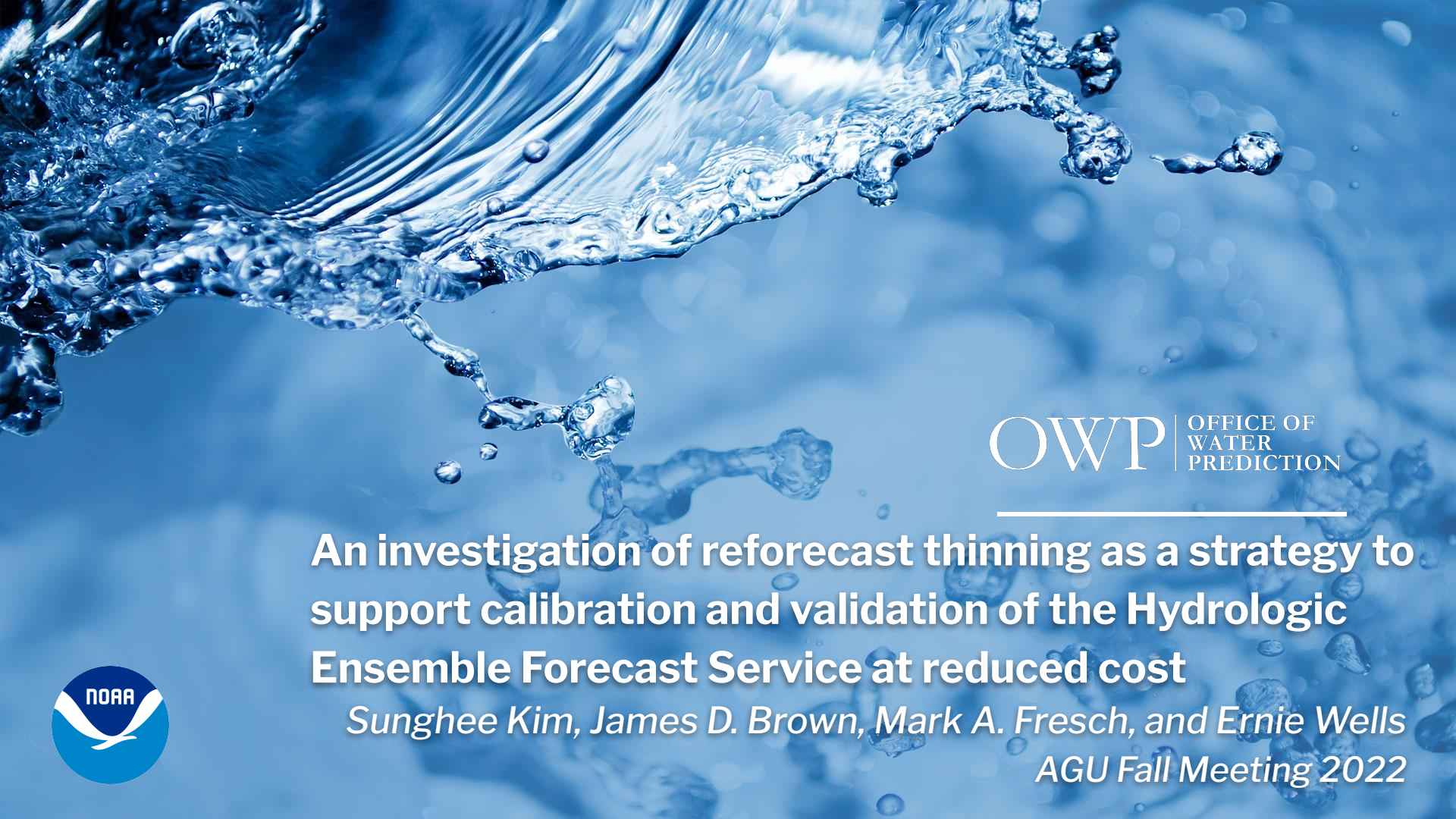

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An investigation of reforecast thinning as a strategy to support calibration and validation of the Hydrologic Ensemble Forecast Service at reduced cost

