MDE Product Development Team
January - March 2010 – 2nd Quarter Report - FY 2010
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(Compiled and edited by S. Benjamin and B. Johnson)

Executive Summary

Task 10.5.1: Infrastructure support related to operational running of the RUC and NAM operational modeling systems.

- RUC upgrade at NCEP implemented on Tues 2 March 2010
  - Included addition of Canadian aircraft, improvement to snow cover use of NESDIS data, fix to sigma level thickness in vertical coordinate to solve 21 Jan 2010 RUC crashes.
- Discovered on 12 April that some of the corrected executables were not moved the right place on 2 March, causing poorer lower Tropospheric RUC forecasts since then. NCEP decided to schedule the fix to this error on Tuesday 20 April.

Task 10.5.4 Develop, test, and implement Rapid Refresh configuration of the WRF modeling system.

- RR implementations at NCEP making very good progress - code/scripts have now been run in 6h cycle at NCEP. Next update: new version of GSI with RR cloud-analysis changes along with WRFv3.2.
- Rapid Refresh continues to provide results generally better those from RUC (temperature and wind aloft and at surface).

Task 10.5.5: Develop, test, and implement 3DVARs for RR and NAM

- ESRL RR cycle ported to faster nJET system, requiring some modification to GSI compiling
- RR GSI – updating underway to latest NCEP version (Q1FY10 version)
  - commits to NCEP repository from RR are now being made in April

Task 10.5.17: Infrastructure support for NAM, future RR, future HRRR, support for community WRF model

- WRFv3.2 released 2 April 2010. Contributions from NCAR to WRF model, especially on WRF physics, and from GSD on DFI and land-surface model. WRFv3.2 now being tested in HRRR and RR applications.

Task 10.5.15: Develop methods for improved cloud/hydrometeor analysis in RR

- Careful inter-comparison of RR and RUC cloud analysis conducted to allow further improvement to GSI cloud/hydrometeor assimilation code.
- Ceiling forecast skill from RR now generally exceeding that from RUC
- Testing of METAR-cloud-based RH observations in variational humidity analysis in development RUC.

Task 10.5.24/19: Development/testing of HRRR

- CONUS HRRR reliability further improves with interaction between scientists and computer management team at NCEP.
- Improvements to RUC-based initial conditions.

Summer 2009 retrospective experiments underway to evaluate radar assimilation impacts within RUC and HRRR on HRRR forecasts. Continued good performance from HRRR in winter season fields.

Task 10.5.1 Infrastructure Support Related to Operational running of the non-WRF Rapid Update Cycle System in NCEP Operations

ESRL/GSD

Upcoming RUC change package at NCEP – implemented 2 March 2010.

Preparation for upcoming RUC change package at NCEP, including extension to 18h, GSD assisting EMC (Geoff Manikin) where current parallel version was run from summer 2009 through implementation.

ESRL and NCEP discovered on 12 April that some of the corrected executables were not moved the right place on 2 March, causing poorer lower Tropospheric RUC forecasts since then. NCEP decided to schedule the fix to this error on Tuesday 20 April.

- ESRL/GSD initially discovered that there must be some problem by comparing verification results between 2 versions of the RUC, the operational one at NCEP, and the "backup" RUC run at ESRL. The skill margin between the operational and backup RUC was sufficiently large to prompt ESRL to ask NCEP to re-check details on the final implementation. NCEP then discovered that some of the modified RUC executables were not properly installed to replace previous versions on 2 March. The result was that the RUC boundary condition code was using a different vertical coordinate from the RUC analysis and forecast model.
- A single RUC model crash occurred during this period (on 30 March) that was likely related to this mis-installation, but degraded forecasts throughout the period (2 March – 20 April) have occurred in the lower troposphere for wind, temperature, and relative humidity.

Back to the positive side, changes in the implementation on 2 March, which will be "completed" on 20 April when the installation error is correct, included:

- Extension from 12h/9h duration to 18h at all forecast times.
- Correction to cloud analysis code for warm clouds.
- Corrections to snow cover treatment (see next item)
- Decrease in sigma coordinate thickness – more robust for extreme frontal zone case of 21 Jan 2010.
    - Operational RUC crash on 21 January 2010. Diagnosed by GSD to be related to an extreme frontal zone off the West Coast and behavior of the RUC vertical coordinate in this situation. The initial fix was simply to reduce the RUC model time step (implemented at 18z on 21 Jan), and the next day, a better fix was developed allowing the original longer time step, a simple modification in the coordinate (reduction in sigma layer thicknesses). This code change will be implemented to the NCEP RUC as part of the overall change package (next paragraph) now scheduled for 2 March 2010. This better fix via code change was implemented on 22 Jan to the GSD RUCs (backup (initializes HRRR) and development versions).

Snow cover investigation and changes to operational code:

- Background: An important change was made to the RUC on 31 March 2009 to begin using NESDIS snow cover data to trim areal coverage from the RUC 1h forecast under certain conditions (2m temps > 2 deg C, no current precipitation in RUC1h forecast).
- Two discoveries were made, both resulting in deficiencies in evolution of snow cover in RUC and both necessitating code changes to be implemented as part of the upcoming change package:
    - Change snow cover update time to 23z (after new NESDIS IMSsnow data becomes available) instead of the previous setting for 19z (meaning, that snow cover clearing was 20h later than it needed to be).
    - Snow clearing code needed to be matched from land-points in IMSsnow data to nearest land-points in RUC.

NCEP

Subtasks

10.5.1.1 Maintain hourly RUC runs and provide grids of SAV and AHP guidance products. (30 Sept 10)

The operational RUC experienced a series of crashes on 21 January, associated with an intense Pacific front. An emergency fix was made to the model that afternoon to reduce the model time step from 20 to 15 seconds, with the thought that CFL instability was the cause of the crashes; this shorter time step delayed the delivery of RUC products by a few [3-4] minutes but was deemed necessary to get the model running again. It was later determined that the true cause of the crashes was the method in which the RUC vertical coordinate is specified. The minimum layer thickness was set to 15 mb and it was possible to get significant discontinuities at adjacent points where different methods to define the layers are used; tests revealed that setting the minimum thickness to 10 mb prevented all crashes that occurred with that event. The RUC began failing intermittently on 30 March and it does appear to be a CFL violation this time – more to follow next month. (Manikin)

10.5.1.2 Provide vendors with gridded model data via Family of Services (FOS), and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (30 Sept 10)

NCEP maintained real-time availability of SAV and AHP 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). (DiMego)

10.5.1.3 Provide full grids from RUC runs on NCEP and NWS/OPS servers. (30 Sept 10)

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/.** (DiMego)

10.5.1.4 Maintain access to model verification data. (30 Sept 10)

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** . NCEP statistics can also be viewed/accessed via the ESRL/GSD site **http://www-ad.fsl.noaa.gov/users/loughe/projects/NCEP_verif/** (DiMego)

Deliverables

10.5.1E1 (30 September 2010) (Keyser, Liu)
Perform ingest, quality control and preparation of both existing and new observations in support of the operational RUC runs.

CURRENT EFFORTS: NCEP/NCO is investigating radiosonde sites that report an invalid instrument type. NESDIS hasn't yet responded to problems with the GOES 1x1 field-of-view cloud data. Changes are being made to speed up the dump processing by the superior but slower NRL aircraft QC code before it can be implemented at NCEP next quarter. An updated version of the NCEP BUFR library is being tested for FY2010 implementation. Efforts are underway to bring in new SSM/IS product data from the DMSP F-16, F-17 and F-18, satellites as a replacement to the discontinued SSM/I products. The Florida and Georgia DOT and Aberdeen PG mesonet providers remained down. The Anything Weather mesonet provider was down over the last half of March. The Colorado and Minnesota mesonet providers (down last quarter) returned in January. A sudden, large variability in the RUC dump run times occurred on 21 January. Random dumps began taking up to 5 minutes longer to run because of machine contention between the production and an NCO RUC parallel test, so the parallel start time was slightly changed on 26 February. Most of the 24 February 1500 UTC mesonet data contained incorrect latitude, longitude and elevation values after the MADIS system was returned to service after a scheduled outage. Some of these bad data made it into the RUC and NAM analyses, but no degradation in quality was noted (automated QC rejected most of the obs). (Keyser)

The 2009 radar processing update bundle was sent to NCO for implementation. This update includes improving the radar data QC package, dumping VAD winds from the QC package and converting 3D mosaic products to GRIB format. An update to include the PBL estimation algorithm in this version of QC package was also requested. Efforts were made to test the PBL estimation algorithm and dump estimated the PBL values in BUFR format. The final tests before implementation were then begun. The fix files were updated to process radar data from 4 new stations in Hawaii. An RFC was submitted and this change was tested for implementation. A bug was found in the Level-II raw data where wrong radar station location information is delivered by LDM system. This bug applies to all sites sending out legacy radar data. The bug was reported Radar Operations Center (ROC) and the ROC developed a fix. NCO requested that the 2009 radar bundle (with its multiple executables) be separated into several packages - one package for each executable. (Liu, Keyser)

PLANNED EFFORTS: See also PLANNED EFFORTS listed under Task 10.5.17.E1 below for aircraft quality control issues. Implement new bufrlib, radar processing upgrade bundle and NRL quality control package. 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 schedule backlog has developed for implementations on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: NCO, NSSL.

UPDATES TO SCHEDULE: None.

10.5.1E2 (30 September 2010) (Manikin, ESRL)
Perform configuration management for RUC, including thorough documentation, and respond promptly to any code malfunctions or performance issues.

CURRENT EFFORTS: There was a failed model cycle on 30 March that was caused by a violation of CFL instability criterion. Since only one cycle failed, no change was made to the model time step this time. (Manikin and ESRL)

PLANNED EFFORTS: Work with NCEP Central Operations to set up a contingency plan to handle random RUC crashed in case the violation of CFL instability criterion arises again. (Manikin)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A schedule backlog has developed for implementations on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: NCO & ESRL.

UPDATES TO SCHEDULE: None.

10.5.1E3 (30 September 2010) (Manikin, ESRL)
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: All RUC cycles and their accompanying output were extended to 18 hours, beginning with the 1200 UTC cycle on 2 March. The change package also included code to assimilate Canadian aircraft observations and a correction to a problem with virtual potential temperatures not being adjusted in response to changes in mixing ratio associated with cloud building. There was also a modification to the timing of the model snow clearing. It had been performed each day at 1900 GMT, but the snow data file becomes available around 2300 UTC, so it makes sense to clear snow during the 23z cycle. A second clearing is also now performed at 18z the next day to catch eastern points which might have temperatures too cold at 23z for the model to allow the removal. Finally, the reduction of the minimum layer thickness, which allowed the time step to be set back to 20 seconds (it had been kept at 15 since the January crashes) was included in this implementation. A second implementation on 9 March involved an update to the station list for the model bufr data. Requests from users were gathered, and approximately 80 new stations were added with 15 deleted. The identifiers and latitude and longitude values for others were also updated. (Manikin and NCO/PMB)

PLANNED EFFORTS: Continue monitoring.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO & NWS WFOs.

UPDATES TO SCHEDULE: None.

