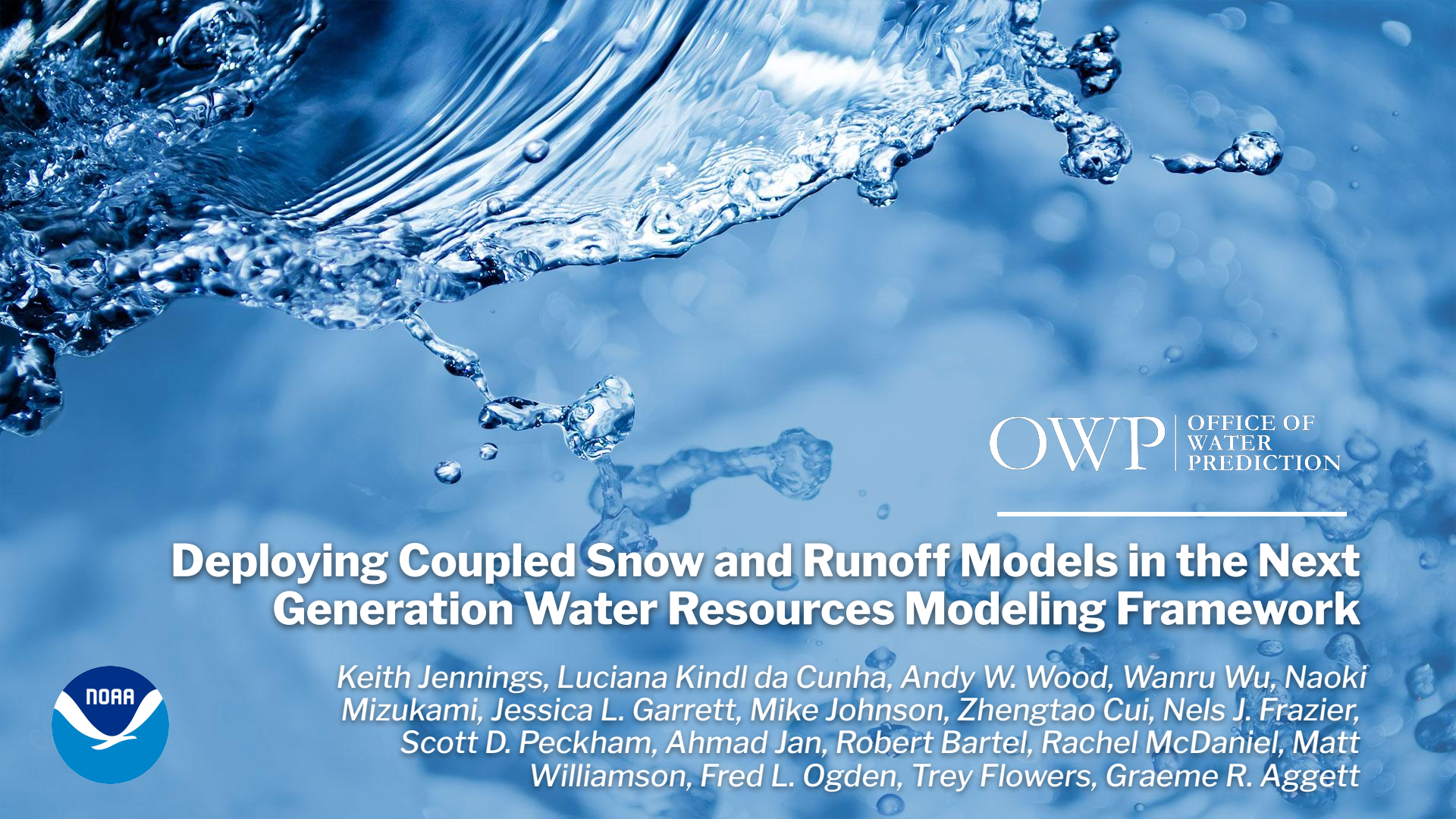


OWP | OFFICE OF WATER PREDICTION

Deploying Coupled Snow and Runoff Models in the Next Generation Water Resources Modeling Framework

Keith Jennings, Luciana Kindl da Cunha, Andy W. Wood, Wanru Wu, Naoki Mizukami, Jessica L. Garrett, Mike Johnson, Zhengtao Cui, Nels J. Frazier, Scott D. Peckham, Ahmad Jan, Robert Bartel, Rachel McDaniel, Matt Williamson, Fred L. Ogden, Trey Flowers, Graeme R. Aggett

Evaluation of forest snow processes models (SnowMIP2)

Nick Rutter,[1] Richard Essery,[2] John Pomeroy,[3] Nuria Altimir,[4] Kostas Andreadis,[5]

The Representation of Snow in Land Surface Schemes: Results from PILPS 2(d)

A. G. Slater,[a,c] C. A. Schlosser,[b] C. E. Desborough,[c] A. J. Pitman,[c] A. Henderson-Sellers,[d]

A comparison of 1701 snow models using observations

Richard Essery[a,*], Samuel Morin[b], Yves Lejeune[b], Cécile B Ménard[c]

Surface-subsurface model intercomparison: A first set of benchmark results to diagnose integrated hydrology and feedbacks

Reed M. Maxwell[1], Mario Putti[2], Steven Meyerhoff[1], Jens-Olaf Delfs[3,4], Ian M. Ferguson[1,5],

son

and DMIP Participants [1]

Validation of the energy budget of an alpine snowpack

The Project for Intercomparison of Land-surface

phase 2(c) Red–

3. Spatial and

The integra

IH-MIP2: A

integrated hydrology and feedbacks

Stefan Kollet [1,2], Mauro Sulis [3], Reed M. Maxwell[4], Claudio Paniconi [5], Mario Putti[6],

There is no “best” model

Liang a, [1,1], Eric F. Wood a, Aaron Boone cl, Sam Chang d, Fei Chen

els for the

assessment of water resources in a data-scarce region, the Upper Blue Nile River Basin

s and validation

stem

The distributed model intercompa

(DMIP): motivation and experimen

Michael B. Smith, Dong-Jun Seo, Victor I. Koren, Seann M. Reed, Ziya Z

stin Sheffield,[4]

A Comprehensive Distributed Hydrological Modeling Intercomparison to Support Process Representation and Data Collection Strategies

