2nd Quarterly Report for January - March 2009

FY 2009

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Executive Summary

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

- **RUC fixes for snow cover, cloud retention – implemented at NCEP on 3/31/2009 after development and testing at ESRL/GSD and NCEP/EMC.** ***Details in http://ruc.noaa.gov/gif/ruc13/RUC-snow-cloud-fix-31mar09.pdf***
  - Mods to improve accuracy of snow cover in RUC by using NESDIS satellite data to modify RUC snow
  - Cloud analysis code mods to improve retention of saturation in cloudy 3-d volume after assimilation of METAR and GOES cloud observations.

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

- Continued real-time feed of RR files to other AWRP RTs and Alaska Region NWS and getting feedback from them
- Improvements in RR - Modification to land-surface model for snow on ice to improve near-ice near-surface forecasts, DFI, terrain detail, cycling of land-surface variables,
- **March presentations to Alaska Weather Symposium**
  - **http://ruc.noaa.gov/pdf/RR-AK-Wx-Symp-Mar09-pt1.pdf and http://ruc.noaa.gov/pdf/RR-AK-Wx-Symp-Mar09-pt2.pdf**

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

- RR GSI – development of new forward model for surface obs to match RUC techniques, sensitivity tests for surface obs, profiler, satellite. RR ARW- New development for application of LSM for snow on top of sea-ice

Task 09.5.6: Improve WRF model

- Version 3.1 released 9 April 2009 (NCAR). RR-WRF will be subsequently upgraded to include WRFv3.1 upgrades.

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

- Further modifications to WRFpost to provide consistency with RUC post-processing (e.g., ceiling, visibility, MSLP)

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

- *New larger HRRR domain (eastern 2/3 CONUS) started for real-time runs – 25 March 2009*
- Improvements made to RUC radar-enhanced initial conditions for HRRR
- Additional GSD progress toward a time-lagged HRRR-based convective probability forecast
- Added new HRRR post-processing for additional storm parameters

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

GSD

RUC change package implemented on 3/31/2009 to improve snow cover and forecast retention of analyzed clouds/ceiling/visibility using METAR and satellite data. Also see Task 9.15.
Details in http://ruc.noaa.gov/gif/ruc13/RUC-snow-cloud-fix-31mar09.pdf

Background:
Snow cover: GSD also developed a method to improve areal snow cover in the RUC by using NESDIS snow/ice analyses produced daily. This method solves a RUC problem identified by forecasters from NWS and The Weather Channel in both of the last 2 cold seasons in that the RUC had held on too long to snow cover, not melting snow cover quickly enough. Now, once daily (at 19z after the daily NESDIS snow analysis becomes available), NESDIS snow cover fields are used to set RUC snow water equivalent to zero at appropriate grid points under certain conditions, including absence of cloud or current 1h precipitation and temperature > 2 deg C. This change was implemented in the GSD versions of the RUC (including that initializing the HRRR) in early February.

Cloud retention: GSD also developed modifications to the RUC analysis code to ensure saturation. See online pdf for more details **-- *http://ruc.noaa.gov/gif/ruc13/RUC-snow-cloud-fix-31mar09.pdf***

NCEP
Dennis Keyser reports that some radiosonde sites are reporting an invalid instrument type. NCEP/NCO is investigating. NOAA Profiler Network wind and RASS data continue to be received via the temporary MADIS GTS patch while the NWS hardware outage that began on 1 October continues. Still waiting for NESDIS to respond to two problems with the GOES 1x1 field-of-view cloud data where a few random files have reports encoded with missing lat/lons and a bogus satellite ID, and the later arrival of the GOES-East data. Efforts are being made to get TAMDAR airframe type and airline code into the PrepBUFR file for ESRL so they can work on an improved bias correction. From 15 December - 6 January, GOES-13 replaced GOES-12 as GOES-East due to a GOES-12 thruster anomaly. During that time, the RUC assimilated GOES-13 IR and WV imager (cloud-top) winds in place of GOES-12 winds but did not use GOES-13 layer PW and cloud data. There were intermittent gaps in all GOES-11/-12 data on 27-28 January from a NESDIS server outage. NESDIS reported that a GOES-12 navigation problem on 29-30 January led to winds being produced some 15 km too far south. An accelerated RFC has been submitted to NCEP/NCO to modify the RUC dump processing to no longer sleep for five minutes and then re-dump all data when no ARINC MDCRS data are available. This led to the 15Z 11 February RUC being delayed 7 minutes (MDCRS data problem from a power failure at the Leesburg FAA facility). After this change is implemented, the RUC will run without ARINC MDCRS data but, most likely, with MDCRS data from the backup AFWA feed.

Geoff Manikin reports implementation on 3/31/2009 a fix to the operational RUC for handling of snow cover (along with cloud analysis change – see GSD paragraph above). Several users have pointed out cases in the past year in which the RUC model maintains snow cover where it has in reality melted away. The current RUC model fully cycles its own snow cover; the model accumulates snow where it falls in model forecasts and reduces the snowpack with sufficiently warm temperatures. There is no outside analysis used to make adjustments (like NAM or GFS). Code has been written to use a daily NESDIS snow analysis and bring it into the RUC daily at 19z. Points will be found where the model has snow cover but the analysis has none. At these points the snow cover will be eliminated if the temperature is above freezing and no snow has fallen in the previous hour. The amount of snow on the ground will not be changed if both the model and analysis have snow at that point, even if the amounts differ greatly. The analysis code will also be modified to fix a series of bugs that reduce the model's ability to maintain analyzed cloud cover. Statistics demonstrate that there is a significant drop-off in cloud cover between the analysis and the 1-hour forecast, and tests have shown that changing the timing of the call to the cloud analysis code and introducing a loop to reintroduce saturation at points where non-cloud

observational increments dry the air can greatly help the issue. NCEP Central Operations is currently in a "moratorium" state where no code changes will be made, unless there is a bug or significant model problem. Both of these issues seem to fit that criterion, so there is hope of an implementation this spring.

Subtasks

October 2008 through September 2009

09.5.1.1 Maintain hourly RUC runs and provide grids of SAV and AHP guidance products

A problem was pointed out by an AFWA user that the new output variable of forecast total precipitation was wrong. The problem was solved as part of a RUC implementation on 31 March 2009. (Manikin)

09.5.1.2 Provide vendors with gridded model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway.

NCEP maintained real-time availability of SAV and AIV guidance to all vendors from the operational hourly RUC on pressure surfaces on the 80-km AWIPS grid #211 via the NWS Family of Services (FOS) data feed and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (EMC Team and NCO/PMB/Dataflow Group).

09.5.1.3 Provide full grids from RUC runs on NCEP and NWS/OPS servers. (30 Sept 09)

NCEP maintained real-time availability of full resolution gridded data from the operational RUC runs via anonymous ftp access via the NCEP server site at **ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/ruc/prod/** and at the NWS/OPS site at **ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/** in hourly directories named MT.ruc_CY.00 through MT.ruc_CY.23. This includes hourly BUFR soundings and output grids which undergo no interpolation. Both sites now contain only grids packed into GRIB2 format, see **http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml**. A limited set of fields from the RUC runs (and other NCEP models) can also be viewed at **http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/**. (EMC Team and NCO/PMB/Dataflow Group)

09.5.1.4 Maintain access to model verification data. (30 Sept 09)

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

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

Deliverables

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

CURRENT EFFORTS:

See CURRENT EFFORTS listed under Task 09.5.17.E1 below for code transition to new computer issues. NOAA Profiler Network wind and RASS data (used by the RUC) are being received via the temporary MADIS GTS patch because of a continuing NWS hardware outage. NCEP/NCO is investigating an invalid instrument type reported by some radiosonde sites. NESDIS hasn't yet responded to two problems with the GOES 1x1 field-of-view cloud data where a few random files begin with reports encoded with missing lat/lons and a bogus satellite ID and where GOES-East data arrives later. From 15 December through 6 January, GOES-13 replaced GOES-12 as GOES-East due to a GOES-12 thruster anomaly. During that time, the RUC assimilated GOES-13 IR and WV imager (cloud-top) winds in place of GOES-12 winds but did not use GOES-13 layer PW and cloud data. There were intermittent gaps in all GOES-11/-12 data on 27-28 January from a NESDIS server outage. NESDIS reported that a GOES-12 navigation problem on 29-30 January led to winds with incorrect locations. An accelerated RFC was implemented by NCEP/NCO on 10 March to modify the RUC dump processing to not sleep for five minutes and then re-dump all data when ARINC MDCRS data are unavailable. That had led to a 7 minute delay in the 15Z 11 February RUC (MDCRS drop-out from a power failure at the Leesburg FAA facility). If necessary, the RUC will now run with MDCRS data from the backup AFWA feed or no ARINC MDCRS data. TAMDAR data were not available for assimilation from March 12-27 while AirDAT moved their data a new server. (Keyser)

PLANNED EFFORTS:

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

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: None.

