MDE Product Development Team
October 2009 - FY10 Monthly Report
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(Compiled and edited by S. Benjamin and B. Johnson)

Executive Summary

Rapid Refresh / RUC Technical Review at ESRL – Tues 3 Nov 2009 – 160-slide presentation – **http://ruc.noaa.gov/pdf/RR-RUC-TR_11_3_2009.pdf** . This PowerPoint contains information on RR and HRRR progress.

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

- Testing underway at NCEP for 18h RUC, implementation to wait to Jan-Feb.
- TAMDAR thinning from limited NOAA funding has reduced RUC accuracy starting in late October.

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

- Partial cycling for Rapid Refresh running in primary 1-h cycle at GSD, giving much improved results
- Wind, temperature forecasts from RR now exceeding those from RUC.

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

- Sept - GSI code change to upgrade to FY09 version (with all RR features added) and to move cloud analysis *after* variational solver and add removal of super saturation and negative moisture.
- RR GSI – completion of elevation correction for surface obs to match model value, retrospective test show small positive impact.

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

- Contributions from NCAR to WRF model, especially on WRF physics.

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

- Ceiling forecasts from RR now matching or exceeding those from RUC, due to improvements to RR cloud/hydrometeor analysis

Task 10.5.24/19: Development/testing of HRRR

- HRRR now running over full CONUS domain

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

GSD

- General monitoring of operational RUC at NCEP, inter-comparisons with backup RUC, dev RUC run at ESRL.
- Monitoring two TAMDAR availability issues for RUC. Comparisons of RUC forecast skill and TAMDAR counts between different RUC versions (oper-NCEP, backup-ESRL, dev-ESRL)
    - Restoration of TAMDAR RH data to NCEP (first noticed by ESRL in August) on 14 Oct. Counts increased as expected. Obs-RUC-1h-forecast differences also about as expected (6-12%).
    - Noted beginning of TAMDAR thinning starting 10/28 by about 90%.
        - About half of the TAMDAR temperature forecast improvement is lost from the thinning (compared to the devRUC, where all TAMDAR data is used), and about 80% of the TAMDAR moisture forecast is also lost from the thinning.
- Inter-comparison of oper-RUC vs. ESRL versions regarding ceiling and cloud height products, including verification against METAR ceiling obs.
    - Oper-RUC assimilates limited area NESDIS cloud product (over CONUS only), backup and devRUC use NASA Langley hourly cloud product (over Rapid Refresh domain, including complete RUC domain). See Task 5.15 on further work on cloud/hydrometeor assimilation.

NCEP

Dennis Keyser reports that NCEP/NCO is investigating radiosonde sites that report an invalid instrument type. Still waiting for NESDIS to respond to two problems, the GOES 1x1 field-of-view cloud data (where a few random files have data problems) and the late arrival of GOES-East data. A problem with 20 August MADIS netCDF TAMDAR file changes (that prevented TAMDAR moisture data from being decoded at NCEP since then) was corrected on 14 October. The amount of TAMDAR data available to NCEP (from both AirDAT and MADIS) was reduced by 90% after 29 October when the amended AirDAT contract with the NWS went into effect. NCEP plans to obtain all TAMDAR data from AirDAT as alternate to MADIS and add airframe type and company code to allow improved bias corrections to be developed. The backup AFWA feed for MDCRS data was discontinued on 30 October when their contract with ARINC expired. These data are used by NCEP only once or twice a year on average when the primary ARINC MDCRS feed goes down. NCEP continues working toward moving the NRL-based aircraft QC code into production. Changes are being made to speed up the dump processing in order to reduce the extra time used by this new QC code. The problem of some drifting buoys with missing station pressures not being decoded properly was corrected on 27 October. No tide gauge data was available October 5-6. An updated version of the NCEP BUFR library software is being tested for implementation in FY2010. The quality of SSM/I products from the operational F-13 satellite has been degraded since early August due to instrument problems. There was a 10-hour SSM/I outage on 3 October.

Geoff Manikin reports that work is underway to extend all RUC cycles to 18 hours and to produce output hourly throughout each 18 hr forecast. Code has been tested and RFCs delivered to NCEP Central Operations. The change package also includes code to assimilate Canadian aircraft observations and a correction for a problem with virtual potential temperatures not being adjusted in response to changes in mixing ratio associated with cloud building. This package has a projected implementation in Quarter 2 of FY 2010.

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

Progress in Rapid Refresh development toward upcoming implementation at NCEP over next few months as experimental RR cycle for testing before final submission to NCO for operational implementation next April-June.

NCEP

Eric Rogers continued running the NEMS- and NMMB-based NDAS/NAM real-time parallel system on the CCS. Additional fixes were installed to fix problems with the assimilation of NEXRAD radar data and the use of the parallel NAM 00z 12-36 h forecast precipitation to adjust NDAS soil states outside of the CONUS.

All NCO testing for the operational implementation of the minor bug- fix bundle for the NDAS/NAM was successfully completed, and the EMC real-time parallel NAM forecast was turned off 9 October 2009. The implementation is scheduled for 3 November 2009.

