



NOAA's National Water Model Version 4.0: Leveraging the NextGen Framework to Improve Hydrologic Operations

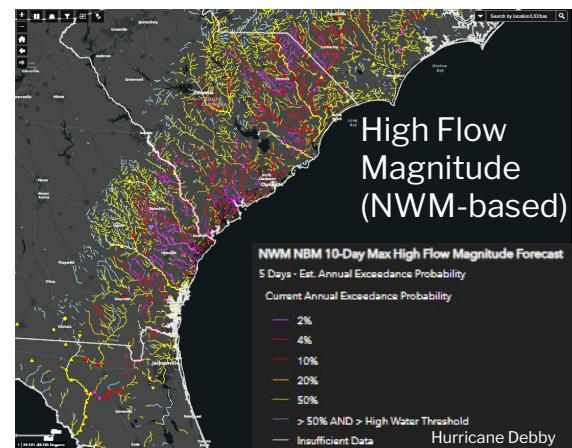
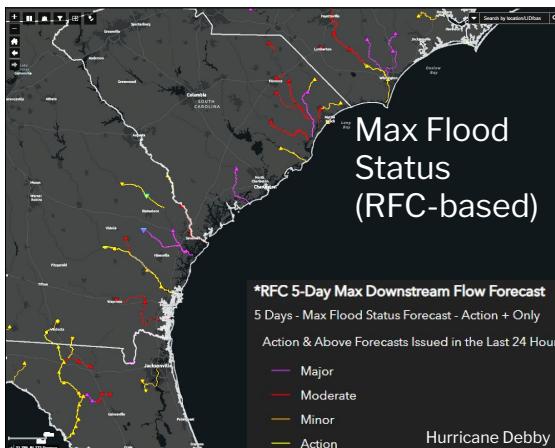


*Brian Cosgrove, Ed Clark, Trey Flowers,
Tom Graziano and Fred Ogden
Large Collaborative Team*

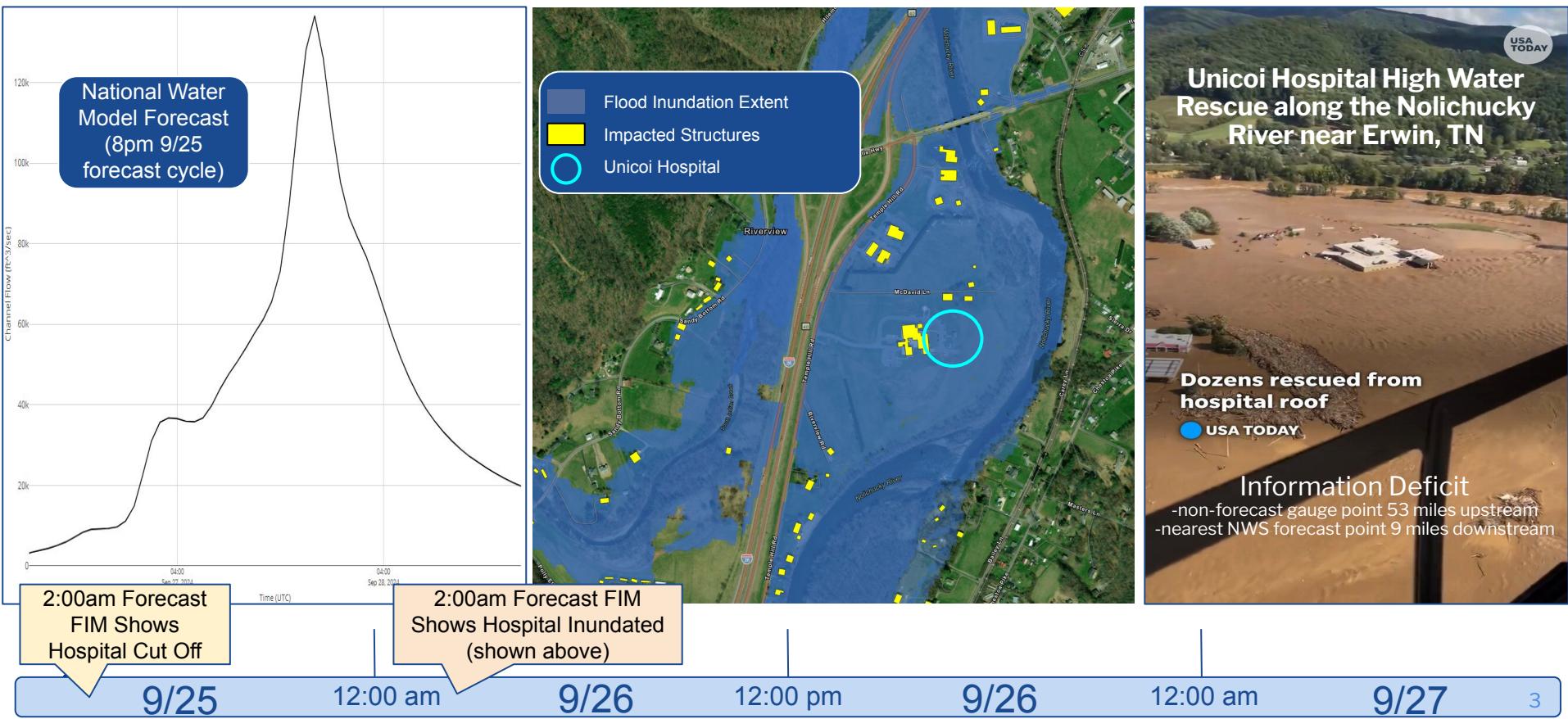
National Water Model (NWM)