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

CURRENT EFFORTS:

Numerous user complaints were documented concerning 2-meter temperatures in the RUC in areas where the model failed to melt snowpack quickly enough. The model cycles its own snow cover with no updates from any outside analysis (unlike the NAM and GFS), and any snow that falls in the model accumulates and then melts only when model temperatures are warm enough. This has led to errors as large as 25 degrees Fahrenheit in early spring warm air masses. Code was written by GSD to bring in the NESDIS snow cover analysis once a day to adjust the model snow cover. If snow exists at a model grid point but not in the NESDIS analysis, it will be eliminated in the model if the temperature is above 274 K and no precipitation has fallen at that point within the past hour. Work was also done to respond to statistics showing that RUC skill in analyzing and predicting clouds drops off dramatically in the first hour's forecast. A major source of the problem was that the cloud analysis is performed too early in the analysis procedure, allowing non-cloud observations to generate sub-saturation at points where cloud was analyzed. This can prevent the model from maintaining the cloud after the analysis. A lesser issue was erroneous METAR clear reports being assimilated and causing holes in the cloud cover. Code was modified to process the cloud observations near the end of the analysis and code was added to make a

final check to ensure saturation at cloud points. A change was also made to allow cloud data to supersede METAR clear reports, as long as the cloud data passes all quality control checks. Work was done to verify that the RUC version on the new computer runs reliably and produces results consistent with the current operational version. A web site is updated hourly with graphics to assist this effort. (Manikin and ESRL)

PLANNED EFFORTS:

Continue work with NCO/PMB to verify the accuracy of RUC codes and scripts on the new computer. Prepare to push RUC forecast range to 18 hours with hourly output by Q4 FY2009 as promised to SPC and AWC. (Manikin)

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

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: None.

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

CURRENT EFFORTS:

Regarding the issues mentioned in 09.5.1E2 and 09.5.1.1.1, a parallel system was run by EMC in February/March to test the code improvements/fixes. After evaluation by EMC, ESRL, and outside users, it was clear that the new code provided a significant improvement. A presentation was made to NCO for a quick implementation, given the potential for huge temperature errors over spring snowpack and the noted precipitation errors. NCO approved the request and implemented the code at 12Z 31 March 2009. (Manikin and NCO/PMB)

PLANNED EFFORTS: Continue monitoring efforts.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: None.

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

NCEP
Since many of his activities listed under Task 09.5.1 also pertain to NAM, they are not duplicated here. For the NAM specifically, Dennis Keyser reports AIRS radiance data counts have been below average since last May due to file gaps and late posting of files (as on 27 Feb) caused by hardware issues with NESDIS' processing. Alaskan radiosonde data receipt has improved after NCEP contacted Alaska region, but some sites still need to move up their launch time so the NAM-GSI can use their data. During the 15 December through 6 January, GOES-East switch, the NAM-GSI assimilated GOES-13 IR and WV imager (cloud-top) winds, but only monitored GOES-13 sounder radiances. The quality of NOAA-16 AMSU-B radiances is gradually degrading, but these data are still usable by the NAM-GSI. An emergency implementation on 15 January turned off the NAM-GSI's use of METOP AMSU-A, channel 7 radiances, which are too degraded to use. JMA IR and visible satellite winds were not available on 17-18

February because a temporary satellite transition from MTSAT-1R to MTSAT-2, where the winds were not available. Methods to speed up dump processing of NEXRAD Level II data are being explored. The following data types are now monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), QuikSCAT 0.5 deg. scatterometer wind superobs (which had an outage 1-2 January from a 2008 leap year issue), Mesonet mass data, and MDCRS moisture data).

Dennis Keyser also reports that, per a request by ESRL/GSD, he added 50 km ASCAT (18 December) and WindSat (28 January) data (non-superobs) to his personal cron runs that generate PREPBUFR files for ESRL's testing of the Rapid Refresh (RR) system in Boulder. The PREPBUFR files will be copied to the private ESRL para directory in ftpprd in early March. ESRL is currently assimilating hourly lightning data from Keyser's dumps in their experimental RR runs. They are looking into testing other new data types currently present in the production RR/RUC PREPBUFR and dump files. These include Multi-Agency Profiler winds, Canadian AMDAR data, QuikSCAT data (up to 2 hours old), and METOP-2 radiances. Keyser has added WindSat and 50 km ASCAT data to his RTMA PREPBUFR cron runs. These new data will eventually be tested in the parallel RTMA. Efforts are underway to remove legacy restrictions on surface observations processed into PREPBUFR file – e.g. the requirement that all surface obs must have a pressure report will be eliminated. This will allow many new surface observations (land, marine and Mesonet) to be assimilated in the RTMA.

Eric Rogers reports that on 26 January the WRF-NMM model running in the NDAS/NAM was changed to fix a bug that had been found in the land-surface model involving the use of the RESTART logical variable required when cycling or cold-starting. The origin of the bug was traced back to the inclusion of the unified NOAH LSM into NAM operations in March 2008. Sadly, there was no regression test for this contingency and it was not detected until partial cycling was implemented in the NDAS in December 2008. The code error was activated at the start of the first (tm12) forecast of each NDAS run when the WRF-NMM forecast model, instead of cycling the frozen soil moisture from the previous NDAS run, was recomputing it using the explicit Flechinger equation. This led to inconsistencies between the frozen soil moisture and the total (liquid+frozen) soil moisture and the soil temperatures, leading to warm 2-m temperature biases in cold regions.

Matt Pyle reports that a HiResWindow bug fix was implemented in early January to solve a problem with the initialization of the Alaskan domain. Several cycles in late December 2008 did not run due to low (< 500 hPa) surface pressures in the model domain. The revised code tolerates both very low and very high (> 1080 hPa) surface pressures if the model topography supports such extreme values. Testing on the new CCS computer was performed, examining both computational performance and quality of model output relative to the current operational CCS system. These tests revealed no problems for the HiResWindow on the new computer.

Subtasks

09.5.17.1 Maintain four-per-day North American Mesoscale runs and provide aviation guidance grids. (30 Sept 09)

On 26 January the WRF-NMM model running in the NDAS/NAM was changed to fix a bug that had been found in the land-surface model involving the RESTART logical variable required when cycling or cold-starting. The origin of the bug was traced back to the implementation of the unified NOAH LSM into the NAM in March 2008. This error was not detected until partial cycling was implemented in the NDAS in December 2008. The code error was invoked at the start of the first (tm12) forecast of each NDAS run when the WRF-NMM forecast model, instead of cycling the frozen soil moisture from the previous NDAS run, recomputed it using the explicit Flechinger equation. This led to inconsistencies between the frozen soil moisture and the total (liquid+frozen) soil moisture and the soil temperatures, leading to warm 2-m temperature biases in cold regions. (Rogers and NCO/PMB)

On 18 March the algorithm in the NAM post-processor that computes lowest freezing level height was changed to use shelter (2 m) temperature instead of skin temperature in the calculation when the height of the lowest freezing level is between the lowest model level and 2 m above ground. Done in response to

mainly AWC complaints, this change will eliminate rare occurrences of spurious freezing level height bulls-eyes when there is an inversion at 2 m and the temperatures at the lowest model level and the surface are nearly identical. (Rogers and NCO/PMB)

Real-time parallel NAM/NDAS testing began in January and continued through the quarter on three bug fixes to the WRF-NMM forecast model component of the NDAS/NAM. The first fixes a bug in the horizontal advection of W and height in the non-hydrostatic module; missing factor of 2 is added. The second removes the addition of rain water mixing ratio to the input cloud water mixing ratio array used by the GFDL radiation code. This change should make the clouds less opaque to short- and long-wave radiation at grid points where rain is falling in the column. The third fixes a bug in the turbulence subroutine to correctly define a constant. Impact so far has been extremely small. (Rogers)

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

NCEP runs 4/day runs of WRF-NMM at 4 km and WRF-ARW at 5 km when there are no hurricane runs. Five domains are run with three large domains - Eastern CONUS (00z & 12z), Western CONUS (06z) and Alaska (18z), and two small domains - Hawaii (00z & 12z) and Puerto Rico (06z &18z). For most of this quarter, the HiResWindow runs were made since there were few tropical systems to cause preemption. NCEP also maintains twice-per-day runs of six WRF-based members (3 running NMM and 3 running ARW) of the Short Range Ensemble Forecast (SREF) system with aviation guidance available from **http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html** which now includes specific output for Alaska and Hawaii (eastern Pacific). (Pyle, Du and NCO)

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

NCEP maintained real-time availability of SAV and AIV guidance to all vendors from the operational 4/day NAM on pressure surfaces on the 80-km AWIPS grid #211 via the NWS Family of Services (FOS) data feed and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). Higher resolution grids (40-km grid #212 and 12-km grd #218) are also made available to FOS (and NOAAPORT) users. (EMC Team and NCO)

09.5.17.4 Provide full grids from NAM, and the HiRes Window on NCEP and NWS/OPS servers. Maintain access to model verification data. (30 Sept 09)

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

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

Fine-tuning continued (with NCO) on the HiResWindow model task counts on the new CCS, to get run times more similar to the current operational computers. Initial configurations for both the WRF-NMM and WRF-ARW were running too quickly on the new machine. (Pyle)

The first half of NCEP's new computer system in Fairmont, WV was accepted by the government in December. The conversion of NCEP's models to this machine (known as Cirrus) was begun in January by EMC and NCO and by the end of the quarter is nearly complete. A moratorium on changes to the Production Suite is in effect until the second half of the new computer system (to be known as Stratus) is installed in Gaithersburg, MD, is accepted and NCO is running Production on it. Due to power limitations there, installation of Stratus will have to be handled in phases. For this reason, the moratorium is scheduled to last until at least late July - Quarter 4 of FY2009. Contractually, full acceptance of both halves must occur by 30 September 2009.