Since many obs-processing activities listed under Task 10.5.1 also pertain to 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. Mobile synoptic data were not available 26-30 October due to provider site issues. The following data types are monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), QuikSCAT 0.5 deg. scatterometer wind superobs (which have now degraded in quality), Mesonet mass data, and MDCRS moisture data. NOAA-19 1b radiances will soon also be monitored. Lower P6 Level II 88D radar data dump counts (vs. their P5 counterparts) are being investigated. We are generating NAM/NDAS PrepBUFR files with 50 km ASCAT and WindSat scatterometer wind data (both non-superobed) and NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and SBUV-2 data. These changes to obs monitoring are being tested in the real-time parallel NDAS/NAM. Using 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 as a possible replacement for the current synthetic wind data bogus. A legacy restriction (that only surface data with a reported pressure is processed) will be removed to allow many new surface observations (land, marine and Mesonet) to be assimilated in the RTMA and possibly NAM/NDAS. The geographical domain for the RTMA dumps will soon expand beyond the NAM domain to include Guam.

NCAR/MMM

NCAR/MMM implemented a number of code modifications and bug fixes for WRF physics. Jimy Dudhia added a QNSE surface-layer fix to the repository in preparation for DTC long-term testing of the option. Dudhia also modified the gravity-wave drag option to solve problems with thin model layers. Lastly, Dudhia worked with Wei Wang (NCAR/MMM) on finalizing changes to resolve problems seen in long runs with nest feedback and surface vertical velocity. These were added to the repository.

Some RRTMG longwave radiation scheme problems were fixed. These fixes will help the simulation of outgoing longwave radiation by including snow as cloud ice, with the additional benefit of making the results less sensitive to the microphysics option chosen. Meanwhile, the same addition in shortwave radiation should improve cloudy surface solar fluxes. Another fix from the RRTMG developers addressed specific microphysics schemes that have simplified treatment of ice clouds. These mods are being added to the repository.

Dudhia obtained a possible new microphysics scheme for WRF, the Milbrandt 2-moment scheme, from Jason Milbrandt of Environment Canada. Testing on this scheme is beginning.

Dudhia started working with the DTC on examining HWRF physics and advising the DTC on merging options, especially microphysics and radiation, with existing ones in WRF. Dudhia also contributed to merging several new roughness length formulation options into surface-layer schemes to help with hurricane applications and thermal roughness lengths over land. Fei Chen of NCAR/RAL has provided these options.

PLANNED EFFORTS:

NCAR: The development and improvement of the physics component of the WRF infrastructure and the implementation of modifications will continue.

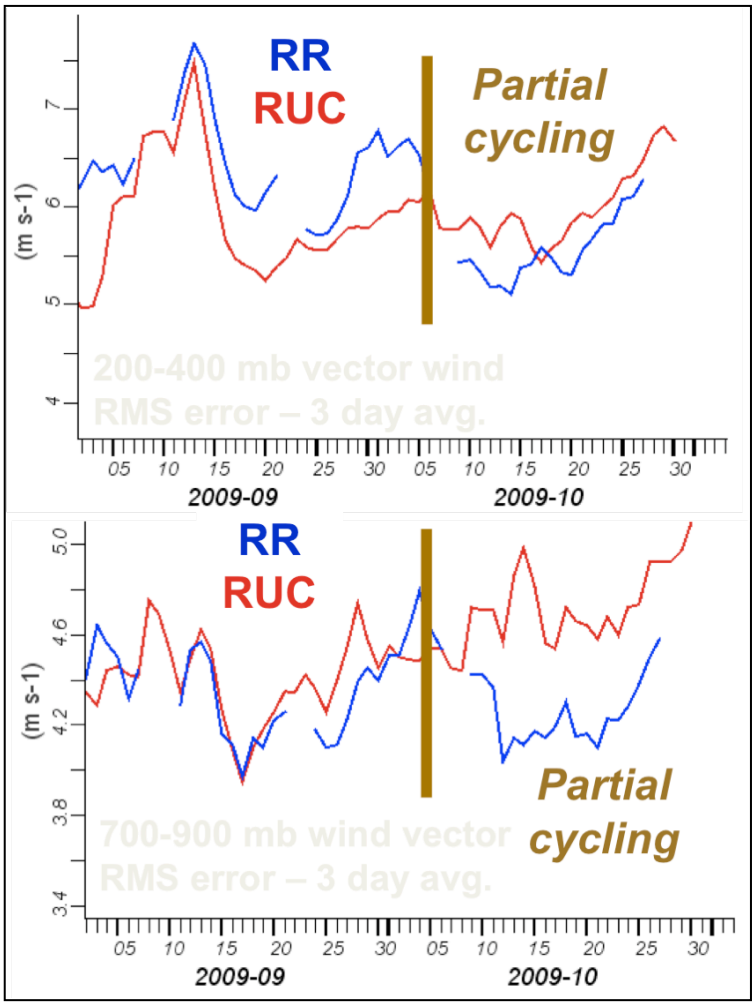
Task 10.5.4 Develop, test, implement, and improve the Rapid Refresh.

GSD

Progress on the Rapid Refresh continues. Although there have been some incomplete cycles (model forecast failing to complete to 12h, particularly during normal working hours when the load on Jet is heavier), the number of missed cycles is much less than last summer. This has enabled continued strong effort toward remedying known problems. On 3 November our progress was summarized as part of an ESRL/GSD Technical Review presented in Boulder. The presentation is available at **http://ruc.noaa.gov/pdf/RR-RUC-TR_11_3_2009.pdf** . With the termination of the 2/3 CONUS HRRR runs in early November, an attempt will again be made to put both RR cycles under reservations on w/hJet. If this is successful, reliability should be further improved.

