



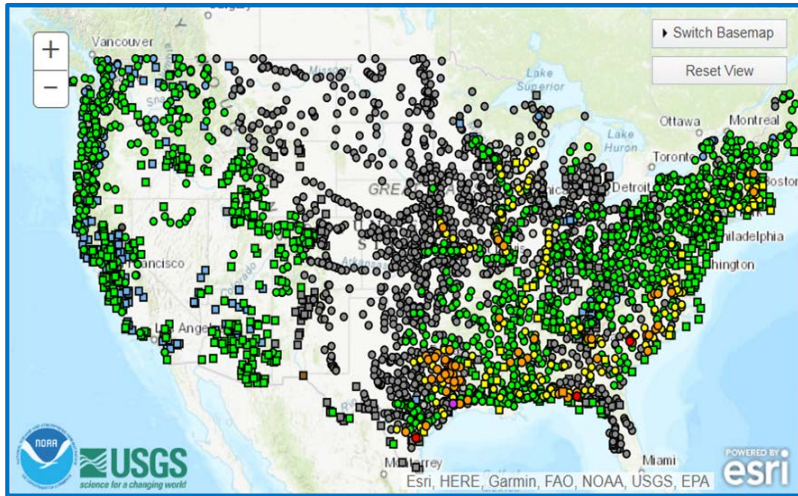
# NOAA's National Water Model Background, Capabilities and Future Plans



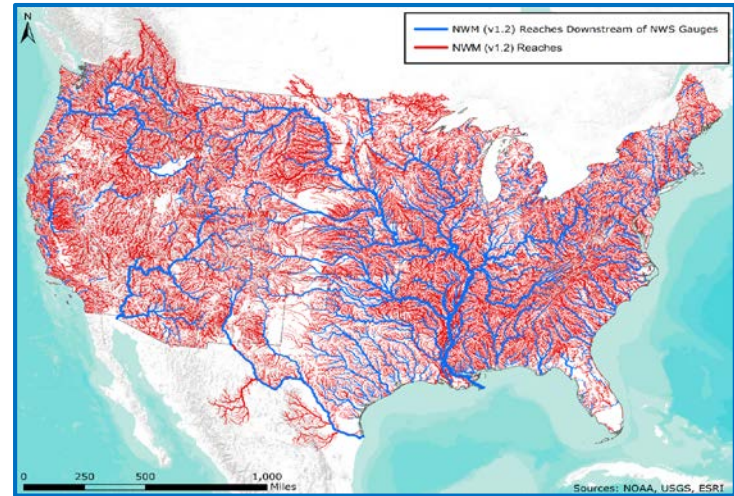
# National Water Model (NWM)

- Full spectrum hydrologic model, providing complementary hydrologic guidance
- NWM was upgraded to V2.0 in June 2019 by OWP, NCEP and NCAR
- Hydrologic core is WRF-Hydro, a community-based hydrologic modeling framework

