MDE Product Development Team
February 2013 Monthly Report
Submitted 14 March 2013

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Executive Summary

Task 1: Improve turbulence guidance from NWP forecasts

- RAP version 2 continues at GSD, now with some changes started (9-level land-surface model, snow building and revised trimming), continuing to yield improved upper-air wind/temp/RH forecasts over RAP-NCEP. The same is true for surface moisture and precipitation forecasts.
- Further changes in testing in development (not primary) ESRL RAP including data assimilation and modeling improvements. All of these will be included in final Rapid Refresh v2 (RAPv2) with implementation at NCEP, now proposed for early 2014 after NCEP implementation moratorium is lifted.
- Three real-time parallel RAP cycles (with extensive verification of each) running on Zeus NOAA research supercomputer located in Fairmont, WV to evaluate likely enhancements to RAP data assimilation / model system.
- ESRL testing hybrid/ensemble data assimilation in real-time parallel RAP of 80-member GFS global ensemble data to help specify background error covariance information, to be included in RAPv2
- Ongoing evaluation of refined cloud analysis procedure [with selective use of Effective Cloud Amount ECA) parameter provided by the CLAVR-x (Clouds from AVHRR Extended) satellite data.
- NCEP making progress on NAM and NAM-nest
- Operational RAP including RAP GSI component successfully ported to new WCOSS machine
- Continued progress on testing and evaluation of RAP data assimilation and model changes within the RAP real-time parallel and retrospective cycles including:
  -- use of global ensemble information within GSI-based hybrid assimilation procedure for RAP
  -- improved 9 level version of Smirnova Land Surface Model
  -- evaluation and likely use of specially adapted version of MYNN BL scheme
  -- improvements to RAP radar-based hydrometeor building and clearing
- Discussions with EMC, NSSL, and CAPS personnel at Norman Warn-on-Forecast (WoF) meeting on assimilation strategies and use of RAP/HRRR and their ensembles for WoF.

Task 2: Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

- GSD running two real-time experimental HRRRs (a primary one - PRIM on JET and a developmental one – DEV on Zeus, both with real-time verification. The DEV version is being used to evaluate the final HRRR data assimilation configuration for the 2013 warn season evaluation.
- Ongoing transfer of real-time HRRR fields from JET to NCEP Central Operation (NCO) for distribution
- Continued retrospective and real-time parallel testing and refinement of 3-km, 15-min radar reflectivity assimilation during a 1-h pre-forecast cycle for the HRRR.
- Retrospective and real-time parallel testing of full GSI application at 3-km as part of HRRR initialization, including assimilation of radial velocity.
- Real-time experimental HRRR-based RTMA 2D surface analysis and RUA cloud analysis running on Zeus with graphics (including “analysis – background” plots) available on web and quantitative “fit to observations” verification.

Task 3: Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

- 9-level RUC land-surface model is producing much improved near-surface wind forecasts and also improved 2m temperature forecasts

- Integration of bug correction into RAP/ WRF regarding lack of radiation effects from snow mixing ratio in atmosphere, which has been contributing to a daytime warm bias in the RAP and HRRR at the surface.
- Improved lower-troposphere and near-surface forecasts of especially of wind are now being produced from the GSD/Olson version of MYNN boundary-layer scheme.
- NCAR/RAL making excellent progress on aerosol-aware microphysics

Task 4: Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA

- Continued progress and encouraging results from retrospective HRRR experiments using a 3-km, 15-min cycling, one-hour pre-forecast radar assimilation period, is now planned to be applied in the real-time HRRR for 2013.
- Initial tests of a fully cycled 3-km assimilation using GSI for the HRRR and 3D 3-km application for the Rapidly Updated Analysis (RUA).
- Multiple presentations on latest HRRR results at AMS Aviation, Range, and Aerospace Meteorology (ARAM) Conference in January.

Task 1: Improve turbulence guidance from NWP forecasts

Improving turbulence forecast quality would involve efforts to improve initial conditions for the RAP and NAM (and HRRR and NAM nests) and to improve the models (WRF-Advanced Research WRF (ARW)-RAP and NOAA Environmental Modeling System (NEMS)- Nonhydrostatic Multi-scale Model – B (NMMB)).

Tasks will include:

- Continuing evaluation of RAPv2 toward summer 2013 implementation at NCEP, incorporating changes developed in 2012.
- Collaborating on developing & testing best approaches for use of hybrid/EnKF/3DVAR within common GSI coding structure.
- Collaborating on developing and testing physics schemes between WRF and NEMS' physics layer.
- Negotiating Data Mining List priorities with NCEP Central Operations and external points of contact associated with the most desirable new sources of observations. (NCEP and ESRL)
- Continuing final testing of RAPv3, including initialization of the HRRR.

