

# Forecast-guided reservoir operations in large-scale water resource models

April 29<sup>th</sup> 2021

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# Dam operators use forecasts



Glen Canyon Dam

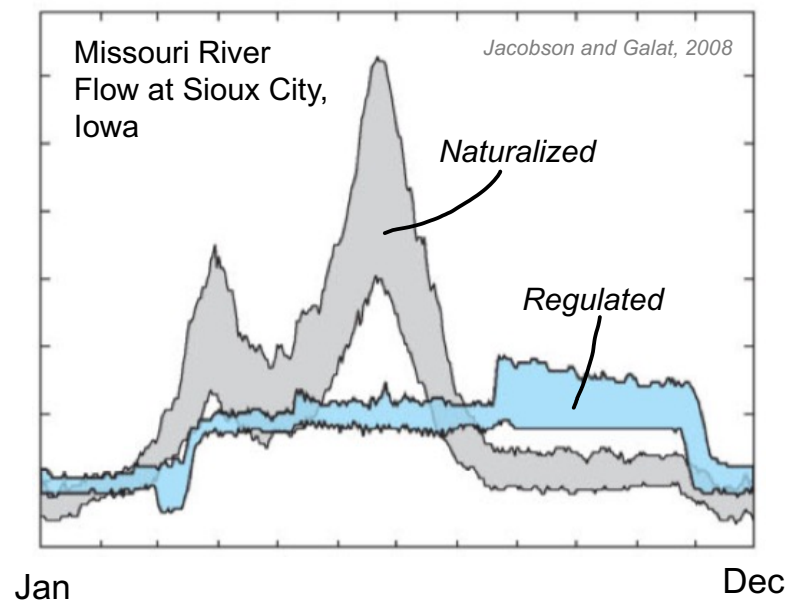
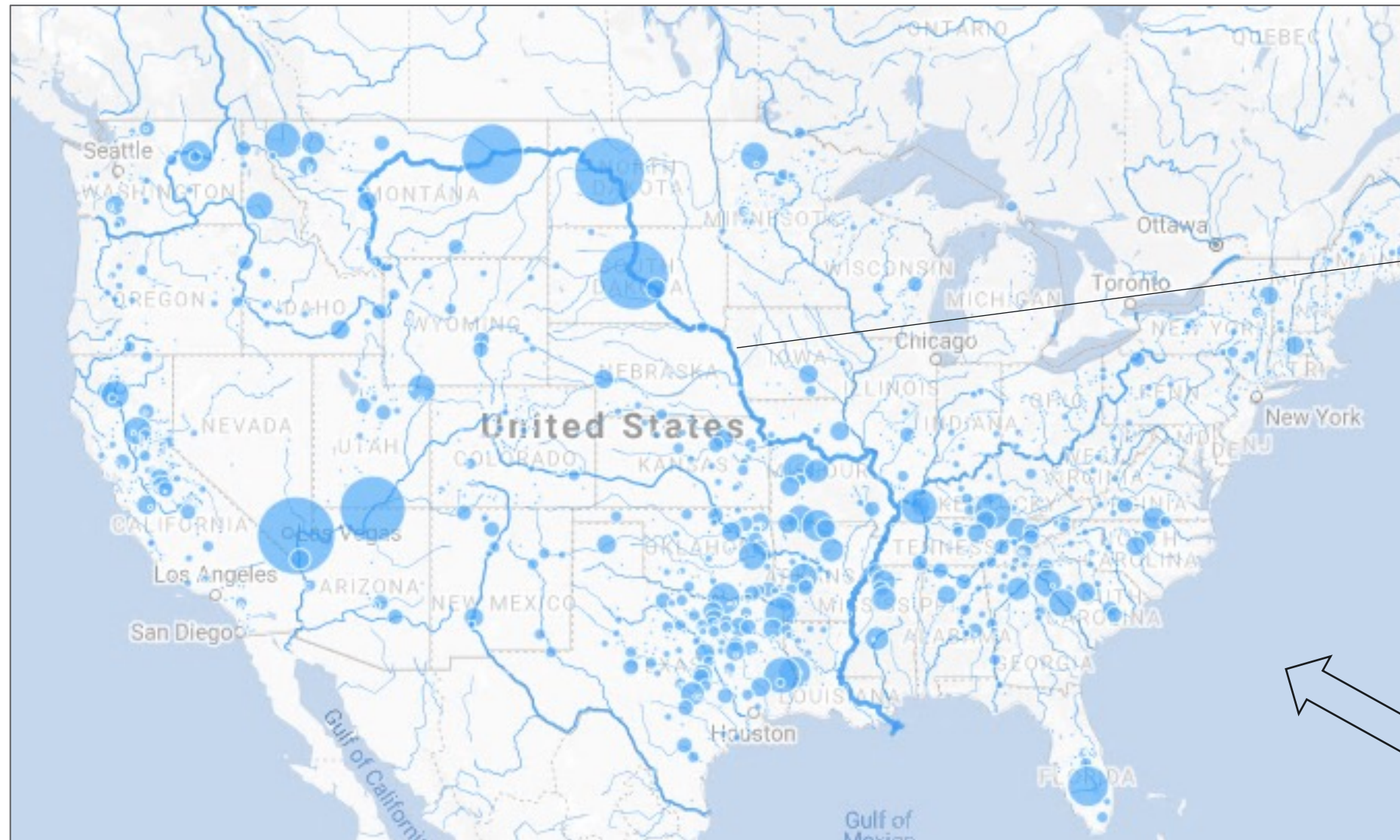