## RFC AHPS



## NWM

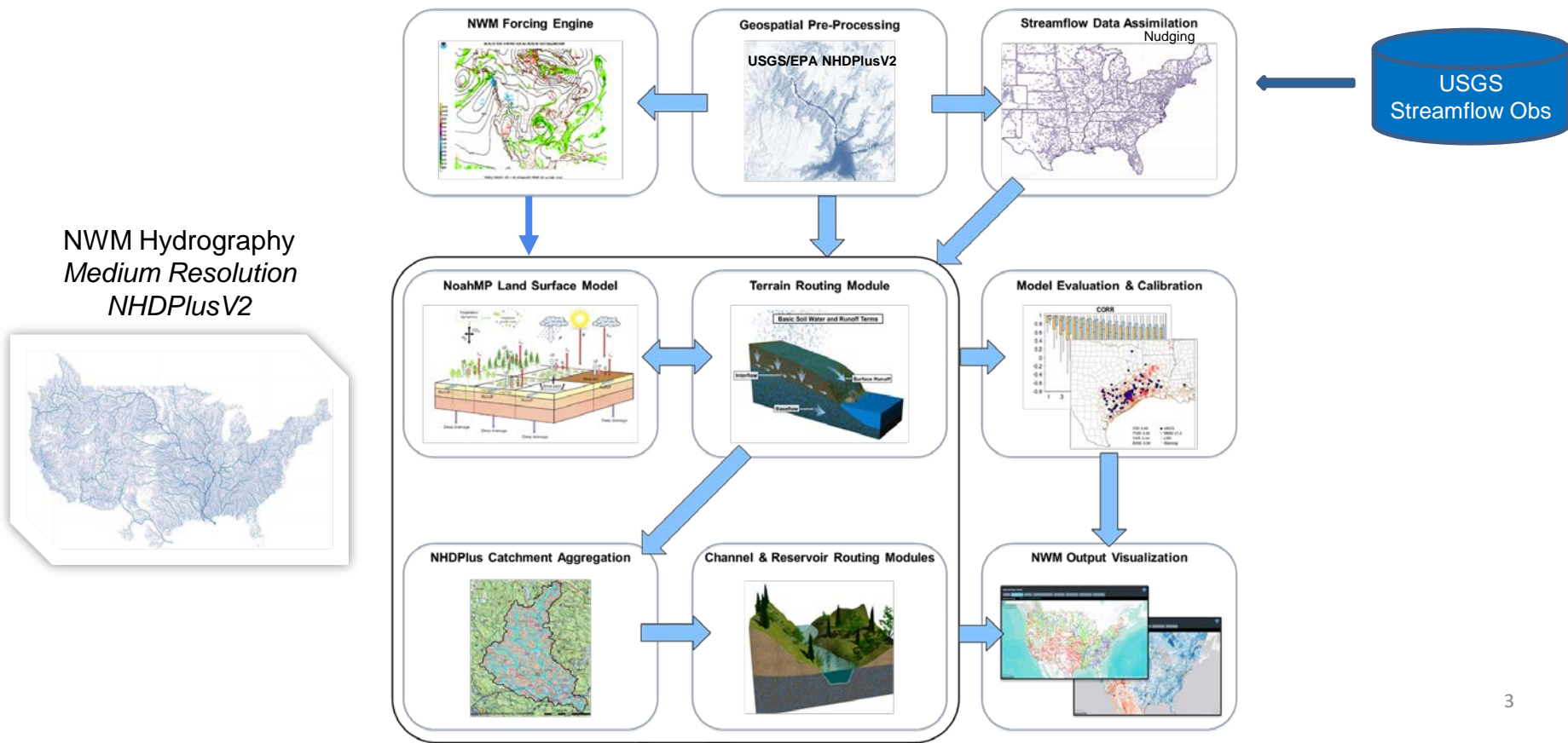


**River Forecast Centers:** Authoritative forecasts at ~3,600 RFC Points

**NWM:** Guidance at 2.7 million NHDPlus river segments, filling in coverage gaps and enriching existing points

# National Water Model System Structure

Fusion of column structure of land surface models, distributed structure of hydrologic models and national USGS/EPA NHDPlusV2 stream network. Supported by verification and visualization elements.



