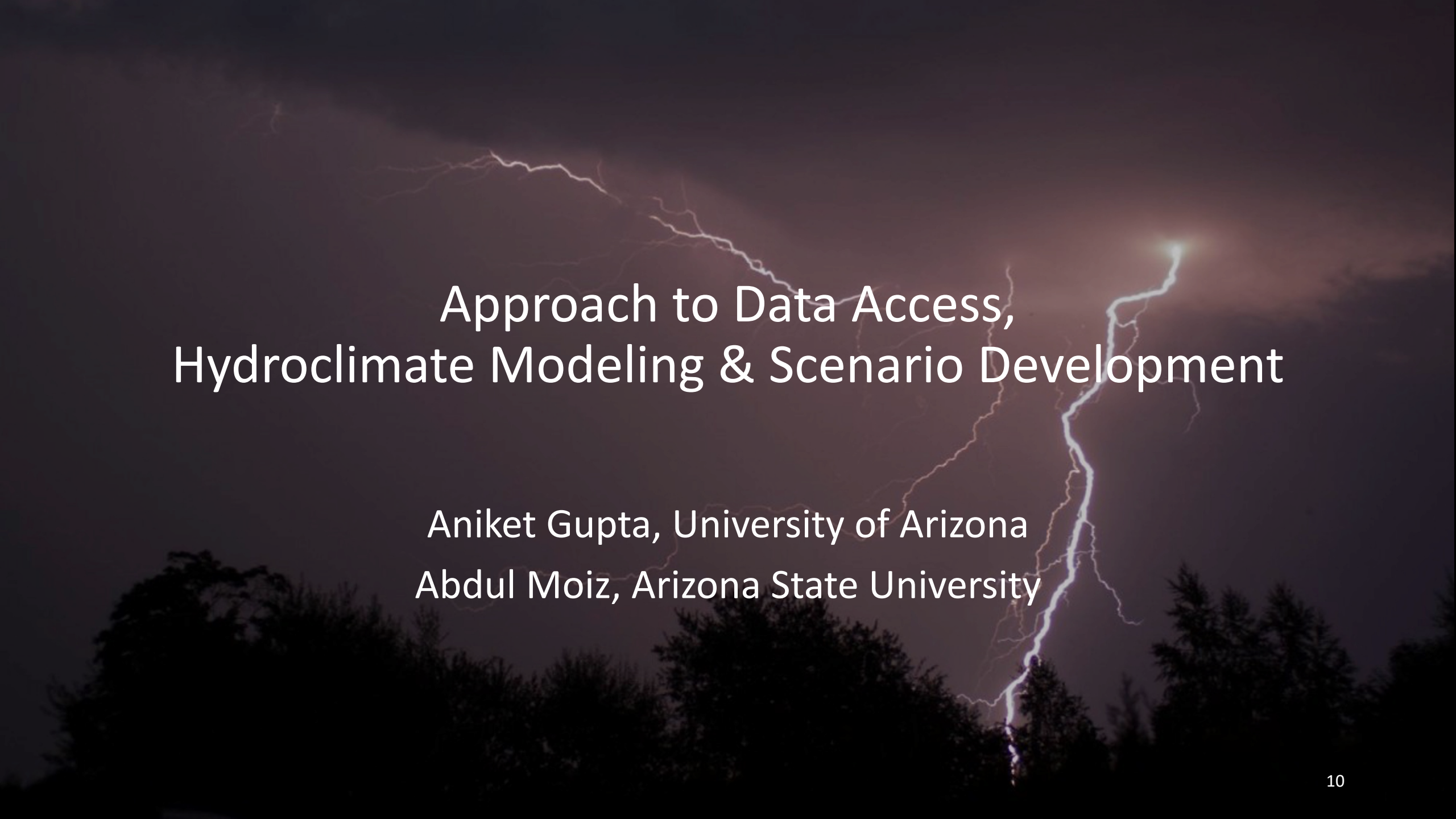


Approach to Data Access, Hydroclimate Modeling & Scenario Development

Aniket Gupta, University of Arizona

Abdul Moiz, Arizona State University

Why the Hydroclimate Team?

1. Collect all available hydrometeorological observations in Arizona
2. Apply a suite of hydrologic models to reconstruct key water balance variables across the state, with a focus on:
   a. Potential aquifer recharge regions
   b. Areas of high evapotranspiration (ET)
3. Build confidence in models via thorough validation against observations
4. Perform ad-hoc high-resolution hydrologic simulations in specific basins to support capture and recharge solutions
5. Assess future changes of key water balance variables using climate model outputs under different greenhouse gas emission scenarios

Collection of Hydrometeorological Datasets

Hydrometeorological Observations

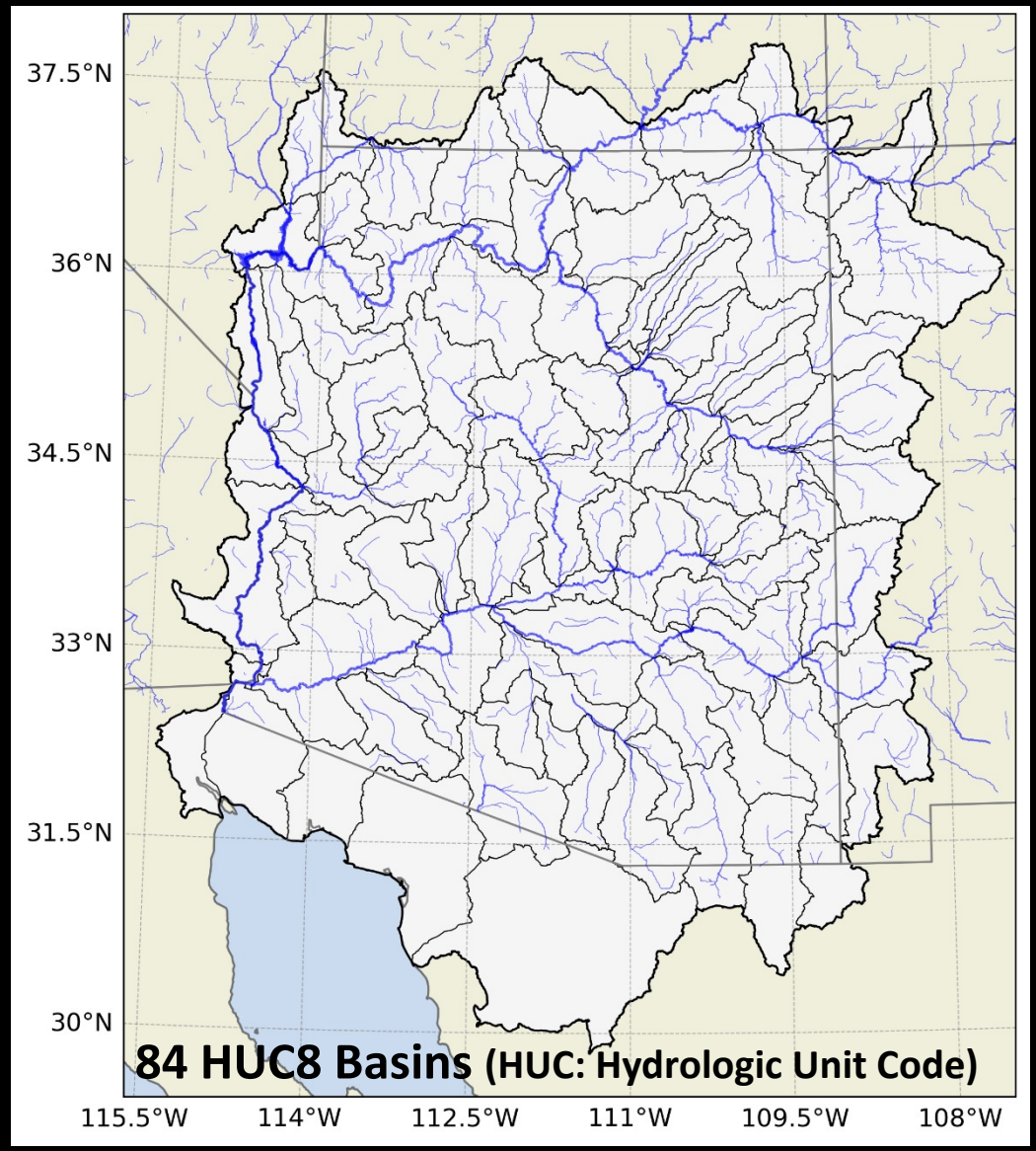
Dataset	Variables	Resolution
Analysis of Record for Calibration (AORC)	Precipitation Air Temperature Other Meteorological Variables	1-km, 1-hour
FLUXNET Tower	Evapotranspiration	Point, 30-min
USGS Gages	River Discharge	Point, 15-min
SNOTEL Stations	Snow Water Equivalent	Point, 1-day

