



# Updates on the National Water Center & National Water Model

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NWS-Middle Atlantic RFC

December 2016

# Overview

- National Water Center is gradually spinning up operations at facility in Tuscaloosa
- Initial version of National Water Model was operational in August 2016
- Development of v1.1 has been completed and will be implemented in the spring



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# Office of Water Prediction

- OWP Silver Spring, MD
  - Tom Graziano, office director
- OWP Chanhassen, MN (NOHRSC)
- National Water Center, Tuscaloosa, AL



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# National Water Model (NWM) Facts

- Goal is to build a national water model framework that can run on centralized computing, accelerate Research to Operations, and provide enhanced services
- Initial version of National Water Model has been operational since August 2016
- High resolution hydrologic model forecasts
  - uses the WRF-Hydro framework developed at the National Center for Atmospheric Research (NCAR)
  - Are implemented on NWS operational High Performance Computers by NWS and NCAR staff



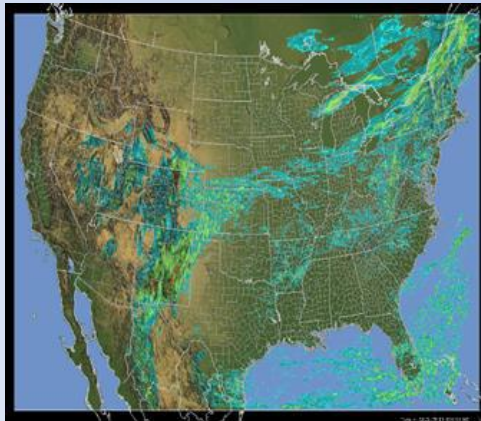
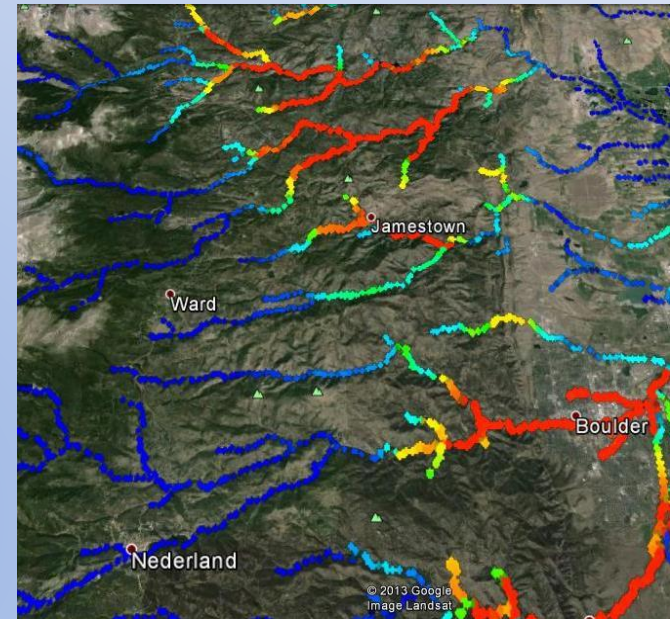
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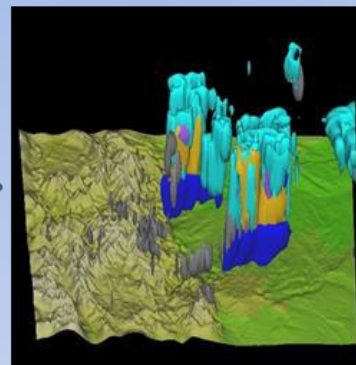


# National Water Model Overview

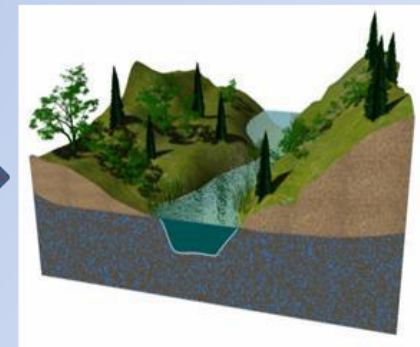
- **Designed as a community-based (and supported) model coupling architecture**
  - Analogous to CHPS, but for supercomputer-driven, high performance hydrologic modeling
- **Extensible, multi-scale, and multi-physics**
  - Seamlessly handle local to national applications
  - Readily accommodate changes and enhancements
- **Powerful assimilation and prediction of major water cycle components**
  - Including precipitation, soil moisture, snowpack, groundwater, and streamflow



