MDE Product Development Team
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With contributions from Geoff DiMego and Mary Hart (NCEP/EMC);
Stan Benjamin, John Brown, Steve Weygandt (NOAA/ESRL/GSD);
Jordan Powers, Roy Rasmussen (NCAR);
And Ming Xue (OU/CAPS)

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

Executive Summary

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

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

- Rapid Refresh continues to provide results better than or equal to those from RUC.
- Overall performance of the RR is now generally suitable for implementation of the RR.
- Transfer to NCEP cirrus largely complete, initial work by Geoff Manikin to build parallel cycle underway

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 being readied, planned for April

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

- WRFv3.2 nearing readiness. Contributions from NCAR to WRF model, especially on WRF physics, and from GSD on DFI and land-surface model.

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

- Ceiling forecasts from RR now generally exceeding those 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

GSD

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

Preparation for upcoming RUC change package at NCEP, including extension to 18h, assisting EMC (Geoff Manikin) where current parallel version is being run (**http://www.emc.ncep.noaa.gov/mmb/ruc2/para/**)

Changes 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

Geoff Manikin that the RUC package was implemented on 2 March 2010, to extend the RUC forecasts out to 18 hours every hour. Code was been tested and delivered to NCO. The change package also includes 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 will also be a modification to the timing of the model snow clearing. It was previously performed each day at 1900 GMT, but since the snow data file becomes available around 2300 UTC, the snow clearing now takes place during the 23Z RUC cycle. A second clearing is now performed at 18Z the next day to catch eastern US grid points which might have temperatures too cold at 23Z for the model to allow the removal. Finally, the change package included a reduction of the minimum layer thickness, which allows the time step to be set back to 20 seconds (it was changed to 15 seconds in response to model crashes on 21 January).

A second implementation was accomplished on 9 March in which the station list for the model BUFR data will be updated. Requests from users have been gathered, and approximately 80 new stations will be added and 15 deleted. The identifiers and latitude and longitude values for others will be updated.

Dennis Keyser reports that works continues on: radiosonde sites that report an invalid instrument type, late arrival of GOES 1x1 field-of-view cloud data, bring in new SSM/IS data from DMSP F-16 and F-17 satellites to replace discontinued SSM/I products, use of TAMDAR data from AirDAT as a MADIS alternative and the NRL-based aircraft QC code. A major upgrade to the NCEP BUFR library is being tested for implementation in FY2010. The Florida and Georgia DOT and Aberdeen PG mesonet providers have been down for several months.

A sudden, large variability in the RUC dump run times occurred on 21 January. Dumps for a few random cycles began taking up to 5 minutes longer to run, because the initiation of an NCO parallel production RUC test on 21 January caused machine contention between the production and parallel dump jobs. On 26 February the start time of the parallel dumps was slightly changed to fix the problem. Most of the 24 February 1500 UTC mesonet data contained incorrect latitude, longitude and elevation values due to a problem triggered when 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 (most obs were likely rejected by the automated QC).

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

GSD

Excellent progress in Rapid Refresh development in January 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.

NCAR/MMM

CURRENT EFFORTS: NCAR continued to prepare the next major WRF release, V3.2. This will be out in spring. Work included testing, implementation of bug fixes, and coordination
(Release Committee).

Various code changes (in preparation of V3.2) were made for different physics schemes. For the Noah LSM, internal budget terms were fixed. 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. The budget-keeping code was corrected.

For the RRTMG longwave radiation scheme, Jimy Dudhia of NCAR/MMM implemented a bug fix obtained from Mike Iacono (AER, Inc.). A minor bug in the computation was biasing surface fluxes by 0.1-0.2 W/m**2.

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

Lastly, Dudhia worked with visitor Song-You Hong (Yonsei Univ., Korea) on improvements to the YSU PBL scheme for V3.2, which were found by discussion with Peggy Lemone (MMM). Dudhia is also working with developers on the next-generation hybrid TKE version of the YSU scheme.

PLANNED EFFORTS: The support of the physics component of the WRF infrastructure and the implementation of modifications will continue. NCAR will continue to prepare the V3.2 release.