Deliverables

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

CURRENT EFFORTS:

NOAA Profiler Network wind and RASS data are received via a temporary MADIS GTS patch because of a continuing NWS hardware outage. The NAM-GSI uses profiler winds and monitors RASS temperatures. NCEP/NCO is investigating an invalid instrument type reported by some radiosonde sites. AIRS radiance data counts have been below average since last May due to file gaps and late posting of files (as on 27 February) caused by hardware issues with NESDIS processing. AIRS radiance and MODIS wind data were not available on 24 February and on 27 February - 3 March due to NESDIS hardware issues. On 15 December - 6 January, GOES-13 replaced GOES-12 as GOES-East due to a GOES-12 thruster anomaly. During that time the NAM-GSI assimilated GOES-13 IR and WV imager (cloud-top) winds, but only monitored GOES-13 sounder radiances. There were intermittent gaps in all GOES-11 and -12 data on 27-28 January from a NESDIS server outage. NESDIS reported that a problem with GOES-12 navigation on 29-30 January led to winds with incorrect locations. GOES-11 06Z radiance data counts were depressed for most of March due to eclipse season. The quality of NOAA-16 AMSU-B radiances is gradually degrading, but these data are still usable by NAM-GSI. A 15 January emergency implementation turned off NAM-GSI's use of METOP AMSU-A channel 7 radiances, which are now too degraded. JMA IR and visible satellite winds were not available on 17-18 February because of a temporary satellite transition from MTSAT-1R to MTSAT-2 (no available winds). TAMDAR data were not available for assimilation from March 12-27 while AirDAT moved to a new data server. In late March the amount of Canadian AMDAR data available to the NAM-GSI was permanently reduced by 75% (especially in the east) due to budgetary issues. On March 27, 50 km ASCAT and WindSat scatterometer wind data (both non-superobed) were added to crons that generate NAM/NDAS PrepBUFR files, and crons were added to dump METOP IASI radiances at the nominal NAM/NDAS data cut-off times. These are now being monitored in anticipation of testing in the parallel NAM-GSI. The following data types are now monitored by the operational NAM-GSI: RASS virtual temperature profiles (NPN and MAP), QuikSCAT 0.5 deg. scatterometer wind superobs (2008 leap year issue caused an outage 1-2 January), Mesonet mass data, and MDCRS moisture data. Work with NCO/PMB is in progress to transition observation ingest, dump and quality control and processing codes and scripts to the new computer. WindSat and 50 km ASCAT data have also been added to the RTMA PrepBUFR crons for eventual be testing in the parallel RTMA. Efforts are underway to remove a legacy restriction that all surface data must have a pressure report to be processed into the PrepBUFR files. This will allow many new surface observations (land, marine and Mesonet) to be assimilated in the RTMA. Alaskan radiosonde data receipt improved after NCEP contacted Alaska region, but there is still a need for some sites to move up their launch time for the NAM-GSI. Methods to speed up dump processing of NEXRAD Level II data are being explored. (Keyser)

PLANNED EFFORTS:

Use AIRS AMSU-A radiances in the next NAM-GSI update in late 2009 (assimilation stopped in April 2008 when channel 4 went bad). Add a new aircraft quality control module from NRL, as soon as run times improve when profiles are generated. This code is now being tested in daily real-time Regional and

Global parallel runs. Change PrepBUFR processing to add report sub-type information so the analysis can use different obs errors and develop bias corrections based on data sub-types (airframes and ascent/descent tags, mesonet providers and sub-providers, radiosonde instrument type and on-site correction indicators). Complete impact tests in NAM for several new data types: TAMDAR (from AirDAT feed); QuikSCAT 0.5 deg. scatterometer wind superobs (eventually using "new science" QuikSCAT); mesonet mass and roadway data, and new mesonet data feeds (including "hydro", "snow", modernized COOP, UrbaNet and late-arriving mesonet data); MDCRS aircraft moisture; NPN and MAP RASS virtual temperature profiles; JMA, European and MAP profiler winds; GOES 3.9 micron and visible satellite winds; WindSat and ASCAT scatterometer wind data; METOP IASI radiances; ozone from NOAA-series SBUV-2 and METOP GOME-2; GPS radio occultation data; SSM/I and TRMM/TMI rain rate; METEOSAT-9 IR and visible satellite winds; NOAA-19 AMSU-A, MHS and HIRS-4 radiances. Coordinate with the field to speed up more Alaskan RAOB processing for the NAM dumps. Try to retrieve as much data as possible over Alaska (especially mesonet, aircraft and coastal surface). Add GSI events to the NAM PrepBUFR files. Let GSI use the actual or estimated anemometer, barometer and thermometer heights on ships. Generate and QC high vertical-resolution aircraft profile data near airports. Explore (with NCO) the possibility of a use-list to keep experimental data coming in on operational channels out of the operational analyses. Develop a platform-specific surface quality control module within the PrepBUFR processing framework. (Keyser)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: GSD & NCO.

UPDATES TO SCHEDULE:

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

CURRENT EFFORTS: No requests from other RT's were received during the second quarter.

PLANNED EFFORTS:

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None

INTERFACE WITH OTHER ORGANIZATIONS: NCO

UPDATES TO SCHEDULE: None

Task 09.5.4 Develop, test, and implement the Rapid Refresh.
NCEP
See obs processing work for ESRL's RR testing described under Task 09.5.17, otherwise no NCEP activity to report.

GSD

We were successful in compiling the new Q1FY09 version of GSI on wJET and this has been running in the developmental RR 1-h cycle since late February. A new twist to the persistent problem of crashes along the lateral boundaries is that they are occasionally occurring at locations along the lateral boundaries away from terrain, and not always over the Colombian Andes. This problem continues under active investigation, with attention focused on the formulation of the background error covariance in the GSI, and whether the GSI is properly handling the sigma coordinate of the background WRF-ARW 1-h forecasts (the NAM and GFS use a hybrid sigma-pressure vertical coordinate). Related work is underway to update our RR retrospective capability. Previously we had a 1 week 3-hourly cycle retrospective capability for a period from March 2008. This retrospective has been helpful for evaluating

many aspects of the RR cycling formulation, but to best analyze the error buildups and crashing along the boundary, we need a 1-hourly cycled retrospective. Also, the previous retrospective did not include use of the level 2.5 radial velocity data. We are currently saving files and modifying scripts to make a new 1-hourly retrospective. Heavy usage of the ESRL supercomputer has been causing some dropped cycles on the GSD primary (not development) version of the RR and forced us to temporarily turn off the dev RR. The dropped cycles have complicated efforts to diagnose and solve the periodic model crashing problem. A mechanism for reserving cores for has recently been installed on the ESRL supercomputer and we are migrating the RR cycle to this system, which will increase the reliability of the RR cycles. Ming Hu has also nearly completed modifications to interpolate NESDIS sea-ice cover to the RR grid for updating. Previously, sea-ice cover was only being updated when the RR was restarted from the GFS every few days.

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

During the quarter, GSD also continued to modify the NCEP version of WRFpost, originally written by NCEP/EMC to post process the WRF-NMM. RUC post-processing algorithms for ceiling, visibility, radar reflectivity and the MAPS sea-level pressure algorithm have been introduced into the post, and additional severe weather indices (notably the updraft-helicity index) are being added as well. In addition, the output of 15min-interval VIL (Vertically integrated Liquid, a 2-d field) was made more efficient in collaboration with folks at NCAR-RAL as part of the HRRR effort (See Task 24). Particularly for ceiling and visibility, RR results out of WRFpost are now much more consistent with RUC behavior (of course, identical behavior is not to be expected since the models are different). Specifically, shallow fog in the model is no longer considered to be low ceiling unless hydrometeors extend to over 100m above the surface.