Task 10.5.17 Infrastructure support for operational running of Rapid Refresh, North American Mesoscale, and HiResWindow (and future HRRR) at NCEP, including support for community WRF model

ESRL/GSD
Excellent progress in Rapid Refresh development during the Jan-Mar quarter toward upcoming implementation at NCEP. More information under Task 5.4 report.

NCEP
Since many obs-processing activities listed under Task 10.5.1 and 10.5.4 also pertain to the NAM, they are not duplicated here. For the NAM specifically, Dennis Keyser reports that some Alaskan radiosonde sites still need to move up their launch time so the NAM-GSI can use their data. The GOES-12 sounder has increased noise in recent months and an episodic filter wheel problem has developed. These problems may reduce the quantity and quality of GOES-12 radiances. GOES-13 sounding and wind test files are being provided to NCEP as this platform moves eastward before replacing GOES-12 in mid-April. MODIS winds were not available for 30 hours

on 2-3 February due to firewall issues upstream of NESDIS. JMA winds were not available for 10 hours on 3-4 February for reasons unknown. EUMETSAT winds were not available for 11 hours on 5-6 February during severe weather at some ground reporting stations. The following data types are monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), Mesonet mass data, and MDCRS moisture data. Monitoring of NOAA-19 1b radiances will soon start. Reduced Level II 88D radar data dump counts on the IBM P6 (vs. the P5) are being investigated. NAM/NDAS and RTMA PrepBUFR files are being generated in parallel with 50 km ASCAT and WindSat scatterometer wind data (both non-superobed) and production NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and SBUV-2 data are being created. These changes to obs monitoring are being tested in Eric Rogers' real-time parallel NDAS/NAM. Replacing the current synthetic wind data bogus with the GFS tropical cyclone relocation procedure (for medium to strong tropical cyclones) to update the global first guess fields input to the t-12 hour NDAS is being tested. A legacy restriction (that only surface data with a reported pressure is processed) will be removed to allow many new surface observations (land, marine and Mesonet) to be assimilated in the RTMA and possibly NAM/NDAS. The parallel RTMA for Guam is testing the use of low-level satellite-derived winds (added to parallel RTMA dumps on 25 January).

Yali Mao completed the initial transition of the RUC-based FIP source code from C/C++ to FORTRAN to be eventually added to NCEP's product generation suite.

Subtasks

10.5.17.1 Maintain hourly RR and four/day North American Mesoscale runs and provide aviation guidance grids. (30 Sept 10)

Four-per-day NAM runs have been maintained. Parallel tests of the NEMS/NMMB model in the EMC NAM parallel system continue on the CCS. Two NMMB parallels are now being run, the one a control run and the other an experimental run with model and/or analysis changes for inclusion in the control run. In January the Eulerian passive tracer advection of scalars was turned on in the control run, and the experimental run has concentrated on tests of radiation parameterization changes: 1) halving the absorption coefficients for water and ice to 800 and 500, respectively, and 2) changes to the radiation code to remove bugs that were causing unrealistic vertical profiles of longwave and shortwave heating rates. The changes led to a reduction in the NMMB's forecast cold bias in surface and lower Tropospheric temperatures. All radiation changes were put into the control run on 30 March. (Rogers)

Work has begun on building the infrastructure (pre- and post-processing) to make a high-resolution one-way NMMB nested run inside the North American parent domain on one of the NMMB parallels. Initial tests will be made of a 4 km CONUS nest forecast from 0-60 h inside the 12-km parent run either once or twice per day. (Rogers)

10.5.17.2 Maintain four/day HRW runs and provide aviation guidance grids. (30 Sept 10)

Four-per-day HRW runs have been maintained and none were preempted this quarter for hurricane runs. Digital filtering was added to the NCEP WRF-NMM dynamical core (it was already in place for the WRF-ARW core) for potential use with high frequency data assimilation. The filtered solution demonstrates significantly less noise over the first 3+ hours of the forecast, and appears to have little impact on the forecast at longer forecast ranges. Both of these test results are in line with the literature for digital filtering, and give confidence that it is working properly within the WRF-NMM. Preliminary examination of the impact of digital filtering in the assimilation of radar radial winds has begun. (Pyle/Liu)

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 – East-Central CONUS (00z & 12z), West-Central CONUS (06z) and Alaska (18z), and two small domains - Hawaii (00z & 12z) and Puerto Rico (06z &18z). (Pyle and NCO) NCEP also maintains twice-per-day runs of six WRF-based members (3 running NMM and 3 running ARW) within the Short Range Ensemble Forecast (SREF) system. Aviation guidance prepared from the SREF is available from **http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html** which now includes specific output for Alaska and Hawaii (eastern Pacific). (Du, Zhou)

10.5.17.3 Provide vendors with gridded model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway. (30 Sept 10)

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 grid #218) are also made available to FOS (and NOAAPORT) users. (DiMego & NCO)

10.5.17.4 Provide full grids from RR, NAM, and the HRW on NCEP and NWS/OPS servers. Maintain access to model verification data. (30 Sept 10)

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 output 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/** (DiMego)

10.5.17.5 Maintain access to model verification data. (30 Sept 10)

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** . NCEP statistics can also be viewed/accessed via the ESRL/GSD site **http://www-ad.fsl.noaa.gov/users/loughe/projects/NCEP_verif/** . (DiMego)

10.5.17.6 Provide assistance to Inflight Icing, Turbulence, Convective Weather, Ceiling and Visibility and Oceanic Weather PDTs when their algorithms and product generation systems are ready to transition into NCEP's operational Production suite and/or unified model post-processor.

There were no requests for assistance this quarter. Yali Mao has been asking clarification questions of Gary Cunning who is the NCAR point of contact for her on the FIP – see below.

Deliverables

10.5.17.E1 30 September 2010 (Keyser, Liu)

Perform ingest, quality control and preparation of both existing and new observations in support of the operational RR, NAM & HRW WRF runs.

CURRENT EFFORTS: In addition to the items reported in 10.5.1E1, some Alaskan radiosonde sites still need to move up their launch time so the NAM-GSI can use their data. The GOES-12 sounder has increased noise over the past few months, which may reduce the quantity and quality of the GOES-12 radiances (and retrievals in the RUC). GOES-13 sounding and wind test files are being provided to NCEP as this platform moves eastward before replacing GOES-12 in mid-April. On 12 January, NESDIS lowered the priority of NOAA-18, reducing the timeliness of radiances from this satellite. AIRS IR and AMSU-A radiances were not available from 1-4 January due to New Year's transition problems and then again from 9-27 January due to an instrument anomaly. MODIS winds were not available for 12 hours on 29 January due to a leap second processing problem and again for 30 hours on 2-3 February due to NESDIS firewall issues. GOES-W SFOV products were not available for 5 hours on 23 March and GOES-E SFOV products were not available for 4 hours on 25 March (both outages due to hardware problems). JMA winds were not available for 10 hours on 3-4 February for unknown reasons. EUMETSAT winds were not available for 11 hours on 5-6 February during severe weather at some ground reporting stations. On 9 March the latitude, longitude and elevation for several METAR sites in Alaska were updated based on the latest METAR dictionary. The effect of removing U.S. (including Alaska) synoptic surface data (sites with wrong elevations) from the GFS-GSI is being investigated. Latitude, longitude and elevation will be updated for many Canadian and U.S. METAR sites and many Canadian synoptic sites based on the latest METAR and synoptic dictionaries. The following data types are monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), Mesonet mass data, and MDCRS moisture data. NAM/NDAS and RTMA PrepBUFR files are being generated in parallel with 50 km ASCAT and WindSat scatterometer wind data (both non-superobed) and production NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and SBUV-2 data are being created. These changes to obs monitoring are being tested in Eric Rogers' real-time parallel NDAS/NAM. Use of the GFS tropical cyclone relocation procedure (for medium to strong tropical cyclones) to update the global first guess fields input to the t-12 hour NDAS is also being tested in Eric's parallel as a replacement for the current synthetic wind data bogus. A legacy restriction (that only surface data with a reported pressure is processed) will be removed to allow many new surface observations (land, marine and Mesonet) to be assimilated in the RTMA and possibly NAM/NDAS. The parallel RTMA for Guam is using the expanded set of observations generated for the region around Guam. It is also testing the use of low-level satellite-derived winds (added to parallel RTMA dumps on 25 January). Experimental Rapid Refresh (RR) PrepBUFR files containing 50 km ASCAT, and WindSat data (non-superob) 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, along with early (T+0:26 minute) parallel dumps for 0000 and 1200 UTC (added on 6 January). EMC and GSD have requested 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. Alaska Region is working to provide NCEP with their Level II full resolution data. Level II data from 4 DOD Hawaiian radars is now being sent to NCEP and will be added to our BUFR database in April. (Keyser)

PLANNED EFFORTS: In addition to the items reported in 10.5.1E1, add use of AIRS AMSU-A radiances to the next NAM-GSI update. Add a new aircraft quality control module from NRL once NCO evaluation is finished. Change PrepBUFR processing to add report sub-type information for development of bias corrections based on data sub-types. Develop a "uselist" in order to control what incoming (e.g., GTS) data is allowed into the assimilation. Complete NAM impact tests for 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 (including WVSSII instrument being installed on Southwest aircraft); 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/IS wind speed and total precipitable water products; SSM/IS and TRMM/TMI rain rate; METEOSAT-9 IR and visible satellite winds; NOAA-19 AMSU-A, MHS and HIRS-4 radiances; RARS 1c radiances (to fill in gaps in NESDIS 1b ATOVS radiances); VAD winds from QC'd NEXRAD Level II data; GOES-13 and -14 radiances and winds. 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 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 radar data sources (TDWR, Tail Doppler Radar from hurricane hunter P3 aircraft, Canadian, CASA, possible additional DOD sites). Examine possible use of mixed-satellite (Aqua and Terra) MODIS winds which have better coverage and timeliness than the current single-satellite MODIS winds. (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A schedule backlog has developed for implementations on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: ESRL/GSD & NCEP/NCO & NWS/Alaska Region & NESDIS.

UPDATES TO SCHEDULE: None.

10.5.17.E2 30 September 2010 (Manikin, ESRL/GSD)
Perform configuration management for RR, including thorough documentation, and respond promptly to any code malfunctions or performance issues.

CURRENT EFFORTS: No activity to report.

PLANNED EFFORTS: Once ESRL delivers code, work will begin on constructing a parallel.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A schedule backlog has developed for implementations on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: ESRL/GSD & NCO

UPDATES TO SCHEDULE: None.

10.5.17.E3 30 September 2010 (Manikin & ESRL for RR, Rogers for NAM & Pyle for HRW)
Monitor RR, NAM & HRW performance, respond to any problems detected by ESRL/GSD, NCEP, or any users, diagnose source/cause of the problem, develop solution, test changes and coordinate with NCO on implementation.

CURRENT EFFORTS: NAM and HRW were monitored during the quarter. No operational issues were encountered.

PLANNED EFFORTS: Continue monitoring NAM & HRW.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A schedule backlog has developed for implementations on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: NCO

UPDATES TO SCHEDULE: None.

10.5.17.E4 30 September 2010 NCEP
(Manikin, Mao)
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.

Translation of the most current FIP (Forecast Icing Potential / Severity) from C/C++ to FORTRAN was completed, and work started producing GRIB2 format fields directly and working around the MDV format. (Mao)

PLANNED EFFORTS: Respond to requests as received. Verify the translated FIP output. (Mao)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: Limited access to RUC data while waiting for CCS account to be granted. (Mao)

INTERFACE WITH OTHER ORGANIZATIONS: NCAR, AWC.

