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Service Change Notice 18-58
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From: Dave Myrick
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Subject: Upgrade to the RAP and HRRR Analysis and Forecast
 System: Effective July 11, 2018

Effective on or about Wednesday, July 11, 2018, beginning with the 1200 Coordinated Universal Time (UTC) run, the National Centers for Environmental Prediction (NCEP) will implement Version 4 of the Rapid Refresh (RAP) and Version 3 of the High-Resolution Rapid Refresh (HRRR) systems.

Major changes will include:

- New HRRR Alaska system
- HRRR forecast extensions for specific cycles
- RAP forecast extensions for specific cycles
- Numerous data assimilation changes

Analysis Changes:

- The RAP and HRRR will both use an updated version of the Gridpoint Statistical Interpolation (GSI) analysis code.
- The weighting of the ensemble-based component in the hybrid data assimilation will increase from 0.75 to 0.85 for the RAP and HRRR.
- The assimilation of velocity Azimuth Display (VAD) wind retrievals, Atmospheric Motion Vectors (AMV) over land, and Tropospheric Airborne Meteorological Data Report (TAMDAR) will be added to the RAP and HRRR.
- The assimilation of Infrared Atmospheric Sounding Interferometer (IASI), Cross-Track Infrared Sounder (CrIS), and Spinning Enhanced Visible and InfraRed Imager (SEVIRI) radiances will be added to the RAP including direct readouts.
- The assimilation of radar radial velocity and lightning data will be added to the HRRR.
- Planetary boundary layer (PBL) pseudo observations will be refined to reduce a relative humidity bias.
- Meteorological Terminal Aviation Routine Weather Report (METAR)/Geostationary Operational Environmental Satellite (GOES) cloud building is made consistent below 1200 m AGL (above ground level).

- During cloud building, cloud number concentrations will be more physically consistent with cloud mixing ratios to support more retention of clouds/ceilings through the first few forecast hours.
- Latent heating in the radar reflectivity assimilation is reduced in the RAP to improve precipitation and reflectivity biases in both the RAP and HRRR.
- The assimilation of the Global Positioning System (GPS)-Integrated Precipitable Water will begin again. This data was turned off in the RAP and HRRR in April 2017 due to corrupted data.

Changes to Model:

- The RAP and HRRR will both begin using Weather Research and Forecasting (WRF) version 3.8.1; both will continue to use the Advanced Research WRF (ARW_ core).
- The RAP and HRRR will switch to using a hybrid vertical coordinate system, which improves the depiction of the mesoscale environment.
- The representation of terrain will be improved, leading to better wind and turbulence forecasts.
- The RAP and HRRR will begin to use full geometric diffusion, which improves wind and temperature forecasts over terrain.
- The Mellor Yamada Nakanishi Niino (MYNN) planetary boundary layer scheme is being updated to improve the depiction of subgrid-scale clouds and the mesoscale environment including eddy diffusivity mass flux (EDMF).
- The 9-level Rapid Update Cycle (RUC) land-surface model is being updated to include 15" Moderate Resolution Imaging Spectroradiometer (MODIS) data to improve the lower boundary, and roughness lengths have been refined over various land use types.
- The Thompson microphysics scheme is being updated to improve the depiction of upper-level clouds.
- The RAP and HRRR will begin to use real-time greenness vegetative fraction from the Visible Infrared Imaging Radiometer Suite (VIIRS).
- The RAP and HRRR have refined diagnostics of 2 m temperature (removed grid-point speckling over snowpack at night), 10 m wind (more physically consistent), 10 m wind gust (removed a low bias) and visibility (removed a low bias).

Many of these changes to the data assimilation, land-surface model, boundary layer scheme, and microphysics scheme are designed to improve the depiction of cloud fields and to mitigate a high precipitation and reflectivity bias in the RAP and HRRR that is most notable during the first several forecast hours. Significant reduction of these biases has been evident during the extensive testing period.

Output Changes:

- The RAP and HRRR will be extending the forecast hours 4 times

a day. The RAP will be extended out to 39 hours for cycles 03, 09, 15 and 21 UTC. The HRRR will be extended out to 36 hours for cycles 00, 06, 12 and 18 UTC. The HRRR sub-hourly output, however, will not cover the forecast extensions; it will continue to be available only through hour 18 for all cycles. These forecast extensions will facilitate future NCEP plans for the High-Resolution Ensemble Forecast (HREF) system.

- A new HRRR Alaska system will be introduced with this upgrade. HRRR Alaska will run every third hour, with forecasts out to 18 hours for cycles 03, 09, 15 and 21 UTC and out to 36 hours for cycles 00, 06, 12 and 18 UTC. HRRR Alaska will provide additional high-resolution guidance over the state of Alaska with more frequent cadence.

- The HRRR directory structure will be modified to include conus and alaska subdirectories on the NCEP Web Services:

<http://nomads.ncep.noaa.gov>
<ftp://ftp.ncep.noaa.gov>
<http://www.ftp.ncep.noaa.gov>

OLD directory: hrrr/prod/hrrr.YYYYMMDD
NEW directory: hrrr/prod/hrrr.YYYYMMDD/conus
NEW directory: hrrr/prod/hrrr.YYYYMMDD/alaska
Where YYYYMMDD is Year, Month and Day

- The forecast lengths of both the RAP and the HRRR will be extended on the NCEP servers NOMADS Grib Filter and OpenDAP Services for the specific cycles:

http://nomads.ncep.noaa.gov/cgi-bin/filter_rap.pl
http://nomads.ncep.noaa.gov/cgi-bin/filter_rap32.pl
http://nomads.ncep.noaa.gov/cgi-bin/filter_hrrr_2d.pl
<http://nomads.ncep.noaa.gov:9090/dods/hrrr>
<http://nomads.ncep.noaa.gov:9090/dods/rap>

