MDE Product Development Team
(Based on Work Plan for 12-month Period from 1 April 2014 through 31 March 2015)
FY14 July Monthly Report
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(Compiled and edited by J. Brown and B. Johnson)

Executive Summary

Task 1: Improve Turbulence Guidance From NWP Forecasts From RAP, HRRR, NAM, NAM-Nests And, Eventually, NARRE And HRRRE

- Operational RAPv2 continues to run reliably at NCEP.
- RAPv3 and HRRR code continues frozen for 2014 warm season exercise, strong effort to isolate and eliminate daytime warm-season warm / dry bias with some success for upcoming RAP and HRRR versions.
- Development continues for further assimilation and model improvements in RAP.
- Results of test of initial pre-NARRE 8-member ensemble (4-NMMB, 4-ARW) retrospective experiment very encouraging.

Task 2: Improve Quality Of Convective Weather Forecasts From RAP, HRRR, NAM, NAM-Nests And, Eventually, NARRE And HRRRE

- HRRR operational implementation planned for 30 Sept. 2014
- Continued work at GSD on warm and dry daytime bias in 2-m temperature and dew point in prefrontal southerly flow in RAPv3, with tests focusing on improvements to land-surface modeling, adding temperature pseudo-innovations, modifications to forward model for surface temperature assimilation, and sub-grid-scale shallow cumulus parameterization.

Task 3: Improve Quality Of Icing Weather Forecasts From RAP, HRRR, NAM, NAM-Nests And, Eventually, NARRE And HRRRE

- Extensive set of the physics changes, along with data assimilation and other model improvements to both the RAP and HRRR forecast systems were implemented for the 2014 warm season evaluation as summarized in the following report: http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2014.pdf.
- Aerosol-aware microphysics scheme from NCAR (Greg Thompson) within WRFv3.6 is running in a RAP parallel cycle and is being evaluated.
- Initial tests also made within RAP of improved lake surface temperatures through WRF CLM (Community Land Model) lake model also within WRFv3.6.

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

- GSD froze all data assimilation and model changes for ESRL RAPv3/HRRRv2 as of 10 April 2014 on Jet and Zeus. The ESRL RAPv3/HRRRv2 changes will be implemented at NCEP in 2015.
- The real-time frozen ESRL RAPv3/HRRRv2 system will continue to run with gridded field dissemination during the CoSPA season that began on 17 April 2014 and will run until 01 November 2014.
- ESRL HRRR “failover” capability to use feed from Zeus instead of Jet during Jet downtime continues to work.
- ESRL HRRR output format changes for alignment with the NCEP HRRR operational implementation will be coordinated with COSPA program partner labs after 01 November 2014.
- Initial discussion with MIT/LL regarding a capability to provide hourly updated vertically integrated liquid and echo top estimates from the ESRL RAP for oceanic regions outside of the HRRR domain.
- Initial discussion with NCAR regarding NCEP HRRR implementation details including improvements in timing of gridded forecast delivery (reduced latency) and other differences between the ESRL HRRR and NCEP HRRR.

Task 1: Improve Turbulence Guidance From NWP Forecasts From RAP, HRRR, NAM, NAM-Nests And, Eventually, NARRE And HRRRE

Improving turbulence forecast quality involves efforts to improve initial conditions for the RAP and NAM (and HRRR and NAM Nest models) 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 RAPv3 toward 2015 implementation at NCEP, incorporating changes developed in 2013 and 2014
- Development of RAPv4 toward 2016 implementation at ESRL and subsequent implementation at NCEP. (Note, some improvements from RAPv4 will be thoroughly tested in all seasons and included in the RAPv3/HRRRv2 package for NCEP.)
- Collaborating on developing and testing best approaches for use of hybrid/EnKF/3DVAR data assimilation within common GSI coding structure.

ESRL

Regarding the operational NCEP RAP

The RAPv2 continues to run well in NCEP operations, without any model or post-processing issues during July.
The RAP web page http://rapidrefresh.noaa.gov has information on the operational RAPv2 configuration including a February 2014 NWS webinar ppt on RAPv2 - http://ruc.noaa.gov/pdf/RAPv2-NWSwebinar-18feb2014-FINAL.pdf. A link to the RAPv2 Technical Implementation Notice is there also. A webpage on RAP output grids from NCEP is at http://ruc.noaa.gov/rr/RAP-NCEP-output-grids.html.

RAPv3 model testing and evaluation

The preliminary RAPv3 configuration of 5 April continues to run reliably in the RAP-primary cycle at GSD.
This cycle continues to drive the HRRR-primary running at GSD in support of the 2014 warm-season exercise. We expect to keep this cycle frozen through 31 October 2014. A summary of the upgrades from RAPv2 going to RAPv3 (and HRRRv2) has been published on the web at **http://ruc.noaa.gov/pdf/RAPv3-HRRR-April2014.pdf** with a more detailed description available at **http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2014.pdf**. Except as discussed below, this version has been running well.

As noted in last quarter's report, an increasing daytime warm and dry forecast bias became evident during April, May and June east of the Rockies, particularly under conditions of mostly clear skies and low-level southerly flow with dry soil conditions. The evidence for this was apparent both using the ongoing daily RAP verification and visual inspection of forecasts. Beginning last quarter and continuing in July, this problem has been the subject of concentrated effort in GSD.

This is not a new problem; the RAPv3 performance in this regard is, in fact, slightly better than for the RAPv2 now running at NCEP. Related to this, when there is a southern-plains dry line, the dry line position often tends to be slightly too far east. As discussed under Task 3, we have identified some key issues and are pursuing several promising approaches (Task 3). We are optimistic that this issue will be resolved before we must port the RAPv3 code to NCEP in October. In late July and early August, some very effective changes have been tested and evaluated in land-surface modeling (focused on wilting point in certain land-use areas) and shallow-cumulus cloudiness.

Tanya Smirnova has completed merging WRFv3.6+ (i.e., an NCAR WRF repository version from early June with several bug fixes from the original WRFv3.6 release in April) with GSD enhancements not yet in the WRF repository. The most important difference between this v3.6+ version and the WRFv3.5.1 currently running in the RAP-primary cycle is availability of the NCAR-Thompson aerosol-aware microphysics (see Task 3). Our RAP-dev3 cycle is now running WRFv3.6+ with the aerosol-aware microphysics, and evaluation is underway. This early testing of a new WRF release is a departure from our practice in previous years due to the October 2014 deadline (Task 1 deliverable E4) for having RAPv3 and HRRRv2 code ready for transfer to NCEP. This code transfer will also include merger of a new GSI release with RAPv3 upgrades by Ming Hu.
NARRE-related activities

Last quarter it was reported that Isidora Jankov carried out a very promising set of experiments using a preliminary ensemble configuration including both ARW and NMMB. In July the GSD personnel most likely to be involved in NARRE development met with Jacob Carley of NCEP to exchange ideas and outline future options and directions for NARRE development. This will include integrating the NAMRR now under development at NCEP, options for initializing the NARRE forecast ensemble including use of the GFS ensemble perturbations and by other means, and possible physics configurations for different members.