- First implemented in 2016, the NWM provides key nationwide hydrologic guidance and underpins several value added products
 - NWS Hydrologic discussions
 - Nationwide, hourly timing/probability of high flow
 - Street-level flood inundation mapping

Key Strength:
Dense coverage in
space and time -
complementary



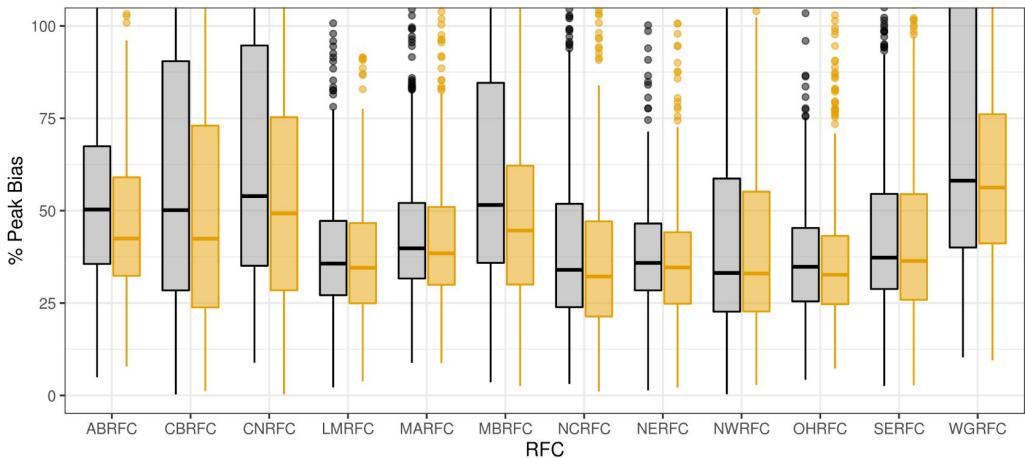
Enabling Flood Inundation Mapping with the NWM



