

Assessing the **Utility and Limitations** of **OpenET** for SWAT Model Calibration in **Arid and Semiarid** Landscapes of the Western United States



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SWAT Modeling Made Simple



hawqs.tamu.edu

HAWQS

Hydrologic and Water Quality System



Land Use	National Land Cover Database (NLCD)	
	USDA NASS Cropland Data Layer (CDL)	2014 – 2017
	USDA NASS Fields	2006 – 2010
	U.S. Fish and Wildlife Service (FWI) National Wetlands Inventory (NWI)	2018
Soil	USDA NRCS SSURGO Database	
	USDA NRCS STATSGO Database	2018

Watershed Boundaries	EPA NHDPlus v2	
Stream Networks	EPA NHDPlus v2	2019
Elevation	USGS National Elevation Dataset (NED)	2018

SWAT Model setup- just a few clicks away!!

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



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

Downstream subbasin

031502

03150201

03150202

03150203

03150204

Projects

HUC14 - 12030102030604 (1)

HUC14 - 12030102030604

HUC12 - 120601010811

HUC14 - 02050306150302

HUC14 - 12070202030704

All projects

Create a new project

Upload a project

User-submitted datasets

Brigida Watershed, Brazil

Pontal Watershed, Brazil

Vistula and Odra Watersheds, Poland

Buchanan - LCRA

Ghana-HAWQS

NEW CORB SWAT-MODFLOW

Mahanadi

Updated Ewaso Ng'iro Basin

UA_basins_Prypiat_Dnister_SiverDonets

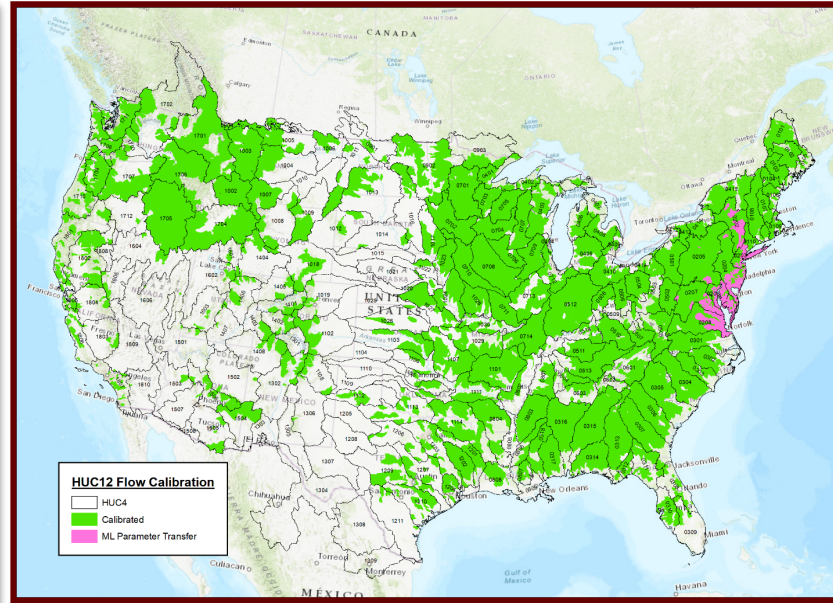
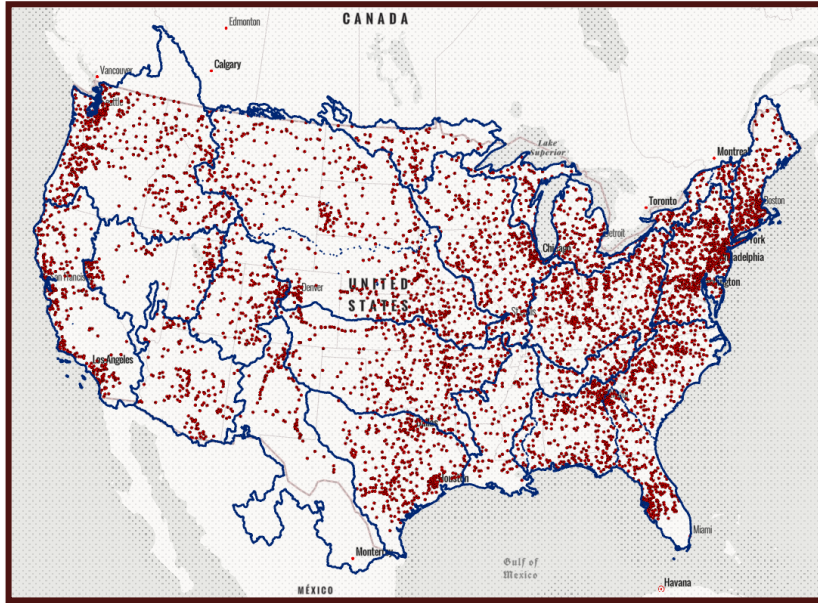
Ukraine with transboundary parts (20/20/20 HRU)

Ukraine with transboundary parts (5/5/5 HRU)

Africa 10km

HAWQS API

SWAT Hydrological Calibration- USGS gages



Calibrated **38,295** HUC12s out of 79,837

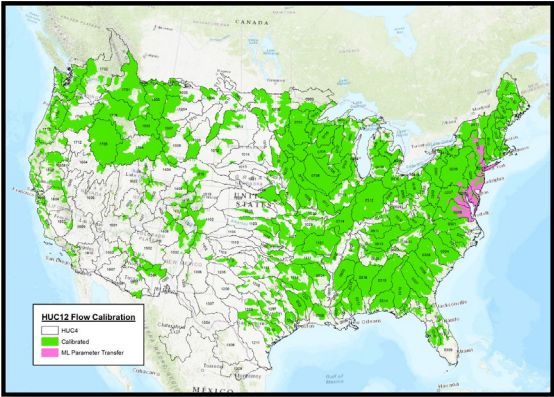
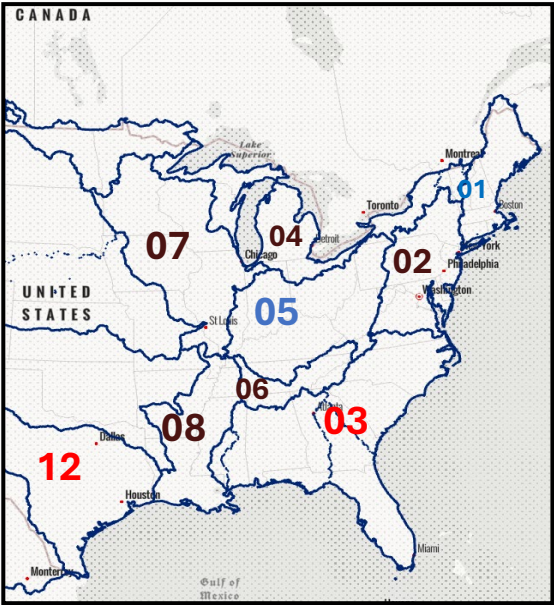
4,113 gages calibrated across CONUS

