

SWAT Conference 2025, Colorado

*A **HAWQS-SWAT-LSTM** Framework for Hydrologic Predictions in Ungauged Watersheds*

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Motivation

First IAHS Scientific Decade 2003–2012, entitled *Predictions in Ungauged Basins (PUB)*

“Aim of reducing uncertainty in hydrological predictions.”

'grass-roots' movement intended to engage the interest of hydrologists around the world

Book was launched in 2003 and concluded by the PUB Symposium 2012



A decade of **Predictions in Ungauged Basins (PUB)**—a review (Hrachowitz et al., 2013)

“There is still a long way to go in terms of predictions: much of the success so far has been in gauged and not in ungauged basins.”

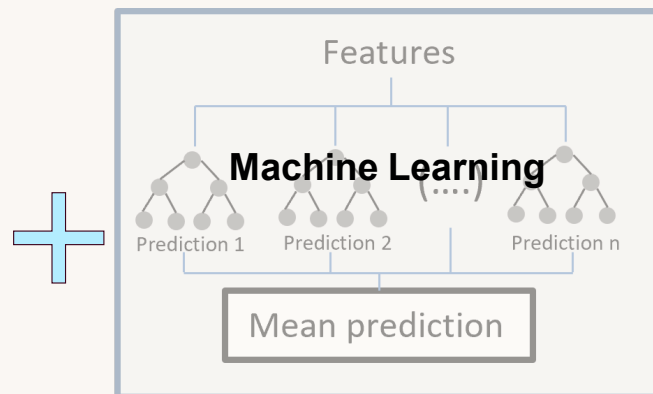
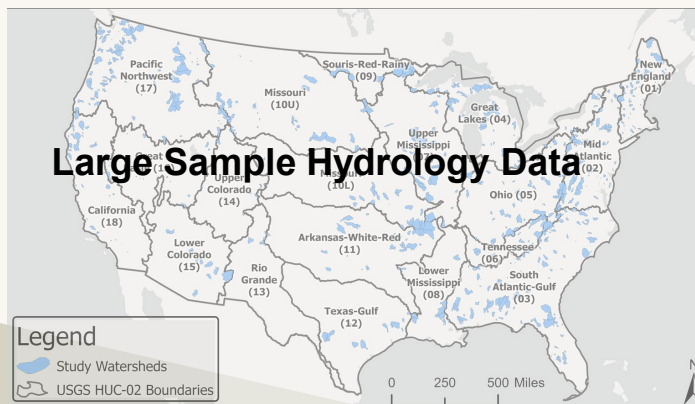
23 Unsolved Problems in Hydrology (Bloeschl et al., 2019)

Problem No. 5 – “What causes spatial heterogeneity and homogeneity in runoff, ... and material fluxes (... nutrients, sediments)?”

Problem No. 6 – “What are the hydrologic laws at the catchment scale and how do they change with scale?”

In 2019, A large sample hydrology with Machine concept was first to formally demonstrate

“machine learning trained on large-sample hydrological datasets”