The new Alaska grid will also be made available through NOMADS

- The new HRRR Alaska domain output will be added to the NCEP Web Services with the following files under the alaska subdirectory:

hrrr.tCCz.wrfprsfHH.ak.grib2
hrrr.tCCz.wrfnatfHH.ak.grib2
hrrr.tCCz.wrfsfcfHH.ak.grib2
hrrr.tCCz.wrfsubhfYY.ak.grib2
hrrr.tCCz.class1.bufr.ak.tm00
hrrr.tCCz.bufrsnd.tar.ak.gz

Where CC is the cycle (00,03,06,09,12,15,18,21) and HH is the forecast hour (00-36), and YY is the forecast hour (00-18)

- RAP Precipitation Field Changes

The RAP currently generates convective, non-convective and total precipitation. In the previous upgrade total precipitation was added to the output as part of the RAPv3 upgrade. This was so users no longer needed to sum the convective and non-convective

amounts. To become consistent with other NCEP models that generate only total and convective precipitation, the run total and 1-hour accumulation non-convective precipitation fields (NCPCP) will be eliminated in this upgrade.

- RAP Cloud Ice

The full vertical profile of cloud ice parameter (kg/m^2) is replaced by full vertical profile of the cloud ice mixing ratio (kg/kg) on all grids which contain a cloud ice profile (13 km native and pressure level, 32 km full domain, 16 km Alaska, 13 km CONUS native level, and 20 km CONUS).

- Total Accumulated Snowfall

The labeling for total accumulated snowfall is modified at forecast hour 00 (f00) for the RAP and HRRR to include a 0-0 day acc fcst label. This change makes accumulated snowfall consistent with the other accumulation fields at f00.

- Added and Removed Parameters from the RAP output on NCEP Web:

- * Cloud ceiling height is added to the Alaska grid.
- * Surface roughness length is added to the full domain 13 km native level grid.
- * Instantaneous upwelling shortwave radiation at the top of the atmosphere is added to the full and CONUS 13 km native level grids.
- * Run total accumulated freezing rain is added to the 13 km full domain pressure level grid, the 13 km CONUS pressure level grid, and the Alaska grid.

- Added Parameters for the HRRR (files wrfprs and wrfsfc) output on NCEP Web:

- * Accumulated Freezing Rain
- * Instantaneous Upwelling Shortwave Radiation at Top of Atmosphere
- * Max Reflectivity at -10C over the previous hour
- * Hourly Maximum 10-m U wind component
- * Hourly Maximum 10-m V wind component
- * Hourly Minimum Updraft Helicity in 2-5 km layer
- * Hourly Minimum Updraft Helicity in 0-3 km layer
- * Hourly Maximum Updraft Helicity in 0-3 km layer
- * Hourly Minimum Updraft Helicity in 0-2 km layer
- * Hourly Maximum Updraft Helicity in 0-2 km layer
- * Hourly Maximum Relative Vertical Vorticity in 0-2 km layer
- * Hourly Maximum Relative Vertical Vorticity in 0-1 km layer
- * Hourly Maximum Estimate of Maximum Hail/Graupel Size in Model Column
- * Hourly Maximum Estimate of Maximum Hail/Graupel Size at Lowest Model Level

- Added Parameters for the HRRR (files wrfsfc) output on NCEP Web:

- * 300-mb U wind component
- * 300-mb V wind component

- Added Parameters for the HRRR (files wrfsubh) output on NCEP Web:

- * Surface Height
- * Upward Shortwave Radiative Flux

- Added Parameters for the HRRR (files wrfnat) output on NCEP Web:

- * Volumetric Soil Moisture Content (Fraction) at surface (labeled as 0 meters below ground)
- * Volumetric Soil Moisture Content (Fraction) at 0.1 meters below ground

- The following changes are made to existing parameters in the wrfprs, wrfsfc, and wrfnat files on NCEP Web:

The hourly maximum updraft and downdraft speeds, currently labeled as parameters computed over a depth between 400 and 1000 mb are now labeled as parameters computed over a depth between 100 and 1000 mb to reflect a change to the computations.

- BUFR Output

A few current stations are being modified, and new stations are being added to the station time series BUFR data for the RAP and HRRR. The update to the station list for the RAP and HRRR will be done in conjunction with the updates to the stations lists for the NAM, GFS, SREF, and Hi-Res Windows. Please reference the concurrent SCN for more information,

http://www.nws.noaa.gov/os/notification/scn18-57bufr_updates.htm

- Product Delivery Time Changes

The RAP and HRRR station time series BUFR data will arrive later for the extended cycle. The 03, 09, 15, and 21 UTC RAP BUFR data will arrive 10 minutes later than the files for the other cycles, and the 00, 06, 12, and 18 UTC HRRR BUFR data will arrive 30 minutes later than the files for the other cycles.

- There will be no changes to data on NOAA/PORT/SBN

Parallel Data Available:

A consistent parallel feed of data is available on the NCEP server via the following URLs:

<http://para.nomads.ncep.noaa.gov/pub/data/nccf/com/hrrr/para>

<http://para.nomads.ncep.noaa.gov/pub/data/nccf/com/rap/para>

For more general information about the RAP and HRRR, please see:

<http://rapidrefresh.noaa.gov>

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, 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.

NCEP will evaluate all comments to determine whether to proceed with this upgrade.

For questions regarding this implementation, please contact:

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NWS National Service Change Notices are online at:

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

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