NOAA's National Water Model:
From V2.1 Operations to Future Enhancements in V3.0

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Large integrated OWP and NCAR team

OWP OFFICE OF WATER PREDICTION

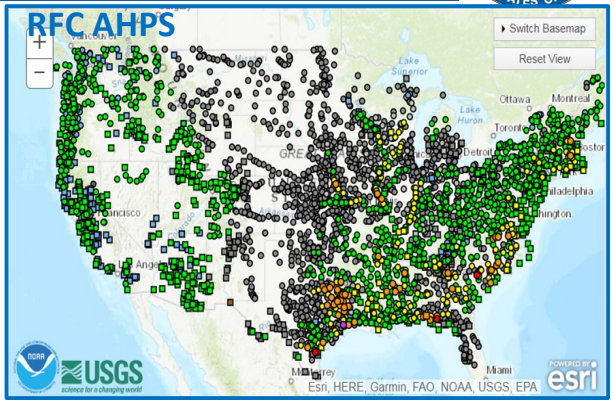
NCAR NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

National Water Model Overview

- Full spectrum hydrologic model, providing complementary NWS hydrologic guidance
- NWM will be upgraded to V2.1 in January 2021 by OWP, NCEP and NCAR

River Forecast Centers: Authoritative forecasts at ~3,600 RFC Points

NWM: Guidance at 2.7 million NHDPlus river segments, filling in coverage



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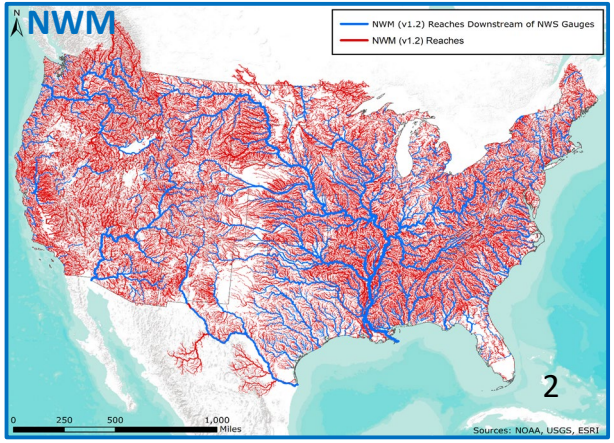
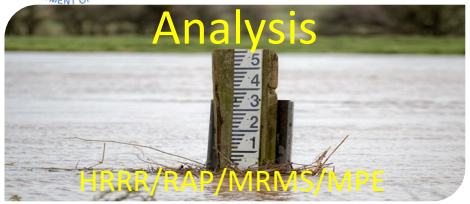


V1.0 2016 ● V2.1 2021 ● V3.0 2023 ● Next Gen

Current Capabilities: Operational Forecast Cycling



Lookback Range 3-28 hrs

New for V2.1…open loop (non-DA) members

18 Hour Forecast

Hawaii / Puerto Rico
3 Hour Lookback
48 Hour Forecast
HiRES ARW/NAM-NEST
(MRMS for Hawaii)
(Open Loop Configs)