Gabriele Baroni[1,2], Bernd Schalge[3], Oldrich Rakovec[2,4], Rohini Kumar[2], Lennart Schüler[2], Luis Samaniego[2], Clemens Simmer[3,5], and Sabine Attinger[1,2]

Continental Hydrologic Intercompar

1: A Large-Scale Hydrologic Model Co

Continental United States

Danielle Tijerina[1], Laura Condon[2], Katelyn FitzGerald[3], Mary Michael O'Neill[4], Kevin Sampson[3], David Gochis[3], and Reed Maxwell[1]

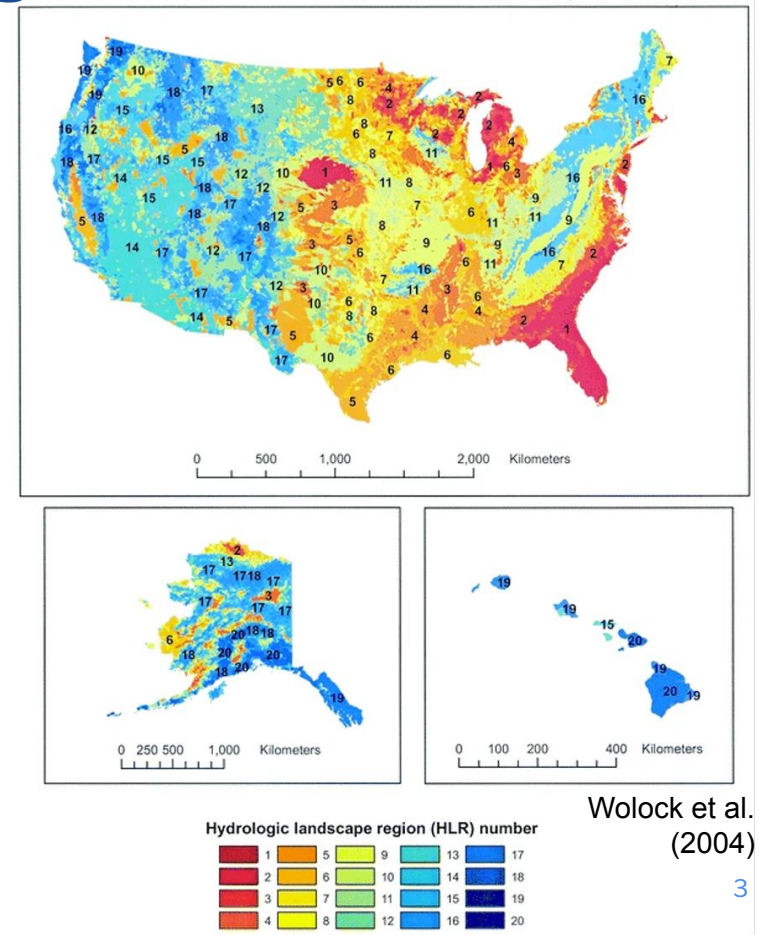
and Data

uivalent

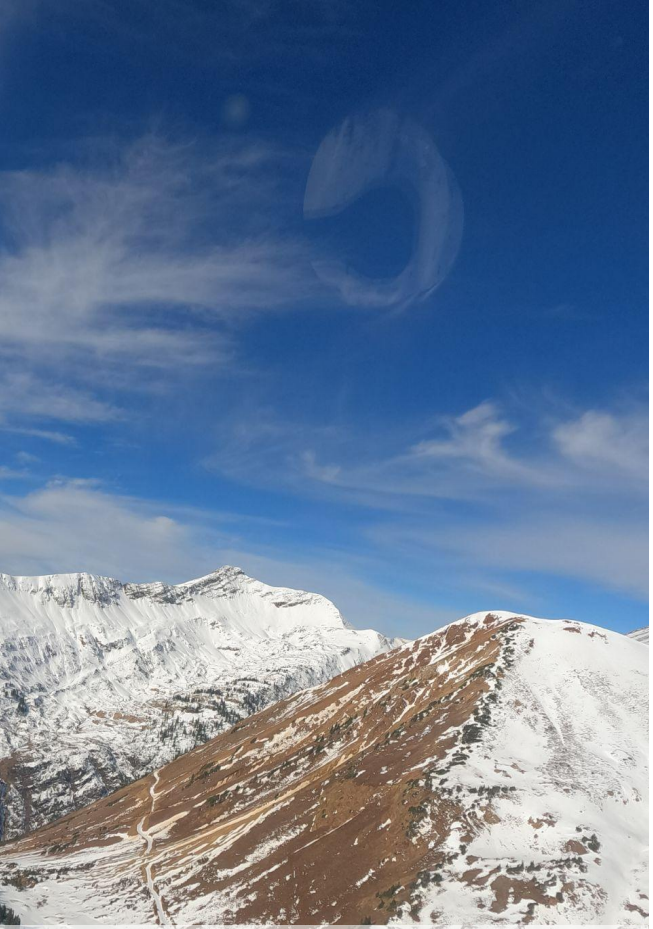
Ming Pan,[1] Justin Sheffield,[1] Eric F. Wood,[1] Kenneth E. Mitchell,[2] Paul R. Houser,[3]

But what if you have to model a large domain?

- The National Water Model (NWM) does just that
  - Forecasting framework in multiple configurations, historical reanalysis runs, 1 km gridded output for a suite of variables, streamflow forecasts at several million locations
- NWM forecast domain is hydroclimatically and physiographically diverse
  - Need for a multi-model solution



Wolock et al. (2004)