## Current Operations

April 26<sup>th</sup> 2021

The operating tier for water year 2021 (September 2020 through October 2021) was established in August 2020 as the Upper Elevation Balancing Tier, consistent with Section 6.B of the Interim Guidelines. Consistent with Section 6.B of the Interim Guidelines, Lake Powell's operations in water year 2021 will be governed by the Upper Elevation Balancing Tier. With an 8.23 maf release from Lake Powell in water year 2021, the April 2021 24-Month Study projects the end of water year elevation at Lake Powell to be below 3,575 feet. Therefore, in accordance with Section 6.B.1 of the Interim Guidelines, Lake Powell will continue to release 8.23 maf through the remainder of the water year 2021.

# Large scale models represent reservoir operations. Should those operations account for **forecasts use**?



*Dams in the Global Reservoirs and  
Dams (GRanD) database  
Source: The Water Desk*

## Two immediate **challenges**:

Lack of **documented rules** that are:

- Widely available
- In a consistent format

Lack of a **scheme to integrate forecast-guided operations** into a large-scale hydrological.

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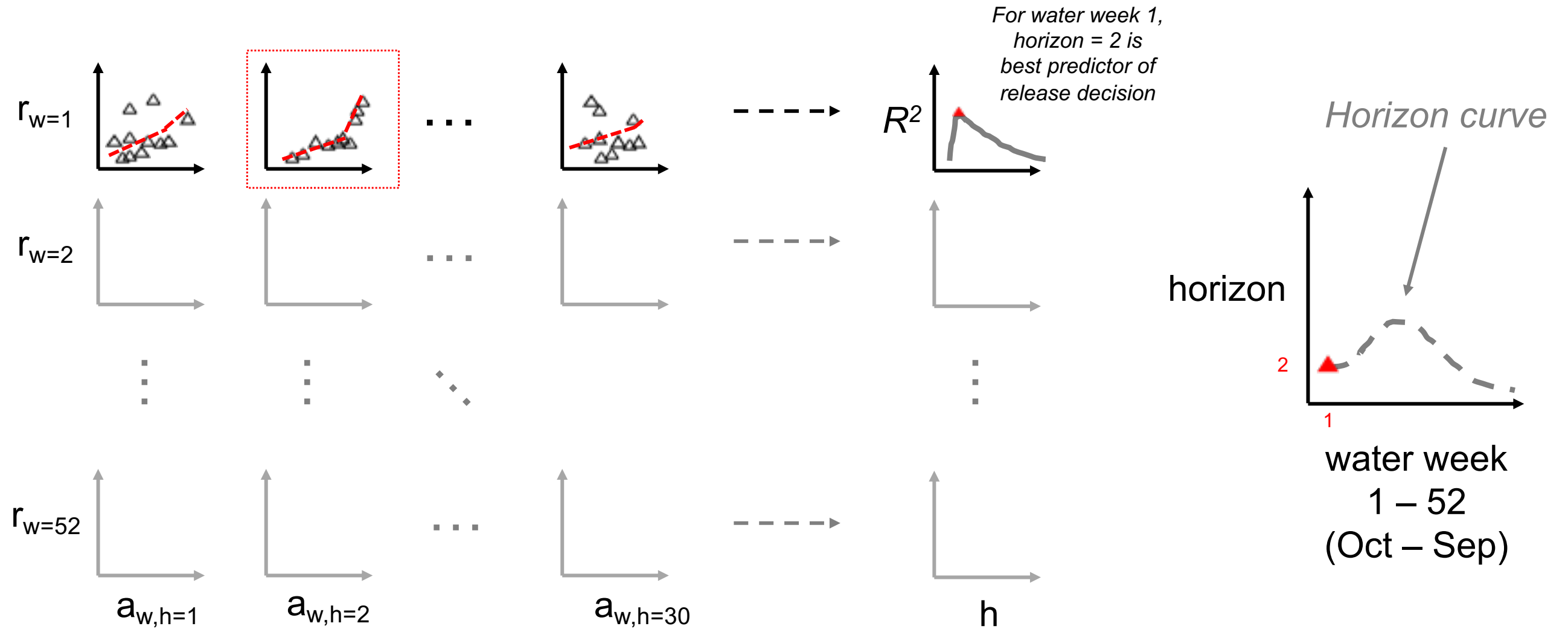
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Lack of a **scheme to integrate forecast-guided operations** into a large-scale hydrological.

*Can we use observational records of **storage**, **inflow**, and **release** to **infer** both the **seasonally-varying use of forecasts** and associated **operating policies** for a large sample of reservoirs?*