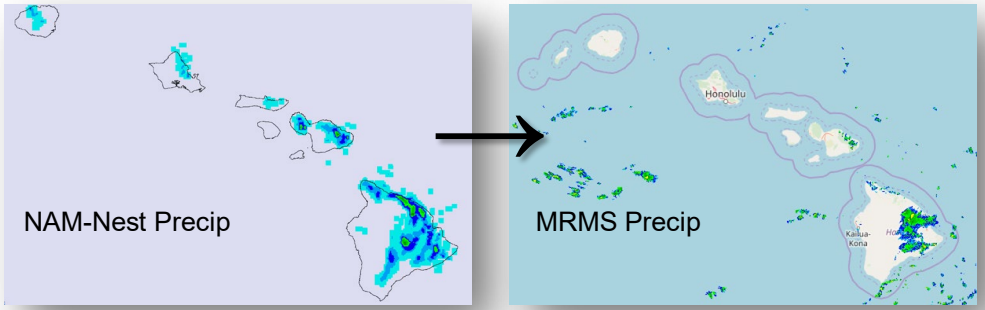
~10 Day Ensemble Forecast

New for V2.1…open loop (non-DA) member

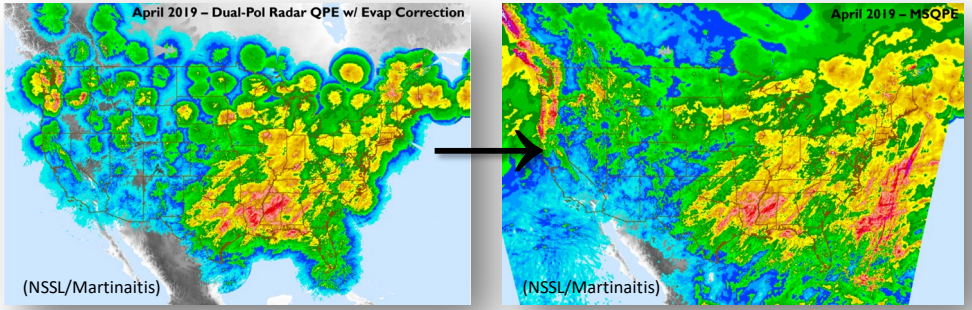
30 Day Ensemble Forecast

Improved Forcing for NWM V2.1

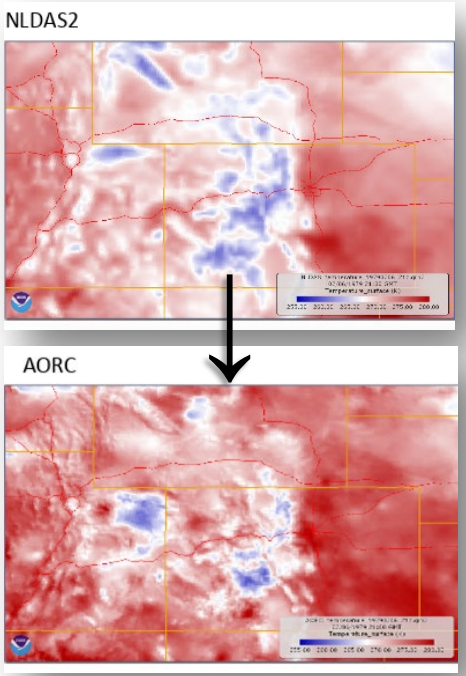
MRMS V12 Hawaii QPE in real-time operations



MRMS V12 Blended Radar/Gauge/Model QPE product over CONUS in real-time operations

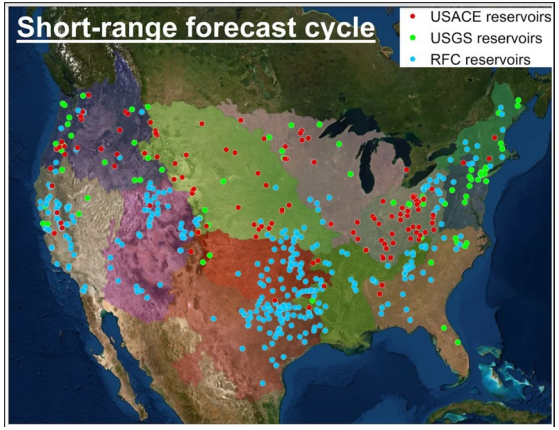


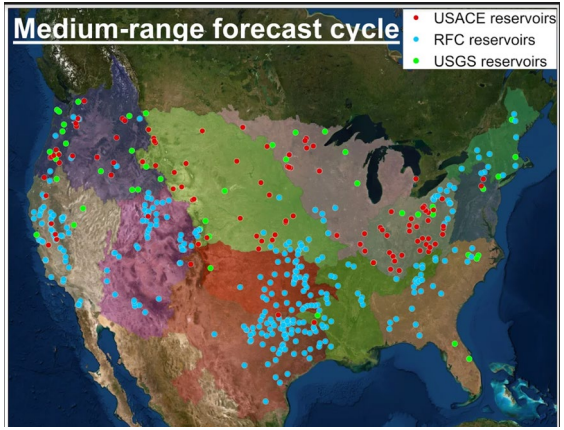
Analysis of Record for Calibration (AORC) in calibration / retrospective runs



NWM 2.1 Highlights: Reservoirs and Domain Expansion

Key Link to Field and Skill Improvement: Improved treatment of reservoir outflow via ingest of RFC-provided forecasts. Also, application of reservoir persistence approach leveraging USACE and USGS observations. Improved physics.

