircraft were added to the devRUC in early August and to the backup RUC in late August.
- Assimilation of NASA Langley cloud data. Langley began producing hourly GOES-based cloud fields (top pressure, top temperature, liquid water path, ice water path) over most of the Rapid Refresh domain. Code was developed to assimilate this larger-domain data into the RUC, and was implemented into the devRUC at ESRL in early August and into the backup RUC in late August. Similar changes were introduced into the similar cloud analysis code in the GSI used in the parallel Rapid Refresh in early October (see Task 5.15). This is the first assimilation of cloud-top data over Alaska. Discussions with NESDIS and NASA Langley occurred on testing a proposed new NESDIS cloud product to allow comparisons with the Langley product.
- Use of PBL depth in the radar reflectivity assimilation was introduced into the dev RUC in Sept 2009 as a proxy for cloud base. If shown to be beneficial overall, this will be introduced to the backup RUC and counterpart RR radar assimilation code.

NCEP

Details below from Dennis Keyser and Geoff Manikin.

Geoff Manikin began work on extending the operational Rapid Update Cycle to 18 hours. The current RUC configuration features runs to 12 hours every third cycle (0000 UTC, 0300 UTC, etc) and to 9 hours for all in-between cycles. The new configuration will have all 24 cycles run to 18 hours. A parallel cycle has been set up

to make sure that there are no model problems with the extended run time and to also be certain that all extra products are successfully created. This code will be turned over to NCEP Central Operations soon in hopes of a late fall implementation.

Subtasks

09.5.1.1 Maintain hourly RUC runs and provide aviation guidance grids. (30 Sept 09)

There were no issues related to RUC aviation performance this quarter. (Manikin)

09.5.1.2 Provide vendors with gridded model data via Family of Services (FOS), and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (30 Sept 09)

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** 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 runs more reliably in Production and 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)

Deliverables

09.5.1E1 (30 September 2009) (Manikin, Keyser, Liu)
Perform ingest, quality control and preparation of both existing and new observations in support of the operational RUC runs.

CURRENT EFFORTS: NCO is investigating an invalid instrument type reported by some radiosonde sites. Incorrect elevations for many radiosonde and surface sites in the NCEP station dictionaries were updated on 4 August. All sources of TAMDAR data that were shut off on 7 April returned on 6 July after NWS and AirDAT reached a new agreement. Work restarted on getting TAMDAR airframe type and airline codes into the PrepBUFR file for ESRL's bias correction work. TAMDAR data were not decoded on 20-26 August due to an unadvertised change in the MADIS NetCDF files; the NCO decoder was updated on 26 August and TAMDAR added to the "critical" tracking list. GSD discovered in late September that the 20 August MADIS changes also resulted in no TAMDAR moisture data being decoded at NCEP since then. This problem was corrected on 14 October. Results from the new NRL-based aircraft QC code were compared to the existing QC code for two weeks in August; the new code is superior so NCEP will switch to it sometime this fall. The transition of

observation ingest, dump and quality control and processing codes and scripts to the P6 computer was successfully completed on 12 August. See CURRENT EFFORTS listed under Task 09.5.17.E1 below for final results. Some drifting buoys are not being decoded properly when they have a missing station pressure; NCO is looking into this problem. An updated version of the NCEP BUFR library software is being tested for a fall implementation. 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. The quality of SSM/I products from the operational F-13 satellite began to degrade in early August due to instrument problems. (Keyser)

EMC is testing code to assimilate Canadian aircraft data in the RUC to accompany the U.S. TAMDAR data. This new code will be part of the extension to 18 hour implementation (see 09.5.1E2) later this fall. (Manikin)

PLANNED EFFORTS: See also PLANNED EFFORTS listed under Task 09.5.17.E1 below for aircraft quality control issues. Obtain all TAMDAR data from AirDAT as alternate to MADIS feed and add airframe type and company code to allow improved bias corrections to be developed. (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A critical shortage of disk space on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: Complete.

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: Work is underway to extend the RUC to 18 hours for all cycles, at the request of AWC and SPC. The new configuration (along with a few bug-fixes) is now running in parallel at EMC. (Manikin and ESRL)

PLANNED EFFORTS: The RUC code will be handed off to NCO in October and a late fall implementation is likely. (Manikin)

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

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: Complete.

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: EMC developed a code fix to address a problem identified by a user this past summer. During the cloud assimilation, when a grid point is identified as "cloudy", the water vapor mixing ratio is increased, but the virtual potential temperature is not adjusted upward accordingly. As a result, when a user attempts to de-virtualize this potential temperature, the resulting value is far too cold. This fix is part of the RUC upgrade with the 18h extension package (Manikin and NCO/PMB)

PLANNED EFFORTS: Add this correction to the RUC 18 hour extension implementation. Continue monitoring efforts.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: Complete.

ESRL/GSD papers on RUC, Rapid Refresh, HRRR presented at WMO 2009 Symposium on Nowcasting (WSN09), Whistler, BC, 31 Aug – 4 Sept 2009
(Available from **http://nowcasting2009.ca**)

Integrated assimilation of radar, satellite, and METAR cloud data for initial hydrometeor/divergence fields to improve hourly updated short-range forecasts from the RUC, Rapid Refresh, and HRRR,
Stan Benjamin, Ming Hu, Steve Weygandt, Dezso Devenyi

Overview of the Rapid Update Cycle and Rapid Refresh
Stephen S. Weygandt, T. G. Smirnova, M. Hu, J. M. Brown, D. Devenyi, S. G. Benjamin, W. R. Moninger, S. E. Peckham, G. A. Grell, K. J. Brundage, B. D. Jamison, C. W. Harrrop, J. B. Olson (presented by John Brown)

Evaluation of the High Resolution Rapid Refresh (HRRR): an hourly updated convection resolving model utilizing radar reflectivity assimilation from the RUC / RR
Steve Weygandt, Stan Benjamin, Tanya Smirnova, Kevin Brundage, Curtis Alexander, Ming Hu, Brian Jamison, Susan Sahm

Probabilistic thunderstorm guidance from a time-lagged ensemble of High Resolution Rapid Refresh (HRRR) forecasts
Curtis Alexander, Doug Koch, Steve Weygandt, Tanya Smirnova, Stan Benjamin, and Huiling Yuan

Assimilation of surface observations for RUC and Rapid Refresh
Dezso Devenyi, Stanley G. Benjamin, Stephen S. Weygandt, Ming Hu (presented by Stan Benjamin)

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

NCEP
Eric Rogers continued running the NOAA Environmental Modeling System (NEMS)-based NDAS/NAM real-time parallel system on the P6 supercomputer (which took over operational production on 18 August). Several fixes were installed in various codes to remove egregious errors and improve performance. Additionally, a full retrospective capability with the NEMS-based system was built and used to run several case studies of problematic operational NAM forecasts to help assess performance.