Hydrologic Models

- National Water Model (NWM; available from NOAA at 1 km, 1 hr)
- Noah-MP (applied by the team at 4 km, 1 hr)

Period: 1980 - 2023

USGS Hydrologic Unit Code 8 (HUC8)



Water Budget

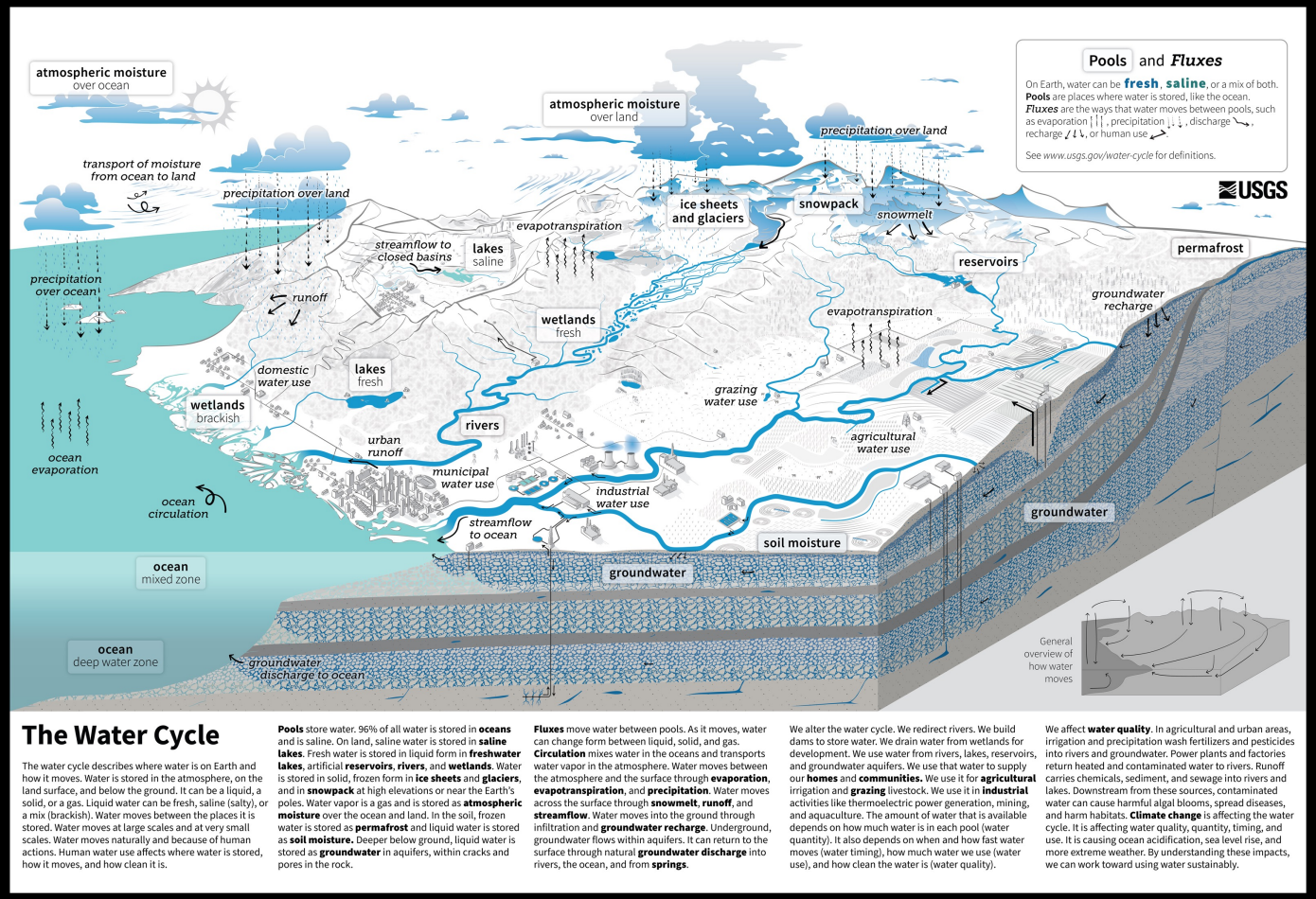
$$RE = P - ET - R$$

Observation | Simulation | Observation/ Simulation

RE = Recharge