ESRL

Regarding the NCEP RAP

The operational RAP at NCEP continues to run without any technical problems although with a single post-processing glitch during the month. The RAP continues to show improved reliability over the previous RUC at NCEP. On 3 March a UniPost crash occurred, due to a spurious decrease in height with decreasing pressure in a grid column on one of the lateral boundaries. A patch was made that has avoided such problems since. An improved specification of height on the lateral boundaries will be introduced with the RAPv2 implementation.

Geoff Manikin reported in early February that the NCEP RAP is now converted to run on the new WCOSS computer. Geoff cites work by Ming Hu of GSD as critical to this process. Next will come testing of a parallel cycle on the WCOSS machine. Once this is successful. Geoff Manikin is prepared to begin accepting updated RAPv2 code from GSD for testing on the WCOSS computer. We now anticipate that this may be possible by late spring or early summer.

Regarding the ESRL RAP

The principal thrust of RAP work at ESRL/GSD during February continued toward further improvements to the RAP in preparation for freezing the HRRR for the summer 2013 convection season and the transfer of RAPv2 code to NCEP.

During February we continued to use the 3 real-time RAP-development cycles on Zeus to do controlled comparisons of several changes to both analysis and model still under consideration at the beginning of the month. We also continued to use summer retrospective periods for testing of these changes under summertime conditions. At this writing we have decided on the following changes in the RAP for the upcoming March code freeze required for CoSPA in preparation for this year's warm-season exercise. Other possible changes still in testing are discussed below this list.

- Replacement of the current purely 3dVAR analysis option in the Gridpoint Statistical Interpolation (GSI) analysis by GSI's new hybrid EnKF-variational option, together with use of 6-9h forecast grids from the 80-member GFS ensemble that are part of the highly successful global implementation of the GSI hybrid. Performance of this in the Zeus RAP-dev3 cycle has produced a dramatic improvement in RAP performance and this is now running in all the RAP development cycles. We are working with NCEP to improve RAP reliability on Zeus (making it less dependent on Jet availability) by transferring these files directly from NCEP to Zeus.

- Use of the 9-level RUC LSM that has been in real-time testing since fall 2012, and has been reported on in previous MDE reports to give generally improved temperature forecasts.

- Use of increased surface roughness over urban and forested areas as well as seasonally dependent surface roughness over agricultural areas and use of a leaf-area index that is a function of land-use type and seasonally dependent vegetation fraction.

- Incorporation of a bug fix from NCAR concerning short-wave radiation attenuation by hydrometeors (see Task 3)

Still to be decided at this writing are whether to replace the current MYJ surface layer and planetary boundary layer (PBL) schemes with the MYNN surface and PBL schemes, and whether to continue to use the Grell G3 scheme from WRFv3.2.1 for parameterization of deep and shallow convection, or to switch to the new Grell-Freitas (G-F) deep and shallow scheme. If we choose G-F, we will also switch to the WRFv3.4.1 code (including the version 3.4.1 of the NCAR Thompson microphysics) from the WRFv3.3.1 currently in the RAP-primary cycle. These decisions will be made in the next several days, pending the outcome of ongoing comparison real-time and retrospective testing with RAP and retrospective testing with HRRR spawned from RAP.

Continued intensive evaluation of the new GSI cloud analysis enhancements including Effective Cloud Amount (ECA) from the improved CLAVR-x (Clouds from AVHRR [Advanced Very High Resolution Radiometer] Extended) data from NESDIS continued during February. However, we have decided to hold off for the time being on implementation of this, pending more evaluation of thresholds to use in determining areas of partial cloudiness (equivalent to METAR SCT or BKN sky cover) and other considerations implied in switching to the CLAVR data

We have also been developing or testing several possible HRRR enhancements for both assimilation and model. See Task 2 for further discussion.

GSI efforts toward RAPv2 from ESRL

1. Work on use of data from the 80 GFS global ensemble data assimilation ensemble members to improve the RAP mesoscale assimilation and forecast continues with inclusion in the 2013 warm season code freeze and the RAPv2 code transfer to NCEP almost certain. Following an initial ~ 1 month real-time test period in Nov./Dec. 2012, this ensemble assimilation system, which showed very positive results, this configuration is being run in the GSD RAP-dev3 real-time parallel cycle in Zeus and being investigated more fully in a controlled week long retrospective evaluation (for a test period from late May / early June 2012), using GFS ensemble files provided by Darryl Kleist from EMC.