HUC2	Total Gages	Calibration Successful	Gages Calibrated (%)
R01	258	241	93.41
R02	553	482	87.16
R03	808	696	86.14
R04	334	241	72.16
R05	528	473	89.58
R06	98	88	89.80
R07	414	352	85.02
R08	104	95	91.35
R09	88	58	65.91
R10	593	297	50.08
R11	392	247	63.01
R12	330	167	50.61
R13	91	24	26.37
R14	183	78	42.62
R15	156	42	26.92
R16	131	45	34.35
R17	515	349	67.77
R18	268	141	52.61
Total	5844*	4113	70.37

Bawa et al., 2023, Environmental Modelling & Software

HUC2	Calibration Successful	High PBIAS	Calibration Unsuccessful	Original calibration sites	Gages Calibrated (%)
R01	229	10	3	242	94.6
R02	356	69	51	476	83
R03	494	84	228	700	70.6
R04	199	27	12	238	83.6
R05	449	14	10	473	94.9
R06	72	14	0	86	83.7
R07	298	8	48	354	84.2

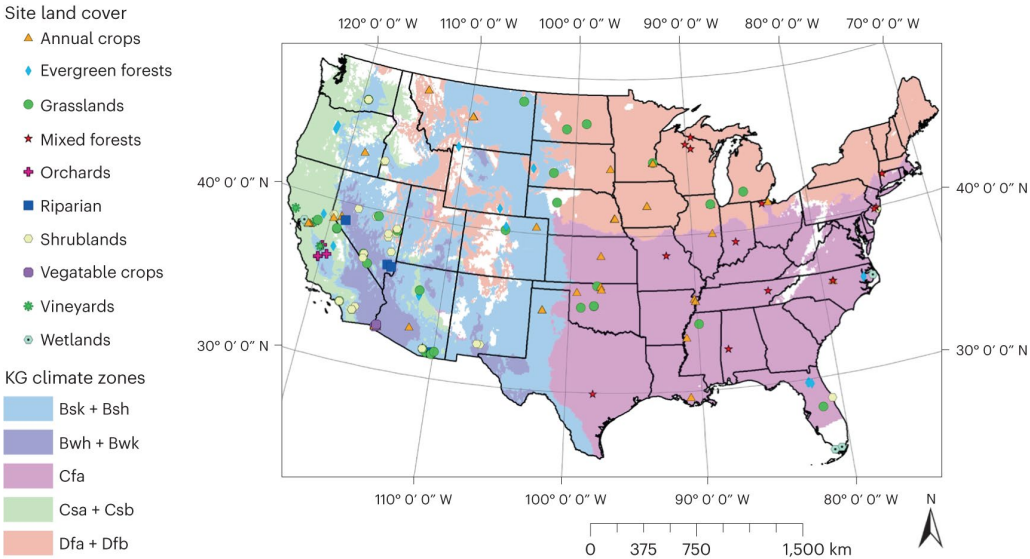
R12	74	-	-	124	59.7%
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Bawa et al., 2025, Environmental Modelling & Software

openET- Multi-model satellite-based evapotranspiration data estimation platform.

OpenET-ensemble

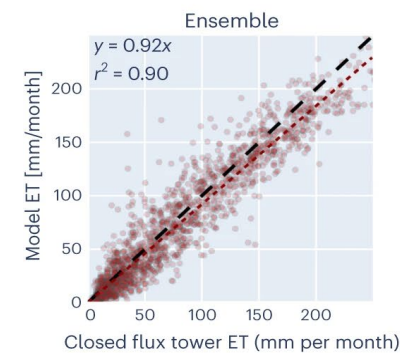
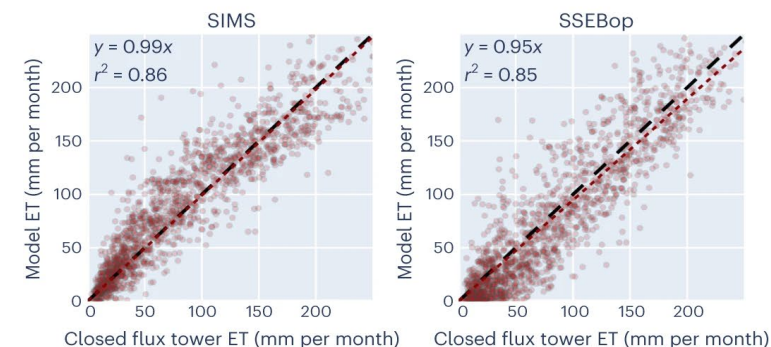
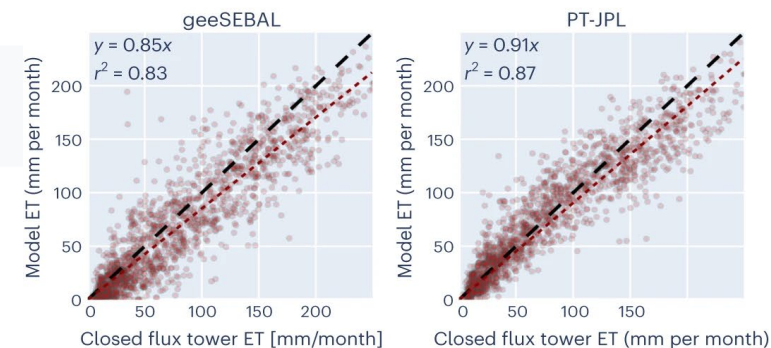
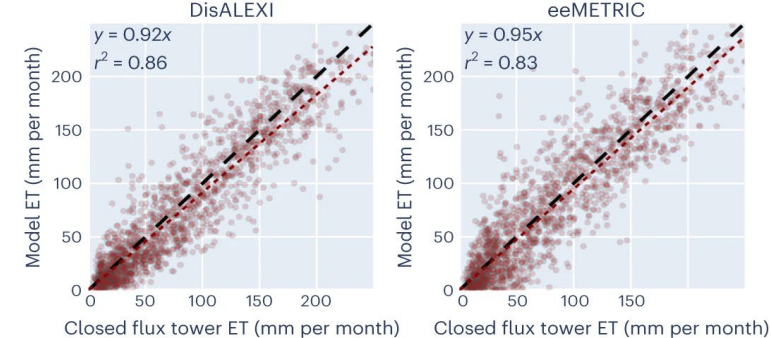