In the WRF-NMM NDAS/NAM parallel, degraded performance (higher upper level temperature biases) led to the temporary removal of two bug fixes to the microphysics installed in July: 1) a dummy variable representing the mean mass of large ice particles (snow) was instead the first-guess mean diameter of the ice particles. This bug occurs only when the first-guess number concentrations of large ice particles are outside of a predefined range; and 2) enforce a minimum number concentration for large ice particles (1 per liter) at all temperatures, rather than not enforcing it at >0C in the operational code where a fixed mean diameter is assumed. Examination of the skill score time series showed that the first change was causing the higher temperature bias, which disappeared when it was removed. The second change had no adverse impact and will be reinstated in early September. NCO has given a tentative implementation date for this minor bug fix bundle of 13 October.

Since many obs-processing activities listed under Task 09.5.1 also pertain to NAM, they are not duplicated here. For the NAM specifically, Dennis Keyser reports there are errors in the mesonet wind uselist provider listings, which caused the loss of over 600 sites in the NAM-GSI. A request to correct the uselist was submitted in August after NCO's moratorium ended. Some Alaskan radiosonde sites still need to move up their launch time so the NAM-GSI can use their data. A request (from May) to add NOAA-19 1B HIRS-4, AMSU-A and MHS radiances to the 1B ingest and dumps, is awaiting implementation by NCO (hopefully in September). Consultation with NESDIS revealed that NCEP's logic for checking the calibration flag for ATOVS HIRS-3 and HIRS-4 radiances is incorrect. When the flag is set, NCEP currently disregards all channels instead of checking the calibration quality for each channel and allowing good channels to be used. This change was tested in the parallel GSI and is

included with the NOAA-19 change request package. 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. A final comparison of observational dump counts between the P5 (Dew) and P6 (Stratus) computers (before the P6 took over operational production on 18 August) showed generally the same number of observational data in both from the NCO-based decoders (which handle mainly non-satellite observations), slightly more satellite data in the P6 dumps (mainly due to their being ingested more frequently), and slightly less Level II NEXRAD radial wind data. The cause of the lower P6 NEXRAD dump counts is being looked into. Crons are generating NAM/NDAS 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 SBUV-2 data. These changes to obs monitoring plus several NMM bug-fixes are being tested in Eric Rogers' real-time parallel NDAS/NAM. Tests are underway to evaluate the impact of using the GFS tropical cyclone relocation procedure to update the global first guess fields input to the t-12 hour NDAS in medium to strong tropical cyclone cases. This could replace the current synthetic wind data bogus. Efforts continue 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. The geographical domain for the RTMA dumps, currently the same as the expanded NAM domain, will soon expand to include the Guam region.

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 continues to run on the CCS, testing 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. In early August, parallel verification statistics showed degraded performance (higher upper level temperature biases), which led to the temporary removal of two bug fixes to the microphysics installed in July: 1) a dummy variable representing the mean mass of large ice particles (snow) was instead the first-guess mean diameter of the ice particles. This bug occurs only when the first-guess number concentrations of large ice particles are outside of a predefined range; and 2) enforce a minimum number concentration for large ice particles (1 per liter) at all temperatures, rather than not enforcing it at > 0C in the operational code where a fixed mean diameter is assumed. Examination of the skill score time series showed that the first change was causing the higher temperature bias, which disappeared when it was removed. The second change (which removed spurious snow at the surface) had no adverse impact and was reinstated in early September. (Rogers)

The NDAS/NAM system using the NEMS/NMMB model, the NEMS Preprocessing System (NPS), the NMMB version of the GSI analysis, and the unified NCEP post-processor continues to run in a real-time parallel on the CCS. Numerous modifications and bug fixes have been made to this run during this period of testing, which can be considered a "shakedown" of the system. Most of the changes made were to move the NEMS/NMMB parallel closer to the operational NDAS/NAM configuration (similar resolution and number of grid points, increased divergence damping during the NDAS NMMB forecast, fixes to the update of the model sea ice using the daily NESDIS sea-ice analysis). (Rogers)

09.5.17.2 Maintain four-per-day HiRes Window runs and provide aviation guidance grids. (30 Sept 09)

A set of script changes for the operational HiresW system were submitted on 28 September. Over the previous month there had been several non-reproducible failures in the HiresW as different parts of the overall job conflicted with each other at the script level. These failures generated product delays as the jobs had to be rerun. The submitted changes separate the components of the system more cleanly, and should make the HiresW more robust and its product delivery timelier. (Pyle)
NCEP maintains 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 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**. HRW outputs were added to NOAAPORT feed this quarter and will become available to NWS forecast offices 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)

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)

NCEP's new computer system in Gaithersburg, MD and Fairmont, WV was declared operational and began producing NWS forecast guidance on 12 August. The NCO moratorium on model upgrades ended on 18 August, 2009.

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: In addition to the items reported in 09.5.1E1, some Alaskan radiosonde sites still need to move up their launch time so the NAM-GSI can use their data. A final comparison of observational dump counts between the P5 and P6 NCEP computers (before operational production switched to the P6 on 18 August) showed generally the same number of observations from the NCO-based decoders (which handle mainly non-satellite observations), slightly more satellite data in the P6 dumps (mainly due to their being ingested more frequently), and slightly less Level II 88D radial wind data. The lower P6 Level II 88D dump counts are being investigated. Some drifting buoys are not being decoded properly when they have a missing station pressure. NCO is looking into this. Errors in the mesonet wind uselist provider listings were corrected on 25 August, making over 600 new sites available for assimilation by the NAM-GSI. NOAA-19 was added to the HIRS-4, AMSU-A and MHS 1B radiance ingest and dumps on 29 September, and is being tested in the parallel NAM-GSI. Logic for checking the NESDIS calibration flag for HIRS-3 and HIRS-4 radiances in the NCEP ingest was corrected on 29 September. The ingest now checks the calibration quality for each channel, allowing individual "good" channels to be passed. This change will prevent significant outages, like on 9 July (18 hours) for METOP-2 HIRS-4 and on 6-7 July (13 hours) for NOAA-17 HIRS-3. The 29 September change package also increased the reported radiance lat/lon accuracy for all ATOVS 1B instruments and satellites from 0.01 to 0.0001 degrees, which had