Subtasks

14.5.1. 14.5.1.1 Ongoing (NCEP, GSD)
Maintain hourly RAP and HRRR runs and provide grids of SAV and AHP guidance products.

There were no issues with the RAP in July. The HRRR is not yet operational; it is covered in 14.5.2.E1. A job was added to dump WSR-88D L2 radial winds at T+16 each hour (10 minutes earlier than the production cutoff time of T+26) and post the dump files to ftpprd server as requested by GSD. (Manikin, Keyser)

14.5.1.2 28 July 2014 (NCEP, ESRL & CAPS)
Groups collaborate on developing and testing best approaches for use of hybrid/ EnKF/3DVAR and 4d-ens-var within common GSI coding structure.

The NCEP developers gave lectures on radar data assimilation and the NCEP GSI data assimilation system at the July GSI Tutorial in Boulder. (Carley, Wu, Parrish)

ESRL

GSD (Ming Hu) is preparing a new GSI repository from which MDE research partners (GSD, EMC, CAPS, OU, others) will check out common software for regional ensemble data assimilation toward NARRE.

NCEP

Work has not begun as of May. (Carley, Wu, Parrish)

14.5.1.3 30 Sept 2014 (CAPS, GSD, EMC)
Test and evaluate direct radial velocity and reflectivity data assimilation within the 40-20km/13km dual resolution hybrid system. (Resolution dependent on computing resources)

CAPS

For FY2014, developments work at CAPS for direct assimilation of radar data in the EnKF and hybrid systems will be limited (most of this work was proposed under plan B for FY2014 which was not funded). In July, further efforts were made at CAPS adding direct reflectivity assimilation capabilities into the GSI hybrid system, including adding a reflectivity observation operator that considers ice phases into the hybrid GSI cost function. Mixing ratios of rain/snow/hail were added into GSI as new analysis variables; radar reflectivity data can be read into GSI; the reflectivity observation operator and its tangent linear and adjoint models were adopted from the ARPS 3DVAR into GSI. The kernel part of GSI, like the calculations of cost function and its gradient, were also modified to assimilate reflectivity. Initial code testing has begun.
EMC

The evolution of the temperature tendencies before and after the digital filter initialization was checked to confirm that the filter was behaving correctly. Other forecast fields were also scrutinized. (Liu, Carley)

14.5.1.4 1 Jan 2015 (ESRL, CAPS)
Test the 40/13 km dual-resolution system with hourly DA cycles including all observation types, including radar reflectivity data via cloud analysis and DDFI.

14.5.1.5 28 Feb 2015 (NCEP, ESRL & NCAR)
Groups collaborate on developing and testing physics schemes between WRF and NEMS' physics layer.

NCEP

A bug was found in the NMMB model code used to include the contribution of convective precipitation to the radar reflectivity calculations. A fix was found and added to the NEMS code repository. A fix is also being worked for the NMMB for making the GrADS control files associated with the model restart files. A summer student using different versions of the 4-km parallel CONUS nest ran multiple tests. The experiments with shallow convection and decreasing the horizontal grid spacing to 1 km showed the largest improvement in forecasting the onset of deep convection late on 17 April 2013 over southwest Oklahoma. The RRTM v3 codes have been unified so the regional NMMB and the GFS use the same radiation modules. Changes were made to the radiation modules that dealt with the treatment of trace gases, aerosols, surface properties, and zenith angle (astronomy) calculations. These codes were committed to the NEMS repository. (Ferrier, Aligo, Jovic)

GSD

GSD successfully ran a preliminary NARRE configuration testing ARW with RAP and NAM-like physics and also with NMMB using NAM physics, and will next expand the NMMB options including the Thompson MP scheme.

14.5.1.6 28 Feb 2015 (NCEP)
Complete testing of improved or extended 88D processing and quality control, taking advantage of dual-pol where possible.

The new Supplemental Adaptive Intra-Volume Low-Level Scan (SAILS) radar data code was submitted to NCO for operational implementation. The performance of the radar data processing code was improved after working with IBM. (Liu)

14.5.1.7 15 Mar 2015 (ESRL, CAPS, NCEP)
Complete readying of initial regional ensemble data assimilation capability to initialize real-time parallel RAP version and NAMRR.

NCEP

In the process of setting up the NDAS after the big structural change in GSI by NASA/GMAO, significant changes to the scripts and other fixes were found to be necessary. The impact to the short-term (3-hour) forecasts of temperature and surface pressure was found to be slightly negative while the impact to the humidity was positive. Meetings were held in July with ESRL regarding the development of the NARRE and NAMRR. NAMRR runs were started for a period near the end of May 2013 in collaboration with ESRL to compare with RAP forecasts, and to serve as a small step toward developing the NARRE. (Carley, Wu, Parrish)

14.5.1.8 28 Mar 2015 (NCEP and ESRL)
Negotiate Data Mining List priorities with NCEP Central Operations and external points of contact associated with the most desirable new sources of observations.

NCEP

No new items were requested so Data Mining List remained unchanged. (Keyser, Whiting).

GSD

New agreements with energy companies for use of their proprietary tower and nacelle wind data were drafted in May by GSD and coordinated with NWS. Access to this proprietary wind data is already on the DML.

14.5.1.9 31 March 2015 (NCEP)
Establish a pre-implementation version of the hourly updated NAMRR with a goal to use the common regional ensemble data assimilation.

The NAMRR system is being streamlined for performance on WCOSS. (Carley)

Deliverables

All Option A unless noted otherwise.

14.5.1.E1 10 April 2014 (ESRL)
Finalize RAPv3 and HRRRv2 for summer 2014 real-time exercise.

COMPLETE. A summary of the spring 2004 RAPv3 and HRRR v2 configurations has been published on the web at **http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2014.pdf**

14.5.1.E2 31 May 2014 (NCEP)
With approval of NCEP Director, NAMv3.1 upgrade package is implemented at NCEP.

The NAMv3.1 evaluation ended on July 30th. NCEP director will be briefed August 8th with implementation scheduled for August 12th. (Rogers)

14.5.1.E3 30 July 2014 (NCAR/MMM)
Deliver a WRF Users' Workshop and a WRF tutorial for the user community.