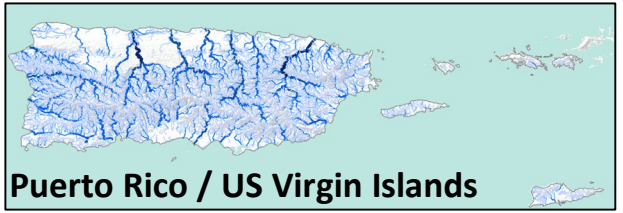




Short-range forecast cycle:
number of USGS sites: 74
number of USACE sites: 122
number of RFC sites: 316
Total number of sites: 512

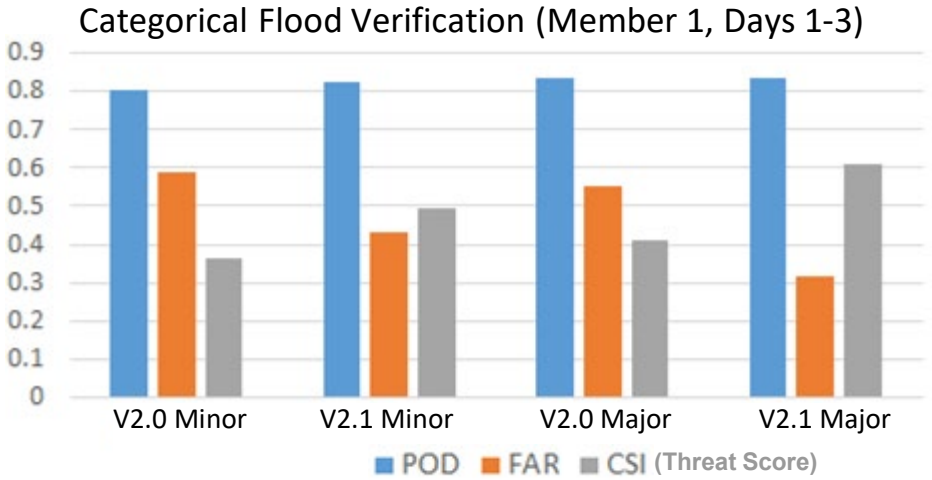
Medium-range forecast cycle:
number of USGS sites: 46
number of USACE sites: 106
number of RFC sites: 308
Total number of sites: 460

Domain Expansion:



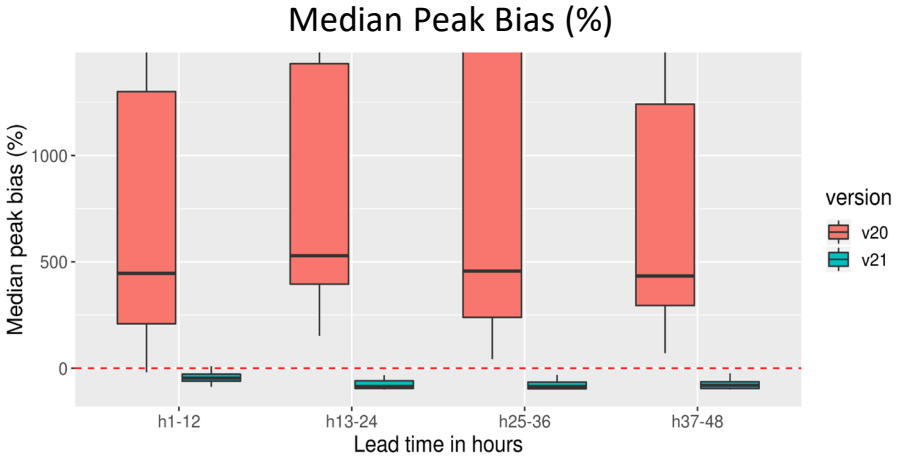
Performance Improvements in NWM V2.1: Overview