positive results in GBL-GSI tests. NESDIS reduced instrument noise and bias by changing their GOES imager and sounder patch temperatures from their warm season to cold season set-points for GOES-11 and -12 on 15 and 23 September, respectively. 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. NAM/NDAS and RTMA PrepBUFR files are being generated with 50 km ASCAT and WindSat scatterometer wind data (both non-superobed) and NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and SBUV-2 data. These changes to obs monitoring are being tested in Eric Rogers' real-time parallel NDAS/NAM. Using the GFS tropical cyclone relocation procedure (in medium to strong tropical cyclone cases) to update the global first guess fields input to the t-12 hour NDAS is being tested as a possible replacement for the current synthetic wind data bogus. Efforts continue to remove a legacy restriction that only surface data with a reported pressure is processed into the PrepBUFR files. This will allow many new surface observations (land, marine and Mesonet) to be assimilated in the RTMA and possibly NAM/NDAS. The geographical domain for the RTMA dumps will soon expand beyond the NAM domain to include Guam. (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 once NCO evaluation is finished and run times are improved. Change PrepBUFR processing to add report sub-type information so the analysis can 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); 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. 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. Work with NCO to bring in new sources of radar data (TDWR, Tail Doppler Radar from hurricane hunter P3 aircraft, Canadian, CASA). Examine possible use of mixed-satellite (Aqua and Terra) MODIS winds which have better coverage and timeliness than the current single-satellite (Aqua-only or Terra-only) MODIS winds. (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A shortage of P6 disk space.

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 last quarter. A new hire, Yali Mao, has started to work on the "proof of concept" project to transition the CIP/FIP suite of product generation running at AWC to NCEP.

PLANNED EFFORTS: Continue the transition project. Yali Mao and Geoff DiMego will both be visiting AWC on November 17 with DiMego staying on until 19th.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: As a new hire, Yali Mao is still spinning up.

INTERFACE WITH OTHER ORGANIZATIONS: NCAR, AWC.

UPDATES TO SCHEDULE: None

Task 09.5.4 **Develop, test, and implement the Rapid Refresh.**

GSD

The file-system problems on the Jet computer continued to hamstring RR development efforts during the first half of Quarter 4. However, a new large file system (/lfs1) became available on 17 August. Thereafter, runs of both the RR and HRRR have been much more reliable, accelerating progress. Another item of good news is that nJet, a new machine with more cores that are nearly twice as fast as those on wjet and hJet, also became available in late August. nJet is primarily dedicated to another funded project, but 408 cores of this machine are available for the HRRR runs. The regular 2/3 CONUS HRRR runs were moved to this machine in early October, which has freed up cores for the Rapid Refresh runs.. There continued to be close communication and collaboration with the Raytheon systems team at ESRL during all of this, and we acknowledge their strenuous efforts to deal with these matters.

The improved RR 1-h cycle reliability in late August allowed rapid progress toward making the RR more robust. Some highlights follow.

- Radar-based latent heating fields were found to be erroneous in areas away from CONUS. This was corrected immediately.
- Limits to latent heating in WRF model were designed and successfully tested. These limits are similar to those used in the RUC model. Imposing a latent-heating limit allowed the RR 1-h cycle to run continuously to nearly 5 days in both the primary RR 1-h cycle and the retro-period cycles. It also eliminated CFL violation messages from occurring in the interior portions of the domain, confirming that the latent-heat limit does control vertical motion brought on by grid-scale latent-heat release. However, the less-frequent crashes continued to occur in the southeast corner of the domain as before, following a gradual buildup of moisture and CAPE in this area.
- A bug in the GSI cloud analysis proved to be a critical piece of the puzzle. On GSI computational tiles where cloud data was present and used to alter the moisture field, specific humidity was converted to mixing ratio, but then not converted back to specific humidity at the conclusion of the cloud analysis. (For the same water vapor content in the air, the water-vapor mixing ratio is very slightly larger than the specific humidity, but both are small, usually less than 0.02 kg/kg.) Eliminating this inconsistency eliminated the gradual buildup of moisture in the southeast corner of the domain.
- This cloud analysis bug fix allowed the RR1h to continuously cycle for over 10 days at a stretch without crashing. However, much less frequent crashes have continued. In addition, we began to notice discontinuities in forecast reflectivity aligned along the grid lines in the forecast radar reflectivity fields. Investigation revealed a bug in the modifications we introduced to the WRF model to suppress convection during the first 30min of the forecast in areas where radar observations indicate no convection exists. Tests indicate that fixing this bug has eliminated these artifacts in the convective precipitation.
- Meanwhile, the less frequent crashes have been tied to CFL violations arising from spurious localized strong inflow across the lateral boundaries of the RR domain. This gradually develops during the cycling. At this writing an intensive effort is being made to diagnose and fix this problem, which we believe lies somewhere in the details of the cycling procedure using GSI.

A decision was made by ESRL and NCEP/EMC in June to implement “partial cycling” for the Rapid Refresh, similar to that implemented for the operational NAM in December 2008. In the Rapid Refresh partial cycling, the atmospheric fields are rederived in a catch-up hourly update cycle twice daily, starting from GFS (most likely, because GFS fields are available to a higher altitude than in the NAM) or NAM grids. The land-surface fields are fully cycled within the Rapid Refresh. 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. During this quarter, Ming Hu coded and tested a partial cycling system for the RR. This was put into the primary RR 1-h cycle in early October. The system starts from GFS atmospheric fields (still fully cycles the LSM fields) two times per day (03z and 15z) and performs an hourly updated pre-forecast cycle for 6-h (through 9z and 21z respectively). Then a regular fully hourly cycled RR proceeds until the next partial cycling time. Preliminary results suggest improved performance for short-range upper-level wind forecasts for the partially cycled RR compared to the fully cycled RR (both running at GSD).

GSD continues work toward preparing the WRFpost for the Rapid Refresh. Work began in July to introduce the NCAR-Thompson microphysics-based precipitation-type algorithm that has served RUC users very well, but was

put on hold pending fixing the RR 1-h cycle crash problems.

GSD has also developed a possible new domain for the Rapid Refresh based on the rotated lat-lon grid for its WRF-ARW dynamical core. 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. This possible new domain is very similar to the present Lambert-conformal domain, and has about 3% fewer grid points. With identical maximum and slightly larger minimum grid spacing, it should be more computationally efficient. Comparison runs between this new domain and the present one have been conducted. However, code enhancements to WRFpost by NCEP to allow use of the rotated lat-lon projection with the (Arakawa C grid) ARW core as input will be necessary before this projection is used for any of the routine RR runs. Notice will be given to native-grid users of RR output in advance of any changes to the native-grid output.