In early October this cycle began using the partial-cycling procedure (discussed in the FY09Q4) report in which the atmospheric fields are rederived in a catch-up hourly update cycle twice daily, starting from GFS or NAM grids. (Because the NAM grids available at GSD are not available to sufficiently high altitude, we are using the GFS in our testing at GSD.) The land-surface fields are fully cycled within the Rapid Refresh. This partial cycling design takes advantage of the improved data assimilation for longer waves in the global GSI than for the regional GSI used in the NAM and RR. The procedure starts from GFS atmospheric fields (excepting the land-surface fields (soil temperature/moisture at 6 levels, snow water equivalent/density/temperature in 2 layers), which are fully cycled by the RR) two times per day (03z and 15z) and performs an hourly updated pre-forecast cycle for 6h (through 9z and 21z respectively). Then a regular full, hourly, cycled RR proceeds until the next partial cycling time. Results from the partial cycling are very encouraging, showing improvement for most fields over those obtained earlier without the partial cycling. (Figure 1 below: Top image 200-400 hPa layer 3h forecast – RMS wind vector error vs. raobs. Lower – same but for 700-900 hPa layer. Partial cycling implemented on 4 October 2009.)

Testing of alternatives to the standard WRF-ARW procedures for deriving 2-m temperature and dew point and 10-m wind also continues. On the basis of verification against METAR surface observations, we decided to revert back to the WRF-ARW procedure for inferring 2-m temperature using skin temperature and surface heat flux, rather than using the temperature forecast at the midpoint of the lowest model layer, which is about 8m AGL. Using this 8m value further damped the diurnal cycle. The alternative of using the forecast mixing ratio at this 8-m level is still under consideration. On the other hand, METAR verification revealed that using the 8-m horizontal wind directly as the diagnosed 10-m wind is to be preferred to using the WRF-ARW procedure, which presumes a coarser vertical resolution than we specify.



The dev RR cycle continues to run with full cycling of RR fields (i.e., without the partial cycling discussed above). We continue to see the gradual buildup of isolated spurious strong flows normal to the lateral boundaries, particularly on the western boundary over the Pacific. The partial cycling in the primary RR 1-h cycle masks this, since the amplification of this feature is very gradual. Nevertheless, we

regard this as a serious issue that must be resolved, and are now investigating a possible WRF issue to force recalculating tendencies inside the WRF model consistent with GSI updating and non-3h-initial times.

NCEP

Dennis Keyser reports that experimental Rapid Refresh (RR) PrepBUFR files containing 50 km ASCAT, WindSat data (non-superob) and expanded (time-window) QuikSCAT data (0.5 deg lat/lon superobs) are being generated at NCEP and copied to a private ESRL directory on the NCEP ftpprd server. The quality of the QuikSCAT data has degraded to the point that it should not be used by any assimilation system (it was turned off in the GBL-GSI on 7 October and in the RTMA analysis on 16 October). RR dumps of expanded (time-window) Level 2.5/3 88D radial wind data are being copied to a public ftp directory. These and hourly lightning data are being tested in ESRL's experimental RR runs. Future data tests will include Multi-Agency Profiler winds, Canadian AMDAR data and METOP-2 radiances. EMC and GSD request that the ROC start their hourly processing of Level 2.5 88D data 10 minutes earlier so more data will arrive before the RR cutoff. This is critical for the Alaska portion of the expanded RR domain, where the only source of radial wind data is the Level 2.5/3. The possibility of adding Level II 88D data over Alaska is being discussed.

Subtasks:

10.5.4.1 Ongoing (GSD, NCEP)

Ongoing evaluation of performance of real-time and retrospective runs of RR system for SAVs, AHPs.

Partial cycling has substantially improved verification of the primary RR1h cycle relative to the RUC when measured against rawinsondes. RMS vector wind errors at all levels at 3 and 12h are now consistently better by up to 0.5m/s or so than the RUC backup, and RMS temperature errors are similar. There is a small high bias on wind speeds at most levels for the RR1h, and a small warm bias in temperature in the lower and middle troposphere.

Work continues toward improving diagnosis of 2-m temperature and dew point, and 10-m wind (see above).

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) and in grib1 and grib2 formats.

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.

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.

As noted under subtask 1, we have seen appreciable improvement in RR1h performance over the CONUS relative to the GSD backup RUC since we implemented partial cycling.

Deliverables:

10.5.4.E1 20 Dec 2009 (GSD)
Report on Rapid Refresh testing at annual NCEP Production Suite Review meeting.

10.5.4.E2 1 Aug 2010 (GSD, NCEP)
Complete documentation (in Technical Procedures Bulletin-like document) of Rapid Refresh system.

10.5.4.E3 1 May 2010 (GSD, NCEP)
Pending EMC, and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit Rapid Refresh software to NCO.

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

GSD
With the successful implementation of a partial cycling system for the Rapid Refresh (RR), a number of enhancements to the RR cloud analysis (see task 5.15), and good results from a detailed verification assessment, most elements are in place for the RR transition to NCEP. We are currently running two full parallel RR cycles at GSD, a primary (RRprim), and a developmental (RRdev). In addition, we have a 1-week retrospective test case period, which has been used to evaluate changes in more controlled environment.