UPDATES TO SCHEDULE: NONE

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

GSD

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 continues to be generally superior to or equivalent to the GSD backup RUC over the CONUS. Two exceptions are 2-m daytime dew points, which are forecast too high over the eastern CONUS, and relative humidity above about 600mb, which has a high bias that is largest at initial time. The latter problem is possibly tied, through the partial cycling, to GFS use of RH based on a mixture of ice and water saturation between 0 and -20C and on ice saturation at temperatures colder than -20C. Investigation is ongoing.

We have temporarily moved the dev RR cycle to nJet as part of the transition toward initializing the HRRR from the primary RR cycle instead of from the RUC. The primary RR cycle continues to run on wJet. As expected, the RR runs much faster on nJet; 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. As soon as we are convinced that the primary and dev cycles, which are now using identical codes, are giving acceptably very similar results, we will move the primary RR cycle to nJet, running under reservations, and use the devRR cycle to further tune the temperature tendency derived from the hydrometeor analysis and used in the forward (diabatic) part of the DFI. We also plan to compare an alternative pair of dynamics namelist options (monotonic moisture advection and no 6^{th}-order diffusion) using the devRR. We are also considering running the primary RR to 15h or 18h at certain times of the day, depending on computing resources on nJet. When the RR becomes operational at NCEP, it will be run hourly to 18h (see Task 1 for discuss operational implementation of progress toward the 18-h RUC.)

Following last month's solution to the problem of spurious strong jets normal to the lateral boundaries, the introduction of a namelist option to set the tendencies on the lateral boundaries to zero was accepted by the NCAR WRF-ARW developers for inclusion with the upcoming 3.2 release.

Tanya Smirnova and Curtis Alexander continue to add RUC options to the NCEP WRFpost-processor (WPP). 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 will be tested at GSD on RR output 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.

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 mid-February to mid-March, RMS vector wind errors at all levels at 3 and 12h from the RR primary 1-h cycle were consistently better than or equal to the RUC backup. 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).

With the approach of spring, we are beginning to see 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 appears to be much 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 field, 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.

At a December meeting between GSD and EMC teams, it was agreed to build an RR components from a common set of scripts (initial work by Eric Rogers) and the common NCEP unified post-processor program. On Thurs 14 Jan 2010, ESRL/GSD gained access to the NCEP Unipost code repository (thanks to Hui-ya Chuang and others at NCEP for this).

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

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

GSD

Ming Hu has continued to build a real-time cycle at NCEP and has both the 6-hourly lateral boundary condition cycle and the hourly cycle running. He has communicated information about the cycle to Geoff Manikin, who has begun work to create a real-time cycle for NCEP pre-implementation testing. Two file access issues from last month have been resolved: accessing a real-time feed of the pressure-level GFS files for use as boundary conditions and accessing the PrepBUFR observations. One other fairly minor 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 has also sent a plan to John Derber outlining the steps to add the RR-specific changes to the NCEP GSI SVN repository trunk. The submission will include the following sequence: 1) trunk portability and regression test, 2) add background cloud/hydrometeor fields and cloud analysis observations, 3) add radar and lightning data, cloud analysis lib and driver, 4) test GSI trunk with cloud analysis in RR cycle, 5) add binary I/O to trunk.

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.

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.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

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 now producing at least equal results to the RUC in all 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.
The Rapid Refresh will be upgraded to WRFv3.2 when it is released by NCAR in early spring 2010. WRFv3.2 will include some improvements to the Thompson microphysics and RUC land-surface model. 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. NCAR has submitted these enhancements to the WRF svn repository and they will be part of the WRF v3.2 release expected by late March 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. They have collected high-quality data that may be of use to us in diagnosing model issues in the far north.

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 Eidhammer 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 ran 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.

PLANNED EFFORTS:
Continue testing the new aerosol scheme.

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED:
None

INTERFACE WITH OTHER ORGANIZATIONS: GSD
GSD is anticipating starting a cycle with chemistry using the global FIM model. This will allow improved background fields for regional aerosol models.

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 reported in previous months, the RR is generally equal to or better than the RUC for ceiling forecasts critically dependent on cloud/hydrometeor assimilation. Some recent changes to the RUC cloud/hydrometeor assimilation technique will be added to the GSI cloud/hydrometeor assimilation as part of the GSI commits to the NCEP repository.

