Advancing streamflow prediction using hydrological multimodel ensemble forecasting system

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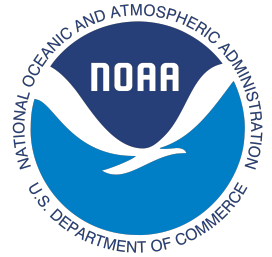
August, 2023



9th NOAA Ensemble Users Workshop

Three key points

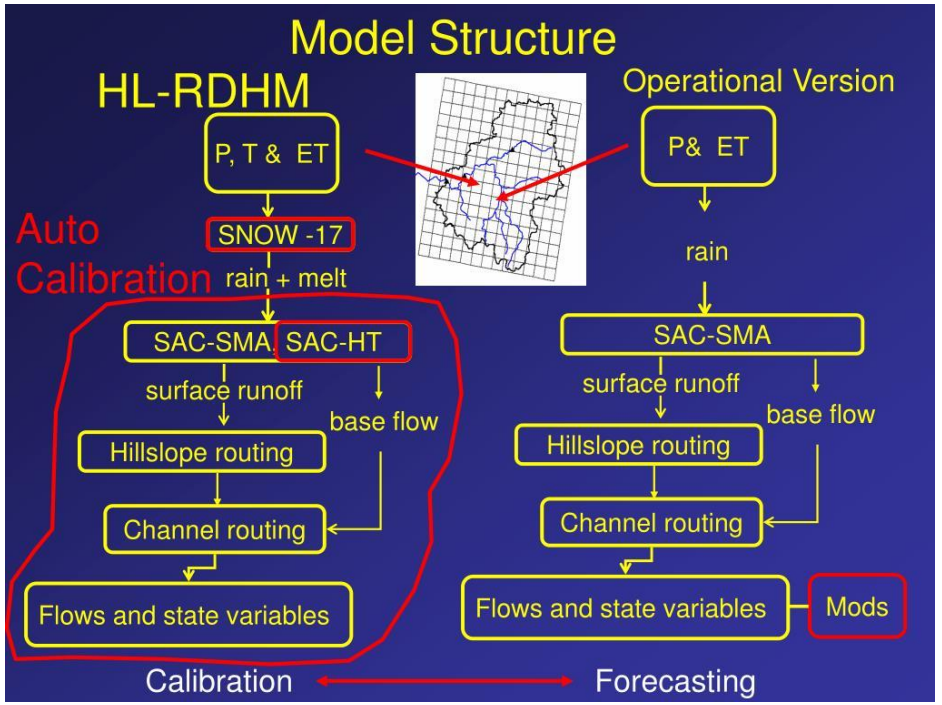
i) We demonstrate a regional hydrologic multimodel ensemble prediction system.

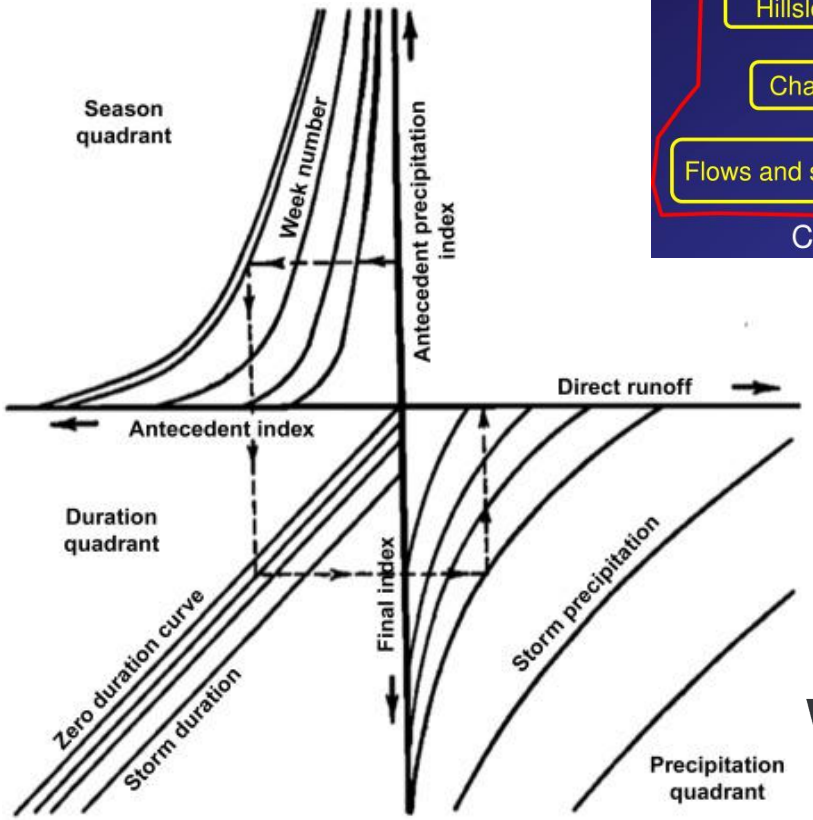
ii) Multimodel ensemble forecasts have higher skill than single model forecasts.