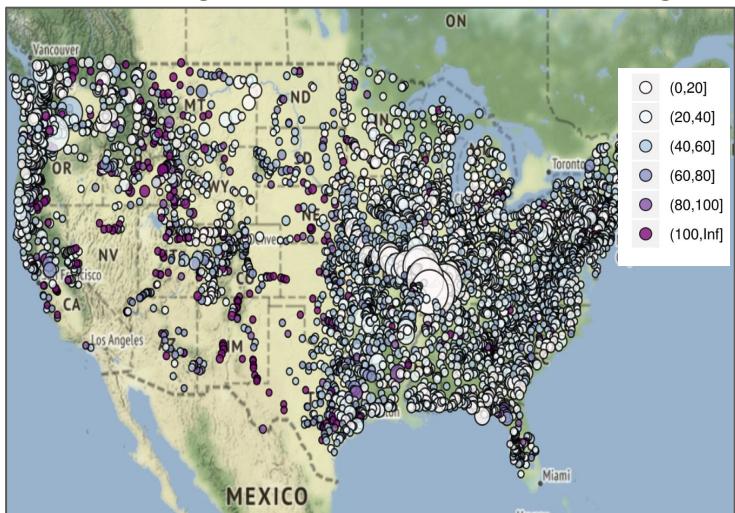
NWM: Current Performance Challenges

- Despite successes, regions of lower skill persist

Percent Peak Bias across CONUS RFCs
(lower is better, v2.1 left, v3.0 right)



NWM v3.0 Streamflow Peak Bias (%) at USGS Gauges (WY 2014-2016, AORC Forcing)



Leveraging Spatial Variation in Model Physics to Improve Skill

- Recognized Challenge: Dominant hydrologic processes vary spatially, even over short distances

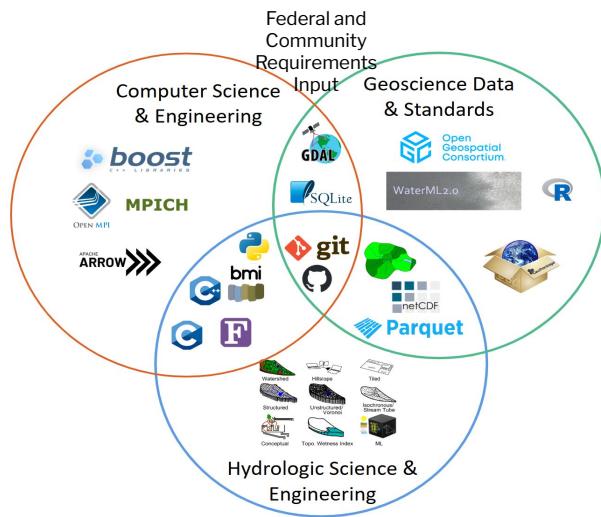


- Current NWM varies model parameters spatially but not model formulations
- Next Generation Water Resources Modeling Framework (NextGen) will support spatially varying model formulations - and use the most performant set of model components for each area of interest
- NWM v4.0 will leverage NextGen to begin to address existing skill issues

NextGen: Progress Towards Operational Use

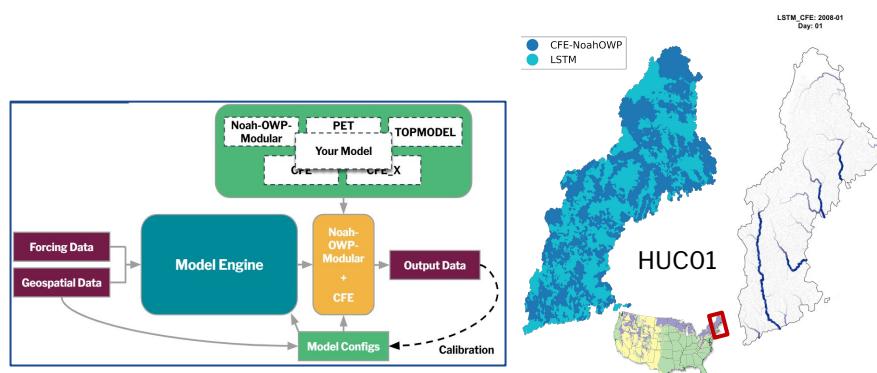
2020

- Recognition of challenge - need for a community-based framework that breaks through traditional hydrologic modeling barriers for research and operations
- Convergence of motivators and enablers