P = Precipitation
ET = Evapotranspiration
R = Runoff

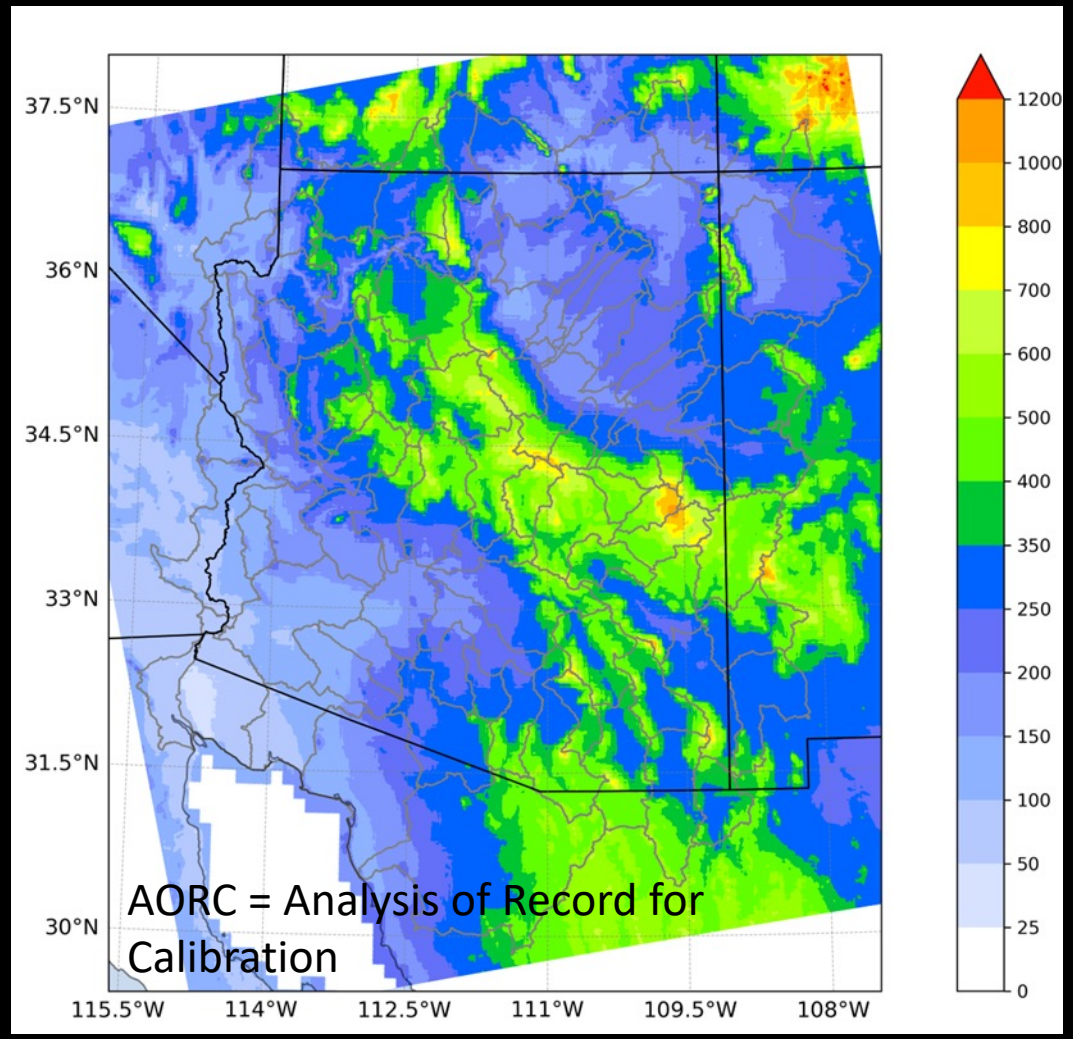
Applied at multiple time scales at each 1- or 4-km pixel and HUC8 basin

Credit: Hayley Corson-Dosch/USGS VizLab

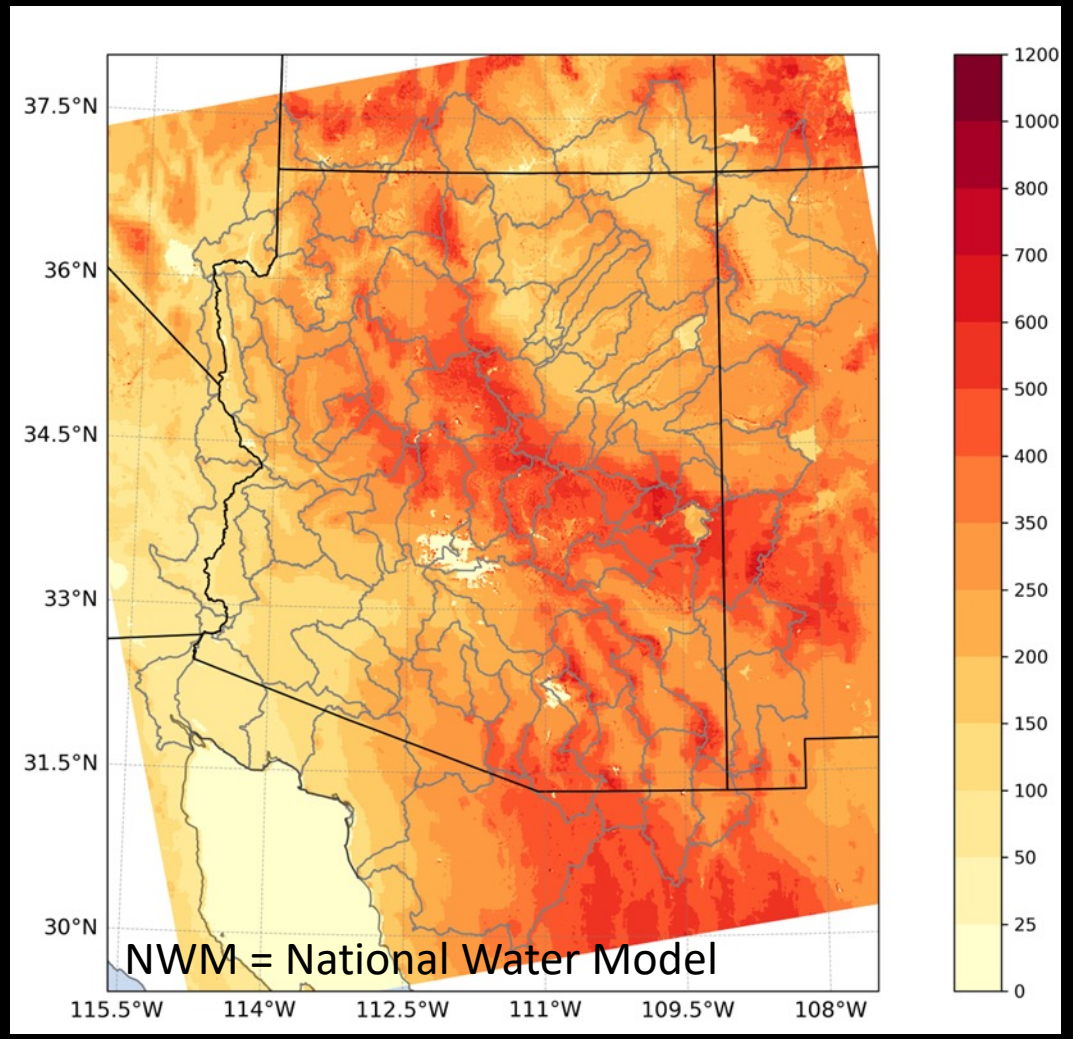


Examples of Observations and Simulations

Mean annual AORC precipitation (1980-2020)

