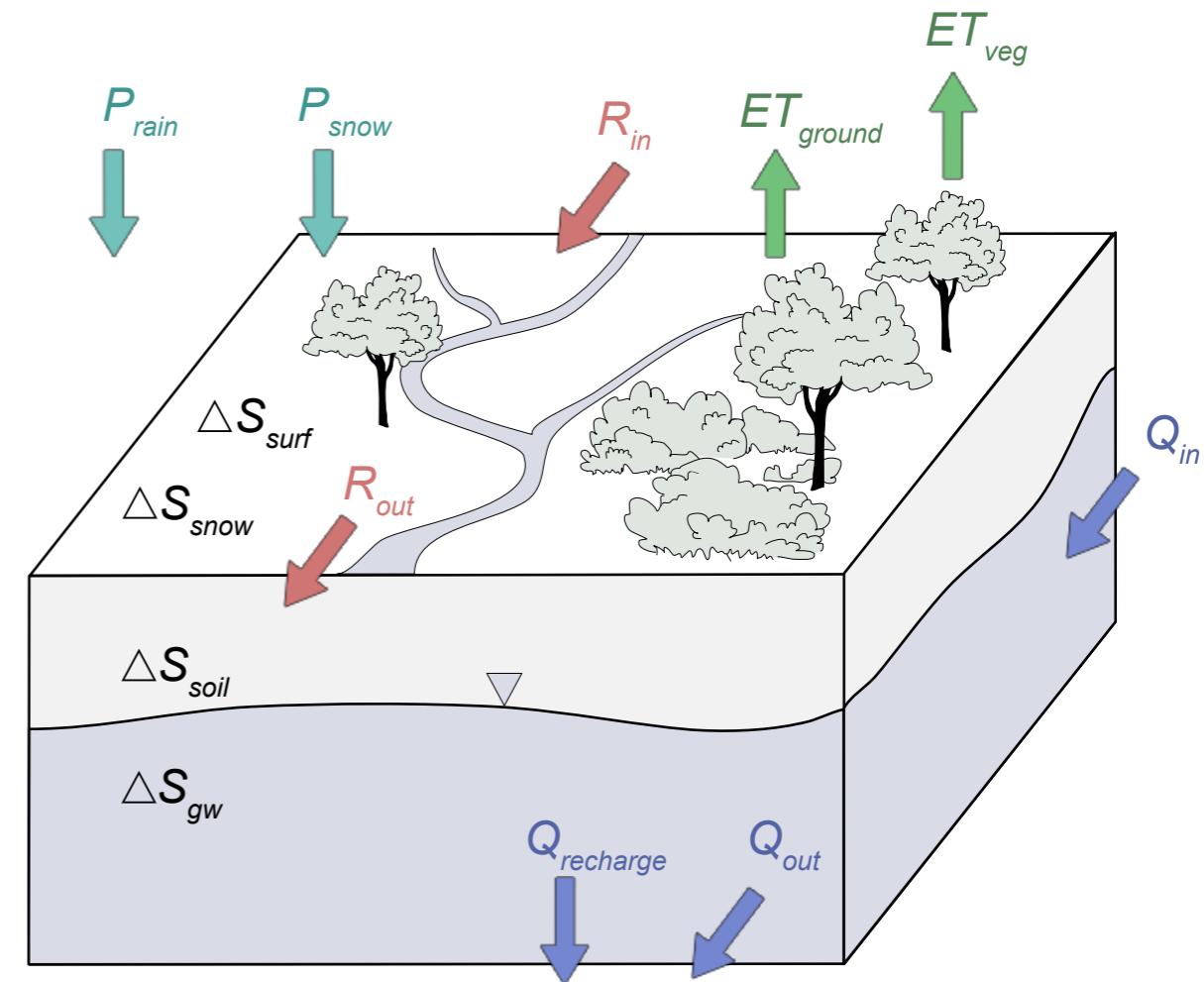


CONUS version 1.0 simulations:

- **2003 - 2007** water year
- Analysis and performance metrics shown here for 2003 - 2005 water years (2006 and 2007 are being processed now)
- All ~ **45 TB on Cheyenne**
- All processing scripts and validation datasets on Cheyenne

Data products for evaluation:

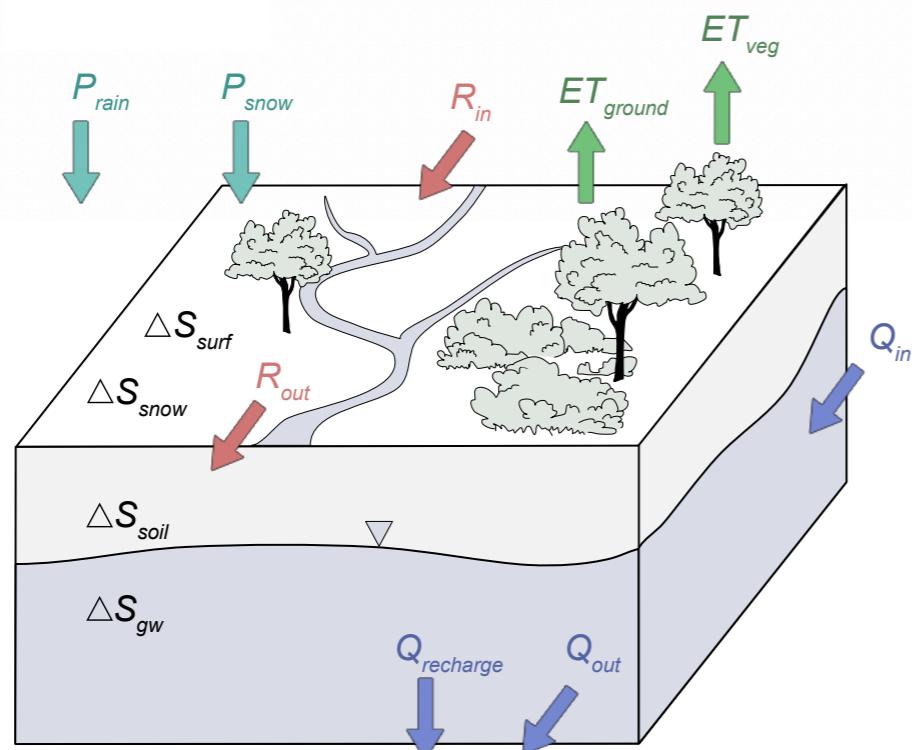
- **USGS stream gauges (N=2392)**
- FluxNET sites (N=29)
- SSeBOP and MOD16A2 MODIS spectroradiometer imaging
- **SNOTEL (N=556)**
- ESACCI Active/passive sensing
- **USGS wells (N=2,486 temporal, N=41,269 static)**
- GRACE gravity anomalies
- GHCND meteorological stations (N=9,139)



