National Water Model

6th Annual FIRO Workshop

August 7, 2019

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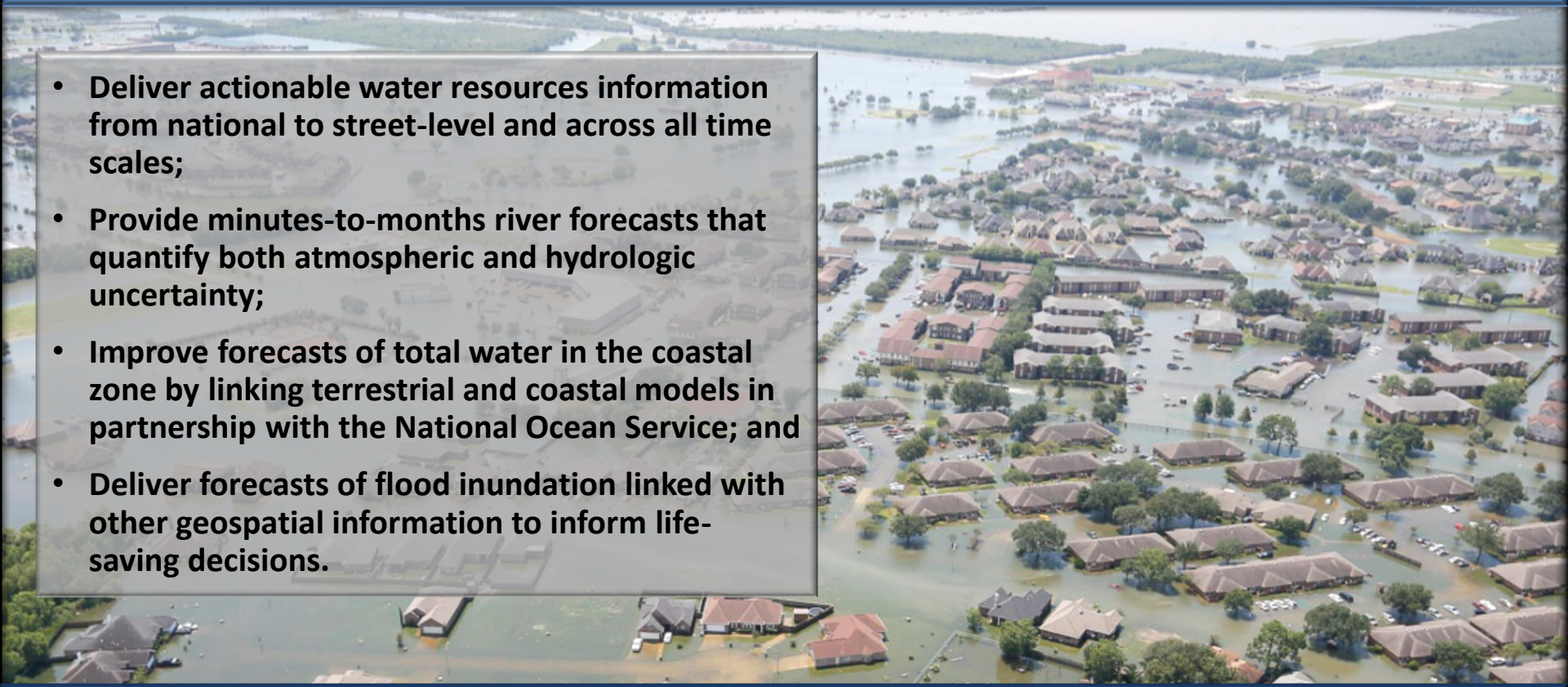
National Weather Service (NWS)
National Oceanic and Atmospheric Administration (NOAA)

NOAA NWS Strategic Plan 2019-2022:
Water-Specific Goals



- Deliver actionable water resources information from national to street-level and across all time scales;
- Provide minutes-to-months river forecasts that quantify both atmospheric and hydrologic uncertainty;
- Improve forecasts of total water in the coastal zone by linking terrestrial and coastal models in partnership with the National Ocean Service; and
- Deliver forecasts of flood inundation linked with other geospatial information to inform life-saving decisions.