Following summer testing, Ming Hu recently implemented a partial cycling system in RR prim. In this system, a 6-h, hourly cycled, pre-forecast is run two times per days (3z and 15z), starting from GFS fields, but retaining hourly cycled RR land surface fields. This pre-forecast cycle is used to spin-up small-scale surface, cloud, and precipitation features, while retaining the favorable large-scale upper-level fields from the global model. Upper-level verification indicates a significant skill improvement with the partial cycling system. Dezso Devenyi has completed work to modify the GSI surface assimilation to account for differences in the model vs. actual terrain height and this change has been evaluated in a 1-week retrospective test, yielding small positive results for surface verification. Dezso is currently working on modifications to allow surface observations to be used throughout the depth of the boundary layer.

NCEP
Wan-Shu Wu worked on fixing the time-reference and time-shift variables in the regional mode of the GSI code. This fix was necessary to exercise FGAT option and was in preparation for the future extension of GSI to 4D-Var. The code will be reviewed and checked into the GSI repository. She also compared the observational error using adaptive tuning and the conventional method of first guess fit. The results from both methods produced statistics of similar magnitude but the vertical structures were different. The adaptive tuning is effective in taking into account the adjustment to the observational error inside the GSI. In an attempt to combine the two methods, the tuning results from the conventional method were used as the first guess to the adaptive tuning. It was observed that the adaptive tuning is not sensitive to the initial statistics used. With help from Eric Rogers she also adapted the parallel scripts to run the NDAS with NMMB. The off line parallel currently includes NOAA 19, METOP-A IASI, and AQUA AMSU-A and ACAR's humidity data for testing.

Dave Parrish continues work on the new version of the dynamic constraint (TLNMC). The very bad initial performance in 12 hr assimilation with the low-res test bed was caused by a one line bug found by John Derber. The performance was much more reasonable after the bug fix, but preliminary results are still a bit worse compared to the existing TLNMC.

Manuel Pondeca has set up a 2.5 km resolution CONUS RTMA using the RUC-downscaled first guess provided by Geoff Manikin. The Hawaii domain is being shifted slightly to match up with an existing Pacific typhoon chart. These systems' performance is under evaluation. He has also begun work on setting up a routine cross-validation capability for the RTMA.

CAPS

Subtasks:

10.5.5.1 30 Nov 2009 (CAPS, NCEP)
Refine the radial velocity analysis component of GSI and determine the optimal decorrelation scales for different analysis passes.

Yi Yang of CAPS completed a mini-retrospective test case (27 hours of hourly cycling for a June 15-16 2009 Kansas convective event) and evaluated combinations of reflectivity and radial velocity assimilation within GSI. Qualitative evaluation of the resultant forecast reflectivity fields indicated a greater forecast impact from the reflectivity assimilation compared to the radial velocity assimilation (with both 1 pass of the radial velocity assimilation and a second pass with shorter length scales). Quantitative verification is ongoing and work to further refine the length scales for the 2nd assimilation pass.

A set of tests for the 16 June 2009 case was completed for evaluating the impact of assimilating level-2.5 "super-obbed" radial velocity data on RR forecast. These forecasts were quantitatively evaluated at GSD. Moderately positive impact assimilating redial velocity data was found, using a reduced correlation scale when analyzing radial velocity data in the second pass of GSI. In addition, 10 new experiments were formed for the RR grid; they can be divided into three groups: one differing in the observational data assimilated; one using different cloud analysis options - the stratiform cloud option originating from RUC cloud analysis system, and one originating from the ARPS cloud analysis package targeting convective clouds); and one differing in the way analysis increments are used (e.g., used via DDFI or used directly). All the experiments were cold started from 15 UTC, June 15, 2009 with one-hour assimilation cycles, and 12-hour forecasts were launched every hour starting from 18 UTC. Verifications of hourly accumulated rainfall were performed in the RUC-13 domain from 19 UTC, June 15, 2009 through 06 UTC, June 16, 2009.

Figure 2 (below) shows the CSI scores (also known as threat scores) for the first group of forecasts. During the formation stage of the convection (before 21 UTC), the impact of assimilating radar radial wind data is relatively small though positive in general. However, the difference between the forecasts with and without radial wind data assimilation becomes larger when the isolated convective system evolved into an organized MCS, and the positive impact lasts at least 6 hours. But again the verification score looks similar to each other when the MCS began to dissipate. The scores become more similar again for the later initial condition times after the MCS dissipated. Other verification scores, such as GSS and HSS, show similar behaviors (not shown).