Colorado SPLASH Soil Moisture Survey, October 2021

Challenges

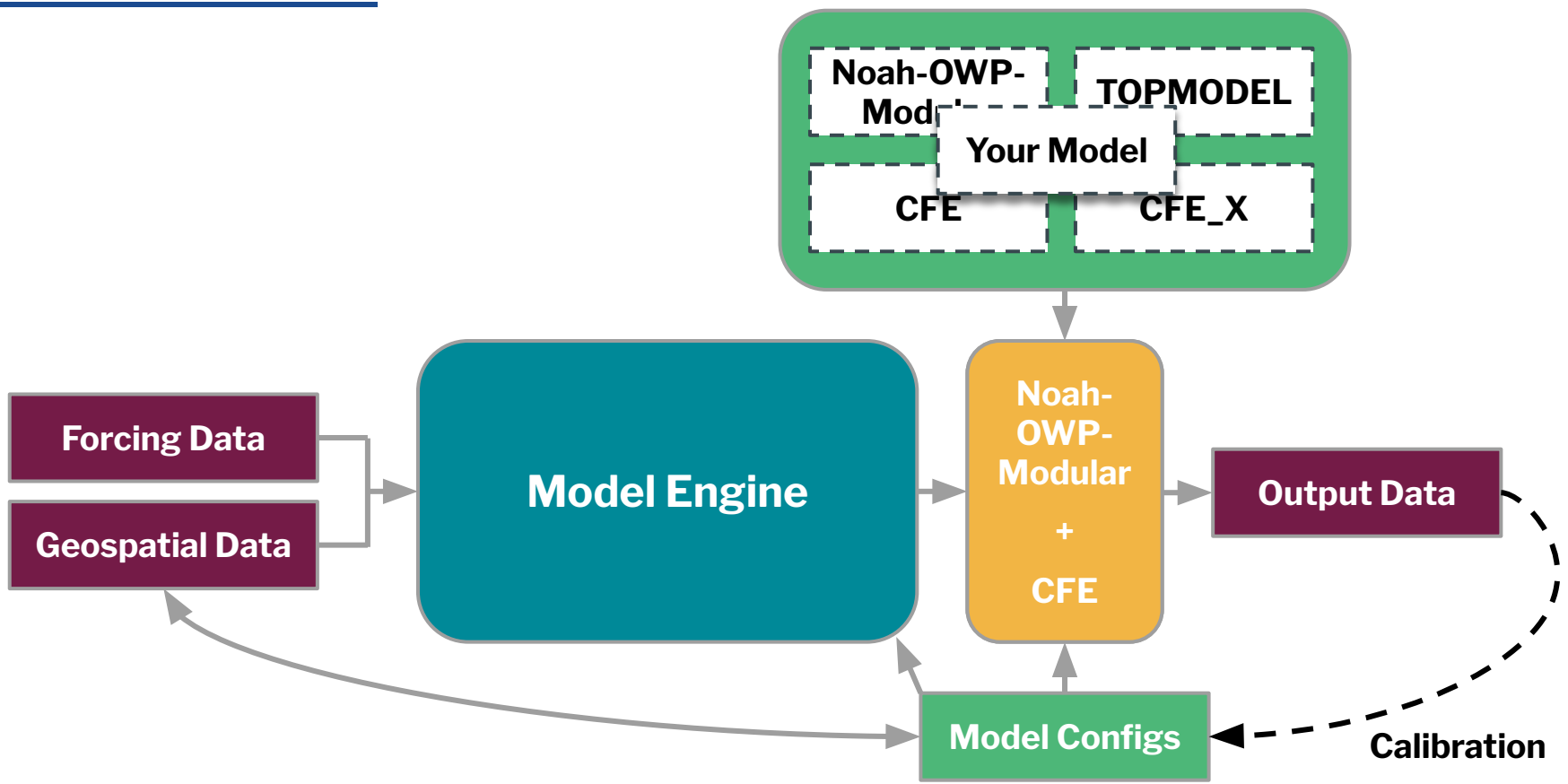
- Models written in different languages
- Inconsistent process representation
- Coupling difficulties
- Myriad data standards and formats
- Incompatible workflows
- Time

What if we can tackle these challenges?

Approach

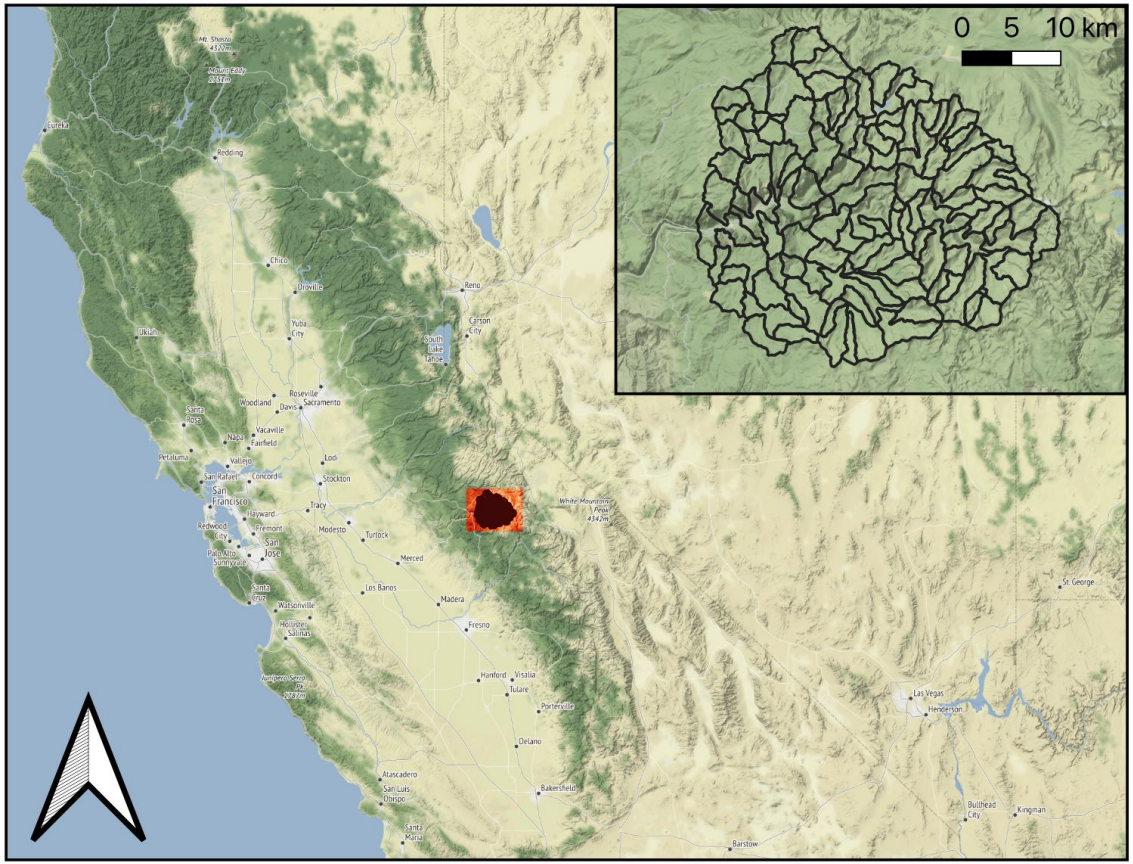
- Language-agnostic modular modeling system
- Plug-and-play capability through standard middleware (Basic Model Interface)
- Unified data standard and workflow
- Time (use less of it)