https://www.weather.gov/media/wrn/NWS_Weather-Ready-Nation_Strategic_Plan_2019-2022.pdf

National Water Model: Myths and Realities

NWM – What it is :

- Designed as a compliment to current capabilities from the River Forecast Centers
- Provides additional guidance from hours to 30 days
- The first instance of hydrologic model coupled in one direction with NOAA's Numerical Weather Prediction capabilities on High Performance Computing

NWM – What it is not:

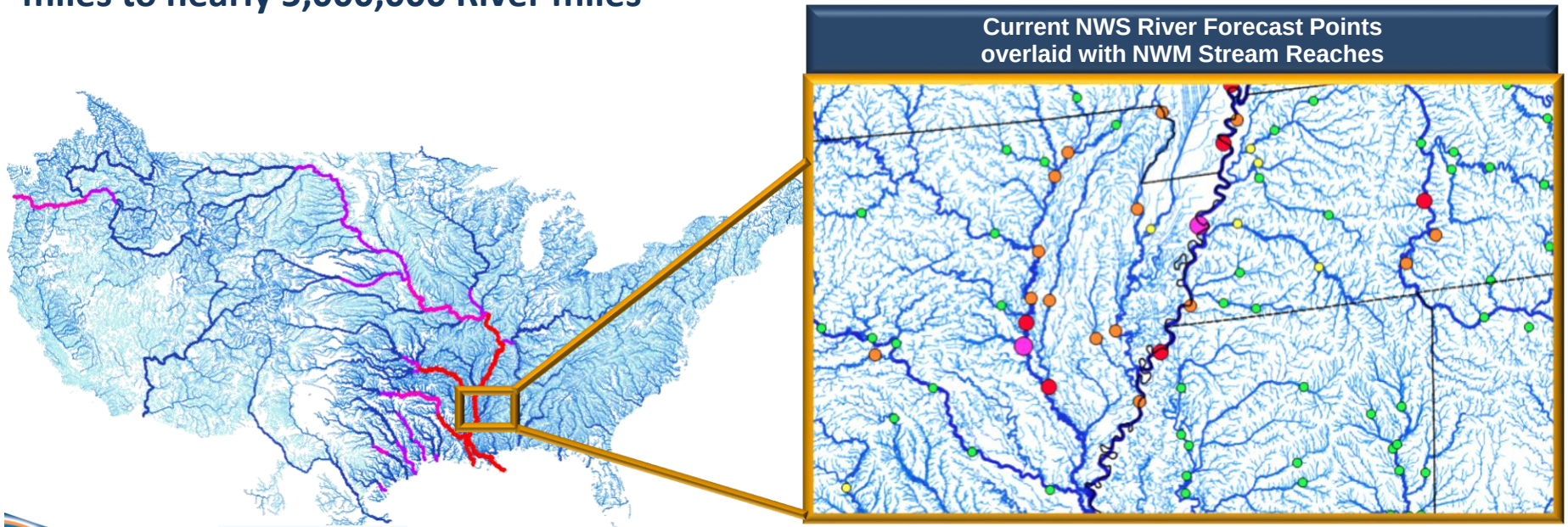
- A replacement for the official RFC forecasts or Advanced Hydrologic Prediction Service locations
- A capability that competes with the Hydrologic Ensemble Forecast Service (HEFS) or RFC Water Supply forecasts
- A fully mature, and fully coupled earth system modeling system