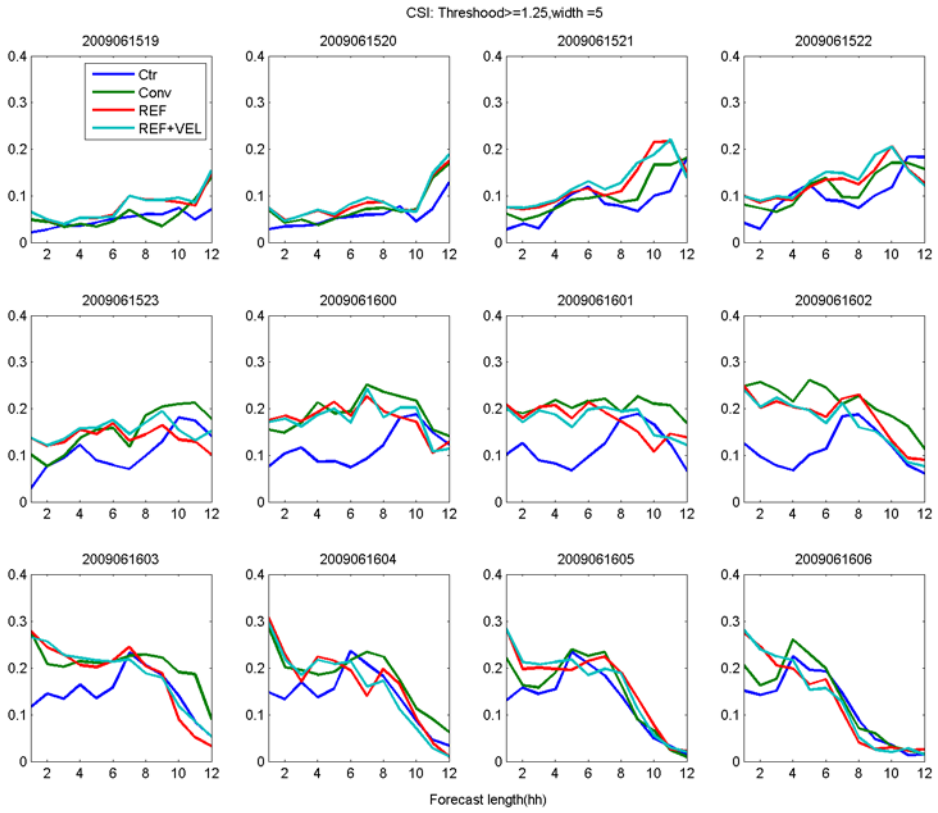


Fig.2. CSI scores of 13-km RR domain forecasts of assimilating different kinds of observation data: Ctr represents without any data assimilation but applied the standard TDFI in the WRF integration; Conv assimilated conventional observations; Ref assimilated additional reflectivity data; REF+VEL assimilated additional radial velocity data. The title string indicates the start hour of each forecast. The horizontal axis indicates the forecast hour.

In the experiment with different cloud analysis options, in the first few hours, the stratiform method is slightly better (see Fig.3), but for the start times in the MCS stage, the convective method performs obviously better. And again the difference becomes smaller during the dissipation stage of the MCS.

The final four experiments examine the impact of different initialization procedures. The results suggest that the inclusion of radar data makes a much bigger difference that the exact procedure that the radar-related analysis increments are introduced, either through the standard RUC DDFI procedure or at one time after digital filter is performed on analysis including conventional data only. Details will be reported later.

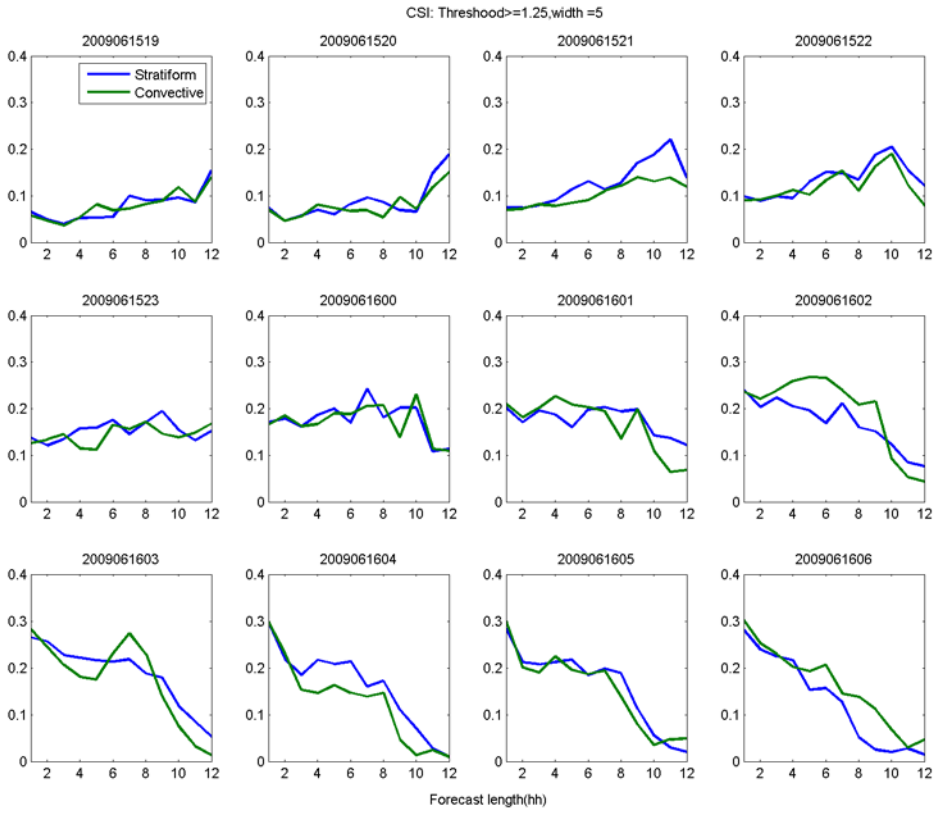


Fig.3. CSI score of RUC forecast with different cloud layer option in the GSI cloud analysis system. All the data including the radar reflectivity and radar velocity data are assimilated. The blue one is the current RUC operational method and the green is implanted from the ARPS cloud analysis system

10.5.5.2 28 Feb 2010 (GSD)

Report on statistical evaluation of pre-implementation Rapid Refresh forecasts initialized with the GSI, including examination of upper-level winds, surface fields, and precipitation.

