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Technical Implementation Notice 11-53 Amended
National Weather Service Headquarters Washington DC
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Subject: Amended: Changing the Rapid Update Cycle (RUC) to the Rapid Refresh (RAP) Analysis and Forecast System: Effective Date Set for May 1, 2012

Amended to set the implementation date for Tuesday May 1, 2012. Users are cautioned that if a Critical Weather Day (CWD) designation is in effect on May 1, this implementation will be delayed until the conclusion of CWD. You can monitor the CWD status at the following webpage:

http://www.nco.ncep.noaa.gov/pmb/cwd/

Also amended to add a clarification about shelter specific humidity replacing shelter mixing ratio in the bgrb files.

On Tuesday, May 1, 2012, beginning with the 1200 Coordinated Universal Time (UTC) run, the National Centers for Environmental Prediction (NCEP) will replace the Rapid Update Cycle (RUC) with the Rapid Refresh (RAP) model. Changes include:

-Covering a much larger domain, compared to the RUC, including Alaska and the Caribbean basin and almost all of North America.
-Introducing a new modeling framework.
-Installing a major upgrade to the prediction model.
-Modifying the data analysis and assimilation system.
-Matching most existing RUC products and adding new ones to cover the expanded domain. A select number of obsolete RUC files will be removed.
-Introducing experimental North American Rapid Refresh Ensemble using Time Lagged (NARRE-TL) forecast.
-Modifying some product output and changing the names of all directories and output filenames from *ruc* or *ruc2a* to *rap*.

Details on the various changes are provided below, along with a notice about possible changes to product generation time. NWS has tried to capture all of the changes occurring with this implementation. In the event that something was overlooked, we will amend this Technical Implementation Notice (TIN).

General Framework:

Like the RUC, the RAP will be run 24 times per day, once for each hour. Each run will be integrated to 18 hours, and output will be available for each forecast hour. Due to the larger domain, lateral boundary conditions for the RAP will be provided by the Global Forecast System (GFS) instead of the North American Mesoscale (NAM) model as is done for the RUC.

The model will be fully cycled with all fields, including snow cover, carried through to the next cycle. The model will continue to trim snow cover twice per day based on the National Environmental Satellite Data and Information Service (NESDIS) analysis. To prevent the model from drifting away from the synoptic truth, two 6-hour partial cycles will be initiated each day at 03z and 15z by bringing in a guess for atmospheric fields only from the GFS and then performing a series of analyses and 1-hour forecasts with the final 1-hour forecast used as the first guess for the 09 and 21z cycles.

Like the RUC, the RAP has a 13 km horizontal resolution and 50 vertical levels. A sigma vertical coordinate is used in the RAP, compared to the sigma-isentropic hybrid vertical coordinate in the RUC. The pressure top of the RAP is at 10 hPa, compared to 40-70 hPa pressure top on the highest isentropic surface in the RUC. The native horizontal grid for the RAP is a rotated latitude-longitude grid.

Analysis Upgrade:

The Gridpoint Statistical Interpolation (GSI) analysis system has been adapted for the RAP. It maintains several important components of the RUC analysis:

-Cloud hydrometeor analysis.
-Assimilation of radar reflectivity data.
-Diabatic digital filter initialization.

Additional observations are assimilated in the RAP that are not currently assimilated in the RUC, including:

-Satellite radiances, including Advanced Microwave Sounding Unit (AMSU)-A and AMSU-B, similar to that done for the North American Mesoscale (NAM) model.
-Aircraft moisture observations from United Parcel Service (UPS) and Southwest Airlines.
-915-MHz profiler wind observations.
-Geostationary Orbiting Environmental Satellite (GOES) cloud pressure/temperature from National Aeronautics and Space Administration (NASA) Langley over full RAP domain added to NESDIS cloud data already assimilated in the RUC model upgrade.

The RAP model component is a configuration of the Weather Research and Forecasting (WRF) model, using the Advanced Research WRF (ARW) core. It keeps, however, mostly RUC-like physics including:

-A version of the Grell convective scheme.

