NOUS41 KWBC 031925 AAA
PNSWSH

Service Change Notice 17-41 Updated
National Weather Service Headquarters Silver Spring, MD
325 PM EDT Wed May 3 2017

To: Subscribers:
-NOAA Weather Wire Service
-Emergency Managers Weather Information Network
-NOAAPORT
Other NWS Partners, Users and Employees

From: Dave Myrick
NWS Office of Science and Technology Integration

Subject: Updated: Upgrade of National Water Model
Effective: May 8, 2017

Updated to change implementation date from May 4 to May 8 due to Critical Weather Day

Effective on or about Thursday May 4, 2017, beginning with the 1200 Coordinated Universal Time (UTC) run, the National Centers for Environmental Prediction (NCEP) will begin operationally running Version 1.1 of the National Water Model (NWM).

The NWM is an hourly cycling uncoupled analysis and forecast system that provides streamflow for 2.7 million river reaches and other hydrologic information on 1km and 250m grids. It provides complementary hydrologic guidance at current NWS River Forecast Center river forecast locations and significantly expanded guidance coverage and type in underserved locations.

The NWM ingests forcing from a variety of sources including Multi-Radar Multi-Sensor (MRMS) radar-gauge observed precipitation data and High-Resolution Rapid Refresh (HRRR), Rapid Refresh (RAP), Global Forecast System (GFS) and Climate Forecast System (CFS) Numerical Weather Prediction (NWP) forecast data. USGS real-time streamflow observations are assimilated, and all NWM configurations benefit from the inclusion of over 1,260 reservoirs. The core of the NWM system is the NCAR-supported community WRF-Hydro hydrologic model. WRF-Hydro is configured to use the NoahMP Land Surface Model (LSM) to simulate land surface processes. Separate water routing modules perform diffusive wave surface routing and saturated subsurface flow routing on a 250m grid, and muskingum-cunge channel routing down NHDPlusV2 stream reaches. River analyses and forecasts are provided across a domain encompassing the CONUS and hydrologically-contributing areas, while land surface output is available on a larger domain that extends beyond the CONUS into Canada and Mexico (roughly from latitude 19N to 58N). In addition, NWM forcing datasets are provided on this domain at a resolution of 1km.

List of Enhancements in Version 1.1:

1. Forecast cycling
    - Extension of short range forecast from 15 to 18 hours
    - Increased frequency of medium range forecast from 1 to 4 times per day
2. Parameter Updates
    - Parameter calibration to reduce hydrologic biases
    - Improvement of the Multi-Radar/Multi-Sensor (MRMS), High Resolution Rapid Refresh (HRRR) and Rapid Refresh (RAP) precipitation blending in NWM Analysis
    - Improvement of HRRR/RAP precipitation blend in NWM Short Range forecast
    - Incorporated a data-driven approach to channel parameter estimates utilizing a regression model based on USGS cross-sections.
3. Stream Connectivity Refinements
    - Corrections to NHDPlusV2 streamflow connectivity errors noted by RFCs
    - Addition of new oCONUS hydrologically contributing areas
4. Additional Upgrades
    - Fix for overly large infiltration rate in sandy areas during intense precipitation
    - Fixes to underlying topography leading to isolated extreme OCONUS ponded water values
    - Fix for high altitude excessive snow melt
    - Fix for isolated negative underground runoff
    - Enhancements to USGS data decoder and preprocessor
    - Corrected locations and stream reach attributions to several previously mismatched USGS gauge locations.
    - Shift from NetCDF3 to NetCDF4 output file format. End user software may need to be adjusted to adapt to this change. NetCDF version 4.2 or later libraries are recommended.
    - NetCDF metadata and data structure updates to improve compatibility with NetCDF file readers--as above, decoders may need to be adjusted to adapt to these changes.