Model Acronym	Model Name	Primary References
ALEXI/DisALEXI v 0.0.32	Atmosphere-Land Ex change Inverse / Dis aggregation of the Atmosphere-Land Exchange Inverse	Anderson et al., 2007; Anderson et al., 2018;
eeMETRIC v 0.20.26	Google E arth E ngine implementation of the M apping Evapotranspiration at high R esolution with Internalized C alibration model	Allen et al., 2007; Kilic et al., 2011; Allen et al., 2011
geeSEBAL v 0.2.2	Google E arth E ngine implementation of the S urface E nergy B alance A lgorithm for L and	Bastiaanssen et al., 1998; Laipelt et al., 2021
PT-JPL v 0.2.1	P riestley-Taylor J et P ropulsion L aboratory	Fisher et al., 2008
SIMS v 0.1.0	S atellite I rrigation M anagement S upport	Melton et al., 2012; Pereira et al., 2020
SSEBop v 0.2.6	O perational S implified S urface E nergy B alance	Senay et al., 2013; Senay et al., 2018

OpenET Ensemble ET Accuracy Summary

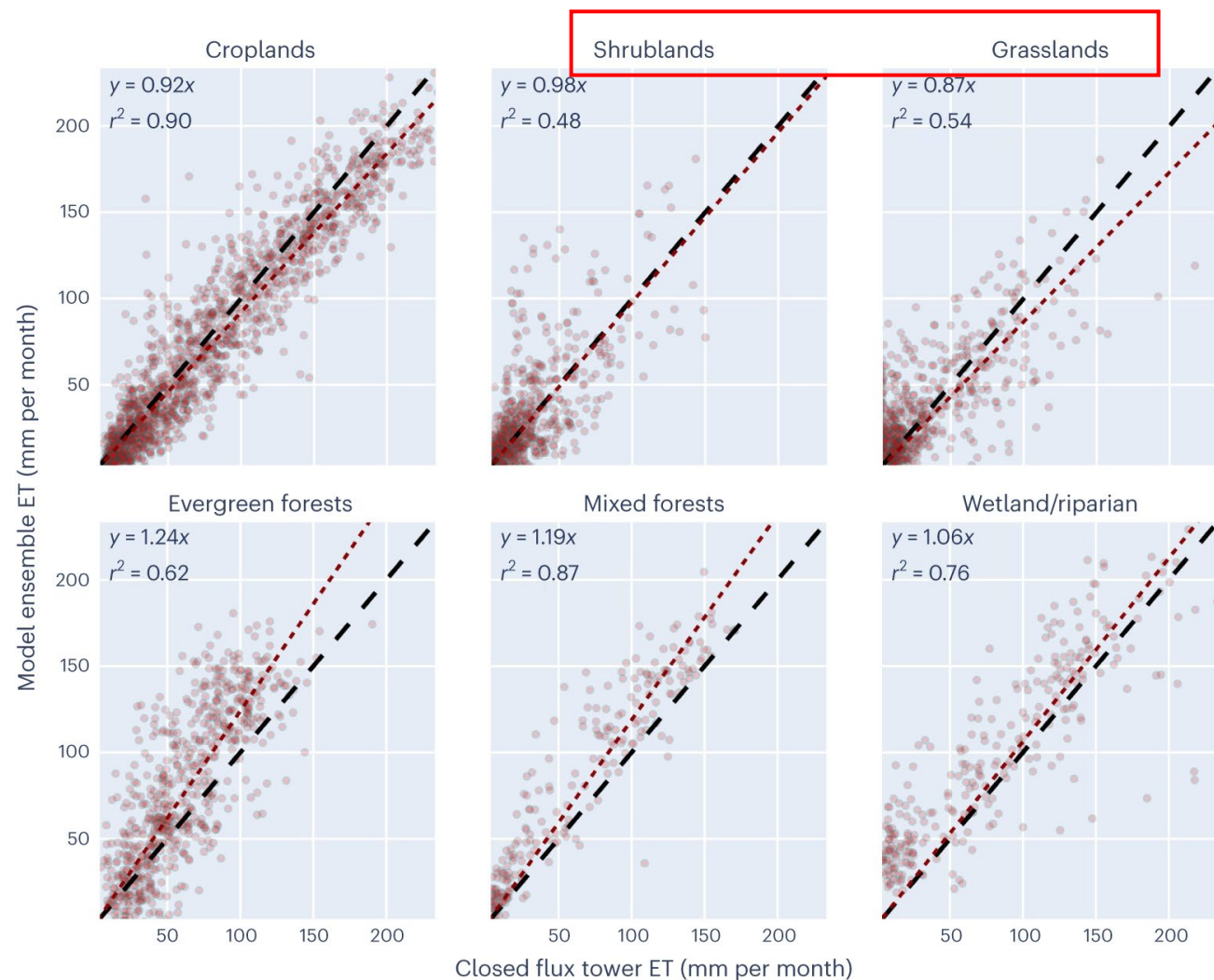
Croplands

Time Period	Slope	Mean Bias Error)	Mean Absolute Error	Root Mean Squared Error	r-squared	Mean flux tower ET
Water Year: 16 sites with 72 total water years	0.91	-73.91 mm (-7.5%)	112.12 mm (11.3%)	121.87 mm (12.3%)	0.84	991 mm
Growing Season: 39 sites with 177 growing seasons	0.96	-11.9mm (-2.0%)	78.14 mm (12.9%)	93.79 mm (15.5%)	0.87	605 mm
Monthly: 46 sites with 1,791 total months	0.92 (n = 53)	-5.27 mm (-5.8%)	15.84 mm (17.3%)	20.44 mm (22.4%)	0.90 (n = 53)	91 mm
Daily: 55 sites with 5,508 total Landsat overpass days	0.86 (n = 60)	-0.35 mm (-10.0%)	0.83 mm (23.6%)	1.09 mm (31.1%)	0.81 (n = 60)	3.5 mm



