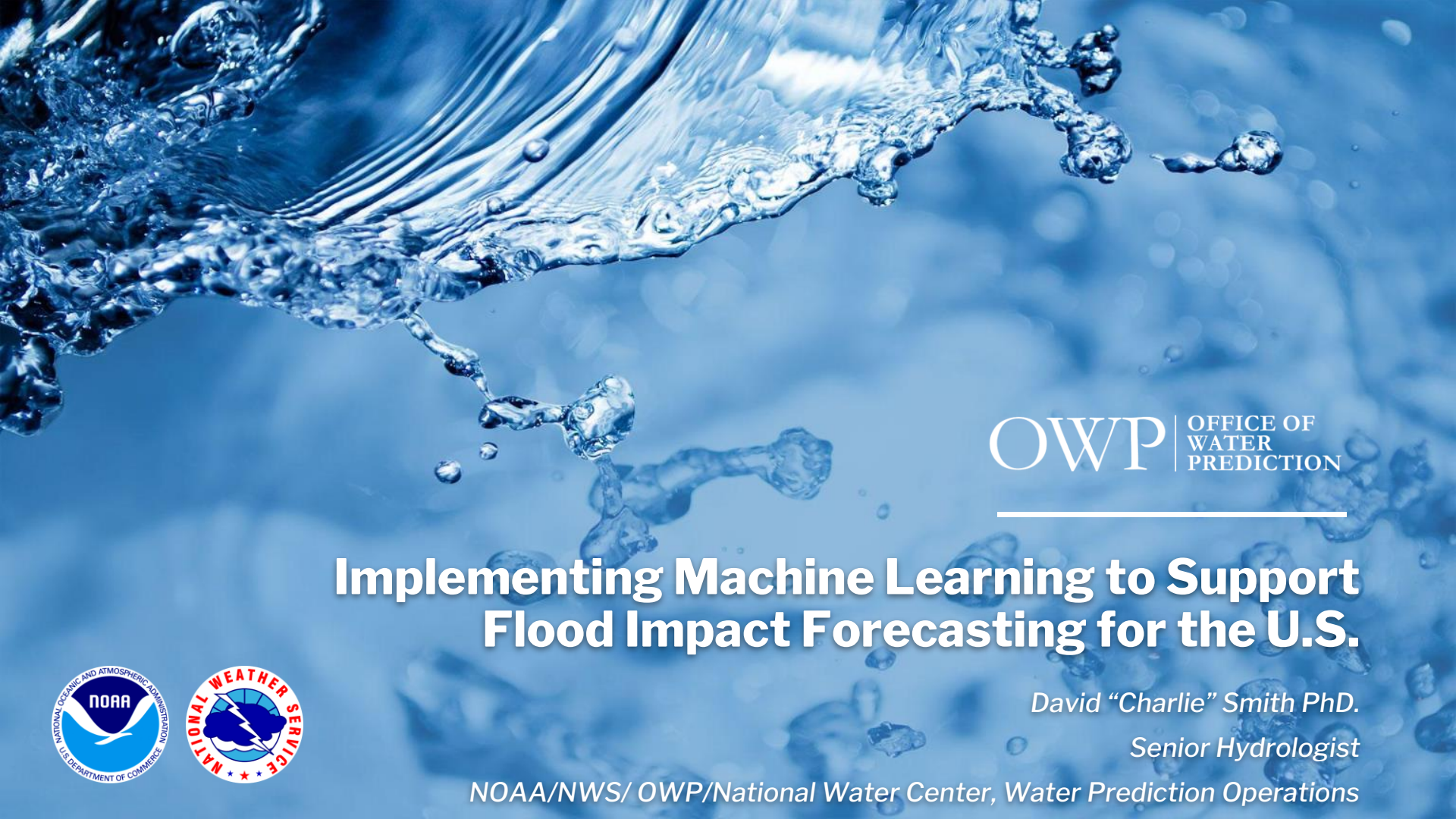


OWP | OFFICE OF WATER PREDICTION

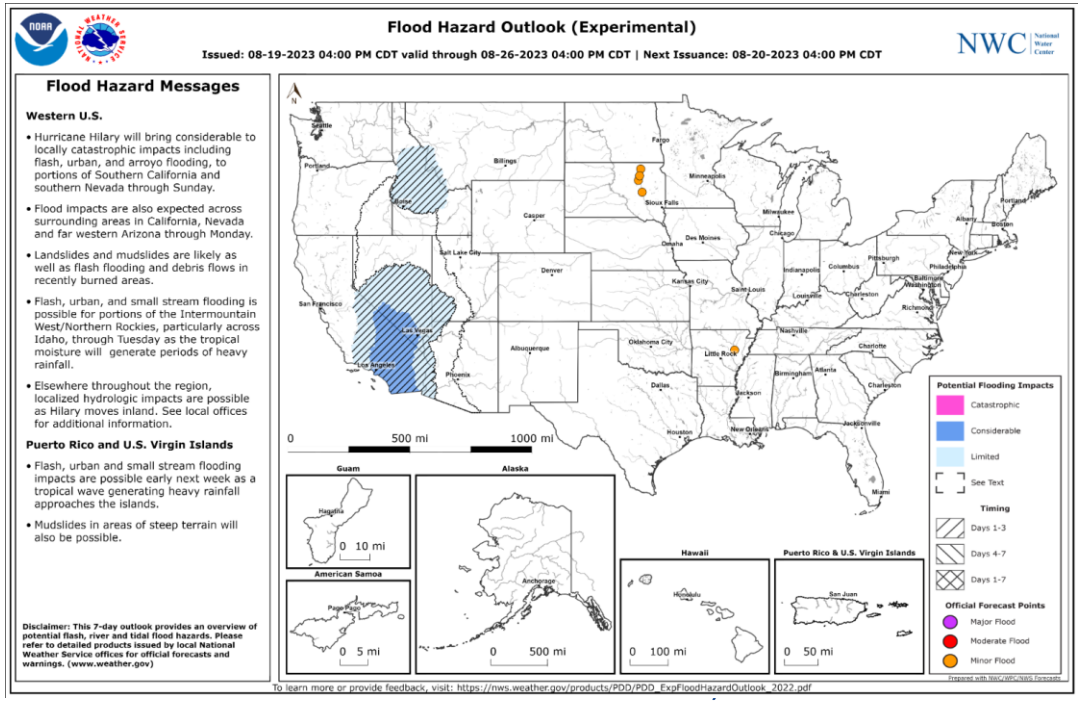
Implementing Machine Learning to Support Flood Impact Forecasting for the U.S.

David "Charlie" Smith PhD.

Senior Hydrologist

NOAA/NWS/ OWP/National Water Center, Water Prediction Operations

The NWC's Experimental Flood Hazard Outlook (FHO)



https://www.weather.gov/owp/operations-fho

The NWC's Experimental Flood Hazard Outlook (FHO)

- Outlooks, Watches & Warnings
- Hydrologic Models & Forecasts
- Meteorological Models & Forecasts
- Antecedent Conditions
- Winter Conditions
- Special Occurrences
  - Tropical Weather
  - Atmospheric Rivers
  - Ice Jams
- Observations

Challenges and Motivation

- Development of FHO currently relies heavily on forecasters' critical assessment of over 30 variables.
- Selection of specific basins to highlight is up to the forecaster.
- Basin selections may vary with forecasters based on a number of factors.
- The classification by category (magnitude and timing) may vary among forecasters.
- FHO includes CONUS and OCONUS, so multiple areas may need focus simultaneously.

Machine Learning “First Look” Flood Hazard Outlook

- Provide an objective, quantitative, and programmatic approach in defining and characterizing potential flood impacts across the U.S.
- Provide a baseline classification to highlight areas of concern considering key variables, such as population density, land use, terrain, soil type and moisture, quantitative precipitation forecasts (QPF), and many others.
- Increase the efficiency of FHO production by creating a starting point.
- Bring the attention of a forecaster to areas that may be less obvious.