- A solution to *World Peas*

National Water Model

V2.0 Implemented June 19, 2019

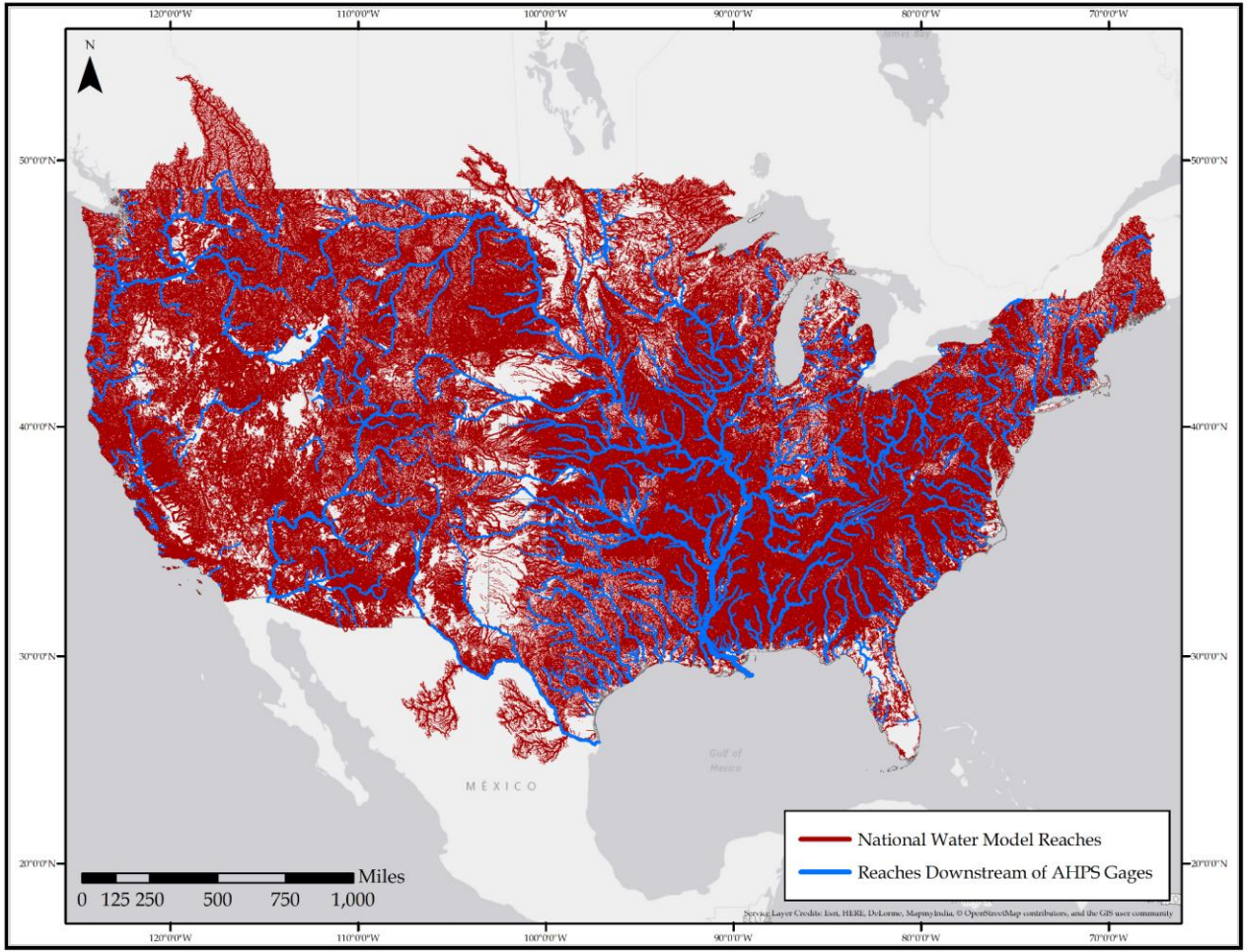
- **Continental-scale water resources model providing high resolution, spatially continuous estimates of major water cycle components**
- **Operational forecast streamflow guidance for currently underserved locations: 100,000 River miles to nearly 5,000,000 River miles**