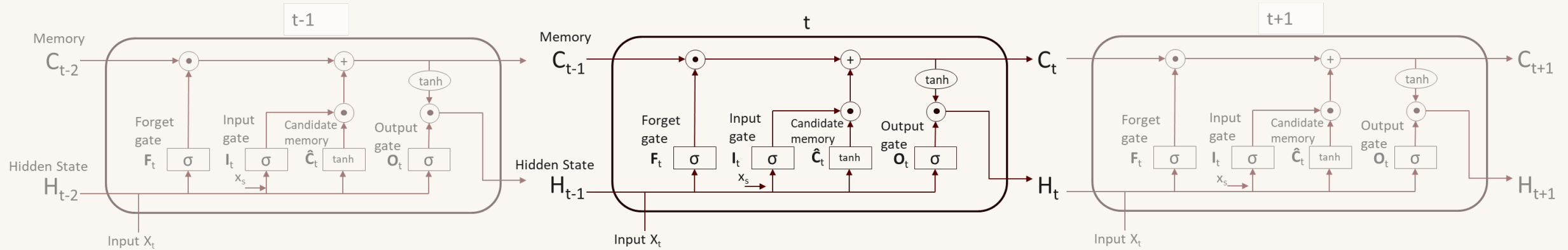


A) Predictive Performance

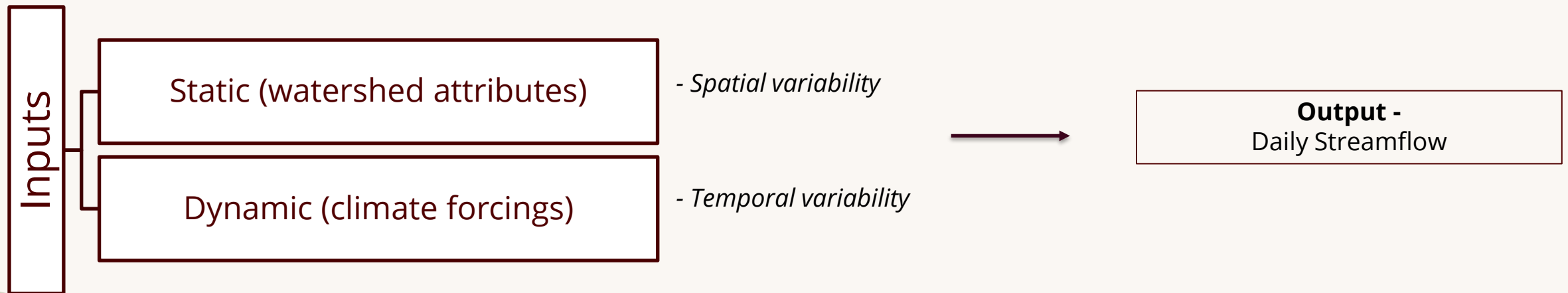
- Hydrologic Signatures (FDCs)
- Daily streamflow
- Water Quality

B) Model interpretations for hydrologic inference.

Entity-Aware LSTMs



Entity Aware LSTMs (EA-LSTM) <https://neuralhydrology.readthedocs.io> (Kratzert et al., 2019)