UPDATES TO SCHEDULE: None

NCAR/MMM

CURRENT EFFORTS:
NCAR hosted and led a WRF tutorial January 25–February 4, 2010. The tutorial covered model structure, preprocessing, and operation, and practical sessions let participants run model components and make test simulations. Over 60 people from 20 countries attended.

NCAR has begun to plan the 11th WRF Users' Workshop. This will be held at NCAR from June 22–24.

NCAR/MMM lead the preparation of the latest WRF major release, V3.2. This involved leading the WRF Release Committee, code testing and implementation by MMM scientists and software engineers, and preparing new documentation.

In preparation of V3.2, various code changes were made for physics schemes. For the Noah LSM, internal budget terms were corrected. Specifically, in the LSM's computation of a residual term to check the conservation of the soil heat budget, it was found that the residual wasn't zero.

Dudhia with Wei Wang (NCAR/MMM) to resolve problems with the WSM and WDM microphysics schemes' rainfall budgets that were related only to runs with long timesteps (>120s). This was related to the schemes' sub-stepping.

With the RRTMG longwave radiation scheme, Dudhia implemented a fix obtained from Mike Iacono (AER, Inc.). There, a minor bug in the computation was biasing surface fluxes.

In PBL physics, Dudhia added an ability for the MYNN PBL scheme to output PBL heights (obtained from Mariusz Pagowski (NOAA/ESRL)). This change has a minor effect on results, as PBL heights have a small role in the

stability function computation. Dudhia also worked with visitor Song-You Hong (Yonsei Univ., Korea) on improvements to the YSU PBL scheme for V3.2.

Dudhia (NCAR/MMM) completed work on cleaning up the use of pressure information by radiation physics and cumulus physics. The purpose was to improve efficiency by avoiding repeated computations of hydrostatic pressure needed by these schemes. Other fixes for the release included sea-ice updating fixes to reset water properties after ice disappears, a fix for out-of-bounds warnings in the nesting code, and a final clean-up of the BEM (Building Energy Model) urban code.

Dudhia worked with Steven Cavallo (MMM) to improve the handling of top-of-atmosphere radiation in the RRTM longwave scheme. First, it was found that the RRTM's isothermal assumption for above the model top was inaccurate, so a new climatological lapse rate profile was implemented. Second, in datasets that had no upper-level RH, the Ungrib pre-processor's assumed RH was too high for pressures above about 50 hPa. This was fixed.

Lastly, NCAR decided upon the pre-processor handling of missing relative humidity fields. With the new release, Ungrib will leave missing values as zero, and real will test for high values above 100 hPa. Real will also set zero values to a specified low mixing ratio (1.e-6 kg/kg).

PLANNED EFFORTS: The WRF V3.2 release will be made at the beginning of April (FY10Q3). Support of the physics component of the WRF infrastructure and the implementation of modifications will continue. In addition, NCAR will work on the organization and hosting of the 11th WRF Users' Workshop in June.

UPDATES TO SCHEDULE: NONE

Task 10.5.4 Develop, test, implement, and improve the Rapid Refresh.

ESRL/GSD

In general, the RR is performing better than the RUC for most forecast fields, and the RR code has been transferred to NCEP and implemented in a test 6h cycle there. ESRL/GSD (Ming Hu) and NCEP (Geoff Manikin) have run the RR with an NCEP-acceptable script. Finally, the RR is now running in clock time similar to that for the RUC (5 min for analysis, 20 min to get to 12h output time forecast (18h total planned for RR, similar to RUC since 2 Mar 2010). All 3 of these bode very well for successful implementation of the RR at NCEP later in 2010.

Now for some details:
Rapid Refresh primary and dev 1-h cycles continue to run on wJet/hJet at GSD. Performance with the “partial cycling” in the primary RR cycle over the CONUS through the quarter continues continued to be generally superior to or equivalent to the GSD backup RUC over the CONUS. Verification of both RUC and RR precipitable water forecasts against GPS-MET observations shows also a high bias, as does the verification of daytime 2-m dew points over the eastern CONUS. The 2-m dew points are being derived directly from the model predicted water-vapor mixing ratio at the midpoint of the lowest model computational layer (about 8m AGL).

One major step forward early in the quarter was the solution to the problem of spurious strong jets normal to the lateral boundaries developing in the course of the 1-h cycling. (Although this untoward behavior was largely suppressed by the partial cycling, its beginnings could still be seen on some occasions in the hours just before the new partial cycle was introduced.) The solution, implemented by Tanya Smirnova, was to modify the NCAR WRF routine *update_bc* to account for a cycling frequency (hourly) higher than the frequency of availability of new lateral boundary conditions from the GFS (every 3 hours), and to make the external-model tendencies consistent with the analysis increments from the GSI in the lateral-boundary blending zone of the RR. In addition, during the

DFI step, the tendencies from the GFS at the lateral boundaries are replaced by zeroes. This latter procedure has always been done in the RUC DFI with no ill effects. The devRR cycle was cold-started with the modified *update_bc* in late January and has shown no development of the spurious jets with continuous (not partial) cycling. Further, rerunning of the 10-day April 2009 retro period with continuous (not partial) cycling showed no signs of development of the spurious jet. Since 12 February both the primary and dev RR cycles have been running with the modified *update_bc*, partial cycling, and zero tendencies along the lateral boundaries during the DFI. These upgrades, with the zero tendencies during the DFI as a namelist option, were accepted by the NCAR WRF developers and included in the 2 April public release of the new WRF-ARW V3.2 code.

(Next related to both 5.24 and 5.4): Our intention during most of the quarter was to begin initializing the High-Resolution Rapid Refresh (HRRR) from the RR primary cycle running at GSD, instead of the GSD backup RUC. To improve reliability, our plan was to run both the primary RR 1-h cycle and the HRRR on the fastest ESRL computer, nJet. However, we concluded in early April that there are still issues with the functioning of the cloud analysis and radar processing within the Gridpoint Statistical Interpolation (GSI) for the RR. Addressing these, plus testing of other remaining GSI enhancements and possible model configuration changes (particularly the rotated lat-lon grid), will be required before a final set of RR code is given to NCEP for the RR implementation. Thus, using the RR in a fixed configuration to initialize the HRRR for this summer's COSPA experiment would preclude RR implementation at NCEP until well into FY2011 (see further discussion under task 24). For now, we are continuing to run the primary and dev RR 1-h cycles on ESRL's wJet computer.

The official code release of WRF V3.2 was made on 2 April. We are currently in the process of converting to run all RR cycles plus the HRRR with this code. No major problems have been encountered or are anticipated.

Fast run-time for RR on nJet: As expected, the RR runs much faster on nJet (a more recent component of the ESRL super-computer, which includes the dedicated nodes for the HRRR)

- With 64 cores, the GSI completes in about 5 min on nJet, 10min on wJet.
- The 12-h model forecasts using 160 cores run in about 18-19 min on nJet, compared to 44min on wJet.

RR post-processing: Following discussions at NCEP in December, we were granted access to the NCEP repository UniPost code in January. The UniPost code is an upgrade of the WRF PostProcessor (WPP) that we have extensively modified to include RUC post processing algorithms, as reported over the last 1-2 years. replaces the Tanya Smirnova with help from HuiYa Chuang of EMC got the UniPost running on Jet and upgraded to include our earlier WPP changes. Tanya and Curtis Alexander continued to add RUC options to the NCEP WRFpost-processor (WPP) during the quarter. The recently implemented RUC algorithms for precipitation type applied to the RR are giving similar results to the RUC in areas of mixed, freezing and frozen precipitation. Enhancements were made to WPP over the past year or more to run as part of the Unipost at GSD for both the RR and HRRR.

The UniPost also incorporates recently developed NCEP enhancements to post process wrfout files from the ARW when the ARW is run using the rotated lat-lon grid option. These were tested at GSD on output from the cold-start RR, but full implementation of the lat-lon grid awaits GSI changes to accommodate the lat-lon wrfout files as model-background input to the GSI. Generated from WRF using a slightly modified RR domain based on this grid once required library routines are received from NCEP.

Geoff DiMego recommends strongly that in the interest of efficiency we follow the NAM in using the EMC program *prdgen* to generate smoothed 2-d output fields (e.g., sea-level pressure and 3-d fields, such as 500mb height, interpolated to constant pressure levels) instead of generating these directly (but less efficiently) in the UniPost. (Native-grid output and unsmoothed derived quantities such as CAPE would continue to be generated by

UniPost.) We will be working with NCEP to introduce this change in tactics as part of setting up the cycling RR at EMC.

NCEP
Dennis Keyser reports that experimental Rapid Refresh (RR) PrepBUFR files containing 50 km ASCAT and WindSat data (non-superob) 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, along with early (T+0:26 minute) parallel dumps for 0000 and 1200 UTC. EMC and GSD have requested 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. Alaska Region is working to provide NCEP with their Level II full resolution data. Level II data from 4 DOD Hawaiian radars is now being sent to NCEP and will be added to our BUFR database.

Subtasks:

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

NCEP
Nothing to report. (Manikin)

GSD
The partial cycling primary RR cycle continues to show performance that is equivalent to or better than the backup RUC running at GSD for wind and temperature when measured against rawinsondes. For the quarter, RMS vector wind errors at all levels at 3 and 12h from the RR primary 1-h cycle were consistently better than ~~or~~ the backup RUC. We have determined that the upper-level wind forecast skill is dependent on how many cycles have taken place since the last GFS partial cycling, with lower error when partial cycling was invoked most recently (09z, 21z).

During the melt season in March, we saw too-cold 2-m temperatures over snow covered areas experiencing low-level warm advection of air with temperature well above 0C. However, this cold bias was less severe for the RR than in the RUC, apart from the beneficial effect on both RR and RUC of daily snow trimming based on the NESDIS snow-cover product.

10.5.4.2 1 Nov 2009 (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.

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, and precip fields) for each of 3 grids (full RR, Alaska 249, CONUS) Both grib1 and grib2 formats have been available and continued to be available through February. However, as of 3 March, the grib1 format files were discontinued and only grib2 files are now available. Per a NWS Aviation Testbed meeting in November in Kansas City, the RR will produce two primary output files:
1. native level 3-d files plus all 2-d fields (land-surface, precip, others), including 2-d diagnostic fields
2. pressure level 3-d files plus all of the same 2-d fields

It was agreed (NWS, NCEP, AWRP PDTs) that these RR files will meet all known requirements.

As a result of discussions with Bob Sharman of the Turbulence PDT, we have added a few additional 2-d fields desired to streamline the generation of their G2G forecasts and have clarified procedures used for calculation of certain quantities by the WRF Postprocessor (WPP). Coordination between GSD and AWC to facilitate transfer of experimental RR grids to AWC is nearly complete and AWC has begun examining RR grids.