1-10's km



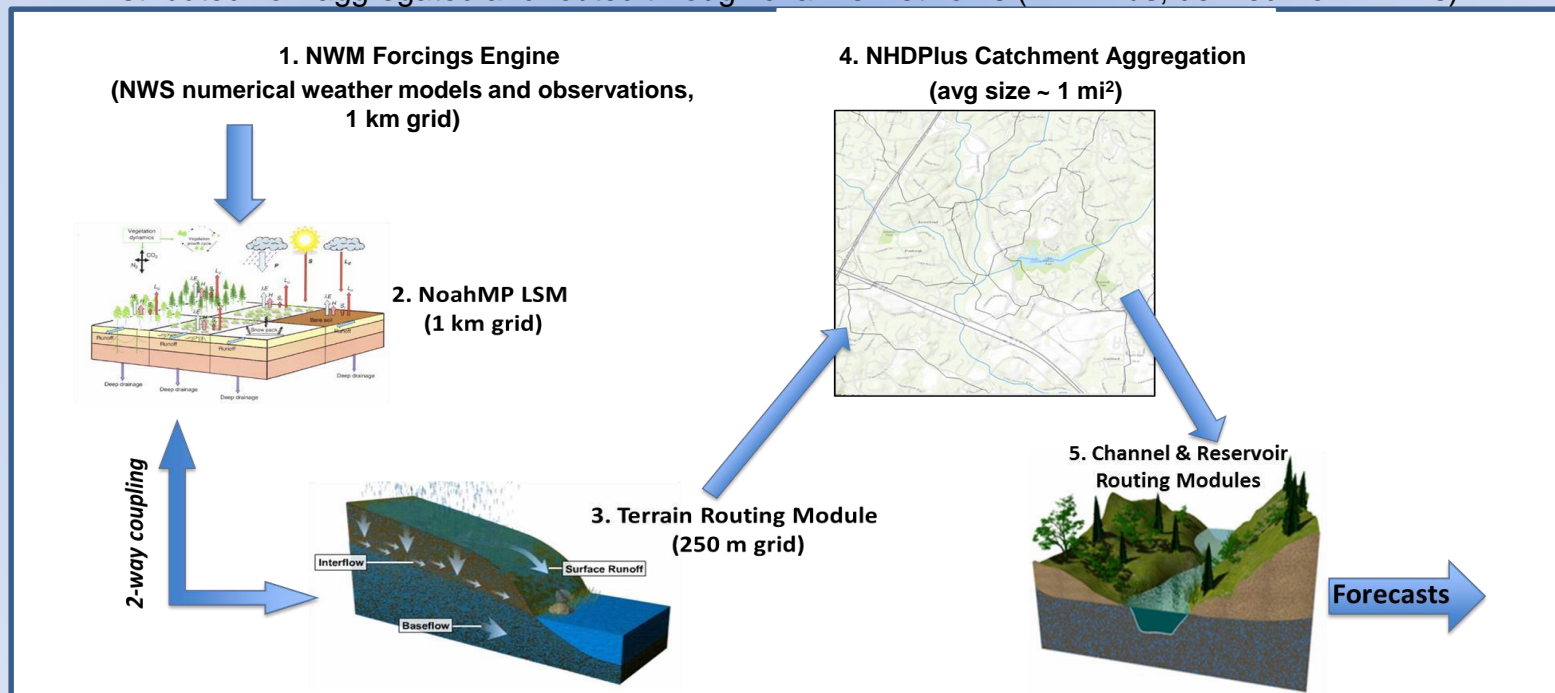
100's m - 1's km



1-10's m

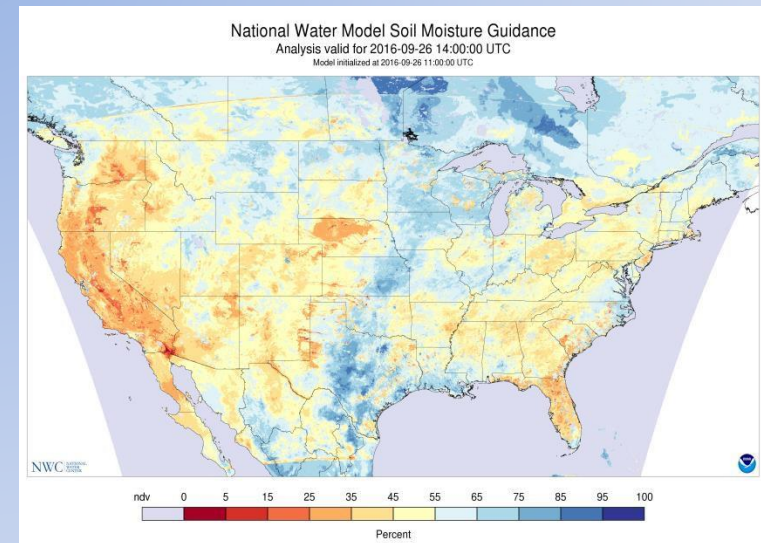
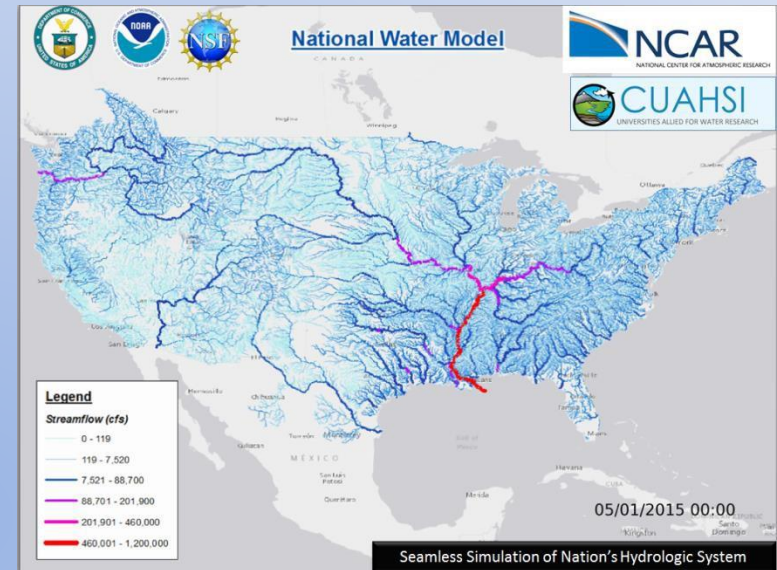
# National Water Model Overview