Subtasks

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

NCEP

Experimental Rapid Refresh (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 generated at NCEP and copied to a private ESRL directory on the NCEP ftpprd server. RR dumps of expanded (time-window) Level 2.5/3 88D radial wind data are being copied to a public ftp directory. These and hourly lightning data are being tested in ESRL's experimental RR runs. Future data tests will include Multi-Agency Profiler winds, Canadian AMDAR data, QuikSCAT data (up to 2 hours old) and METOP-2 radiances. EMC and GSD request that the ROC start their hourly processing of Level 2.5 88D data 10 minutes earlier so more data will arrive before the RR cutoff. This is critical for the Alaska portion of the expanded RR domain, where the only source of radial wind data is the Level 2.5/3. The possibility of adding Level II 88D data over Alaska is being discussed. (Keyser)

GSD

Starting in late October 2008 (but subject to the serious interruptions due to file-system problems beginning in spring and continuing until very recently), two parallel full hourly cycled versions of the Rapid Refresh have been running at GSD, together with verification and web-based plots, with files from the primary RR going to many users (including AWR PDTs). Most recently, the surface verification used for the RUC has been modified for use with the RR to facilitate comparison of RR and RUC performance. Preliminary comparisons indicate scores are similar, except the RR has a higher bias in 10-m wind speed and 2-m dew point (equal skill for 2-m temperature). There are, however, differences in the method for diagnosing the surface variables between the RUC and the WRF-ARW that may account for this bias. These differences are being addressed and the impact on the surface verification will be examined.

Verification of standard atmospheric variables (temp, RH, wind) for the RR has improved significantly in Oct 2008 as described at the end of this paragraph. The RR verification through early March over the RUC verification domain continued to indicate the experimental Rapid Refresh was 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. Efforts to evaluate and resolve this issue were stalled by the computer and crash issues of the past few months, but have resumed. Using our retrospective cycle period, we found that the suspected adverse effect of Rayleigh damping (used to prevent spurious reflection of upward propagating gravity-wave energy) near the top boundary of the model does not fully account for the degradation in upper-level wind forecasts relative to the operational RUC. This degradation is greater for 3-h forecasts than for 12-h forecasts, pointing to possible GSI or cycling issues. Nevertheless, we have turned off the Rayleigh damping in favor of restoring enhanced diffusion near the top of the model. We have also just recently switched to the partial cycling option in our GSD operational RR and a preliminary analysis of upper-air verification statistics indicates that it has improved the upper-level verification and the RR now has better scores than the RUC.

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.

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). The real-time feed for this data is now in place, and it was introduced into the RUC dev13 cycle at GSD for evaluation as of 6 August 2009 and into the Rapid Refresh as of early October 2009. Initial results look good for both the RUC and the Rapid Refresh. Also in early Oct. 2009, another key Rapid Refresh change that will significantly benefit ceiling and visibility forecasts was made. The cloud analysis code within the GSI was switched to be after the variational moisture solver, which prevents the variational moisture solver from sub-saturating regions where clouds have been specified, thereby enhancing the retention of the cloud information in the subsequent Rapid Refresh forecast.

Various AWRP RTs at NCAR have also been accessing the RR grids and are evaluating the performance of their algorithms on this data. Back in May, Bob Sharman (Turbulence PDT) informally expressed concern over noise in the 500 hPa field grids they were receiving, and smoothing to remove small-scale detail from the heights of constant pressure surfaces has been introduced into the WRFpost for both the “cold start RR” and the primary 1-h cycle. The Icing PDT makes revealing displays comparing the hydrometeor fields from the RR vs. RUC, and we have found these useful for evaluating performance of the NCAR-Thompson microphysics.

At the recent World Meteorological Organization Symposium on Nowcasting, we had extensive discussions with Alister Ling, a supervisory forecaster at the Prairie Weather Center in Edmonton, Alberta, Canada. These mainly centered on the properties and forecast challenges in prediction of stratocumulus clouds in arctic air masses. This is also a challenge for forecasters in Alaska. These discussions will likely lead to some refinements in the RR cloud analysis.

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.

See Q3 MDE report.

09.5.4.4 30 Sept 2009 (previously extended to Q2 FY10 @ Jan09 AWRP meeting – DiMego and Benjamin) (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.

09.5.4.5 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.
Moved to 31 July 2010 per updated FY10 MDE milestone plans (with start/top dates) sent to Warren Fellner on 10 Sept 2009.

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.

UPDATES TO SCHEDULE

09.5.4.4, 09.5.4.5, 09.5.4.E2, 09.5.4.E3 – see above, all in previous reports

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

GSD
Several upgrades / changes have been made to: 1) the GSD primary real-time RR cycle (operRR), 2) the GSD parallel developmental real-time RR cycle (devRR), and 3) the GSD retrospective cycle (retroRR). All three cycle have switched to using the new FY09 version of the GSI code from NCEP, with all Rapid Refresh related changes included. The operRR is running with a partial cycling option, while the devRR and retroRR are running with full cycling options, allowing us to explore remaining issues. Ming Hu has added code to the GSI that ingests the NASA Langley cloud top data (coverage to 70 deg) and has moved the cloud analysis after the GSI variational moisture solver (and added code to remove instances of super-saturation and negative moisture) and both of these are included in the current devRR cycle. The cloud analysis change is key for preserving saturation in regions where clouds have been specified, thereby increasing retention of this information in the Rapid Refresh forecast.

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. After confirming satisfactory results from single case study experiments, these changes were tested within the RR retrospective framework. It has just completed and surface verification results will be reported next month. Dezso is now working on a set of modifications to handle coastline observations.

Dezso Devenyi 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. Also, work has begun to scope out possible techniques for converting the cloud analysis which is currently non-variational to a variational formulation. Four scientists from GSD visited NCEP/EMC the third week of August to discuss these plans.

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.

See Q3 MDE report.

New:
Using the selected test case (from 15 June overnight into 16 June 2009) Yi Yang of CAPS has recently completed a set of mini-retrospective experiments to evaluate the forecast impact from assimilation of level 2.5 radial velocity data (from NCEP files). Work is ongoing to verify the forecast from the different experiments.

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.

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.

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.