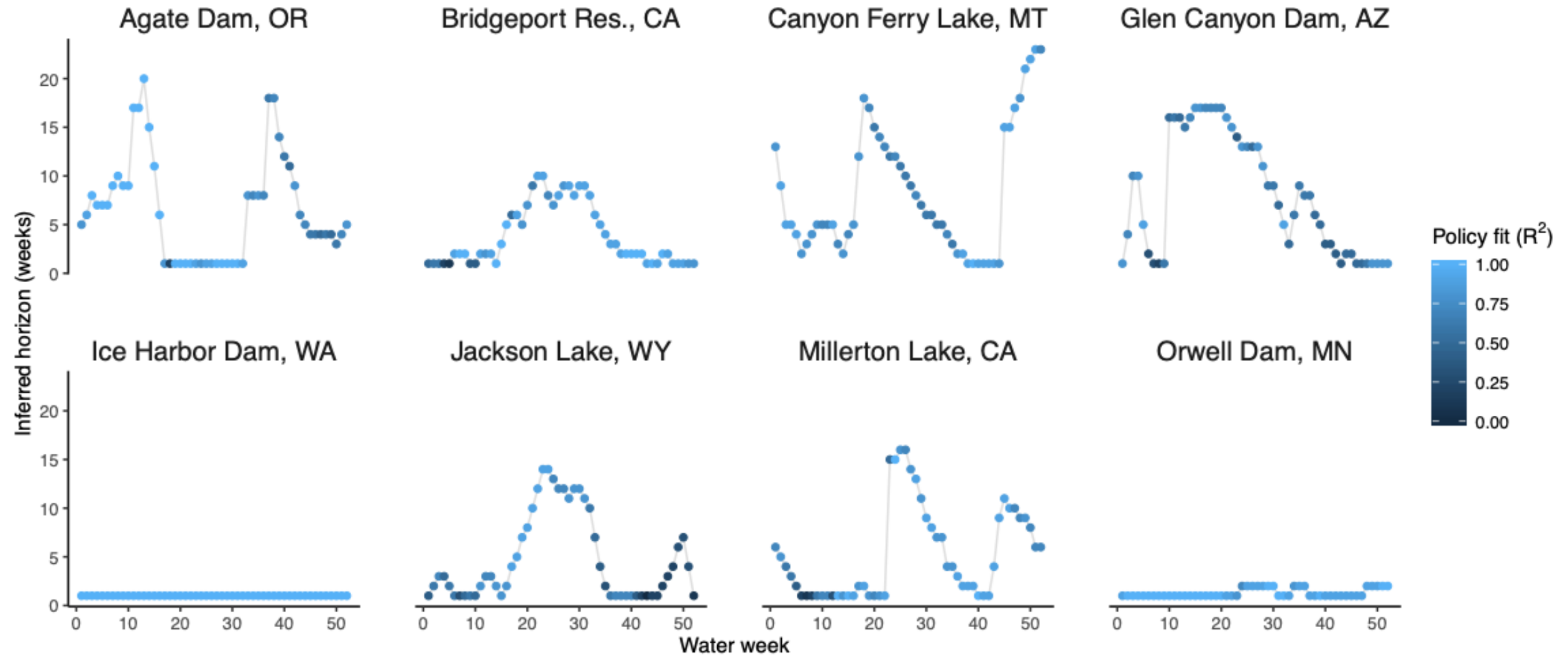
# The “horizon curve”