Tools Used to Create the First Look FHO

- Python 3
- Rasterio
- GDAL
- Shapely
- Geopandas
- Scikit-learn 1.3.2
  - Ordinary least squares Linear Regression

Training Data

Static Data

- Basins (16,055) - USGS Hydrologic Unit (HUC 10)
- Basin Shape
- Urban Area
- Basin Size
- Aridity
- Cropland
- Forests
- Sand and Clay content
- Flatland
- Relief

5 Years of Historic Data

- NASA SPoRT Relative Soil Moisture 0 - 10 cm depth
- RFC Quantitative Precipitation Estimates
- River Flooding (RFC Historic Observations)
- USGS Historic Streamflows

ANSWER

Local Storm Report Density (Flooding)

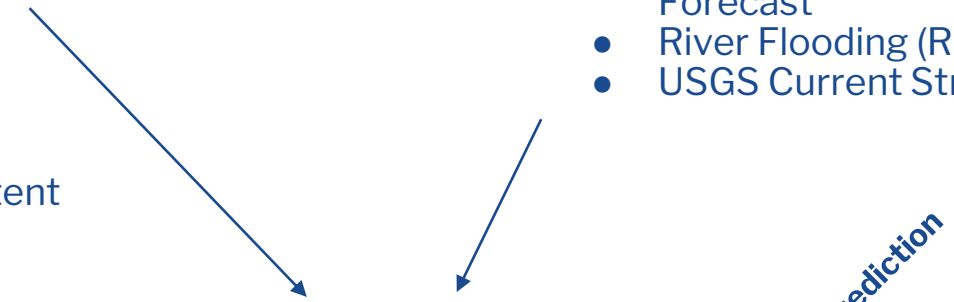
Production Data

Static Data

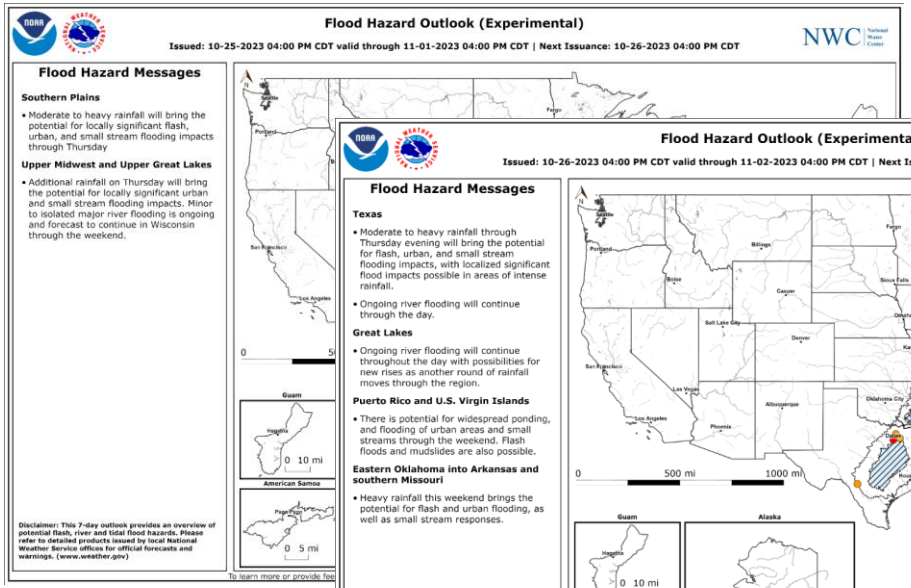
- Basins (16,055) - USGS Hydrologic Unit (HUC 10)
- Basin Shape
- Urban Area
- Basin Size
- Aridity
- Cropland
- Forests
- Sand and Clay content
- Flatland
- Relief