The computer disk outage in late May greatly complicated efforts to evaluate and refine the Rapid Refresh until a new file system became available in mid August. With the

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)

Work on preparation of the upgrade package continued. The observational error variances in the analysis system were re-evaluated again with a different accumulating scheme to account for sampling errors. The new table will be tested in the full resolution NMMB system when the system becomes more mature. The method to remove the channel biases of the satellite radiances in the analysis was shared by both the global and the regional systems. It was believed that the use of the radiances in the regional system was less than optimal, and the inferior performance was related to the smaller domain. Efforts have been made to improve the satellite bias correction in the regional system. The satellite bias correction files were separated with respect to time of the day. Using the previous bias from the same time of the day as the first guess, the character of the bias with respect to the solar zenith angle can be accumulated. A low resolution 30-day impact study indicated that although the biases clearly showed differences for different times of the day, the experiment produced a neutral impact on the forecasts. It was also observed that the angle-dependent part of the bias correction was quite similar between the global and regional systems but the biases were removed more completely in the global system. Although the mean of this component was different between the global and regional systems, the fast changing bias corrections from the atmospheric contributions could easily absorb the differences. An attempt to use the global angle dependent bias corrections in the regional NDAS was done with the low resolution system and the atmospheric part of the satellite bias correction still evolved with the assimilation. A month-long data assimilation impact study indicated the change produced a neutral impact. (Wu)

VAD winds are being dumped from the 2008 version (still our newest) radar QC package. Because the current VAD winds transmitted to NCEP are generated onsite with different local configurations and without benefit of NSSL QC, it is expected VAD winds generated at NCEP using a single standard configuration and using data processed through NSSL QC will be superior to the current VAD winds. The radar QC package was updated to

the 2009 version, where the VAD wind processing was further improved. PBL height estimates are being output from the VAD wind processing but these are lacking the expected amplitude of diurnal cycle of minimum at night and maximum during the day when the radar estimates are too low by ~200m. Grid-vs.-grid verification was set up (with help from BinBin Zhou) for HiRes forecasts using both composite reflectivity and echo top. The enhanced use of radial winds in the GSI is being tested by initializing high resolution convective resolving runs paralleling Matt Pyle's special SPC runs. Composite reflectivity Equitable Threat Scores (ETS) were improved in the 3 hour forecast and 24 - 36 hour forecasts after assimilating radar radial wind. The impacts on other forecast periods were very small. (Liu)

The NEMS NMMB interface was transferred from the operational NAM GSI code to the new subversion-managed GSI. Eric Rogers has been using this in his new parallel NMMB NDAS. Two code errors were discovered and fixed. One caused large scale gravity waves to radiate from the North Pole and the other kept all but tm12 88D radar data from being used. The new version of the dynamic constraint (TLNMC) was successfully transferred to the subversion GSI trunk and results of a test case were reproduced. Unfortunately, the new TLNMC produced large negative impacts in a 12 hour assimilation using the low-res test bed. Guess surface pressure fits to data became much worse compared to the control with no constraint, and with the old constraint. It is not known yet what caused this negative impact. (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)

PLANNED EFFORTS: Continue preparations for a possible FY2010 regional GSI minor upgrade. Continue checking the new TLNMC code and find the cause of the negative impact in the assimilation tests with the new TLNMC. Examine use of digital filter. (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) COMPLETE
Finalize enhancement package for radial velocity data analysis to begin testing at GSD toward future implementation for Rapid Refresh.

Yi Yang at CAPS completed a set of experiments using the hourly cycled 13-km RR experiments for a Southern Plains MCS case (16-17 June 2009), comparing a control (no radar assimilation) and several combinations of reflectivity and radial velocity assimilation (including 1-pass and 2-pass radial velocity assimilation). Analysis of these results is continuing, but preliminary results indicate more modest impacts from the radial velocity assimilation compared to the reflectivity assimilation. Also, we are working with EMC to test Shun Liu's enhanced radial velocity package (available with the FY10 GSI) within the 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.

Moved to 28 February 2010 per updated FY10 MDE milestone plans (with start/top dates) sent to Warren Fellner on 10 Sept 2009.

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 cycles for much of the summer, but have been resolved in the past 6 weeks, resulting in much improved reliability of the RR cycling runs, and evaluation efforts have intensified. (See subtask 5.4.1 for further discussion.)

CURRENT EFFORTS: The switch to a new file system in late Aug. has significantly improved the reliability for both the RR and HRRR.

UPDATES TO SCHEDULE: See 09.5.5.E2, E4 – mentioned in previous reports

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.

GSD began running the second-moment Thompson microphysics scheme in the Rapid Refresh as part of the transition to WRFv3.1. This culminates significant work by NCAR and Greg Thompson over the last 2 years and is a major advance for the Rapid Refresh over the RUC in this regard. Improved icing, cloud, and precipitation forecasts will result in certain situations, including Arctic winter conditions.

Joe Olson continued testing the new WRFV3.1 version of the Mellor-Yamada-Nakanishi-Niino boundary-layer scheme that was implemented last year by Mariusz Pagowski of GSD. A more physically based formulation of the mixing length has been implemented in the scheme. This has eliminated pockets of unrealistically large mixing lengths and turbulence kinetic energy in the upper troposphere in several test cases. Testing and evaluation of this scheme will continue.

Tanya Smirnova is reexamining the coupling between the RUC LSM, the MYJ surface-layer and PBL codes for inconsistencies, particularly in the treatment of surface fluxes. This is partly motivated by our long-standing concern that the diurnal cycle in the RR is slightly damped in amplitude relative to METAR observations when the MYJ surface and boundary layer schemes are used.

Although not strictly a physics issue, we have had a long-standing concern about the WRF procedure to diagnose 2-m temperature and mixing ratio over land from the skin temperature and surface soil moisture.
In particular, in this diagnosis, the predicted lowest atmospheric layer temperature and mixing ratio are not used.
Tanya Smirnova is testing modifications that take these values into account.

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)

A module to account for wet scavenging of dust particles by rainout (precipitation particles colliding with the dust particles) has been implemented in the Thompson microphysics scheme. Wet deposition is the most efficient removal process of dust in the size range centered around 1 micrometer in diameter. The rain out module is based on a wet scavenging module in WRFchem in the MOSAIC framework, but modified to work in the simpler WRF code. The scheme was tested using the ideal hill test case for different dust loading and cloud top scenarios

Trude Eidhammer wrote a report (**http://ruc.noaa.gov/faa-mde/Report-5.8-Jul09-NCAR.doc**) summarizing her work in developing and implementing a new ice nucleation scheme in WRF based on new ice nucleation parameterizations of Paul DeMott and others. This scheme also includes a 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. The report was delivered to Stan Benjamin on July 30 on schedule (deliverable 09.5.8.3).

Deliverables

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)
COMPLETE: (**http://ruc.noaa.gov/faa-mde/Report-5.8-Jul09-NCAR.doc**)

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)
COMPLETE: 2nd moment Thompson microphysics incorporated into RR on 25 June 2009 as part of WRFv3.1 implementation into RR.