2. Improvements to the use cloud analysis through selective use of Effective Cloud Amount (ECA) parameter provided by the CLAVR-x satellite data. By allowing a more selective building in mid- and upper-level regions where the ECA) parameter indicates only limited partial cloudiness, the new procedure reduces the high bias in mid- and upper-level high relative humidity without degrading the low-level ceiling verification scores.

Ming Hu successfully merged the GSD RAP GSI with the NCEP SVN trunk, enabling GSD access to the latest improvements form the GSI community. Ming also submitted the GSD group GSI code changes to apply the surface innovation-based soil temperature and moisture adjustment.

Haidao Lin continued his work on obtaining improved results for AIRS satellite radiance assimilation. Finally, GSD assimilation scientists participated in discussions with EMC, NSSL, and CAPS personnel in Norman, OK at a Warn-on-Forecast (WoF) workshop. Ideas and strategies for data assimilation to address short-range high impact weather forecast needs were discussed, including plans for use of the RAP/HRRR and their ensembles.

Other activities, some noted more fully under other tasks, also were undertaken:

- The NCAR WRF developers made a first beta release of WRFv3.5 available for testing by friendly developers in late January and a second release in early March. This includes a number of contributions by GSD developers that are being evaluated for inclusion in the March 2013 RAP code release discussed earlier: the latest version of the RUC LSM (Smirnova), the Grell-Freitas deep and shallow convection, the MYNN PBL and surface-layer schemes updated through late December (Olson) and the current version

of the RAP digital filter initialization (Peckham and Smirnova). Tanya Smirnova has made some preliminary non-cycled runs with this release.

- Continued evaluation of the Earth Networks, Inc. lightning data for use as a possible alternative to the Vaisala GLD360 lightning product.
- Retrospective testing of satellite radiance bias corrections and choice of background error (Task 5).
- Retrospective testing for both RAP and HRRR of the impacts of proprietary in situ tower wind data and other special data continues under funding from the DOE Wind Forecast Improvement Project.

NCEP

Major progress on the transition of the RAP code to the new WCOSS computer was made in February. All modifications to the code and scripts and the accompanying testing were completed, and EMC has handed the code over to NCO for testing as part of production. NCO is now building the WCOSS production version of the RAP and will begin running tests in March. (Geoff Manikin)

BinBin Zhou modified the surface cooling computation to improve results in the fog diagnostic code of the NARRE-TL's ensemble product generator. (**http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/NARRE/web_site/html/icing.html**) (BinBin Zhou and Jun Du)

The transition to WCOSS of the observation processing codes used for the Rapid Refresh continues. The last of the obs processing codes will be delivered to NCO before the end of March. (Dennis Keyser)
Near-real-time parallels of the NAM and its NAM Data Assimilation System (NDAS) are running on both CCS and Zeus computer systems. The NDAS system in all parallels is using a hybrid variational-ensemble analysis with ensemble perturbations generated from the global EnKF system. Additional changes in GSI and NDAS include: GOES-15 radiances, variational QC scheme inside GSI, Meteosat 10, satellite wind subtypes with different data thinning, radiosonde level enhancement in GSI, mesonet wind observation reject list (from RTMA), new VAD wind profiles from Doppler radars, and GPS bending angle observations. Shun Liu began work on testing GSD's cloud analysis in a real time parallel. The NAMX parallel forecast was used as the control, and early results showed that the temperature was improved at the end of NDAS assimilation cycle but a dry bias was found in the moisture verification. (Eric Rogers, Shun Liu, Wan-Shu Wu)

A near-real-time parallel RTMA has been maintained on the CCS computer system for CONUS (2.5km) and Alaska (3km). Work continues on adding a GLERL-type analysis for lake winds to the RTMA-GSI. An enhanced prepbufr file is being generated that includes a number of lake pseudo-wind observations created by adjusting the nearby land observations to the water conditions. The GSI code is also being changed to add the option of making two separate wind analyses for the land and water masses, which are to be joined together with the help of the land-sea mask. (Manuel Pondeca, Steve Levine)

The three Level-2 radar processing codes that were successfully compiled and tested in January were given to NCO in early February to test for WCOSS production. Shun Liu examined NCO's test results and made modifications to codes and scripts so they met production requirements. (Shun Liu)