As previously reported, NCAR held the 2014 WRF Users' Workshop June 23–27, including strong participation from NOAA/ESRL/GSD. NCAR/MMM also conducted a basic WRF tutorial July 21–July 25, with 60 participants. The tutorial covered model processors and utilities, configuration, and operation. Practice sessions allowed participants to run various components of the system. The WRF-related tutorials continued through July 28–August 1 with tutorials on WRF data assimilation, regional climate modeling, and WRF-Chem (led by Steven Peckham and Georg Grell from GSD).

PLANNED EFFORTS: NCAR will organize, conduct, and host a WRF tutorial in January 2015.

UPDATES TO SCHEDULE: NONE

14.5.1.E4 20 Oct 2014 (ESRL)
Code for RAPv3 and HRRRv2 finalized for transfer to NCEP/EMC for 2015 implementation.

Progress has been steady with testing having started with WRFv3.6, earlier in the year than GSD has done previously with the annual WRF release. Merger of WRFv3.6+ with RAP / HRRR enhancements was completed in July and the RAP-dev3 cycle is now running WRFv3.6+ with the Thompson-Eidhammer aerosol-aware microphysics option turned on. See Task 3 for more details.

14.5.1.E4.1 31 Mar 2015 (ESRL)
Report on wind accuracy from RAP and HRRR by quarter for previous year, strongly related to turbulence guidance.

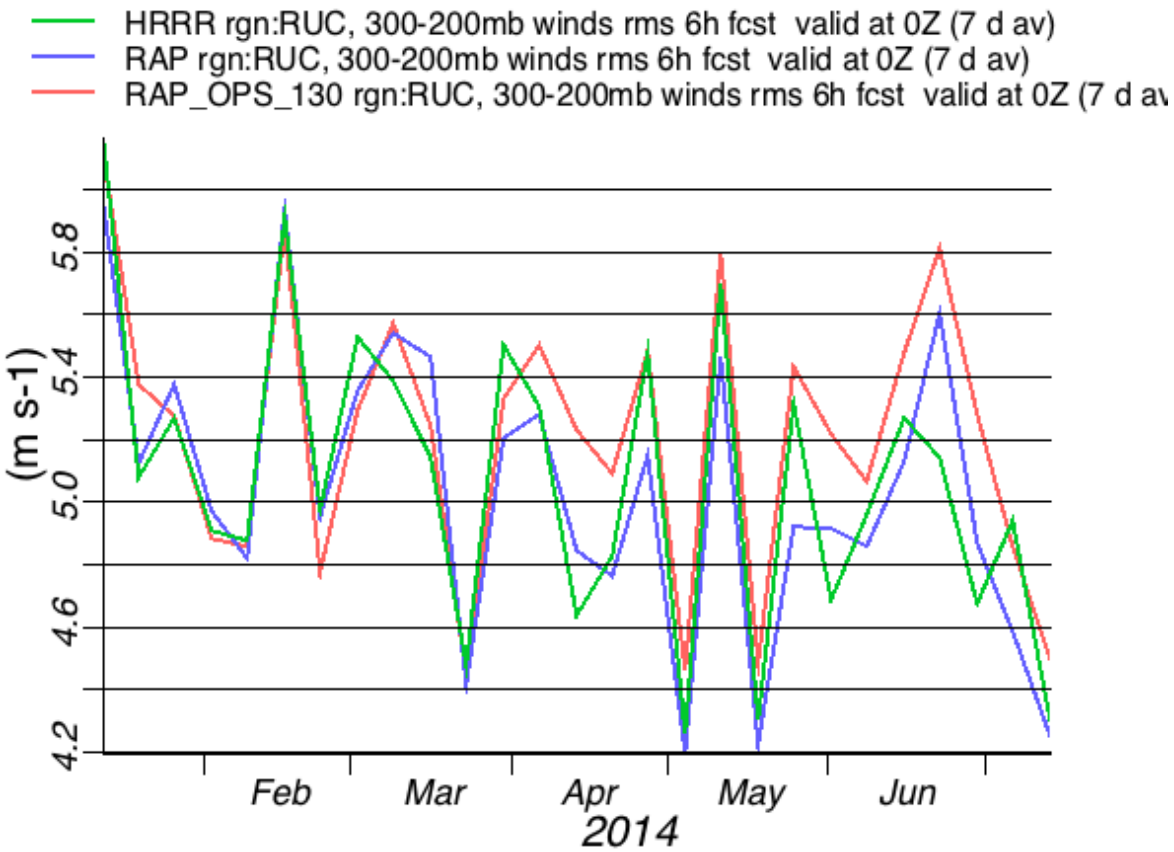

Figure 1: Upper-level (300-200 hPa) wind forecast RMS vector error vs. raobs for 6h forecasts from RAPv3 (ESRL, in blue), RAPv2 (NCEP, in red), and HRRR (ESRL, green). All scores are from native gridded data, not from isobaric coordinate data and show 7-day averages for forecasts valid at 00z. Units – m/s.

An initial look at upper-level 6h forecast wind accuracy over the last 6 months shows relatively similar wind accuracy between the operational RAP (red), ESRL RAP (blue), and ESRL HRRR (green) as shown in Fig. 1. After the introduction of RAPv3 and HRRRv2 in the ESRL runs in early April, those updated runs are generally showing improved wind forecast skill over that from the NCEP RAP (red). This also implies that turbulence guidance, heavily dependent on upper-level wind forecast accuracy, has also been improved from this update. Details on the RAP-HRRR updates in early April 2014 are described in **http://ruc.noaa.gov/pdf/RAPv3-HRRR-April2014.pdf** and **http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2014.pdf.** Verification against aircraft observations is also shown in Fig. 2 but only for the ESRL RAP (changing from RAPv2 to RAPv3 in early April). In future months, results from the NCEP RAP and HRRR models will be added to allow comparison for winds vs. aircraft observations.