iii) Hydrologic model diversity enhances forecast skill more than increasing ensemble size alone.

- Many hydrological models with no clear advantage of one model over another
- Challenging to choose a single model for all flow conditions

Is a hydrological multimodel system useful for improving streamflow forecasts?





HL-RDHM:https://www.slideserve.com/september-aguilar/overview-of-nws-distributed-model-hl-rdhm

API-CONT:http://www.nws.noaa.gov/oh/hrl/nwsrfs/users_manual/part2/_pdf/23apislc.pdf

WRF-Hydro:https://ral.ucar.edu/solutions/products/wrf-hydro-modeling-system

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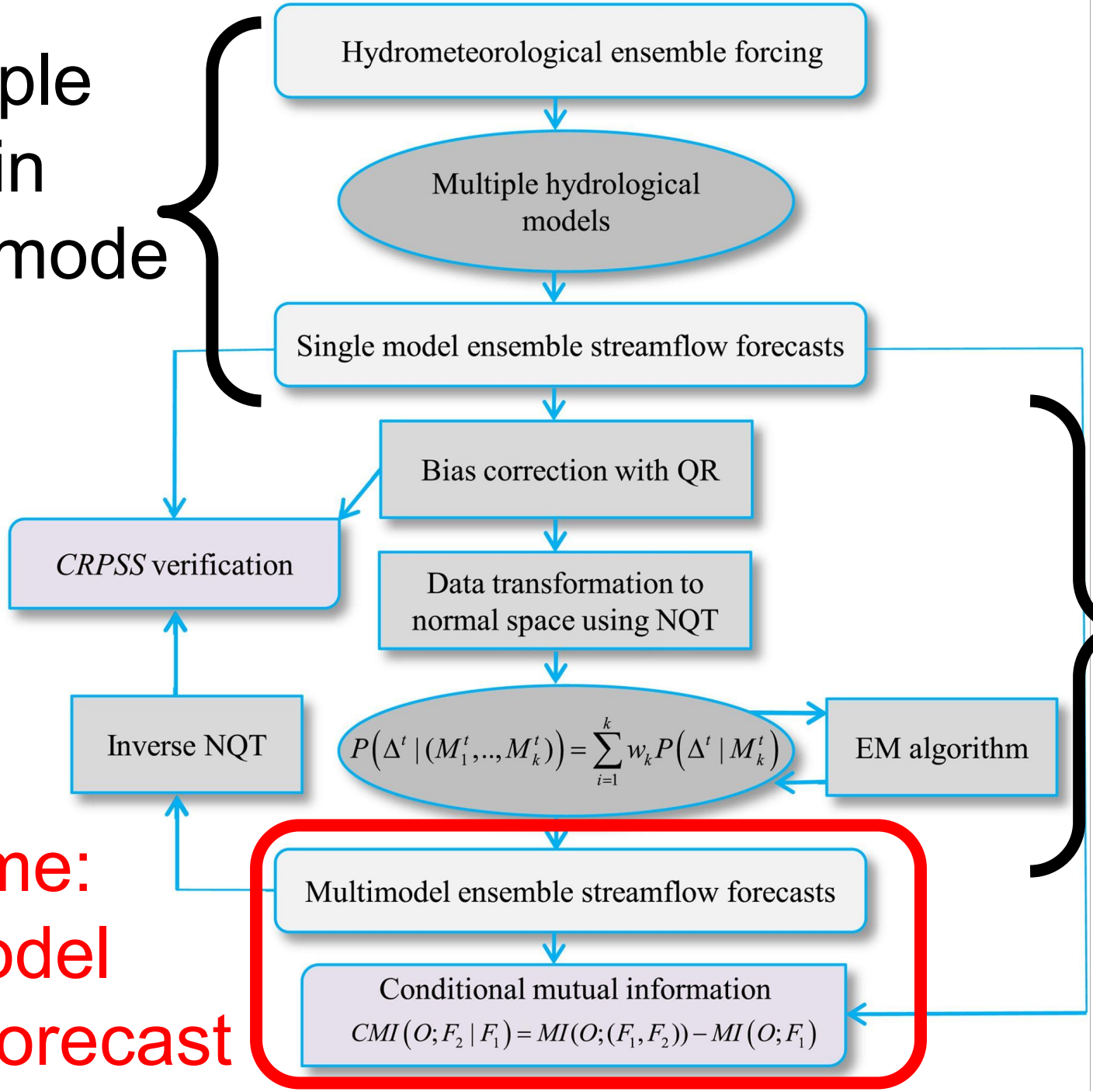
We assemble, implement and verify a regional **H**ydrologic **M**ultimodel **E**nsemble **P**rediction **S**ystem [**HMEPS**]