Next Generation Water Resources Modeling Framework

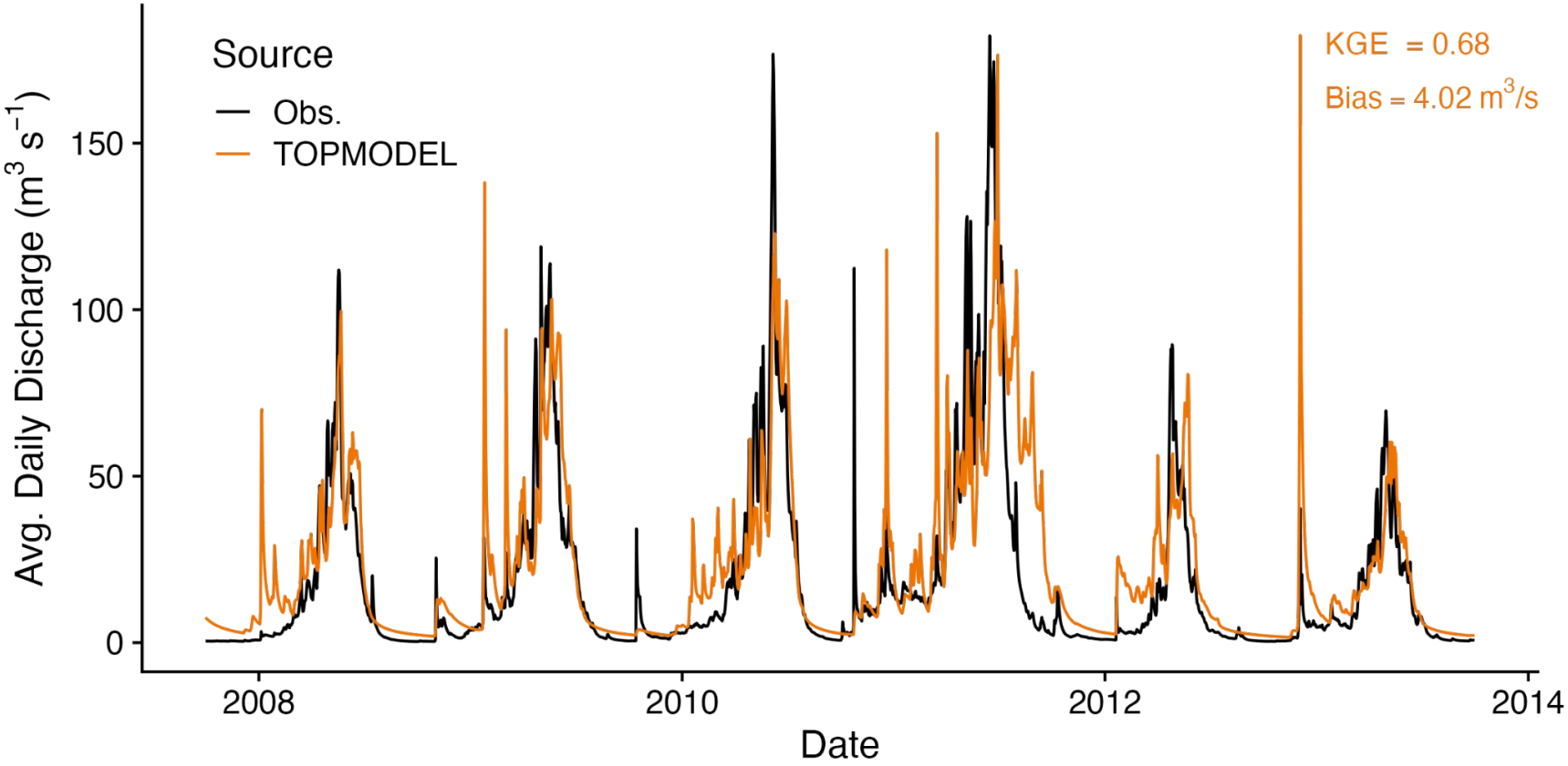


Merced River headwaters, western Sierra Nevada, USA

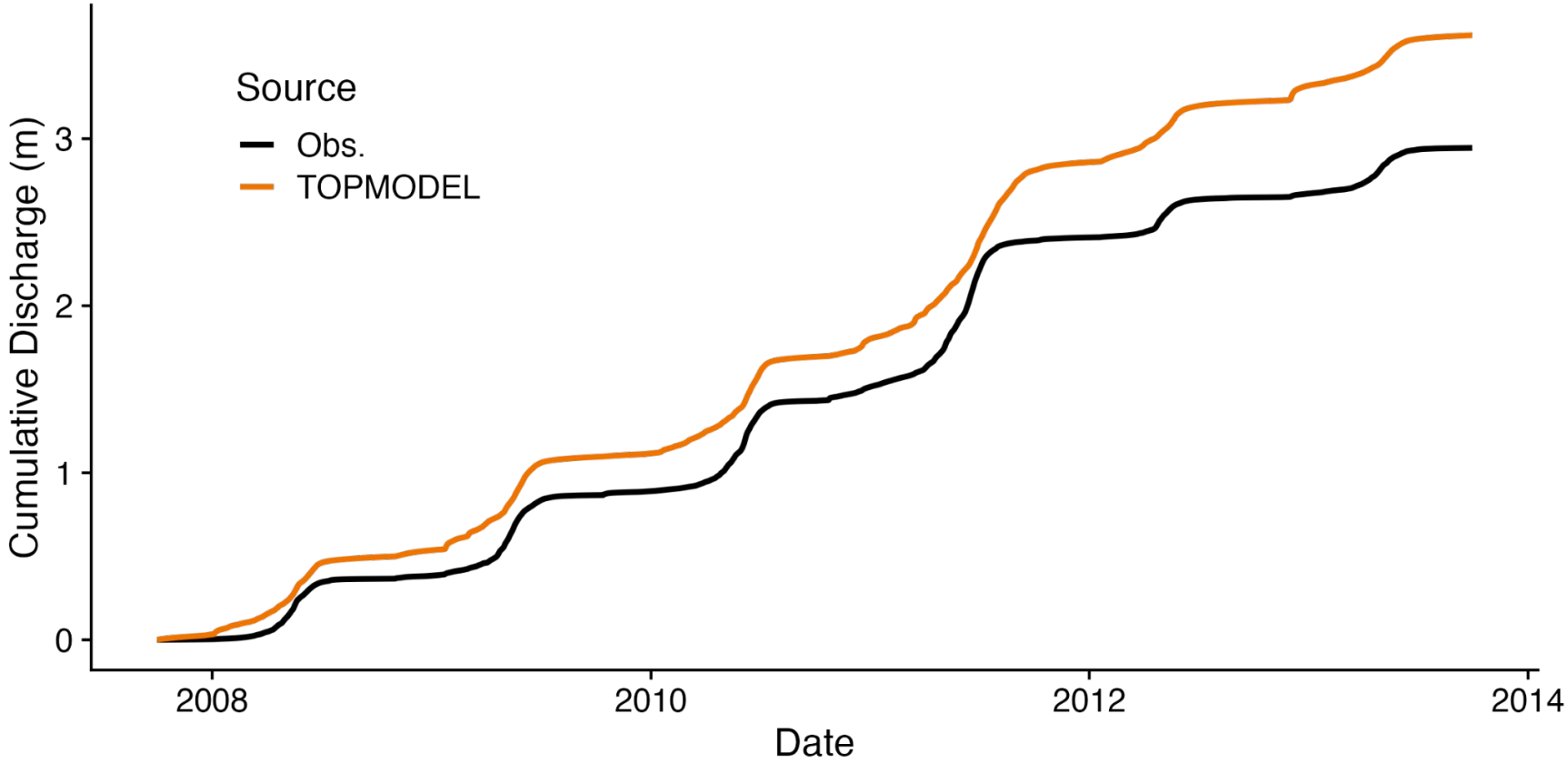
- Sub-basin info:
  - 1714 m to 3484 m elevation
  - 850 mm to 1270 mm annual precipitation
  - 44.4% to 94.4% annual snowfall fraction