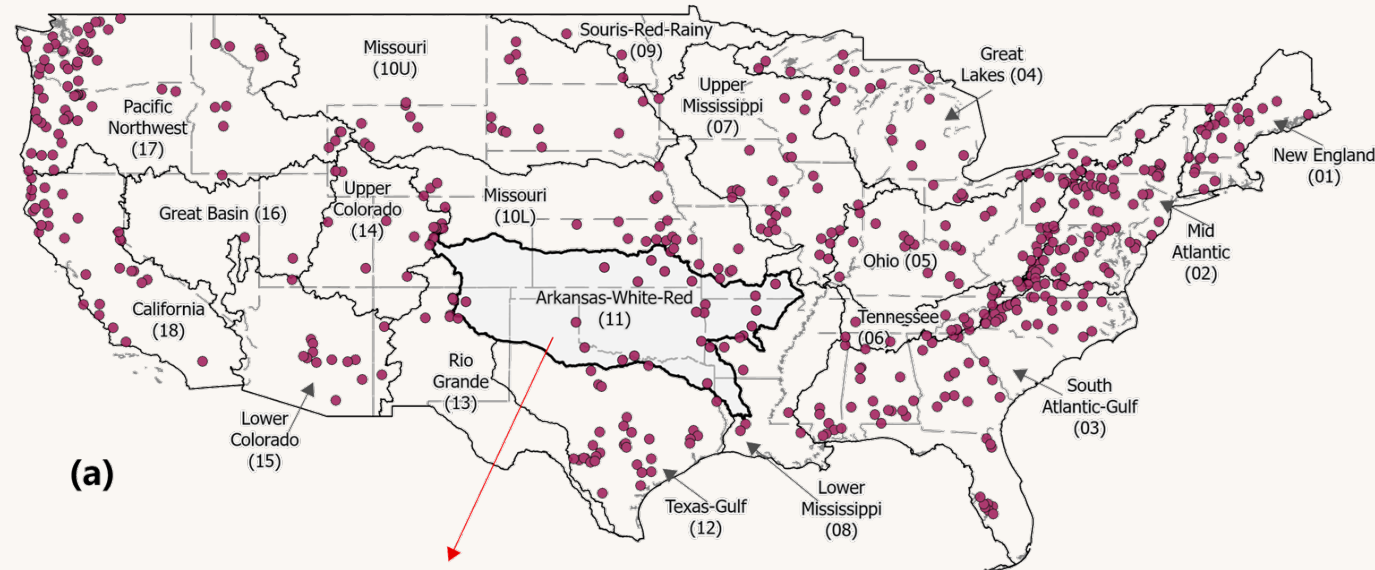


Study Area and Experimental Designs

531 watersheds location from CAMELS

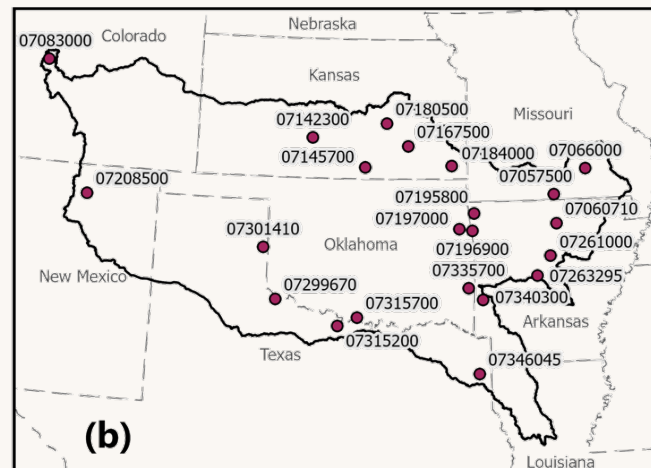
CAMELS : Catchment Attributes and Meteorology for Large-Sample Studies

Training: 509 watersheds



(a)

Test: 22 watersheds



(b)

- USGS Hydrologic Regions
- Arkansas-White-Red Region
- Study Watersheds
- US State Boundaries

SWAT Modeling Made Simple

HAWQS

Hydrologic and Water Quality System



hawqs.tamu.edu

TEXAS A&M
AGRI LIFE
RESEARCH



USDA 
Agricultural Research Service

SWAT Model setup - just a few clicks away!!



hawqs.tamu.edu

HAWQS

Hydrologic and Water Quality System
A National Watershed and Water Quality Assessment Tool

Recent Activity

Projects

Group Projects

+

New Project

HAWQS Dataset

HUC8

HAWQS Version 2

HUC8

HUC10

HUC12

HUC14

HAWQS Version 2 Calibrated

HUC12 Flow Calibrated

User-submitted datasets

Test upload

Downstream subbasin

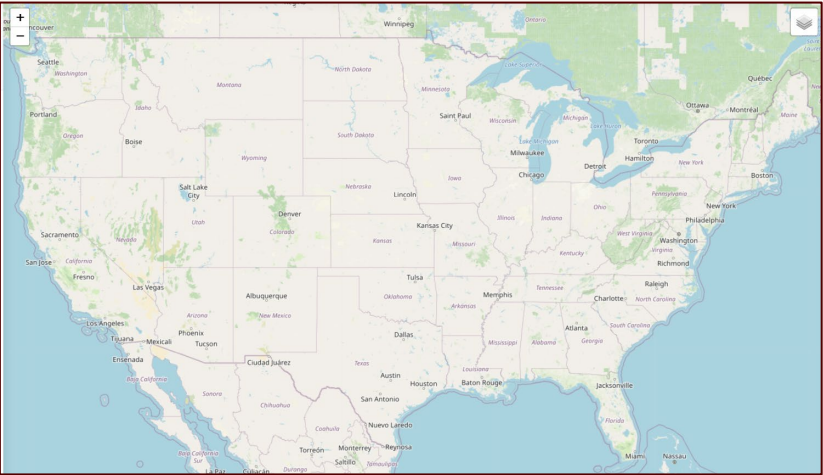
031502

03150201

03150202

03150203

03150204



HAWQS API

HAWQS Dataset

HUC8

Downstream subbasin

03150204

Advanced options

The selected watershed contains 14 subbasins and 54,152 HRUs. [View routing table.](#)