Sharma, Sanjib, Ridwan Siddique, Seann Reed, Peter Ahnert, and Alfonso Mejia. "Hydrological model diversity enhances streamflow forecast skill at short-to medium-range timescales." *Water Resources Research* 55, no. 2 (2019): 1510-1530.

Sharma, Sanjib, Ridwan Siddique, Seann Reed, Peter Ahnert, Pablo Mendoza, and Alfonso Mejia. "Relative effects of statistical preprocessing and postprocessing on a regional hydrological ensemble prediction system." Hydrology and Earth System Sciences 22, no. 3 (2018): 1831-1849.

Run multiple models in forecasting mode



Multimodel ensemble postprocessor

Outcome: Multimodel ensemble forecast

We consider diverse set of hydrologic models

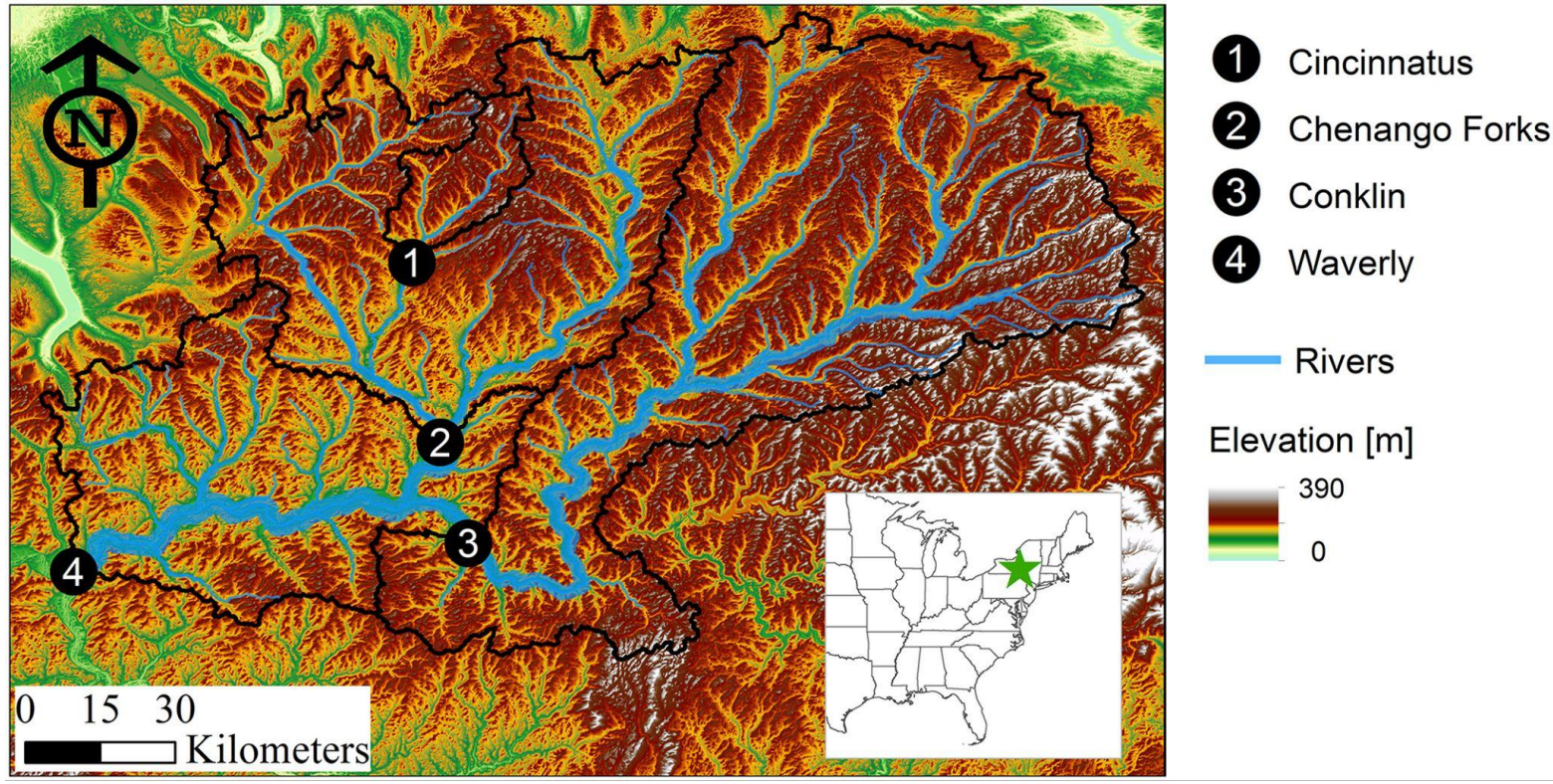
i) HL-RDHM **(<u>distributed, conceptual</u>)**
- 2 x 2 km^2 resolution