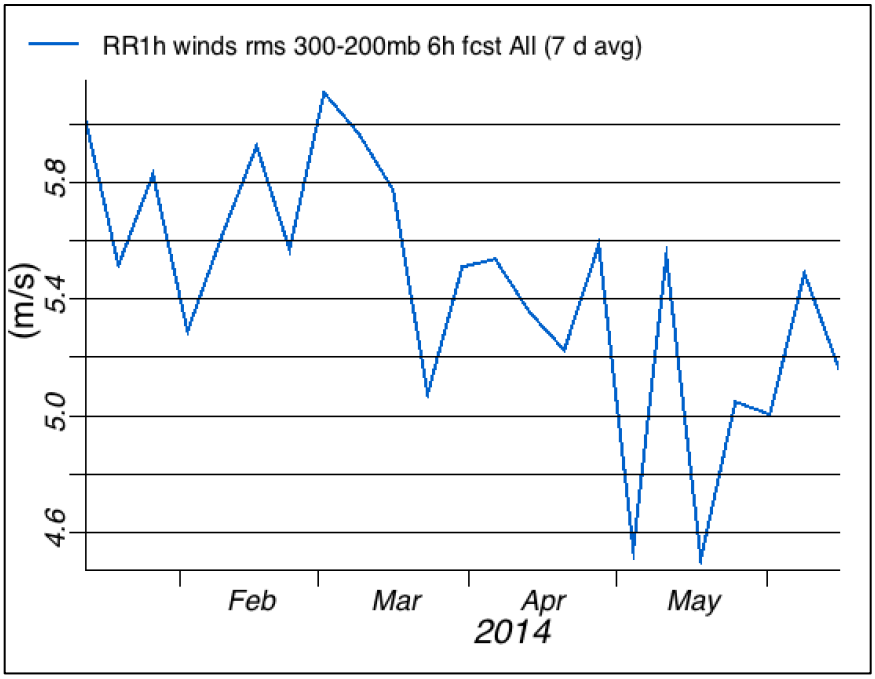

Figure 2: Upper-level (300-200 hPa) wind forecast RMS vector error vs. aircraft for 6h forecasts from RAPv3 (ESRL, in blue). Units – m/s.

14.5.1.E5 31 Oct 2014 (ESRL, CAPS, NCEP)
Complete the testing of the 40-20/13 km dual-resolution hybrid DA system for RAP with 3-hourly cycles with conventional data.

CAPS

Most efforts at CAPS were spent on adding reflectivity assimilation capabilities in GSI in July. Funding to CAPS for FY03 and FY04 has not arrived so CAPS was working on project with its own funding.

NCEP

No work was done in July. (Carley)

GSD

GSD has tested localization options for the GFS-ensemble-based covariances for the 40km hybrid DA system for RAP. GSD is also setting up a GSI repository for use for common GSD-NCEP-CAPS experimentation for hybrid ensemble data assimilation development.

14.5.1.E6 20 Dec 2014 (ESRL)
Report on RAPv3 model and data assimilation configuration and progress. This will include a report on wind verification and its improvements in RAPv3 vs. RAPv2.

14.5.1.E7 31 Jan 2015 (ESRL and NCEP)
Finalize code for RAPv3 to NCO for implementation at NCEP.

NCEP

The RAPv3 code being tested by ESRL will not be given to EMC until after the HRRR implementation in September. (Manikin)

GSD

GSD is carefully evaluating RAPv3 performance as described in the general information under Task 1 above. A set of further changes anticipated as possible for fall changes to the ESRL RAP code before transfer to NCEP for the final NCEP-RAPv3 configuration has been established. This set includes WRFv3.6, aerosol-aware microphysics, improved coupling between parameterized shallow convection and short-wave radiation, and improvements to GSI data assimilation including treatment of surface observations and assimilation of cloud and radar data.

14.5.1.E8 31 Jan 2015 (ESRL, NCEP)
Pending NCEP computer readiness and EMC and NCEP initial recommendations, Requests for Change (RFCs) are filed to submit code changes as part of upgrade for RAP v3 software to NCO.

NCEP

This work will not begin until after the HRRR implementation in September. (Manikin)

14.5.1.E9 31 March 2015 (NCAR/MMM)
Incorporate physics and dynamics improvements into WRF from the user community, GSD, and NCEP for use in the RAP and HRRR. Oversee code preparation and integration of these improvements into the WRF repository for future model version releases and FAA use. Assist in the implementation of bug fixes. In collaboration with GSD, assist in the development and evaluation of physics schemes for the RAP and HRRR that are contributed to the ARW.

Jimy Dudhia (NCAR/MMM) consulted with the DTC (Developmental Testbed Center) on enabling the GFS surface/slab model to work with the Noah LSM in WRF. Currently the DTC is seeing surface temperatures and fluxes in simulations that look unrealistic.

Dudhia obtained modified code from Jim Bresch (NCAR/MMM) for stabilizing model diffusion in complex terrain. In WRF V3.6, a preliminary version of adjusted diffusion was released. The code modifications obtained should be more robust, and they are targeted for V3.6.1.

Dudhia added a fix for the Goddard shortwave scheme's cosine zenith angle computation to the repository. This provides for consistency with diffuse/direct radiation diagnostics. Dudhia also added a repository fix for the 3-D diffusion TKE option in its stability factor computation.

Dudhia consulted with NCAR visitor Sebastian Masson of IPSL (Institute Pierre Simon Laplace, France). IPSL is coupling WRF with an ocean model and examining radiation differences between the Dudhia and Goddard shortwave schemes. Dudhia worked with setting up diagnostics for physics tendencies.

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

UPDATES TO SCHEDULE: NONE

14.5.1.E10 31 March 2015 (ESRL and NCEP)
Deliver progress report on development of NARRE.

NCEP

An error was fixed in the meridional winds associated with the GRIB2 output files from the NCASE. The corrected output was provided to WPC for evaluation in their Flash Flood and Intense Rain (FFaIR) experiment (several EMC staff participated in this experiment). NCASE products were monitored daily for quality. The directions of the wind barbs on NARRE-TL plots were corrected in response to comments from an NWS Eastern Region forecaster. (Du, Zhou, Yang, Jovic)

Deliverables Task 1: Improve Turbulence Guidance From NWP Forecasts	Delivery Schedule
A. Finalize RAPv3 and HRRRv2 for summer 2014 real-time exercise.	APR 2014 COMPLETE
B. Code for RAPv3 and HRRRv2 finalized for transfer to NCEP/EMC for 2015 implementation. Strong progress toward this at GSD through RAPv3/HRRRv2 current real-time evaluation.	OCT 2014
C. Complete the testing of the 40-20/13 km dual-resolution hybrid DA system for RAP with 3-hourly cycles with conventional data.	OCT 2014
D. Report on RAPv3 model and data assimilation configuration and progress. This will include a report on wind verification and its improvements in RAPv3 vs. RAPv2. Preliminary RAPv3 configuration already available in http://ruc.noaa.gov/pdf/RAPv3-HRRR-April2014.pdf.	DEC 2014
E. Finalize code for RAPv3 to NCO for implementation at NCEP.	JAN 2015
F. Report on wind accuracy from RAP and HRRR by quarter for previous year strongly related to turbulence guidance. Initial evaluation on wind accuracy from RAP and HRRR vs. raobs and aircraft observations has been started and included in this monthly report.	MAR 2015
G. Requests for Change (RFCs) filed to submit code changes as part of upgrade for RAPv3 software to NCO.	MAR 2015
H. Deliver progress report on development of NARRE.	MAR 2015

Task 2: Improve Quality Of Convective Weather Forecasts From RAP, HRRR, NAM, NAM-Nests And, Eventually, NARRE And HRRRE

Subtasks

14.5.2.1 15 April 2014 (GSD)
Report on enhancements to RAP 13-km and HRRR 3-km radar data assimilation for beginning 2014 warm-season evaluation using the ESRL-updated version of the HRRR (i.e., HRRRv2).