Wan-Shu Wu discovered that the ozone sensitive channels from IASI/Metop-A had been turned on by mistake in the analysis system and turned them off. Great efforts were put into moving the GSI package to the new WCOSS computer. Code bugs were found and fixed (because the WCOSS compiler works differently from the CCS) with only minor changes in results. Bugs that caused a GSI (out of memory) failure when running NEMS NMMB using both GFS ozone and GEFS GSI were traced and fixed. Data from the new Metop B satellite were available for use in the operational GSI system, but changes were made so that different satellites can be treated differently and Metop B data won't be used inadvertently in either CCS or WCOSS. (Wan-Shu Wu)

CAPS

A regional dual-resolution hybrid DA system for RAP with 3-hourly cycles with conventional data is established based on the 40 KM EnKF ensemble and the 13 km hybrid analysis. Forecasts are verified against sounding and surface observations. The results are compared to those launched from GSI3DVAR analyses assimilating the same data sets at 13 KM and interpolation from well-tuned regional GSI-based EnKF system at 40 KM. Tests do

show that are still problems with the hybrid scheme (with WRF-based 40 km EnKF) when the ensemble covariance is used at 100% for single temperature observation tests; the wind increments are zero in such a situation. Further testing and debugging are still needed and we hope that dual-resolution results will be better than single resolution results.

Additional information on RAP-related tasks

ESRL

After having no non-radar data available for the GSD RAP primary cycle since the RUC stopped running operationally at NCEP on 1 May, early PrepBUFR files (with incomplete radiosonde observations) were again made available to GSD on 27 November by NCEP Central Operations (NCO) for the 00z and 12z RAP runs at ESRL to initialize the HRRR. There was another subsequent outage from 22 Dec 2012 through 25 Jan 2013, when it was restored again. This is noted in a FAQ webpage for the HRRR at **http://ruc.noaa.gov/faq/HRRR.faq.html.**

GSD continues to make pgrb and bgrb files from the ESRL/GSD RAP-primary (RAPv2) real-time 1-h cycle available from its FTP site for users in NWS and other labs).

NCEP
on pressure surfaces via the NWS Family of Services (FOS) data feed and via the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (EMC&NCO)

NCEP maintained real-time availability of full resolution gridded data from the operational RAP runs via anonymous ftp access via the NCEP server site at **ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/rap/prod/** and at the NWS/OPS site at **ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/** in hourly directories named MT.rap_CY.00 through MT.rap_CY.23. This includes hourly BUFR soundings and output grids, which undergo no interpolation. Both sites now contain only grids in GRIB2 format **http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml.** Gridded RAP fields are now also available on **NOMADS** for the CONUS domain on 13 km grid #130 and the larger North American domain on 32 km grid #221. A limited set of fields from the RAP runs (and other NCEP models) can also be viewed at **http://mag.ncep.noaa.gov/NCOMAGWEB/appcontroller.** (EMC&NCO)

Verification of RAP

ESRL's verification of the RAP is available from **http://ruc.noaa.gov/stats**. NCEP maintained its capability and provided access to routine verifications of the operational RAP analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch website: **http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html** .

Deliverables	Delivery Schedule
Task 1 – Improve turbulence guidance from NWP forecasts	
a. Finalize code for RAPv2 for implementation at NCEP (ESRL, NCEP) • Good progress again toward this deliverable.	Mar 2013
b. Complete the testing of the 40/13 km dual-resolution hybrid DA system for RAP with 3-hourly cycles with conventional data (GSD, CAPS) • ESRL testing hybrid DA in RAP with full observational data, exceeding milestone, using GFS ensemble data.	Mar 2013

Deliverables	Delivery Schedule
d. Report on early version of RAPv3 primary cycle at GSD with physics enhancements for initialization of the HRRR. (ESRL)	Dec 2013
e. Report on the optimal configurations for including satellite data in the 40/13 km dual-resolution hybrid system to ensure overall positive impacts of the data (NCEP, ESRL)	Dec 2013
f. Finalize RAP version to initialize experimental HRRR for 2014 real-time use toward operational HRRR (ESRL)	Mar 2014
g. Deliver progress report on development of NARRE (NCEP, ESRL)	Mar 2014
h. Deliver progress report on ensemble/hybrid data assimilation for use in NARRE (ESRL, NCEP)	Mar 2014
i. Subject to NCEP Directors' approval, upgrades to observation processing &/or quality control and/or GSI and/or NMMB systems become Operational at NCEP. (NCEP)	Mar 2014
j. Incorporate physics and dynamics improvements from the user community, GSD, and NCEP into WRF for use in the Rapid Refresh system. (NCAR-MMM)	Mar 2014