ii) Continuous API **(<u>lumped, conceptual</u>)**
- Operational forecasts from NOAA's MARFC

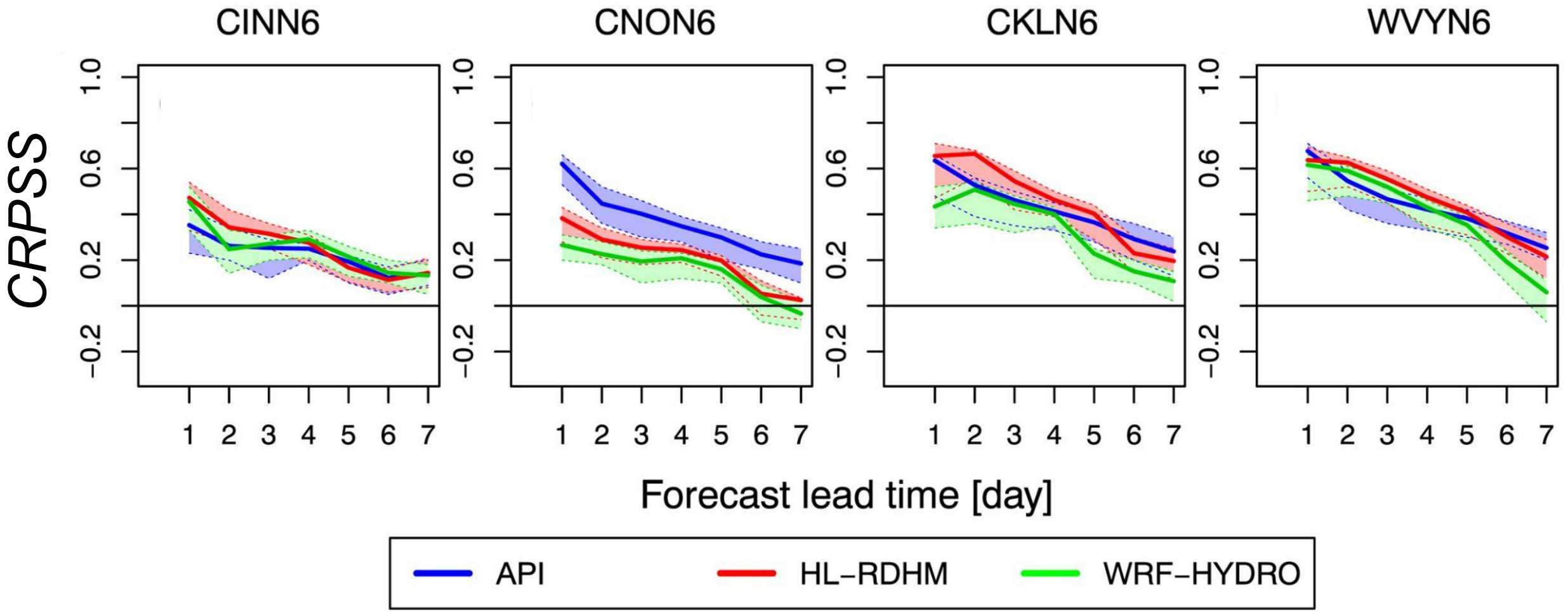
iii) WRF-Hydro **(<u>distributed, land surface</u>)**
- Employs land surface model NoahMP
- Gridded wave diffusion routing
- 1 x 1 km^2 resolution