10.5.4.3 30 July 2010 (GSD, NCEP, NCAR)
Updated report on status of tactical planning for making RR-WRF ARW model code for 2013 in compliance with Earth System Modeling Framework (ESMF) in agreement with the Sept 2007 Rapid Refresh MOU between NCEP and GSD. Work in this area will commence in FY11.
ESRL/GSD continues to prepare its new global FIM model (**http://fim.noaa.gov)** using ESMF and the NCEP configuration for ESMF, NEMS, with initial testing at NCEP planned by August. This has provided valuable experience for ESRL software engineers in use of NEMS and even helping to design its configuration at NCEP. The FIM experience for NEMS prepares ESRL well for the upcoming adaptation of the WRF-ARW dynamic core toward NEMS in the 2013 version of the Rapid Refresh.

10.5.4.4 31 Mar 2010 (GSD, NCEP)
Complete pre-RFC 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.
An NCEP Charter document for the Rapid Refresh implementation was completed on 10 Dec 2009 and submitted to NCO via Geoff DiMego. An update to the RR Charter will be written within the next few weeks.

Deliverables:

10.5.4.E1 20 Dec 2009 (GSD)
Report on Rapid Refresh testing at annual NCEP Production Suite Review meeting.
Stan Benjamin, Steve Weygandt and Ming Hu attended the NCEP Production Suite Review 8-10 December and gave an update on RR progress. This presentation can be found at
http://www.emc.ncep.noaa.gov/annualreviews/2009Review/presentations/Benjamin-Weygandt-RUC_C.ppt

10.5.4E3 (30 September 2010) NCEP
(Manikin)
Pending EMC, and NCEP Center initial recommendations, Request for Change (RFC) forms are filed to submit Rapid Refresh software to NCO.

CURRENT EFFORTS: Recommendations are pending since system testing isn't complete yet.

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A schedule backlog has developed for implementations on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: ESRL.

UPDATES TO SCHEDULE: None.

Task 10.5.5 Develop, test, and implement improvements to the operational data assimilation supporting Rapid Refresh and North American Mesoscale runs.

ESRL/GSD

Ming Hu and Geoff Manikin continue to make very good progress on building a real-time cycle at NCEP. Ming has made script and filename modifications to conform with NCEP standards and transferred code ands scripts to Geoff Manikin. Geoff has both the 6-hourly lateral boundary condition cycle and the hourly cycle running. Two previous file access issues have been resolved: accessing a real-time feed of the pressure-level GFS files for use as boundary conditions and accessing the PrepBUFR observations. Also, Stan Benjamin has been in communication with Dennis Keyser, who is now producing hourly level two radial velocity files and lightning files. Steve Weygandt has been in communication with Georg Trojan concerning Alaska lightning data (currently being transferred from AK NWS to GSD in ASCII format). GSD IT will convert these data to BUFR format (using code from Ming Hu) and send these data to NCEP via the TOC. One other outstanding issue for running the RR cycle at NCEP is to convert the GSI I/O (for the ARW option) from netCDF to binary.

Ming Hu continues his work with NCEP's John Derber and Mike Lueken to get GSD cloud/hydrometeor analysis changes included in the NCEP SVN repository version of GSI. In March 2010, Ming has outlined a series of steps to get the changes introduces, including 1) adding background cloud/hydrometeor field I/O, 2) adding cloud observations input, 3) adding radar reflectivity / lighting observation input, 4) adding cloud analysis driver and library. Based on Ming's input, John created a series of GSI "track" tickets, and work has progressed and getting the changes added. Based on feedback from John and Mike, Ming has modified portion of the GSD code additions, including changes in obs_para.F pertaining to methods for searching through the surface observations. Iterative work between GSD and NCEP EMC is ongoing in this area.

Additional work by Stan and Ming has focused on resolving some remaining inconsistencies in the Rapid Refresh cloud analysis relative to the RUC cloud model and to propagate recent changes to the RUC cloud analysis over to RR cloud analysis within GSI. A key change among these is the removal of moistening in regions of radar reflectivity data, which has reduced a persistent high relative humidity bias in the RUC. The design structure of the cloud analysis in which the input of the needed cloud background fields and observations is integrated and fully consistent with the other I/O, but the cloud analysis is a library with a single driver routine makes adding these modifications to the NCEP SVN version easier. It will also facilitate replacement of the current non-variational cloud analysis with a variational cloud analysis.

A detailed evaluation of Rapid Refresh vs. RUC skill scores has been completed and a link to it is included under item 10.5.5.E2. As before, results continue to show good RR performance in all categories: upper-air verification, surface verification, precipitation verification and ceiling verification.

NCEP

Manuel Pondeca is adding the assimilation of ocean surface ASCAT and WindSat winds as well as low-level satellite winds to the RTMA. He is also finalizing a journal article on the RTMA. A 2.5km CONUS RTMA parallel is being run and downloaded for routine evaluation by NWS' Eastern & Western regions.

Dave Parrish reports that the hybrid ensemble option in GSI now has a working dual resolution capability for use with the GFS model in combination with GEFS perturbations. The dual resolution was tested with T382L64 GFS and T190L64 GEFS using a test case provided by Daryl Kleist. Single observation tests give very similar results between the uniform T382 quadratic grid resolution and T382 quadratic/T190 linear grid. The cost of running the hybrid ensemble GSI without dual resolution is too high for operational use at T382 and higher resolutions, but dual resolution with the hybrid ensemble results in only a modest increase in cost. The additional code required for dual resolution capability will also make it easier to read ensemble perturbations, global and/or regional for use

with hybrid ensemble in regional GSI. The first use of this new code is to read in T382 global ozone directly into GSI for use with the NEMS NMMB model.

Wan-Shu Wu worked on evaluating a new type of virtual temperature observation (RASS). The statistics of the data fit to the first guess were collected and the adaptive tuning method used to evaluate the amplitude of the observational error, which is inversely proportional to the quality of the data. This type of data, with a very large RMS fit to the first guess, showed up routinely in the rejected and monitored statistics. The rejected data represents data rejected by the gross check inside the GSI, while the monitored statistics include contributions from both the monitored data specified by the CONVINFO file and the rejected data from all the other QC steps outside the GSI. The first guess fits for the rest of the RASS data that passed all the QC steps showed that RASS still has a large bias and RMS fit to the background. The biases are also very different from those of the radiosondes. However, with tighter gross check bounds that exclude about 20% of the stations, the adaptive tuning results show that the rest of the data are of sufficiently good quality.

Subtasks

10.5.5.1 Refine the radial velocity analysis component of GSI and determine the optimal decorrelation scales for different analysis passes. (30 Nov 09)

The forecast of 7 December, 2009 precipitation case was rerun with and without assimilating radar radial wind. After examining the two results, it appears that short-term forecast in storm scale was improved with radial wind assimilation. However, the improvement on forecast score is slight. The radar radial wind will be assimilated three times with hourly intervals. (Liu) Completed.

10.5.5.2 Report on testing of 2DVAR GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 2.5-km resolution. (31 May 10)

A 2.5km CONUS RTMA parallel is being run (with downscaling of RUC 1h forecasts to 2.5km) and is being downloaded for routine evaluation by NWS' Eastern and Western regions. The system is to eventually replace the current 5km operational CONUS RTMA. A 2.5km RTMA was also developed for the Guam NDFD grid, and RFCs were submitted to NCO for the system's implementation. Furthermore, the capability to assimilate ocean surface ASCAT and WindSat winds as well as low-level satellite winds was added to the RTMA. A paper is being prepared for publication. (Pondeca, Manikin, Chuang)

10.5.5.3 Establish hourly cycled NDAS-like assimilation system on NOAA R&D computer at NCEP (machine called "vapor") using GSI and NMMB within NEMS to be adapted to a NEMS- and ARW-based RR by ESRL/GSD. (30 Jun 10)

The hourly cycled assimilation system has been built and is functional. The digital filter option still requires some work and the lack of a strong constraint in the GSI remain as big stumbling blocks for a routine running of this NAM Rapid Refresh. (Rogers, Wu) Completed.

10.5.5.4 If authorized by NCEP Director, implement initialization of HiResWindow runs using CAPS/Shun Liu improved techniques for radial velocity analysis in GSI together with Diabatic Digital Filter use of 88D reflectivity Mosaic. (31 Jul 10)

Digital filtering was added to the NCEP WRF-NMM dynamical core (it was already in place for the WRF-ARW core) for potential use with high frequency data assimilation. Preliminary examination of the impact of digital

filtering in the assimilation of radar winds has begun. The implementation of upgrades to the HiResWindow runs in NCEP Production will likely be delayed due to a backup in the schedule within NCO. (Pyle/Liu)

10.5.5.5 Based on case-study testing and refinement of the research quality code, deliver result in an 'experimental' code for an upgrade package (e.g. strong constraint, improved satellite channel bias correction, improved use of WSR-88D radial wind and/or satellite radiances and/or retuned covariances to the GSI for FY2011 change package to the NAM. (31 Jul 10)

A new type of virtual temperature observations (RASS) was evaluated in preparation for being used in NAM/NDAS. The statistics of the data fit to the first guess were collected and the adaptive tuning method used to evaluate the amplitude of the observational error, which is inversely proportional to the quality of the data. The data with very large RMS fit to the first guess showed up routinely in the rejected and monitored statistics. The statistics also showed that the RASS data that passed all the QC steps still have a significant bias and large RMS to the forecast fields. The biases are also very different from those of the radiosondes. However, with tighter gross check bounds that exclude about 20% of the stations, the adaptive tuning results show that the rest of the data are of sufficiently good quality. (Wu)

Deliverables:

10.5.5.E3 31 Dec 2009 (GSD, CAPS)
Further refinement to the radial velocity analysis component of GSI for Rapid Refresh configuration.
With some assistance from GSD, Yi Yang at CAPS conducted a controlled retrospective test for a Kansas MCS case from 15-16 June 2009. Comparisons were made between Rapid Refreshes run with no radar assimilation (the control), reflectivity assimilation, single-pass radial velocity assimilation, a 2-pass radial velocity assimilation (using a shorter error correlation length scale) and both radial velocity assimilation option in conjunction with the reflectivity assimilation. 3-h, 6-h, and 12-h precipitation verification score comparison indicate that as expected the biggest improvement over the control comes from the addition of the reflectivity assimilation. Consistent with similar tests conducted at NCEP, addition of the radial velocity data (with either 1 or 2 passes) yielded little additional improvement.

Discussion with Shun Liu and Dennis Keyser on the radial velocity data access issue has yielded progress. The very large size of the existing level II files (that made real-time transfer to GSD and use within the RR difficult) is because the files contain 3-h of radial velocity data. Work is underway at NCEP to produce smaller level II files (containing data from a much narrower time window). Transfer and use of these files will alleviate the data latency issue with the level 2.5 files that precluded real-time use of them within the GSI for RR.

10.5.5.E2 28 Feb 2010 (GSD, NCEP)
Complete report on Rapid Refresh performance, including that from the GSI component of the RR, in comparison with the operational RUC.
A detailed comparison of RR and RUC has been completed including upper-level, surface, precipitation and ceiling verification. Results, which show good RR performance in most areas are summarized in a report available at: **http://ruc.noaa.gov/pdf/RR_verif_Feb10.pdf**

10.5.5.E2 28 Feb 2010 (Manikin)
Pending EMC, and NCEP Center initial recommendations, Request for Change forms (RFC's) are filed to submit GSI code as part of Rapid Refresh software to NCO.

CURRENT EFFORTS: Work is underway on constructing a parallel RR by Geoff Manikin (EMC) and Ming Hu (GSD).