Task 2: Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

GSD

In February 2013, work continued on retrospective and real-time testing of the HRRR in conjunction with RAP testing toward a final set of combined RAP and HRRR improvements for an anticipated mid-March code freeze for a warm season evaluation. Impacts on HRRR forecasts from both RAP changes (detailed in sections 1 and 3) and changes to the HRRR system (primarily final adjustments to the 1-h pre-forecast with 15-min cycled data assimilation) are being evaluated. As noted in the January report, tests of the 3-km 15-min cycled 1-h radar-assimilation pre-forecast was yielding encouraging results, but the method still required some adjustment to maximize the utility of both the radar and conventional observations. Intensive additional testing and refinement has yielded an improved system, which is very likely to be included in the upcoming HRRR code freeze. The improved procedure retains the 1-h pre-forecast with the four applications of the 15-min. radar heating (-45, -30, -15, 00 min.) to spin-up small-scale convection. Modification to the convection thresholds for application of the heating has been made to focus the heating on more intense cores. Following this 3-km pre-forecast cycle, a full 3-km GSI is applied to incorporate the latest conventional observations, including level 2 radar radial velocity data. Within this 3-km GSI, a cloud analysis is completed, allowing specification of a detailed cloud and precipitation hydrometeor fields in the 0-h HRRR fields. Results are encouraging, indicating the new procedure is yielding improved skill for reflectivity prediction during the first few hours, without degrading skill at longer lead times.

In addition to the 3-km HRRR data assimilation changes, several enhancements to the HRRR model formulation have either been implemented or are in final testing with very likely implementation. These include: 1) upgrade to WRF 3.4.1 with physics upgrades, 2) upgrade from 6-layer LSM to 9-layer LSM, 3) change from MYJ PBL scheme to an especially adapted MYNN scheme, 4) update to the Thompson microphysics scheme. Final configuration tests are ongoing with a code freeze planned for mid-March.

Work in two other important areas is ongoing. First, a key milestone was achieved on Feb. 14, when real-time transfer of HRRR grib2 output files from JET to NCEP Central Operations (NCO) commenced, with dissemination

via their ftp server commencing shortly thereafter. Second GSD scientists and IT personnel continue to work with NCEP IT specialists to complete key file transfer links that would enable complete independence between the JET and ZEUS real-time experimental RAP/HRRR systems. This work involves obtaining independent feeds of key observations and parent model grids to the JET and ZEUS machines and obtaining independent transfer and dissemination of the output grids from the machines.

Work also continues in coordination with EMC and NSSL colleagues on further developing and evaluating HRRR-based Real-Time Mesoscale Analysis (RTMA) and Rapidly Updated Analysis (RUA) products. Good progress has been made for both of these, with prototype hourly updated test systems running in real-time over the past few months (though temporarily suspended to allow for more intensive evaluation RAP/HRRR changes. A report summarizes this work can be found at:
http://ruc.noaa.gov/pdf/GSD_RTMA_report_March15_2013.pdf

Deliverables	**Delivery Schedule**
Task 2 – Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE	
a. Report on initial tests of 3-km 15-min RTMA cloud / surface analysis for use in frontal diagnostics, CI assessment and other near-surface assessments (ESRL, NCEP) • *Good progress toward 3km RTMA and RUA surface and cloud analyses* • *Successful initial tests summarized in report:* **http://ruc.noaa.gov/pdf/GSD_RTMA_report.pdf**	Feb 2013 COMPLETE
b. Incorporate all assimilation and model changes that affect the HRRR into a frozen version of HRRR (and parent Rapid Refresh) for 2013 real-time use (ESRL) • *Good progress toward significantly upgraded HRRR for 2013 real-time use*.	Mar 2013
c. Provide preliminary 15-min RTMA surface analyses as experimental improved basis for frontal diagnostics and other diagnostics from surface analyses (ESRL, NCEP)	Apr 2013
d. Report on computing resource status on NCEP Central Computing System, NOAA R&D Site A and NOAA R&D Site B with regards to possible implementation of HRRR (NCEP, ESRL)	Jun 2013
e. Complete FY13 internal assessment with revised 3-km HRRR running every hour (ESRL)	Sept 2013
f. Provide revised 15-min RTMA surface analyses as primary basis for frontal diagnostics and other diagnostics from surface analyses for real-time use in 2014 (ESRL, NCEP)	Feb 2014
g. Finalize all changes to the HRRR for real-time use in 2014 (ESRL)	Mar 2014

Task 3: Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

GSD

Summary: Extensive testing and evaluation continued in February directed toward a final decision on the physics configuration in the RAPv2 code to be frozen in March 2013. Most emphasis was given to the land-surface model (LSM), boundary layer and convection. This is detailed below.