- **Distributed, (mostly) physical hydrologic modeling platform**
  - Based upon WRF-Hydro framework developed by NCAR, but adapted for NWS operations
  - Flexible, interwoven collection of physical and conceptual models (or modules)
- **High-resolution, CONUS-wide**
  - Atmospheric forcings and land surface model run at 1 km
  - Water routed (over/through terrain grid) at sub-km resolution (and sub-hr timesteps)
  - Distributed flow aggregated and routed through channel networks (NHDPlus, derived from DEMs)



# National Water Model Overview

- **What Version 1.0 is:**
  - Streamflow forecast guidance for underserved locations
  - Spatially continuous, national estimates of hydrologic states
  - Modeling architecture that permits infusion of new data and science, and allows for geointelligence linkages
  - **Foundation** for sustained growth in nationally consistent operational hydrologic forecasting capability



# National Water Model Overview

- **What Version 1.0 *is not*:**
  - Not interactive
    - No real-time forecaster engagement (operational supercomputer requirement)
  - Not uncalibrated
    - Mostly parameterized via geospatial datasets
    - Calibration parameters determined via sensitivity analyses
    - Appropriate parameters will undergo iterative refinements (via scaling factors); first round of calibration activities is happening as we speak
  - Not a finished product
    - Lacks physical groundwater, channel seepage, and water management components
    - Recurring cycles are planned for fixes, upgrades, and refinements





# NWM Initial Configurations

Analysis & Assimilation	Short-Range	Medium-Range	Long-Range
<b>Cycling Frequency</b>	Hourly	Hourly	Daily
<b>Forecast Duration</b>	Hourly	Daily	4x Daily (4 memb per cycle)
<b>Forecast Duration</b>	- 3 hrs	0-18 hours	0-10 days
<b>Forecast Duration</b>			0-30 days
<b>Meteorological Forcing</b>	MRMS blend/ HRRR/RAP bkgnd.	Downscaled HRRR/RAP blend	Downscaled GFS
<b>Meteorological Forcing</b>			Downscaled & bias-corrected CFS
<b>Spatial Discretization &amp; Routing</b>	1km/250m/NHDPlus Reach	1km/250m/NHDPlus Reach	1km/250m/NHDPlus Reach
<b>Spatial Discretization &amp; Routing</b>			1 km/NHDPlus Reach
Assimilation of USGS Obs			
Reservoirs (1615 water bodies parameterized with level pool scheme)			



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# NWM Initial Operating Capability (IOC) Key Features

- Modeling architecture designed for the rapid infusion of new techniques
- Forecasts for underserved and ungauged locations; potential for flash flood program improvements
- Blends in streamflow observations from 6K-7K USGS gages. Assimilation of snow data and soil moisture data is being developed.
- Selected data shipped to RFCs for use in our operational software.
- NWC website map viewer (<http://water.noaa.gov/>) will provide images for streamflow and soil moisture . Other variables will come later.
- “Full” selection of output grids will be available on the NOMADS ftp server