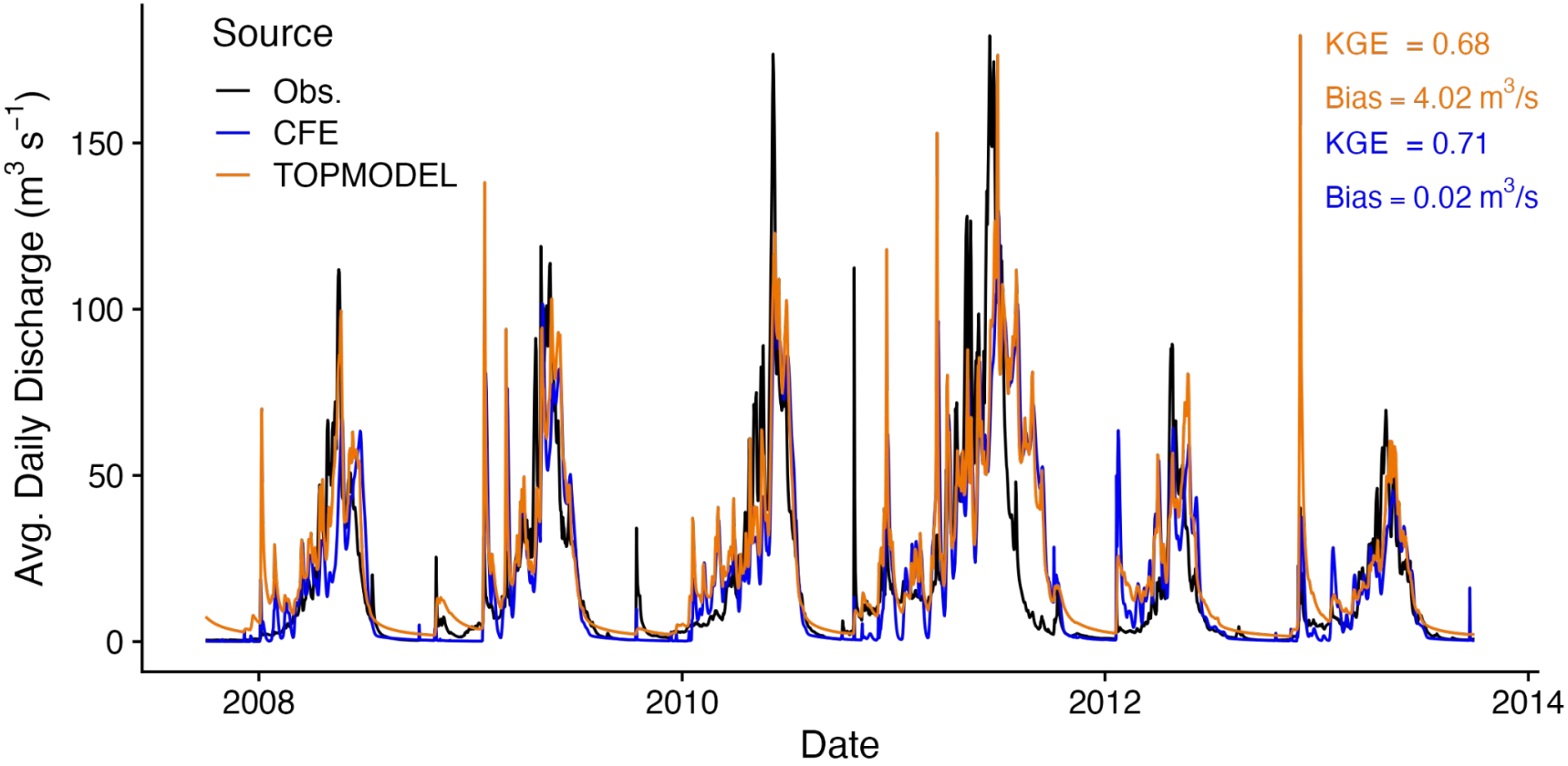
Noah-OWP-Modular coupled to TOPMODEL



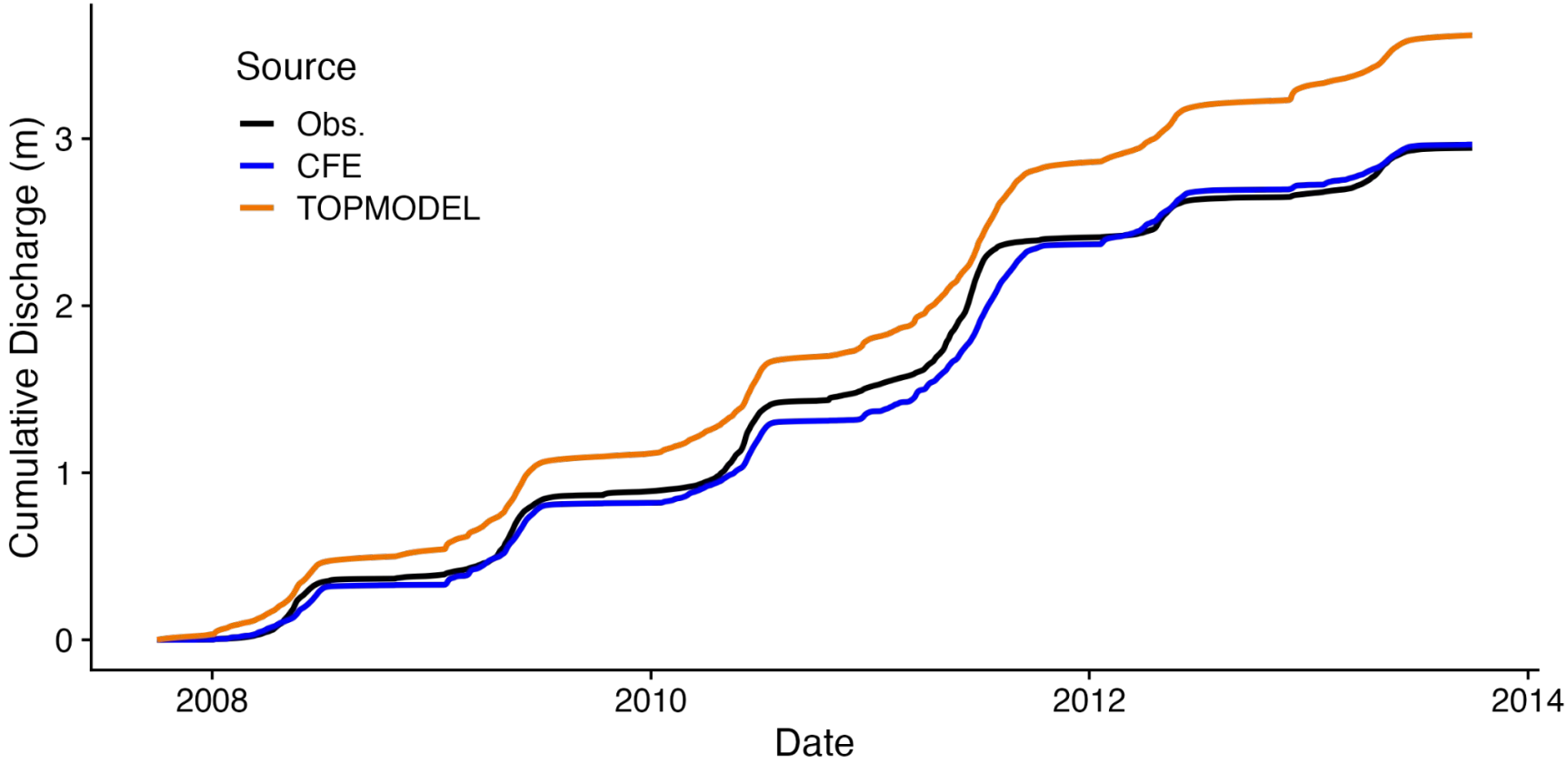