-Thompson cloud and precipitation microphysics.
-Rapid Radiation Transfer Model (RRTM) longwave radiation.
-Goddard shortwave radiation.
-MYJ (Mellor-Yamada-Janjic) planetary boundary layer (PBL)/ turbulent mixing.
-RUC/Smirnova land-surface model.

Updated versions of the cloud microphysics, Grell convection, and RUC land-surface schemes are used in the RAP over older versions used in the RUC.

Output Product Changes:

The RUC currently generates output on pressure levels (pgrb) and native levels (bgrb) at horizontal resolutions of 13, 20 and 40 km for every forecast hour (0-18). Smaller files with near-surface data (sgrb) are generated at a smaller number of forecast hours at the same resolutions, and an 80 km data set generated for a few forecast hours is also available. The RUC output is made available to users on the NWS ftp server, the NCEP server, and a subset of the output is available on NOAAPort.

The NWS issued a Public Information Statement (PNS) on November 9, 2011 requesting comments on the proposal to remove several RUC products. Please see:

https://www.weather.gov/media/notification/pdfs/pns11ruc_removal.pdf

Based on the responses received, the decision was made to terminate the following RUC products as part of this implementation:

-All sgrb data.
-80 km data.
-Native level output at 40 km resolution.

Please see the PNS referred to above for specifics about the exact files to be removed and the dissemination outlets for these files.

The following new data sets will be available on the NCEP server, with output at all forecast hours:

-Full domain 32-km grid (Advanced Weather Interactive Processing System (AWIPS) grid 221).
-11 km Alaska grid (AWIPS grid 242).
-16 km Puerto Rico grid (AWIPS grid 200).

To facilitate a smooth transition from the RUC to the Rapid Refresh, NCEP is making look-alike files in the RAP to mimic output provided by the RUC. Files with data on native levels (bgrb) and pressure levels (pgrb) will be provided on the same 130 (13 km) and 252 (20 km) grids currently generated by the RUC. In addition, RAP pgrb data (not bgrb) will be provided on the 236 (40 km) grid. NCEP has tried to match the fields offered by the RUC, but there are a few exceptions listed below resulting from the use of the NCEP unified post processor. When a RUC parameter is unavailable, NCEP

has tried to find a similar parameter that RAP can generate, but a few fields could not be matched and were eliminated. There are also situations in which the same parameter is available in the RAP as in the RUC, but the Product Definition Section (PDS) of the gridded binary (GRIB) encoding identifies the parameter in a different way. All of these differences are documented below.

Note that changes to the order of the parameters in the files are not documented. It is standard NCEP practice to change the sequence of fields in a file without documentation. Users are advised to extract records from the files by using the PDS instead of using the order of records. Also, note that these look-alike files, which match the domain covered by the RUC, only cover a portion of the expanded RAP domain: 32-km full-domain files on grid 221 will be available in the RAP. No full-domain data sets will be available at any other resolution other than 32 km: 11-km files on grid 242 will be available for users wanting high-resolution RAP output over Alaska, and 16-km files on grid 200 will be available for users wanting high-resolution RAP output over Puerto Rico.

The differences between RAP and RUC files are discussed below:

BGRB (native levels):
-The vertical profile of virtual potential temperature (parameter 189) in the RUC is replaced by temperature (parameter 11) in the RAP.
-The vertical profile of mixing ratio (parameter 53, vertical coordinate 109) in the RUC is replaced by specific humidity (parameter 51) in the RAP. The shelter value (vertical coordinate 105) of mixing ratio in the RUC is also replaced by specific humidity in the RAP.
-The net longwave flux at the surface (parameter 112) in the RUC is replaced by the surface downward longwave flux (parameter 205) in the RAP.
-The net shortwave flux at the surface (parameter 111) in the RUC is replaced by the surface downward shortwave flux (parameter 204) in the RAP.
-The RAP maintains 3-hour buckets for convective and non- convective precipitation like the RUC, but it adds in 1-hour and run total buckets.
-The lightning parameter (187) now has values in the RAP where 1 indicates a model prediction of an ongoing thunderstorm, and 0 is the null event. The RUC field currently contains zeros at all points.
-The rate of water dripping from canopy to ground (parameter 188) is not available in the RAP.
-The fields of snow temperature (parameter 239) at 5 and 10 cm are not available in the RAP.
-The field of surface mixing ratio (parameter 53) and density (parameter 89) at 5 cm are eliminated.
-The storm-surface and baseflow-groundwater runoff parameters are now 1-hour accumulations in the RAP, compared to the instantaneous values in the RUC.
-The following new parameters are added to the bgrb files: PBL height (parameter 221), surface height (parameter 7 at surface), surface wind gust (parameter 180), skin temperature (parameter 11 at surface), friction velocity (parameter 253), and upward longwave flux at the top of the atmosphere (parameter 212 at TOA).
-The "best" convective available potential energy (parameter 157) and convective inhibition (parameter 156) fields are now true values of those