NCAR NATIONAL CENTER FOR ATMOSPHERIC RESEARCH CUAHSI OWP OFFICE OF WATER PREDICTION

National Water Model

National Water Model



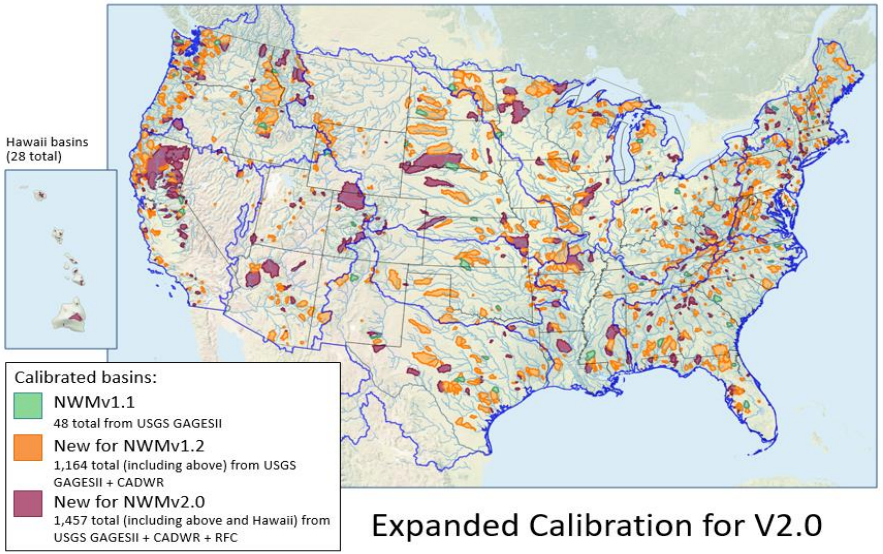
Upgrades to NWM V2.0 and NWM V2.1

v1.0 → v1.1/1.2 → v2.0

Foundation
Established August 2016
Water Resource Model for 2.7 Million Stream Reaches

First/Second Upgrade
May 2017/March 2018
Increased cycling freq. and forecast length, improved calibration, soil/snow physics and stream DA

Third Upgrade
June 2019
Expansion to Hawaii, medium range ensembles, compound channel parameterization, increased modularity, improved calibration, longer Analysis w/MPE



Expanded Calibration for V2.0

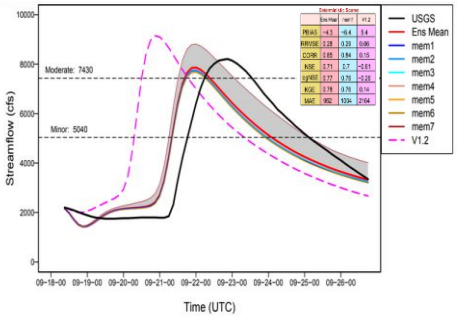
v2.1

Fourth Upgrade
Fall 2020
Expansion to Puerto Rico and Great Lakes, increased modularity, enhanced reservoir module, physics improvements, forcing bias-correction, improved calibration, and improved Hawaii QPE

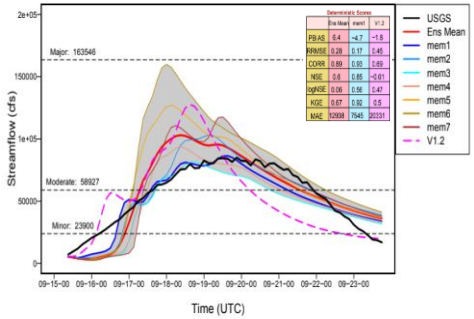
NWM V2.0 Medium-Range Real-time Ensemble Forecast Examples

Hurricane Florence

NWM Medium-Range Forecast (06Z 9/18)
Lynches River at Effingham, SC

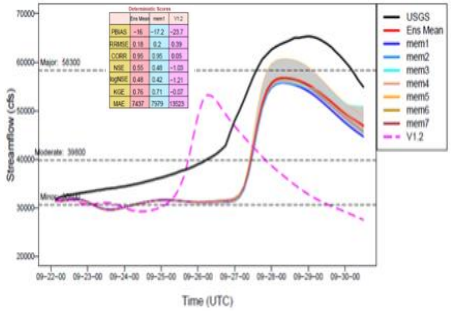


NWM Medium-Range Forecast (06Z 9/15)
Cape Fear River at William O. Huske Lock near Tar Heel, NC

