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From: Dave Myrick
 NWS Office of Science and Technology Integration

Subject: Upgrade of National Water Model: Effective March 6, 2018

Effective on or about March 6, 2018, beginning with the 1200 Coordinated Universal Time (UTC) run, the National Centers for Environmental Prediction (NCEP) will begin operationally running Version 1.2 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. The model 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. U.S. Geological Survey (USGS) real-time streamflow observations are assimilated and all NWM configurations benefit from the inclusion of ~1,500 reservoirs. The core of the NWM system is the National Center for Atmospheric Research (NCAR)-supported community Weather Research and Forecasting (WRF)-Hydro hydrologic model. WRF-Hydro is configured to use the Noah Multi-Parameterization (Noah-MP) 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 continental U.S. (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 1.2:

- Refined land surface and hydrologic parameters by expanding calibration from ~40 to ~1,000+ calibration basins and improving parameter regionalization process.
- Improved streamflow data assimilation in Analysis cycle.
- Introduced the ability to make on-demand updates of hydrological parameters within the modeling system. Users can find notifications for when an update was introduced here:

<http://water.noaa.gov>

- Made various hydrofabric improvements including:

Fixing 500 stream breaks

Adding 12,468 outside the CONUS (OCONUS) basins (94,824 km²)

Adding 680 USGS stream gauges into assimilation routine

Adding 328 reservoirs (now totaling ~1,500)

Including a new elevation base harmonized with the NHDPlus channel network.

- Changes to the fields and metadata contained within NWM output files including:

Compressing the reservoir output files from the Analysis, Short-, Medium- and Long-Range configurations to match compression applied to other model output file types. This compression greatly reduces reservoir-type output file sizes. Files affected include:

nwm.tCCz.analysis_assim.reservoir.tm##.conus.nc Where CC is cycle (00-23) and ## is 00-02.

nwm.tCCz.short_range.reservoir.f###.conus.nc Where CC is cycle (00-23) and ### is 001-018

nwm.tCCz.medium_range.reservoir.f###.conus.nc Where CC is cycle (00, 06, 12, 18) and ### is 003-240

nwm.tCCz.long_range.reservoir_M.f###.conus.nc

Where CC is cycle (00, 06, 12, 18), M is member (1-4) and ### is 006-720.

- Changed the data type of the output variable "inflow" from "float" to "integer" in the reservoir model output files from the Analysis, Short-, Medium- and Long-Range configurations as part of compression. Files affected include:

nwm.tCCz.analysis_assim.reservoir.tm##.conus.nc Where CC is cycle (00-23) and ## is 00-02.

nwm.tCCz.short_range.reservoir.f###.conus.nc Where CC is cycle (00-23) and ### is 001-018

nwm.tCCz.medium_range.reservoir.f###.conus.nc Where CC is cycle (00, 06, 12, 18) and ### is 003-240

nwm.tCCz.long_range.reservoir_M.f###.conus.nc

Where CC is cycle (00, 06, 12, 18), M is member (1-4) and ### is 006-720.

- Changed the data type of the metadata variable "time" from "double" to "integer" in the forcing output files to match the convention used in the non-forcing (i.e., model) output files. Files affected include:

nwm.tCCz.analysis_assim.forcing.tm##.conus.nc Where CC is cycle and ## is 00-02

nwm.tCCz.short_range.forcing.f###.conus.nc Where CC is cycle and ### is 001-018

nwm.t\${cyc}z.medium_range.forcing.f###.conus.nc Where CC is cycle and ### is 001-240.

- Addition of output variable (velocity) to the Long-Range channel output files. Files affected include:

nwm.tCCz.long_range.channel_rt_M.f###.conus.nc

Where CC is cycle (00, 06, 12, 18), M is member (1-4) and ### is 006-720.

- Adding three output variables (QSfcLatRunoff, QBucket, QBtmVertRunoff) to the Short-Range and Analysis channel output files to support channel-only configuration of NWM used in research and development activities. Files affected include:

nwm.tCCz.analysis_assim.channel_rt.tm##.conus.nc Where CC is cycle (00-23) and ## is 00-02.

nwm.tCCz.short_range.channel_rt.f###.conus.nc Where CC is cycle (00-23) and ### is 001-018

-Removal of variable (qlat) from the Analysis, Short-, Medium- and Long-Range channel output files. Files affected include:

nwm.tCCz.analysis_assim.channel_rt.tm##.conus.nc Where CC is cycle (00-23) and ## is 00-02.

nwm.tCCz.short_range.channel_rt.f###.conus.nc Where CC is cycle (00-23) and ### is 001-018

nwm.tCCz.medium_range.channel_rt.f###.conus.nc Where CC is cycle (00, 06, 12, 18) and ### is 003-240 nwm.tCCz.long_range.channel_rt_M.f###.conus.nc Where CC is cycle (00, 06, 12, 18), M is member (1-4) and ### is 006-720.

- Network Common Data Form (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.

General Framework:

Version 1.2 of the NWM will be run in the same four configurations as Version 1.1--Analysis and Assimilation, Short- Range, Medium-Range and Long-Range.

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>
<ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/nwm>
<http://ftp.ncep.noaa.gov/data/nccf/com/nwm>

Output Changes on the NCEP web services:

No directory structures or file name conventions will change with this upgrade. Users should refer to the V1.1 and V1.0 Technical Implementation Notice (TIN) and Service Change Notice (SCN) for information on filename and directory structures:

https://www.weather.gov/media/notification/tins/tin16-30natl_water_model.pdf
https://www.weather.gov/media/notification/pdfs/scn17-41natl_water_modelaaa.pdf

Changes were made to the internal contents of the output files. These include:

- Adding three new variables (QSfcLatRunoff, QBucket, QBtmVertRunoff) to the Short-Range and Analysis channel output files.
- Removing one variable (qlat) from the Analysis, Short-, Medium- and Long-Range channel output files.
- Changing the metadata variable "time" data type from "double" to "integer".
- Changing the output variable "inflow" from "float" to "integer" in the reservoir model output files from the Analysis, Short-, Medium- and Long-Range configurations.

As in V1.1, 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 one products for the 18 UTC 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.

File availability time changes:

Due to the variability of the timing of observation input data from the USGS, an increased frequency of running the observation aggregation process, and enhanced parsing of quality control flags, the USGS timeslice files will continue to vary in timing and updates throughout the day. Output files from the NWM medium range forecast will now be available up to 25 minutes earlier due to changes in the file contents mentioned above.

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/NWM_live/web/data_tools/NWM_v1.2_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 URL:

<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>

Direct questions regarding this implementation to the contacts below. NCEP will evaluate feedback and decide whether to proceed.

For questions on the science aspects, please contact:

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

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National Service Change Notices are online at:

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

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