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

Subtasks

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

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

Verification of standard atmospheric variables (temp, RH, wind) through early March over the RUC verification domain continued to indicate the experimental Rapid Refresh is competitive with the RUC at most forecast lengths and output times. Upper level wind RMS errors were almost an exact match to the RUC, except near the tropopause where scores were a bit worse. Beginning in mid-late March, however, performance of the RR got worse, particularly for winds and temperature near the tropopause. Investigation is underway, but likely candidates are 1) the fact that we had turned on aircraft data as part of our investigation of the lateral boundary related crashes and 2) the increased number of missed runs and breaks in the cycle caused by the excessive load on the ESRL supercomputer.

Excessive relative humidity in the early hours of forecasts from the primary 1-h RR cycle during mid-March was traced to a problem with a procedure introduced earlier in March to ensure that where clouds are present at the beginning of the forecast the relative humidity is guaranteed to be 100%. This was fixed on 16 March by increasing the threshold cloud water and cloud ice mixing ratios required to consider clouds to be present.

Verification over the RUC domain does not include Alaska, and much attention has been given to Alaska verification during the quarter. For this, we have been using Joe Olson's instantiation of DTC's Meteorological Evaluation Tool (MET) for verification over Alaska. As of January, this tool had shown clearly that there were issues in two areas: In the river valleys of interior Alaska with shallow cold air, and on the northwest coast when winds are onshore. The interior-Alaska difficulty stemmed partly from the failure of the GSI to respond fully to surface data (see Task 5).

Using less smooth terrain (implemented in Feb) improved the response to surface data, since the GSI observational error of METAR stations is related to the difference between the station elevation and the model elevation at the station location. We are now using a terrain file with less smoothing in both RR 1-h cycles.

The frequent prediction of insufficiently cold temperature found in onshore flow events in NW Alaska in Jan-early March was found to be related to our oversimplified treatment of ice in the RUC Land-Surface Model (LSM). Tanya Smirnova made a major modification to the RUC LSM this quarter (implemented on 4/2/2009, see discussion under Task 8). Tests of this modification for several days in our RR cold start runs indicated overall improvement in 2-m temperature forecasts along the NW Alaska coast, so we introduced this into the RR 1-h cycles.

NCEP

In January, 50 km ASCAT and WindSat (non-superob) data have been added to crons that generate RR/RUC PrepBUFR files (ESRL/GSD request). Also, on 20 March the Level 2.5/3 NEXRAD radial wind and QuikSCAT data time windows were expanded. Since early March these PrepBUFR files are copied to a private ESRL directory for experimental RR runs. ESRL is currently assimilating hourly lightning data from cron run dumps in their experimental RR runs. They plan to test other new data types currently present in the production RR/RUC PrepBUFR and dump files. These include 6-minute wind profiler data, Multi-Agency Profiler winds, Canadian AMDAR data, QuikSCAT data, and METOP-2 radiances. (Keyser)

09.5.4.2 1 Nov 2008 (GSD, NCEP)

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

(ESRL/GSD)

GSD has made many different types of RR files available to users (AWR RTs, NWS) and worked to assist them to access, process and display RR grids within various workstation environments. We are currently producing 4 flavors of RR files (native level, pressure level, surface field, and precip fields) for each of 3 grids (full RR, Alaska 249, CONUS) and in grib1 and grib2 formats. George Trojan at Alaska Region NWS has ported RR grids to the AWIPS workstation and forecasters at ANC and FAI and the AAWU have now had a few months to evaluate them.

Members of the RR development group at GSD and NWS Alaska Region Science and Operation Officers met by telcon on 10 February to discuss RR issues, including assessment of RR performance. Further discussions were held in person in early March when Stan Benjamin, Steve Weygandt and Joe Olson participated in the 10-12 March Alaska Weather Symposium (along with Cory Wolff from NCAR/IFIRT). The Alaska folks reiterated their concerns about RR initialization and forecasts of temperatures in the valleys last winter. Temperatures are either about right or, more often, *much* too warm. Offices with marine responsibilities have also requested that RR assimilate Canadian buoy and scatterometer data (for surface winds). GSD just started regularly accessing an experimental NAM PrepBUFR file from NCEP that contains the QuikSCAT and ASCAT surface winds and has looked at the impact of these data on one case. Further use of this data will likely be delayed until the boundary-crashing problem discussed earlier is resolved. The Alaska-Region forecasters would also like a partial cloudiness product and BUFR soundings for Alaska and adjacent areas.

As a result of discussions with Alaska forecasters late last year, NASA Langley initiated an effort to produce GOES-based cloud products over most of the Rapid Refresh domain (more under 09.5.15). As of early April, these files are now available and work is underway to modify the RR GSI code to ingest these observations into the cloud analysis.

Various AWRP RTs at NCAR have also been accessing the RR grids and are evaluating the performance of their algorithms on this data. The Icing RT makes revealing displays comparing the hydrometeor fields from the RR vs. RUC. This processing uncovered a grib1 to grib2 conversion issue that was fixed by NCEP/NCO in February.

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

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

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

Deliverables

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

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

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

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

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

NCEP

Wan-Shu Wu worked on using the scatterometer winds over oceans (QUIKSCAT) in NDAS. The initial tests showed that the largest analysis response to the QUIKSCAT was not in the first layer but 5 to 10 layers above. Since the data were taken at the surface, this response reflected an error in the background error covariances. She checked into the recursive filters used in the vertical direction and found that although the formulation was correctly self-ad joint, a buffer zone extending beyond the surface was needed in the control variables. Since the domain was extended vertically the distribution of the fields among processors needed to be redesigned. It was also necessary to modify the background error variances. Two impact studies are planned to quantify the influence of the changes in background errors and the influence of using the QUIKSCAT data.

Dave Parrish reports that the new multigrid Helmholtz solver with an extension from regional to global domain was incorporated into the complete forward model for the new regional TLNMC (dynamic constraint). Unfortunately, the global grid extension causes significant problems when incorporated into the complete forward model. The preliminary tests were all done with one Helmholtz equation, used to obtain a balanced mass variable correction from input divergence tendency. But there are three other equations to solve before the balanced wind correction can be obtained, and the domain-extended solver creates highly unrealistic large scale wind corrections. Iterations to simulate a nonlinear normal mode initialization diverge quickly. This work was put on hold for two weeks in order to assist Shun Liu with debugging of the new vertical velocity control variable as it was being merged into the 1st Quarter FY2010 (Q1FY10) version of GSI.

After a further review of normal mode initialization literature, the regional method of Bourke and McGregor (1983) seems to be easiest to implement. They solved the same equations but with simple homogeneous boundary conditions on the edge of the domain. Even though these boundary conditions are not strictly correct, reasonable results were obtained. An earlier test version of the multigrid solver, applied only over the regional domain without extension, was swapped into the full regional TLNMC forward model using the homogeneous boundary condition. A test was performed on the background field, which produced reasonable balance increments for mass and wind. The nonlinear normal mode iteration also converged. In order to do actual test analyses, the ad joint of the new TLNMC forward model is still required. A working ad joint of the multigrid solver (the most complex part of the code) was completed in late February.

Shun Liu continued merging code to include a vertical velocity control variable from the Q1FY08 version of GSI into the latest Q1FY10 version. After merging the codes, the new version cannot duplicate the older version results. Efforts were made to check the ad joint and tangent linear model of the vertical velocity equation. Efforts were also made to check if the strong constraint changes could cause the differences between old and new versions. Bugs were found in the new GSI and fixed and the new code now matches the old result. In addition, Q1FY10 codes related to anisotropic recursive filters were also modified so the vertical velocity control variable can properly work with anisotropic recursive filter codes. Tests of these modifications showed that the vertical velocity can be assimilated properly with Q1FY10 version of GSI.

Manuel Pondeca reports that he added a time-of-the day dependent bias-correction scheme for the RTMA first guess and started its evaluation. He also added the "First Guess at the Appropriate Time (FGAT)" capability to the RTMA, which makes the use of larger assimilation time-windows more justifiable. Evaluation of the scheme's performance has begun. In collaboration with several Weather Forecast Offices, he also re-calibrated the anisotropic background error covariance models used with the RTMA to eliminate the occasional occurrence of unrealistic streaks in the temperature and moisture analysis over complex terrain.