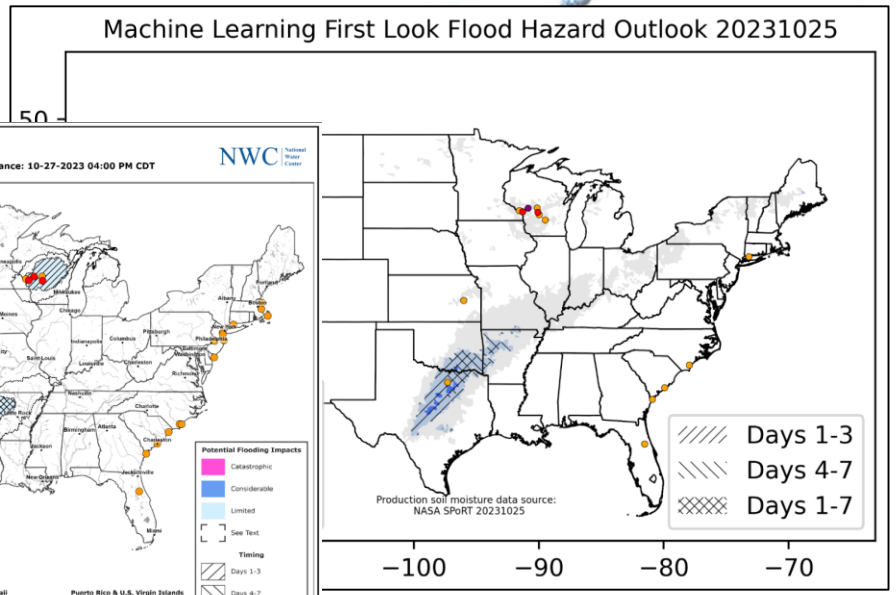
Latest Data

- NASA SPoRT Relative Soil Moisture 0 - 10 cm depth
- WPC Quantitative Precipitation Forecast
- River Flooding (RFC Max Forecast)
- USGS Current Streamflows