As a result of the successful testing of major revisions to the RUC LSM coupled with enhancements to the land-surface fields used by the LSM (see MDE-FY13-Q1 report), we have introduced the new 9-level configuration into all the GSD RAP-development cycles, and will soon do so for the RAP-primary that drives the HRRR. The increased resolution improves 2-m temperature forecasts during the evening transition without leading to cold biases at other times of the day or in winter conditions of snow cover and reduced insolation. Further, the 10-m wind performance has been improved by the modifications to land use and land-surface properties discussed in the FY13-Q1 report.

The NCAR (Greg Thompson) bugfix to incorporate attenuation of incoming solar radiation by clouds in the Goddard short-wave radiation scheme used in the RAP will also be part of the RAP physics configuration used with the RAP-primary that will feed the HRRR for this summer's convection exercise.

The concerted effort by Tanya Smirnova and Joe Olson in December 2012 to find and correct the cause of the excessive occurrence of nighttime fog over snow-covered areas has kept the MYNN PBL and surface layer as a strong candidate to replace the MYJ because of its overall improved wind forecasts. However, intensive testing this month has produced some less encouraging results for other fields, and continued testing and evaluation of possible last-minute changes is nearing completion. These pertain to the surface layer, in particular, the roughness length for heat and the entrainment at the top of the daytime mixed layer.

Extensive testing of the new Grell-Freitas convective scheme with the shallow convection and radiation feedback options turned on continues. A couple of bug-fixes to the scheme that improve conservation and consistency properties were introduced in February, requiring some retesting for confirmation of earlier favorable results with this scheme relative to the v3.2.1 version of the Grell G3 scheme currently in RAPv2. Predictions of wind, temperature, and relative humidity, as well as precipitation are all being considered in the decision on whether to replace the current G3 with G-F.

In a related effort, David Dowell and Curtis Alexander introduced code into the GSI cloud analysis to ensure that the conversion between reflectivity and mixing ratios of rain, snow and graupel are consistent with the v3.4.1 Thompson scheme.

GSD has had discussions with the NCAR WRF developers concerning small-scale oscillations in low-level fields under conditions of steep terrain slope and strong surface wind when the 6^{th} order diffusion is turned on. However, a definitive solution awaits further effort and will not be available for this year's CoSPA summer exercise.

NCEP

EMC ran a timing test of the HRRR code on WCOSS in February. (Curtis Alexander from ESRL also first performed the same test.) This was a preliminary test to obtain an initial sense of run time and resources required to run the system to assist with future efforts to implement the HRRR. (Geoff Manikin)

Brad Ferrier provided information to Greg Thompson (NCAR) regarding the NMMB model code to help him in integrating his microphysics scheme into the model. Eugene Mirvis helped Laurie Carson (DTC) port the NMMB code that NCEP runs on Zeus to NCAR's Yellowstone computer, where Greg Thompson was able to run a 4-hr test forecast for a 1 Feb 2011 case. (Brad Ferrier)

NCAR/RAL

CURRENT EFFORTS: Work will quickly resume once 2013 funds become available. The newly revised aerosol code connected to the Thompson microphysics scheme as well as newly revised RRTMG radiation code appear to be working well and will be transferred to NOAA-GSD soon.

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED:

FAA funding for 2013 still has not yet arrived at NCAR-RAL; so all employees were informed to stop work on the project in mid-January.

INTERFACE WITH OTHER ORGANIZATIONS:

NCAR/MMM

NCAR conducted a WRF tutorial at its Foothills Lab January 28–February 5, 2013. This included a WRF tutorial and a MET (Model Evaluation Tools) tutorial. Approximately 60 participants attended the tutorial. The tutorial is further described at: **http://www.mmm.ucar.edu/events/tutorial_131/index.php**.

PLANNED EFFORTS: NCAR will prepared and host another WRF tutorial in Boulder later this year, in July.

UPDATES TO SCHEDULE: NONE

NCAR and the WRF Release Committee continued to prepare for the next major release, WRF Version 3.5. The release is planned for April 2013, and details may be found at: **http://www.wrf-model.org/release.php**. Candidate features include software framework improvements, new physics options, new observation types for WRFDA, and WRF-Chem additions.

The first friendly-user release was issued, with feedback received. These distributions allow the code to be tested and problems to be identified and corrected before the general release. The second, and final, friendly-user release will be in the first week of March.