parameters rather than being calculated using moist static energy as in the RUC. These fields in the RAP are computed using the virtual temperature correction.
-The field of shelter mixing ratio (parameter 53 at 2 meters) is replaced by shelter specific humidity (parameter 51 at 2 meters).

PGRB (PRESSURE LEVELS):

-The surface-based lifted index (parameter 131) now has the vertical coordinate defined as 101 (layer being two isobaric levels) with 500 and 1000 as the two levels. The RUC defines it as a surface field (vertical coordinate 1). This parameter is now computed using the virtual temperature correction.
-The "best" lifted index (parameter 132, labeled as computed between 0 and 180 mb) replaces the best lifted index (parameter 77, labeled as computed at the surface) in the RUC. This parameter is now computed using the virtual temperature correction.
-The 0-3 km storm-relative helicity field (parameter 190) is correctly labeled with vertical coordinate 106 with 3,000 and 0 m as the levels in the RAP; it is a surface field in the RUC. Note that the 0-1 km helicity is correctly labeled in both the RAP and RUC.
-The storm motion components (parameters 196 and 197) are correctly labeled with vertical coordinate 106 with 6,000 and 0 m as the levels in the RAP; they are surface fields in the RUC.
-The storm-surface and baseflow-groundwater runoff parameters are now 1-hour accumulations in the RAP, compared to the instantaneous values in the RUC.
-The convective available potential energy (parameter 157) and convective inhibition (parameter 156) fields (surface-based and best) are now true values of those parameters rather than being calculated using moist static energy as in the RUC. These fields in the RAP are computed using the virtual temperature correction.
-Cloud base height (with vertical coordinate 2) and cloud top height (with vertical coordinate 3) now use parameter 7 (geopotential height) in the RAP; the RUC defines them as parameter 8 (geometric distance). Also, note that grid points with no defined cloud base or top use a bitmap for this field in the RAP; the RUC uses -9999 for the value.
-The pressure level from which a parcel used in Convective Available Potential Energy (CAPE)/Convective INhibition (CIN) computations is lifted (parameter 141, vertical coordinate 116) in the RAP replaces the pressure level of maximum equivalent potential temperature (parameter 1, vertical coordinate 246) in the RUC. Both parameters are computed similarly.
-The convective cloud top height field (parameter 7, vertical coordinate 243) uses -500 as a value of no cloud in the RAP; the RUC uses 0.
-The relative humidity computed with respect to the precipitable water (parameter 230) now has a range of 0 to 100 in the RAP. This parameter was incorrectly scaled by 1/100 in the RUC.

Binary Universal Form for the Representation of meteorological data (BUFR) (station time-series data):

-The RAP will continue to generate station time-series BUFR data in the formats of one monolithic file containing data for all stations and individual station files. The RAP, however, generates data for more

stations than the RUC due to its larger domain. The RUC currently generates data for 1,168 locations; the RAP will generate this data for 1,448 locations. There will be no change in the format or content of the data for each station.

Experimental NARRE-TL product:

The new experimental NARRE-TL products are constructed from a weighted blend of the six most current RAP and four North American Mesoscale (NAM) forecasts covering the 01-12 hour period. The weighting is inversely proportional to forecast length and new 01-12 hour NARRE-TL guidance is produced every hour. The parameters are geared towards aviation needs. For CONUS:

http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/NARRE/web_site/html/conv.html

For Alaska:

http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/NARRE_Alaska/web_site/html/conv.html

In addition to these sites, this guidance will be available from the NCEP server site.