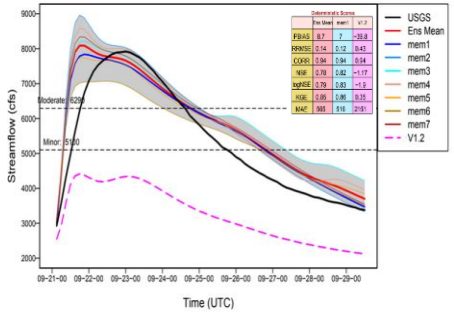


Iowa Flooding

NWM Medium-Range Forecast (00Z 9/22)
Iowa River at Wapello, IA

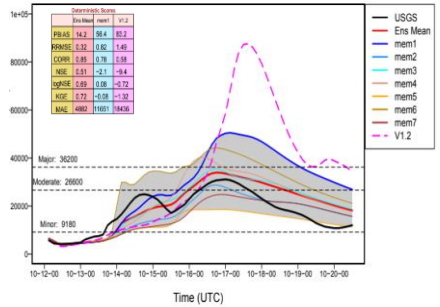


NWM Medium-Range Forecast (00Z 9/21)
East Fork Des Moines River, Near Algona IA

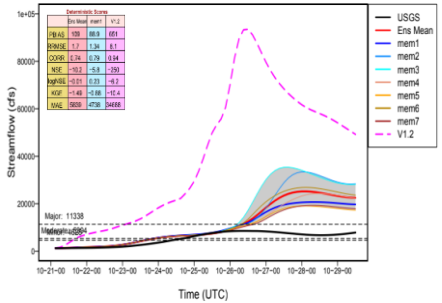


Texas Flooding

NWM Medium-Range Forecast (12Z 10/12)
Trinity River at Dallas, TX



NWM Medium-Range Forecast (00Z 10/21)
Nueces River near Three Rivers, TX



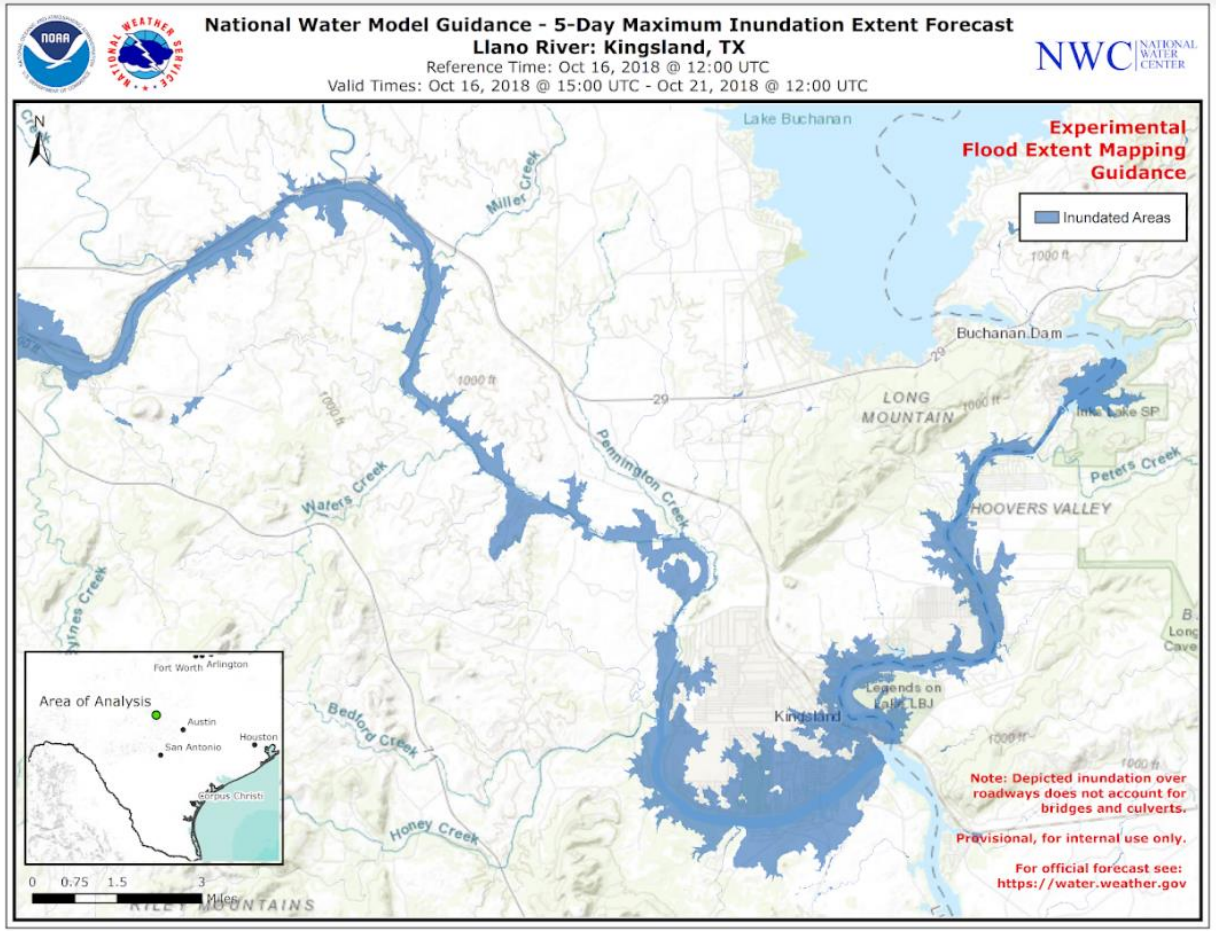
NWM V2.0 displayed good performance for Hurricane Florence flooding, and in Iowa and Texas flood events, new ensemble begins to capture forecast uncertainty