2021

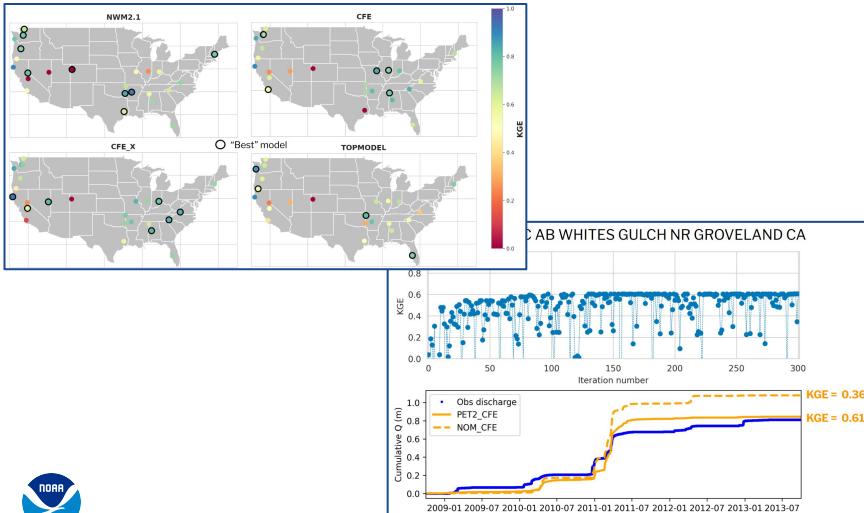
- Design and construction proceeding on prototype framework
- Demonstration of spatially variable formulations



NextGen: Progress Towards Operational Use

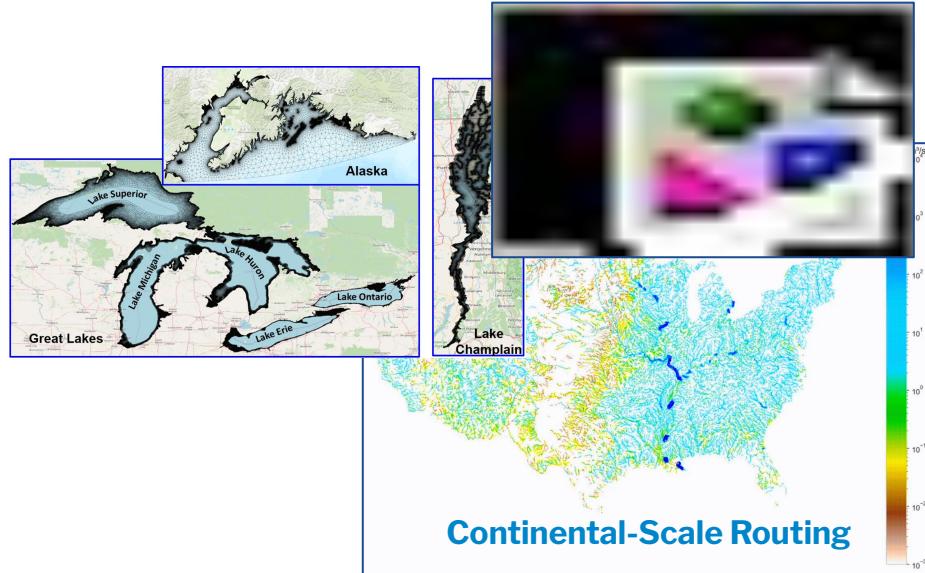
2022

- Multi-formulation tests across CONUS
- Development of prototype calibration capability