Show routing on map

Give your project a name

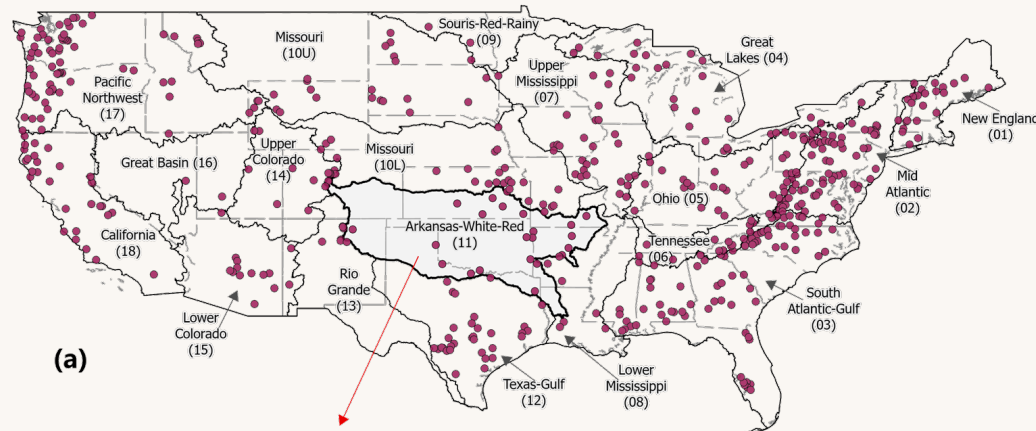
HUC8 - 03150204

Create Project

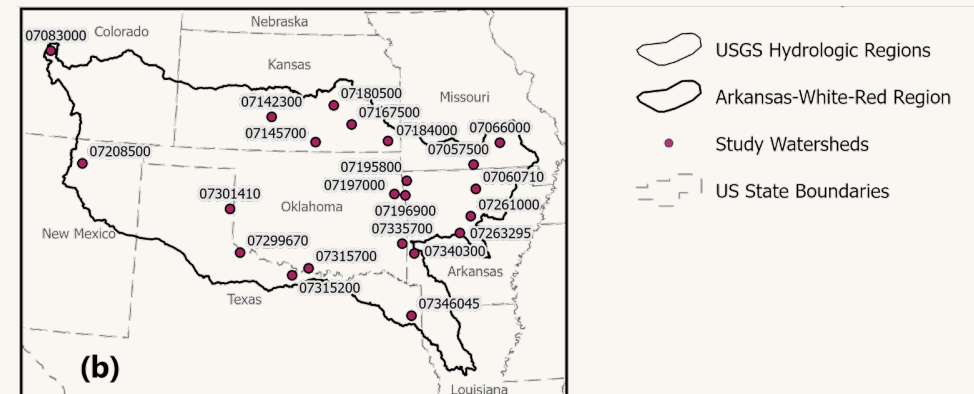
Objectives

- 1) Evaluating HAWQS as a FAIR source for LSTM inputs (**HAWQS-LSTM**)
- 2) Evaluating HAWQS-LSTM for PUB (**HAWQS-PUB-LSTM**)
- 3) Calibrating SWAT models using LSTM outputs (**SWAT-LSTM**)