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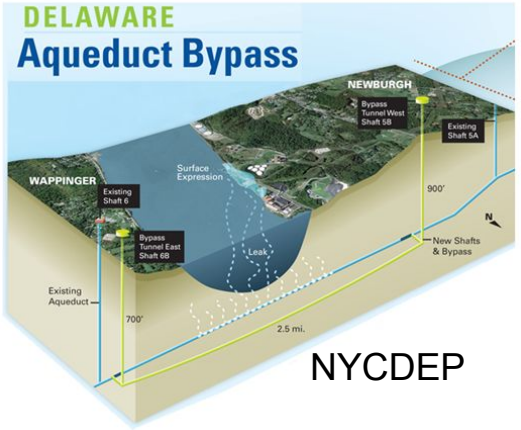
AGU Fall Meeting 2022

Hydrologic Ensemble Forecast Service (HEFS)

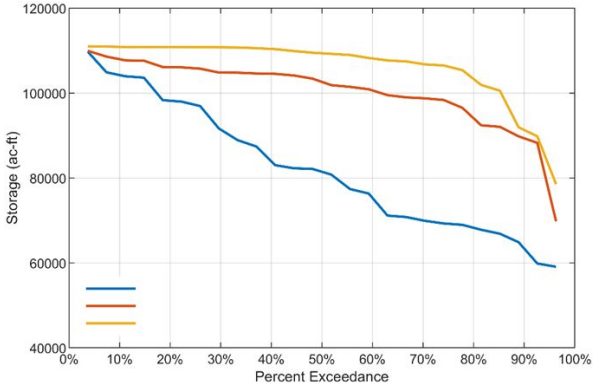
- Hydrologic ensemble forecasts for short- to long-range and are available at nearly all US NWS forecast streamflow locations
- Important and growing number of end-users, such as:
  - NYC Dept. of Env. Protection (NYCDEP)
  - Lake Mendocino Forecast Informed Reservoir Operations (FIRO)

Learn more: https://youtu.be/-gNdEVRoXtU



NYCDEP

Lake Mendocino FIRO



Objectives of the thinning study

Can reforecasts be "thinned", i.e. reduced in number, without negatively impacting HEFS?

1) Assess impacts of thinning on HEFS calibration

- The HEFS is a statistical weather generator
- It is calibrated with a "large sample" of reforecasts
- Does thinning harm forecast quality via calibration?

2) Assess impacts of thinning on HEFS validation

- Validation guides HEFS investments and users
- Validation statistics are sample estimates
- Does thinning harm validation via sampling bias/uncertainty?

Experiment Design

Two thinning methods developed by:

- University of Wisconsin, at Milwaukee (UWM method)
- NOAA's Physical Sciences Laboratory (PSL method)