Noah-OWP-Modular coupled to TOPMODEL



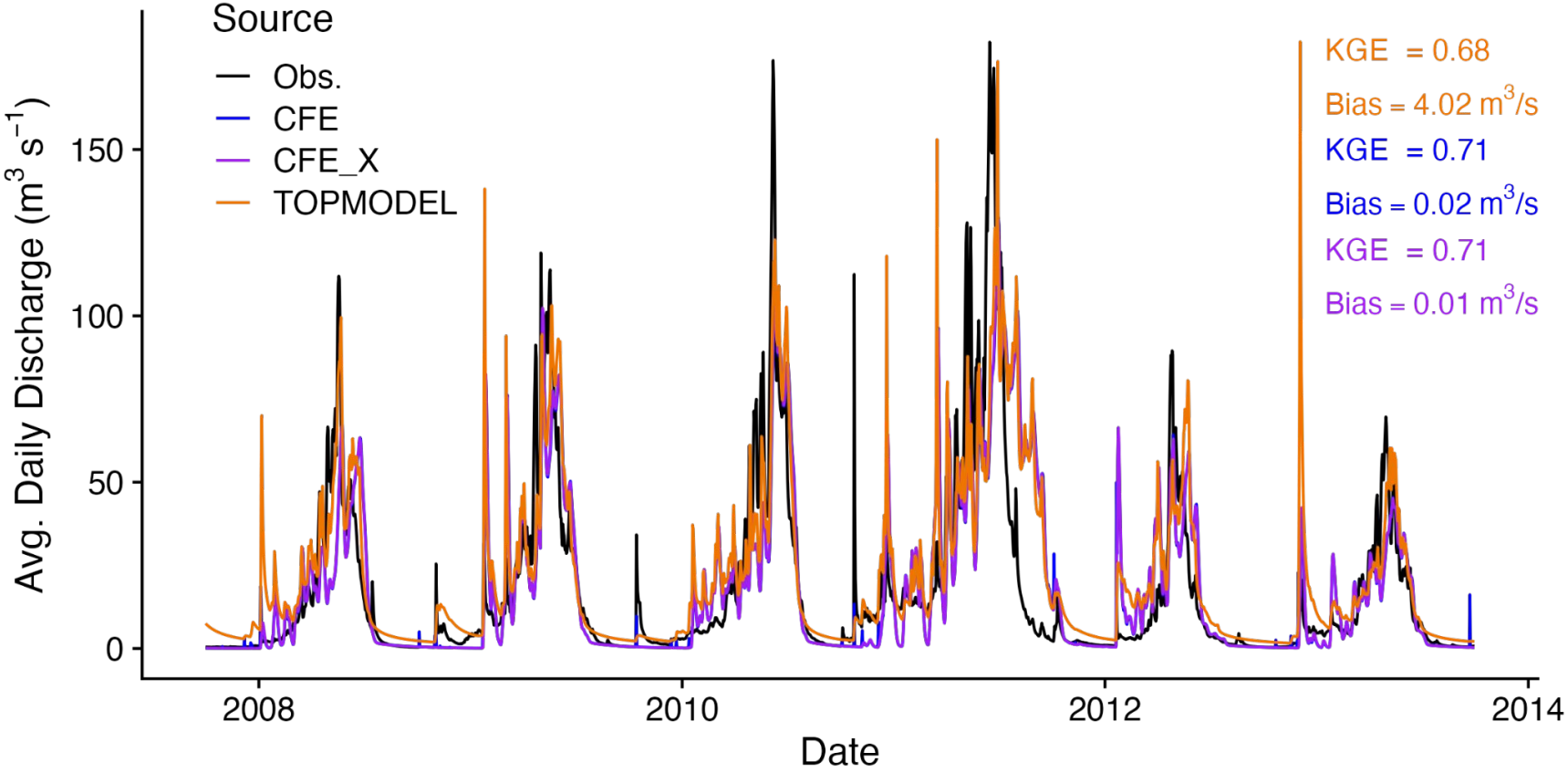
Noah-OWP-Modular coupled to CFE w/Schaake