Training: 509 watersheds



Test: 22 watersheds



23 attributes for EA-LSTM models

Dynamic- 5; Static - 18

Response Variable:
Streamflow



Meteorological Forcings

PRCP
TMP_MXdgC
TMP_MNdgc
SOLAR
SNOWFALLmm

Dynamic



SWAT Inputs

Area	hydA
SNOW	hydB
AVG PET	hydC
%forest	hydD
CH_W	CN2
CH_D	Aridity Index
CH_S	

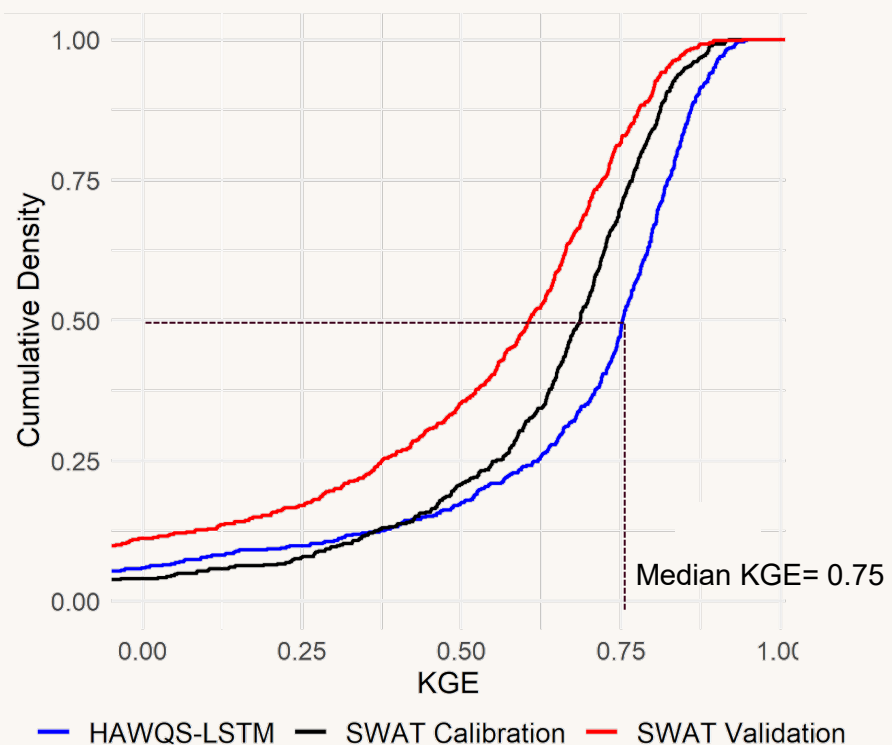
Static



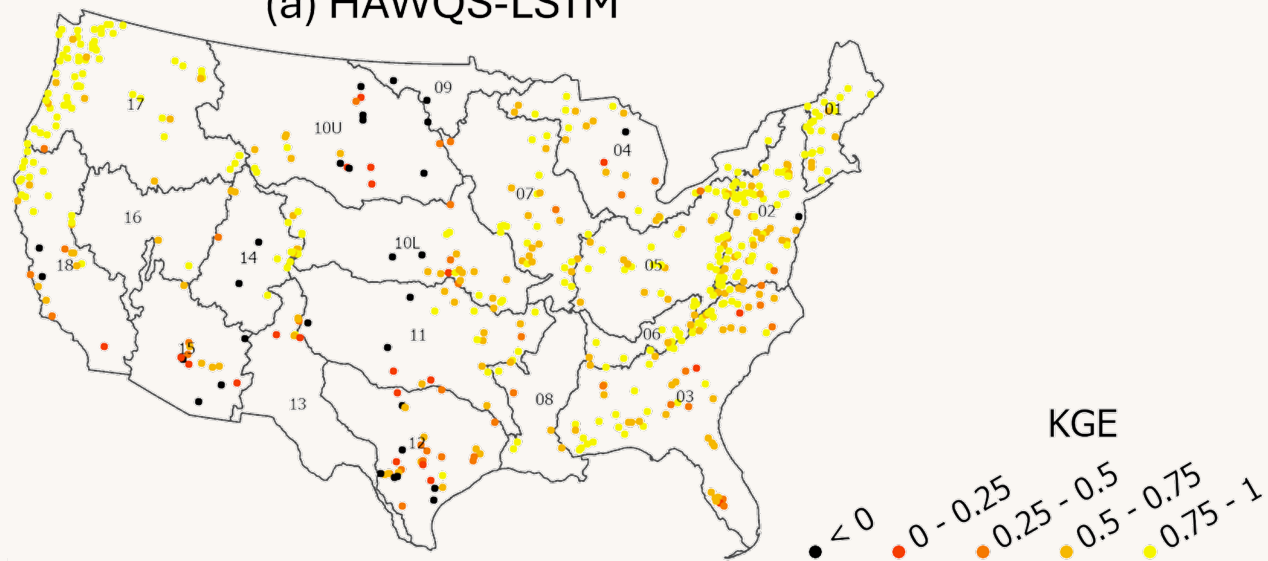
SWAT Uncalibrated Outputs (Annual Average)