Validated precipitation and streamflow

Quantified sampling uncertainty of validation metrics

Cross-validation designed to mimic HEFS operations

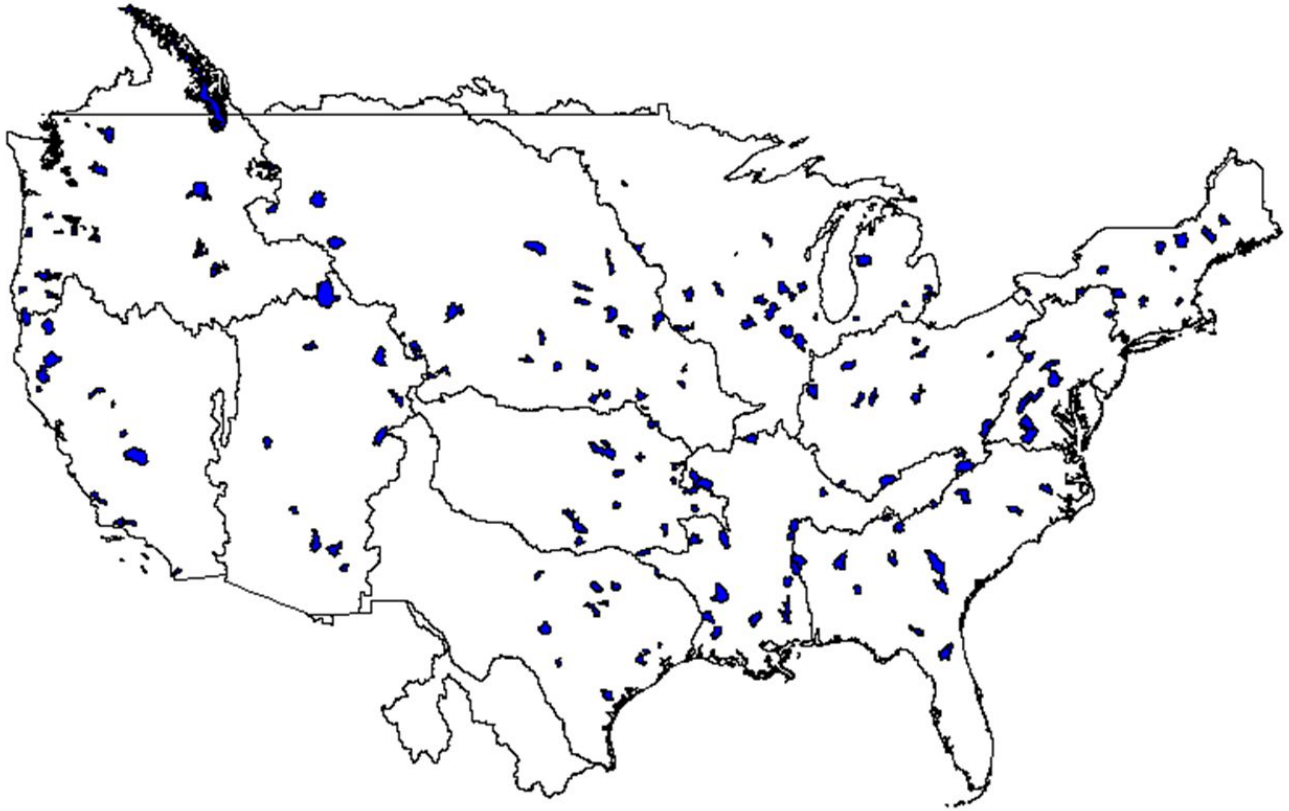
- 20-yr validation (2000-2019) set was divided into two 10-yr periods

Experiment basins (in blue)

within the U.S. River Forecast Centers boundaries

- Validation used 150 representative basins

- PSL and UWM methods each supplied 1/5th of total issued dates, i.e. the thinning fraction is ⅕ the data



