Selection and Use of Model Evaluation Metrics of Multi-decadal Hydrological Simulations to Support Operational Hydrological Forecasting

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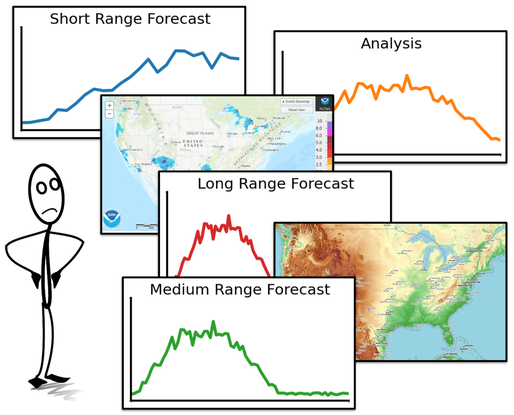
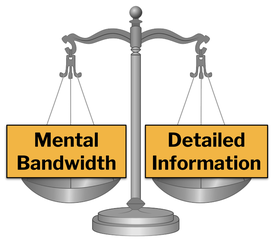
HOW ACCURATE IS THIS MODEL?



National Water Center (NWC) operations, guidance, and flood inundation products are primarily based on output from the National Water Model (NWM), but how accurate is model output?

THE METRICS CHALLENGE



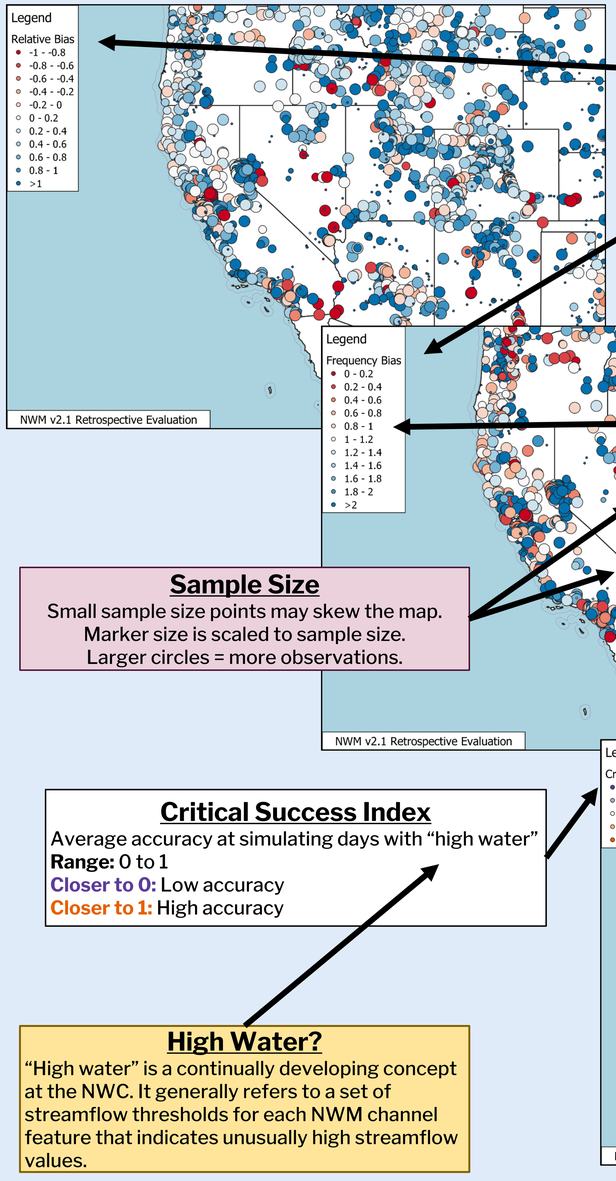
Model evaluation metrics offer a summary of the model's accuracy compared to a benchmark (typically observations). No single metric offers a full picture of the model, so we use multiple metrics. However, too many metrics or a redundant combination of metrics can be misleading or hard to understand.

KEEP IT SIMPLE

Magnitude | Frequency | Average Accuracy

Feedback from forecasters indicated particular interest in three aspects of model evaluation: streamflow magnitude, flood frequency, and average accuracy. We focused on relative bias, frequency bias, and critical success index of simulated daily maximum streamflow.

GENERALIZING CONTINENTAL SCALE MODEL PERFORMANCE (OR NOT?)



Relative Bias
Tendency to over or under simulate streamflow magnitude
Range: -1 to infinity
Values < 0: under-simulation ("dry" tendency)
Values > 0: over-simulation ("wet" tendency)

Frequency Bias
Frequency of simulated "high water" days compared to observed
Range: 0 to infinity
Values < 1: Model simulated fewer "high water" days than observed
Values > 1: Model simulated more "high water" days than observed

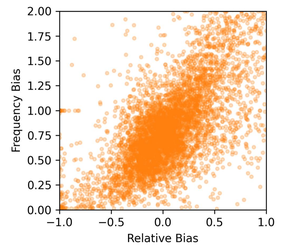
Color Ramps
Values are distinguishable based on diametrically opposed colors.

Sample Size
Small sample size points may skew the map.
Marker size is scaled to sample size.
Larger circles = more observations.

Critical Success Index
Average accuracy at simulating days with "high water"
Range: 0 to 1
Closer to 0: Low accuracy
Closer to 1: High accuracy

High Water?
"High water" is a continually developing concept at the NWC. It generally refers to a set of streamflow thresholds for each NWM channel feature that indicates unusually high streamflow values.

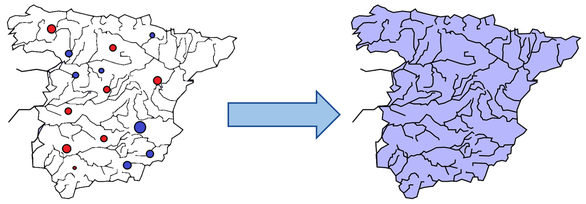
AREN'T THESE ALL JUST BIAS?



The metrics presented here can be highly correlated. Future work will focus on diversifying metrics to support operational flood guidance and working with forecasters to create more informative and detailed evaluations.

WHAT'S NEXT?

Can we spatially average metrics? Should we?



NWC hydrologic guidance products are based on hydrologic units (watersheds). Evaluations are based at streamflow gage locations. Forecasters have expressed interest in evaluation results summarized by watershed. However, spatial aggregation of evaluation metrics requires further research due to heterogeneity and nonuniform gage coverage.

REFERENCES

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2. Cosgrove, Brian, David Gochis, Trey Flowers, Aubrey Dugger, Fred Ogden, Tom Graziano, Ed Clark et al. "NOAA's National Water Model: Advancing operational hydrology through continental-scale modeling." JAWRA Journal of the American Water Resources Association (2024).

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DATASETS:
1. NOAA National Water Model CONUS Retrospective Dataset—Registry of Open Data on AWS, accessed 28 Nov 2023, https://registry.opendata.aws/nwm-archive/.
2. U.S. Geological Survey, 2016, National Water Information System (USGS Water Data for the Nation), accessed 28 Nov 2023, http://waterdata.usgs.gov/nwis/.

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