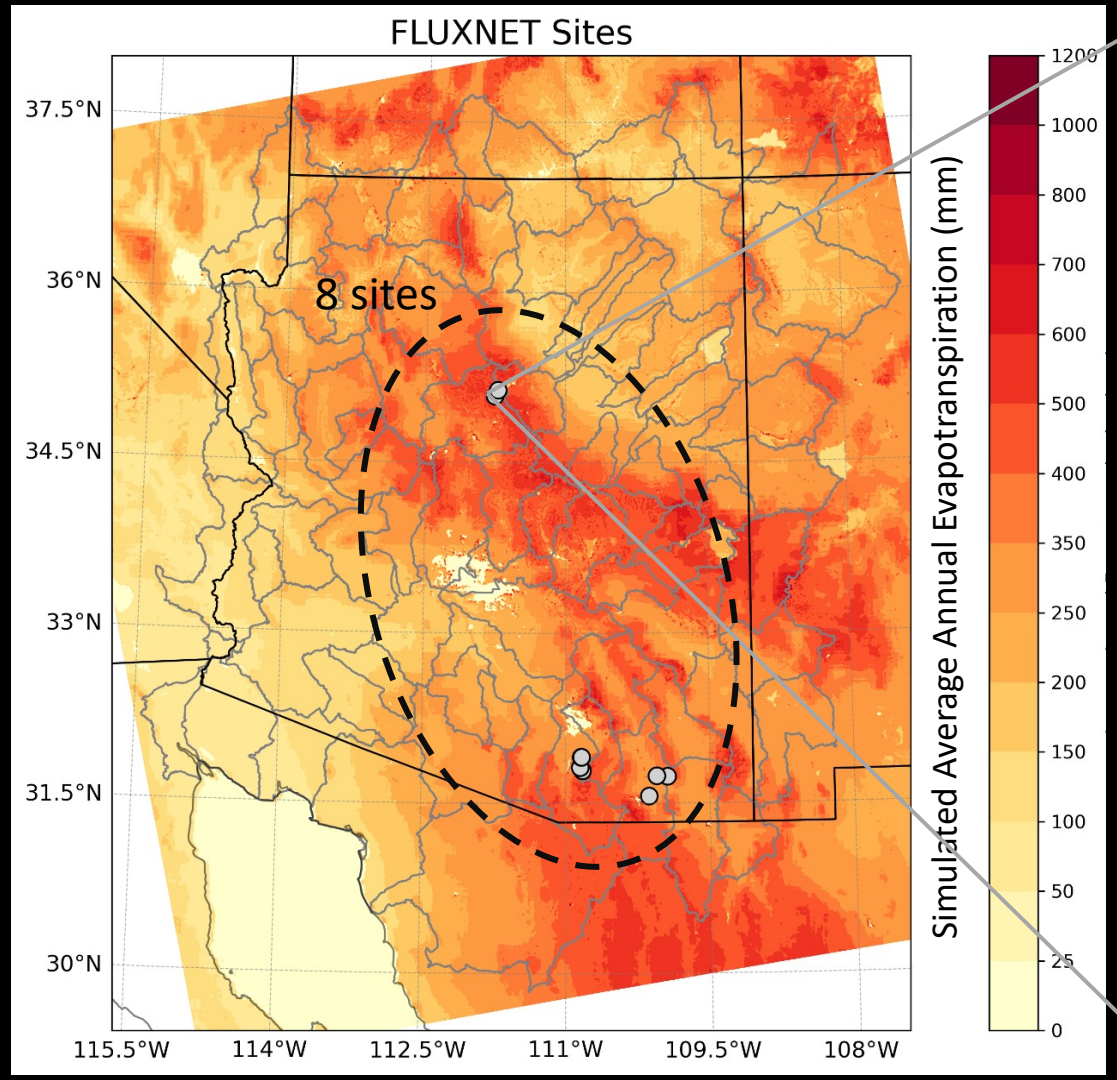


Mean annual NWM ET (1980-2020)

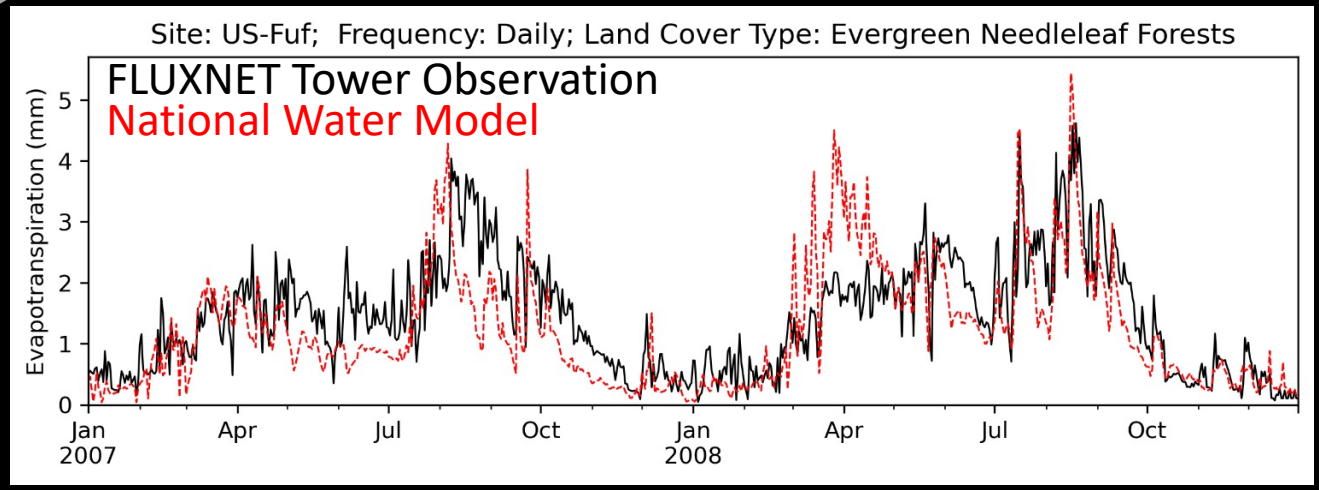


Building Confidence in Models

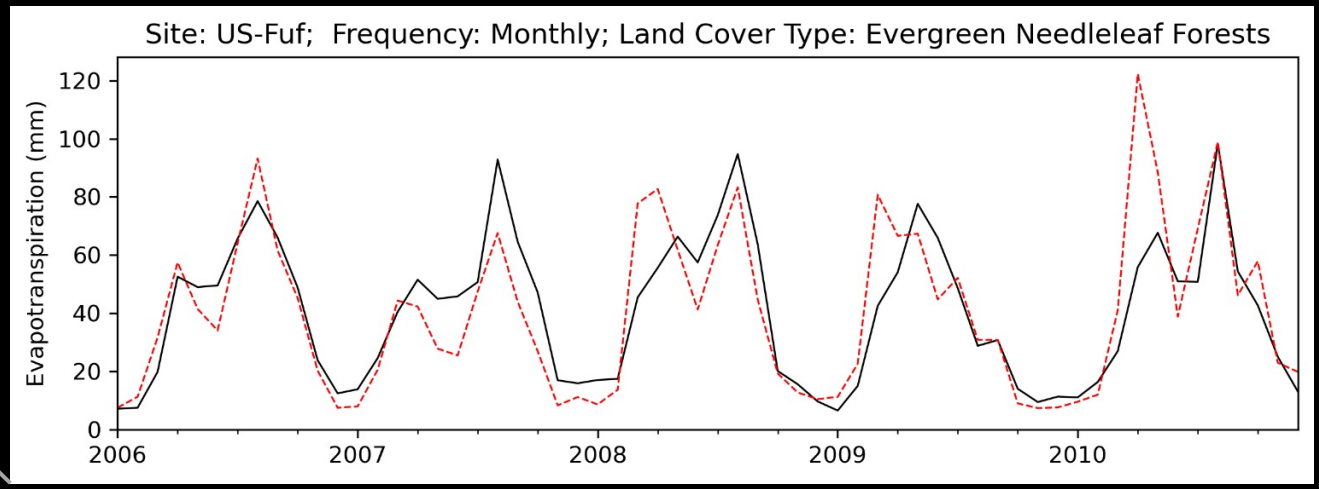
Validation of ET against eddy covariance estimates