CONUS Verification – Medium-Range



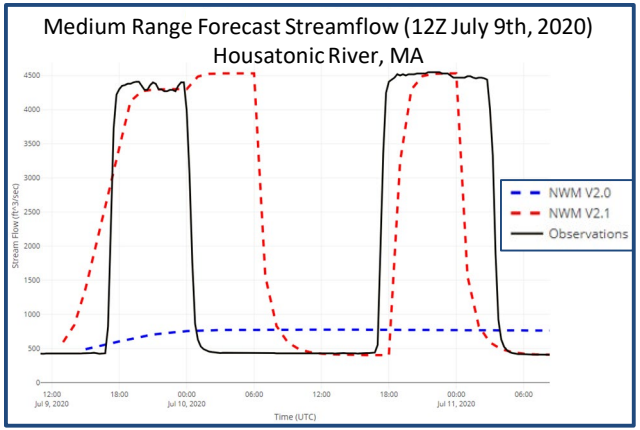
- Categorical flood forecast skill is greatly improved in V2.1. Similar results for days 4-10. Ensembles exhibit higher scores.

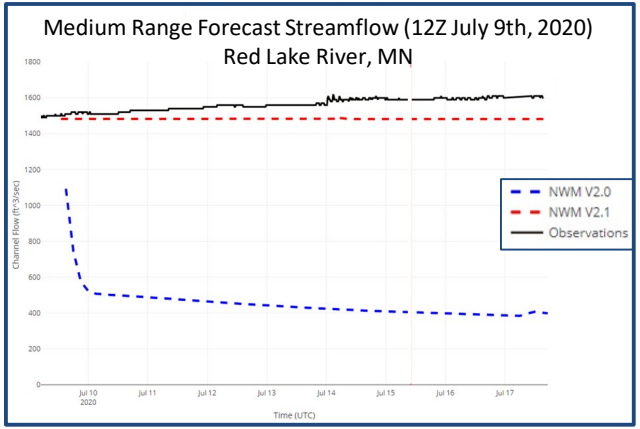
Hawaii Verification – Short-Range



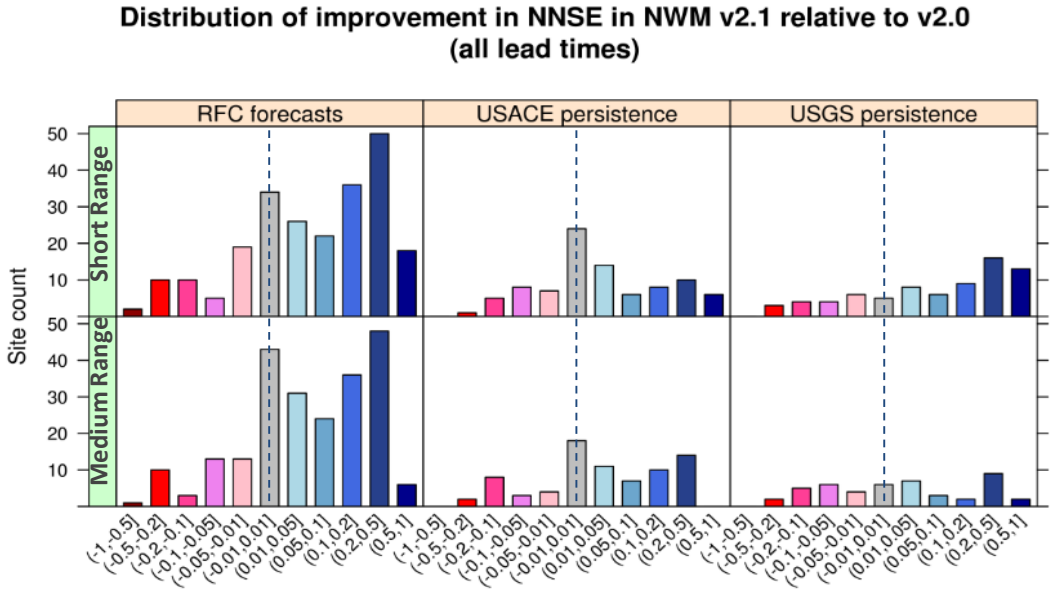
- Large overestimation of peak streamflow discharge in v2.0 is significantly reduced in v2.1 across all lead times