Noah-OWP-Modular coupled to CFE w/Schaake

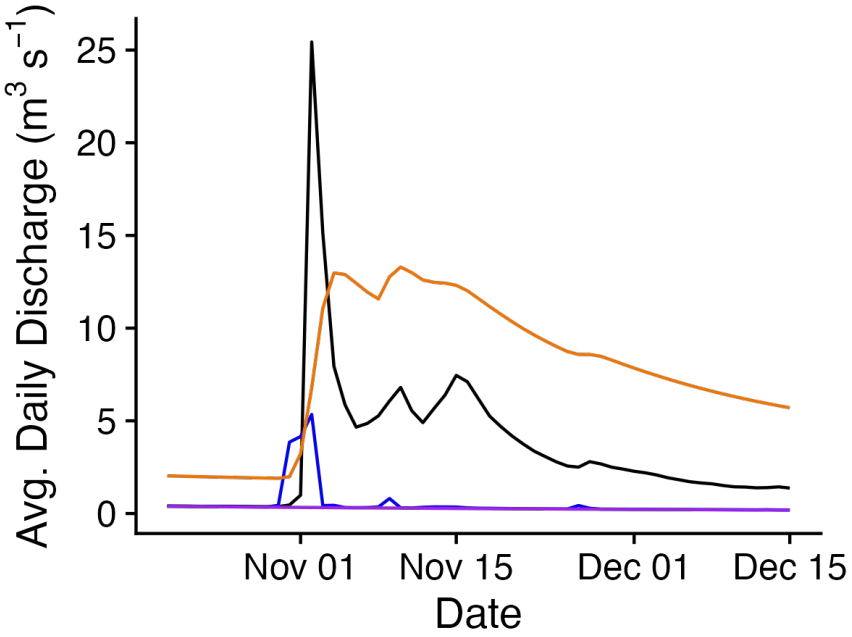


Noah-OWP-Modular coupled to CFE w/Xinanjiang

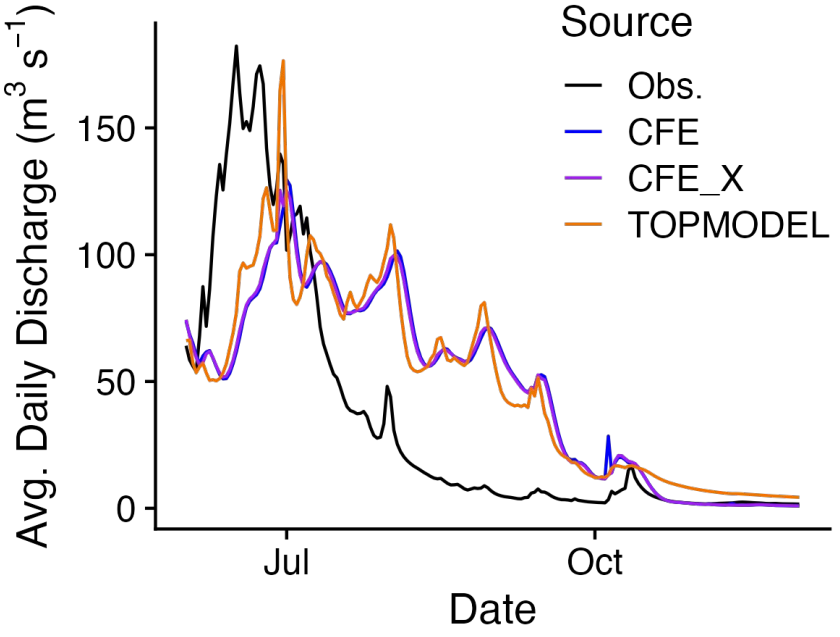


Still more opportunities for improvement

Runoff dynamics not captured



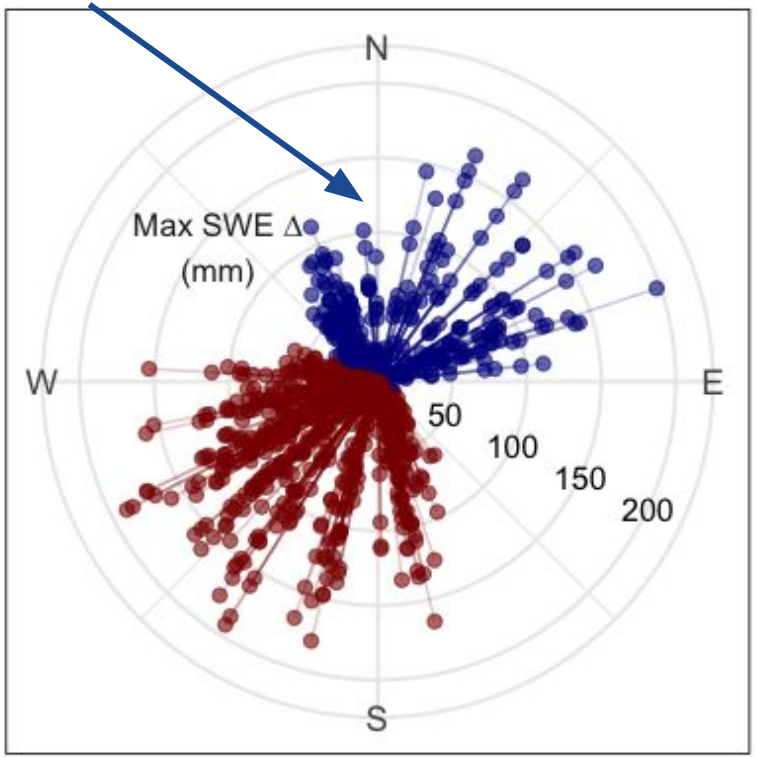
Snowmelt dynamics not captured

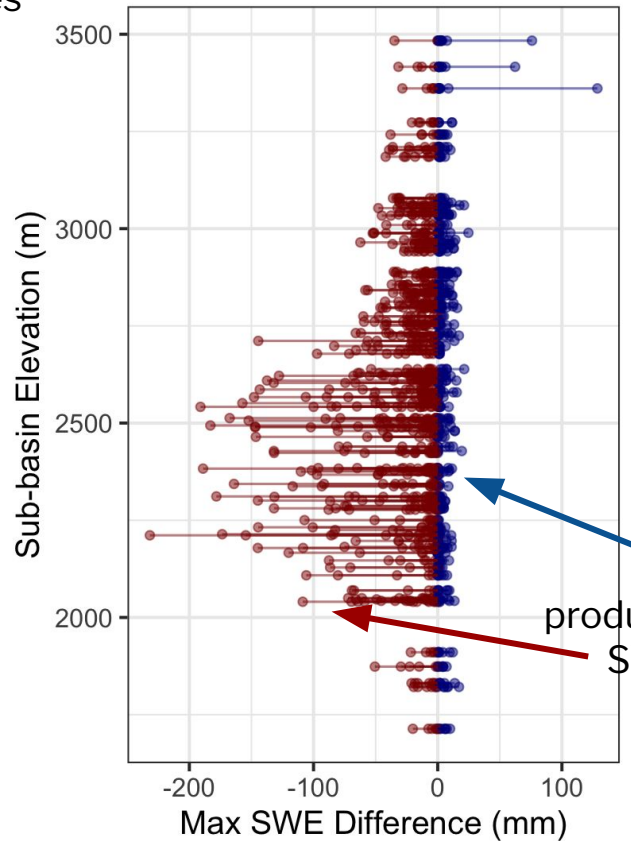


- Calibrate surface and infiltration-runoff models
- Improve process representation or add new models

Process improvements to Noah-OWP-Modular

Slope and aspect mod produces **more** SWE on N-facing slopes

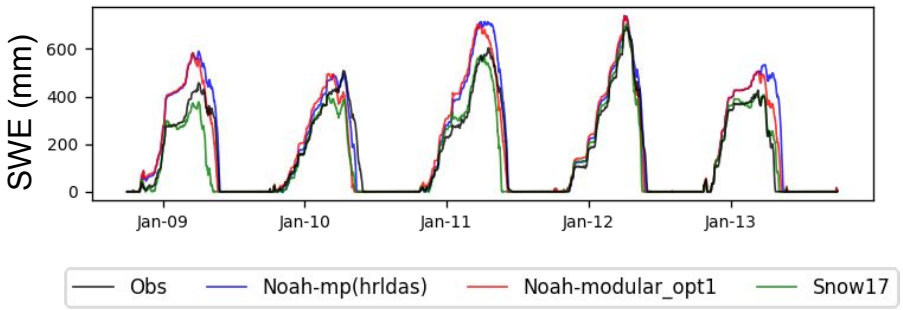




T_W mod produces **mixed** SWE effects