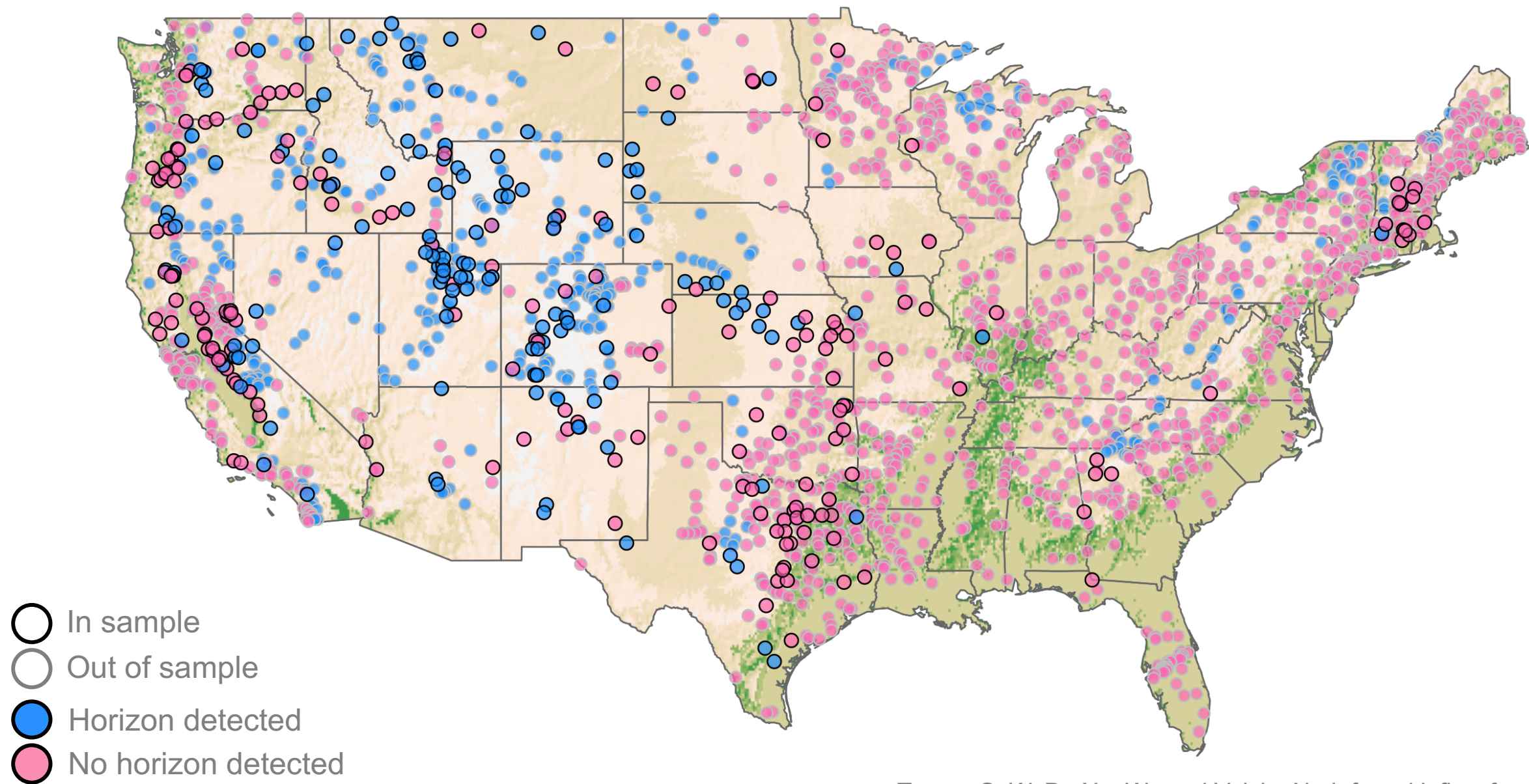
Increasing forecast lead time

Turner, S. W. D., Xu, W., and Voisin, N.: Inferred inflow forecast horizons guiding reservoir release decisions across the United States, *Hydrol. Earth Syst. Sci.*, 24, 1275–1291, 2020.