COMPLETE: As reported in the April 2014 MDE report:

Following extensive testing and evaluation, a RAP/HRRR change bundle was made in late March 2014. The package includes changes to both the data assimilation and a model portion of both the RAP and HRRR forecast systems and is summarized in the following report at **http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2014.pdf**

The testing involved single-case study experiments, retrospective evaluations, and real-time parallel cycles of individual changes and grouping of changes to check all aspects of the change bundle. The change bundle was a mix of addressing known issues and adding new capabilities. Highlights of the change bundle for the RAP include enhancements to the hybrid data assimilation and the cloud analysis, improvements in the snow cycling and dew point assimilation, and upgrades to the Grell-Freitas (GF) cumulus parameterization and the MYNN planetary bounder layer scheme. Highlights for the HRRR include most of the RAP enhancements plus adding a hybrid assimilation procedure and adjustments to the strength of the reflectivity-based diabatic heating. Also, both the WRF model and GSI analysis were updated to the latest community repository versions.

Statistical evaluation of both the RAP and HRRR retrospective and real-time parallel runs showed broad improvement in nearly all aspects (upper-air, surface, precipitation, reflectivity, etc.). Real-time performance has been good; although evidence of a warm, dry bias has been seen for pre-frontal, southerly flow regions. A variety of aspects related to this are being investigated in off-line, retrospective, and real-time parallel tests, including partial cloudiness, radiation and land surface model issues, and surface temperature assimilation factors. Specific data assimilation changes include creation of pseudo-innovations to the 1h forecast depth of the PBL (planetary boundary layer) for surface temperature observations (similar to the pseudo-innovation created for surface dew point observations) and modification to the forward model for surface temperatures. Some strong dependency was found on land-surface model configurations, with effective changes to wilting points made in real-time and retro tests started in early August showing major reduction to the warm-dry bias near the surface.

14.5.2.2 15 May 2014 (GSD)
Improved (optimized weight factors, and observation selection) 15-min HRRR-based RTMA.

Request for delay to 1 Sept 2014.

A key scientist to work on this task left GSD for another position in March. There has been some experimentation done on improved observation selection for the HRRR-based RTMA but more work will be done before the new requested due date. Experiments will also examine the run time for 15-min RTMA analysis with goal of reducing it to near 10 min.

14.5.2.3. 5 August 2014 (GSD)
Complete testing of updated version of 3-km sub-hourly radar assimilation within HRRR pre-forecast cycling period.

Testing continues, though highest priority is on RAP warm, dry bias. Changes were made for 2014 warm season evaluation, resulting in reduction of high bias during first few HRRR forecast hours.

14.5.2.4 20 Oct 2014 (GSD)
Complete 2014 HRRR summer evaluation using modeling and assimilation modifications determined in 2013 exercise. Collaborate on analysis of HRRR tests and deliver summary of results.

14.5.2.5 15 Dec 2014 (GSD)
Based on 2014 RAP and HRRR results, provide update report on development and testing of data assimilation and model enhancements important for improving forecasts of convective weather within the RAP and HRRR.

14.5.2.6 5 Dec 2014 (GSD)
Single-case test of storm-scale ensemble data assimilation completed for HRRR over small Northeastern U.S. domain.

14.5.2.7 15 March 2015 (NCEP)
Establish routine verification of NCEP suite of convective weather guidance and begin design of calibration strategy for ensemble systems.

The new Verification 3.1.0 package was submitted to NCO for implementation. This package contains a correction to subtract the terrain height for cloud base height so that it is consistent with the observed height reports. Corrected cloud verification has been generated off-line. Implementation is scheduled for August 26. (Zhou, Du, Yang, Shafran)

Deliverables

14.5.2.E1 1 August 2014 (NCEP and ESRL)
HRRRv1 implemented at NCEP pending available computing resources.

ESRL

Request Delay Till 30 Sept. 2014

HRRRv1 implementation currently scheduled for 30 Sept. 2014.

Final NCEP operational implementation version of HRRR code fully frozen in NCO parallel cycle with commencement of final 30-day field and functional evaluation on 15 Aug. Approval for proceeding to this step given at the NCEP/EMC Change Control Board (CCB) meeting on 6 Aug. 2014. Implementation set for 30 Sept. 2014, but could be delayed if 30 September is a critical weather day.

NCEP

HRRRV1 code was turned over to NCO and frozen (except for post processing issues) in early July after addressing an issue related to the topography near the boundaries. NCO ran the system in parallel through the end of the month and set up an ftp feed for data. The code has been completely stable and runs end-to-end in just over one hour. The official evaluation period will begin on August 15th, with implementation targeted for September 30th. (Manikin)

14.5.2.E2 1 April 2014 (NCEP)
Subject to NCEP Directors' approval, upgrades to HiResWindow and initial convection-allowing-scale ensemble (NSSE) becomes Operational at NCEP.

The HiResWindow version 6.0 upgrade package was implemented into NCEP Production on June 11th. (Pyle)

14.5.2.E3 1 April 2014 (NCEP)
With approval of NCEP Director, RTMAv6 upgrade package is implemented at NCEP.

The RTMA/URMA upgrade version 2.2.1 was implemented on January 28, 2014. (Manuel Pondeca, Steve Levine, Yanqiu Zhu, Ying Lin, Jeff Mcqueen, Geoff Manikin, Jim Purser, Dave Parrish, Yuqiu Zhu)

14.5.2.E4 15 July 2014 (ESRL)
Report on status of enhancements to HRRR for 2014 version, based on retrospective and real-time testing.

Mid-term assessment indicates overall good performance for 2014 HRRR (RAPv3/HRRRv2) compared to 2013 version. In particular, reduced (improved) bias for radar reflectivity is seen in 2014 HRRR compared to 2013. CSI scores are similar overall. More details can be found in the report at:
http://ruc.noaa.gov/pdf/HRRR_midterm_evaluation_2014.pdf

Testing and evaluation of RAPv3 / HRRRv2 system is ongoing to address a warm, dry bias seen in pre-frontal southerly flow areas (see subtask 14.5.2 for details).

14.5.2.E5 15 Oct 2014 (ESRL)
Complete 2014-summer evaluation with revised 3-km HRRR running every 1 h.