GSD has requested that the NASA Langley cloud-top data be set as a highest priority on the NCEP Data Mining List. NCEP has added the Langley cloud data to the list of requirements for the Rapid Refresh implementation.

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.

Thanks to work from Ming Hu, testing of the GSI cloud analysis within the RR on the ESRL jet supercomputer is complete and 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 it is running in an hourly test mode. Geoff Manikin is currently working to build a full parallel RR cycling for final NCEP testing and work is underway to get the generalized cloud analysis fully incorporated into 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.

As of late February, the HRRR is running with high 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.

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.

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
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. 1 below shows a significant improvement in HRRR forecast skill with radar assimilation, as anticipated. Thanks to NCAR for this verification.

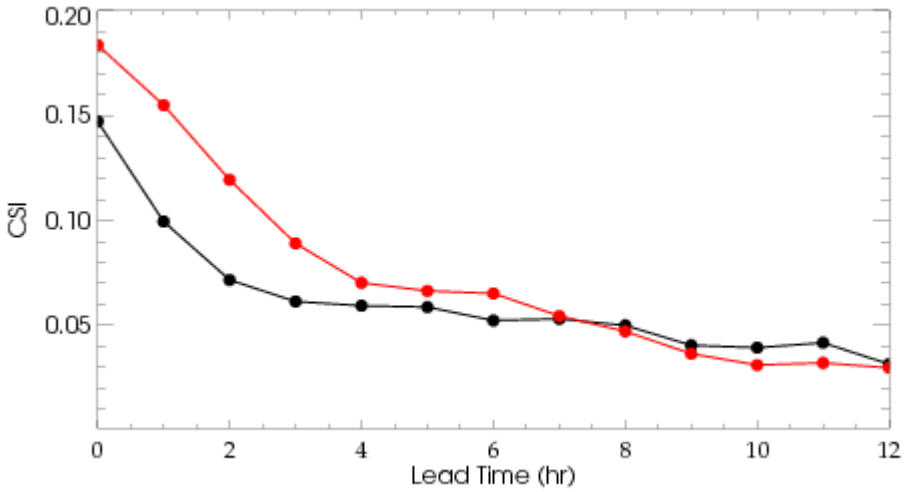

Fig. 1 CSI skill score comparison for the HRRR run from a RUC with the radar assimilation (red curve) with a HRRR run from a RUC without the radar assimilation (black), averaged over seven runs during the morning of 30 July, 2000. (Credit for figure: James Pinto, NCAR)

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.

Previous tests have shown small positive impact of level-2.5 radial velocity data on short-range precipitation forecasting for RR and HRRR configurations. More efforts are made in the past month on systematic tests on reflectivity data assimilation via cloud analysis and initialization procedures. In the process, bug was found and fixed in the cloud analysis package. It occurred with the assignment of the initial value of precipitation type which was set to -99999 while the correct value should be 0. The precipitation type 'no rain', 'rain', 'snow', 'freezing rain', 'sleet' and 'hail' are represent by integer value 0~5 respectively in GSI. The initial value of -99999 led to the shift of the precipitation type index by one. For example, snow becomes rain water. Fig.2 shows the vertical cross section of analyzed precipitation type. As expected, the bug leads to too much super-cooled water above zero temperature line. Experiments on the RR grid for the June 16, 2009 test case were rerun with the bug fix. The GSS scores show only a small difference between the two versions, indicating the type assignment is of secondary importance compared to the heating introducing through the cloud analysis – this is consistent with earlier studies performed at CAPS using ARPS cloud analysis system. In the model forecasts, adjustments occur quickly to make the hydrometeor spices consistent with the model microphysics.