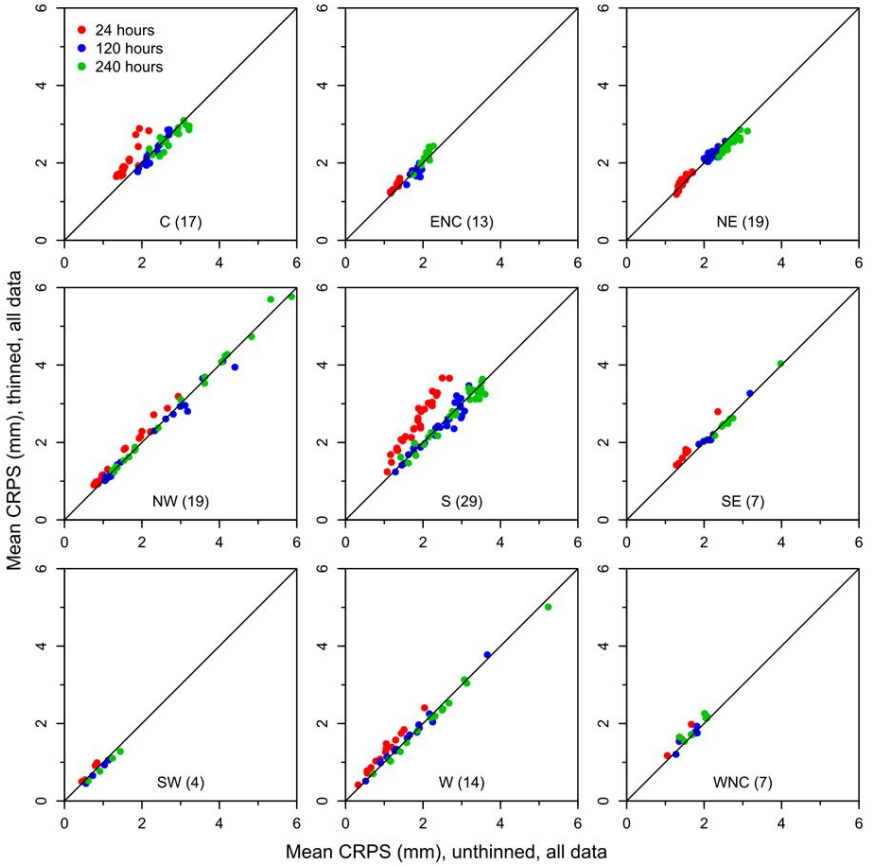
Results and analysis: precipitation, bias

For brevity, only a small sample of results are presented both for the UWM method only (similar story for both)

CRPS (ensemble equivalent of MAE) for thinned v. unthinned for nine US climate region for 24hr totals ending at three different lead-times (24, 120, and 240 hrs)