# Examples of horizon curves

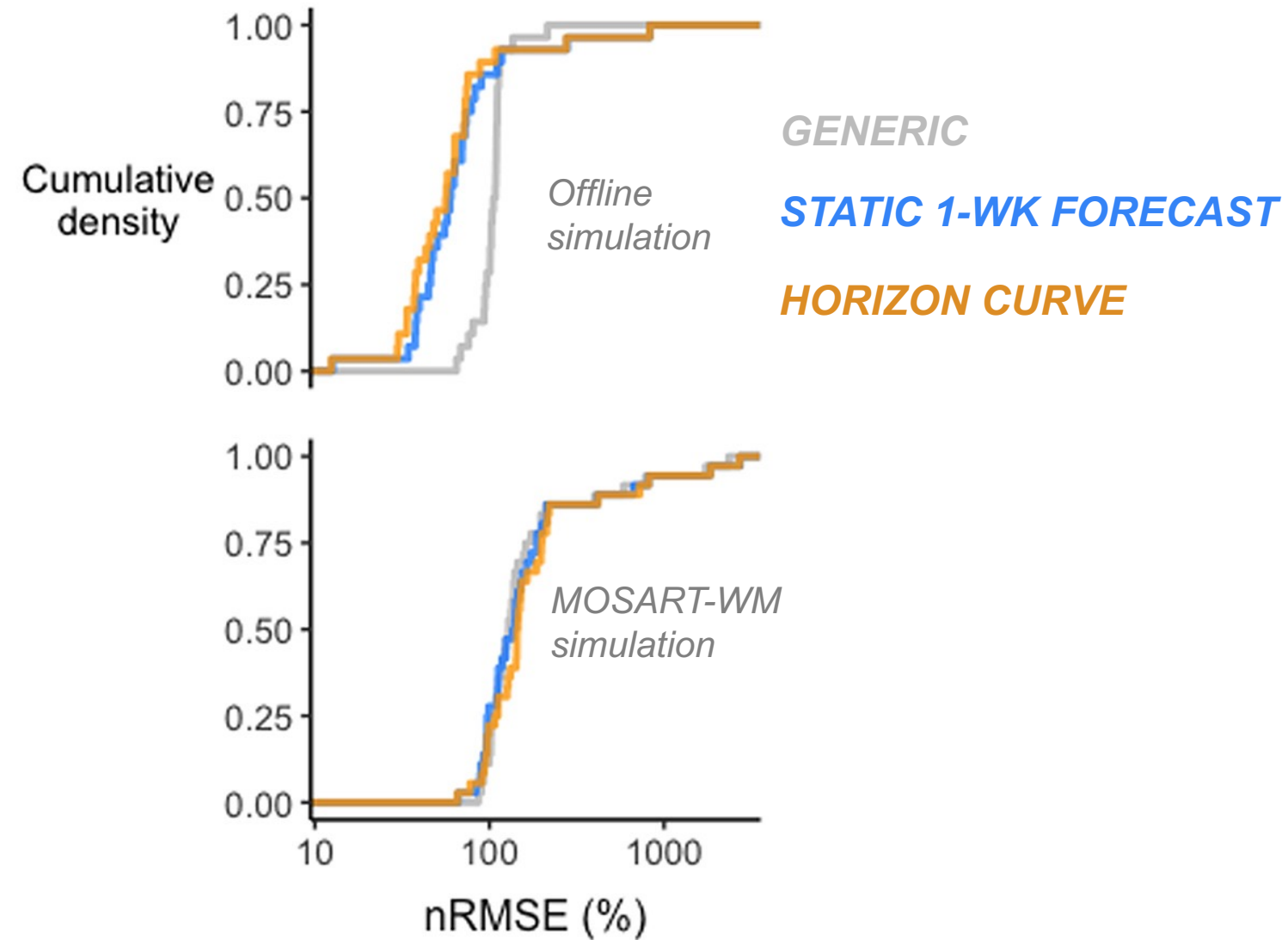