Detailed evaluation of RR forecasts, including upper-level fields, surface fields, and precipitation fields was completed as part of a GSD internal review of the AMB branch. Results (see slides 82-86 in the RR-RUC Technical Review PowerPoint from (**http://ruc.noaa.gov/pdf/RR-RUC-TR_11_3_2009.pdf**), were very encouraging, with RR upper-level wind and temperature skill equal or better than RUC at virtually all levels. RR upper-level moisture was similar to RUC, but a bit worse at some levels. Surface verification was also encouraging for the RR, with scores similar to the RUC for temperature, dew point and winds.

10.5.5.3 31 May 2010 (NCEP, GSD)

Report on testing of 2DVAR GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 2.5-km or finer resolution.

10.5.5.4 30 June 2010 (NCEP)

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

10.5.5.5 31 July 2010 (NCEP)

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

10.5.5.6 31 July 2010 (NCEP)
Based on case-study testing and refinement of the research quality code, deliver results in an 'experimental' code for an upgrade package (e.g. 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 FY2011 change package to the NAM.

10.5.5.7 30 Sept 2010 (GSD)
Report on testing of FY11 version of GSI for FY11 Rapid Refresh upgrade.

Deliverables:

10.5.5.E3 31 Dec 2009 (GSD, CAPS)
Further refinement to the radial velocity analysis component of GSI for Rapid Refresh configuration.

See discussion in 10.5.5.1

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 was completed in preparation for a GSD internal review of the AMB group, including upper-level, surface and precipitation verification. Details are in slides 82-91 in (**http://ruc.noaa.gov/pdf/RR-RUC-TR_11_3_2009.pdf**) and summarized in 10.5.5.2.

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.

10.5.5.E4 31 Aug 2010 (GSD, CAPS)
New version of GSI including revised radial wind assimilation for FY11 RR upgrade.

10.5.5.E5 30 Sept 2010 (NCEP)
Subject to NCEP Director approval, implement NEMS/NMMB version of GSI (e.g. strong constraint, revised bkgs+obs errors) in NAM/NDAS.

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.
An RR retrospective test of the MYNN vertical mixing (boundary-layer) scheme with enhancements to the mixing-length formulation proposed by GSD is underway. 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.

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. Impacts over Alaska are being monitored as we head into the winter season. So far, performance has been satisfactory.

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.

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)
Provide an improved microphysics scheme to GSD for evaluation toward the FY11 Rapid Refresh upgrade.

CURRENT EFFORTS:
During FY09, a new ice nucleation scheme based on aerosol concentration was implemented into WRF. This scheme needs monthly background climatological aerosol initial concentration and mixing ratio. During this work period, a background field was obtained via the GOCART model, and software written to interface with the WRF model. This background field is then available to the WRF model for use in the updated Thompson microphysics scheme for ice nucleation and droplet activation when running real simulations.

A few ideal 2D squall line simulations with all the new dust and ice updates in the Thompson microphysics to see that results are reasonable.

PLANNED EFFORTS:
Continue testing the new aerosol scheme.

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED:
None.

INTERFACE WITH OTHER ORGANIZATIONS:
GSD

UPDATES TO SCHEDULE:
None.

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

GSD

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.

A number of improvements have been made to the RR/GSI cloud analysis, including moving the cloud analysis after the variational solver, so that modifications made by the cloud analysis are retained within the final analysis fields. In addition, Ming Hu and Stan Benjamin have conducted a detailed evaluation and comparison of the RR/GSI cloud analysis with that from the RUC, and have identified and resolved a number of small differences between the RR and RUC cloud analyses that were degrading the RR cloud analysis skill scores. As a result, POD and TSS scores for both analyses and 1-h forecasts have improved recently for the RR and are now very competitive with the RUC (see Fig.4 below). These improvements were first introduced in to the RRdev cycle, and then ported to the RRprim cycle.

We continue to assimilate experimental NASA Langley satellite-derived cloud-top data into the RRdev cycle. These data provide much more extensive coverage over Canada and Alaska, and the tropical Pacific and Atlantic Ocean regions of the RR domain. Qualitative evaluation of results indicates that introduction of these data help to reduce a high bias in high-level cloudiness of the tropical ocean regions.