OpenET Ensemble ET Accuracy Summary

land cover type



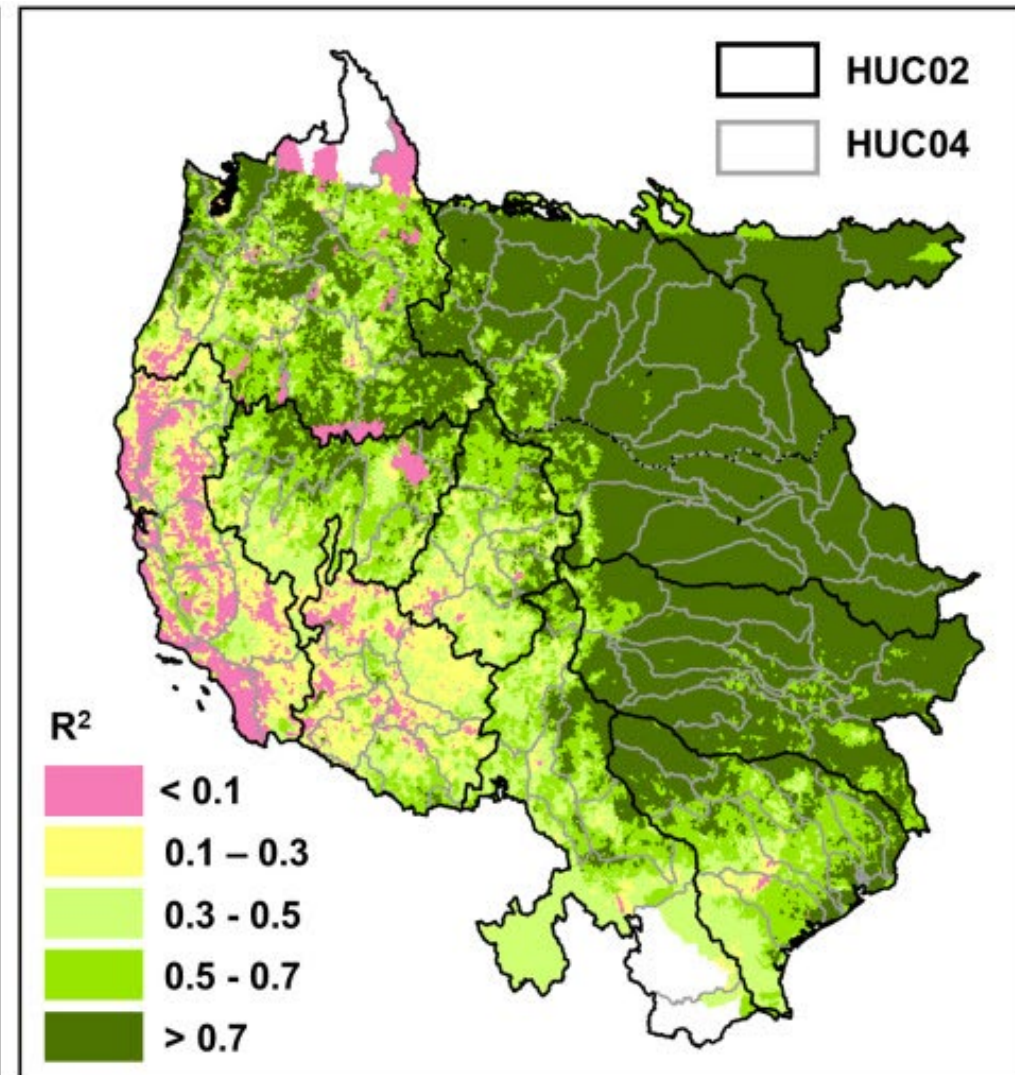
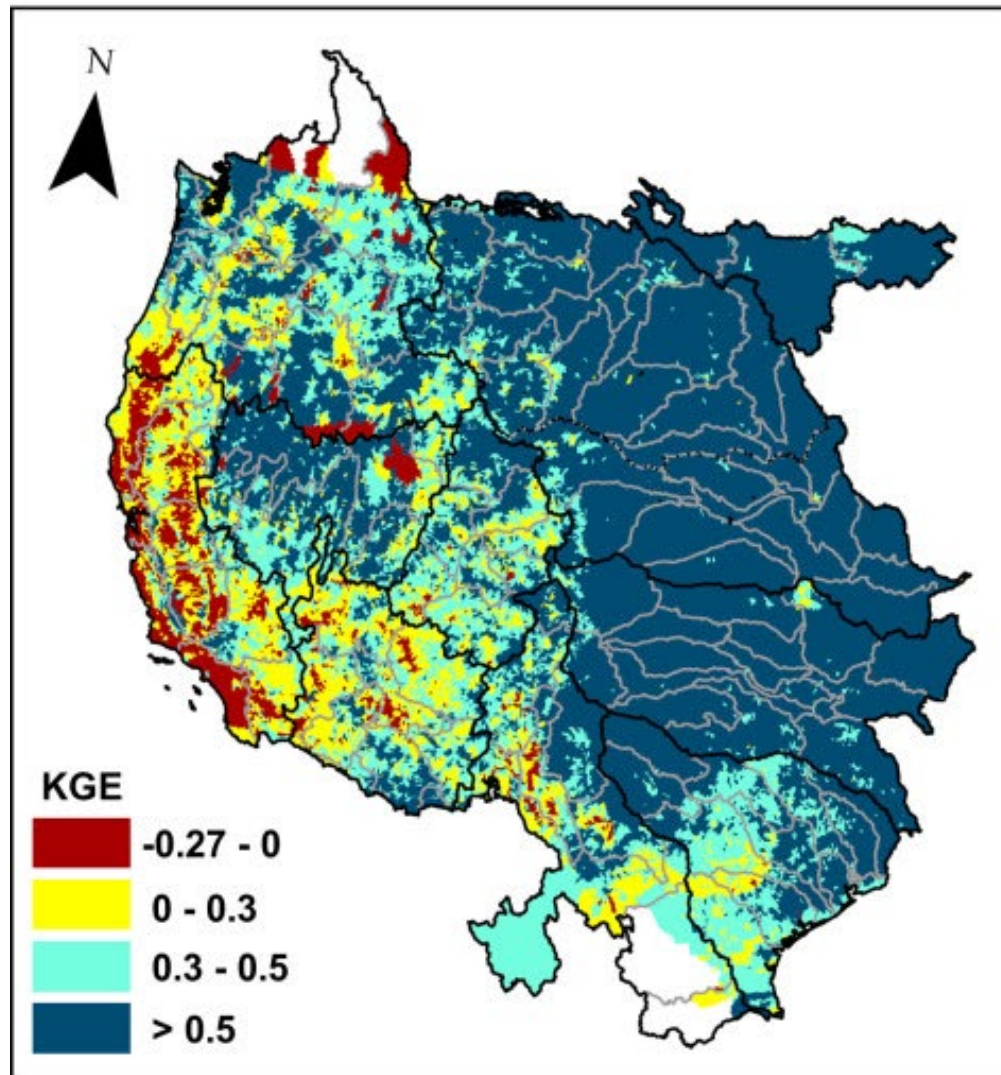
Land cover type	Statistic	Ensemble	Range
Croplands 45 sites N = 1682 months Mean station ET = 93.68 (mm)	Slope	0.95	0.86 - 1.04
	MBE (mm)	-3.64 (-3.9%)	-13.77 - 5.16 (-14.7 - 5.5%)
	MAE (mm)	15.55 (16.6%)	17.96 - 22.92 (19.2 - 24.5%)
	RMSE (mm)	19.97 (21.3%)	23.43 - 28.72 (25.0 - 30.7%)
	R-squared	0.95	0.89 - 0.93
Evergreen Forests 14 sites N = 783 months Mean station ET = 61.02 (mm)	Slope	1.19	1.06 - 1.32
	MBE (mm)	14.16 (23.2%)	7.07 - 21.11 (11.6 - 34.6%)
	MAE (mm)	23.79 (39.0%)	24.67 - 31.43 (40.4 - 51.5%)
	RMSE (mm)	28.62 (46.9%)	30.0 - 37.91 (49.2 - 62.1%)
	R-squared	0.79	0.71 - 0.78
Grasslands 20 sites N = 672 months Mean station ET = 42.56 (mm)	Slope	1.03	0.73 - 1.28
	MBE (mm)	-1.23 (-2.9%)	-11.88 - 9.73 (-27.9 - 22.9%)
	MAE (mm)	19.19 (45.1%)	20.17 - 28.1 (47.4 - 66.0%)