- Conduct real-time summer 2014 HRRR forecasts using 3-km WRF with 3-km assimilation 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 2014 HRRR experiments
- 2014 real-time summer evaluation ongoing. Results indicate very similar reflectivity CSI scores for the 2014 vs. 2013 HRRR, but a significant reduction (improvement) in the bias for the 2014 HRRR, especially at longer lead times (6 hour forecast and beyond). We are continuing to investigate and test refinement for a warm and dry near surface bias evident in the HRRR forecasts.

14.5.2.E5.1 31 Mar 2015 (ESRL)
Report on convective weather forecast accuracy from HRRR by quarter for previous year.

14.5.2.E6 15 Nov 2014 (ESRL and NCEP)
Based on real-time parallel and retrospective testing, HRRRv2 code finalized and ready for transfer to NCEP/EMC

ESRL

Operational implementation of RAPv3 / HRRRv2 originally scheduled for April 2015, but NCEP now states (as of ~14 August) that a 3-5-month delay from that date now appears likely. Changes from ongoing testing and evaluation of warm, dry bias will be incorporated into this code upgrade package. GSD continued to evaluate HRRRv2 during the real-time 2014 warm-season exercise.

NCEP

HRRRv1 must be implemented at NCEP before any transfer to EMC of the HRRRv2 code currently being tested at ESRL can be considered. The slip in the HRRRv1 implementation into September means this deadline may need to slip as well. (Manikin)

14.5.2.E7 15 Jan 2015 (ESRL, assistance from CAPS under 5.1 support)
Report on initial retrospective test of storm-scale ensemble data assimilation for small Northeast U.S. domain.

14.5.2.E8 31 Jan 2015 (ESRL/GSD, NCEP)
Pending NCEP computer readiness and EMC and NCEP initial recommendations, Requests for Change (RFCs) are filed to submit HRRR code changes as part of upgrade for HRRR v2 software to NCO.

NCEP

This work has not yet started. (Manikin)

ESRL

This work awaits final HRRRv1 operation implementation, completion of testing of changes for HRRRv2 at ESRL/GSD, and transfer of these changes to NCEP/EMC.

14.5.2.E9 1 Feb 2015 (ESRL and NCEP)
Provide revised 15-min RTMA surface analyses as improved alternative for frontal diagnostics and other diagnostics from surface analyses for CoSPA.

ESRL

This work awaits final HRRRv1 operation implementation, completion of testing of changes for HRRRv2 at ESRL/GSD, and transfer of these changes to NCEP/EMC.

NCEP

Work towards a 15-min RTMA must wait for completion of the HRRRv1 implementation in September. (Manuel Pondeca, Steve Levine, Jim Purser)

14.5.2.E10 15 March 2015 (ESRL)
Finalize all changes to the HRRR for the summer 2015 exercise into a frozen version of HRRR (and parent experimental RAP). This will include latest results on reflectivity verification.

Deliverables Task 2: Improve Quality Of Convective Weather Forecasts	Delivery Schedule
HRRRv1 implemented at NCEP pending available computing resources STATUS: HRRRv1 operational implementation planned for 30 Sept. 2014	AUG 2014 Request Delay till 30 Sept. 2014
B. Report status of enhancements to HRRR for 2014 version, based on retrospective and real-time testing. STATUS: Preliminary mid-summer report indicates 2014 HRRR improves upon the high bias seen in 2013, especially for longer forecasts. Testing of enhancements for warm, dry bias in RAP, HRRR ongoing. Report at: **http://ruc.noaa.gov/pdf/HRRR_midterm_evaluation_2014.pdf**	JUL 2014 COMPLETE
C. Complete 2014-summer evaluation with revised 3-km HRRR running every 1 h. Conduct real-time summer 2014 HRRR forecasts using 3-km WRF with 3-km assimilation 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 2014 HRRR experiments. STATUS: 2014 evaluation ongoing, evaluation of warm, dry bias in RAP	OCT 2014
D. Based on real-time parallel and retrospective testing, HRRRv2 code finalized and ready for transfer to NCEP/EMC.	NOV 2014
E. Report on initial retrospective test of storm-scale ensemble data assimilation for small Northeast U.S. domain.	JAN 2015
F. Requests for Changes (RFCs) are filed to submit HRRR code changes as part of upgrade for HRRRv2 software to NCO.	JAN 2015
G. Provide revised 15-min RTMA surface analyses as improved alternative for frontal diagnostics and other diagnostics from surface analyses for CoSPA.	FEB 2015
H. Report on convective weather forecast accuracy from HRRR by quarter for previous year.	MAR 2015
I. Finalize all changes to the HRRR for the summer 2015 exercise into a frozen version of HRRR (and parent experimental RAP). This will include latest results on reflectivity verification.	MAR 2015

Task 3: Improve Quality Of Icing Weather Forecasts From RAP, HRRR, NAM, NAM-Nests And, Eventually, NARRE And HRRRE

Subtasks

14.5.3.1 1 Apr 2014 (GSD NCEP and NCAR/RAL)
Begin initial testing of the current version of NCAR “aerosol-aware” microphysics in RAP and HRRR models. This will use a climatological aerosol distribution for cloud-condensation nuclei and ice nuclei initially.

The WRFv3.6+ version, upgraded to incorporate RAP/HRRR specific changes, is now running in RAP-dev3 with the Thompson-Eidhammer aerosol microphysics activated. Although we don't have a fully controlled comparison with the WRFv3.5.1 aerosol unaware microphysics, the differences we have been seeing between dev3 and the dev2 and dev1 cycles running WRFv3.5.1 are similar to those reported in last quarter's report with the cold-start comparison: slightly larger areas covered by precipitation and sometimes heavier amounts as well. A notable beneficial impact is that the surface warm/dry bias (see below) is less with this configuration.

A concern is that the RAP forecast is taking about 12% longer to run on the Zeus supercomputer than does WRFv3.5.1 with the aerosol unaware microphysics using the same number of processors. We will not have comparable timing results on WCOSS until after RAPv3 and HRRRv2 code is transferred to NCEP.

GSD is also now testing another new physics parameterization, using the Common Land Model (CLM, from NASA) lake component to give an improved estimate of lake surface temperatures. GSD is also using this lake model in the RAP-dev3 cycle running WRF3.6+. This lake model will likely be a component to RAPv4 and possibly to the NCEP-RAPv3 in testing this fall. Its use will likely improve near-surface conditions in the RAP and HRRR models in areas near small-size lakes (i.e., smaller than the size of the Great Lakes) for which we do not have good lake surface temperatures currently.

NCEP

EMC will await the results of GSD's effort before planning physics development in 2015 or beyond. (Ferrier, Aligo)

14.5.3.2 1 Apr 2014 (GSD)
Continue evaluation and modification of proposed RAPv3 physics suite in preparation for submission of code to NCEP, pending NCEP readiness, later in 2014.