Performance Improvements in NWM V2.1: Reservoir Outflow



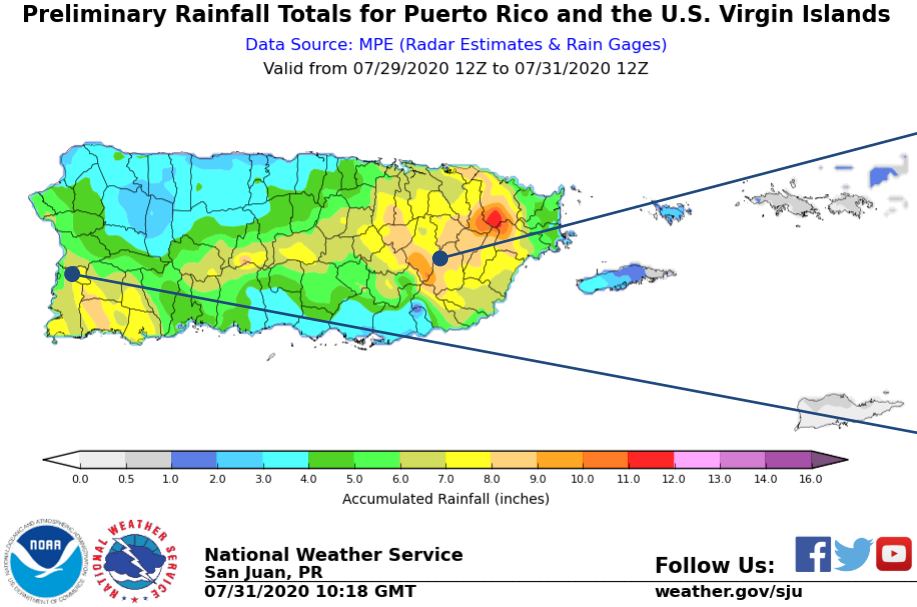


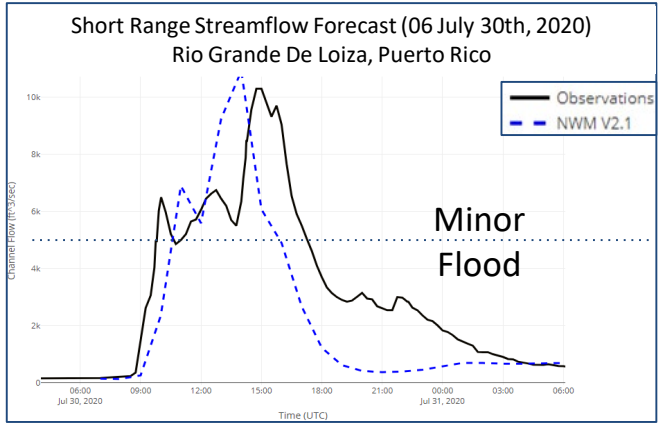
USGS Obs-Based Persistence

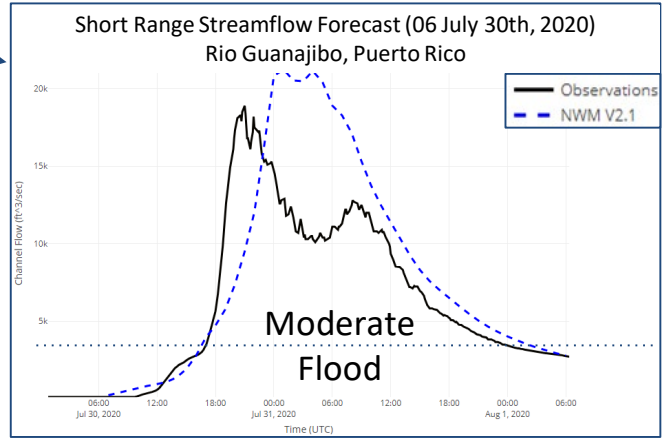


- **Left**: NWM V2.1 ingest of RFC (top), USGS (bottom) and USACE (not shown) data greatly improves streamflow forecast downstream of reservoirs
- **Right**: NWM V2.1 NNSE greatly improves via data ingest

Performance Improvements in NWM V2.1: Hurricane Isaias







- First implementation of PR/USVI domain performing well
- Good streamflow forecast magnitude and timing during Isaias