Daily



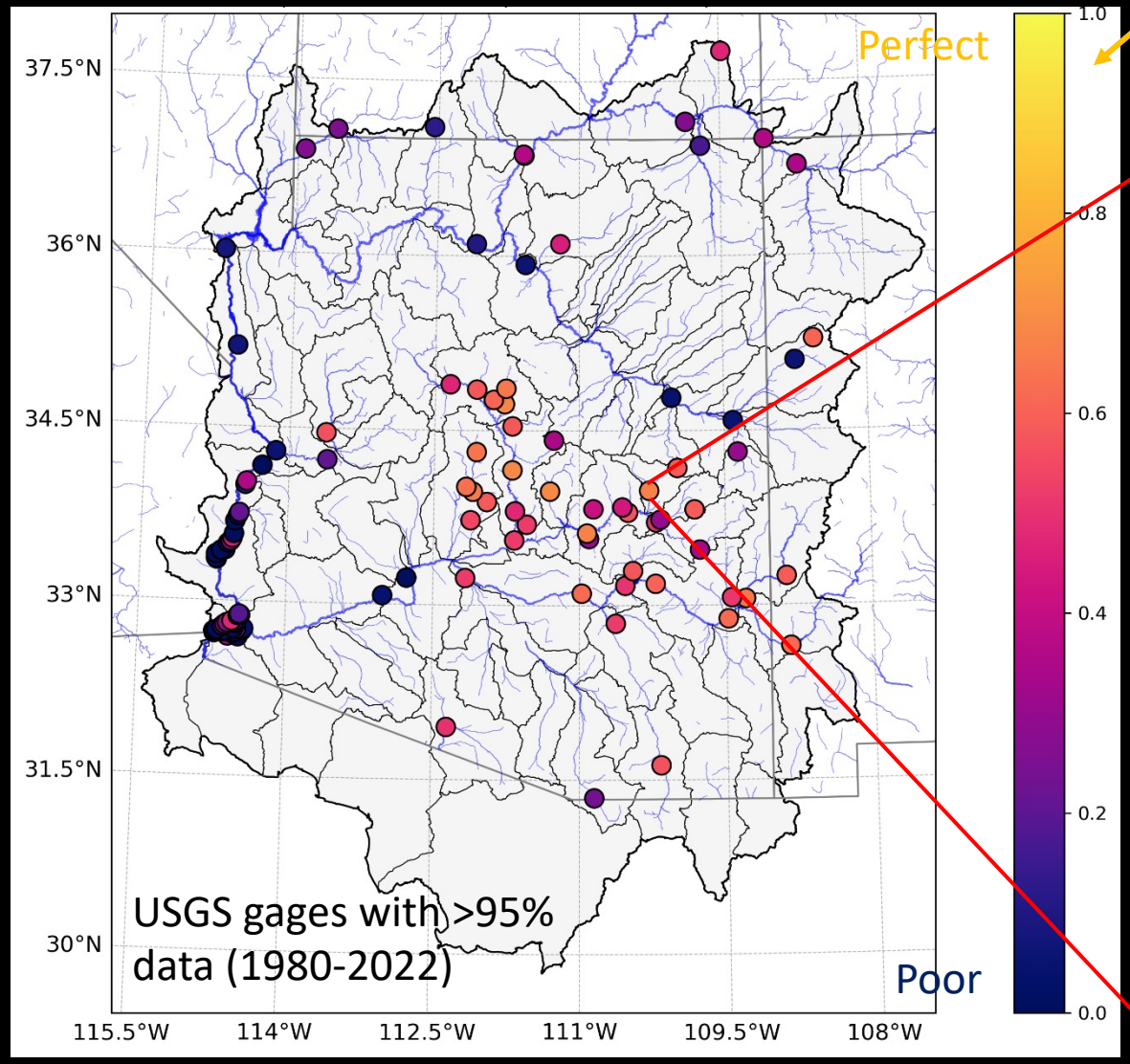
Monthly



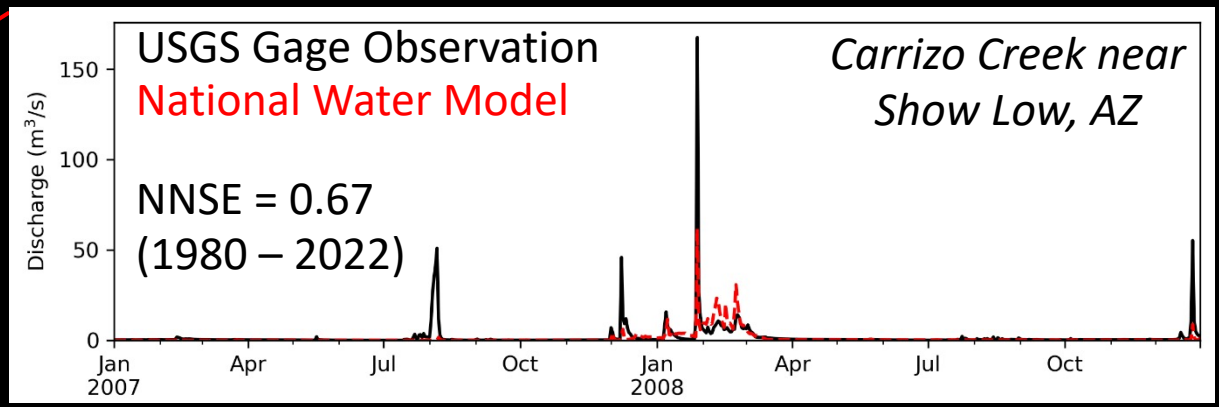
Building Confidence in Models

Validation of river discharge

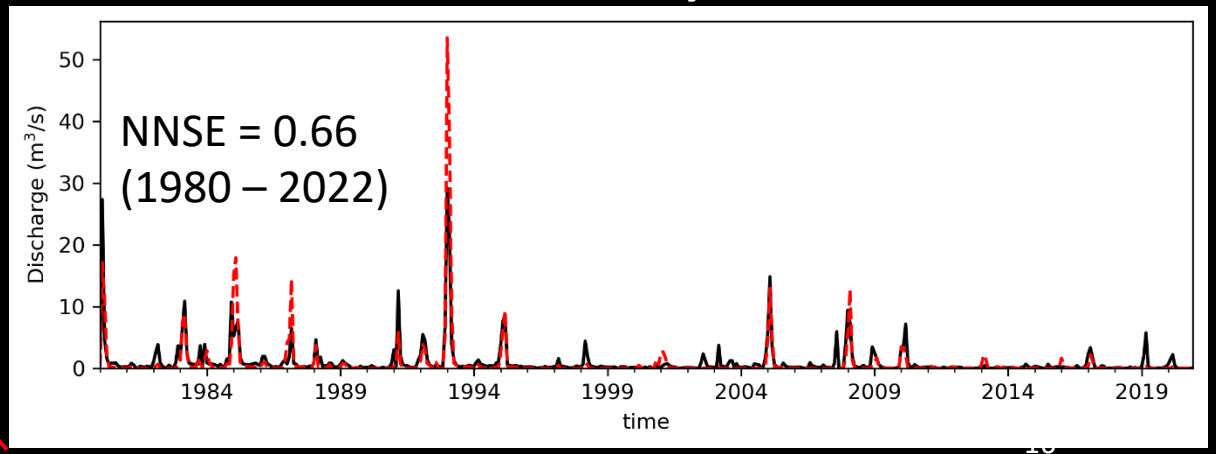
Normalized Nash Sutcliffe Efficiency (NNSE)