Jimy Dudhia of NCAR worked with Stephanie Evan (NOAA) on WSM5 microphysics in upper tropospheric applications. The region studied has been the tropical tropopause, and they are working on correction of biases.

Dudhia also worked with Jim Doyle (NRL) on a schematic of a new physics driver for general use in NUOPC models as part of the Physics Interoperability Group.

PLANNED EFFORTS: The development and incorporation of new physics and dynamics for WRF for the RAP will continue through FY13Q2.

UPDATES TO SCHEDULE: NONE

Task 3 – Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE	**Delivery Schedule**
a. Complete initial evaluation of aerosol-aware microphysics in RAP real-time cycling at GSD for its suitability as part of the RAPv3 prototype for 2014 NCEP implementation (NCAR-RAL, ESRL)	~~Feb 2013~~ Delay until funding restored to NCAR
b. Final model physics code transfer complete to EMC for Rapid Refresh 2 upgrade change package to be implemented at NCEP by spring 2014 (ESRL, NCEP)	Mar 2013

• Freeze of model physics code for March13 version of RAP at ESRL will allow this milestone to be met.	
c. Pending NCEP computer readiness and EMC and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit WRF physics code changes as part of upgrade for Rapid Refresh v2 software to NCO (NCEP, ESRL)	May 2013
d. Transfer upgraded coupled aerosol-microphysics scheme into a test version of HRRR (NCAR-MMM, ESRL)	Dec 2013
f. Finalize microphysics changes and other physics changes to improve icing forecasts for ESRL version of RAP and HRRR for 2014 real-time use (ESRL)	Mar 2014
g. Report summary of icing probability skill measures by quarter for the year. (NCEP)	Mar 2014

Task 4: Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA

Task 4 – Conduct baseline testing of the early 2013 HRRR version

Current:
Execution and evaluation of candidate changes to the ESRL RAP and HRRR for 2013 are underway including 3-km radar reflectivity data assimilation within the HRRR for a one-hour spin-up period from 13-km RAP initial conditions. Following the one-hour spin-up period, a 3-D variational assimilation of all observational data is applied in GSI at the HRRR 3-km scale followed by a non-variational cloud/precipitation hydrometeor analysis at 3-km in GSI. A 15 hr HRRR forecast is then produced from this 3-km GSI analysis. We are using radar reflectivity observations during the one hour pre-forecast period to either suppress convective development in regions with very low (or no) observed reflectivity values, directly specify convective forcing in regions with relatively high values of observed reflectivity, or allow the model to evolve freely in regions with intermediate values of observed reflectivity.

We are anticipating improvement in short-term forecasts (first few forecast hours) of air mass thunderstorms and other small-scale convective structures in the real-time HRRR model forecasts with 3-km radar data assimilation while retaining skill at longer lead times through the assimilation of all observations at the 3-km scale. Curtis Alexander, Eric James, David Dowell and Ming Hu developed and installed this experimental configuration in a real-time parallel version of the HRRR in late February to begin a real-time parallel evaluation of this change.

Planned:
Retrospective HRRR runs including these changes will be executed and evaluated (including reflectivity and echo tops) for the May/June 2011 and 2012 retrospective periods once the final configuration of the 2013 RAP is determined and May/June 2011 and 2012 retrospective runs for the RAP are complete.

Task 4 – Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2013 real-time use

Current:
Ming Hu, David Dowell and Tanya Smirnova are developing an improved retrieval in GSI of rain and snow hydrometeors from radar reflectivity observations that results in a reversible diagnostic of model reflectivity in WRF from the hydrometeors that both matches the observed reflectivity and is consistent with the model microphysics scheme (Thompson) used in the RAP and HRRR. This work will lead to an improved analysis of

radar reflectivity, including echo tops, and these initial conditions should translate into improved reflectivity and echo top forecasts from the RAP and HRRR. This improved retrieval and reflectivity diagnostic is being tested with WRFv3.4.1 and the updated Thompson microphysics scheme in real-time parallel RAP/HRRR runs.

Planned:
Retrieval of rain hydrometeors from radar reflectivity observations in GSI will be modified to handle the two-moment rain hydrometeors and estimate a rain number concentration that is consistent with retrieved changes in the rainwater mixing ratio. WRF will be modified to re-diagnose the model reflectivity field following the retrieval and analysis of hydrometeors in GSI but prior to any execution of WRF physics and dynamics during model integration. These changes will improve the analyzed and forecasted reflectivity and echo tops.