Thinned data tends to overestimate CRPS

Worst in the first day in the South (S) and Central (C) regions

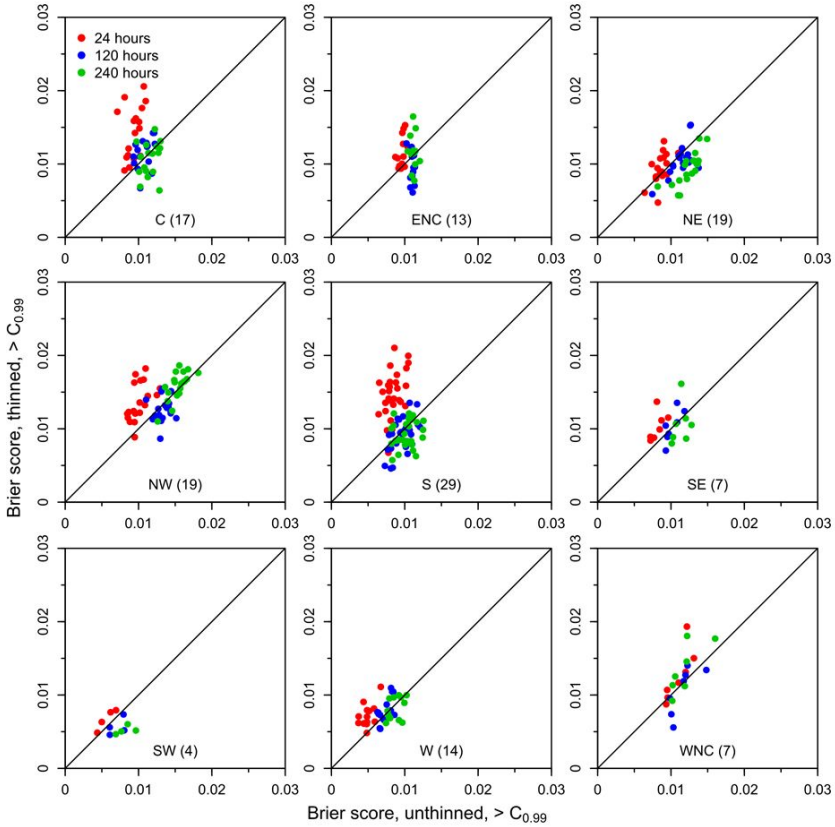


Results and analysis: precipitation, larger values

Brier Score (BS) for q0.99 by US climate region for three 24hr accumulations

Thinned data tends to overestimate BS

Spread is quite substantial in most climate regions



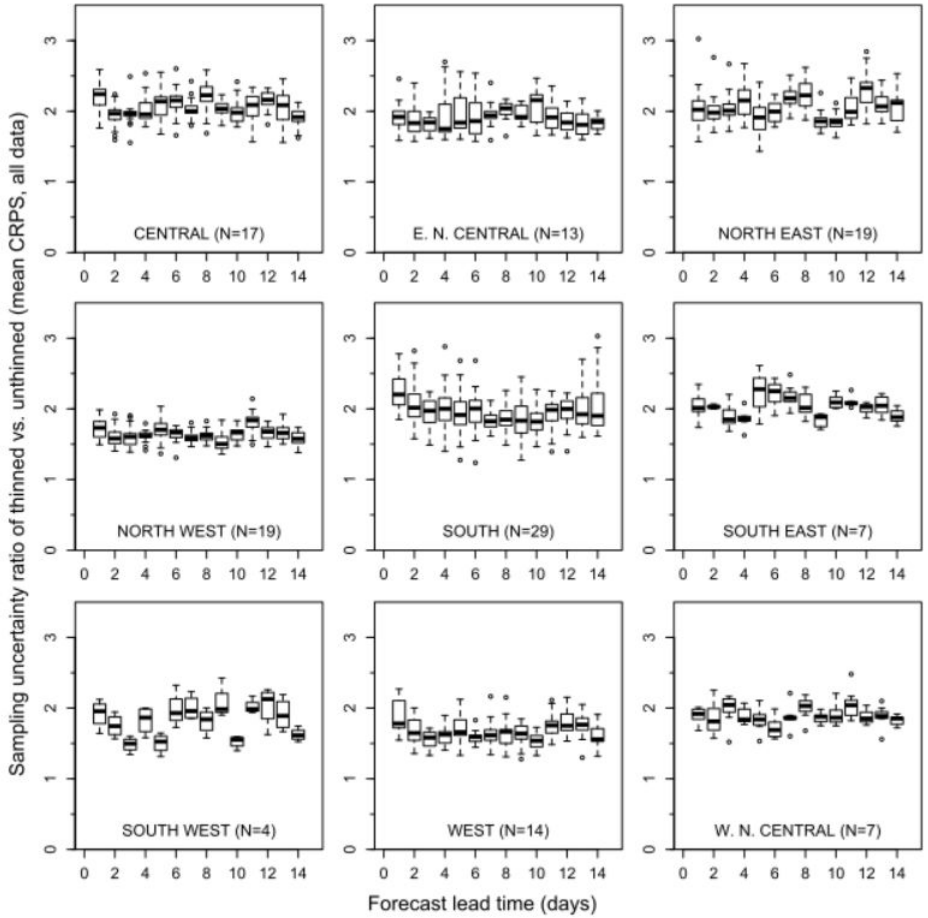
Results and analysis: precipitation, uncertainty

Ratio of the [q0.01,q0.99] interval of sampling distribution of CRPS for thinned vs. unthinned

Above 1 means more sampling uncertainty (2 means 2x more)