Daily



Monthly



High-Resolution Land Surface Modeling in Arizona

Historical Simulations

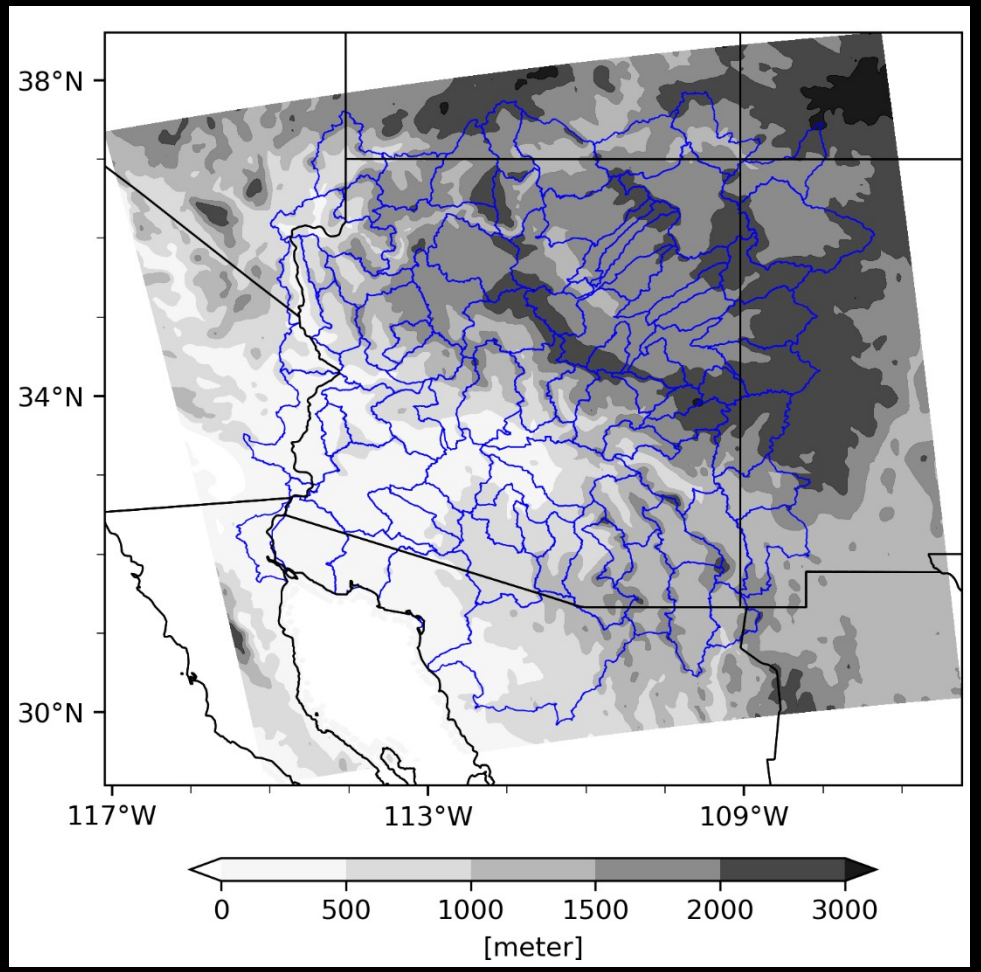
- To estimate the water budget (including ET, runoff, recharge, SWE, etc.) during 1980-2020 in the HUC8 basins over Arizona.
- To find the factors that dominate the spatial and temporal variations in recharge during the historical period.

Future Simulations

- To project the recharge in the middle and end of this century under different emission scenarios.
- To understand the effect of future climate change on recharge.