# National Water Model V2.0: Cycling Overview

## Analysis



HRRR/RAP/MRMS/MPPE

Lookback Range 3-28 hrs

## Short-Range



HRRR/RAP

## Medium-Range Ens



GFS

## Long-Range Ens



CFS



Hawaii  
3 Hour Lookback  
60 Hour Forecast

NAM-NEST

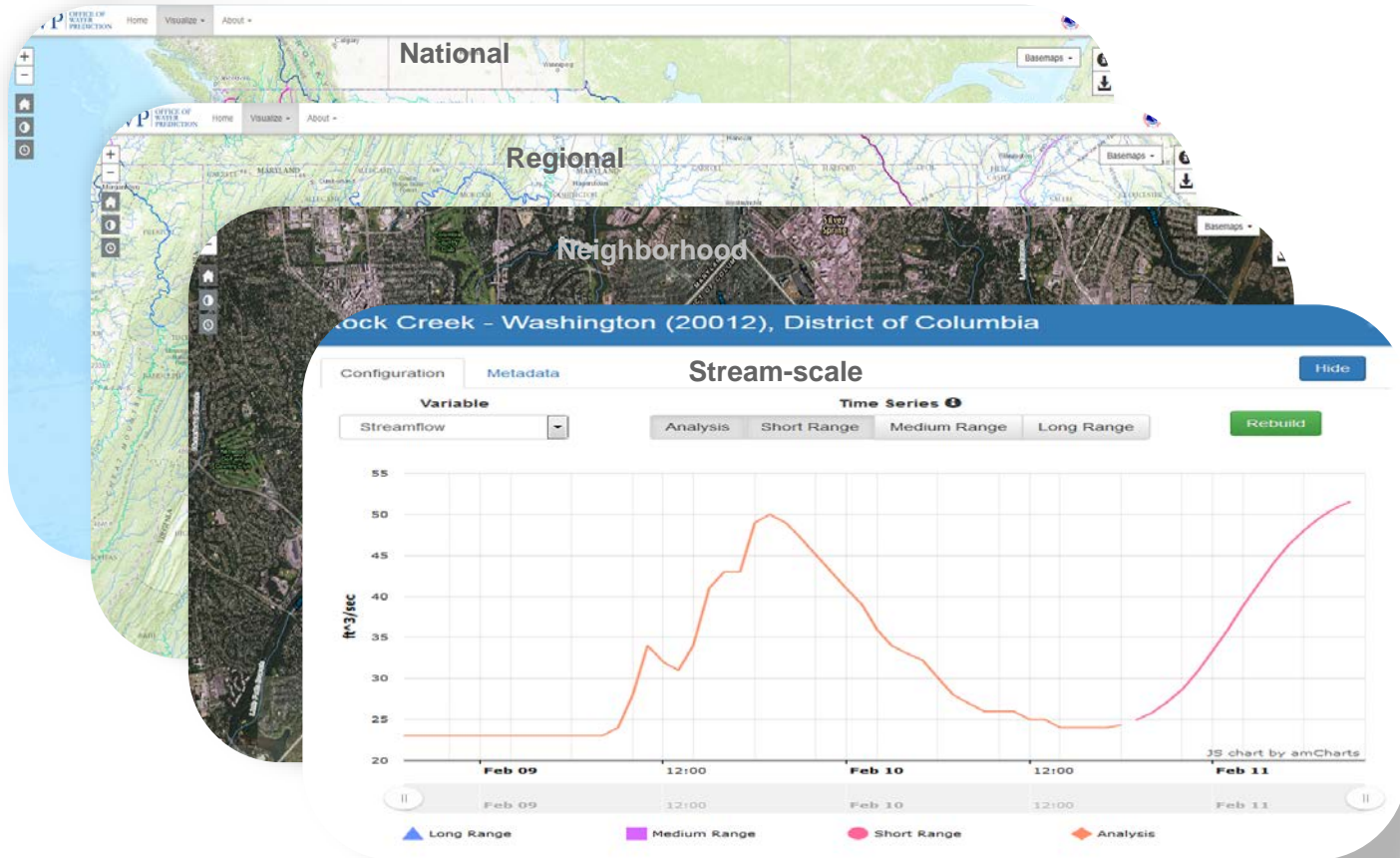
18 Hour Forecast

~10 Day Ensemble Forecast

30 Day Ensemble Forecast

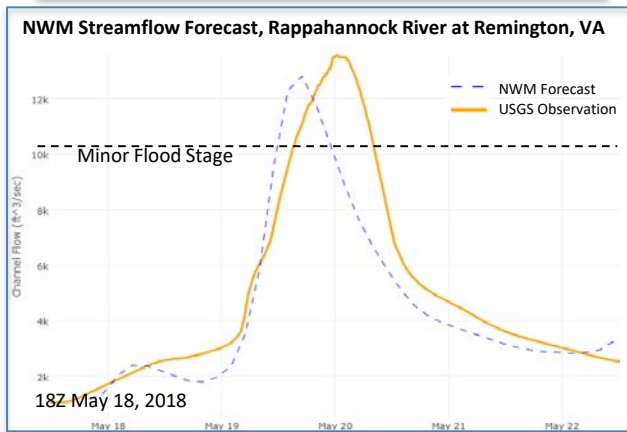
New For V2.0

# NWM Provides Multi-Scale Hydrologic Forecast Guidance



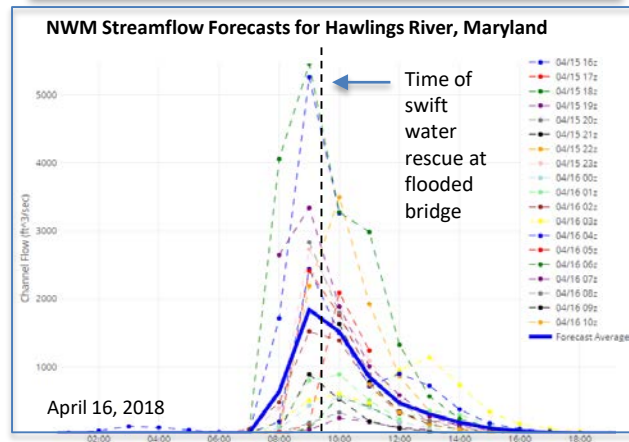
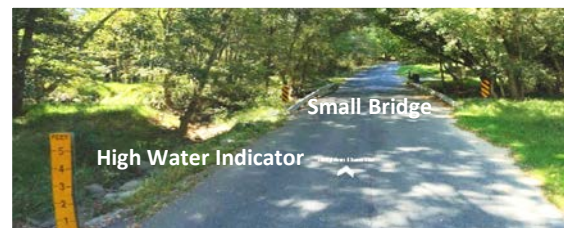
# NWM Output: Complementary Guidance for Forecasters