Each box summarizes basins in a climate region

A 5x thinning fraction adds about 2-3x more sampling uncertainty



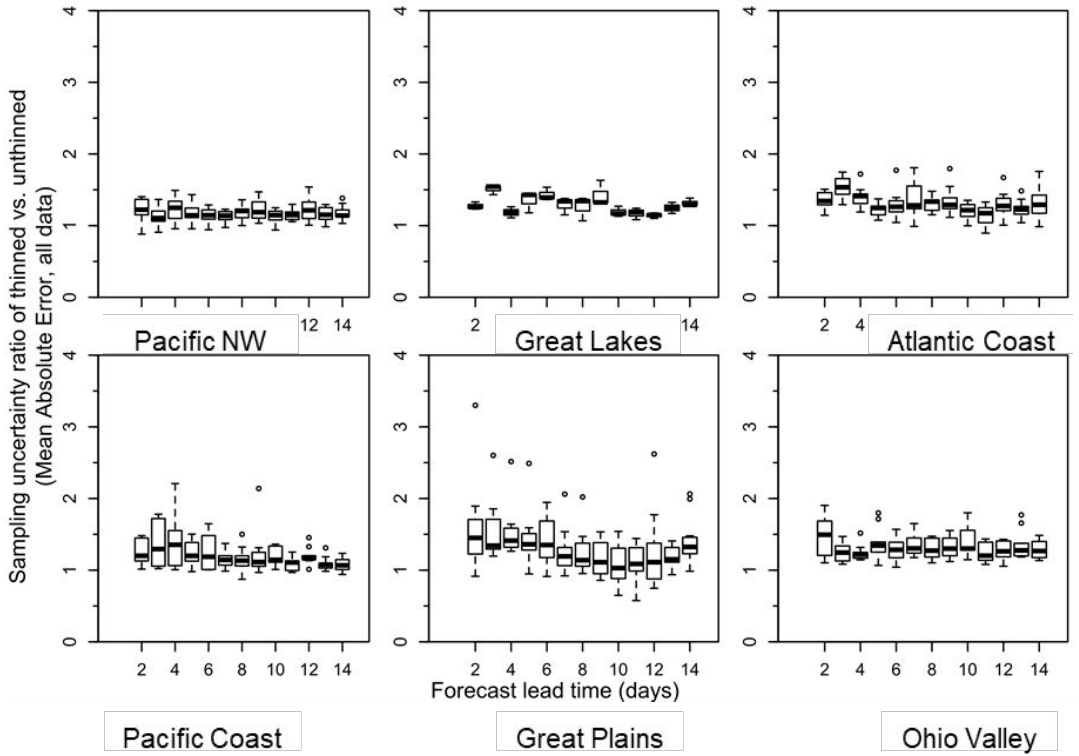
Results and analysis: streamflow, uncertainty

Ratio of the [q0.01,q0.99] interval of sampling distribution of CRPS for thinned vs. unthinned for days 0-15

Above 1 means more sampling uncertainty (2 means 2x more)

Each box summarizes (combines?) basins in different hydro regions

Conclusion: 5x thinning method about 50% more sampling uncertainty



Conclusions

The pessimistic case for thinning:

- Thinning can greatly increase validation sampling uncertainty
- Thinning can introduce significant biases
- Tends to be worse for early lead times and high thresholds

The optimistic case for thinning:

- Streamflow is less sensitive to thinning than precipitation
- The sampling uncertainty ratio points to some data redundancy

Thank You!

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NOAA

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Extra Slides

Topics

- **The Hydrologic Ensemble Forecast Service (HEFS)**
- **Objectives of the thinning study in relation to HEFS**
- **Experimental design**
- **Results and analysis**
- **Conclusions**

Experiment Design

Two-fold cross-validation design

Period of record: 2000-2019, with a daily reforecast

PSL and UWM thinning methods supplied 1/5th of total issued dates

Repeat for the thinned dates and unthinned dates:

Fold 1: calibrate MEFP 2000-2009, forecast 2010-2019

Fold 2: calibrate MEFP 2010-2019, forecast 2000-2009

Combine the forecasts from **Fold 1** and **Fold 2** for validation