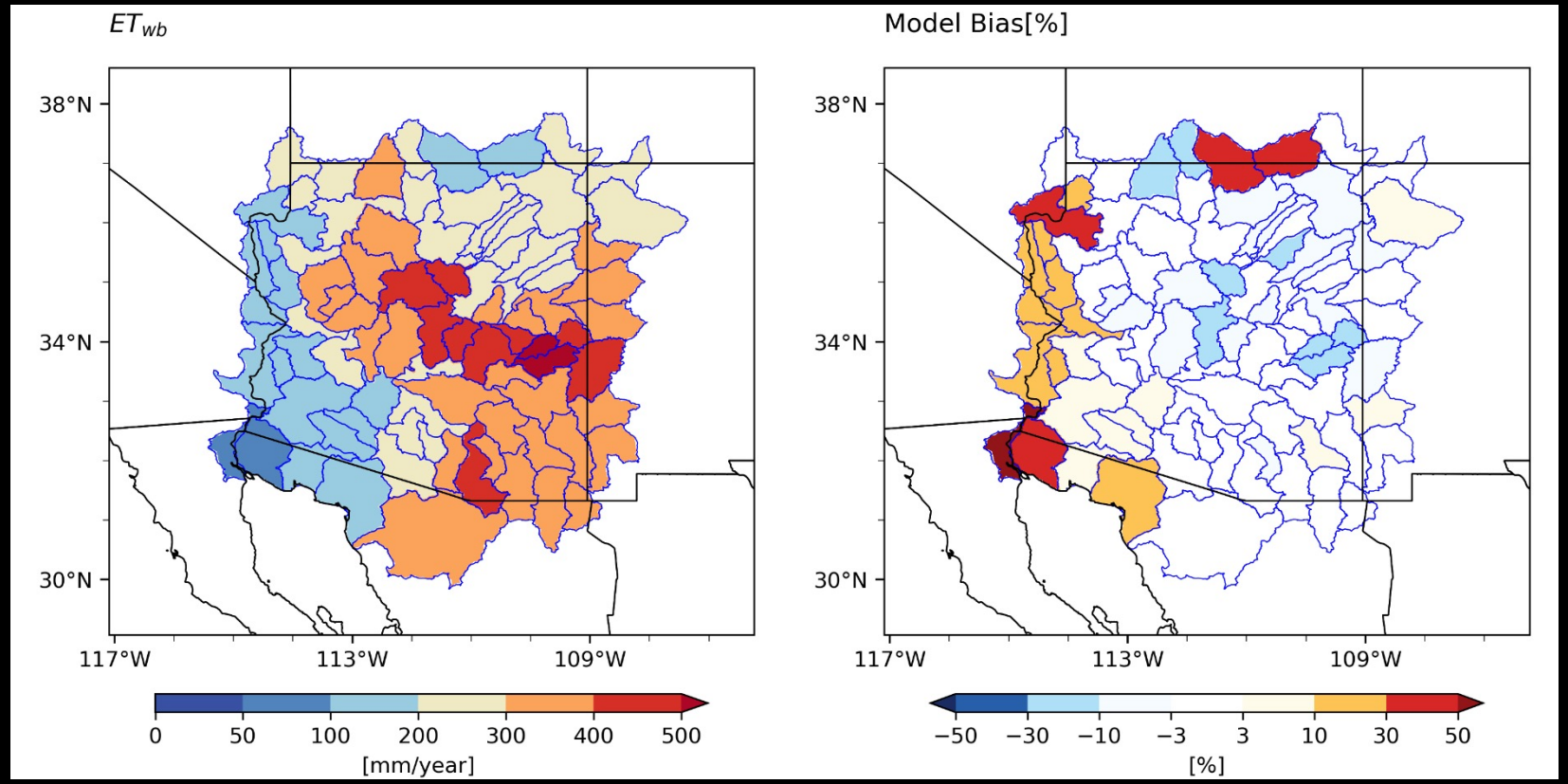
Historical Simulations

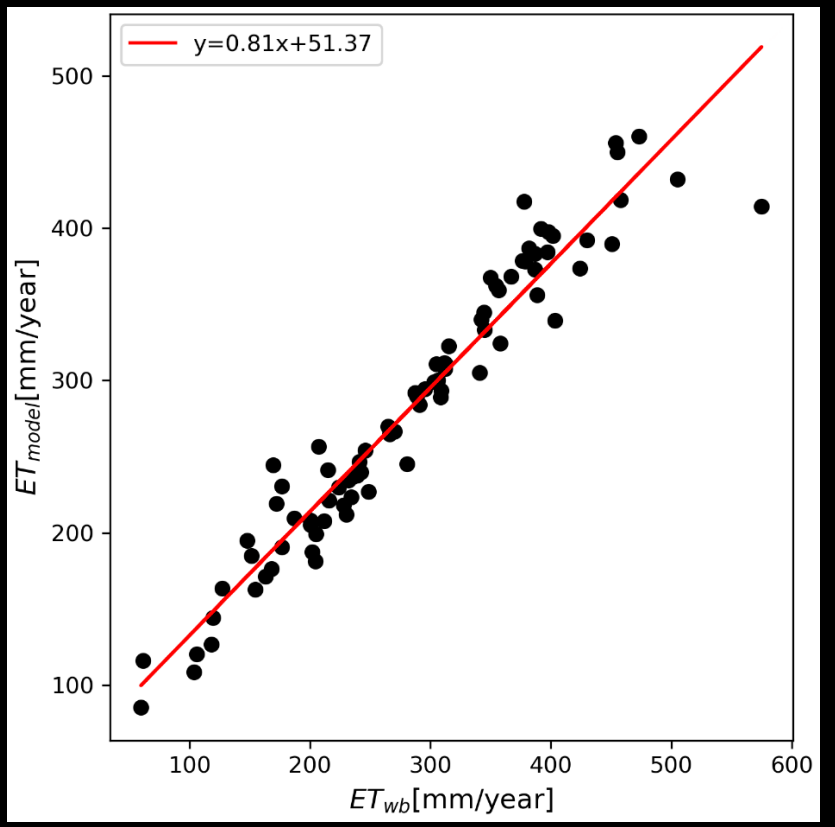
Model	Noah-MP which can represent surface ponding and dynamic root water uptake
Domain	HUC8 watersheds (see blue lines in the right figure) over Arizona
Period	1980-2020
Resolution	4 km (spatial) and 1 hr (temporal)
Forcing data	CONUS404 (dynamically downscaled results of ERA5), AORC (based on multiple observation and analysis datasets), and IMERG (satellite data, 2001-2020)