Task 4 – Assess HRRR reliability and provide monthly reporting

Current:
Work continues towards an independent 2-computer solution for HRRR model forecast production and distribution for use in CoSPA. The RAP and HRRR are running regularly on both high-performance computer systems (Jet and Zeus) and work is ongoing to remove data flow dependencies between the two systems including independent delivery of observational input data directly to Jet and Zeus from NCEP. A direct feed of most observational input data was established between NCEP and Zeus including all conventional prepbufr data. Networking changes were made to permit use of a high bandwidth connection between Zeus and ESRL/GSD for delivery of the RAP/HRRR forecast grids and other input data. The reliability of the Jet and Zeus HRRR runs are as follows:

HRRR Reliability for 0-8 Hour VIL/Echo Tops for February 2013

Jet
All runs: 88.7%
3 or more consecutive missed runs: 94.0% (most meaningful for CoSPA)
6 or more consecutive missed runs: 96.1%
6 outages of at least 3 hrs or longer
3 outages of at least 6 hrs or longer

Zeus
All runs: 51.9%
3 or more consecutive missed runs: 58.3% (most meaningful for CoSPA)
6 or more consecutive missed runs: 62.4%
12 outages of at least 3 hrs or longer
7 outages of at least 6 hrs or longer

Combined (Jet or Zeus)
All runs: 89.9%
3 or more consecutive missed runs: 94.8% (most meaningful for CoSPA)

Planned:
Work will be focused on distribution of HRRR model forecast data to ESRL/GSD from Zeus without using Jet resources through installation of a new hardware system. Requests for dedicated computer reservations on Zeus, to further increase the reliability of the HRRR, will be submitted once the final model configuration for the 2013 HRRR is determined.

Problems/Issues/Schedule Changes Encountered or Anticipated:
The operating system software update on Jet has been completed and most related issues have been resolved thereby increasing the HRRR reliability on Jet during this period. A single remaining software problem is scheduled to be resolved during maintenance on Jet in March 2013. A project management software change on Zeus along with some experimental testing resulted in decreased HRRR reliability on Zeus during this period.

Task 4 – Complete implementation of refined SatCast assimilation for HRRR for real-time use in 2014

Current:
Tracy Smith ported SatCast assimilation code (previously developed for use with the RUC analysis) from the RUC to the RAP (GSI package). The code ingests SatCast IR cloud-top cooling data and maps it into a local heating function that is applied to the RAP fields in a similar manner to the way the RAP assimilates radar reflectivity data. Using a sample IR cloud-top cooling rate data set from a convectively active period in early July 2012, she completed a preliminary 1-day retrospective experiment (control run without the SatCast data and experiment with the SatCast data). Preliminary results indicate that for a scattered thunderstorm situation over the Southeastern U.S., assimilation of the SatCast IR cooling rates leads to a better short-term prediction of small-scale convective systems. Further work is ongoing.

Interact with CoSPA (or other) program partner labs and the FAA

Current:
A CoSPA team meeting including representatives from ESRL/GSD, NCAR/RAL, MIT/LL and the FAA was conducted on Wednesday 13 February 2013 to discuss RAP/HRRR model development updates for 2013 and related plans for the CoSPA 2013 season. A target of 15 March 2013 was proposed for freezing the RAP/HRRR model software for the CoSPA 2013 season that begins on 01 April 2013 and ends on 01 November 2013.

Planned:
A CoSPA technical readiness meeting has been scheduled for 04 March 2013 to allow representatives from ESRL/GSD, NCAR/RAL, and MIT/LL to discuss all technical readiness issues related to the CoSPA demonstration starting on 01 April 2013.

Deliverables	**Delivery Schedule**
Task 4 – Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA	
Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2013 real-time use (ESRL) • Code for revised echo-top / reflectivity diagnostics with revised microphysics proceeding well toward this deadline later this month.	Mar 2013
Conduct baseline testing of the early 2013 HRRR version (ESRL) • Baseline testing of 2013 HRRR version for 2011 baseline period is proceeding and will be reported on next month.	Mar 2013
Report on evaluation of new microphysics scheme and associated echo-top and reflectivity diagnostics in ESRL/GSD RAP and HRRR (ESRL)	Mar 2013
Assess HRRR reliability and provide monthly reporting (ESRL)	Apr 2013
Report on evaluation of revised WRFv3.4 microphysics for RAP/HRRR for its effects on echo-top and reflectivity in ESRL RAP/HRRR (ESRL)	Mar 2014
Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2014 real-time use of HRRR (ESRL)	Mar 2014

Complete implementation of refined SatCast assimilation for HRRR for real-time use in 2014 (ESRL)	Mar 2014
Report on 2014 baseline testing of the HRRR (ESRL)	Mar 2014