Forecasting experiment is conducted in four nested subbasins in the mid-Atlantic region

- GEFSRv2 (2004-2009) is used as weather forcing.
- We employ quantile regression-Bayesian model averaging (QR-BMA) as multimodel ensemble postprocessor.
- Verification is performed conditioned on forecast lead times (1-7 days) & basin size.



There is no single predictive system that can be considered best in all forecasting conditions



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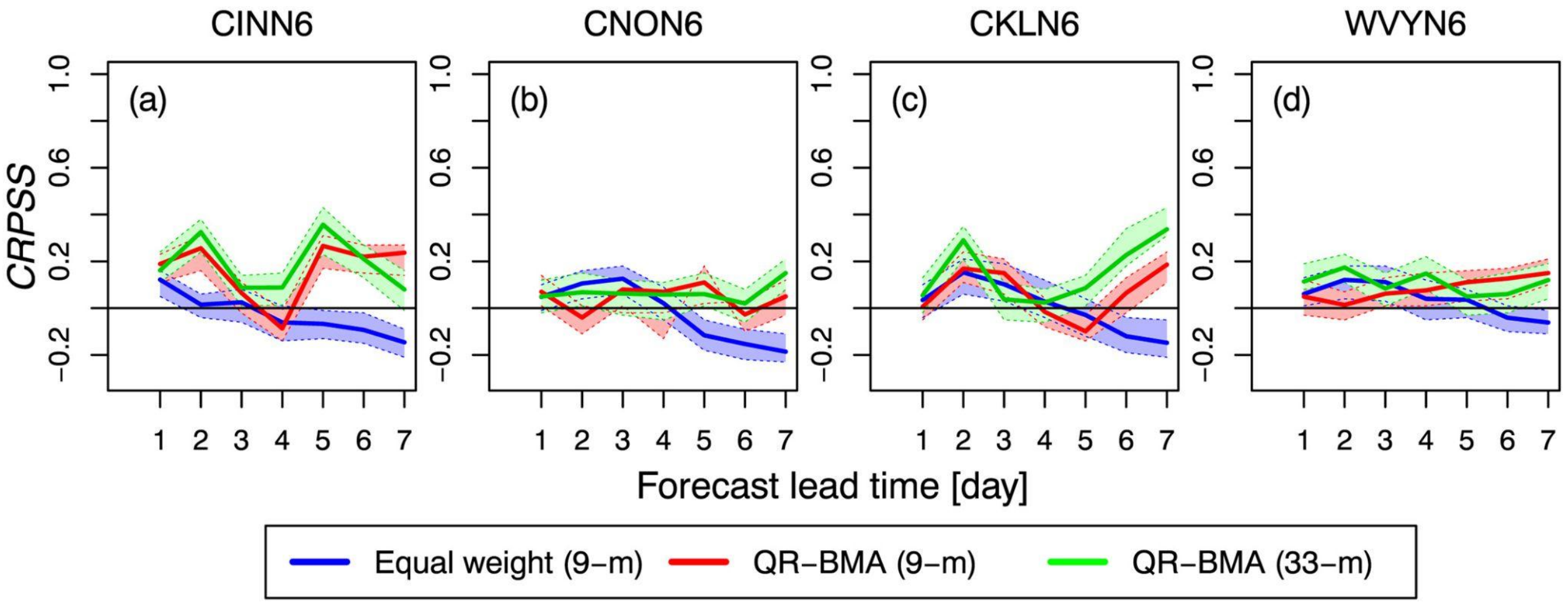
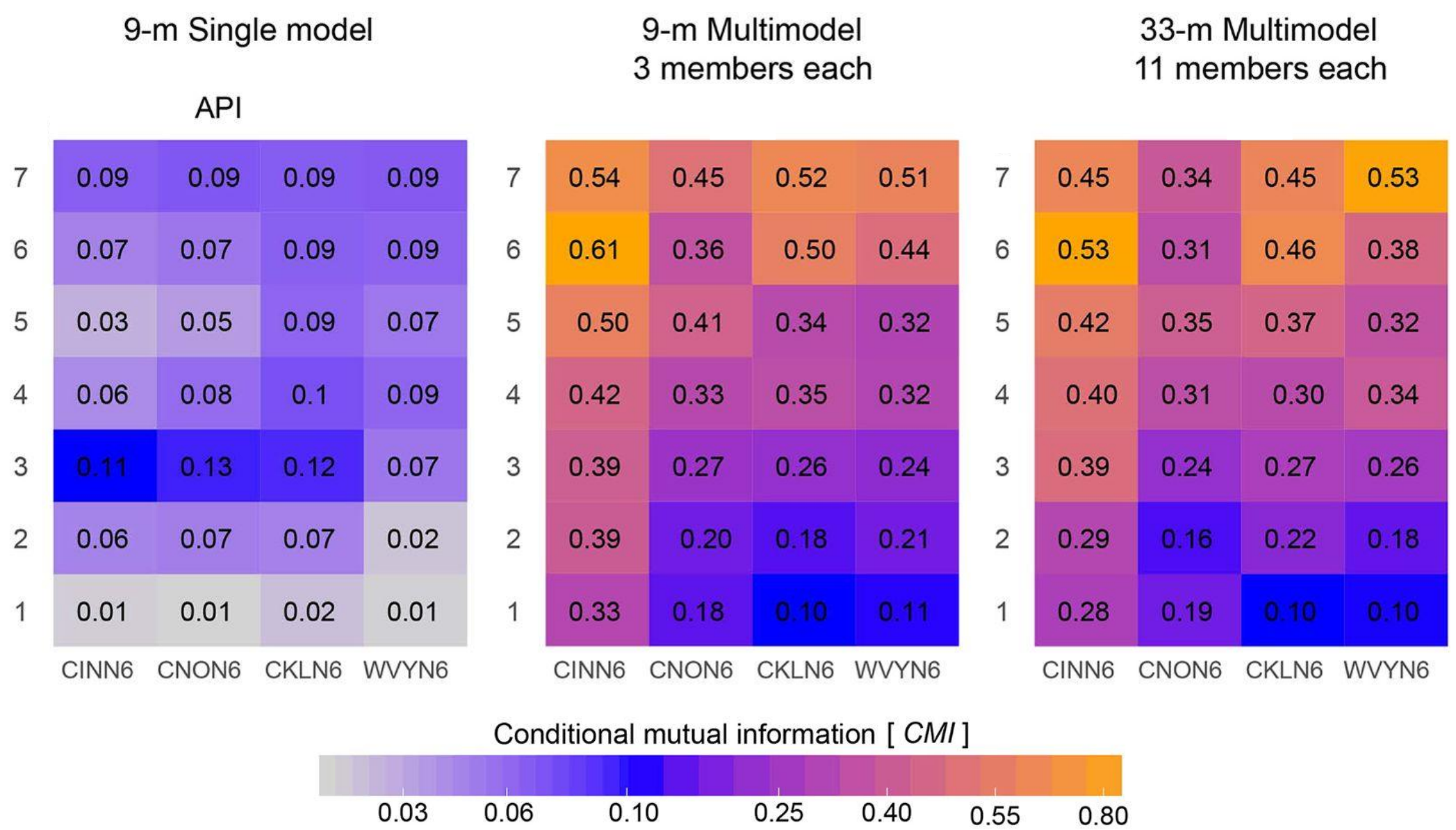
Multimodel prediction improves forecast skill over single model



Are any skill improvements from the multimodel ensemble forecasts dominated by model diversity or the addition of new ensemble members?