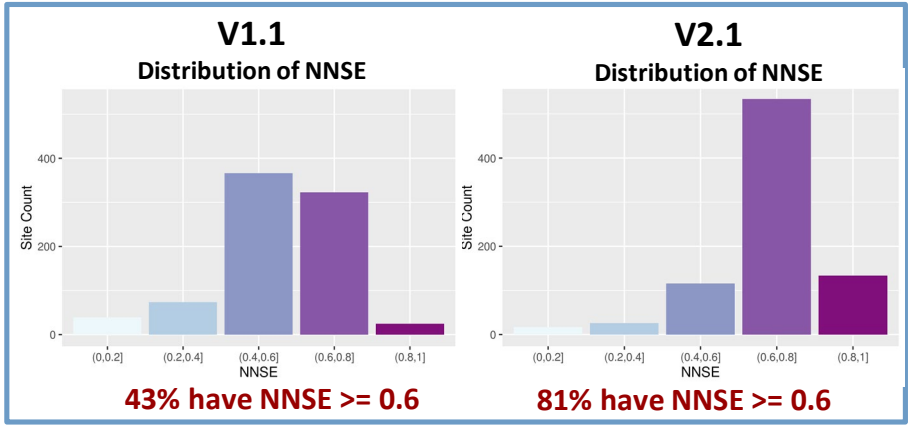
Enhancing the Model: Development Trajectory

v1.0 → v1.1/1.2/2.0 → v2.1

Foundation: 2016
Water resource model
2.7 million reaches

Upgrades: 2017/2018/2019
Hawaii, medium range ens., physics upgrades, improved modularity, MPE ingest

Next Upgrade: Jan 2021
Expansion to PR and Great Lakes, reservoir modules, forcing upgrades, open-loop, and improved Hawaii forcing

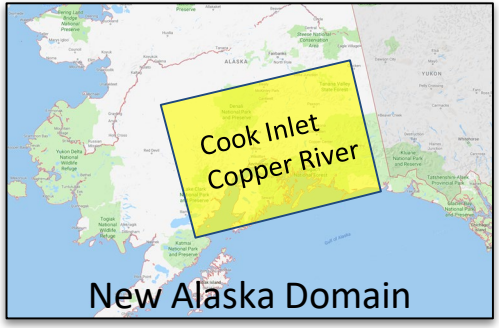


v3.0

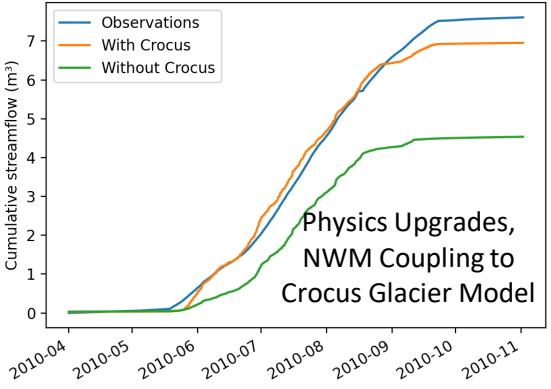
Future Upgrade: 2023
Coastal coupling, expansion to Alaska, improved runoff module, parameter, calibration and hydro-fabric upgrades

NWM V3.0: Expanded Partnerships and Activities

Expansion to Alaska with APRFC



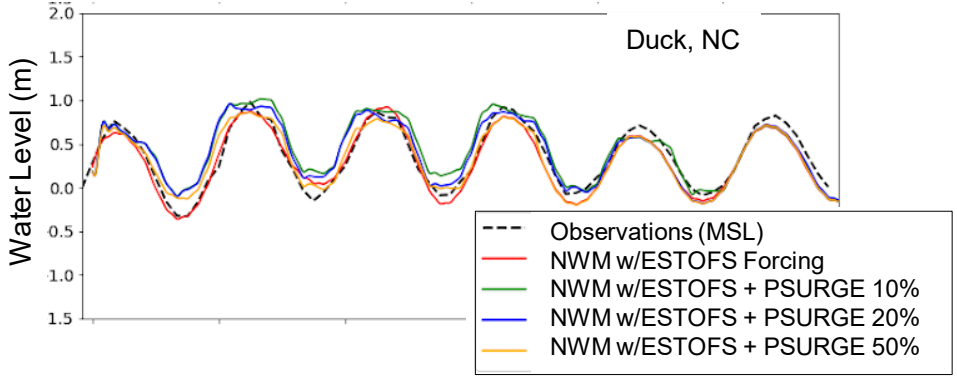
Accumulated Streamflow (m^3 x 10^7)
Gulkana Benchmark Glacier Site