PLANNED EFFORTS: Further modifications to code from GSD (e.g., new GSI version, revised cloud assimilation code, WRFv3.2, rotated lat-lon grid) will be tested first at GSD and then transferred to NCEP/EMC.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A schedule backlog has developed for implementations by NCEP/NCO on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: NCO

UPDATES TO SCHEDULE: None.

10.5.5.E3 1 May 2010 (GSD, NCEP)
Pending EMC, and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit GSI code as part of Rapid Refresh software to NCO.
Task has been previously completed. Kefeng Zhu (CAPS/OU) is conducting additional his radial velocity experiments for the 16-17 June 2009 MCS case geared toward the next version of GSI for RR. One focus has been on the use of shorter correlation length scales. The experiments have been conducted using a Rapid Refresh retrospective setup running on the wjet supercomputer at ESRL. Additional details under subtask 10.5.5.1

10.5.5.E4 30 Sep 2010 NCEP
(Wu, Rogers)
Subject to NCEP Director approval implement NEMS/NMMB version of GSI (e.g. strong constraint, revised bkgs+obs errors) in NAM/NDAS.

CURRENT EFFORTS: Upgraded the GSI code to a latest SVN trunk version. The new features of the GSI include importing ozone field in NAM/NDAS from the global system for use in radiance assimilation via the CRTM, updating the 10m winds, 2m T, and 2m q fields in the NEMS/NMMB. Test the impact of the latest version and turn on GPS RO (Radio-Occultation) data on the short term forecasts. Small positive impact on temperature and humidity fields was observed from the GPS RO data. (Wu)

PLANNED EFFORTS: Work on ozone analysis in NAM/NDAS and fixing the negative ozone mixing ratio imported from the global system. (Wu) Test sensitivity of results to differences between the analysis grid and the model grid and between the regional models (WRF/NAM and NEMS-NMMB) and the generic tangent linear model using global dual resolution GSI code which has been developed for more efficient hybrid ensemble and 4dvar applications. (Parrish)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A schedule backlog has developed for implementations on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: GSD

UPDATES TO SCHEDULE: Due to issues with slow progress on strong constraint and NMMB physics tuning and due to implementation schedule backlog, we must request this milestone be moved into FY2011.

Task 10.5.8 Improve physical processes in the WRF (RR and HRRR) and NAM models, especially including those that affect aircraft icing.

Subtasks:

10.5.8.1 30 Nov 2009 (GSD)

Complete systematic GSD evaluation of physics performance in GSD 1-hour RR cycles for initial RR implementation.

The overall performance of the RR WRF physics configuration was completed as part of the November (GSD Tech Review) and December (NCEP model review) meetings. The behavior of the physics (a critical component) appears to be very good, with the RR model producing at least equal results to the RUC in key areas (upper-level wind/temp – better, surface wind/temp/Td – about equal overall, precipitation – better for CSI, perhaps too high for bias, ceiling – better for MVFR and IFR conditions). Additional evaluations will be conducted up to the transfer of RR code to NCEP/NCO, but these results including the physics now appear adequate.

WRFv3.2 official code release was made by NCAR on 2 April 2010. WRFv3.2 includes improvements in efficiency in generation of lookup tables for the Thompson microphysics (from NCAR) and prediction of temperature in sea ice and accumulation and ablation of snow on sea ice in the RUC land-surface model (from GSD). An RR retrospective test of the MYNN vertical mixing (boundary-layer) scheme with enhancements to the mixing-length formulation is still planned. We are looking particularly for evidence of beneficial impacts on prediction of low level wind and temperature, and amplitude of the diurnal cycle of temperature, as compared to the MYJ currently used in all the GSD RR cycles.

Joe Olson performed a couple of RR cold-start experiments with and without the WRF gravity-wave drag activated. This mainly affected amplitude of mountain waves over the western US. He found that the effect on surface forecasts was small, with a very slight decrease overall in 10-m wind speeds, most obvious in daytime hours and downstream of mountain ranges in the West. There was also some impact on predicted wave-induced middle and high cloudiness downstream of mountain ranges. It remains to be determined whether these differences are of any significance to overall RR performance.

10.5.8.2 30 July 2010 (NCAR/RAL)

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.

10.5.8.3 1 April 2010 (GSD)

Test and evaluate upgrades of RUCLSM to handle sea ice and snow cover on sea ice under wintertime conditions for FY11 Rapid Refresh upgrade.

The new version of the RUCLSM with the explicit prediction of sea ice temperature and its effects on sea ice albedo, as well as accumulation and ablation of snow on the sea ice, continues to run in the RR at GSD. Performance remains satisfactory. These enhancements were included in of the WRF v3.2 release on 2 April 2010. Tanya Smirnova presented a poster on the RUC LSM including these sea-ice enhancements at the ESRL Physical Sciences Review in early March.

10.5.8.4 1 Aug 2010 (GSD)

Continue exploring possibilities for enhancing treatment of sea ice and tundra (including albedo changes and spring-time ponding) in Rapid Refresh domain toward a FY11 Rapid Refresh upgrade.

Discussions have commenced with Ola Persson and other Arctic experts in ESRL's Physical Sciences Division. They point out that the major uncertainty in the surface energy budget over snow in the Arctic is the emissivity of low clouds. Ice clouds have much lower emissivity than water clouds. Ice clouds have much lower emissivity in the infrared wavelengths than water clouds. They have collected high-quality data that may be of use to us in diagnosing model issues in the far north. To incorporate these effects will require enhancements to the existing

coupling between microphysics and radiation in the RR, and will not be incorporated in the initial RR implementation.

10.5.8.5 30 July 2010 (NCAR-RAL)
Evaluate the new aerosol based ice initiation scheme that was implemented into WRF during the previous year using available case studies, including ICE-L and IMPROVE II.

10.5.8.6 30 Aug 2010 (NCAR-RAL)
Develop a scheme to explicitly predict the number of cloud droplets based on an assumed aerosol/CCN spectrum. This includes testing various droplet activation schemes in the recent literature based on updraft, general turbulence characteristics, super saturation, and aerosol properties. These changes will enable improved prediction of the size distribution of water droplets, including when freezing drizzle will occur.

10.5.8.10 30 Sept 2010 (GSD, NCAR)
Begin testing at GSD of latest version of microphysics for Rapid Refresh upgrade in FY2011.

Deliverables:

10.5.8.E2 1 May 2010 (GSD)
Pending EMC, and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit upgraded WRF model physics code as part of Rapid Refresh software to NCO.

10.5.8.E3 30 July 2010 (NCAR-RAL)
Provide an improved microphysics scheme to GSD for evaluation toward the FY11 Rapid Refresh upgrade.

CURRENT EFFORTS:
Trude implemented a new scheme that accounts for the competition between heterogeneous and homogeneous ice nucleation of aerosols. This competition effect can be important for cirrus cloud formation in relative high dust load cases. The scheme is based upon work of Karcher et al. (2006). She also run ICE-L simulations with the new scheme to compare with previous implemented version. In addition, Trude added the option to let the initial aerosol concentrations vary based on land surface characteristics in the aerosol input files. Since background aerosol concentrations are taken from the 2.5 x 2 degree GOCART global model, aerosol concentrations can therefore be “smeared” out and local hot spots missed. We now allow for sulfate to be much higher in urban areas. Dust concentration is also allowed to be increased in the initial file if the surface wind is strong over typical dust emitting surfaces. She developed a test case of a strong blowing dust event in El-Paso region June 21, 2006, coming from thunderstorms nearby. She is using this case to look at the dust emission/deposition modules she implemented in WRF. She conducted several runs with varying dust emission properties and grid scales and is currently analyzing the results.

PLANNED EFFORTS:
Continue testing of the new interactive microphysics-aerosol scheme.

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED:
None

INTERFACE WITH OTHER ORGANIZATIONS:
GSD

UPDATES TO SCHEDULE:
None

Task 10.5.15 Develop improved methods of cloud and moisture analysis for use in the Rapid Refresh and NAM Modeling Systems.

GSD

GSD continues to monitor performance of the cloud analysis within both the RUC and Rapid Refresh. Work is also ongoing to get the RR GSI cloud analysis components ported to EMC GSI SVN repository (see Task 5.5). Work has continued toward transforming the current RUC/RR cloud analysis into a variational-based cloud analysis. Stan Benjamin has continued developing an initial variational enhancement to the RUC cloud analysis in late February. In this formulation, water vapor innovations are created based on existence of ceiling observations (resulting in RH=1.0 obs just above cloud base or ensuring sub-saturation below cloud base). The effects of this change were monitored for a few days and showed the desired result that they had statistical properties similar to those of conventional water vapor innovations). These pseudo-innovations for RH from METAR ceiling obs have been assimilated into the devRUC via the RUC 3DVAR variational water vapor solver. After revisions to only produce RH-METAR-cloud innovations below 2 km on 25 Feb, the devRUC is showing improvements for IFR, LIFR, and MVFR ceilings by 2-5 points for 1h and 3h forecasts.

Subtasks

10.5.15.2 5 Jan 2010 (GSD)

Complete improved version of 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.

As noted in task 5.5, Ming Hu has worked interactively with NCEP's John Derber and Mike Lueken and made significant progress to a major goal of getting the GSD cloud analysis incorporated into the NCEP SVN version of GSI. This will allow GSD to use the latest version of the GSI (complete with the GSD cloud analysis) in the RR implementation at NCEP later this year. See task 5.5 for more details on the work. GSD personnel have continued to monitor performance of the cloud analysis within both the RUC and Rapid Refresh and also within an experimental 3-km cloud analysis running for the HRRR and identified some additional inconsistencies between the two, and made changes to the RR cloud analysis to make it consistent. Stan worked with Ming to make a substantial improvement to internal documentation in the GSI cloud/hydrometeor analysis code.

Stan Benjamin has continued developing an initial variational enhancement to the RUC cloud analysis. In this formulation, water vapor innovations are created based on existence of ceiling observations (resulting in RH=1.0 obs just above cloud base or ensuring sub-saturation below cloud base). The effects of this change were monitored for a few days and showed the desired result that they had statistical properties similar to those of conventional water vapor innovations). These pseudo-innovations for RH from METAR ceiling obs have been assimilated into the devRUC via the RUC 3DVAR variational water vapor solver. After revisions to only produce RH-METAR-cloud innovations below 2 km on 25 Feb, the devRUC is showing improvements for IFR, LIFR, and MVFR ceilings by 2-5 points for 1h and 3h forecasts. This entry point toward variational assimilation of cloud observations will not be included in the initial RR later in 2010 but will likely be introduced in 2011.

10.5.15.3 30 Jan 2010 (GSD)

Complete improved diabatic digital filter initialization (DDFI) in the 13-km RR WRF model including assimilation of radar reflectivity data

Assessment of the enhanced RR DDFI reflectivity assimilation continues with some minor additional adjustments possible (similar to adjustments being evaluated in the RUC). The evaluation includes retrospective case study results, evaluation of precipitation skill scores, and examination of HRRR forecasts initialized from the RUC. Results look good overall, but the RR bias in the first few hours is larger than that from the RUC. This suggests that some reduction in the strength of the latent heating forcing may be appropriate, similar to the latent heating reduction being evaluated in the development version of the RUC. HRRR tests are being performed using initial conditions from the RR compared to the usual configuration with the backup RUC.