NetCDF format changes:

1. In order to reduce the size of NWM output files and align metadata with existing standards and conventions, a few changes have been made to the files' internal data structure. In particular, many variables are now stored as integers with associated scaling factors as opposed to floats. Most 3rd party commercial and open-source applications, like ESRI ArcGIS, QGIS, IDV, Panoply, and the Weather and Climate Toolkit should handle the packed data automatically. Further information on data packing is available at:

www.unidata.ucar.edu/software/netcdf/docs/BestPractices.html

2. In addition, some dimension, variable, and attribute changes have been made. It is highly recommended that users

review the available metadata before attempting to use the NWM 1.1 data files. A listing of file metadata changes is presented below:

All Files:

- "time" dimension is now an UNLIMITED dimension
- Units of "time" variable have changed to "minutes since 1970-01-01 00:00:00 UTC" or epoch time
- "reference_time" dimension and variable have been added
- "units" attributes have been modified to align with CF conventions
- "scale_factor" and "add_offset" attributes have been added to variables containing packed data values
- The "_FillValue" attribute has been added to all data variables

"channel_rt" files:

- "station" dimension and "station_id" variable have been renamed to "feature_id" and now include 2,716,897 reach segments

"land" files:

- "south_north" and "west_east" dimensions have been removed
- "x" and "y" coordinate dimensions and variables have been added
- "soil_layers_stag" and "snow_layers" dimensions have been removed from all "land" files except for those associated with medium_range forecasts
- "ProjectionCoordinateSystem" variable has been added

"terrain_rt" files:

- "x" and "y" coordinate dimensions and variables have been added
- "ProjectionCoordinateSystem" variable has been added

"reservoir" files:

- "station" dimension and "lake_id" variable have been renamed to "feature_id"
- "latitude" and "longitude" variables have been added

"forcing" files:

- "ncXX" dimensions have been removed
- "x" and "y" coordinate dimensions and variables have been added
- "nv" dimension has been added to work with new "time_bounds" variable
- "ProjectionCoordinateSystem" variable has been added

General Framework:

Version 1.1 of the NWM will be run in four configurations that are largely similar to Version 1.0--Analysis and Assimilation, Short-Range, Medium-Range and Long-Range. Notable changes include:

1. The extension of short-range forecasts from 15 hours to 18

hours.
2. The increase in medium-range forecast cycling frequency from one time per day (06Z) to four times per day (00Z, 06Z, 12Z and 18Z).
For a complete description of the overall configuration, input data sources and other elements, users are referred to the NWM Version 1.0 Technical Implementation Notice.

http://www.nws.noaa.gov/os/notification/tin16-30natl_water_model.htm

End users are able to view the output via the interactive map and image viewer on the Office of Water Prediction (OWP) website, http://water.noaa.gov/about/nwm. Additionally, the full set of NWM output and a subset of forcing files are available on NCEP web services at:

http://nomads.ncep.noaa.gov/pub/data/nccf/com/nwm
http://nomads.ncep.noaa.gov/pub/data/nccf/com/nwm
http://ftp.ncep.noaa.gov/data/nccf/com/nwm

Output Changes on the NCEP web services:

1. The directory structure naming convention will be changing for the forcing files, where:
fe_analysis_assim/ -> forcing_analysis_assim/
fe_short_range/ -> forcing_short_range/
fe_medium_range/ -> forcing_medium_range/

2. In version 1.0 all “nc” files were gzipped and labeled with an extension “gz”. With version 1.1 the files use internal compression, will no longer be gzipped and no longer contain that extension. An example:
nwm.tCCz.long_range.channel_rt_3.f006.conus.nc.gz
Changes to
nwm.tCCz.long_range.channel_rt_3.f006.conus.nc
Where CC is cycle

3. The file naming structure will be changing for the forcing files, where:
forcing_analysis_assim/
nwm.tCCz.fe_analysis_assim.##.conus.nc.gz
Changes to
nwm.tCCz.analysis_assim.forcing.tm##.conus.nc
Where CC is cycle and ## is 00-02 (where tm is time-minus, meaning the number of hours prior to valid cycle time)
forcing_short_range/
nwm.tCCz.fe_short_range.f###.conus.nc.gz
Changes to
nwm.tCCz.short_range.forcing.f###.conus.nc
Where CC is cycle and ### is 001-018
forcing_medium_range/
nwm.tCCz.fe_medium_range.f####.conus.nc.gz
Changes to
nwm.t${cyc}z.medium_range.forcing.f###.conus.nc
Where CC is cycle and ### is 001-240