As mentioned under Task 1, intensive effort continues toward alleviating the daytime warm / dry bias east of the Rockies and was discussed in more detail in last quarter's report. Some of the changes we will make or are being tested are Correcting a bug in the WRF model namelist in which the attenuation of solar radiation by (climatological) aerosol was inadvertently turned off. This had the effect of reducing daytime temperatures in sunny areas, but by less than 0.5 deg C. Miscellaneous changes to the MYNN surface and PBL schemes that have the effect of reducing slightly the surface heat flux and allowing for counter-gradient heat flux near the top of the daytime mixed layer. These changes also reduced the warm and dry bias, but again only slightly (by < 0.5 deg C).

Improving the coupling of (parameterized) shallow convection (Grell-Freitas) with short-wave radiation. This at present offers some promise of reducing the biases, based on real-time parallel testing, as over the eastern half of the CONUS in areas of fair weather, shallow cumulus are common on most summer days.

The strongest effects for reducing this bias have been found from adjustment to soil wilting point values especially for cropland areas.

We are also considering possible changes to fixed fields that impact the behavior of the RUC LSM, based on published studies. We are also verifying code and looking into other possibilities. A short retrospective period leading up to and surrounding the 17 June 2014 case in eastern Nebraska that exhibited particularly egregious behavior, leading to a bad HRRR forecast of convection, is being used in this effort, along with the use of the two real-time RAP parallel cycles not tied to the 2014 warm season evaluation.

14.5.3.3 1 May 2014 (GSD and NCAR/RAL)
Begin efforts toward adding aerosol species or size categories as tracers to the RAPv3 and HRRR configurations of the WRF model, including surface sources, which are highly parameterized in the first version of the new microphysics scheme. Interact with WRF-Chem experts for aerosol source datasets, surface emission inventories, and translation of specific aerosol variables into the constituents needed by the microphysics scheme.

Discussions have started between GSD and NCAR about how to incorporate prognostic aerosol information from the RAP-Chem run into experimental versions of the RAP and HRRR.

14.5.3.4 1 May 2014 (NCEP)
Perform case-study simulations of high-impact weather events in order to evaluate NMMB model running the existing and newly added Thompson et al (2008) microphysics schemes.

A diagnostic tool was developed using GrADS to plot vertical cross sections of any orientation, which also showed the underlying terrain. This tool was challenging to develop within GrADS because the latitudes and longitudes varied along the cross section. Different sets of GrADS scripts were modified to make it easier to plot soundings directly from NEMSIO

history files. These revised scripts were provided to the summer student for use in his analysis. Work with NCAR continued on coupling the Thompson microphysics with the RRTM v3 radiation in the regional NMMB. Thompson is currently reviewing the codes and trying to determine why some of his microphysics settings are not being used within the RRTM radiation codes. EMC met with DTC to answer their questions on setting up their microphysics tests evaluating the Thompson versus F-A microphysics planned for the late summer or early fall. Code changes to the RRTM to speed up the run times were tested and compiler-optimized code didn't give bit-identical results. Special tests were run to confirm that the results were still accurate even though not bit-identical. These new RRTM codes can be added to the NEMS repository. (Ferrier, Aligo, Lin)

14.5.3.5 1 Jun 2014 (NCAR/RAL)
Test and evaluate the ice initiation mechanisms via aerosols to ensure the water-ice balance is relatively un-changed versus the prior scheme or else the updated scheme may result in significant loss of skill of aircraft icing forecasts since water is rapidly depleted by ice when too many ice crystals are supplied.

14.5.3.6 1 Sep 2014 (NCAR/RAL)
Continue to increase the complexity and interactions between the newly added aerosol variables in the microphysics with the PBL, radiation, convection, and shallow convection schemes. Particular focus will be the depletion of aerosols nucleated by sub-grid-scale eddies, the effects of which are represented by the PBL and convection schemes.

Current efforts: G. Thompson and T. Eidhammer documented the changes and purpose of changes of the new aerosol-aware microphysics scheme in a final report to AWRP, delivered Aug. 2, 2014. By leveraging with the DOE Solar-WRF team, G. Thompson and T. Eidhammer tested aerosol optical depth calculated from the microphysics scheme aerosol variables incorporated into the radiation scheme. Initial testing looks very promising and subsequent transfer to Pedro Jimenez is being pursued for more extensive testing.

Future work: NCAR-RAL will assist NOAA-GSD to adopt/utilize the new scheme. Trude Eidhammer will resume additional testing of the ice initiation by aerosols in the next month or two.

Problems encountered/Delays: Subtask#6 contains many unknowns due to numerous dependencies with other physics routines. Work may not begin on this subtask until after 1 Oct 2014.

Interface with other organizations: Various DOE Solar-WRF team members including GSD

Deliverables
(All Option A unless noted otherwise)

14.5.3.E1 1 Aug 2014 (NCAR)
Submit updated cloud microphysics code to WRF repository; document changes and purpose of changes in a report.

14.5.3.E2 31 Aug 2014 (ESRL)
Complete initial evaluation of aerosol-aware microphysics in RAP/HRRR test evaluation/demonstration at GSD for its suitability for future NCEP implementation.

14.5.3.E3 1 Dec 2014 (NCAR)
Submit a report and possible journal manuscript related to the aerosol-ice sensitivity experiments including specific application to aircraft icing.

14.5.3.E4 20 Dec 2014 (ESRL)
At the annual NCEP Product Suite Review report on RAP / HRRR physics upgrades. This will include metrics on improvement to cloud and RH forecasts from these physics upgrades.

14.5.3.E4.1 31 Mar 2015 (ESRL)
Report on RH/cloud forecast accuracy from RAPv3 and HRRRv2 by quarter for previous year, related to icing guidance.

14.5.3.E5 31 Jan 2015 (ESRL/GSD, NCEP)
Pending NCEP computer readiness and EMC and NCEP initial recommendations, Requests for Change (RFCs) are filed to submit WRF physics code changes as part of upgrade for Rapid Refresh v3 software to NCO.

NCEP

This work has not yet started. (Manikin)

Deliverables Improve Quality Of Icing Weather Forecasts	Delivery Schedule
Complete initial evaluation of aerosol-aware microphysics in RAP/HRRR test evaluation/demonstration at GSD for its suitability for future NCEP implementation. ESRL/GSD: The aerosol-aware microphysics is now running in an experimental real-time RAP cycled run ("RAP-dev3")	AUG 2014
B. At the annual NCEP Product Suite Review report on RAP/HRRR physics upgrades. This will include metrics on improvement to cloud and RH forecasts from these physics upgrades.	DEC 2014
C. Requests for Change (RFCs) are files to submit WRF physics code changes as part of upgrade for Rapid Refreshv3 software to NCO.	JAN 2015
D. Report on RH/cloud forecast accuracy from RAPv3 and HRRRv2 by quarter for previous year, related to icing guidance.	MAR 2015

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

Subtasks

14.5.4.1 15 Aug 2014 (GSD)
Initial testing toward variational / ensemble cloud analysis scheme within the GSI framework.