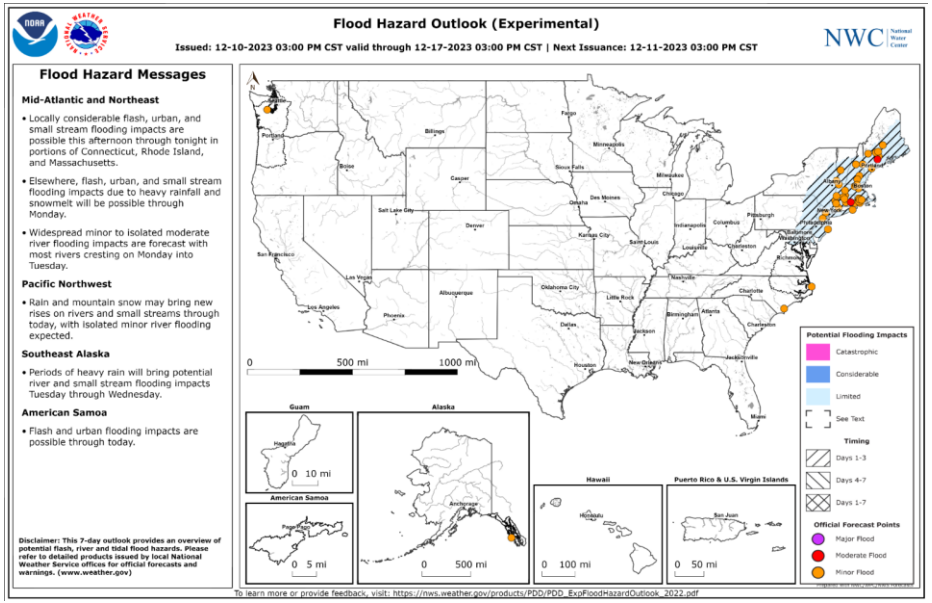


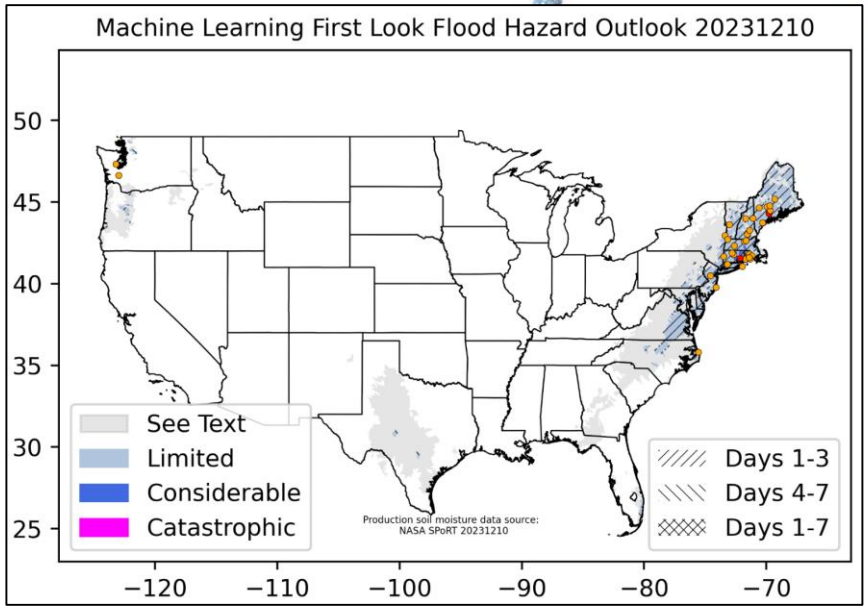
Heavy Rainfall in Southern Plains in October 25, 2023



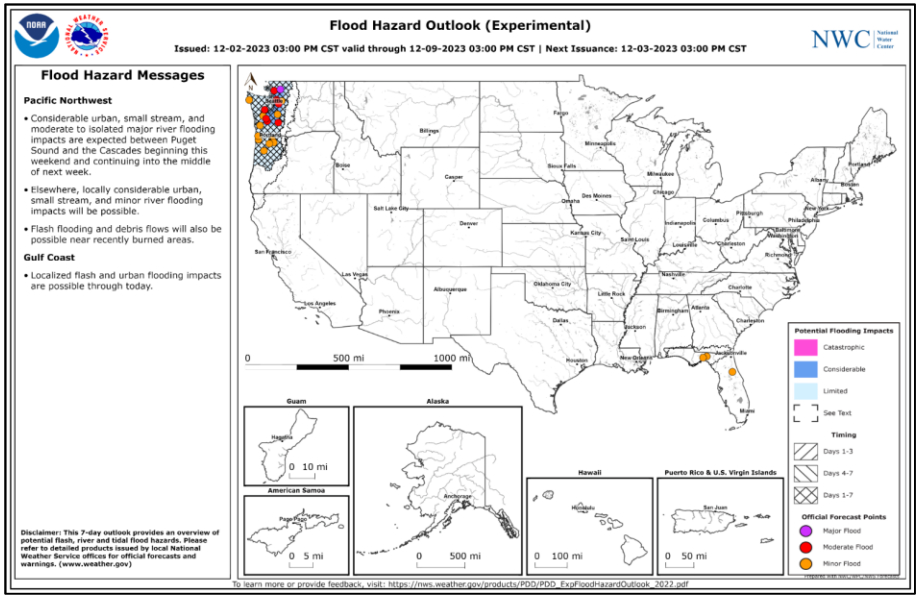


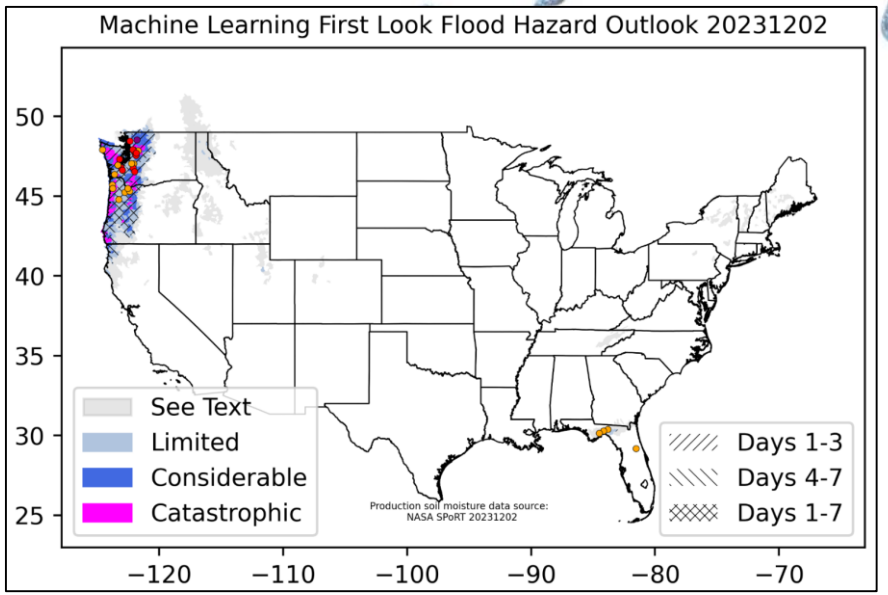
Heavy Rainfall in Northeast in December 10, 2023