GSD

Dezso Devenyi has nearly completed a set of modification to map the surface observations from the actual terrain to the model terrain (using a local lapse rate from the background field). By providing for a more accurate innovation, an improved fit to the surface observation should be obtained. Without this change, surface observations for which there is a significant height difference between the actual and the model would just be down-weighted, resulting in a less close analysis fit to these observations. Dezso also evaluated the impact of scatterometer winds for a single case study. Ming Hu continues to work on 1) tracking down the build-up of errors along the boundaries and resultant crash of the RR every few days, and 2) evaluating the 1QFY09 version of GSI.

09.5.5 30 May 2009 (CAPS and GSD)

Testing and refinement to the radial velocity analysis component of the GSI for Rapid Refresh configuration together with the cloud analysis.

Subtasks

09.5.5.1 31 December 2008 (NCEP and GSD)
Report on testing of 2DVAR GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 5-km or finer resolution.

A time-of-the-day dependent bias-correction scheme for the RTMA first guess was successfully tested in the parallel version of the RTMA used for development work. A First Guess at the Appropriate Time (FGAT) capability was also implemented in the parallel RTMA and its performance is being evaluated. As is consistent with the use of FGAT, the observation time window was increased for all observation types, resulting in a three to four-fold increase in the number of assimilated observations. (Pondeca)

09.5.5.2 31 December 2008 (NCEP)
Establish hourly cycled NAM assimilation system on NOAA R&D computer at NCEP (machine called "haze") using GSI and WRF-NMM to be adapted to ARW-based RR by GSD.

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

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

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

09.5.5.4 28 February 2009 (GSD)
Report on preliminary statistical evaluation of Rapid Refresh forecasts initialized with the GSI, including examination of upper-level winds, surface fields, and precipitation.

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

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

In particular, upper level wind and temperature errors (verified over CONUS raobs) matched or were smaller than those for the RUC. Moisture errors were larger than those of the RUC and this is one of our remaining focus areas. Since that time, there has been some degradation of the RR upper air verification, but we believe this is related to the increase in missed runs and lack of aircraft observations due to the crash-related testing (see 09.5.4). Surface verification confirmed qualitative assessments that the RR GSI does not fit the surfaced observation as closely as the RUC. By the 12-h forecast, however, errors were similar, with the exception of a warm bias at 9z and 12z for the RR. Work by Dezso Devenyi to map the surface observations to the model terrain is nearly complete and will help address this issue.

09.5.5.5 Based on case-study testing and refinement of the research quality code, deliver an 'experimental' code for an upgrade package (e.g. strong constraint, improved satellite channel bias correction, improved use of WSR-88D radial wind and/or satellite radiances and/or retuned co variances) to the GSI for FY2009 change package to the NAM. (31 Jul 09)
(Pondeca, Yanqiu Zhu, Parrish)

Case studies were conducted to prepare for the use of scatterometer winds over oceans (QUIKSCAT) in NDAS. We found that the largest analysis response to the QUIKSCAT was not in the first layer but a few

layers above. Since the data were taken at the surface, this response reflected an error in the background error co variances. The vertical recursive filters used were reexamined and it was found that although the formulation was correctly self-adjoint, a buffer zone extending beyond the surface was needed in the control variables. Since the total numbers of the layers has changed because of the extension, the MPP distribution of the fields from vertical chunk to horizontal slices among processors needed to be redesigned. It was also necessary to modify the background error statistics. Two impact studies are planned to quantify the influence of the changes in background errors and of using the QUIKSCAT data. It was observed that an MPI_IO BUFR read problem happened on the new machine but the GSI code continues to run without generating any error messages. A code check was implemented in GSI to alert users when this problem occurs and IBM suggested a change in the load leveler job submission card. Since the check in the code and the load leveler changes were made, there have been no further silent failures. (Wu)

Work continued to modify the scheme to estimate mixing-layer height from radar reflectivity observations. PBL height data estimated from ACARS and RAOBs were used as ground-truth to refine the algorithm. Preliminary results showed that the estimated mixing-layer height from radar is close to RAOBS but higher than ACARS PBL height. However, only a few co-located ACARS observations or RAOBs were available at the same time and location. All the three types of data are being accumulated for a fair comparison. A set of 12Z WRF-launcher experiments were completed to examine the impact of radial wind on forecasts. A slight positive impact was found when using the improved radial wind assimilation scheme. Work has begun on a high resolution window forecast initialization with radar data. With help from Matt Pyle, HiResWindow parallel scripts were modified and tested. (Liu)

Efforts to use a global embedded multigrid Helmholtz solver for the new regional TLNMC (dynamic constraint) were unsuccessful when incorporated in the full algorithm. After a further review of normal mode initialization literature, the method of Bourke and McGregor (1983) was selected. The same equations are solved, but with homogeneous boundary conditions on the edge of the domain. This scheme was implemented with a simpler regional multigrid Helmholtz solver. Nonlinear initialization of the NMM background field with this scheme converged and generated reasonable balance increments. The adjoint of the new TLNMC code was successfully tested. (Parrish)

Deliverables

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

CURRENT EFFORTS:

The NAM/NDAS upgrade was implemented in December 2008 just prior to the NCO moratorium. Work was begun and completed this quarter with NCO/PMB to transition NAM GSI codes and scripts to the new computer. During the validation of the GSI on the new CCS supercomputer, an MPI_IO BUFR read problem occurred but the GSI code continued to run without generating any error message. A code check was implemented in GSI to alert users when the problem occurs. (Wu)

PLANNED EFFORTS:

Preparations are underway for a possible late 2009 regional GSI minor upgrade. Continue checking the new TLNMC code. Run assimilation tests with the low-res WRF-NMM Testbed comparing the no constraint, existing TLNMC, and new TLNMC. (Wu, Parrish)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO
UPDATES TO SCHEDULE: Completed December 2008.

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

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

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

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

Subtasks

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

Several times during January and February our Alaska verification (see Task 4) revealed onshore flow in northwest Alaska as being too warm. We found this to be an issue common among models, not allowing radiative cooling snow on ice. During the quarter, Tanya Smirnova looked into what would be required to treat ice as a land surface, including the accumulation and ablation of snow on the ice and vertical heat diffusion within the ice, as well as cycling of snow and ice temperature. We hypothesized that this would permit more realistic buildup and maintenance of cold air over the ice surface through greater negative surface heat flux to the atmosphere. Tanya modified the RUC LSM accordingly and subsequent tests with this new version of the RUC LSM in the cold start RR indicated that, indeed, 2-m temperature forecasts along the northwest coast of Alaska were improved. Accordingly, this change was put into both the RR1h cycles on 4/2/2009 and is being evaluated further.

09.5.8.3 30 July 2009 (NCAR)
Research and testing on addition of the new explicit aerosol variable(s) in initiating cloud water and ice. Computer storage and run time considerations will be considered as a constraint on the development. (NCAR task)

Trude Eidheimer ran simulations with various ice nucleation schemes implemented in the Thompson microphysics for an Ice In Cloud – Layer (ICE-L) experiment case (November 16, 2007). The case is from the ICE-L field campaign design to study the link between aerosols (or ice nuclei) to heterogeneous ice nucleation in clouds. A key new element was the inclusion of a variable to keep track of dust particles greater than 0.5 microns in diameter, the particles thought to be the key particles leading to ice formation.

In addition, she is starting to implement a subroutine for calculating emission of dust from the ground based on wind and soil data. The code is based on the GOCART model that is included in WRF-Chem.

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

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

in Rapid Refresh domain toward FY11 Rapid Refresh upgrade.

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

Deliverables

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

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

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

Complete. See FY09 Quarter 1 report.

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

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

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

Subtasks

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

GSD
Work by GSD continues on refining the GSI cloud analysis for Rapid Refresh. Comparison of RUC and RR analyzed ceiling statistics in February indicated slightly worse scores for the Rapid Refresh. The cloud analysis detective work in the RUC has revealed modifications also needed in the RR GSI/WRF code. Changes were also made to WRFpost to bring the ceiling diagnosis into conformity with that used with the RUC. One particular difference in the WRFpost was causing very extensive low ceilings in the RR post-processed fields, but this was fixed as of 10 January 2009.

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

Stan Benjamin, with help from Steve Weygandt, Bill Moninger, and others, completed a set of RUC changes in the RUC analysis to improve retention of layers of cloud water, especially in the 1000-3000 ft layer (from IFR to MVFR). The key has been to add 2 changes to ensure saturation in cloudy (non-zero cloud water or ice) 3-d grid volumes at the end of the RUC analysis. These same changes are being introduced into the Rapid Refresh (specifically as part of a new DFI step in the WRF model using a new namelist option to retain 3-d hydrometeor fields from before application of DFI).
Background: GSD verification against METAR ceiling observations and extensive had shown that cloud water in these layers will evaporate in the first hour of the model for both the RUC and WRF Rapid

Refresh models. Bill Moninger has developed initial ceiling/visibility verification for the Rapid Refresh. Improvements for the RUC developed from this testing will be transferred to the Rapid Refresh code also (analysis and/or model, as is necessary).