	RMSE (mm)	24.12 (56.7%)	24.62 - 35.96 (57.8 - 84.5%)
	R-squared	0.75	0.54 - 0.8
Mixed Forests 10 sites N = 255 months Mean station ET = 61.02 (mm)	Slope	1.16	0.99 - 1.29
	MBE (mm)	19.14 (31.4%)	8.34 - 27.06 (13.7 - 44.3%)
	MAE (mm)	21.54 (35.3%)	19.51 - 30.3 (32.0 - 49.7%)
	RMSE (mm)	26.8 (43.9%)	24.44 - 36.35 (40.1 - 59.6%)
	R-squared	0.88	0.8 - 0.88
Shrublands 24 sites N = 681 months Mean station ET = 31.07 (mm)	Slope	0.95	0.65 - 1.34
	MBE (mm)	2.89 (9.3%)	-5.2 - 12.87 (-16.7 - 41.4%)
	MAE (mm)	15.68 (50.5%)	17.45 - 22.64 (56.2 - 72.9%)
	RMSE (mm)	19.96 (64.2%)	20.9 - 29.18 (67.3 - 93.9%)
	R-squared	0.66	0.3 - 0.69
Wetlands 7 sites N = 269 months Mean station ET = 87.57 (mm)	Slope	1.14	1.0 - 1.25
	MBE (mm)	14.36 (16.4%)	6.71 - 25.5 (7.7 - 29.1%)
	MAE (mm)	28.94 (33.0%)	29.93 - 36.19 (34.2 - 41.3%)
	RMSE (mm)	35.24 (40.2%)	36.33 - 44.0 (41.5 - 50.2%)
	R-squared	0.82	0.72 - 0.81