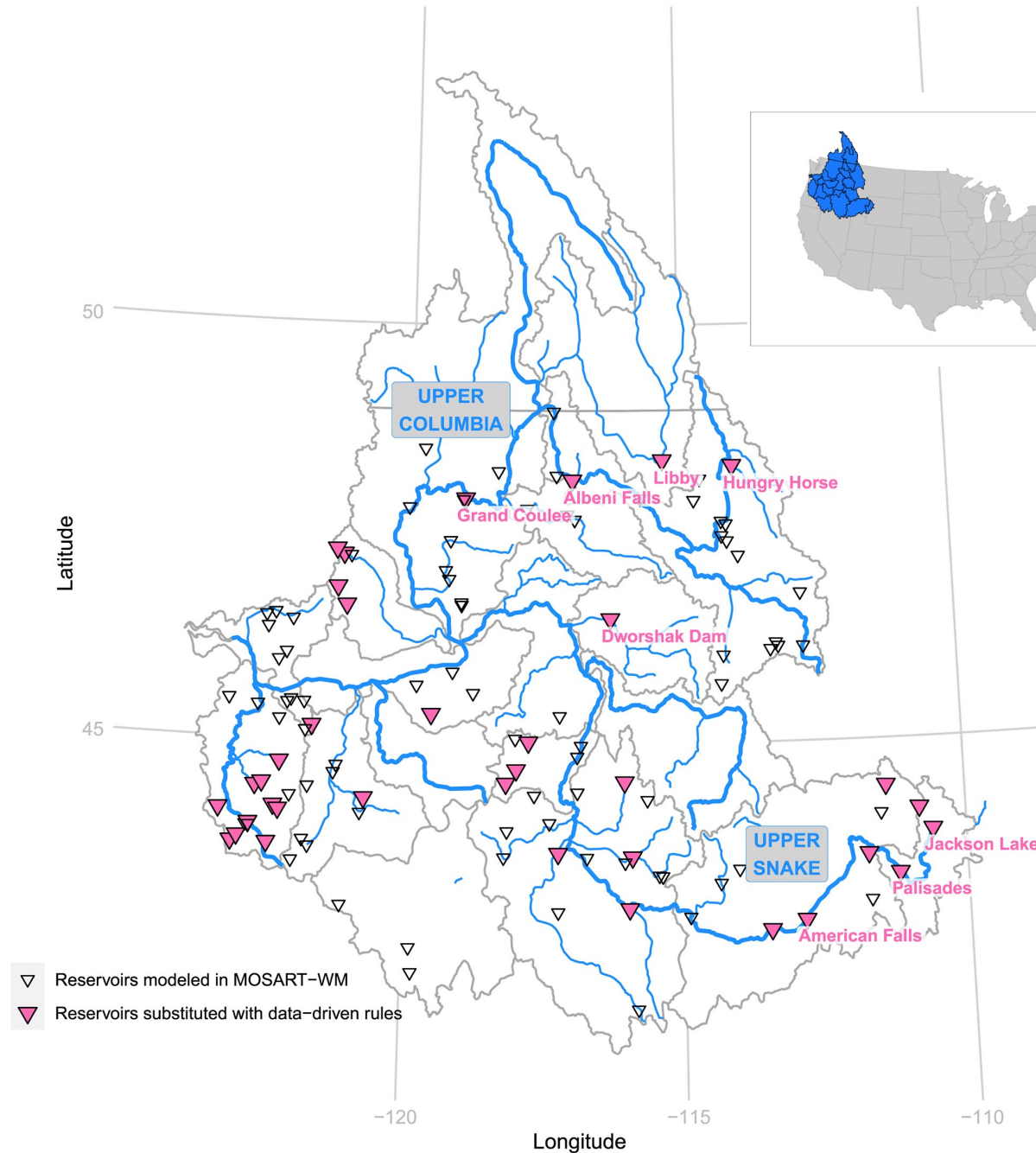