4. New file output will be available
analysis_assim/
nwm.tCCz.analysis_assim.channel_rt.tm##.conus.nc
nwm.tCCz.analysis_assim.terrain_rt.tm##.conus.nc
nwm.tCCz.analysis_assim.land.tm##.conus.nc
nwm.tCCz.analysis_assim.reservoir.tm##.conus.nc
Where CC is cycle and ## is 00-02 (previously only ##=00 was available)
forcing_analysis_assim/
nwm.tCCz.analysis_assim.forcing.tm##.conus.nc
Where CC is cycle and ## is 00-02 (previously only ##=00 was available)
short_range/
nwm.tCCz.short_range.channel_rt.f###.conus.nc
Where CC is cycle and ### is 001-018
nwm.tCCz.short_range.land.f###.conus.nc
Where CC is cycle and ### is 001-018
nwm.tCCz.short_range.reservoir.f###.conus.nc
Where CC is cycle and ### is 001-018
nwm.tCCz.short_range.terrain_rt.f###.conus.nc
Where CC is cycle and ### is 001-018 (previously only ##=001-015 was available)
forcing_short_range/
nwm.tCCz.short_range.forcing.f###.conus.nc
Where CC is cycle and ### is 001-018 (previously only ##=001-015 was available)

medium_range/
nwm.tCCz.medium_range.channel_rt.f###.conus.nc
nwm.tCCz.medium_range.land.f###.conus.nc
nwm.tCCz.medium_range.reservoir.f###.conus.nc
nwm.tCCz.medium_range.terrain_rt.f###.conus.nc
Where CC is cycle (00,06,12,18) and ### is 003-240 (previously only CC=06 was available)
forcing_medium_range/
nwm.tCCz.medium_range.forcing.f###.conus.nc
Where CC is cycle (00,06,12,18) and ### is 001-240 (previously only CC=06 was available)

5. Users will find that long range products have enough of a lag time in creation that they may appear in the previous day’s output directory. For example, long range mem 1 products for the 18z cycle will not show up until the day after their initialization time. For this reason, users are encouraged to look back in the previous dated directory for long range product availability.

The 15 minute USGS observation timeslice files in the corresponding usgs_timeslices directory will only contain files valid on that date. Previously, users could find data for the previous day in the current directory, but with the new version they will need to look back in the corresponding dated

directories to find older data.

6. One other item to note with this upgrade is that the following files will be available 6-10 minutes sooner than with version 1.0.

analysis_assim/
nwm.tCCz.analysis_assim.channel_rt.tm##.conus.nc
nwm.tCCz.analysis_assim.terrain_rt.tm##.conus.nc
nwm.tCCz.analysis_assim.land.tm##.conus.nc
nwm.tCCz.analysis_assim.reservoir.tm##.conus.nc
Where CC is cycle and ## is 00-02

Most NWM NetCDF output files are directly viewable using standard NetCDF visualization utilities. The exceptions are the point-type NWM channel output files containing streamflow and other variables. In particular, due to storage space limitations, the latitude and longitude of each point are stored outside of the file, but are available at:
ftp://ftp.nohrsc.noaa.gov/pub/staff/keicher/WRFH_ppd/web/NWM_v1.1_nc_tools_v1.tar.gz
Scripts are also available at this location which will append this geospatial data to a user selected output file, enabling viewing of channel output files within NetCDF visualization utilities.

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

http://para.nomads.ncep.noaa.gov/pub/data/nccf/com/nwm/para

NCEP encourages all users to ensure their decoders are flexible and are able to adequately handle changes in content order and also any volume changes which may be forthcoming. These elements may change with future NCEP model implementations. NCEP will make every attempt to alert users to these changes prior to any implementations.

For more general information about the NWM, please see:

http://water.noaa.gov/about/nwm

Any questions regarding this implementation should be directed below. We will evaluate any feedback and decide whether to proceed.

For questions on the science aspects, please contact:
Brian Cosgrove
OWP/Analysis and Prediction Division
Silver Spring, MD
301-427-9513
brian.cosgrove@noaa.gov

For questions regarding the data flow aspects of these datasets, please contact:

Carissa Klemmer
NCEP/NCO Dataflow Team
College Park, Maryland
301-683-0567
ncep.list.pmb-dataflow@noaa.gov

NWS National Service Change Notices are online at:
http://www.nws.noaa.gov/os/notif.htm

NNNN