Volk et al., 2024

OpenET web documentation- current

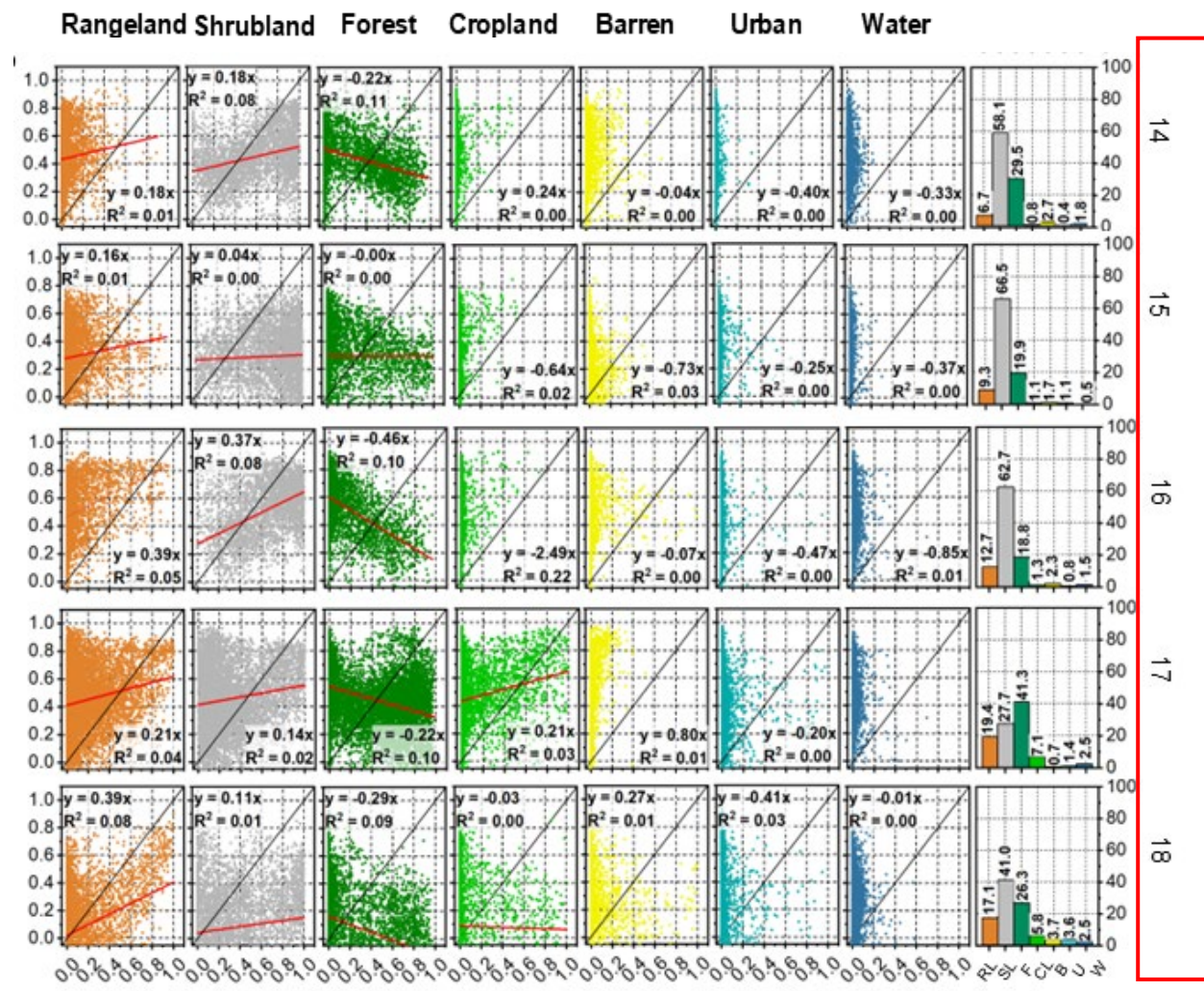
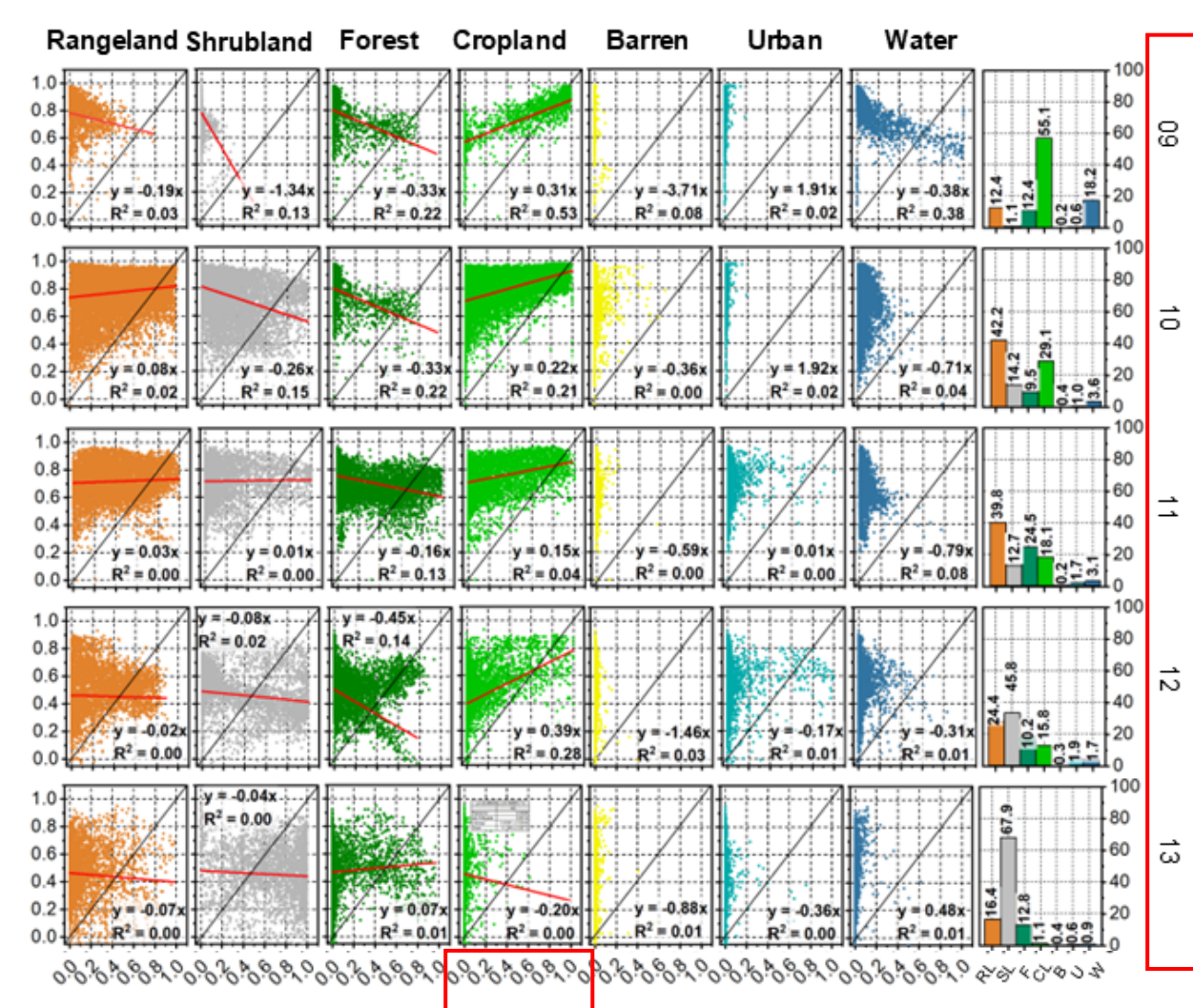
KGE- OpenET Ensemble ET vs SWAT ET