Deliverables:

10.5.15.E2 1 May 2010 (GSD) Completed as of 1 March 2010

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.

This task is on schedule and nearly complete with significant progress by Ming Hu and others. The RR with the cloud analysis is giving results equal to or better than the RUC for ceiling forecasts. Ming has also delivered the RR version of the GSI with the generalized cloud analysis code to NCEP and Geoff manikin is running in an hourly test mode. Ming Hu is also iterating with NCEP personnel (John Derber, Mike Lueken) and made progress toward getting the cloud analysis added to the NCEP GSI SVN repository.

10.5.15.E3 30 Aug 2010 (GSD)

Complete testing of revised cloud analysis for part of FY11 change package to Rapid Refresh

Initial testing of ideas for this, including use of cloud residuals to create relative humidity innovations, are currently being testing in the development RUC at ESRL and will be moved over to a test version of the RR over the next few months. This capability will require substantial modifications in GSI (much in the RUC 3dVAR), and will be deferred to the FY11 change package for the RR.

Task 10.5.24 Develop, test, and improve the 3-km WRF-based High-Resolution Rapid Refresh

Subtasks:

10.5.24.1 15 Jan 2010 (GSD, NCAR/RAL, NCAR/MMM)

Design the assimilation/modeling configuration for the HRRR during the 2010 summer convection forecasting (CoSPA) exercise.

There was a major effort by GSD personnel, working in conjunction with CoSPA partners (NCAT, MIT/LL) and QAPDT, to test, evaluate and refine HRRR components, leading to numerous enhancements. This has including moving the HRRR to dedicated nodes with quick failover procedures for most of the most common computer issues (leading to an improved reliability -- (~92% for all runs, ~98% with outages of 2 hours or less, which still allows delivery of a complete CoSPA product). A number of enhancements have been completed, including breaking up the 15-min VIL file (previously a single file with all output times from the entire 12-h HRRR run) into a series of 3-h files. This reduces the latency in the delivery of the VIL fields for the shorter hour forecast hours and also allows for transfer of at least some of the HRRR output in the event that the HRRR runs does not complete fully (as can happen when with slow I/O on one of the jet cores). An additional benefit is the ability to

add extra surface fields to the 15-min output files. These fields will assist with high time and space resolution frontal and boundary detection.

The Rapid Refresh has also been ported over to the faster (and also fully dedicated) nJET cores and we are conducting retrospective experiments of HRRRs running nested within the RR, as a prelude to a switchover to run the HRRR nested within the RR. This changeover required quite a bit of detailed work by Ming Hu to resolve some issues related the specific architecture of the Nehalem chip. Work is nearly complete to create a set of operator procedures for quickly reacting to any HRRR outages during the summer demonstration. Most recently, an upgrade has been made WRF v3,2 using tiled output, which significantly decreases the runtime allowing for the possibility the HRRR may be able to be run out to 15 hours. As part of this upgrade, GSD personnel worked with Scott Dembek at NSSL to make changes to his code that saves hourly maximum values for key variables.

In addition, a large amount of work was completed to test various enhanced options for initializing the HRRR, including:
1) Running the HRRR within the RR,
2) Adding a 2nd pass of the radar reflectivity-based temperature tendency specification (through use of 3-km versions of the GSI cloud analysis and ARW model diabatic DFI), and
3) Reducing the strength of the reflectivity-based latent-heat temperature tendency in the RUC diabatic DFI.
This work required considerable effort to run a large number of RUC and HRRR retrospective experiments, and included running a 12-hourly parallel HRRR (run off of the real-time GSD RR), and was completed in coordination with NCAR, MIT/LL and QA PDT, who have been valuable in evaluating the various HRRR and downstream CoSPA forecasts. As part of that effort, Curtis Alexander modified the RR scripting and execution to trim nearly 15 minutes out of the hourly cycle, allowing the need RR files to be available with the same latency as the RUC files. Based on extensive testing, we have reached a decision (on 14 April) to maintain the current HRRR system during summer 2010 (initializing the 3-km HRRR from the RUC with use of the same radar-reflectivity based temperature tendency as used in 2009).

While other formulations show much promise and were nearly ready for inclusion in the summer 2010 demonstration (experimental work will continue on them), the present formulation was found to be the most reliable method. In particular, use of the Rapid Refresh in place of the RUC yielded very encouraging results, but we cannot hold the RR code constant through the summer (because of ongoing refinements toward the NCEP operational implementation), as needed for the CoSPA demonstration.

10.5.24.2 15 Aug 2010 (NCAR/MMM, GSD)

In collaboration with GSD, NCAR/MMM will work to evaluate convection-permitting (e.g., 3-km) forecasting by the ARW core for ultimate application in the HRRR. It will perform and evaluate convection-permitting forecasts using the radar-enhanced RR (13-km) grids from GSD for initial conditions, in order to identify strengths and weaknesses of the model at high resolution. This will include analyses, for selected cases, of the evolution of convective storm mode during first 1–3 hours of model transition from 13-km resolution to 3-km resolution. NCAR will collaborate with GSD in the process and submit a summary of results.

This work is ongoing in conjunction with NCAR personnel (including David Dowell, Jenny Sun, Mei Xu, James Pinto, Jimy Dudhia), with monthly meetings to exchange information. Issues that have been examined include domain size, grid-resolution, and choice of background grids, microphysics options, and surface temperature biases (related to model post-processing). In additional, as part of the 2009 retrospective verification, GSD has re-run specific cases (09 through 15 UTC, 29,30,31 July) and transferred files to NCAR and MIT/LL for CoSPA retrospective processing. NCAR's initial evaluation of these results showed an improvement to CSI for VIL

forecasts by 20-40% for 1-5h forecasts when radar reflectivity assimilation was included compared to the operational HRRR runs last summer without radar data.

10.5.24.4 30 May 2010 (NCAR/RAL) Conduct sensitivity runs... (Ken Stone)

We have been coordinating sensitivity runs between the Convective, Turbulence, and Icing PDTs to evaluate the impact of various model configurations on the diagnosis and prediction of convective storms, turbulence and in-flight icing. Four cases were selected for sensitivity experimentation: 6 February 2008, 4 June 2008, 9 October 2009, and 9 December 2009. All of these cases exhibit interesting convection, turbulence, and in-flight icing aspects. We are currently in the process of collecting the relevant datasets to initiate the sensitivity runs. The baseline runs will emulate the WRF-RR (13 km) and the HRRR (3 km) models. Several variations of model configuration and physics packages will be explored.

Deliverables:

10.5.24.E1 30 Sept 2010 (GSD)
Complete FY10 test (likely with full CONUS domain) with 3-km High-Resolution Rapid Refresh running every 1 h.

- Conduct real-time summer 2010 HRRR forecasts using 3-km WRF initialized with radar-enhanced Rapid Refresh over full CONUS domain, monitor performance, modify code/scripts as needed, maintain high reliability working with ESRL computer facility
- Coordinate with other AWRP users and other collaborators, including coordination of HRRR grid transfers
- Provide project management
- Lead writing of report on summer 2010 HRRR experiments

In late Oct. 2009, GSD began running in real-time an hourly cycled CONUS HRRR. The CONUS HRRR runs take about 50 min. of wall clock time on 840 cores. GSD worked with NCAR and MIT/LL too make sure cut down (2/3 CONUS) versions of the key HRRR output files were in place to allow uninterrupted product generation as CoSPA is switched to full CONUS. Following this checkout, the GSD 2/3 CONUS HRRR runs were discontinued. Work is ongoing to further optimize the HRRR code and scripts for reliability and runtime.

10.5.24E2 30 Sept 2010 (NCAR/MMM)
Collaborate with GSD on analysis of convection-permitting forecast cases for 3-km ARW initialized with RUC-RR radar-initialized DFI grids. Draft and deliver summary of conclusions and results.
Work is ongoing with monthly meetings. See discussion in 5.24.2

10.5.24E2 30 Sept 2010 (NCAR/RAL)
Deliver report summarizing all HRRR experimental results on sensitivity to physical parameterizations, initial conditions and assessment of HRRR results for key case studies from high impact weather days.

10.5.24.E3 30 July 2010 (GSD)
Complete a report on initial applications of HRRR forecasts to icing, winter weather, and turbulence forecasts.

Task 10.5.19 Develop and refine techniques to assimilate radar radial velocity and reflectivity data through GSI and Rapid Refresh toward the HRRR.

GSD

Working in conjunction with our CoSPA partners and building upon previous work to rerun HRRR runs for the 29-31 July 2009 test period with the RUC radar assimilation turned on (requiring cycled retrospective runs of the RUC system), much work was done to test 3 key enhancements:
1) Running HRRR initialized by RR,
2) Running a 2nd pass 3-km reflectivity-based temperature tendency based DFI,
3) Reducing the strength of the reflectivity-based temperature tendency (in the RUC, but applicable to RUC, RR, or HRRR). See description of these experiments in task 5.19 and explanation of our decision to maintain the present formulation for the summer 2010 CoSPA demonstration.

This major and sustained testing effort required many coordinated retrospective runs amongst RUC, RR, and HRRR models, included use of parallel RR and HRRR real-time runs, suspension of the HRRR real-time cycle, nearly immediate transfer of HRRR output files to various downstream users (for blending and verification), but lead to significant enhancements to our understanding of the reflectivity assimilation procedure. In particular, real-time tests of the HRRR running within the RR yielded very encouraging results (see Fig. 1) and we seriously considered using this formulation for the summer CoSPA demonstration. The requirement to have a code freeze for the system was not possible, as we need to continue to make modification to the GSD real-time RR system prior to the NCEP implementation. Much progress was also made on the 2nd pass 3-km option,
Included testing of a 3-km GSI-based cloud analysis and several enhancements to the cloud analysis. Finally, a comparison of the strength of the temperature tendency in the RUC, shed light on how the HRRR responds to the RUC forcing. Parallel work on these enhancements to the radar assimilation procedure will continue.