A preliminary planning meeting was held with ESRL/GSD and NCAR to present and discuss approaches for a variational/ensemble cloud analysis. This discussion included a work plan to create a common GSI source code repository and add cloud water and cloud ice control variables and static background errors in GSI. Longer-term plans include creation of cloud water and ice observations based on cloud coverage and testing of cloud water/ice retrievals in a variational framework that can be compared to the original non-variational cloud analysis. A GSD collaborator completed GSI tutorial training in July and initial progress towards a variational/ensemble cloud analysis scheme will be presented at the AMS annual meeting in January 2015.

14.5.4.2 15 Nov 2014 (GSD, NCEP)
Finalize new cloud/hydrometeor analysis for 2015 RAPv3/HRRRv2

GSD

Modifications continue to the WRF-ARW version 3.6 codes including the creation of a total cloud field that combines explicit, parameterized and boundary layer clouds fields for a more accurate depiction of the modeled cloud field that includes unresolved scales. Initial plans have been made to improve the analysis of cloud ice information from satellite observations by incorporating both cloud ice mixing ratio and number concentration into the cloud analysis process for use by the Thompson microphysics scheme. Preliminary case study testing of full-column precipitating hydrometeor building in the HRRR cloud/hydrometeor analysis has been completed. Results of this test indicate an improved 3-D analysis of precipitation and an increase in 1-hr accumulated precipitation at low thresholds. Additional tests will include application of the precipitating hydrometeor analysis during the sub-hourly assimilation/pre-forecast period in the HRRR along with full column cloud building.

NCEP

The DFI work done in 14.5.1.2 is related to this work. (Liu)

14.5.4.3 15 Feb. 2015 (GSD, NCEP)
Report on progress toward variational/ensemble cloud analysis

NCEP

The ability to have vertically varying localization for regional hybrid variational/ensemble analysis and several bug fixes on the cloud analysis was successfully added to the repository. (Liu, Wu, Carley)

14.5.4.4 15 March 2015 (NCEP, ESRL)
Groups collaborate on initial work toward cloud analysis scheme for use in NARRE ensemble system.

NCEP

No work was done in July. (Liu, Wu, Carley)

14.5.4.5 31 March 2015 (ESRL, NCEP)
Establish routine verification of NCEP suite of ceiling & visibility guidance and begin design of calibration strategy for ensemble systems.

NCEP

The grid-to-grid (g2g) verification upgrade was documented and submitted to NCO for implementation. The g2g verification ran into problems verifying radar echo-top heights, because the values assigned to areas within the model domain where there is no radar reflectivity (e.g., clear sky conditions) were being incorrectly interpolated by the copygb utility and are getting mixed up with the areas designated as outside the forecast domain. A temporary short-term fix was devised with help from Eric Rogers and Brad Ferrier. The database used by GSD for the High Impact Weather Prediction Project (HIWPP) verification was compared against the EMC verification database. HRRR forecasts of 1-km AGL reflectivity and echo-top height are being added to the g2g verification. Difficulties in converting the HRRR output into a grid that can be used by g2g, and different (from NCEP) HRRR echo-top height product IDs are being worked. The new Verification 3.1.0 package was submitted to NCO for implementation. This package contains a correction to subtract the terrain height for cloud base height so that it is consistent with the observed height reports. Corrected cloud verification has been generated off-line. Implementation is scheduled for August 26. (Zhou, Shafran, Du, Yang)

Deliverables

14.5.4.E1 1 April 2014 (NCEP)
With approval of NCEP Director, RTMAv6 upgrade package is implemented at NCEP (including visibility).

The RTMA/URMA upgrade version 2.2.1 was implemented on January 28, 2014, (Manuel Pondeca, Steve Levine, Yanqiu Zhu, Ying Lin, Jeff McQueen, Geoff Manikin, Jim Purser, Dave Parrish, Yuqiu Zhu)

14.5.4.E2 1 June 2014 (NCEP)
With approval of NCEP Director, SREF, HiResWindow and NAM upgrade packages are implemented at NCEP (including corrections to ceiling, visibility and cloud field prediction & diagnoses).

Testing of the SREF upgrade continues. The NMMB model can now be initialized with all three analyses and ARW can be initialized with the GDAS and RAP. Initialization of ARW with the NDAS is still being worked. EMC and AWC reviewed results from NAM parallel (NAMX) forecasts of visibility and cloud ceiling heights (C&V) compared to the operational NAM. EMC's results were consistent with AWC's findings, that the 12-km NAMX runs had a low bias in cloud ceiling heights. Improvements in visibility forecasts were found by AWC and EMC through their own objective verification methods. As a result of EMC-AWC discussions, more work is needed in this area to improve the C&V forecasts, as well as to develop more accurate verification statistics at EMC that would focus on lower cloud ceiling heights that trigger flight rule restrictions. (Du, Zhou, Yang, Jovic, Pyle, Rogers)

14.5.4.E3 15 Dec 2014 (ESRL/GSD)
Finalize cloud/hydrometeor assimilation for RAPv3 and transfer code to NCEP.

14.5.4.E4 15 Feb 2015 (ESRL/GSD)
Report on variational / ensemble/hybrid cloud analysis development for RAP and NARRE

14.5.4.E5 31 March 2015 (NCEP)
Subject to NCEP Directors' approval, upgrades to RTMA/URMA (addition of total cloud and cloud base height [ceiling]) become Operational at NCEP.

Real time diagnostic RTMA and RTMA parallel webpages are being maintained. Total cloud amount and cloud ceiling analysis variables were added to the RTMA-GSI code and early testing has begun. Several small bug fixes were added to the GSI to make the code less likely to fail. (Pondeca, Carley, Levine)

Deliverables Task 4: Develop Convection-ATM-Specific Improvements	Delivery Schedule
A. Report on ATM impact related to skill of HRRR forecast.	FEB 2015
B. Complete implementation of new microphysics scheme and associated reflectivity and ET diagnostics in real-time ESRL/GSD RAP and HRRR prior to code freeze for 2015-exercise release.	MAR 2015
C. Report on baseline testing of the early 2015 HRRR version.	MAR 2015
D. Report on evaluation of revised Thompson aerosol-aware microphysics for RAP/HRRR for its effects on echo-top and reflectivity in ESRL RAP/HRRR.	MAR 2015