HUC12/monthly

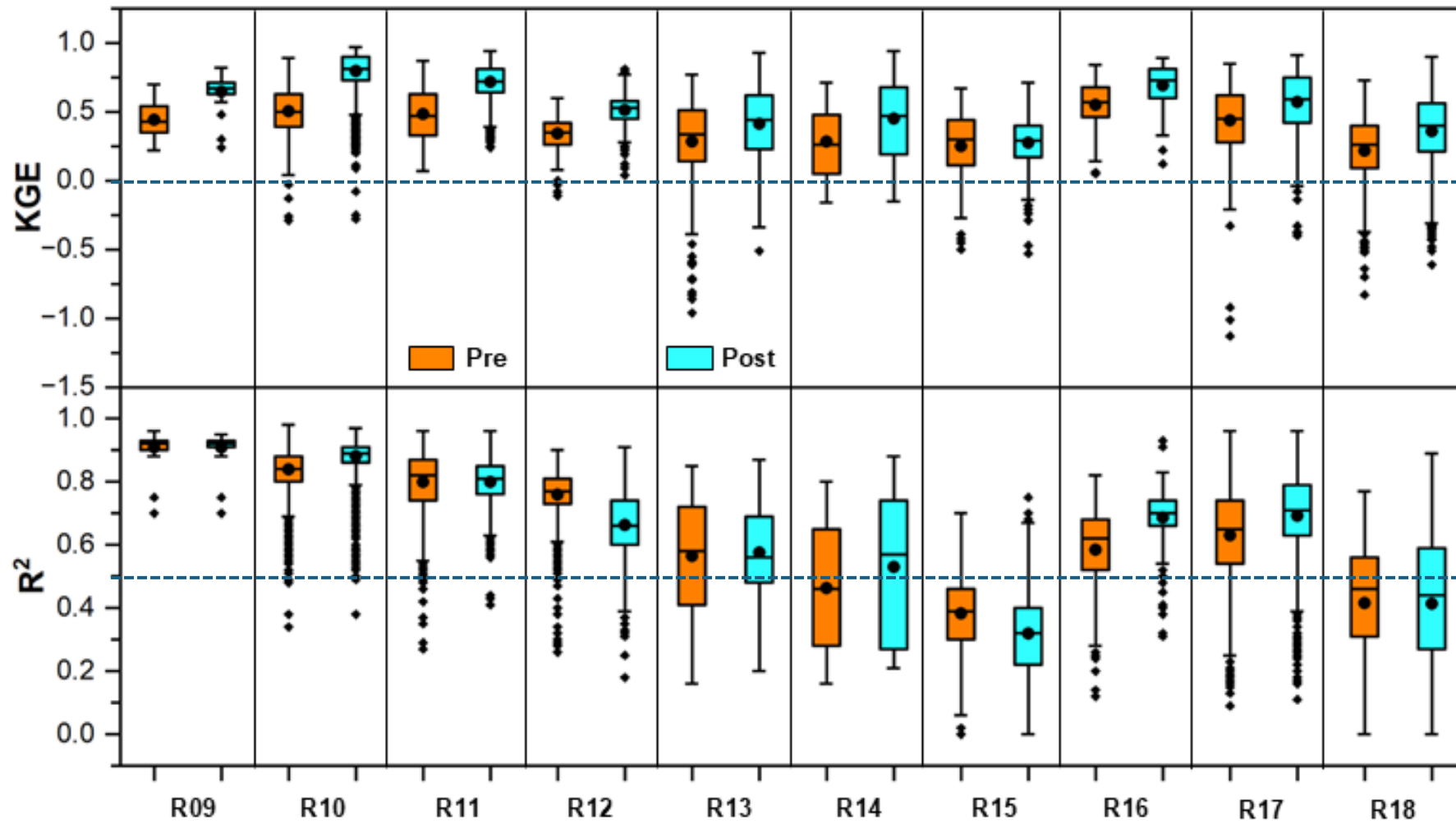


KGE- OpenET Ensemble ET vs SWAT ET

HUC12/monthly

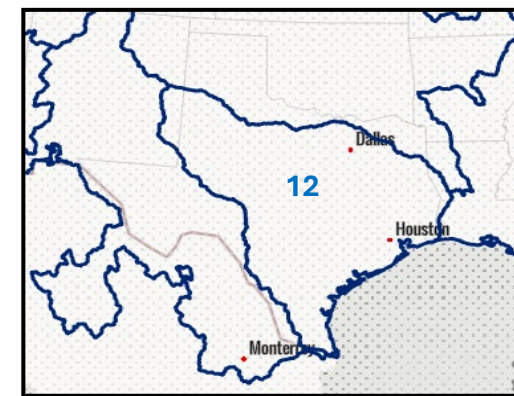
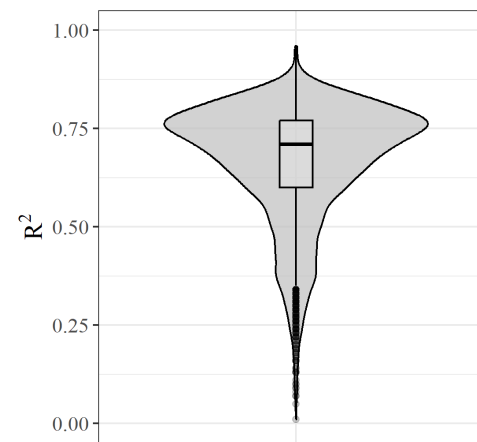
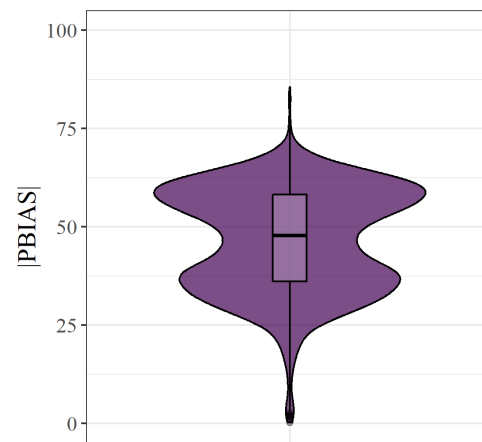
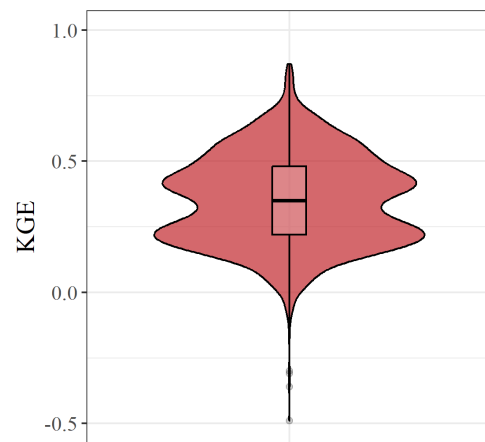