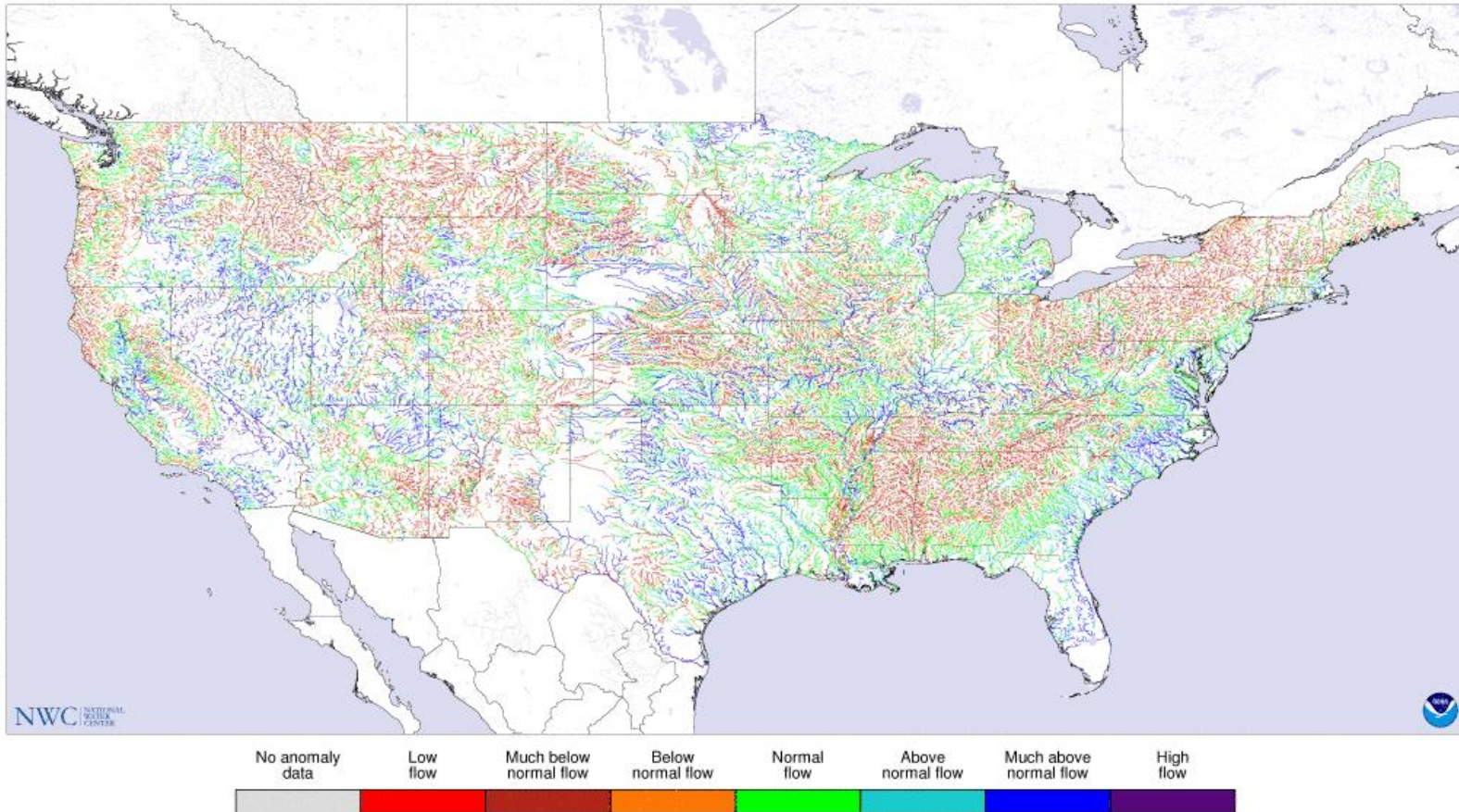


# Sample Output

## National Water Model Streamflow Anomaly (Experimental)

Forecast valid for 2016-07-08 18:00:00 UTC

Model initialized at 2016-07-08 06:00:00 UTC



Current imagery displays data for stream order 3 and greater. Anomaly derived by comparison of NWM modeled streamflow to NHDplus EROM monthly average streamflow.