## Large River at Traditional RFC Forecast Location



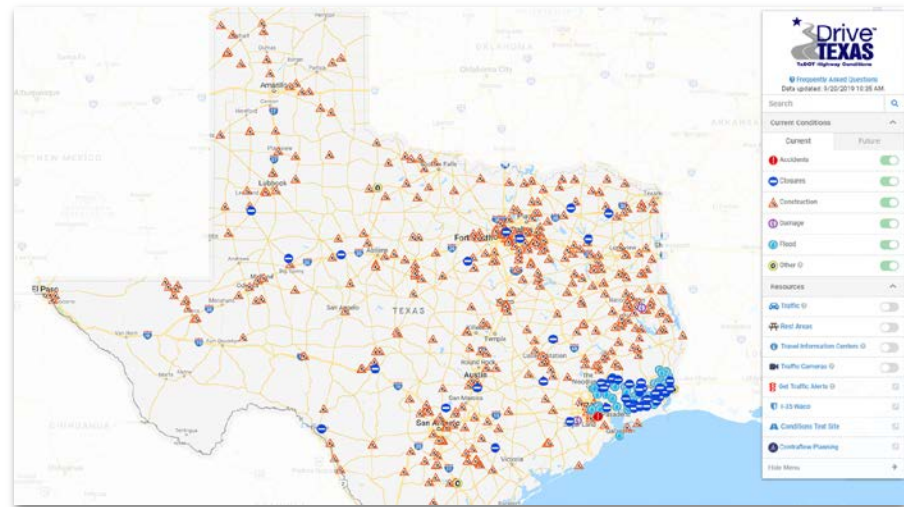
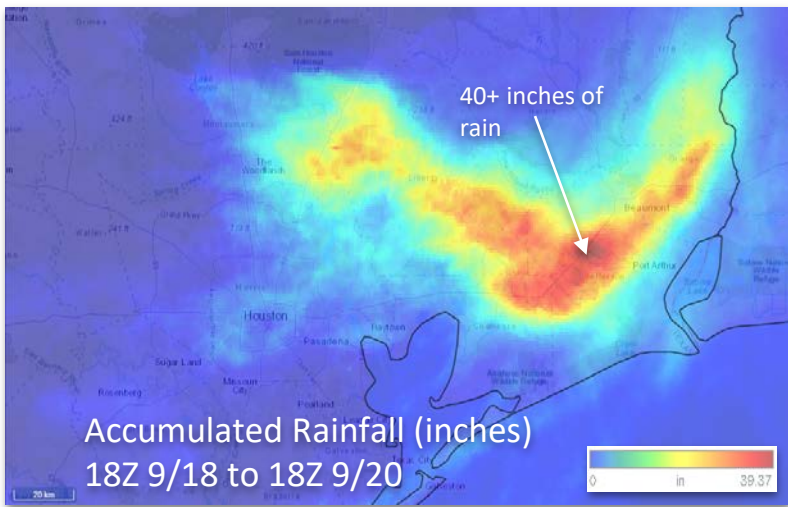
- Leveraging accurate precipitation NWM correctly forecasts minor flooding two days in advance
- Inter-cycle variability/biases highlight need for improved precip forecasts, NWM development

## Small Ungauged Stream Away from Traditional Forecast Point



- Successive NWM forecasts indicate correct timing for dangerous flow
- Run-to-run variability indicates need for continued precipitation improvement

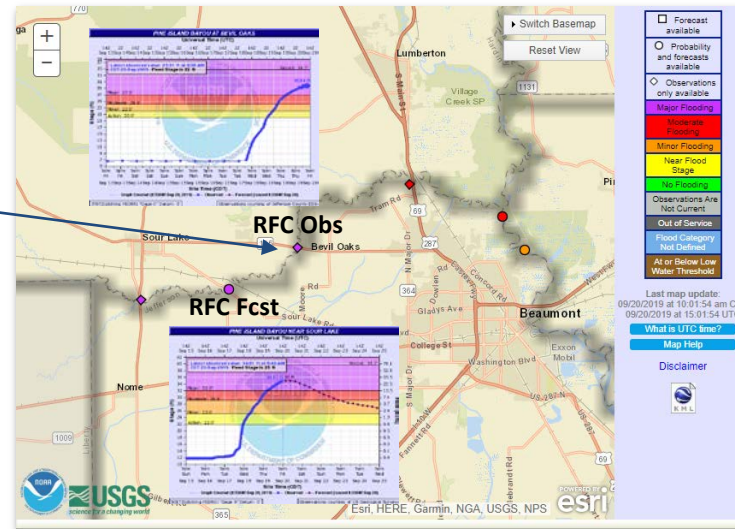
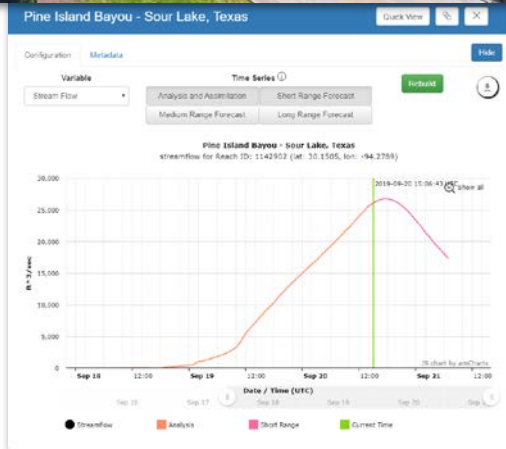
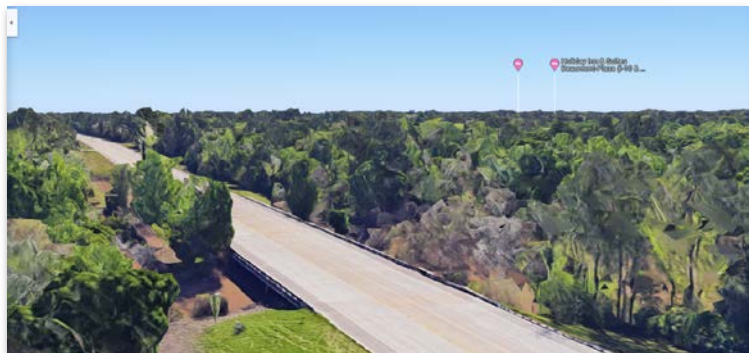
# Use Case: Tropical Depression Imelda (September 2019)