Earlier experiments on the RR grid found that the stratiform and convective cloud options in the cloud analysis performed differently during 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 is 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, due to the relatively coarse resolution of RR grid, only a small number of grid points were identified as convective, the results were therefore more like or occasionally worse those using pure stratiform treatment. Figure 3 shows the average GSS scores from 19 UTC, June 15, 2009 to 06 UTC, June 16, 2009 on both RR and HRRR grids. On average, the default option based on the stratiform method is better than convective method on both RR and HRRR grids. On the RR grid, the GSS scores of the combined version are in-between the stratiform and convective methods in the first two hours and better than both during the 3 to 5 h, but worse than both after 6 hours of forecast. On the HRRR grid, however, the combined version performed slightly better than either stratiform or convective method all of the times when significant precipitation was present.

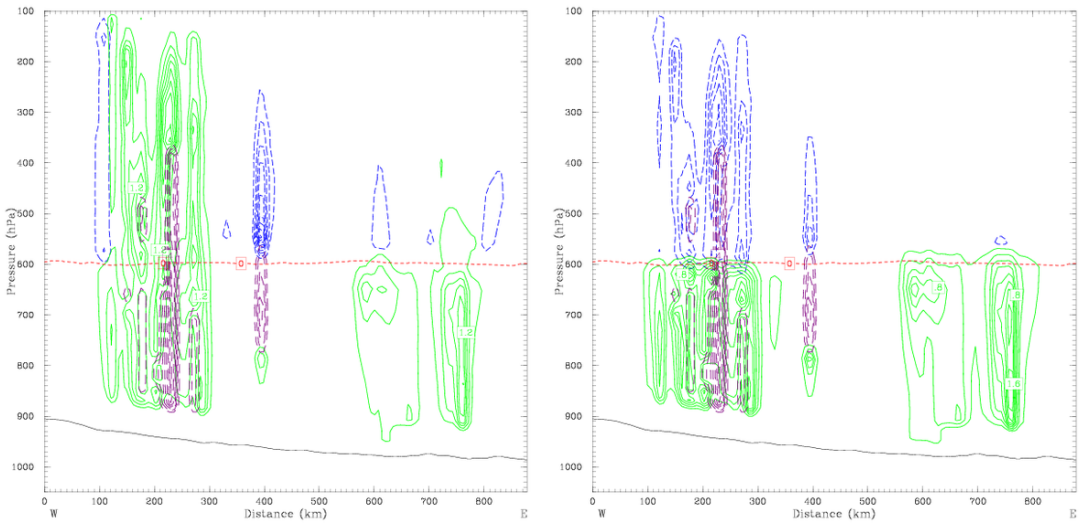

Fig. 2. Analyzed rainwater (green solid line), snow (blue dashed line) and graupel (purple dashed line) precipitation types, before the bug fix in cloud analysis (left), and after the bug fix (right). The red dashed line is zero temperature line.

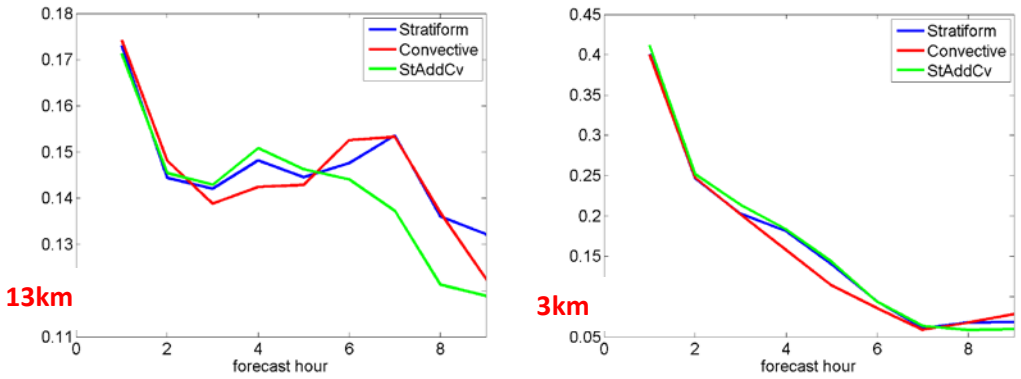

Fig. 3. Averaged GSS scores hourly updated forecasts starting at 19 UTC, June 15, 2009 through 06 UTC, June 16, 2009, for experiments using stratiform, convective and combined (StADDCv) cloud typing in the cloud analysis package, for the RR (left) and HRRR (right) grids.

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 is considering the steps of implementation.

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).

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.