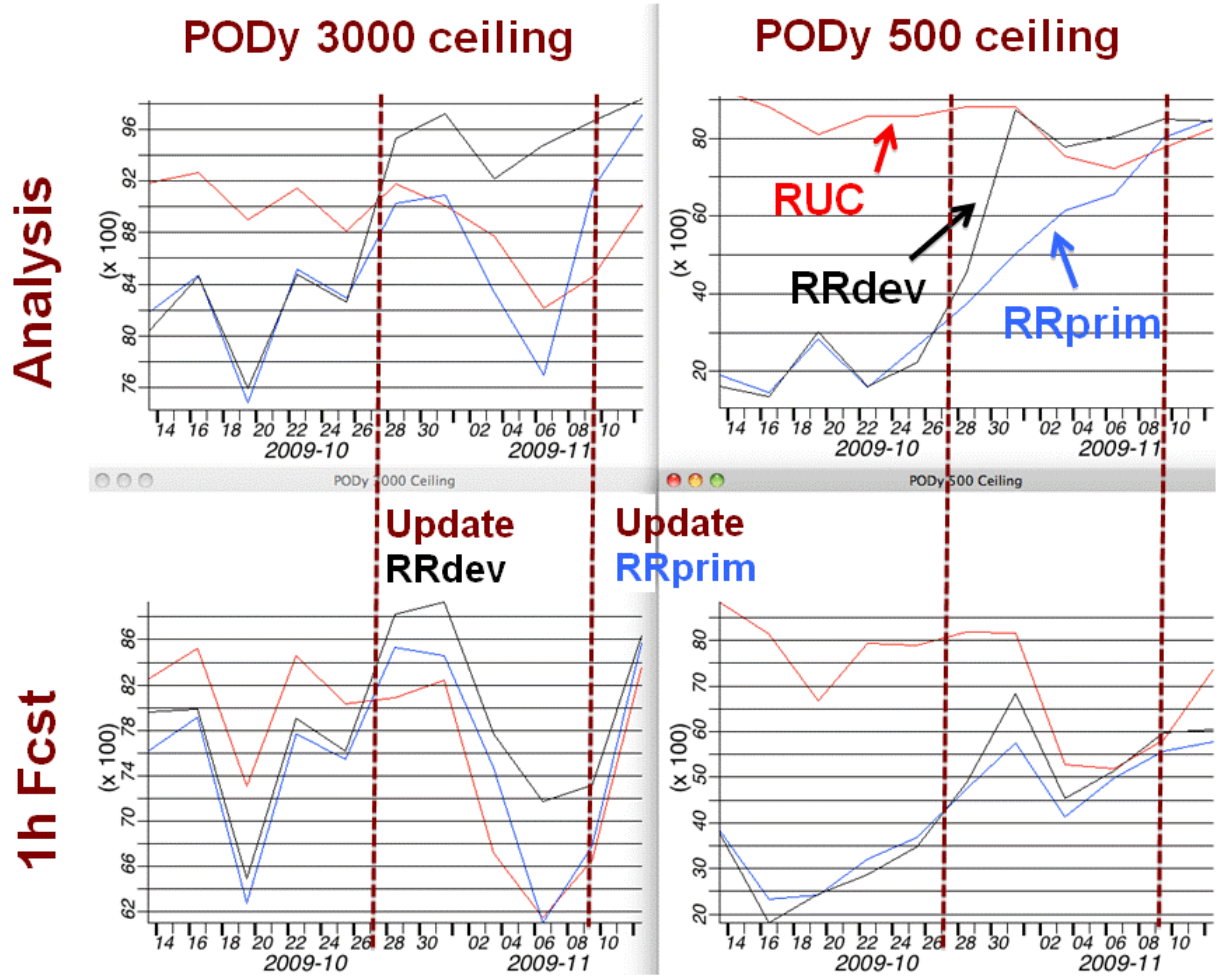


Fig. 4. Comparison of real-time ceiling verification for RUC, RRprim and RRdev cycles. Improvements in the two RR cycles relative to the RUC are readily apparent. Note: Overall skill is influenced by the overall degree of cloudiness across the CONUS.

Further improvements to the RUC/RR cloud analysis have been developed including, for the first time, allowance of partial cloudiness from the background 1h forecast in the vicinity of METAR stations. Also for the first time, innovations (observation-background differences) for clouds using the background grid column nearest to each METAR station are being used. This work will be described in more detail next month.

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 RR DDFI reflectivity assimilation is ongoing, including evaluation of retrospective case study results and summertime precipitation skill scores. Results look good overall, but some adjustment to the strength of the latent heating forcing may be made.

Deliverables:

10.5.15.E2 1 May 2010 (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.

10.5.15.E3 30 Aug 2010 (GSD)
Complete testing of revised cloud analysis for part of FY11 change package to Rapid Refresh

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.

Work is ongoing to finalize the assimilation configuration for the 2010, which will very likely include a second pass of the diabatic DFI-filter-based radar reflectivity assimilation. This 2nd pass filter has been evaluated in case study mode this past summer and gives a big improvement in the first few hours of the forecast. The changes are easy to implement (uses existing code) and will only add a few minutes to the runs time. Additional testing will be completed with implementation into the real-time HRRR early in 2010.

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 is re-running specific cases (09 through 15 UTC, 29,30,31 July) and transferring files to NCAR and MIT/LL for CoSPA retrospective processing.

10.5.24.3 30 Sept 2010 (GSD, NCAR/RAL)
Complete 2010 HRRR summer exercise using modeling and assimilation modifications determined in 2010 exercise. Collaborate on analysis of HRRR tests and deliver summary of results.

10.5.24.4 30 May 2010 (NCAR/RAL)
Conduct sensitivity runs with respect to physical parameterization schemes and initial conditions for multiple high-impact weather days, collaborating with ESRL/GSD. Examine possible reasons for forecast success (or not) for these cases with regard to storm location, timing, intensity, and structural organization.

10.5.24.5 30 July 2010 (GSD)
Analyze and evaluate the results with regard to sensitivity for prediction of turbulence, icing, and winter weather (including ground de-icing) conditions. Collaborate with relevant RT members on evaluation of results. The CONUS HRRR now in planning for FY10 will be particularly strongly tied to the Turbulence RT and allows a HRRR-based GTG, especially for mountain-induced turbulence. This additional 0.5 FTE support will facilitate this interaction also.

We are in communication with the other RTs (beyond CW) about transferring HRRR files for examination.

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 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
See below under subtasks.

