NOUS41 KWBC 311652
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Technical Implementation Notice 13-38
National Weather Service Headquarters Washington DC
1252 PM EDT Thu Oct 31 2013

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From: Tim McClung
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        Office of Science and Technology

Subject: Updates to the Rapid Refresh (RAP) Analysis and
        Forecast System: Effective December 17, 2013

Effective Tuesday, December 17, 2013, beginning with the 1200
Coordinated Universal Time (UTC) run, the National Centers for
Environmental Prediction (NCEP) will update the Rapid Refresh
(RAP) with Version 2.0.0.

The changes are designed to provide overall forecast improvement
on the synoptic scale including upper-level winds, temperature
and humidity, with specific local improvement to forecasts of
2-meter temperatures and dew points and 10-meter winds. This
implementation specifically includes:

- A major upgrade to the data analysis and assimilation system
- A major upgrade to the prediction model
- New parameters added to the output grids
- Update to the station list used for BUFR output soundings.

Details on the various changes are provided below.

Analysis Upgrade

The RAP uses a Gridpoint Statistical Interpolation (GSI) analysis
system which now includes options originally developed for the
Rapid Update Cycle (RUC). RUC preceded the RAP--the cloud
hydrometeor analysis, the assimilation of radar reflectivity
data, and the diabatic digital filter initialization. These
options have helped improve short-range forecasts.

This upgrade includes the following changes to the analysis:

a) using the newest version of the GSI code from the GSI code
repository
b) using GFS ensemble background error co-variances

c) adjusting soil moisture and temperature based on atmospheric low-level temperature and moisture increments
d) adding PBL-based pseudo-innovations for surface moisture observations
e) assimilating lightning data
f) improvements to snow trimming and addition of the capability of adding snow where observational data shows snow cover that is absent in the model background
g) improving initialization of 3-d hydrometeor (cloud) fields from building lower-tropospheric clouds and retaining cloud fraction information from METAR and satellite cloud data
h) modifying radar hydrometeor specification
i) improving assimilation of GPS precipitable water data

Model Upgrade

The RAP model is a configuration of the Weather Research and Forecasting (WRF) model, using the ARW core. This upgrade includes the following changes:

a) updating the Advanced Research WRF (ARW) core to version 3.4.1 from 3.2.1
b) changing the soil model from 6 layers to 9
c) updating version of the Thompson microphysics
d) switching the PBL scheme from Mellor-Yamada-Zanjic (MYJ) to Mellor-Yamada-Nakaniski/Niino (MYNN)
e) fixing the radiation code bug to restore attenuation due to 3-d snow mixing ratio

Output Product Changes

The RAP currently generates CONUS output on pressure levels (pgrb) at horizontal resolutions of 13, 20 and 40 km and output on native levels (bgrb) at horizontal resolutions of 13 and 20 km. RAP output is also available on a 32-km full domain grid, an 11-km Alaska grid, and a 16-km Puerto Rico grid. Data are available on each grid for all forecast hours (0-18) of each cycle.

The following additional parameters are added to the pgrb files of all resolutions:
- 0-180 hPa "best" convective available potential energy and convective inhibition
- 0-90 hPa "mixed" convective available potential energy and convective inhibition
- cloud ceiling height
- simulated radar echo top
- Haines index
- thunder potential
- 0-6 km wind shear (u and v components)
- 80-m temperature, pressure, specific humidity, and u/v wind components
- simulated brightness temperature for GOES East and GOES West (Channels 3 and 4 for each)

- low, middle, high, and total cloud fractions
- planetary boundary layer height, computed using the Richardson number

The following changes are made to all bgrb files:
- add the number of concentration of rain particles on all 50 model levels
- generate soil temperature and moisture content to reflect the new distribution of soil levels. Previous output was at 0, 5, 20, 40, 160, and 300 cm. The new levels are at 0, 1, 4, 10, 30, 60, 100, 160 and 300 cm.

The following changes are made in all 32-km full domain files, all 11-km Alaska files, and all 16-km Puerto Rico files:
- add height, temperature, relative humidity, and u and v wind components at 50 and 75 hPa
- add simulated brightness temperature for GOES East and GOES West (Channels 3 and 4 for each)
- add low, middle, high, and total cloud fractions
- add Haines index
- compute planetary boundary layer height using the Richardson number

The following changes are made in all 32-km full domain files and all 11-km Alaska files:
- generate soil temperature and moisture content to reflect the new distribution of soil levels. Previous output was at 0, 5, 20, 40, 160 and 300 cm. The new levels are at 0, 1, 4, 10, 30, 60, 100, 160 and 300 cm.
- add instantaneous incoming surface long wave radiation flux

The following change is made in all 32-km full domain files and in all 16-km Puerto Rico files:
- add 0-90 hPa "mixed" convective available potential energy and convective inhibition
The BUFR output will add 28 new stations to the station time series BUFR output relocate four existing sites. See TIN 13-35 for information on these additions.
Product Delivery Time Changes:

Due to running the analysis code with the GFS ensemble background error covariances, the analysis output files will be posted up to 2 minutes later than in the current version. This delay, however, is made up during the forecast because the products for the last forecast hour should generally match the current delivery times.

No changes to data availability will occur with this upgrade. RAP products are currently available on NOAAPORT, the NCEP server, the NWS ftp server and on NOMADS.

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 by early November, 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 urges all users to ensure their decoders can handle changes
to the content, changes to content order, 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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For questions regarding the dataflow aspects of these datasets,
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NWS National Technical Implementation Notices are online at:

  http://www.nws.noaa.gov/os/notif.htm

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