Challenges/Limitations to National Water Modeling Capability and Related Services

Llano river, Oct 2018

- Observations, Data, Weather Forcings, Data Assimilation
- Channel Geometry Enhancement
- Model Enhancement, Integration, and Community Development
- Physical Process Understanding
- Heterogenous physical process representations
- Application of Hydro-informatics for Integration of Geospatial Data and Development of Decision Support Tools
- Underlying Model standards and unified (Earth System) Framework – Enabling Community Development
- Characterizing Uncertainty and Risk
- System Interoperability and Data Synchronization
- High Performance Computing Resources

National Water Modeling application -- Realtime and Forecast Flood Inundation Mapping (FIM) Demonstration (October 2016)

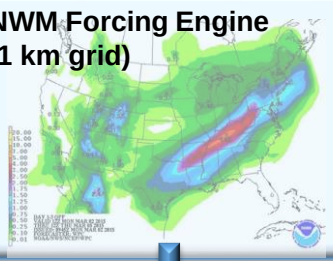


- The Llano River in Texas neared record flooding which resulted in one fatality, numerous evacuations, road closures, and a bridge failure
- Coordinated with SR ROC and WGRFC on the Llano River flooding
- Produced FIM for Kimbell and Llano Counties Texas
- Shared graphics with WGRFC for them to review and share