09.5.8.E2 30 Sept 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 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).
Report is available at (**http://ruc.noaa.gov/faa-mde/Report-5.8-Jul09-NCAR.doc**)

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 April Q2 MDE report. Main tasks this quarter (by Ming Hu) have been completion of porting the cloud analysis modifications to the new GSI version (1QFY09) and moving the cloud analysis after the variational moisture solver in GSI. This latter step is key for retaining in the Rapid Refresh forecast the clouds analyzed within the cloud analysis.

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

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 run with desired results in the GSD operational and now the parallel RR cycles.

Deliverables

09.5.15.E2 30 Sept 2009 (GSD) COMPLETE
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.

Code has been ported to NCEP and testing of the system is ongoing as are efforts with EMC personnel to fully integrate the cloud analysis changes within the EMC SVN repository. Complementary testing at GSD has led to the identification and resolution of a few glitches in the cloud analysis.

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

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 conducted the 10th WRF Users' Workshop on June 23-26.
This task has been completed for FY09.

NCAR conducted a WRF tutorial on July 13-24 in Boulder. This task has been completed for FY09. In addition, NCAR provided another WRF tutorial on September 28-October 2 in Cambridge, England in collaboration with the British National Centre for Atmospheric Science.

PLANNED EFFORTS: None further for FY09.

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.

09.5.6.5 Incorporate physics improvements from the WRF user community, ESRL, and NCEP into the WRF software infrastructure for use in the Rapid Refresh model 30 September 2009 (NCAR/MMM)

CURRENT EFFORTS: During this quarter NCAR released WRF version 3.1.1. This minor release primarily contained bug fixes, with the main improvements addressing: (i) observation and spectral nudging; (ii) nesting ratios of 1:2 and 1:5 (in the case of a large number of processors); (iii) various fixes for physics and dynamics options, including the restart capability and the use of OpenMP; and (iv) reduced memory usage. The updates in V3.1.1 are described at **http://www.mmm.ucar.edu/wrf/users/wrfv3.1/updates-3.1.1.html.**

Jimy Dudhia of NCAR worked with S. Hong (Yonsei Univ.) on a revised YSU PBL scheme being considered for the next WRF release. This work addressed conservation and consistency issues in the flux calculations. With the QNSE PNBL scheme, Dudhia obtained new code for the QNSE surface layer from developer Semion Sukoriansky (Israel) that aims to improve the behavior of the unstable boundary layer. Testing of this new code is being done in preparation for addition to the WRF repository.

Dudhia helped visitor T. Prabhakaran (India) with the use of the WDM6 microphysics scheme, resolving issues in initializing CCN concentrations in nested runs. Dudhia also worked with Steven Cavallo (NCAR/MMM) on the problem of unrealistic cooling at the model top (for tops higher than 50 mb), which is due to an underestimated downward longwave flux. In other radiation physics work, Dudhia obtained fixed code for the RRTMG scheme addressing a problem with a weak outgoing longwave signal in high clouds. The code is still in testing.

Dudhia collaborated with NCAR visitor Jeff Mirocha (Livermore Nat'l Labs) in preparing a sub-grid turbulence package (the NBA scheme) for inclusion in WRF. He also collaborated with Jared Bowden and Zach Subin (Univ. of Cal. Berkeley) in updating the CLM3.5 land model for WRF Version 3.1.

Lastly, Dudhia worked on a code fix for a nested boundary problem seen in long, two-way coupled simulations. The problem has been largely resolved, and the fix will soon be added to the repository.

PLANNED EFFORTS: None further for FY09.

UPDATES TO SCHEDULE: NONE

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

NCAR

CURRENT EFFORTS: Dudhia determined cases for study and then evaluated RR-initialized 3-km convective forecasts for those cases. The runs were done at NCAR for the 2009 severe weather season. The season included cases with and without the RR initialization, and comparisons were made. Dudhia drafted a report on the results and delivered it to NOAA GSD. The results showed that the RUC initialization helped early-forecast rainfall predictions.

PLANNED EFFORTS: None further for FY09.

UPDATES TO SCHEDULE: NONE

GSD

In late August, ESRL/GSD moved the HRRR processing to a new file system (/lfs1) that had just become available. Since that time, HRRR reliability has been near 100%. In addition, in early Oct., GSD began testing a CONUS HRRR configuration on nJet. A web-page for the CINUS HRRR is now available:

http://rapidrefresh.noaa.gov/hrrrconus/

and we will soon have files (including look-alike files for the 2/3 CONUS HRRR domain) available for other CoSPA teams to work with.

Ongoing and evaluation of real-time HRRR runs has continued through, now in the early-fall regime, and has re-enforced previous very good results shown by VORTEX-2, at the AMS NWP meeting, WRF meeting, and the

recent AMS radar conference. Barry Schwartz has completed work to provide verification of HRRR forecasts at slightly larger scales, for which much greater skill is anticipated. Evaluation of his results, confirms this hypothesis, as skill improvements from verifying on a 24-km grid vs. a 3-km are greatest during the afternoon period just after convective initiation. During this time when storms are very small (and rapid up-scale growth is occurring, verification on a 3-km grid is very unforgiving to even small displacement errors).

Coordinated work has also continued with NCAR on evaluating various aspects of the HRRR configuration on forecast skill, with monthly meetings to discuss results and exchange ideas.
An associated report, summarizing NCAR results can be found at **http://ruc.noaa.gov/faa-mde/FAA_NCAR_Dudhia-Sep09.pdf**

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, described under Task 5.20. As of late July the system is running in real-time with verification and several improvements have been implemented yielding significantly better scores.

Subtasks

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). NCAR and GSD have had ongoing meetings through the summer and more extensive
discussions in early Sept. that have helped us to understand several HRRR/CoSPA issues, including evolution of the HRRR fields following the initialization, time dependencies in the HRRR phase correction and how the HRRR is bias-corrected.

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
GSD participated with NCAR in a Convection Weather Retreat at NCAR in early September. In preparation for this meeting, GSD has been able to identify a list of possible changes in radar processing, primarily within the RUC and Rapid Refresh that are promising for improving HRRR forecast accuracy. Many of these are related to the previously-reported deficiencies in the HRRR-2009 version:

- Convection sometimes too late in HRRR
- Issues with high-based convection in high plains areas
- Issues with limited radar near coastline

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.
Tanya Smirnova has run 3-km HRRR experiments using the diabatic DFI.

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.