- Heavy rain from tropical depression Imelda led to widespread flooding
- Texas Department of Transportation mapped many road closures
- Critical to know both start and end times of flooding
  - When should roads be closed?
  - What segments need to be closed?
  - When can they reopen?

# Tropical Depression Imelda: NWM Complementary Guidance

- Some RFC observation or forecast points located near transportation infrastructure
- Here, NWM guidance can provide complementary information



- NWM streamflow guidance for river crossing
- Rapid updates, long forecast horizon

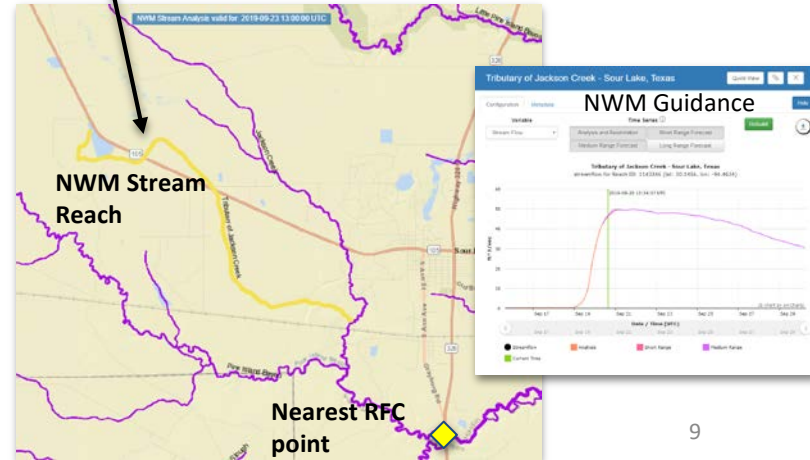


# Tropical Depression Imelda: NWM Complementary Guidance

- No traditional NWS RFC river forecasts are available for many smaller streams

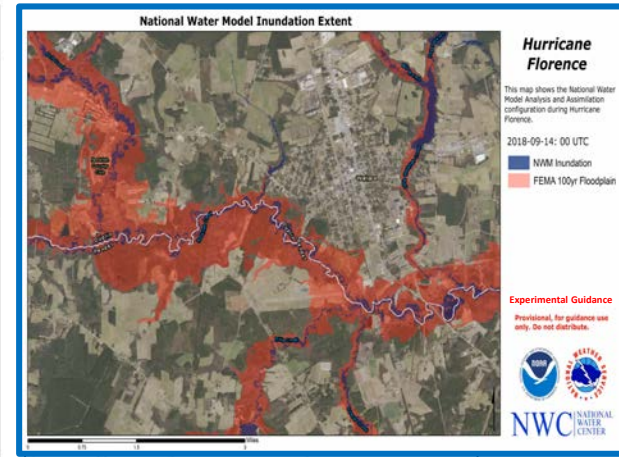
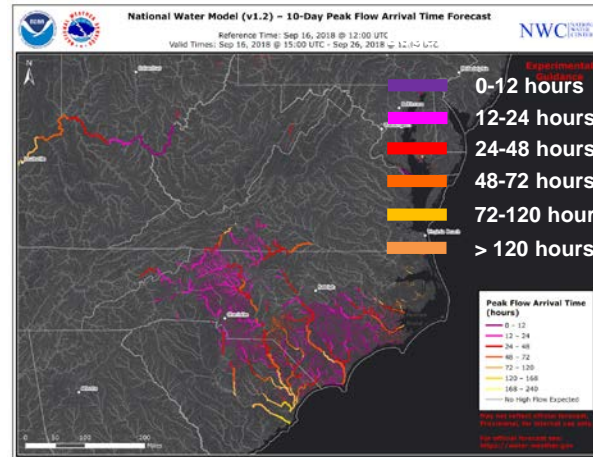
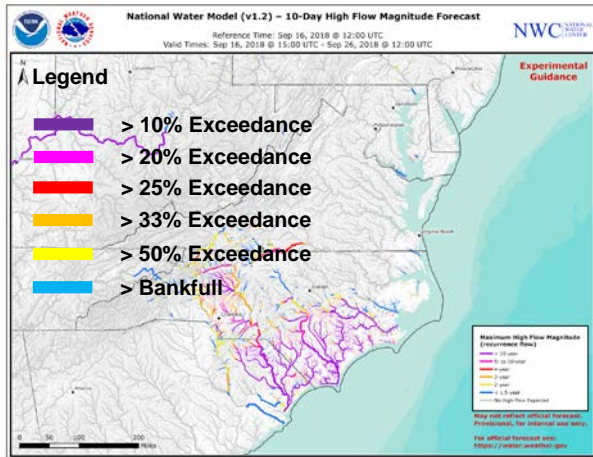