Continued discussions have taken place with NESDIS/CIMSS, NWS, and NASA Langley about options for hourly-updated, North American cloud products from either GOES alone, or a GOES/MODIS mosaic. This problem for RR-appropriate cloud products, including Alaska, is not completely solved yet as of this writing, although a real-time feed will likely soon become available.

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

GSD

09.5.15.4 30 May 2009 (GSD and CAPS)

Request in February from Stan Benjamin and Ming Xue: DEFER due date from 30 March to 30 May. Assumed approved.

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

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

We have the DDFI-based radar assimilation coded and running our real-time RR cycle. We have been evaluating difference between the RR cycles with and without the radar assimilation and comparing them with similar differences in the RUC. Based on recent qualitative assessment, the signal from the DDFI radar assimilation in the RR looks similar to that from the RUC radar assimilation, with the exception that the RR produces larger areas of heavy convective precipitation (though this may be linked more to the model than the implementation of the radar assimilation procedure

Deliverables

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

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

NCAR/MMM

CURRENT EFFORTS:

PLANNED EFFORTS

PROBLEMS/ISSUES/SCHEDULE CHANGES:

Subtasks

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

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

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

CURRENT EFFORTS:

Planning for the 10th WRF Users' Workshop is underway. The workshop committee has met to organize the workshop. The dates will be June 23-26, and the location will be the NCAR Center Green facility in Boulder. Parallel sessions are being considered.

The next WRF tutorial will be held July 13-24 in Boulder at the NCAR Foothills laboratory. Registration is not yet open. It will contain at least a basic WRF component and a WRF-Var tutorial.

PLANNED EFFORTS:

The WRF Users' Workshop announcement will be sent out in FY09Q3. Abstracts and extended abstracts will be solicited. The WRF tutorial will be opened for registration in FY09Q3 and the schedule posted on the WRF users' web page.

UPDATES TO SCHEDULE: NONE

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

CURRENT EFFORTS:

Preparations of the next major release of WRF continued at NCAR. This will be WRF V3.1 and is scheduled for release in April 2009. The repository was frozen and pre-release code testing was performed. New features include new and revised microphysics schemes, PBL schemes, Noah LSM and UCM (Urban Canopy Model) updates, a multi-layer UCM, and NCEP operational physics and dynamics. A listing of the release features may be found at **http://wrf-model.org/users/release.php**.

Various areas of WRF physics were addressed this quarter. Bug fixes for the Goddard microphysics scheme were added, and a problem with the KF cumulus scheme related to long-lasting clouds was resolved for V3.1. The latter was due to an error in limiting cloud lifetimes that was introduced with the adaptive time step capability in WRF V3.0. New microphysics schemes added were double-moment 5- and 6-class schemes (from YSU), a new version of the Thompson scheme, and an updated Morrison scheme.

For radiation, Jimy Dudhia of NCAR/MMM worked on a correction to the CAM scheme for the uninitialized variable "co2mmr". This affects downward shortwave effects from CO2 and longwave trace gas

treatments and decreases surface solar flux overall by 1%. Minor developer fixes related to the RRTMG radiation scheme were also made.

Fixes were made to various PBL schemes: the ACM scheme, the MYNN scheme, and the QNSE scheme. Dudhia resolved an issue with the new QNSE surface-layer that involved its interaction with the new Noah LSM snow albedo. This was fixed by providing the necessary output of Richardson number, consistent with the other surface-layer schemes. Dudhia also finalized changes for PBL/cloud tendencies and added them to the repository. These fixed cloud mixing for the BouLac, MYJ, and MYNN PBL schemes in the ARW. Previously, the ARW sometimes had incomplete tendencies for PBL choices (resulting in no cloud mixing).

New PBL schemes added to the repository and available in V3.1 are the QNSE (Quasi-Normal Scale Elimination), NYMM (Mellor-Yamada-Nakanishi-Niino), and BouLac (Bougeault and Lacarrere) schemes. Issues with the parallel implementation of the BouLac scheme were resolved.

Dudhia worked with the Noah LSM group to add fixes, for V3.1, to the Urban Canopy Model (UCM) regarding emissivity and 2-m diagnostics. He added MODIS table data from the LSM group to LSM tables in the repository. Dudhia also added a fix to the separate sea-surface skin temperature prediction scheme pointed out by user X.-Z. Liang (Illinois State Water Survey). This corrected an error in the latent heat budget.

Dudhia worked on surface analysis nudging code to ensure input consistency with the WRF Obsgrid code and to solve parallelization issues. For 3-D grid nudging, Dudhia made a correction to avoid problems when the variable "regime" is not allocated for some PBL options. This correction ensures that regime is fully-defined.

Lastly, NCAR worked with a visitor is (Hyeyum Shin) from Yonsei University (South Korea) to work on gravity-wave drag testing. The gravity wave drag feature will be in V3.1.

PLANNED EFFORTS:

The release of WRF V3.1 will occur in April. The repository will be unfrozen at that time, and new code and code modifications will be accepted again.

UPDATES TO SCHEDULE: NONE

Deliverables

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

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

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

GSD

GSD presented summer 2008 HRRR statistical verification, as well as case study examples, at the NCEP Production Suite Review (Dec. 9-11). In addition, several NWS entities (SPC, regions) expressed a desire for further development and implementation of the HRRR (with the hourly radar updating via the

RUC / RR). In addition, Stan Benjamin and Steve Weygandt have participated in meetings to discuss the evaluation of the 2008 CoSPA forecasts as well as plan the summer 2009 evaluation effort.

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

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

Subtasks

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

GSD

Tanya Smirnova has recently tested an expanded HRRR domain. The new domain, which extends west to the Rocky Mountains and south to the Gulf Coast, is rotated clockwise to minimize grid points over the Atlantic Ocean. There would be several advantages to this expanded HRRR domain: 1) expanded coverage for key hubs including Atlanta, Minneapolis, Dallas and Denver, 2) by placing the western domain edge well west of the mean dry-line position, the western boundary contamination (from large MCSs that are poorly represented in the parent model, entering the HRRR domain) would be greatly reduced. 3) Greater utility to all users, including NOAA operational forecast units. Initial tests indicated about 56 minutes for a 12-h forecast on 480 processors.

As of 25 March, the 2009 HRRR expanded domain is up and running in real-time on the ESRL supercomputers (under reservations) and producing 12-h forecasts every hour with about a 2-h latency. Working with NCAR, Tanya Smirnova added additional post-processing modifications to add 15-min output of the VIL and echo top, the two key fields needed for the CoSPA blending. We have been working with various friendly users (including SPC) to facilitate transfer of HRRR grids for use / evaluation. We have been monitoring the new expanded domain HRRR runs on a daily basis and completed a detailed analysis of the April 9, 2009 severe weather outbreak case.

09.5.24.2 15 Aug 2009 (NCAR/MMM)
Evaluate techniques for convection-permitting (e.g., 3-km) forecasting by the ARW core in the HRRR configuration.

CURRENT EFFORTS:

In this quarter NCAR/MMM and GSD scientists developed the plan for this work, the evaluation of convection-permitting forecasts. The strategy is to exploit the 3-km real-time NWP to be conducted this spring at NCAR in support of the SPC's Spring Forecast Experiment. NCAR will be running the ARW at 3 km twice-daily using 13-km RUC DFI grids (as used in the ESRL HRRR) for initial conditions. Two to three forecasts/cases will be chosen, based on GSD input, for close evaluation. GSD personnel will review the forecasts daily, and candidates for further study will be noted. The cases will be analyzed jointly by NCAR/MMM and GSD.

PLANNED EFFORTS:

NCAR will produce 3-km ARW forecasts this Spring based on 13-km RUC DFI initialization. In collaboration with GSD, cases will be selected for review. The evaluations will take place over the next two quarters.

UPDATES TO SCHEDULE: None.

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

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

Deliverables

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

CURRENT EFFORTS:

The planning for the approach to the evaluation was completed.

PLANNED EFFORTS:

NCAR will draft the report in the third and fourth quarters as the evaluation is done.

UPDATES TO SCHEDULE: None

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

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

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

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

GSI
We have worked to coordinate RR / HRRR related data assimilation efforts amongst the MDE RT team members at various institutions (NCAR RAL and MMM, CAPS). In the short term, the RUC / RR DA will continue to be used to provide initial conditions for the HRRR. This avoids many of the problems of cycling storm-scale grids, which frequently have very large errors (especially with surface cold pools) even within the first hour. Work is underway with CAPS to more fully examine the impact from the

assimilation of level 2.5 radial velocity data within the RR for both the RR and HRRR forecasts.
Extensive evaluation of the HRRR forecast from the April 9, 2009 southern plains severe weather case has revealed new insight into the evolution of the model fields in the HRRR from the RUC radar data assimilation. Lastly, as part of the 7 year planning, we have had several discussions with MD&E colleagues about advance data assimilation techniques, including EnKF.