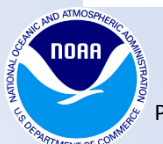
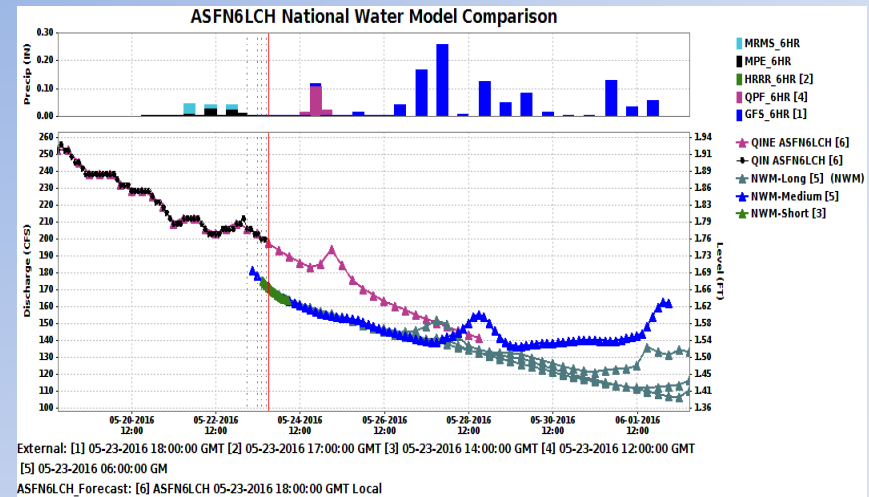
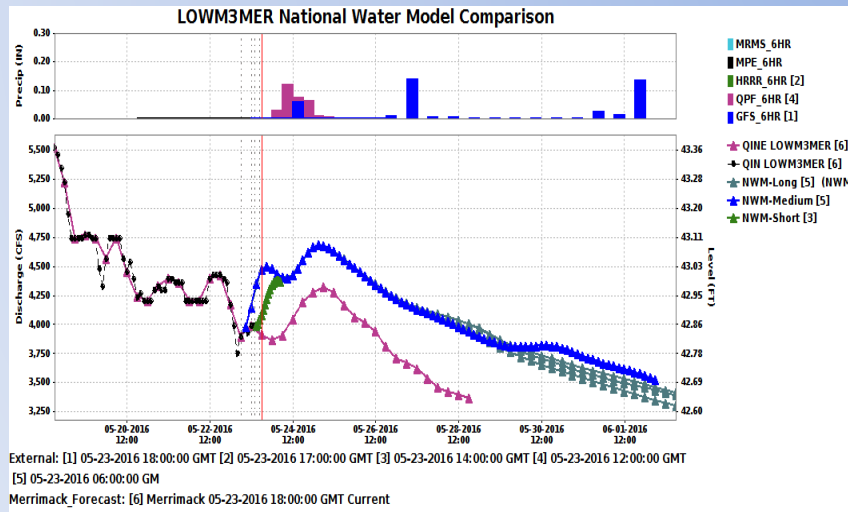
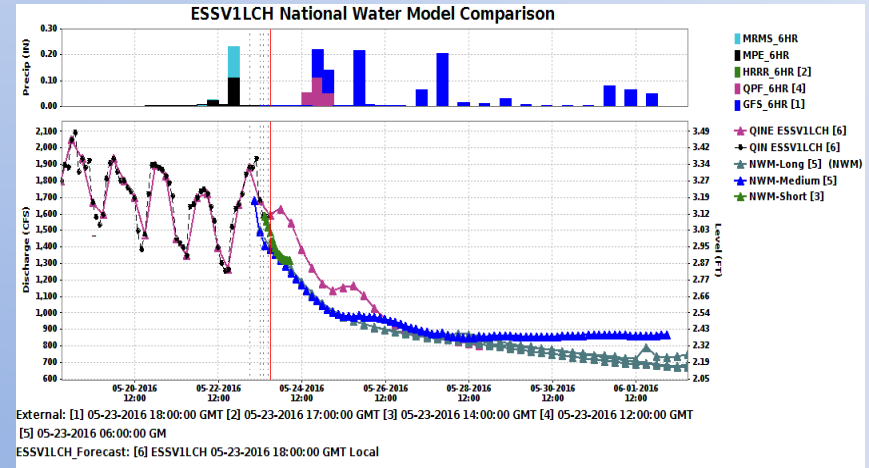
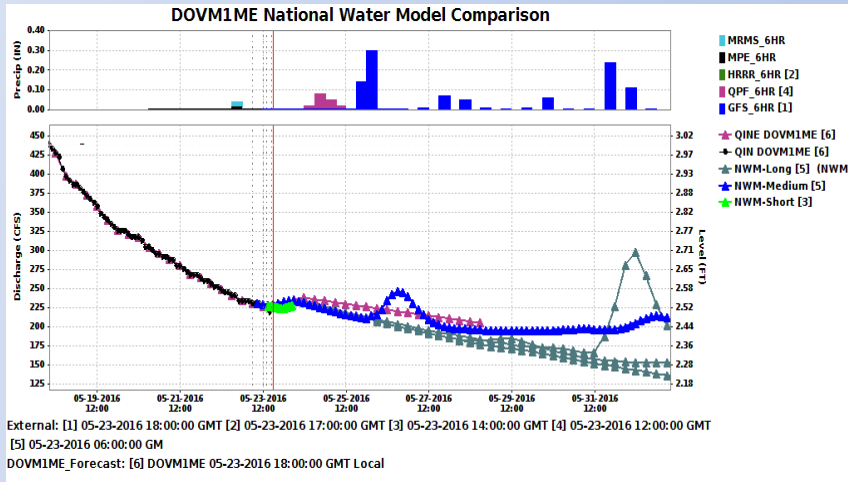


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# NWM Forecast Comparisons



# Some Limitations in IOC

- Forcings not currently available, can be hard to evaluate NWM forecasts
- No way to update model states
- Reservoirs are currently modeled as level pool, complicated operations not included in current version
- No surge component for tidal reaches
- Medium range forecasts only issued once per day
- New builds only every 12-18 months

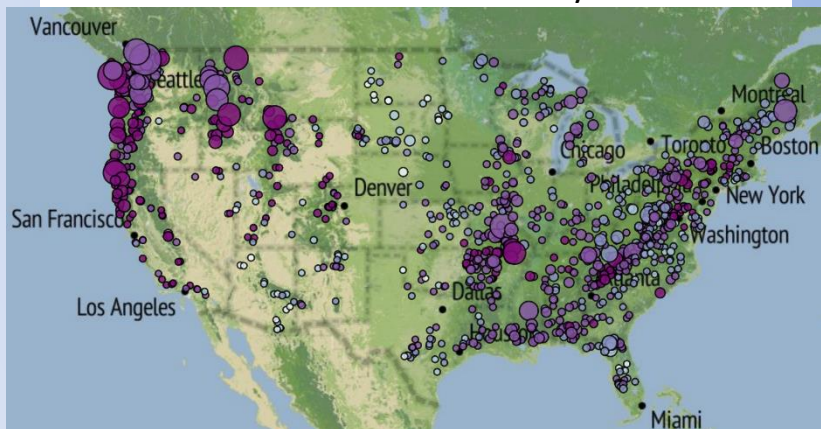


# National Water Model Evaluation

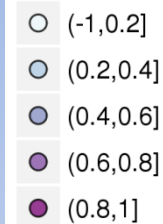
- Some evaluations of model simulations available (see example below), **but forecast skill is still being assessed**
- RFCs and WFOS plan to help NWC evaluate WRF-Hydro forecast output
- NWC approach is to accelerate WRF-Hydro foundation real-time capability and then work to improve the model year-by-year