Initial tests of an improved DFI-based 3-km radar reflectivity assimilation method have been completed for a test case. The experiment required 1) adapting the NSSL radar reflectivity processor program to create a 3-km mosaic, 2) adapting GSI to run at 3-km (with the variational solver turned off) to create a 3-km latent heat-based temperature tendency field, and 3) running the 3-km ARW HRRR with the DFI-based reflectivity assimilation turned on. Initial case study results of this 2nd pass of the radar reflectivity at 3-km gave very encouraging results for a June test case with a cluster of intense thunderstorms.

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. COMPLETE.

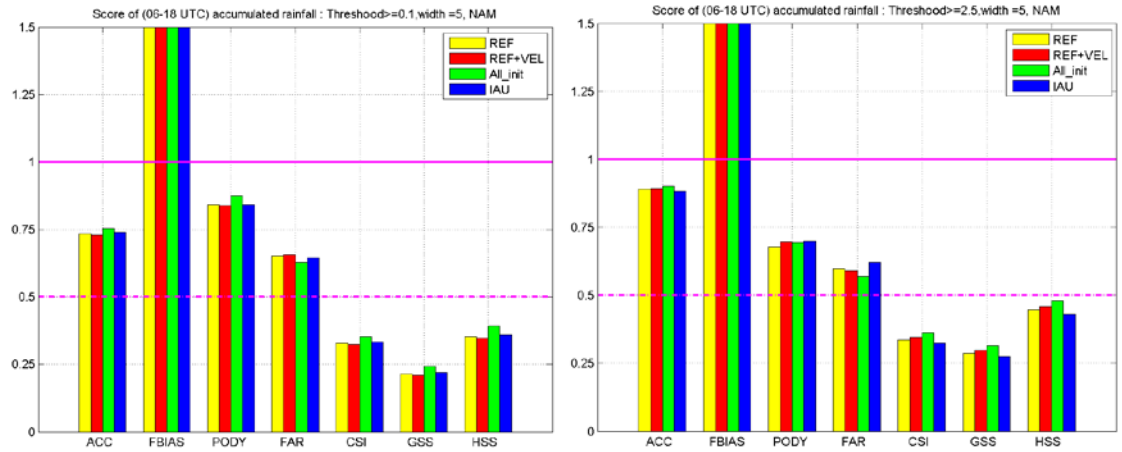
Based on the enhancements to the 13-km radar assimilation method (big fixes, removing latent heating below cloud-base) and the good results for the 3-km assimilation test, code is in place for the new radar assimilation techniques that will be demonstrated in FY10. Retrospective tests will also be conducted over the winter.

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.
During the quarter, Yi Yang of CAPS ran a set of tests for a new case provided by GSD on the GSD machine, using the operational workflow modified for retrospective runs. The case involves individual cells that evolved into a very large MCS across Kansas from 15 June overnight into 16 June, 2009. Evaluating the impact of assimilating level-2.5 super-obed radial velocity data with the RR configuration was the primary goal. The standard DDFI procedure was used, but with different combinations of radar data. Four experiments were performed: run with no reflectivity (Z) or radial velocity (Vr) assimilation, with Z assimilation only, radial velocity assimilation only, both Z and Vr assimilation. Moreover, for the experiments with Vr assimilation, a sub-set of experiments was conducted: one that assimilated Vr and other observations simultaneously in one pass, and the other that assimilated Vr data in the second pass with smaller spatial correlation scales. All experiments cold-started off GFS at 15Z 15 June and did 1-h assimilation cycles through 06z 16 June with 12-h forecast. The outputs were passed on to GSD for systematic evaluation using standard verification tools. Moderately positive impact assimilating redial velocity data was found, especially when analyzing the radial velocity data using a second GSI analysis pass. The impact of assimilating Z data was clearly positive.
In an attempt to further understand the behavior and performance of the DDFI procedure for the RR configuration, an additional set of experiments were performed with the same case. The default DDFI configuration does not include water vapor (q_v) adjustment that is part of the ARPS cloud analysis package, which handles the convective clouds within the GSI generalized cloud analysis package.
Yi Yang modified the GSI cloud analysis and the DDFI procedures within WRF to allow for several variations on how the analysis increments, especially those derived from the cloud analysis procedure using reflectivity data, are used. In addition, moisture adjustment is re-introduced when the ARPS cloud analysis package is used for the analysis using reflectivity data. With this option, the same ARPS cloud analysis procedure for calculating the temperature, moisture and cloud hydrometeor increments/tendencies is used. Within the current GSI version, cloud and hydrometeor variables created using reflectivity data are carried directly into the final initialized initial

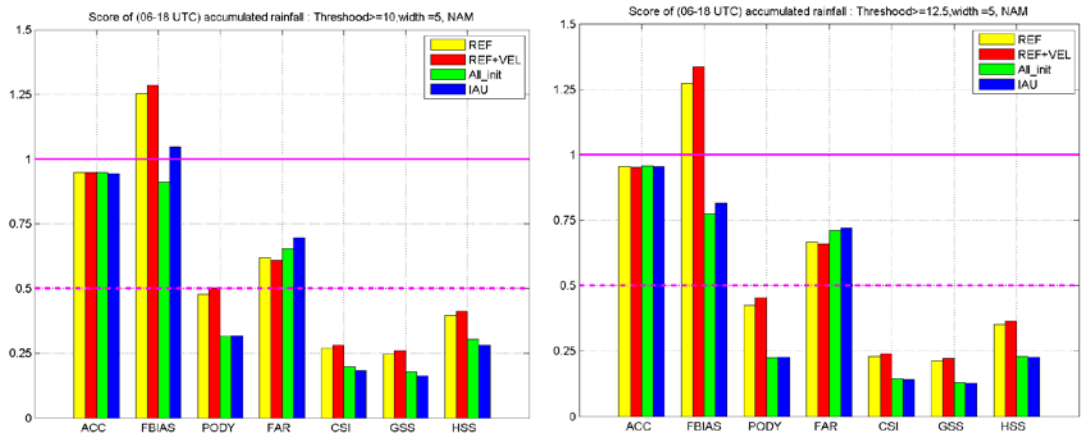
condition without subjecting to the digital filter. With the full set of analysis increments, experiments were performed by Yi Yang where all increments were added at one time at the beginning of the forward step of TDFI, and with all the increments added gradually in the forward step of TDFI (twice DFI) were tested, where only reflectivity (not redial velocity) data were used. The first procedure differs from the typical RR TDFI because of the use of a full set of increments and the application of increments at one instance. The second experiment is essentially the Incremental Analysis Update or IAU procedure available in the ARPS, except for the application of a digital filter.