# Forecast use is detected in high-elevation reservoirs with large storage to inflow ratio



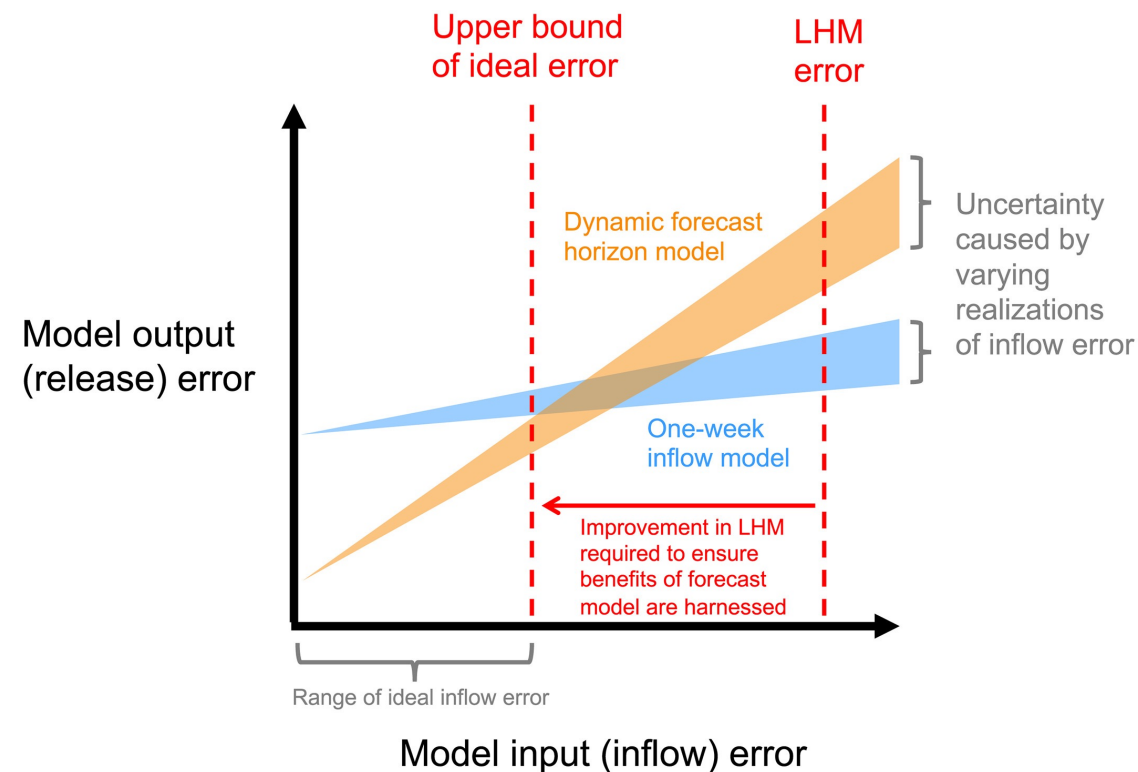
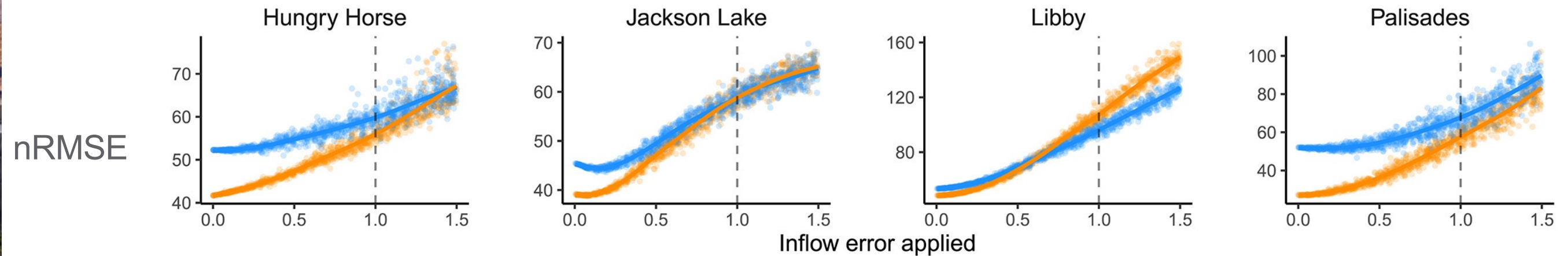
Turner, S. W. D., Xu, W., and Voisin, N.: Inferred inflow forecast horizons guiding reservoir release decisions across the United States, *Hydrol. Earth Syst. Sci.*, 24, 1275–1291, 2020.

# Horizon curve improves simulation... but only in “offline mode”



Turner, S. W. D., Doering, K., & Voisin, N. (2020). Data-driven reservoir simulation in a large-scale hydrological and water resource model. *Water Resources Research*, 56, e2020WR027902.

# Forecast model performance is **sensitive to inflow bias**



## STATIC 1-WK FORECAST HORIZON CURVE

Turner, S. W. D., Doering, K., & Voisin, N. (2020). Data-driven reservoir simulation in a large-scale hydrological and water resource model. *Water Resources Research*, 56, e2020WR027902.

# Summary

- Medium to long-range **flow forecasts matter**
  - Reservoir operators use them
  - Affect release and storage; enhance benefits of dam
- **Forecast use can be detected and modeled** with a horizon curve
  - Requires reasonable length reservoir release / storage records
  - Detects snowpack driven forecast of Western U.S.
- **Flow bias limits prospects** for use of horizon curves in large-scale hydrological models