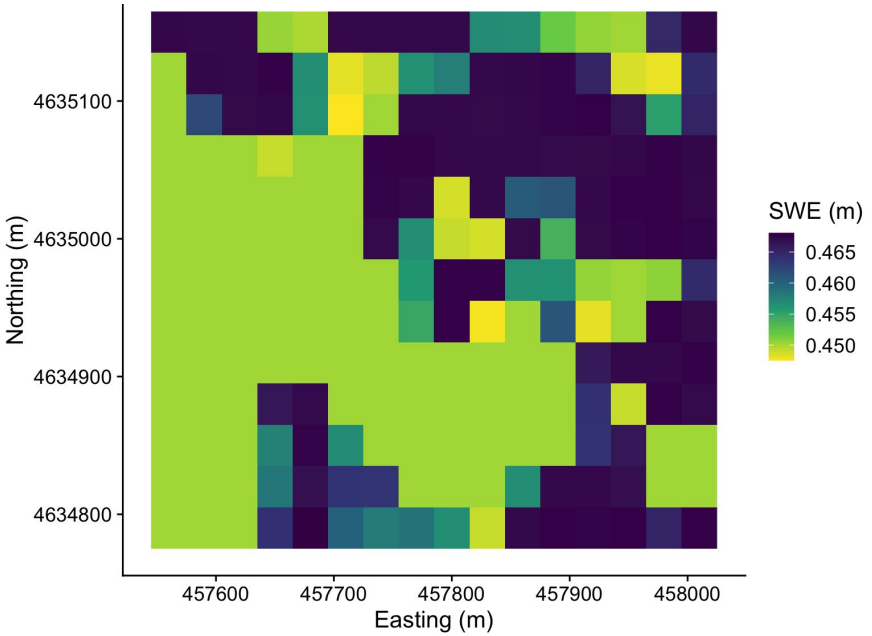
Other snow models

Snow-17



- BMI implementation
- Tested in NextGen

Utah Energy Balance



- In progress

Findings and next steps

- There is no “best” model
- NextGen allows multi-model coupling
  - Language-agnostic
  - Standardized input/output data
- Example shows variable output depending on infiltration-runoff model
- Still some shortcomings in process representation
- Calibration can improve output
- Additional snow models in progress
- ***Community input wanted!***

Thank You!

Keith Jennings

keith.jennings@noaa.gov

https://water.noaa.gov

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