- NWM guidance covers underserved areas (ex. low water crossings)
  - Vital flow timing information
  - Depth, if flow-depth rating curve available



# Further Leveraging NWM Model Output: Flow Forecast Mapping

## A Look Ahead to Potential Visualizations



10-Day High Flow Magnitude  
Full Domain

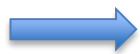
10-Day High Flow Arrival Time  
Full Domain

Inundation Extent  
Texas now, CONUS by ~2021

Where is the event? When will it occur? How likely is it?

# National Water Model: Development Trajectory

**v1.0**



**v1.1/1.2/2.0**



**v2.1**

**Foundation: 2016**

Water resource model  
2.7 million reaches

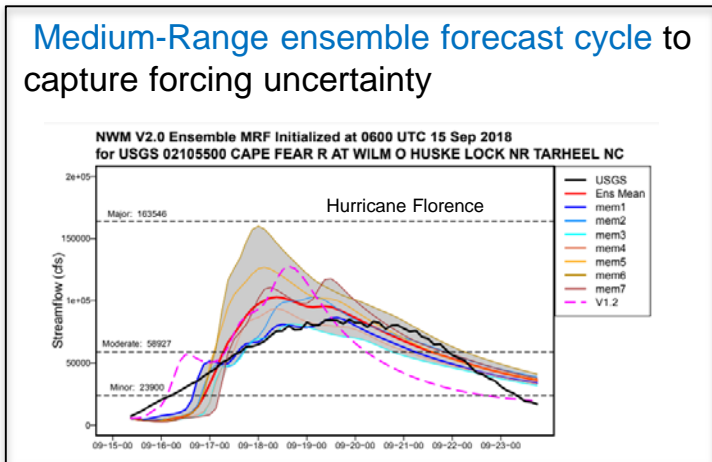
**Upgrades: 2017/2018/2019**

Hawaii, medium range ens.,  
physics upgrades, improved  
modularity, MPE ingest, longer  
Analyses/Fcsts

**Next Upgrade: Early 2021**

Expansion to PR and Great  
Lakes, reservoir modules,  
forcing bias-correction,  
open-loop config, and  
improved Hawaii forcing

Medium-Range ensemble forecast cycle to  
capture forcing uncertainty



**v3.0**



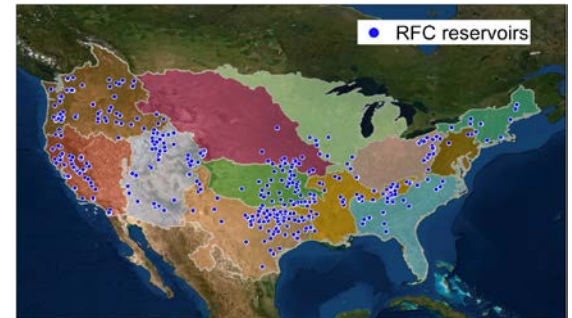
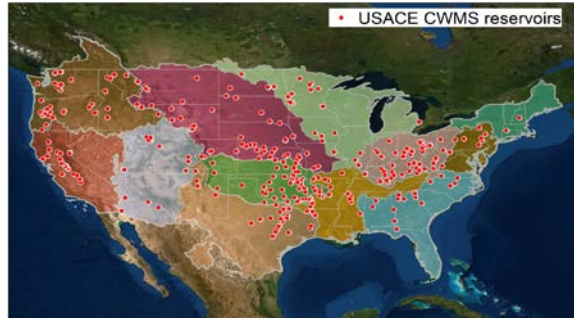
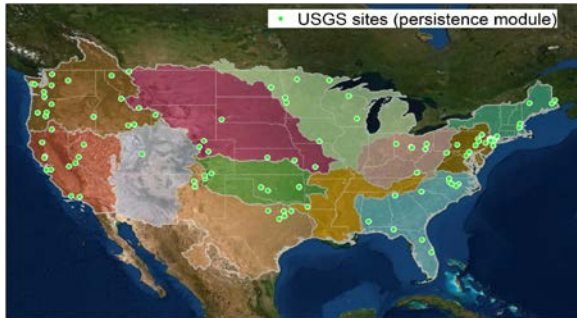
**Future Upgrade: 2022**