Model Performance in Simulating ET

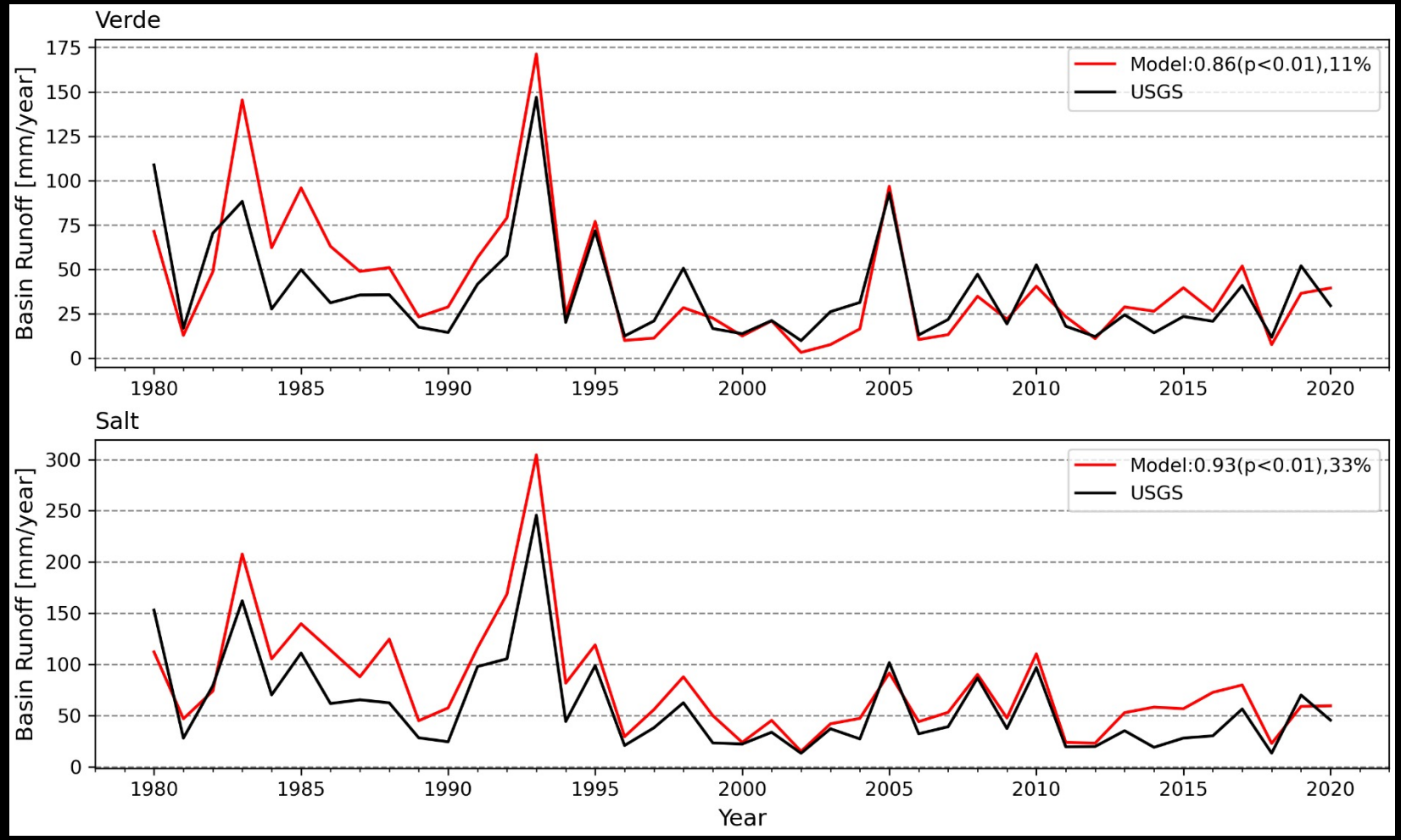
$ET_{wb} \approx$ P - RF_{usgs}





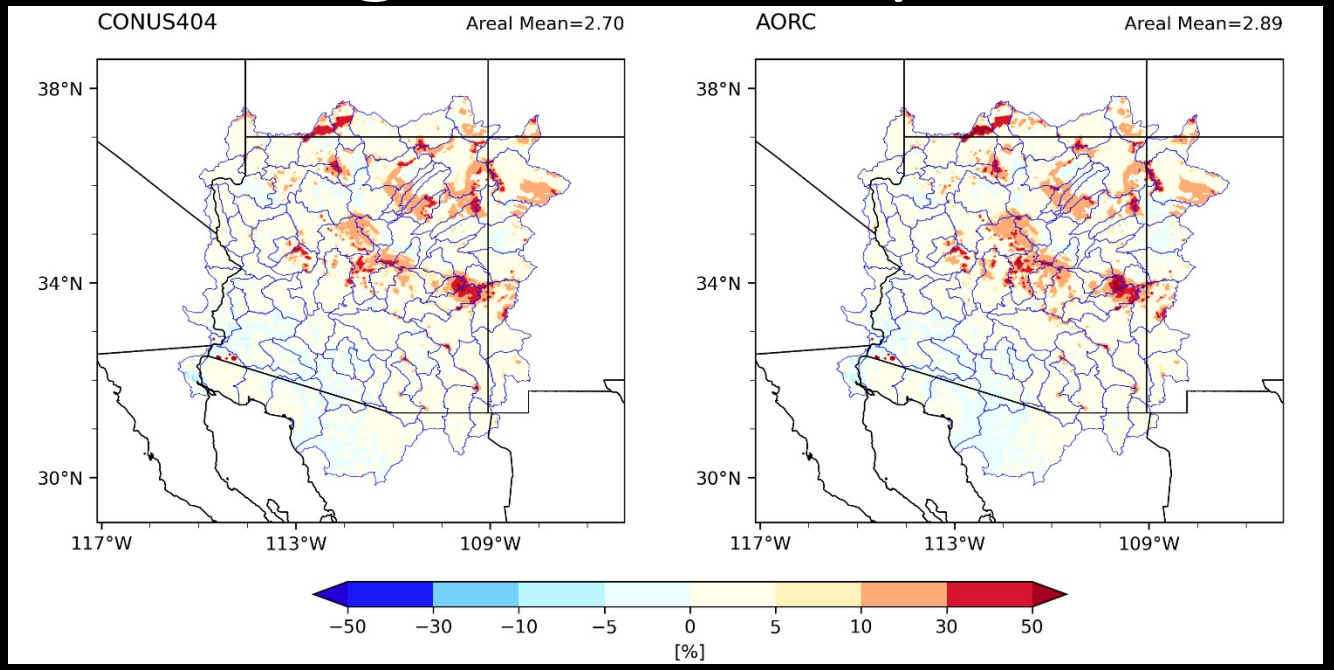
- For most of the basins, the model's relative bias is between -10% and 10%.
- ET_{wb} and ET_{model} are very close, with R=0.81.

Model Performance in Simulating Runoff



- The model can reproduce the annual runoff for the Verde (Salt) Basin with R=0.86 (0.93) and bias=11% (33%)

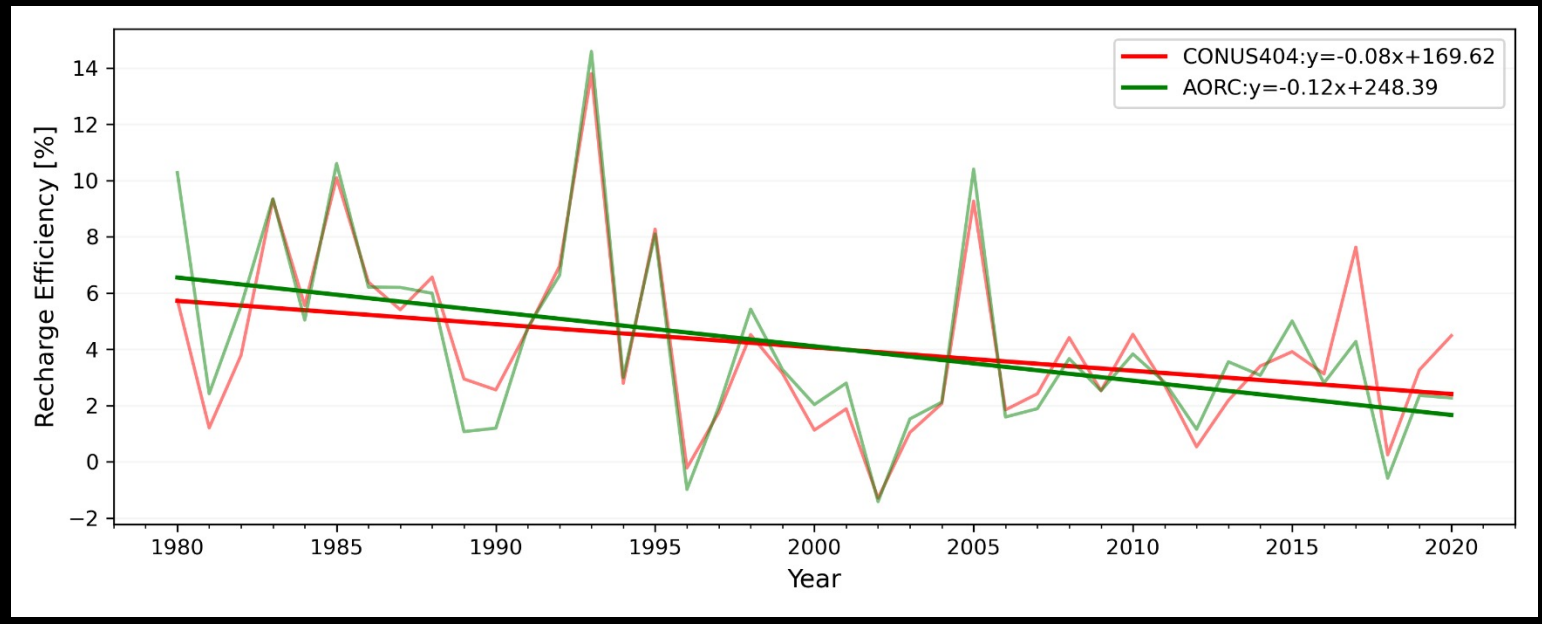
Recharge Efficiency and Its Historical Trend



Recharge Efficiency = Recharge / P x 100

- Very similar mean areal recharge efficiency (2.79% for CONUS404 and 2.89% for AORC)

- Both simulations suggest that recharge efficiency has significantly decreased by about 0.1% per year



Hydroclimate Team Summary

1. Collection of high-resolution point and gridded hydrometeorological observations across Arizona
2. Validation of the latest National Water Model retrospective simulations and Noah-MP ad-hoc simulations in AZ
3. Generation of recharge maps from models and observations for the historical period
4. Estimation of changes in water balance components under future climate scenarios