Subtasks

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

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

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

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

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

09.5.19.3 30 Sept 2009 (CAPS)
Complete new 3-km GSI data assimilation experiments toward improved assimilation of radial wind.

Our earlier experiments using RUC analysis background showed positive impacts of radar data for tropical storm Erin (2007) case based on subjective evaluation. Using the best data assimilation configurations, as new set of experiments were performed by Yi Yang and evaluated quantitatively against radar data. These experiments use a 3 km resolution, the start initial forecasts from 00 UTC, August 19, 2007 and run for 4 hours. Exp-CNTL assimilated conventional data in ruc2a_prepbufr data file at hourly intervals from 04 UTC to 06 UTC; Exp-RF, Exp-VR and Exp-All assimilate in addition, reflectivity (Vr), radial velocity (Z), and both Vr and Z velocity data, respectively, at 10 minute intervals from 04 to 06 UTC.

The forecast composite reflectivity is verified against the NSSL 3D Z mosaic data while the flow field is verified by projecting the velocity field to the radial direction of Oklahoma City (KTLX) radar and comparing the results directly against observed Vr. The projection is done using a radar emulator. Figure 1 presents the Equitable Threat Scores (ETS) of composite Z for the four experiments at a 20 dBZ threshold. It can be seen that both Vr and Z data improve the ETSs, with the score of Exp-All being the best before 15.5 UTC, or 9.5 hours into the forecast. Exp-RF has the highest scores after that. Exp-CNL without using radar data has the lowest scores most of the time.

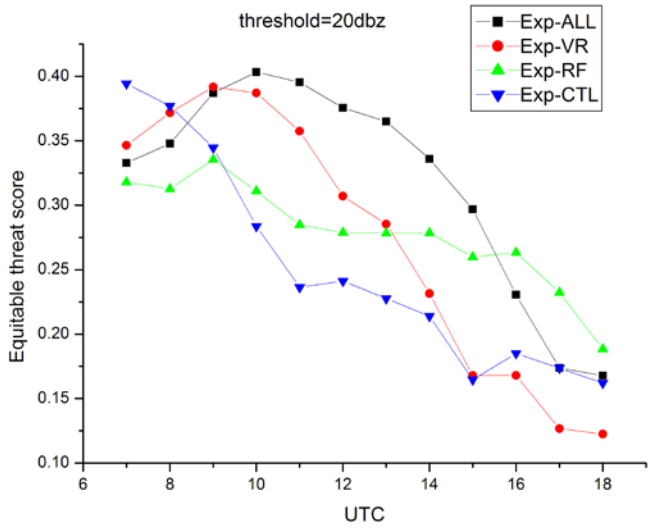

Figure 1. Equitable threat scores of hourly predicted composite reflectivity for the four experiments (Exp-All, Exp-VR, Exp-RF and Exp-CTL) at a threshold of 20 dBZ.

Figure 2 shows the correlation coefficients and root-mean-square errors between the observed and predicted radial velocities over all 14 radar elevations (0.48º to 19.5º) of KTLX radar calculated for the four experiments. Exp-All that assimilated both Vr and Z data shows highest correlation coefficients and lowest rms errors for almost all of the 12 forecast hours.

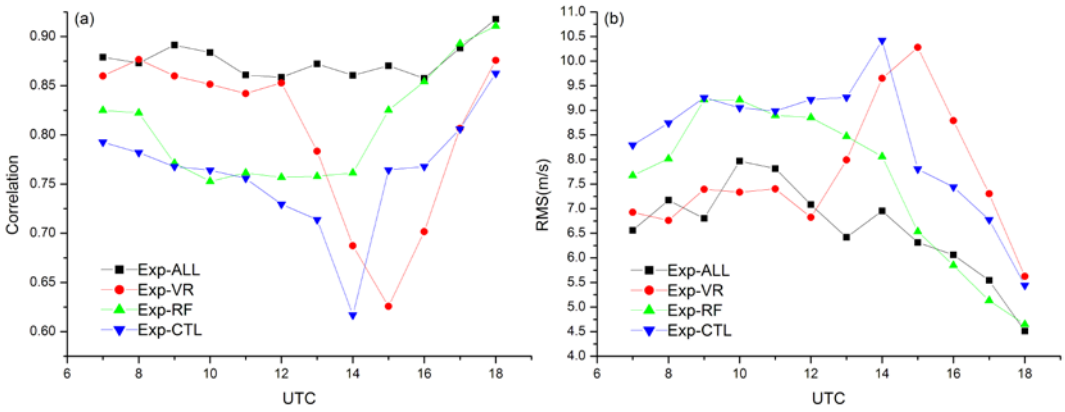

Figure 2. (a) Correlation coefficients and (b) root-mean-square errors between observed and simulated radial velocities over all 14 radar elevations (0.48º to 19.5º) of KTLX radar, for four experiments.

During the quarter, Kefeng Zhu successfully installed MET verification package developed at DTC on OU

and TACC supercomputers, and developed new data conversion and post-processing software (some using MatLab) to for verifying WRF forecasts and displaying the verification results. Further, in order to verify against radar data in the radar coordinates, the ARPS radar emulator was modified to read WRF output directly.

Kefeng Zhu's experiments used NAM as the analysis background and boundary conditions, and the 10-minute assimilation cycles were applied from 00 and 02 UTC. With this configuration, it's found that assimilating Z data or both Z and Vr improves the prediction of the path and rain band pattern but appears to introduce too much hydrometeor and/or too much heating to the system. Investigation is still underway.

Meanwhile, assimilation window from 04 to 06 UTC has been tested to compare the results with those obtained by Yi Yang using RUC background. Using the same configuration as the RUC-based experiments, it was found the conventional and mesonet data divert the vortex southward, while additional radar data cause northward shift (Figure 3). Forecast is also the best when all data are assimilated. Also, different horizontal correlation scales were further tested with GSI. It appears that with NAM background, much smaller horizontal correlation scales than used in the RUC-based case are needed to obtain good forecast results. (Figure 4).

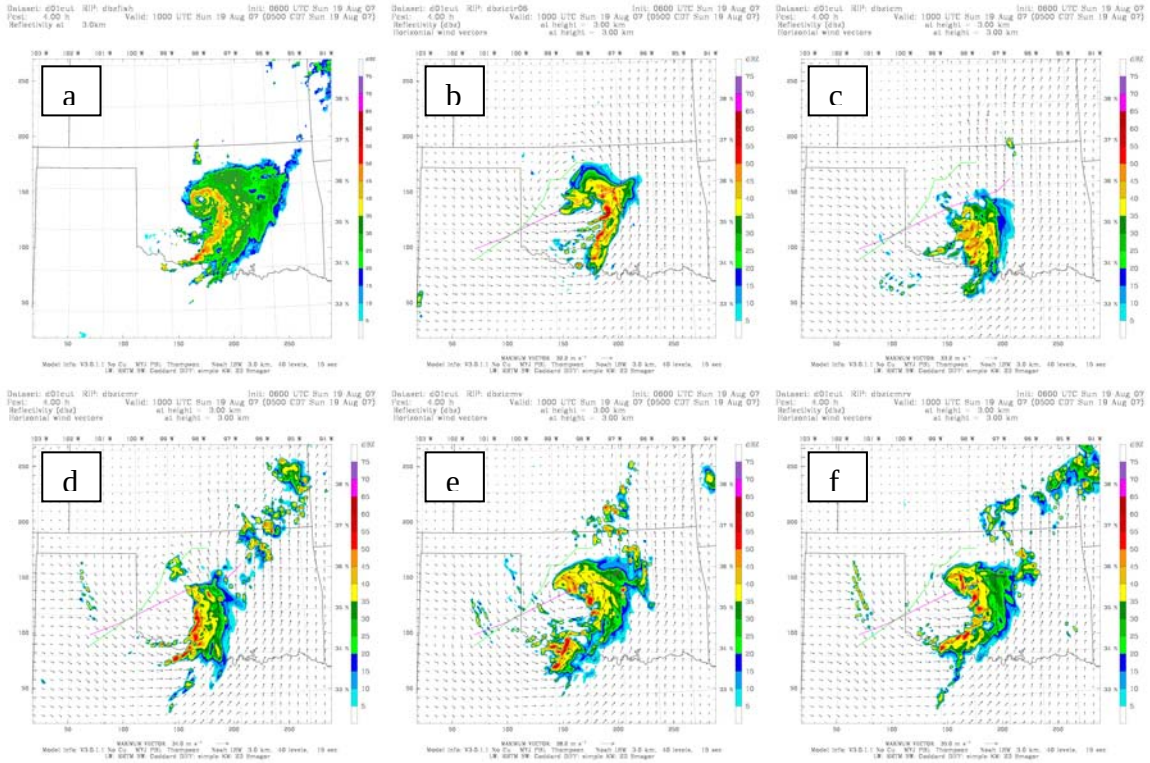

Figure 3. Observed reflectivity (a), and four-hour forecasts valid at 10 UTC, from NAM-based experiments with 10-min assimilation cycles from 04 to 06 UTC. Forecasts (b) without additional data assimilation, (c) assimilating convention and mesonet data, (d) assimilating conventional, mesonet and Z data, (e) assimilating conventional, mesonet and Vr data, (f) assimilating conventional, mesonet, and both Vr and Z data.