Rangeland and shrubland dominating HUC12s



SWAT Hydrological Calibration- OpenET

SWAT Default
Parameters



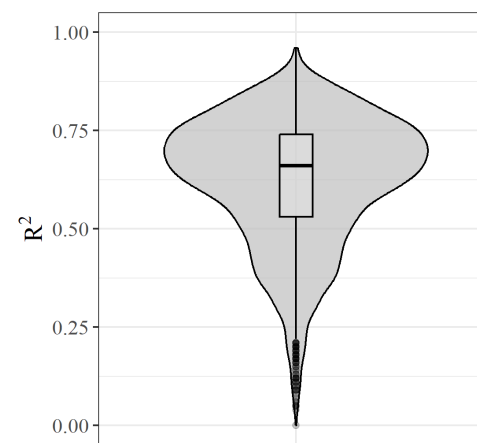
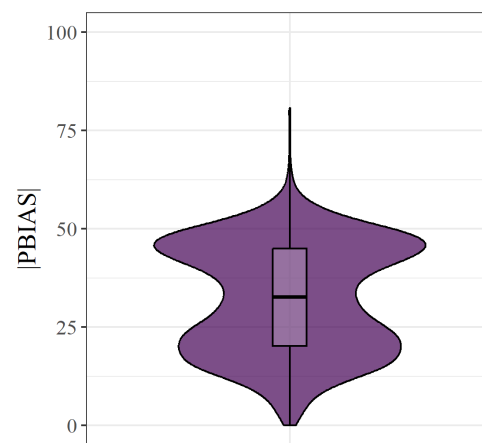
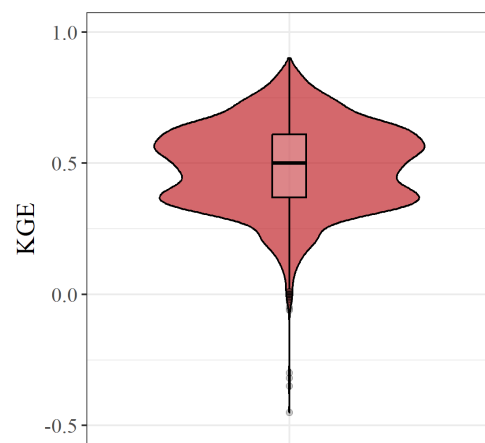
R12: 3,871 HUC12s

KGE > 0.3

Before: 2,278 (58.9%)

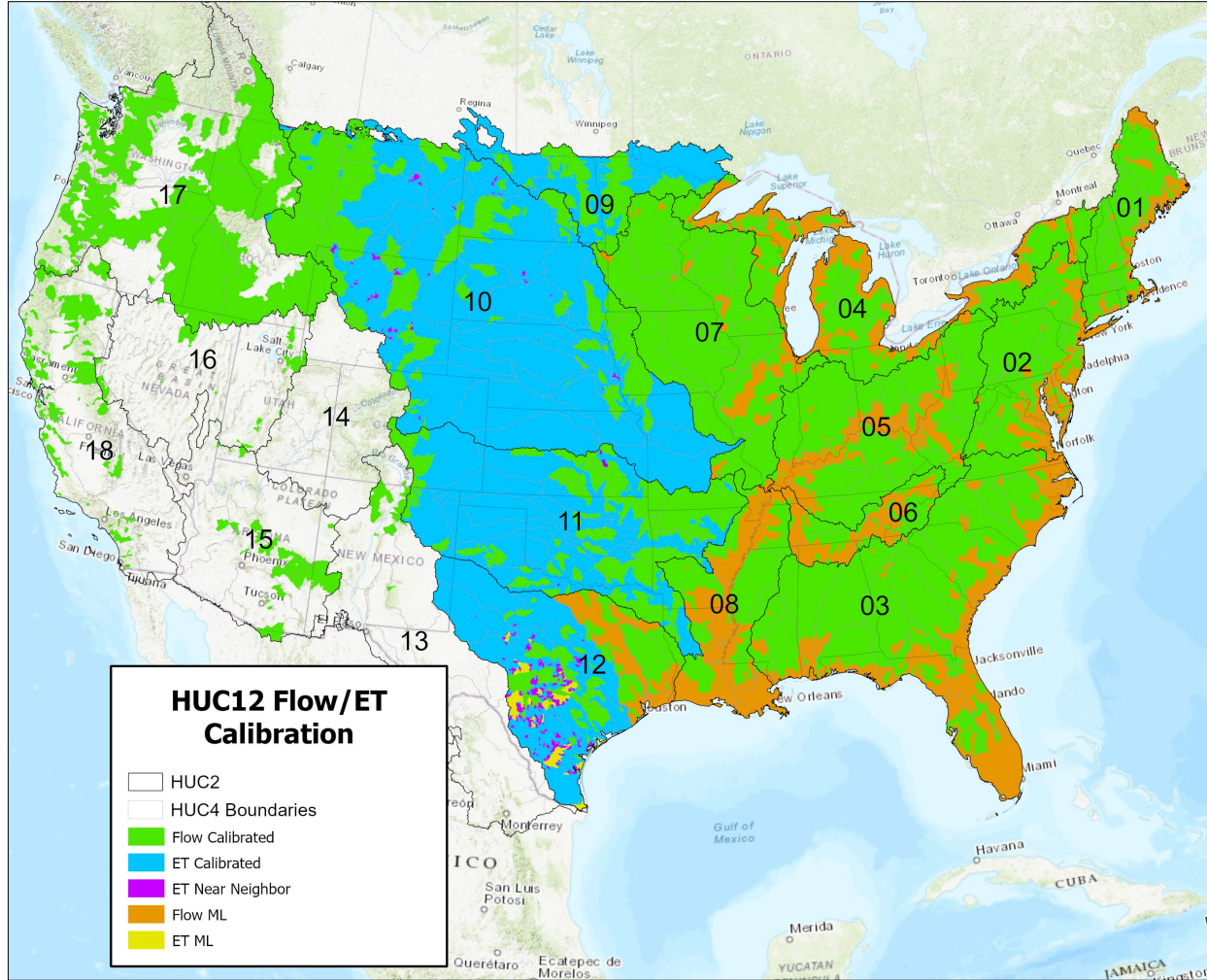
After: 3,498 (90.4%)

After ET
Calibration



HAWQS hydrological calibration status

HUC12/monthly





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Thank you!

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Blackland Research Ext. Center

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