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Technical Implementation Notice 16-30
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Subject: Implementation of National Water Model
Effective: August 16, 2016

Effective on or about Tuesday, August 16, 2016, beginning with the 1200 Coordinated Universal Time (UTC) run, the National Centers for Environmental Prediction (NCEP) will begin operationally running the National Water Model (NWM).

The NWM is an hourly cycling uncoupled analysis and forecast system that will provide streamflow for 2.7 million river reaches and other hydrologic information on 1km and 250m grids. It will provide complementary hydrologic guidance at current NWS river forecast locations and significantly expand 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; all NWM configurations benefit from the inclusion of 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 will also be provided on this domain at a resolution of 1km.

General Framework:

The NWM will be run in four configurations:
-Analysis and assimilation 1 hour snapshot
-Short-Range 15 hour deterministic forecast
-Medium-Range 10 day deterministic forecast
-Long-Range 30 day ensemble forecast

Analysis and Assimilation:

The Analysis and Assimilation configuration will cycle hourly and produces a real-time snapshot of the current streamflow and general hydrologic states across the country. This configuration also produces the initialization for the 15 hour, 10 day and 30 day forecast simulations. Precipitation forcing data are drawn from the MRMS gauge-adjusted and radar-only observed precipitation products along with short-range RAP and HRRR forecasts in areas where MRMS radar coverage does not exist. Short-range RAP and HRRR forecasts supply the other meteorological forcing variables. Real-time USGS streamflow observations are assimilated into this configuration.

Short Range Forecast:

The Short Range Forecast configuration cycles hourly, is forced with meteorological data from the HRRR and RAP, and will produce hourly deterministic forecasts of streamflow and hydrologic states out to 15 hours. The model is initialized with a restart file from the Analysis and Assimilation configuration and does not cycle on its own states.

Medium Range Forecast:

The Medium Range Forecast configuration is executed once per day, is forced with GFS model output, and extends out to 10 days. It produces 3-hourly deterministic output and is initialized with the restart file from the Analysis and Assimilation configuration.

Long Range Forecast:

The Long Range Forecast cycles 4 times per day (i.e., every 6 hours) and produces 30-day ensemble forecasts of streamflow, other hydrologic states and evapotranspiration. There are four ensemble members in each cycle of this forecast configuration, each forced with a different CFS forecast member. This configuration allows for a total of 16 ensemble members per day. It produces 6-hourly streamflow and daily land surface output, and, as with the other forecast configurations, is initialized with a common restart file from the Analysis and Assimilation configuration.

Output:

All NWM output will be stored in NetCDF format in one of three file types:
-1km gridded NetCDF (land surface variables and forcing)
-250m gridded NetCDF (runoff variables)
-Point-type NetCDF (stream routing and reservoir variables)

The two gridded files cover a rectangular domain stretching beyond the CONUS, roughly from 19N to 58N, while the point netcdf files contain model output from the CONUS and hydrologically contributing areas.

End users will be able to view the output via the interactive map 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 will be available on NOMADS and the NCEP FTP server at:

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

The following directory structure will be used:

NWM Model Forcing (fe=forcing engine, cyc=model cycle):
fe_analysis_assim/
nwm.t${cyc}z.fe_analysis_assim.tm00.conus.nc.gz

fe_short_range/
nwm.t${cyc}z.fe_short_range.f###.conus.nc.gz (### is 001-015)

fe_medium_range/
nwm.t${cyc}z.fe_medium_range.f###.conus.nc.gz (### is 001-240)

NWM Model Output (cyc=model cycle):
analysis_assim/
nwm.t${cyc}z.analysis_assim.channel_rt.tm00.conus.nc.gz
nwm.t${cyc}z.analysis_assim.land.tm00.conus.nc.gz
nwm.t${cyc}z.analysis_assim.reservoir.tm00.conus.nc.gz

short_range/
nwm.t${cyc}z.short_range.channel_rt.f###.conus.nc.gz (### is 001-015)
nwm.t${cyc}z.short_range.land.f###.conus.nc.gz (### is 001-015)
nwm.t${cyc}z.short_range.reservoir.f###.conus.nc.gz (### is 001-015)
nwm.t${cyc}z.short_range.terrain_rt.f###.conus.nc.gz (### is 001-015)

medium_range/
nwm.t${cyc}z.medium_range.channel_rt.f###.conus.nc.gz (### is 003-240)
nwm.t${cyc}z.medium_range.land.f###.conus.nc.gz (### is 003-240)

nwm.t${cyc}z.medium_range.reservoir.f###.conus.nc.gz (### is 003-240)
nwm.t${cyc}z.medium_range.terrain_rt.f###.conus.nc.gz (### is 003-240)

long_range_mem1/
long_range_mem2/
long_range_mem3/
long_range_mem4/
nwm.t${cyc}z.long_range.channel_rt_+.f###.conus.nc.gz (+ is 1-4, ### is 006-720)
nwm.t${cyc}z.long_range.land_+.f###.conus.nc.gz (+ is 1-4, ### is 024-720)
nwm.t${cyc}z.long_range.reservoir_+.f###.conus.nc.gz (+ is 1-4, ### is 006-720)

Due to storage space limitations, the latitude and longitude of each output grid-box (for grid-type data) and point (for point-type data) are stored outside of the individual NWM NOMADS NetCDF files, in files available at:

ftp://ftp.nohrsc.noaa.gov/pub/staff/keicher/WRFH_ppd/web/NWM_nc_tools.tar.gz.

Scripts are available at this same location, which will append this geospatial data to a user selected output file, enabling viewing within common NetCDF visualization utilities.

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

http://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

For questions regarding this implementation, please contact:

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NWS National Technical Implementation Notices are online at:

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

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