## Average Daily Streamflow Correlation Over Gages In Unregulated Basins 2011-2013 Simulation With NLDAS2 Forcing, Initial Parameters, No Data Assimilation or Reservoirs

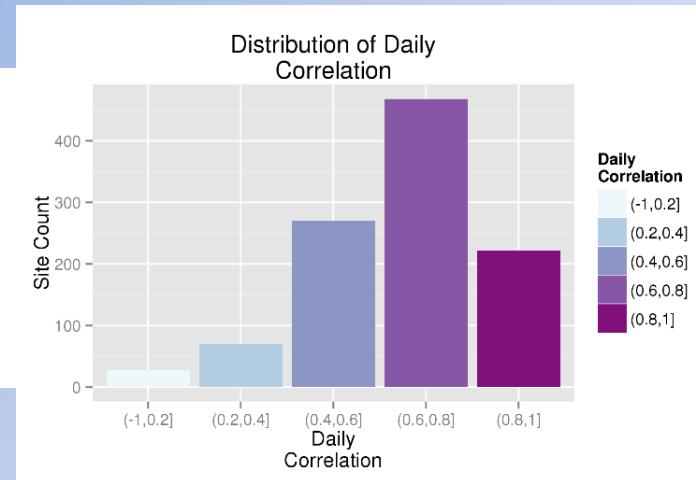
### Distributed CONUS Analysis



### Daily Correlation



71% of basins had correlation > 0.6



*Analysis courtesy Aubrey Dugger (NCAR)...talk given in AMS Benchmarking Session*

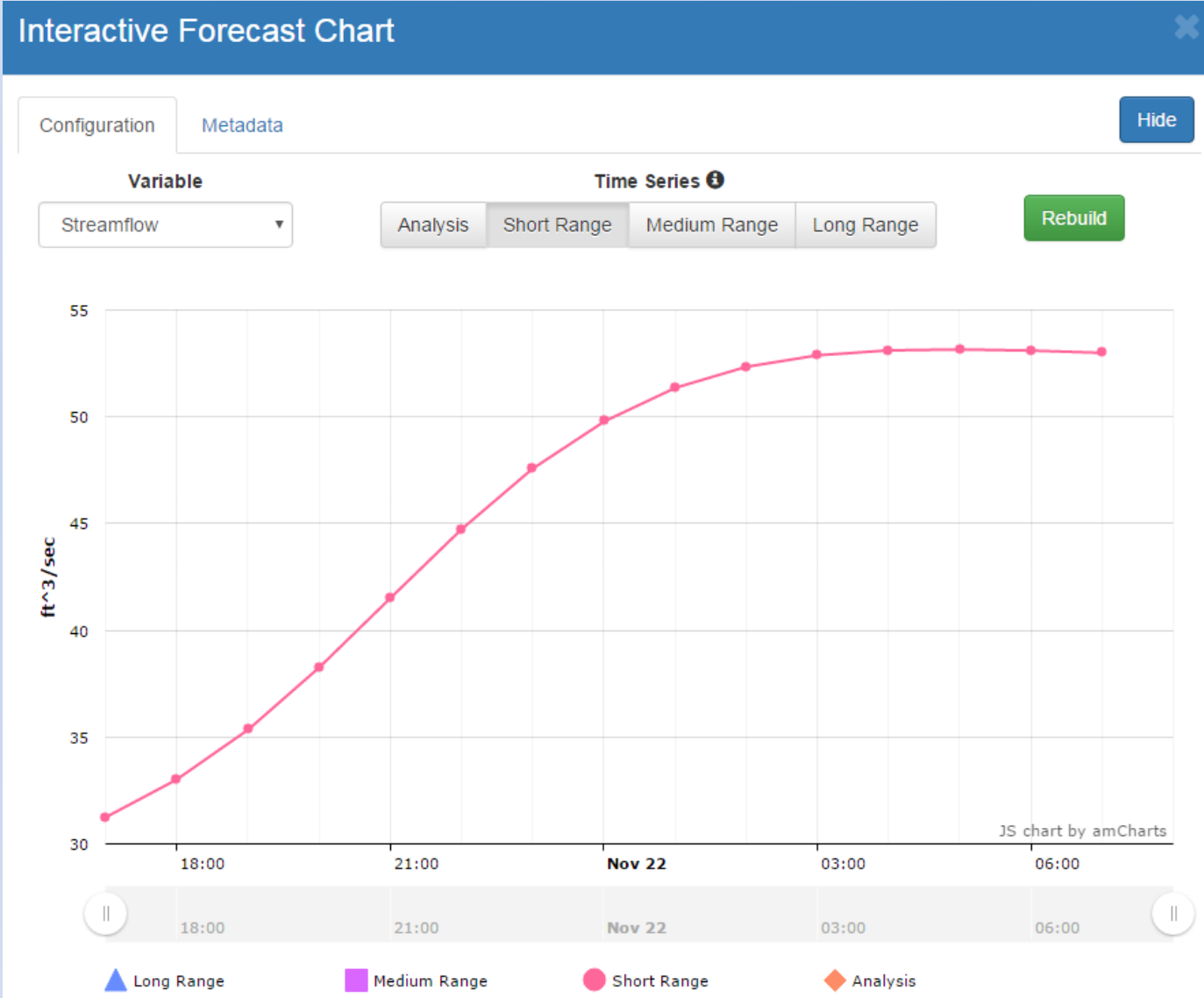
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# What does this mean for MARFC?