NWM Coastal Coupling

- Total Water Level Forecasts
  - Freshwater-estuary-ocean model coupling, leveraging ESTOFS, PSURGE, SCHISM
  - Goal: Simulate compound flooding—freshwater/surge/tides
  - Complements existing regional total water level forecasts with first ever CONUS-wide, Hawaii and Puerto Rico forecasts.

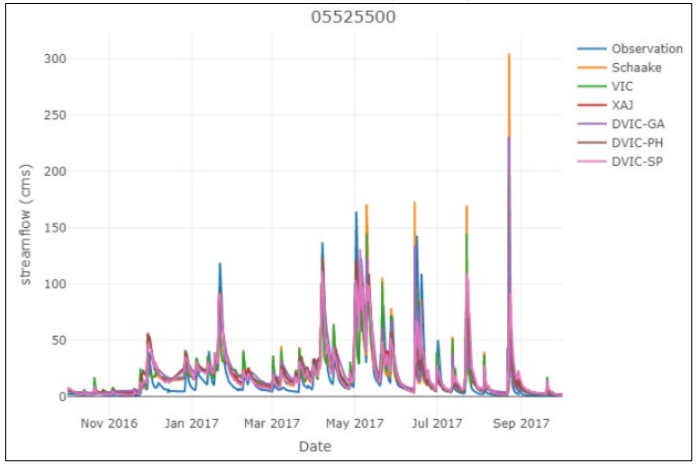
Total Water Level Simulation, Hurricane Florence
NWM with SCHISM Estuary Model



NWM V3.0: Expanded Partnerships and Activities

Exploration of Improved Runoff Schemes

Individual Basin Hydrographs



→ Existing runoff scheme (Schaake-SCK) compared against new options: Xinanjiang (XAJ), Variable Infiltration Capacity Module (VIC) and Dynamic VIC options (DVS, DVG, DVP)

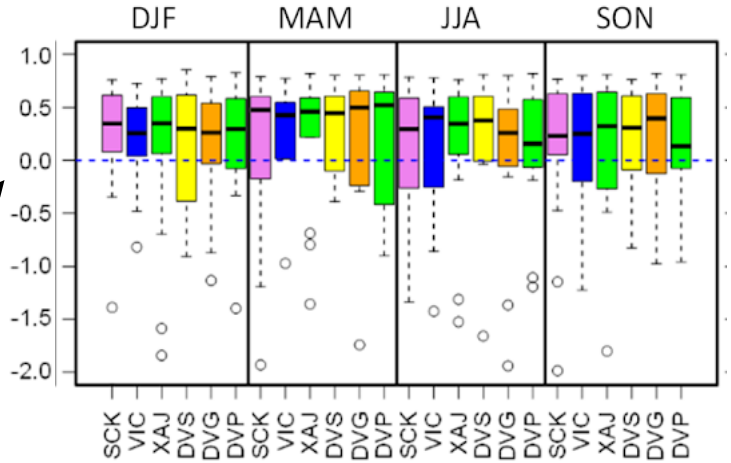
→ Assessment ongoing

Domain-Averaged Statistics

Improved Inland Routing

- Replacement of current Muskingum-Cunge Approach
  - Improved routing for backwater and complex channels
  - Diffusive wave base, with dynamic wave when needed
  - Accompanying hydrofabric upgrades for routing and Flood Inundation Mapping

Nash Sutcliffe Efficiency



Closing Thoughts

- With four upgrades in just over four years, the NWM is rapidly advancing
- What exists now is a foundation that will continue to be built upon
  - v2.1 into operations in January 2021: Domain expansion, reservoir upgrades
  - v3.0 is anticipated in early 2023: Coastal coupling, inland routing upgrades, first-ever Alaska domain, improved runoff module
  - Next Gen NWM planning underway
- Along with upgrades, nationwide NWM- and RFC-forecast-based flood inundation mapping, model-as-a-service and partnerships with Big Data are key elements moving NWM forward

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