SNOW_MELT
TOT_WATER_YIELD
LAT_SOIL_Q
TOT_AQ_RCHRG
AVG_ET

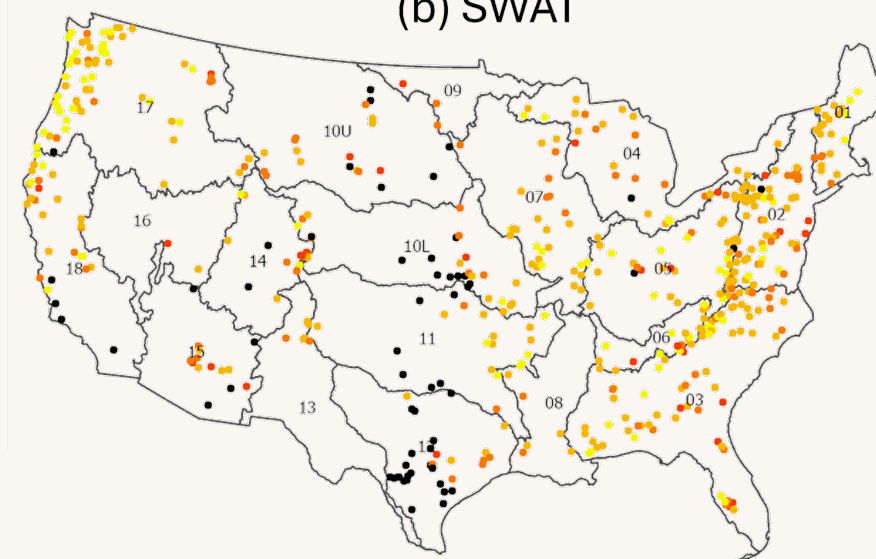
HAWQS-LSTM Forecasting Performance



(a) HAWQS-LSTM



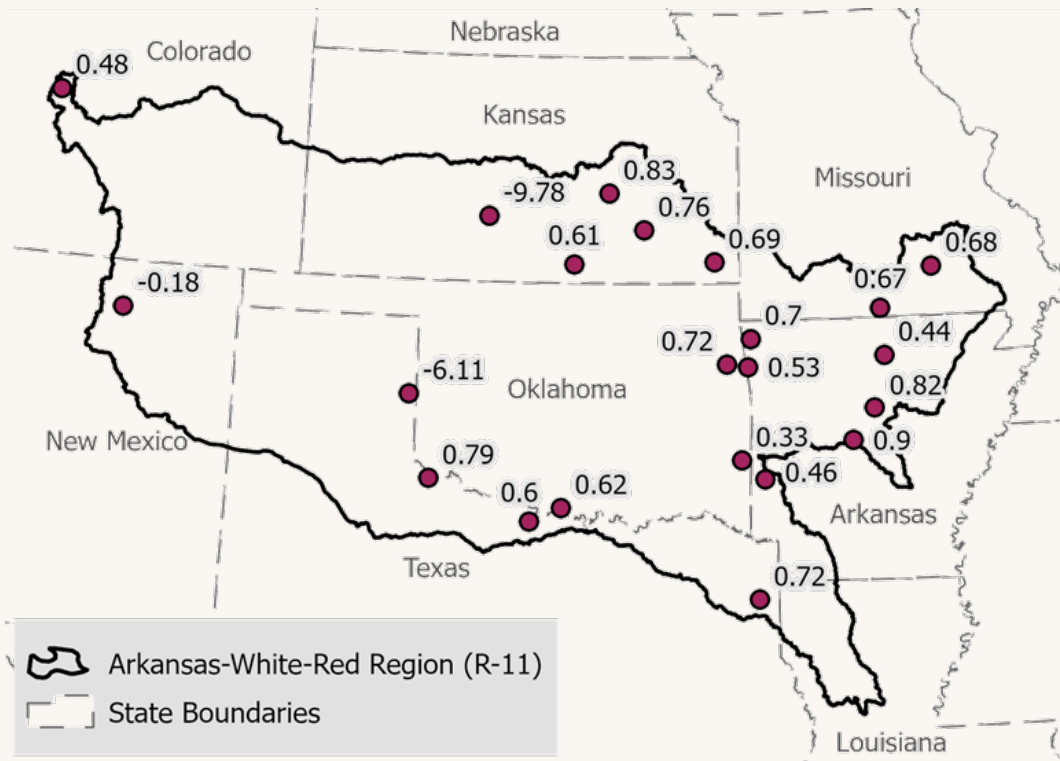
(b) SWAT



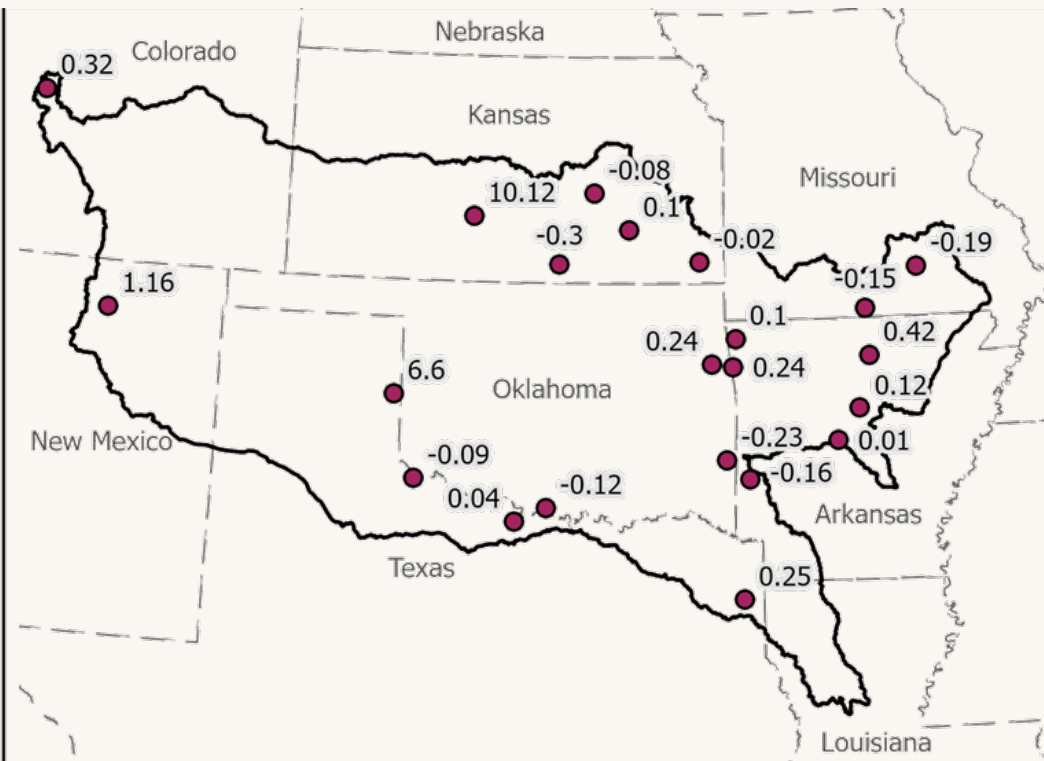
HAWQS-PUB LSTM Performance

19 out of 22 watersheds: $KGE > 0.3$

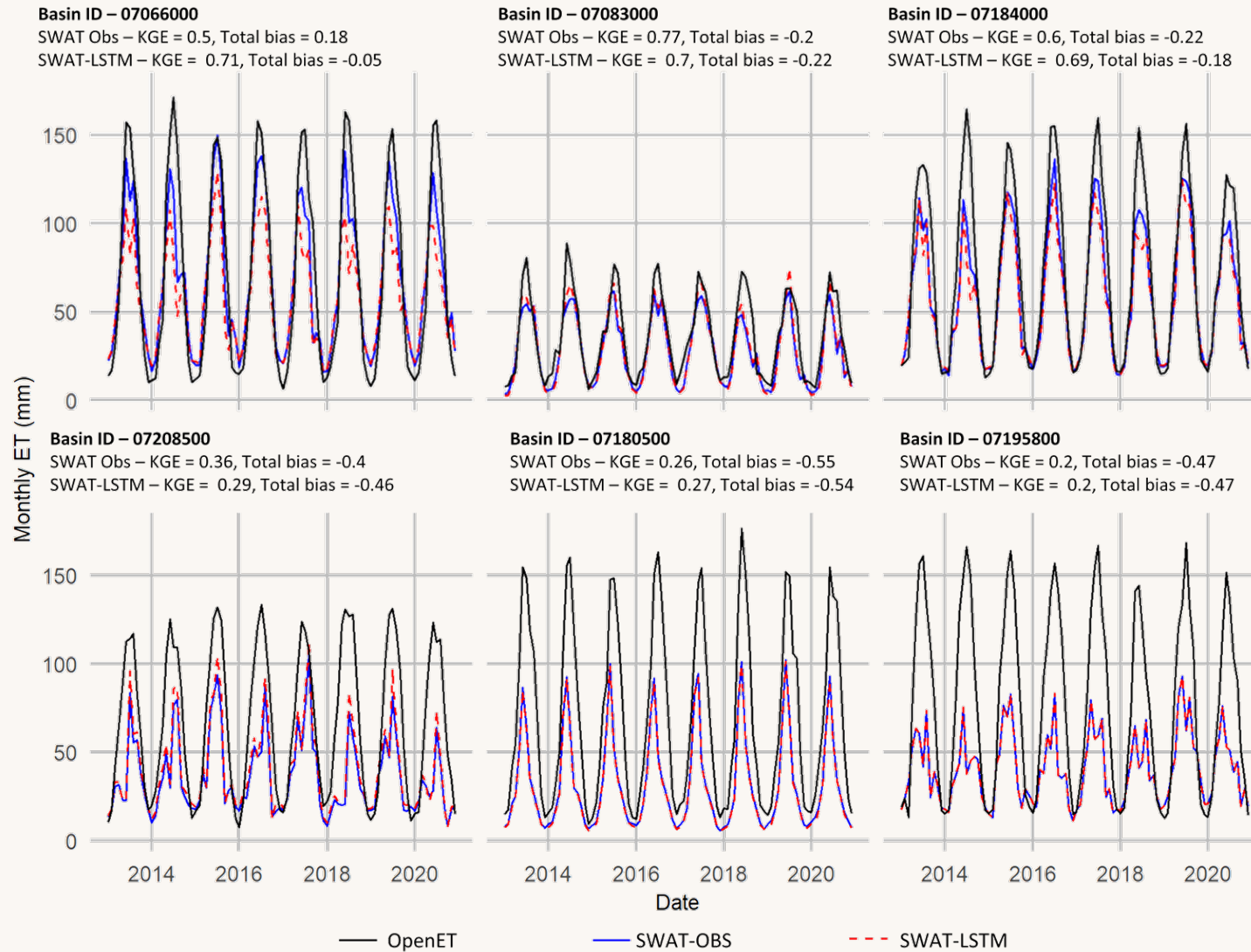
(a) KGE



(b) Total bias



SWAT – LSTM for predicting Evapotranspiration



Best Performing watersheds

Worst Performing watersheds

Key Takeaways

✓ HAWQS: a single FAIR source of inputs for Large Sample DL models.

✓ HAWQS-LSTM model- A reliable streamflow prediction framework

HAWQS-LSTM: a median KGE of 0.75 [forecasting in 531 watersheds]

HAWQS-PUB-LSTM: a median KGE of 0.65 in 22 PUB watersheds

✓ SWAT-LSTM

KGE > 0.3 in 19 of the 22 watersheds [streamflow calibration]

KGE 0.2 - 0.71 [evapotranspiration validation]



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THANK YOU

Contact: arun.bawa@ag.tamu.edu
GitHub: <https://github.com/GEM-TAMU>

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