Coastal coupling, expansion to Alaska, shallow  
groundwater, infiltration physics and hydro-  
fabric upgrades

# NWM V2.1 Highlight: Improving Treatment of Reservoirs

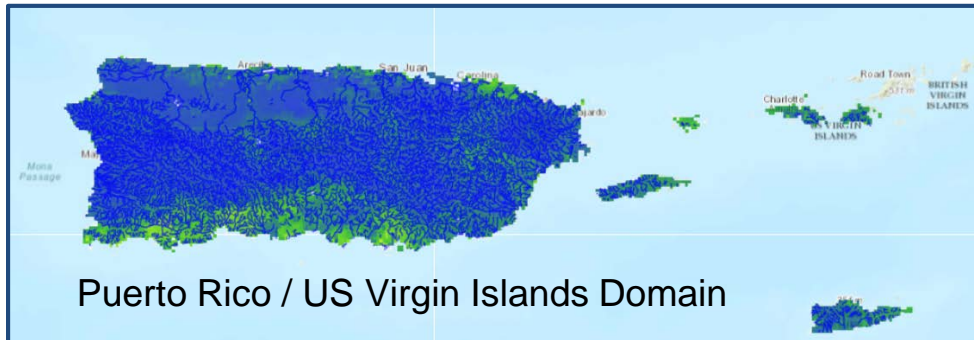
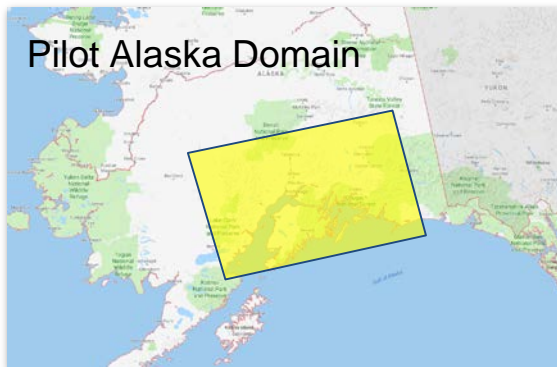
- Reservoir outflows are key to overall NWM streamflow accuracy
- NWM V2.1 will have two data ingest upgrades to improve outflows
  - Persistence-based data assimilation approach
    - ACE Observations from CWMS RADAR service
    - USGS Observations from existing WCROSS USGS stream gauge feed
  - Use of RFC reservoir discharge time series
    - Forecasts from each RFC transferred to NWM on WCROSS supercomputer

## Potential Sites - Refining with Partners



# NWM Version-Over-Version Domain Expansion

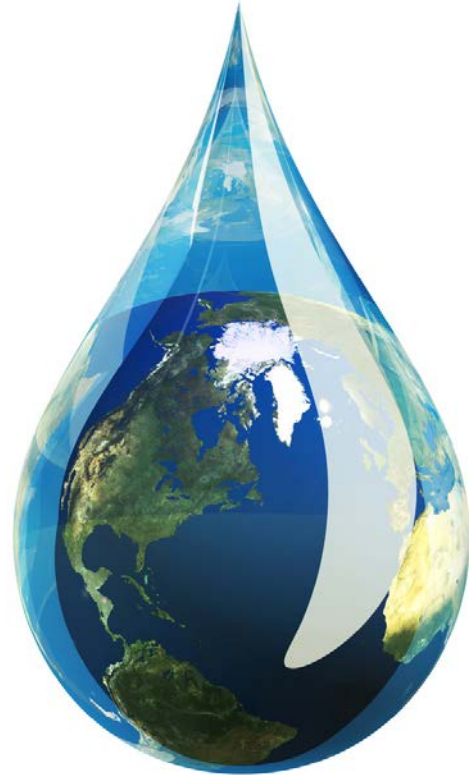
- NWM V2.0 - Hawaii
- NWM V2.1
  - Great Lakes and Lake Champlain (GLERL)
  - Puerto Rico and US Virgin Islands (SERFC and Puerto Rico WFO)
- NWM V3.0 - Alaska