File Names:

The file names for RAP output will differ from the equivalent RUC files. For servers that maintain the nomenclature of the files as they are generated, the following conversions apply:

For forecast cycle XX (00-23) and forecast hour HH (00-18):

-ruc2.tXXz.pgrb13fHH.grib2 becomes rap.tXXz.awp130pgrbfHH (13 km)
-ruc2.tXXz.pgrb20fHH.grib2 becomes rap.tXXz.awp252pgrbfHH (20 km)
-ruc2.tXXz.pgrbfHH.grib2 becomes rap.tXXz.awp236pgrbfHH (40 km)
-ruc2.tXXz.bgrb13fHH.grib2 becomes rap.tXXz.awp130bgrbfHH (13 km)
-ruc2.tXXz.bgrb20fHH.grib2 becomes rap.tXXz.awp252bgrbfHH (20 km)

Note that for analysis files, the RUC uses an "anl" suffix; the RAP will use the conventional "f00" for these files. For example, ruc2.tXXz.pgrb13anl.grib2 becomes rap.tXXz.awp130pgrbf00.grib2.

The 32 km full domain files will have the naming structure rap.tXXz.awip32fHH.grib2.

The 11 km Alaska files will have the naming structure rap.tXXz.awp242fHH.grib2.

The 16 km Puerto Rico files will have the naming structure rap.tXXz.awp200fHH.grib2.

Product Dissemination:

The RUC output is currently available on NOAAPort, and with the exception of the 80km products being removed, all look-alike RAP products will be available on NOAAPort with the same World Meteorological Organization (WMO) headers as the current RUC products.

RUC output is also available on the NWS file transfer protocol (ftp) server and the NCEP server. Along with the file name changes outlined above, all directories on these servers will change from ruc to rap. The RAP output will be available in the following directories:

NWS FTP server:

ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/MT.rap_CY.hh
where hh is the model cycle from 00 to 23.

NCEP server:
http://www.ftp.ncep.noaa.gov/data/nccf/com/rap/prod
ftp://ftp.ncep.noaa.gov/pub/data/nccf/com/rap/prod

Product Delivery Time Changes:

The RAP cycle will be initiated each hour at the same times that the RUC is currently initiated: 26 minutes past the hour for all cycles, except 00/12z, which are started at 58 minutes past the hour in order to wait for raob data to become available. A major difference in the structure of the RAP compared to the RUC results in a major change in the availability time of the analysis. The RUC does a preliminary posting of an analysis that is not possible in the WRF framework of the RAP, so the RAP analysis files will be available 12 minutes later than the current times from the RUC. The more complex set of steps leading to the forecast also result in later availability times for the early RAP forecast files, but the overall code efficiency eliminates the lag fairly quickly. For example, the 3-hour forecast files in the RAP will be available five minutes later than those from the RUC, but the delay is eliminated by forecast hour nine, and the 18-hour RAP forecast files will be available approximately seven minutes sooner than those currently available from the RUC.

For more general information about the RAP, please see:

http://rapidrefresh.noaa.gov

A consistent parallel feed of data will be available on the NCEP server once the model is running in parallel on the NCEP Central Computing System in December. The parallel data will be available via the following URLs:

http://www.ftp.ncep.noaa.gov/data/nccf/com/rap/para
ftp://ftp.ncep.noaa.gov/pub/data/nccf/com/rap/para

NCEP has tried to anticipate all filename and product content changes associated with this implementation, but if we discover additional changes during the course of the testing, we will send an amended version of this TIN with that information as soon as possible.

NCEP urges all users to ensure their decoders can handle changes in content order, changes in the scaling factor component within the product definition section (PDS) of the GRIB files, changes to the GRIB Bit Map Section (BMS), and volume changes. These elements may change with future NCEP model implementations. NCEP will make every attempt to alert users to these changes before implementation.

For questions regarding these changes, please contact:

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National Technical Implementation Notices are online at:

https://www.weather.gov/notification/archive

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