NCEP
Shun Liu has integrated codes for dumping BUFR format VAD winds into the radar quality control package. CCS jobs and scripts were modified to generate a VAD wind BUFR tank and are undergoing parallel tests. A new 2009 version of the radar quality control package is being tested. The LAPACK library is used in the NSSL QC codes is not available on NCEP's super computer, so Shun has adapted the QC codes to use similar subroutines in the ESSL libraries on NCEP's supercomputer as a replacement for those in LAPACK. Occasional test runs initializing 4 km runs of NMM with the extended GSI use of radial winds continue.

CAPS

NCAR/RAL

Subtasks

10.5.19.1 1 Dec 2009 (GSD, NCAR/RAL, CAPS)
Select initial case studies from summer 2009 for 3-km HRRR data assimilation case studies.

GSD is re-running specific cases (09 through 15 UTC, 29, 30, 31 July) selected in conjunction with NCAR and MIT/LL for high weather-related aviation impact. Output is being transferred to NCAR and MIT/LL for CoSPA retrospective processing. GSD also worked with CAPS to select a mini-retrospective case study period (June 15-16, 2009). This period has initially been used for Rapid Refresh testing of reflectivity and radial velocity assimilation, but will also be used for follow-up 3-km HRRR assimilation testing. Lastly, a specific case study period (June 17, 2009) was selected for use in initial tests of the 3-km diabatic DFI-based reflectivity assimilation.

10.5.19.2 31 August 2010 (GSD, NCAR/RAL)
Run case studies from 2009-2010 using 3-km HRRR on GSD jet computer using different RR-based initial conditions

- **Radar-DFI enhanced RR**
- **Test of 3-km radar-enhanced diabatic digital filter initialization (DDFI)**

Initial work ongoing for 3 different case study test periods. See description in 5.19.1

10.5.19.3 30 Sept 2010 (CAPS)
Complete new 3-km GSI data assimilation experiments toward improved assimilation of radial wind.

10.5.19.4 30 Sept 2010 (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 FY09.

Initial case study results for 3-km radar DFI from a June 17, 2009 case study test have yielded very encouraging results.

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.

10.5.19.E2 30 Sept 2010 (GSD, CAPS, NCAR/RAL)
Report on results from improved version of 13km/3km radar assimilation techniques for demonstration in FY10 exercise.

10.5.19.E3 30 Aug 2010 (GSD, CAPS, NCAR/RAL)
Provide additional report on radar assimilation results for HRRR from winter 2009-10 case studies under the lead of GSD with contributions from each organization.

10.5.19.E4 15 Sept 2010 (NCEP)
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.

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

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

GSD
Reports made on HCPF performance from summer 2009, to be reported next month.

NCEP
Jun Du reports that the new upgraded SREF was implemented into NCEP production on 27 October. This implementation includes an increase in resolution for the NMM and RSM members, replacement of some Eta ensemble members with WRF NMM and ARW members, and a switch to hourly SREF output for the first 39 hours of the forecast over the CONUS. Four new aviation products were also added: icing (probability), clear air turbulence (probability), ceiling (mean and probability) and flight restrictions (probability). The work related to the next SREF upgrade aiming for an implementation in November 2010 has been started, with the first tests of a precipitation bias correction scheme.

BinBin Zhou, Jun Du and Yali Mao have completed preparations for their visit to AWC on 16-19 November to discuss SREF aviation products. Geoff DiMego will also attend the AWC Testbed meeting on R2O Issues. BinBin has completed development of the web page for VSREF and will continue to maintain it. He is continuing work on SREF's echo-top verification with the mosaic dataset.

New hire Yali Mao finished studying all the background material on the transition of AWRP modules to NCEP and contacted the previous employee who had started the work on this effort for additional information. Yali Mao now has access to the EMC server at AWC and has gotten copies of the newest FIP and CIP code.

Subtasks:

10.5.20.1 28 Feb 2010 (NCEP)
Complete 'research quality' version of upgrade to SREF (e.g. higher resolution, NEMS members, and more physics diversity or stochastic physics) for consideration in November 2010 SREF upgrade package.

10.5.20.2 15 Feb 2010 (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).

10.5.20.4 31 Aug 2010 (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.

10.5.20.5 30 April 2010 (GSD, NCEP)
Improve preliminary (developed in FY09) procedure appropriate for aviation users from Very Short-Range Ensemble Forecast (VSREF) system using high-resolution RR and NAM existing runs toward a future High-Frequency Probabilistic Forecast (HFProb) generator to be used in NextGen, including common post-processor, obs-based statistical post-processing, optimized member weighting

Steve Weygandt provided code from the RUC Convective Probability Forecast (RCPF) time-lagged ensemble to Binbin Zhou, who has incorporated the algorithm into is SREF infrastructure. Discussion and collaboration is ongoing. Curtis Alexander and Doug Koch have developed a real-time HRRR-based convective probability Forecast (HCPF), which is running on real-time at GSD with web-based display and verification. It was recently switched to run off of the HRRR and provide CONUS coverage. Verification results have been very encouraging.

10.5.20.6 1 July 2010 (GSD, NCEP)
Further calibrate probabilities and potential echo-top (improve statistical reliability) ensemble cumulus information.

Deliverables:

10.5.20.E1 30 June 2010 (NCEP, GSD)
Subject to NCEP Director Approval, implement at GSD initial VSREF product generation for turbulence. Work toward future NCEP implementation [products will not be distributed as Operational but are generated routinely within the RR script as part of NCEP's Production Suite].

10.5.20.E2 30 Aug 2010 (GSD, NCEP)
Demonstrate products from experimental VSREF probabilistic forecasts updated hourly.