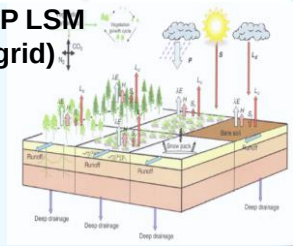
Thanks

National Water Model
Initial Operating Capability: Model Chain

1. NWM Forcing Engine (1 km grid)

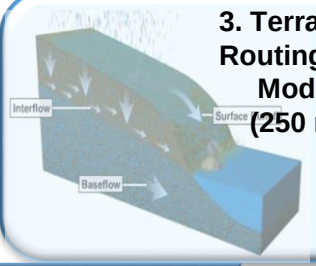


2. NoahMP LSM (1 km grid)



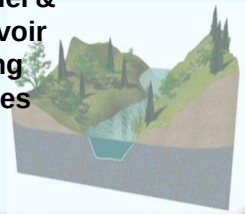
2-way coupling

3. Terrain Routing Module (250 m grid)



4. NHDPlus Catchment Aggregation (2.7M unique catchments and river reaches)

5. Channel & Reservoir Routing Modules



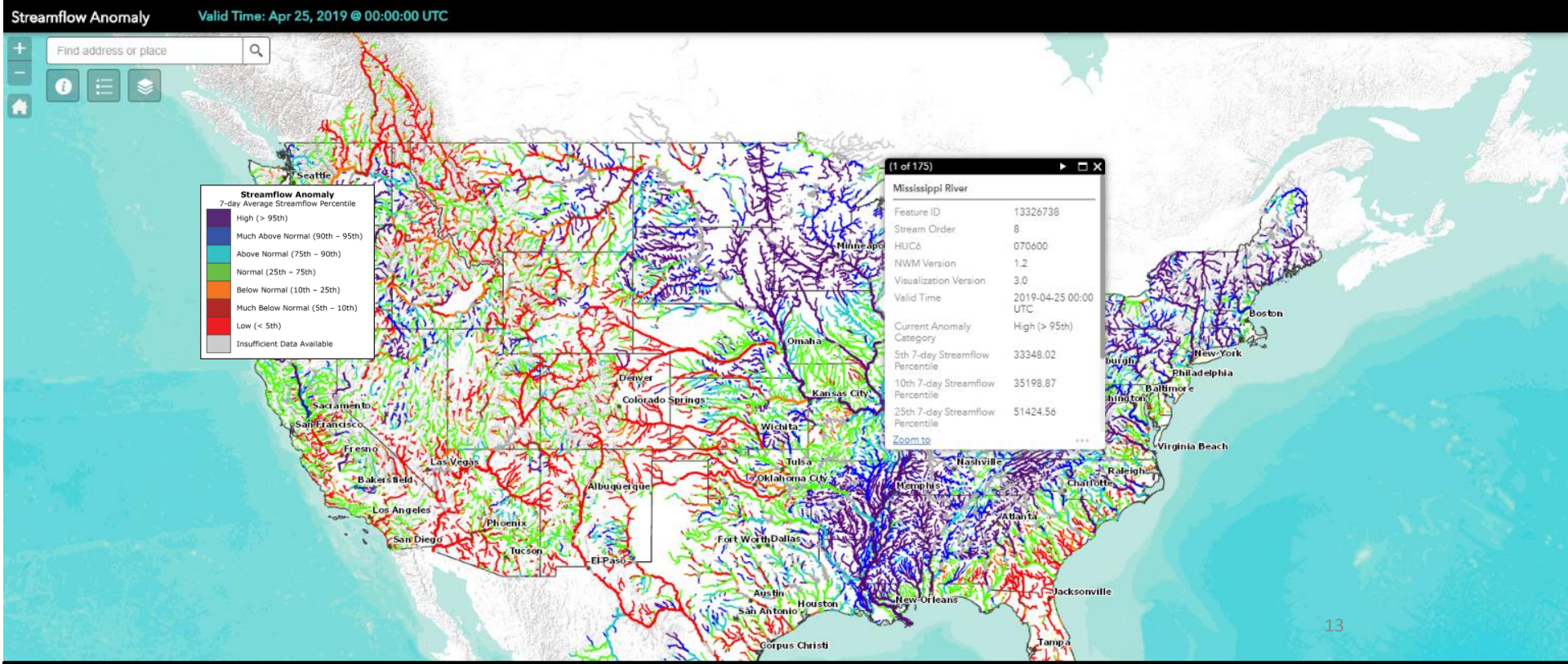
Forecast Products

NWM uses NCAR supported community WRF-Hydro system

NWM: http://water.noaa.gov/about/nwm

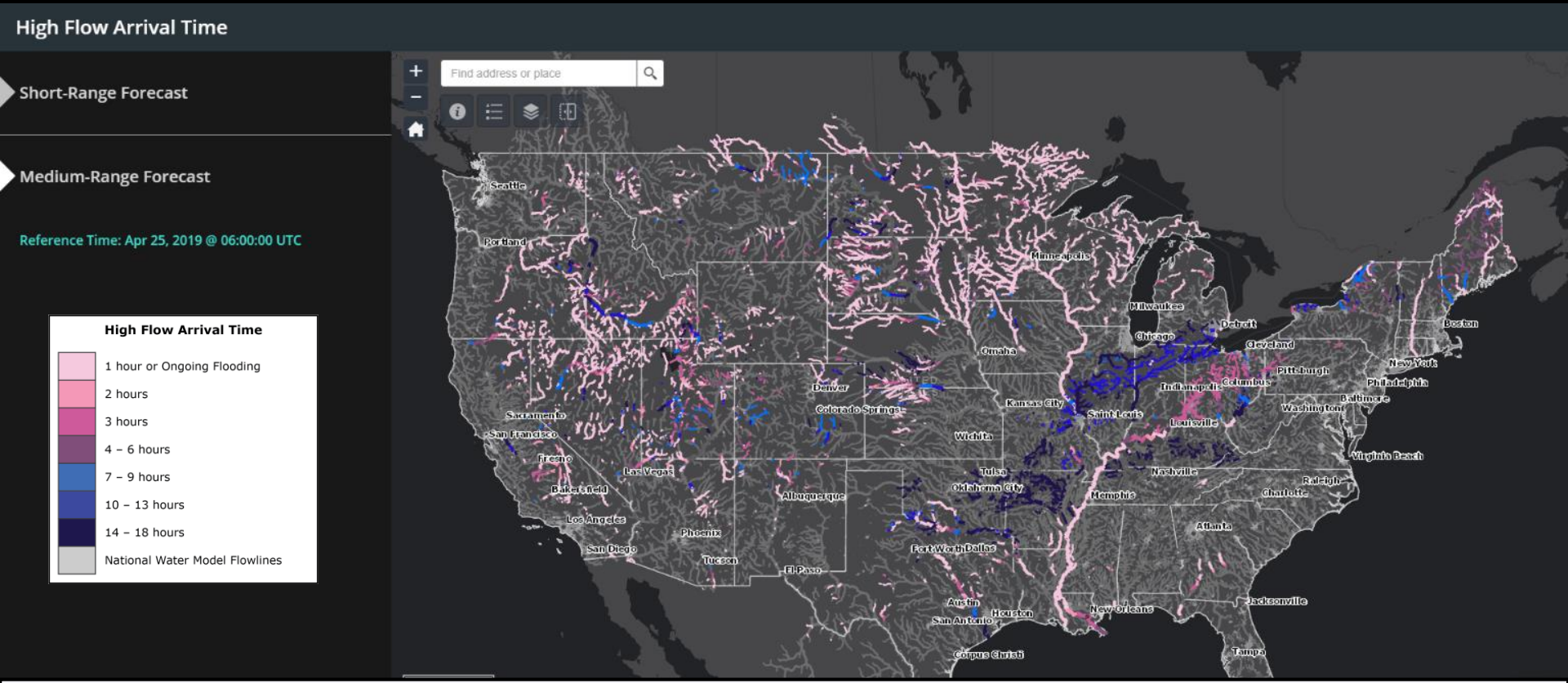
WRF-Hydro: https://www.ral.ucar.edu/projects/wrf_hydro

Data Services: National Water Model - Streamflow Anomaly



Depicts current seasonal streamflow anomalies derived from the past 7 days of NWM (v1.2) output. Anomalies are based on 7-day average streamflow percentiles for each reach for the current calendar day. Streamflow percentiles were derived from 7-day streamflow averages for each reach for each calendar day using a 23-year retrospective analysis of the NWM (v1.2). Updated daily.

Data Services: National Water Model - High Flow Arrival Time



Depicts expected high flow arrival times derived from the latest NWM (v1.2) current and forecast output. Shown are reaches that are expected to be at or above their 1.5-year recurrence flow, and when they are expected to exceed that threshold. Recurrence flows were derived from annual maxima across a 24-year retrospective analysis of the NWM (v1.2).