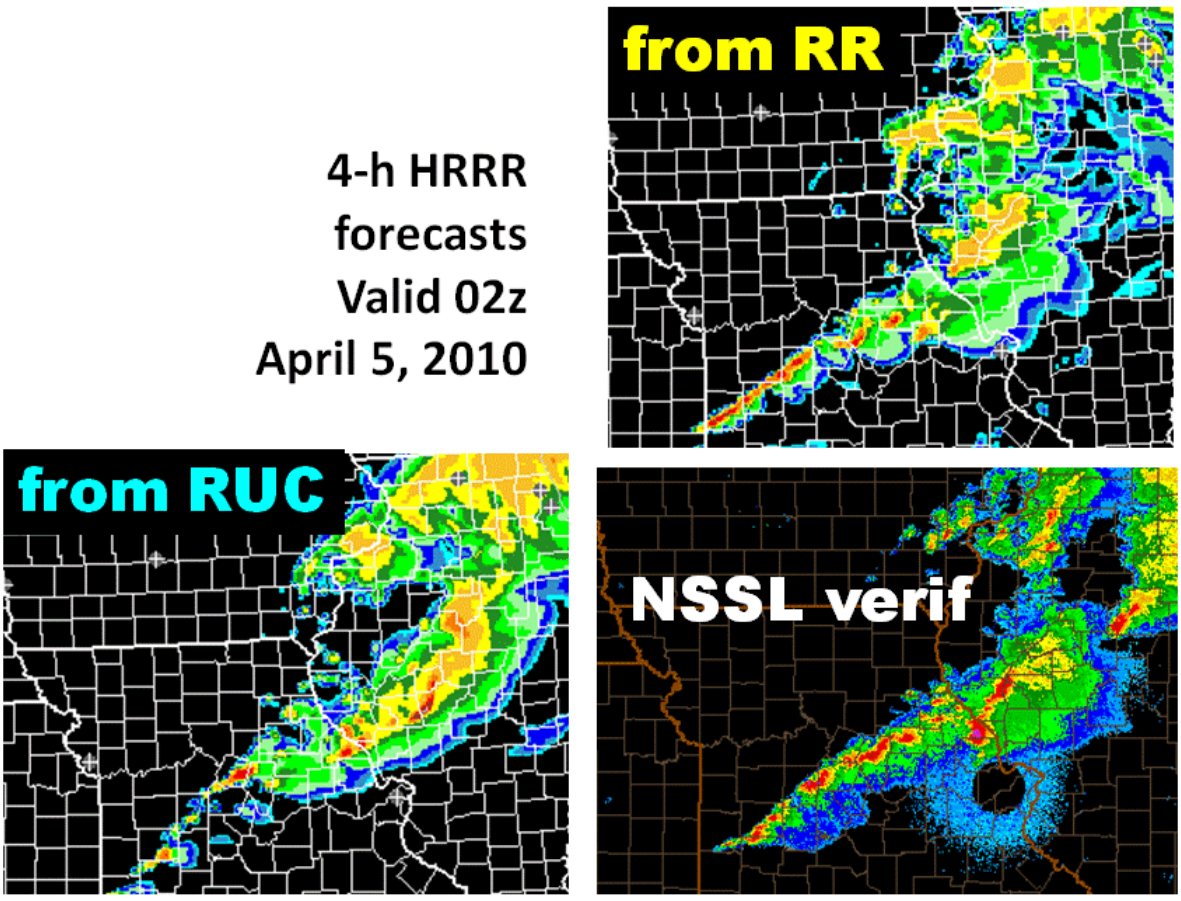

Fig. 1. Variations of 4-h HRRR reflectivity forecasts initialized by RUC (lower left) and RR (upper right) versus observed radar reflectivity (lower right). (Key point: credible forecast from HRRR initialized by RR, planned to become "primary HRRR" by fall 2010.)

GSD reran RUC and subsequent HRRR runs for the 29-31 July 2009 period with radar reflectivity assimilation in RUC working properly, allowing a comparison with the real-time runs last summer. Fig. 2 below shows a significant improvement in HRRR forecast skill with radar assimilation, as anticipated. Thanks to NCAR for this verification.

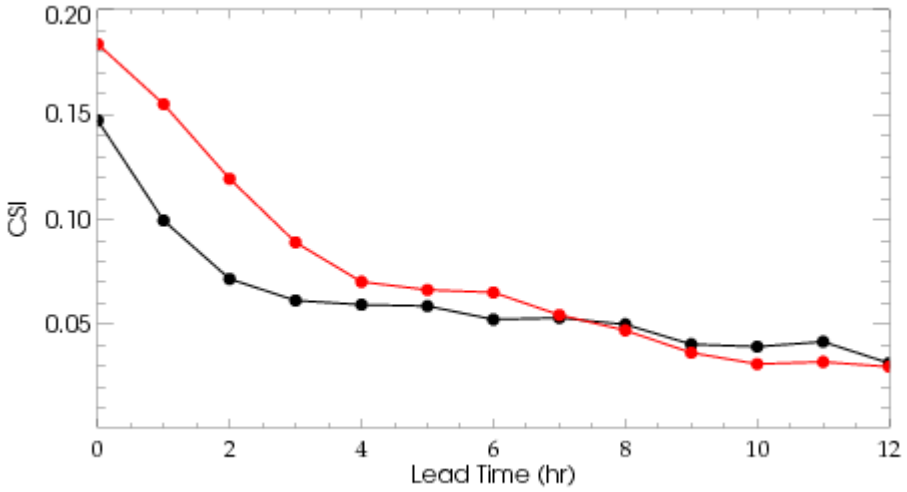

Fig. 2. CSI skill score comparison for the HRRR run from a RUC with the radar assimilation (red curve) with a HRRR run from a RUC without the radar assimilation (black), averaged over seven runs during the morning of 30 July, 2000. (Credit for figure: James Pinto, NCAR)

Recent work by Ming Hu has overcome an important obstacle related to 3-km radar DFI assimilation within the HRRR. Previously, similar "2nd pass" 3-km assimilation experiments on the HRRR 2/3 CONUSD domain had yielded further impressive gains in HRRR prediction skill. Unfortunately, attempts to run the required simplified version of the GSI (using the cloud analysis to compute the latent heating temperature tendency, but with the variational solver turned off) were not successful. Ming tracked the problem down to a memory issue and has found a way around it, allowing us to begin similar tests, now on the full CONUS HRRR domain. Other work is ongoing to compare HRRR runs nested within radar assimilating RR runs vs., radar assimilating RUC runs for the 29 July 2009 test case.

NCEP

Shun Liu modified the RFC'd radar data process bundle. The codes to convert the 3D mosaic package to GRIB format will be RFC'd as a separate package. The corresponding scripts were modified and tested. Shun integrated the codes for dumping PBL from the QC package into the QC package, and a new BUFR tank of PBL was created. The dumping PBL modifications were tested in parallel and are ready to RFC to NCO. He will continue testing the assimilation of radial wind with hourly intervals for the HiRes initialization and add the application of digital filter now available in WRF-NMM thanks to Matt Pyle.

Deliverables:

10.5.19.E1 30 April 2010 (CAPS)

Provide new radial wind assimilation in 13km GSI designed specifically to improve HRRR initial conditions to be applied in summer 2010 HRRR exercise.

During this quarter, a set of experiments were performed by CAPS with the June 16, 2009 test case using the same domain and resolution as the 3-km HRRR grid of March 2009, which covers approximately the eastern 2 / 3 of CONUS. The HRRR used the same options as the current RR except that cumulus parameterization is turned off. Experiments can be divided into four groups: the first using different configuration of HRRR (self-cycling or using the 1-hour forecast from RR grid; with the same DFI procedure as RR or with the standard WRF-DFI or without DFI); the second differing in the observation data base to see the impact of different data; the third using different cloud analysis methods; the last differing in combination of microphysics and plant boundary-layer option.

A previous study found the HRRR were better than RR in the first few hours forecast but worse in the later. Experiments were designed to see if the lower scores of HRRR in the later hours were due to possible undesirable effects of performing self cycling at the HRRR resolution where possible over-prediction of convective-scale features might be harder to suppress or due to over-smooth of storm-scale information by DFI procedures. The self-cycling experiments were first analyzed at 18 UTC, June 15, 2009 using the RR 3-hour forecast as its background while the other experiments always using RR 1-hour forecast instead of the self-cycling forecasted field. A 12-h long assimilation cycle was performed and 9-h forecasts were launched at the end of each analysis cycle. However, the GSS scores indicate the self-cycling performs better. Different DFI configurations show minor differences.

The second group uses the data denial methods to see the impact of different kinds of observations for short-range precipitation forecast on the HRRR grid. These experiments were performed, with all available data assimilated and with radar radial winds using ¼ horizontal de-correlation scales of traditional data in the second pass by the GSI system; with the radar radial wind excluded; with the radar reflectivity excluded and with the traditional data excluded, respectively. As in the experiments on the RR grid, radar reflectivity is found to have the largest impact in the first 6 hours of forecast, followed by traditional data. The level-2.5 radar radial winds, due to its relatively coarse resolution (5 km radial resolution and 6-degree azimuth resolution) have almost no impact on the short-range precipitation forecast on the HRRR grid.

Based on the results of the above two groups of experiments, a third group was performed using the self-cycling procedure with radar radial velocity excluded (to save computation cost). Earlier experiments on the RR grid found that the stratiform and convective cloud options in the cloud analysis performed differently at different stages of the MCS. The stratiform option was found to be better during the formation stage of MCS; when the MCS reached its mature stage, the convective method was clearly better. To develop a more general method, the classification of cloud layer type based on the algorithm of Steiner et al. (1995) was added to the cloud analysis package. However, the combined version on the RR grid showed similar behavior as the stratiform method in the first few hours of forecast but worse than both after 6 hours. It was suggested that this might be related to the relative coarse resolution of RR. Experiments were therefore performed to test the combined version on the HRRR grid. It was found the combined version is slightly better than both stratiform and convective methods. The last group of experiments was performed to test the performance of different microphysics schemes: Lin, Ferrier, Thompson (default setting) and Morrison (two moments). Fig.3 depicts the GSS scores of different microphysics schemes combined with two PBL options. It can be seen that the Thompson scheme is generally better than the Lin scheme in this MCS test. The Ferrier scheme combined with the YSU performed better than the combination with MYJ scheme. However, the WRF forecast crashed when using the Ferrier scheme in the sixth assimilation cycle with YSU and ninth with the MYJ. The two-moment Morrison scheme did not show significant improvement in this case, but did produce a widespread region of trailing stratiform precipitation as

described in Morrison (2008, MWR). As the Ferrier scheme, Morrison scheme combined with MYJ crashed in the 6th assimilation cycle. The cause is under investigation.

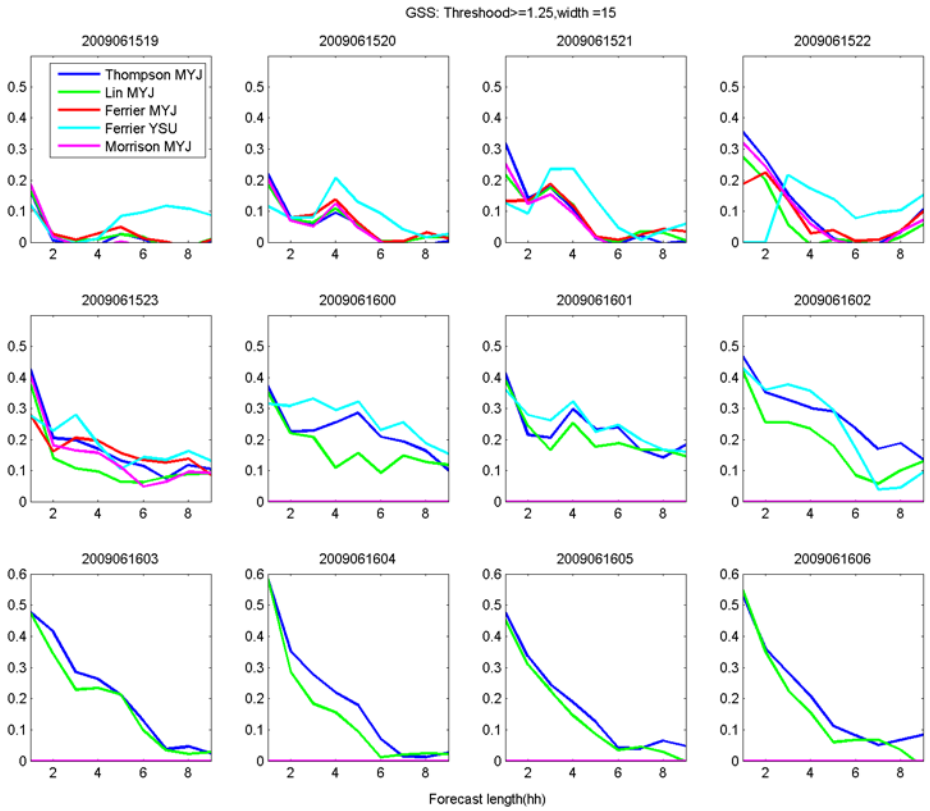

Fig.3. GSS scores of HRRR-grid forecasts using different microphysics and PBL schemes. Zero scores are given when WRF crashed during the forecast.