- No changes to MARFC products
- MARFC will continue using multiple sources of information to develop forecasts and other products including:
  - Internally developed QPE and QPF grids
  - Our own hydrologic and hydraulic model runs (deterministic and ensemble)
  - Snow analyses from NWC/NOHRSC
  - Our own gridded model runs (flash flood guidance and distributed hydrologic model for selected headwaters)
  - Historical analogues
  - Forecaster modifications to translate raw model output into forecasts
  - **PLUS NWM outputs will complement existing information**
- RFCs will work with NWC on NWM evaluation and enhancements.
- RFCs working with partners to get value out of gridded forecasts
  - One Example: Collaboration with USDA, EPA, and states on using forecast runoff to provide guidance on fertilizer application risk



# Point and Click Hydrograph

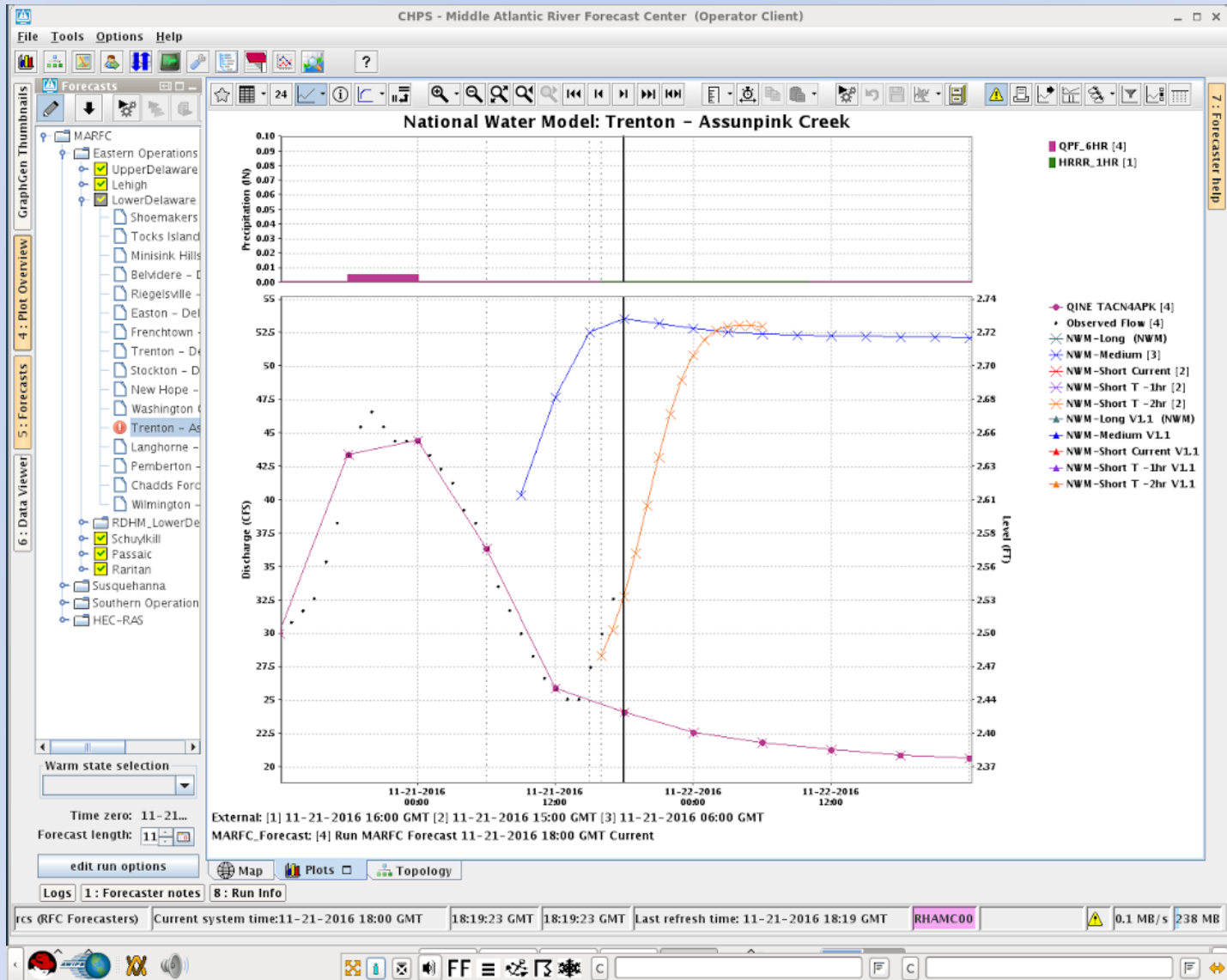


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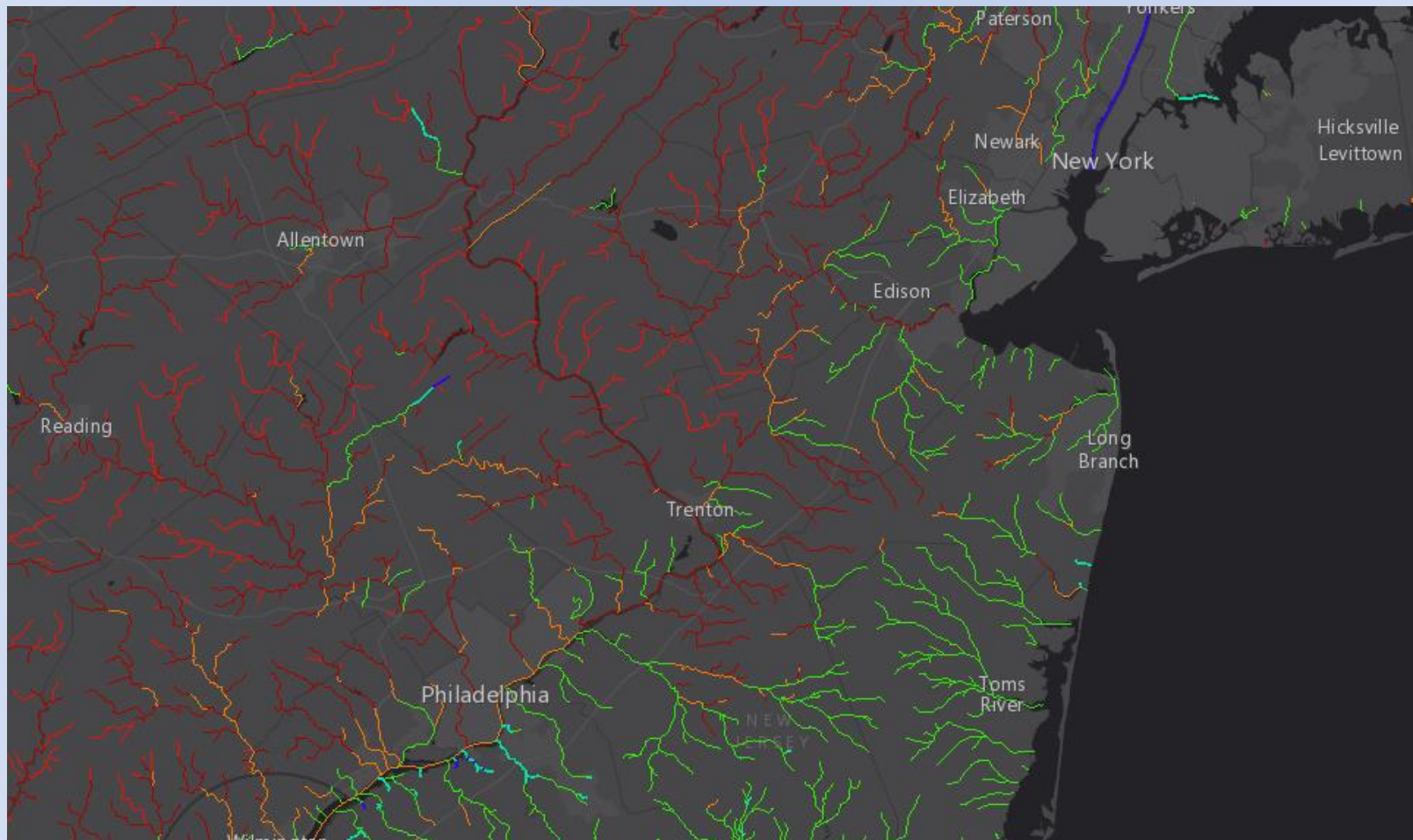
# CHPS Hydrograph



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# Streamflow Anomaly



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# Next Steps

- NWM is undergoing constant evaluation and verification
  - Quantitative assessment at OWP
  - Qualitative assessment at RFCs
- Version 1.1 Enhancements
  - Calibration to improve on high biases in MidAtlantic
  - Extend short term forecast to 18hrs (from 15)
  - Increase medium range frequency to 4x per day
  - Stream connectivity improvements
  - Snowpack modeling and infiltration on sandy soils
  - Begin work on reservoir modeling





Thank You for Your Attention!

Questions?

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