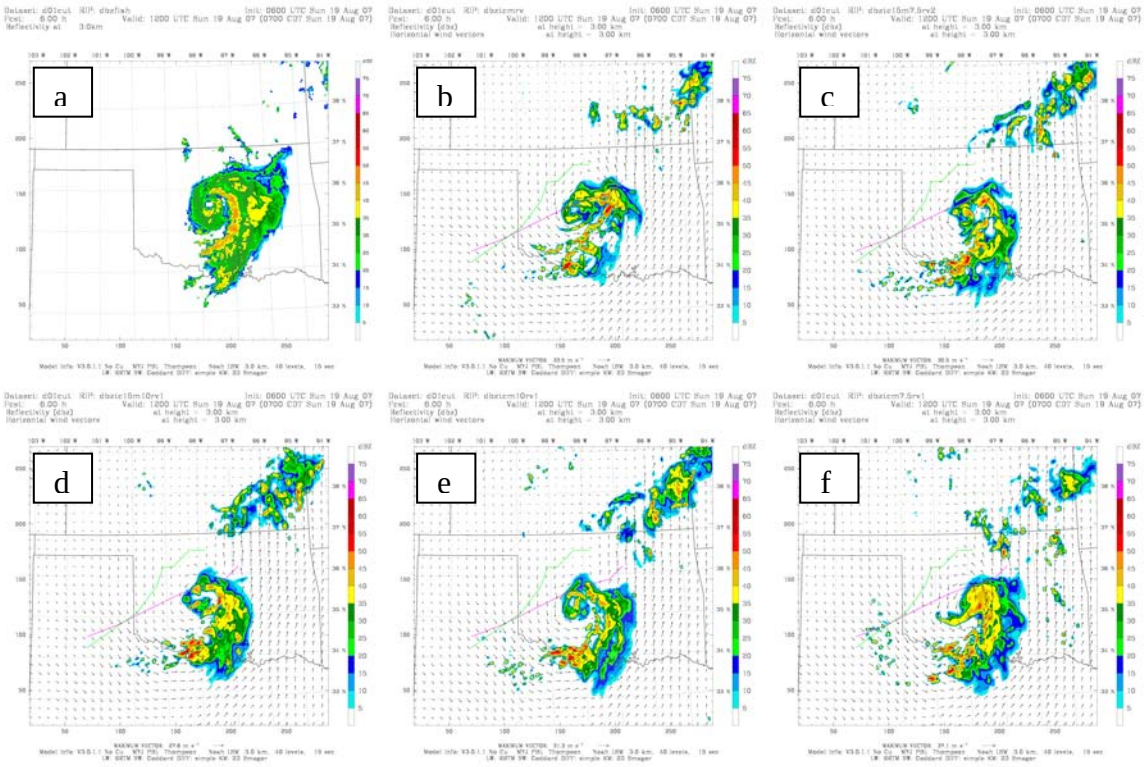

Figure 4. As Fig. 3, but for different horizontal correlation scales and 6-hour forecast length. (a) Observed reflectivity. The multiplication factors for the correlation scales of conventional, mesonet and radar data are, respectively, (b) 0.093, 0.125 and 0.027 as in the RUC-based experiments, (c) 0.09, 0.045 and 0.012, (d) 0.09, 0.06 and 0.006), (e) 0.06, 0.06 and 0.006, and (f) 0.045, 0.045 and 0.006.

In preparation for running tests for new cases in the GSD computing environment, Yi Yang repeated some of Erin experiments on a GSD machine, with a Rapid Refresh workflow modified for running retrospective cases. This is to ensure quick integration of the development and findings into the operational version. CAPS is working with GSD in choosing new cases for testing radial velocity data for 13 km RR grid. In January, Ming Xue presented the Erin data assimilation and prediction results at the AMS Annual Meetings. A CAP received its 55K FY08 funding during the quarter and is expecting the remaining FY08 funds soon.

09.5.19.4 30 Sept 2009 (GSD)
Develop and test improved DFI assimilation of radar reflectivity at 3-km using observation-based specification of latent heating within WRF-DFI developed by GSD and NCAR in FY08.

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

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

NCEP
Jun Du reports that the transition of the operational SREF system from the current NCEP P5 computer to the new P6 computer was carried out and completed. In addition, a new parallel SREF system (matching

the upgrades whose implementation was postponed in December 2008) with hourly output aimed at SPC's & AWC's efforts to improve convection forecast guidance in 2009 was established and is running four-times-per-day on the new P6 computer. This parallel system will replace the current operational system in the near future. The evaluation of this parallel system is underway. A paper on the verification of a fog prediction method using part of the NCEP SREF system was written together with the developer Binbin Zhou. A new method called "neighborhood approach", which might be useful in high-resolution mesoscale runs, was adopted to create a probabilistic forecast based on a single deterministic forecast. It's now being tested using HiResWindow runs as a possible component for the Very Short-Range Ensemble Forecast (VSREF) system. Results will be reported as they become available.

BinBin Zhou is working with MDL & NWS' Pacific Region to develop procedures to verify ceiling/visibility over Hawaii regions. This is another IC4D effort similar to the one going on in NWS' Alaska Region. There are still some issues to be addressed, like how to split flight restriction probabilities at MDL.

Shun Liu has started to run a radar data processing parallel and is archiving GRIB formatted 3D reflectivity mosaic data. This is to allow future retrospective testing to be conducted without the onerous task of retrieving huge files from the Production Suite run-history archive on HPSS.

Subtasks

09.5.20.1 Complete 'research quality' version of upgrade to SREF (e.g. higher resolution, more WRF members and more physics diversity) for consideration in November 2010 SREF upgrade package. (31 Jan 09)

NCEP started transitioning code to a new supercomputer system in January. The transition of the operational SREF system was completed by March. The parallel SREF system with hourly output aiming toward aviation forecasts has been established and is running on the new computer. This parallel system will replace the current operational system within a week of Production running on Stratus (next quarter). In February, the evaluation of this parallel system was started. Work on adding radar reflectivity and echo top to the parallel SREF is underway now at the request of Aviation Weather Center and FAA's Danny Sims. A problem in calculating ceiling probability was also identified and fixed in the SREF ensemble product generator code. (Du)

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

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

A new fog algorithm was designed and developed in FY2007 and presented at Fog Remote Sensing and Modeling (FRAM) Workshop at Dalhousie University, Halifax, Nova Scotia, Canada 21-22 May 2008. This algorithm was incorporated into the special ensembles NCEP ran in support of the Beijing Olympic games in August 2008. A paper about the verification of a fog prediction method using part of the NCEP SREF system was written by Binbin Zhou and Jun Du and is under internal review prior to submission to Weather and Forecasting. (Zhou)

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

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

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

month's report.

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

Deliverables

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

CURRENT EFFORTS:

A new method called the "neighborhood approach" was chosen to create a probabilistic forecast based a single deterministic forecast. The method could be useful in high-resolution mesoscale runs. Although initial coding work has been started to test this new method, using hi-res window runs for the future Very Short-Range Ensemble Forecast (VSREF) system, it was temporarily stopped in favor of other higher priority work related to the parallel and operational SREF systems. (Du)

Work has started on the verification of ceiling/visibility/flight restrictions over Hawaii where IC4D techniques are being tested (following a similar exercise in NWS' Alaska Region). NCEP is helping MDL to pre-process SREF's aviation product GRIB files. The pre-processing procedure includes splitting current probability files into single threshold files. For example, an original ceiling probability file includes 5 thresholds like < 1000, 2000, 3000, 4000, 5000 m. MDL has no tool to decode the multiple-threshold probability file, so code is being developed for MDL to split the file into 5 small files, each with a single ceiling threshold, and then archive them. The split code is just finished and the split files have been reviewed and accepted by MDL. (Zhou)

PLANNED EFFORTS:

Further tune the convective parameterization scheme and run more case studies. Construct initial VSREF system using the highly adaptable ensemble product generator. Wait for MDL evaluation results and make improvements based on their feedback. (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.