10.5.19.E1 15 September 2010 (Liu, Pyle, Parrish)
Demonstrate mini-NDAS data assimilation system using HRRR-like design constructed to precede HiResWindow runs or Matt Pyle's SPC runs using hourly updates with GSI.

CURRENT EFFORTS: (See also Liu activities under 10.5.5 above). A set of two experiments were made to test the assimilation of radial wind with hourly intervals for the HiRes initialization. In the first experiment, radial winds were assimilated twice with hourly intervals. In the second experiment, radial winds were not assimilated at all. In the third experiment radial winds were assimilated only at the beginning of the forecast. After evaluation, it was found that assimilating the radial wind twice improves the forecast reflectivity and this improvement lasts from 6 to 12 hours into the forecast. The digital filter now available in WRF-NMM is also being added to the HiRes initialization. Efforts are underway to examine if, through the digital filter, suitable temperature and moisture increments can be generated with wind increment forcing after the radial wind assimilation. (Liu)

PLANNED EFFORTS: Test the assimilation of radial wind for the HiResWindow initialization with hourly cycle and the application of digital filter, and examine the performance of the new VAD winds. (Liu)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A schedule backlog has developed for implementations on the new P6 computers.

INTERFACE WITH OTHER ORGANIZATIONS: University of Oklahoma, GSD, NCO

UPDATES TO SCHEDULE: None

10.5.19.E2 30 September 2010 (Liu, Pyle, Parrish)
Report on the design and initial development of hybrid ensemble-3DVAR system

CURRENT EFFORTS: The hybrid ensemble option in GSI is now able to read GEFS ensemble perturbations. Arthur Mizzi has completed most of the coding for reading ARW ensemble perturbations. A dual resolution capability has been introduced where the ensemble perturbations can be kept at their own resolution, thus allowing the use of ensemble information directly in a high resolution analysis without the need for dramatic increase in computer resources. This can leverage the use of existing ensembles (SREF, GEFS). The first application of this new code was to read GFS ozone directly into the regional GSI for testing with the NEMS-NMMB model. Testing continues with the new dynamic constraint to find out why regional strong constraint impact is always negative. (Parrish)

PLANNED EFFORTS: Add interface to read existing regional ensemble perturbations from SREF. (Parrish)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: This is a new and relatively immature capability so expectations should be tempered.

INTERFACE WITH OTHER ORGANIZATIONS: CAPS, ESRL/GSD

UPDATES TO SCHEDULE: None.

Deliverables

10.5.19.E4 15 September 2010 (Liu, Pyle, Parrish)
Demonstrate mini-NDAS data assimilation system using HRRR-like design constructed to precede HiResWindow runs or Matt Pyle's SPC runs using hourly updates with GSI.

CURRENT EFFORTS: (See also Liu activities under 10.5.5 above) In preparation for eventual regional data assimilation using ensemble information, the hybrid ensemble method (Wang et al, 2008) has been installed and tested in GSI. This is based on the formulation reported in Wang et al, 2008, and the development has been done in collaboration with Xuguang Wang. The code does not yet read ensemble perturbations. For testing purposes, ensemble perturbations were generated internally from random vectors sampled from the existing fixed background error. Initial hybrid ensemble code installed and tested in GSI. (Parrish)

PLANNED EFFORTS: Add interface to read existing regional ensemble perturbations from SREF. (Parrish)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: GSD, University of Oklahoma

UPDATES TO SCHEDULE: None

10.5.19.E5 15 Sept 2010 (CAPS, NCEP and GSD)
Report on the design and initial development of EnKF data assimilation for Rapid Refresh scale

CAPS has obtained a version of EnSRF code from Dr. Jeff Whitaker of ESRL and discussed with GSD on the version of GSI to use to link with EnSRF codes. The merged version including latest development at NCEP and RR enhancements to GSI is expected to be available soon and it will serve as the starting point.

Task 10.5.20 Develop ensemble-based probabilistic products for aviation users.

GSD

Doug Koch and Curtis Alexander conducted HCPF sensitivity tests and further examined the HCPF skill and documented the skill improvement by adding additional time-lagged ensemble members. In addition statistical reliability plots were created. Additional work has focused on developing a linear regression-based procedure for specify non-constant ensemble member weighting factors as a function ensemble member lead time. Based on recent discussion with Tom Hamill, additional work is now being targeted at for sophisticated ways to obtain statistically reliable probabilistic predictions (including logistic regression and neural networks).

GSD (Curtis, Steve, Stan) has interacted with MIT/LL (Haig, Colleen) to produce a HCPF-like convective probabilistic forecast for CoSPA.

NCEP

Jun Du reports that in test mode the SREF forecasts are being dynamically downscaled, i.e., the 32km SREF was downscaled to a finer 4km resolution based on Hires-Window runs and will be part of next quarters upgrade to the HiResWindow suite. This approach could be applied to aviation-oriented VSREF products in the future.

Binbin Zhou worked on VSREF's plot shifting issue, where the ensemble plots were shifted too far to east and south compared with the observations. This problem was found by GSD a month ago. The problem has been fixed (by correcting the geographic data used when generating the plots), which will be confirmed by GSD after they evaluate the new plots.

Subtasks

10.5.20.1 Complete 'research quality' version of upgrade to SREF for consideration in November 2010 SREF upgrade package. (15 Jan 10)

A research quality version of the SREF has been constructed and work begins to put it through its paces as it matures for next year's major upgrade. The 'research quality' version reflects a change in strategy as we move towards a strictly NEMS-based suite of runs for SREF and everything else in NCEP's Production Suite, to reduce the number of models at NCEP. While we are depending on a multi-model approach to achieve success in the short range, EMC has decided to drop the two legacy models used in the SREF, namely the 6 Eta members and the 5 Regional Spectral Model (RSM) members. These 11 members will be replaced by 2 additional WRF-ARW members and WRF-NMM plus 7 NEMS-NMMB members. Dusan Jovic has written the code necessary to perform the NEMS-NMMB control member breeding cycle. Jun Du is testing the codes in an ensemble framework. The research quality version will continue to have 21 members with 7 each coming from the three models. A major upgrade in resolution is also planned with the horizontal spacing moving from the current 32-35 km to 22-25 km. This will completely fill SREF run slot on the current P6 computer platform. (DiMego and Du) Completed.

Additional product generation work has been done in preparation for adding more aviation specific parameters to the SREF output suite with the 2011 implementation. The hourly probability of thunder product that was developed at SPC by David Bright and heavily used at AWC is being adapted to run within the ensemble product generator. This is not as straightforward as it sounds because the current thunder product computations are

performed entirely within NAWIPS (GEMPAK). Refined bias correction and an ensemble BUFR product are also in the works for the next deliverable. (DiMego and Zhou)

Work related to the precipitation bias correction of the SREF system continues. Some effort was spent on investigation of a new method of smarter ensemble averaging. (Du)

10.5.20.2 Visit AWC to conduct continued training and education on SREF applications; receive feedback on existing guidance, and to acquire new requirements, if funding available. (15 Feb 10)

Jun Du, BinBin Zhou, Geoff DiMego and Yali Mao visited AWC on 16-19 November to discuss SREF aviation products. Geoff DiMego attended the AWC Testbed meeting on R2O Issues. Completed.

10.5.20.4 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. (30 Apr 10)

A 4km hybrid ensemble system has been set up. The production standard scripts have been written and tested. It will be implemented at NCEP production as part of the Hires-Window package later this year. The system will have 44 members, hourly output for the first 36hrs then 3-hourly to 48hrs, output includes individual members, mean, spread and probabilities for three domains - east CONUS, west CONUS, and Alaska in grib1-2 formats. (Du)

There is some concern over the November 2010 target for this implementation due to slippage of many of the 2009 implementations into 2010, which is having a downstream ripple effect on the original 2010 implementations. This is just a heads-up. (DiMego)

10.5.20.5 Improve preliminary (developed in FY09) procedure appropriate for aviation users from Very Short-Range Ensemble Forecast (VSREF) system using high-resolution RR and NAM existing runs toward a future High-Frequency Probabilistic Forecast (HFProb) generator to be used in NextGen, including common post-processor, obs-based statistical post-processing, optimized member weighting. (31 Mar 10)

GSD discovered a problem with VSREF plots, where the ensemble plots were shifted too far to east and south compared with the observations. The problem was fixed (by correcting the geographic background used when generating the plots), which will be confirmed by GSD after they evaluate the new plots. Work began to extend the VSREF from 6- to 12-hours using the newly extended RUC forecasts to 18 hr range plus the NAM forecasts. (Zhou)

10.5.20.6 Further calibrate probabilities and potential echo-top (improve statistical reliability) ensemble cumulus information. (1 Jul 10)

Work continues on SREF's echo-top verification with the mosaic dataset. A poster presentation about a fog ensemble study was prepared for the AMS annual meeting by Jun Du and presented by Binbin Zhou. Binbin also gave an oral presentation at the AMS meeting to introduce NCEP's VSREF system to the community. (Du and Zhou)

Deliverables

10.5.20.E1 30 June 2010 (Du, Zhou)

Subject to NCEP Director approval, implement initial VSREF product generation as part of 2010 RUC/RR upgrade package [products not operational but generated routinely within the RUC script as part of NCEP's Production Suite].

CURRENT EFFORTS: VSREF was upgraded to use the new RUC 18 hour forecast run, so the current VSREF was extended from 6 to 12 forecast hours. 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: Work will continue on convection products in VSREF, by adopting GSD's convection code. An echo-top ensemble product as well as other aviation and convection products will be added using the ensemble product generator. (Du, Zhou)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: There is some concern over the November 2010 target for this implementation due to slippage of many of the 2009 implementations into 2010, which will affect the implementations already scheduled for 2010. This is just a heads-up.

INTERFACE WITH OTHER ORGANIZATIONS: AWC, GSD, NCO

UPDATES TO SCHEDULE: None.

10.5.20.E2 30 August 2010 (Du, Zhou, Mao)
Demonstrate products from experimental VSREF probabilistic forecasts updated hourly.

CURRENT EFFORTS: A shift error in VSREF plots (for all the VSREF products) was fixed and GSD notified so they can evaluate the products and confirm that the fix is correct. An experimental VSREF is now running and is updated hourly. Results can be seen at **(http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/VSREF/web_site/html/cat.html**). (Zhou)

PLANNED EFFORTS: Binbin Zhou and Jun Du plan to (1) develop and include the aviation products listed in the AWC's short-term request for the Nov. 2010 implementation. SPC convection products such as Probability of Thunderstorm (also requested by AFWA) will be added into the SREF ensemble product generator as resources become available. (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: None.