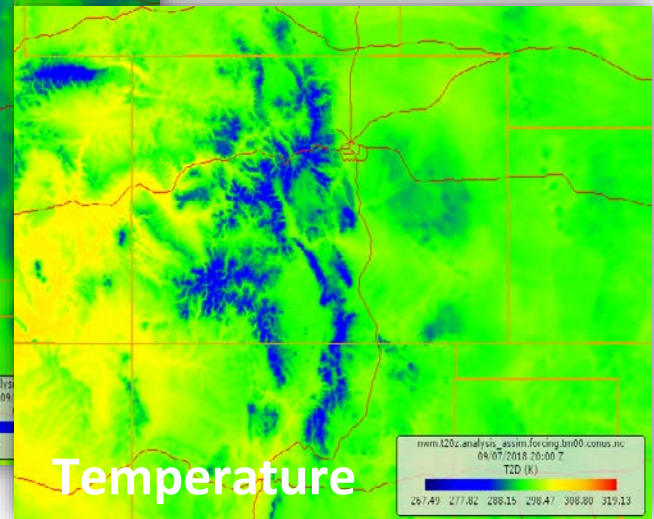
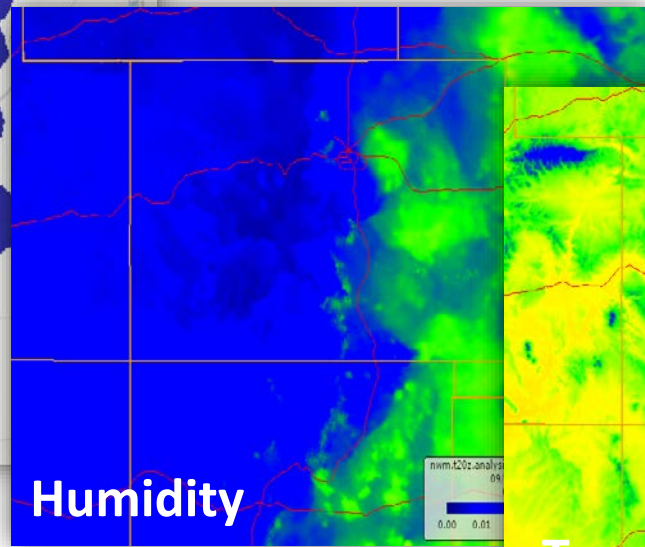
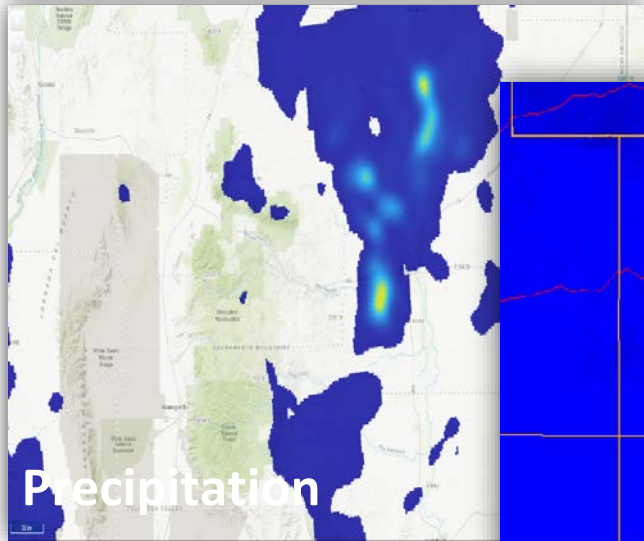
# Closing Thoughts

- The NWM is running operationally 24x7, producing nationwide water resource analyses and forecast guidance
- Complements existing information and provides first-ever operational hydrologic guidance at underserved locations, supporting range of DSS applications
- What exists now is a foundation that will be rapidly upgraded
  - v2.0 was just implemented into operations in June
    - Hawaii domain, new Analysis cycles, medium range ensemble, calibration
  - v2.1 is anticipated in late 2020 / early 2021
    - Inclusion of PR & Great Lakes basin and improved reservoir forecasts
  - v3.0 is anticipated in 2022
    - Improved subsurface flow and channel routing, forecast coastal coupling, AK domain expansion, advanced hydrofabric, updated parameters
  - Next-gen design is underway
- Effective visualization and data delivery are key ongoing efforts
- Expanding partnerships will enable accelerated and expanded enhancements

# Additional Background Material



# NWM Meteorological Inputs



- The NWM ingests weather forcing as drivers of the water and energy cycles
- Eight forcing fields: Temp, Humidity, U/V Wind Speed, Pressure, Shortwave, Longwave, Precip
- The fields are downscaled from several external sources: the HRRR, RAP, GFS, CFS and NAM-Nest models and from MRMS and MPE precipitation observations



# National Water Model Data Dissemination and Big Data

- **The National Water Model outputs massive amounts of data**
  - Real-time Operations: ~400 GB/Day
  - Dual 26-Year Retrospective Simulations (Jan 1993 - Dec 2018)
    - Full Physics (matches AnA, SR, MR): ~35 TB for model output
    - Long-Range Physics (matches LR): ~30 TB for model output
- **NWS NCEP Central Operations handles distribution of real-time operational data via NOMADS distribution service (rolling window)**
- **NOAA's partnership with Big Data is being leveraged to transfer additional NWM data to Big Data partners and from there to end users**