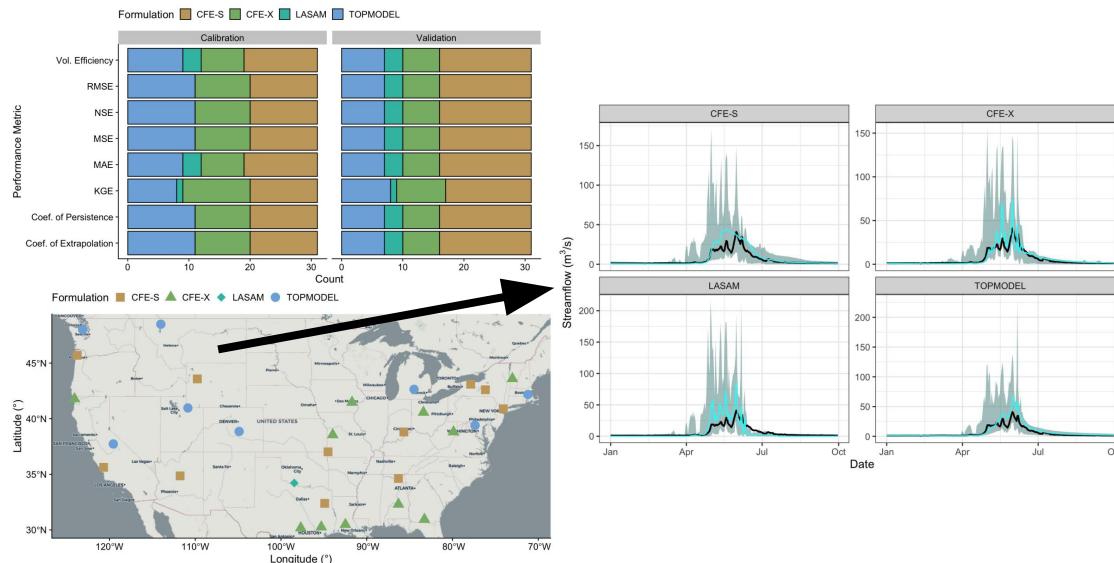
2023

- Continental-scale simulations
- Further development of coastal coupling and forcing components, calibration and regionalization approaches



NextGen: Current Status - Operational Foundation

- All pieces merged into a prototype end-to-end modeling capability
- Enables initial benchmarking of multiple formulations across CONUS
- Ongoing development of Optimization Environment for formulation selection, calibration, regionalization



- With NextGen as a base, NWM v4.0 will feature
 - Spatially varying model formulations
 - An increased number of model physics options
 - Use of the BMI standard to enable plug-and-play components
 - A strong development community (CIROH)

NextGen Flexibility: Modeling Components in NWM v4.0

Model Components	NWM v3.0 (Current Operations)	NWM v4.0 (NextGen NWM)
Stormflow	Noah-MP with Overland/Sub-Surface Routers	CFE-S, CFE-X, TopModel, SAC-SMA, LASAM, LSTM
Soil Processes & Fluxes	Noah-MP	Noah-OWP-Modular, Evapotranspiration, SoilFreezeThaw, SoilMoisture
Snow	Noah-MP, CROCUS	Snow-17, Utah Energy Balance
Baseflow	Conceptual Nonlinear Reservoir	Treatment Varies by Model
River Routing	Muskingum-Cunge with Assimilation	Muskingum Cunge & Diffusive Wave with Assimilation (T-Route)
Reservoirs	Level-Pool with Assimilation	Level-Pool with Assimilation
Coastal	SCHISM	SCHISM, SFINCS

NWM v4.0 will feature an increased number of process modules, providing increased flexibility in the representation of regionally varying hydrologic processes





Closing Thoughts

- The NWM continues to provide critical hydrologic data at complementary time and space scales, and underpins expanding FIM products - challenges remain
- NextGen has progressed from a concept to an end-to-end prototype framework in four years
- NWM 4.0 (2027) will leverage NextGen framework to add to current operational capabilities
 - Spatially variable model formulations including machine learning components
 - Expanded Alaska domain, additional forcing and coastal configurations
- ❖ Multiple NextGen talks tomorrow across two R20 sessions



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Thank You!



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