With the codes modified Yi Yang, Kefeng Zhu redid the above set of experiments for the June 15-16 case, that included a full set of conventional observations, as well as the reflectivity and/or radial velocity data. The Model Evaluation Tools (METv2.0) of DTC was applied to the results on the GSD Wjet machine with the RUC CONUS grid chosen as the verification domain. The experiment with conventional observations and NSSL mosaic reflectivity data (REF), that with additional superobed level 2.5 radial velocity data (REF+VEL) using the standard RR DDFI procedure, that using all the data but adding all the increments at the beginning of the TDFI step (All_init), and that with all the increments including those of q_v, q_c, q_r, q_i, q_s, q_g added gradually IAU during the TDFI step, are performed. The verification scores of forecast accuracy (ACC), frequency bias (FBIAS), probability of detecting Yes (PODY), false-alarm rate (FAR), Critical Success Index (CSI, also known as the Threat Score TS), Gilbert Skill Score (GSS, also known as the Equitable Threat Score ETS), and the Heidke Skill Score (HSS) computed from the 12-h accumulated precipitation for different thresholds for all these experiments are given in Figure 1. Experiment REF+VEL shows slightly higher scores (e.g., GSS) in general than experiment REF, indicating the positive impact of adding radial velocity data. The current RR DDFI procedure, in which wind, temperature, pressure and water vapor are subject to DDFI while the analyzed cloud and hydrometeor fields are directly used at the end of the initialization step (in the final initial condition without subjecting to DDFI) seem to perform better (in terms of GSS for example) that the procedures used in experiments All_init and IAU, especially with the higher thresholds. We do see higher biases also with the DDFI procedure, however. We will apply the verification to shorter forecast intervals next to see if they same conclusion holds for different forecast intervals. Additional experiments will be performed and evaluated in which the GSI analysis will be performed before the cloud analysis. Similar comparisons will be made for the 3 km HRRR resolution.

In general, the radial velocity and reflectivity data assimilation procedures have been tested for several cases at 13 RR and 3 km HRRR resolutions. Positive impacts are found assimilating both types of data using the combined GSI/cloud analysis/DDFI procedure. While further refinements are still needed, the current package is ready for quasi-operational testing.



(a) Threshold=1.25 mm (b) Threshold=2.5 mm



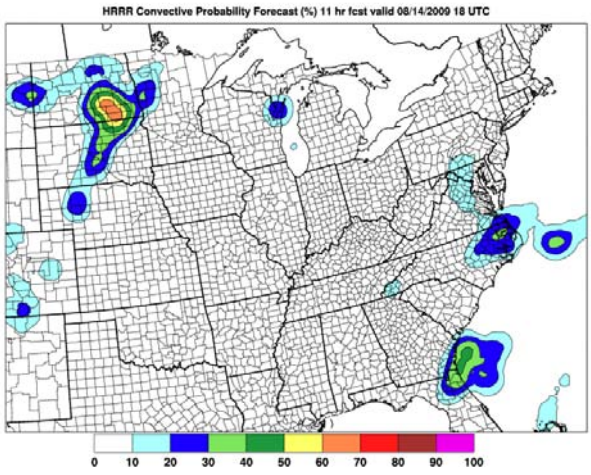
(c) Threshold=10 mm (d) Threshold=12.5 mm

Fig.1. The ACC, FBIAS, PODY, FAR, CSI, GSS and HSS scores computed from the 12-h accumulated precipitation valid at 1800 UTC, 16 June 2009 for four experiments testing different procedures with neighborhood width of 5 grid intervals (65km) at a thresholds of (a) 1.25 mm, (b) 2.5 mm, (c) 10 mm and (d) 12.5 mm.

Task 09.5.20 **Develop ensemble-based probabilistic products for aviation users.**

GSD

Many refinements were made in July to the HRRR Convective Probability Forecasts (HCPF - http://ruc.noaa.gov/hcpf/hcpf.cgi), resulting in much higher reliability compared to observations. A report on the HCPF was made to the WSN09 Nowcasting Symposium (see papers under 5.1) The HPCF system continues to run in real-time with web-products and verification. Doug Koch has nearly completed a study to document the improvement from the time-lagged ensembling (over just the use of a spatial filter on the most recent forecast) for a month-long trial (Aug. 2009).



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)
- NCEP

A presentation package on the evaluation results for the SREF system upgrade was compiled for an implementation approval briefing to NCEP director Louis Uccellini. The package was approved on 9 September and the implementation is scheduled for early November. Both SPC and especially AWC are keen to get the hourly output that begins with this upgrade. Since February, SPC has been using the EMC parallel SREF on P6 to accumulate enough cases to calibrate a new convection/thunder probability, which is now being used at AWC as part of the guidance shared among the generators of the CCFP. (Du)

Geoff DiMego, Bill Lapenta and Jun Du attended the National Workshop of Mesoscale Probabilistic Prediction at NCAR from Sept. 23-24 where a presentation about the SREF system was given. Planning for the next upgrade, an enhanced and higher-resolution SREF system, is underway. (Du)

09.5.20.3 Develop & deliver a new fog algorithm used in SREF product for aviation. (30 Apr 09)

The manuscript "Fog prediction from a multi-model mesoscale ensemble prediction system" was substantially revised according to the reviewers' suggestions, and accepted by Weather and Forecasting for publication. Verification shows that with various approaches including a new fog-detection scheme, an ensemble technique, multi-model approach and an increase in ensemble size, the improvement of fog-forecasting accuracy at 12-36hr forecast length improved steadily and dramatically with the addition of each approach. Accuracy improved from basically no-skill-at-all (ETS=0.063) to a skill level equivalent to that of warm-season precipitation forecasts (ETS=0.334). Since this fog diagnostic scheme can be easily included in an NWP model post processor, fog forecasts can now be conveniently and centrally produced from an operational NWP model. The practical application of this study is clear, especially to the aviation community and navy operations. (Du, Zhou)

Deliverables

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

CURRENT EFFORTS: VSREF development has led to routine running of an experimental VSREF which is now updated hourly. Results for evaluation purposes can be seen at **(http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/VSREF/web_site/html/vsref.html).** A new fog algorithm is included. The probabilistic verification of SREF composite reflectivity and echo-tops using Shun Liu's implementation of NSSL's 88D national mosaics has started. (Zhou)

PLANNED EFFORTS: Jun Du, Binbin Zhou and Yali Ma are scheduled to visit AWC from Nov. 16-17 to discuss aviation products. Since some aviation-related variables such as CAT, Flight Restriction and Icing are binary in nature (yes/no), there is no ensemble mean forecast for them. AWC wants to see ensemble-mean like products for these variables, so one discussion topic is how this can be done (for example, if a dominant-type of forecast will work). 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)

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: Complete.