Model diversity enhances forecast skill more than ensemble size alone



Ongoing works and future plans…

i) How can we enhance the predictability of extreme events?

ii) How can we effectively incorporate and analyze additional uncertainties, considering their potential interactions?

iii) What insights can be gained from emerging data-model fusion strategies, such as combining AI/ML and DA?

iv) What are the robust strategies for flood-risk management?

Thank you!

Looking forward to the discussion

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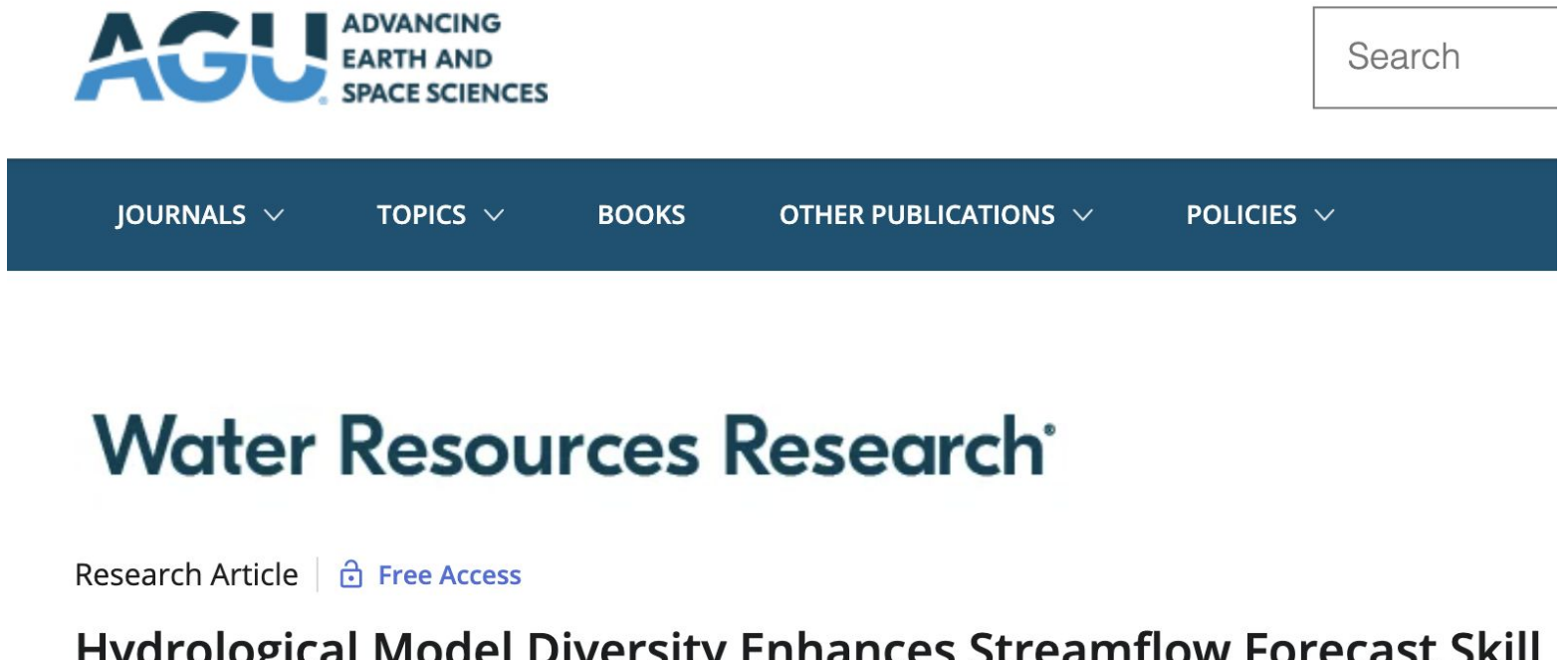

We acknowledge the funding support provided by the NOAA/NWS through Award NA14NWS4680012 and the computational support provided by the Institute for CyberScience at The Pennsylvania State University.