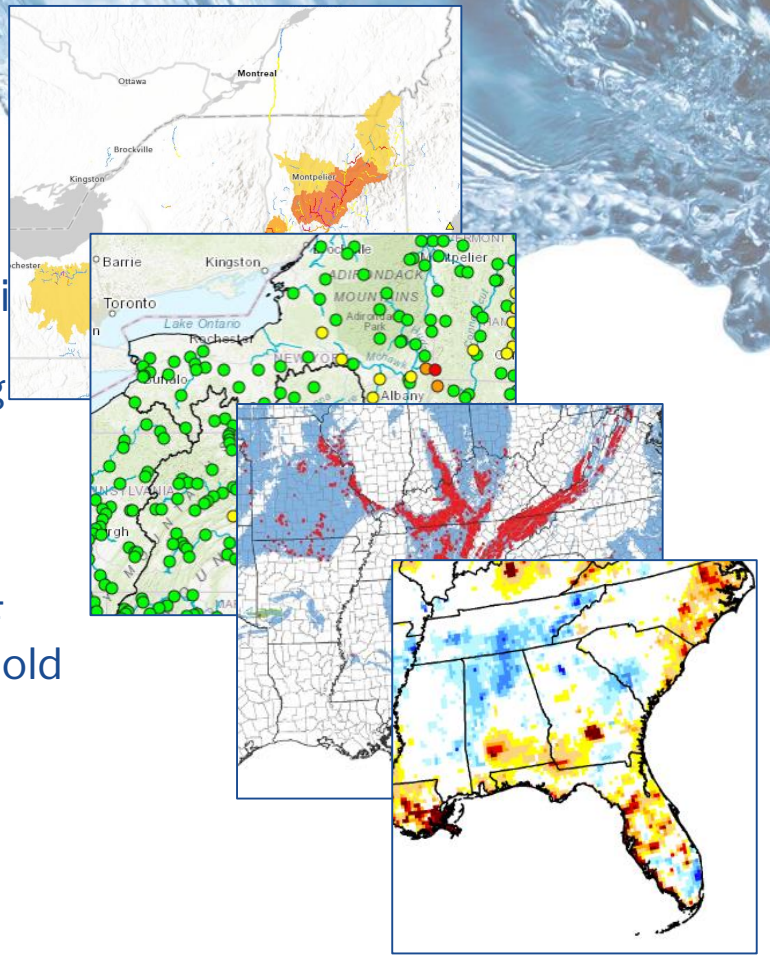
Heavy Rainfall in Pacific Northwest, December 02, 2023





What is Next?

- Incorporate more NWM variables (Snowmelt, Rapi
  onset flooding forecasts)
- Incorporate the Hydrologic Ensemble Forecasting
  System (HEFS)
- Incorporate groundwater (NASA GRACE)
- Karst categories
- More past QPE categories (3, 14, 30-day?)
- Leverage more QPF sources GFS, Euro, NBM QPF
- Consider a version for stream flow above a threshold
  instead of LSRs
- Evaluation and Verification
- Operationalize the ML FHO



Thank You!

David C. Smith, PhD | Senior Hydrologist
NOAA/NWS/OWP/National Water Center
Water Prediction Operations Division
David.C.Smith@noaa.gov

https://www.weather.gov/owp/operations

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