Total: 14,602 in situ locations and 5 remote sensing products

# Spearman correlation between CONUSv1 and observations or remote sensing:

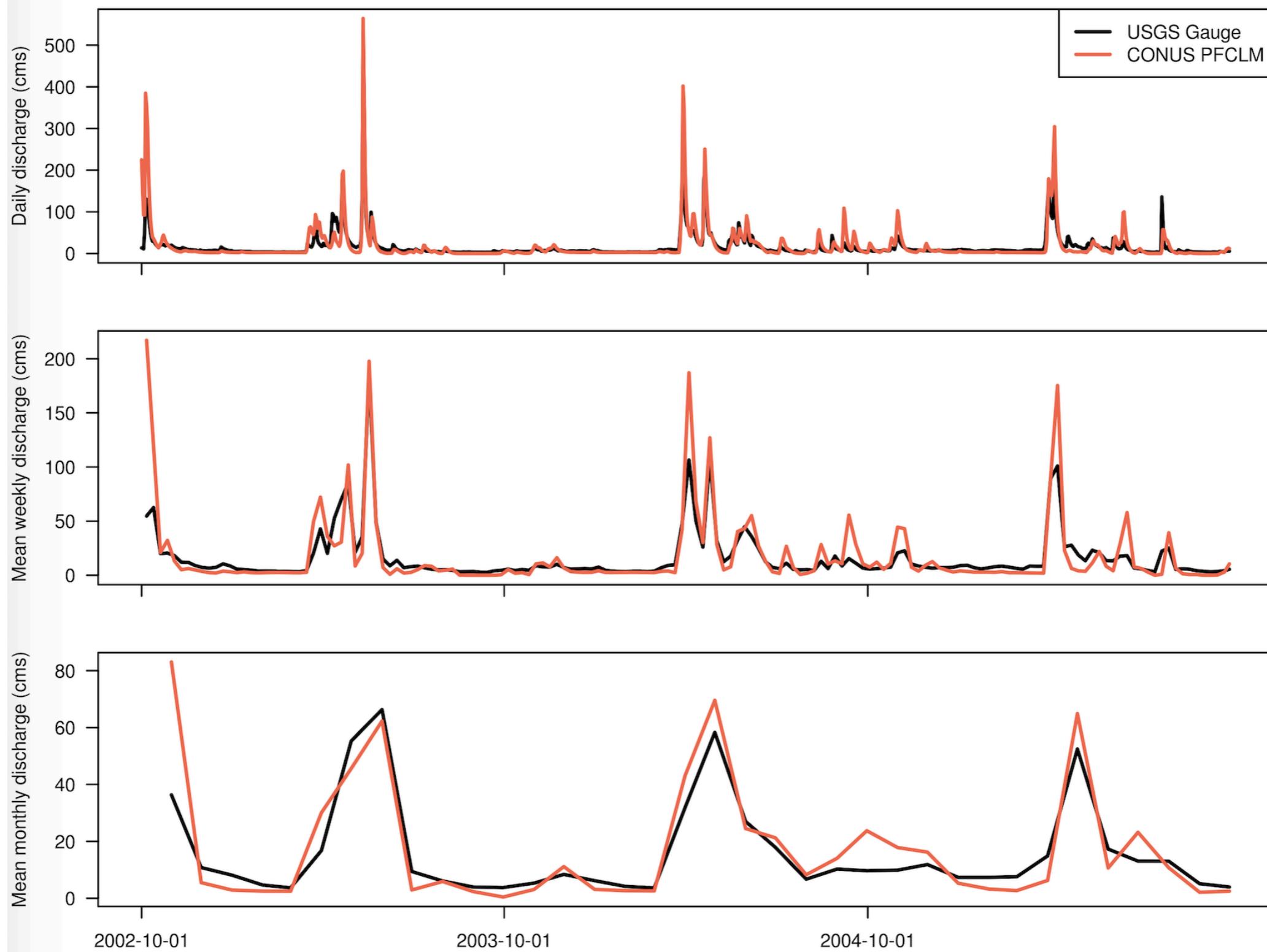
	Temporal, spatial resolution	Component	Percentile			
			25th	50th	75th	
USGS stream gauges	Daily, point scale	$R$		0.46	0.65	0.77
FluxNET	Daily, point scale	$ET$		0.65	0.72	0.81
SSeBop	Monthly, HUC8	$ET$		0.85	0.91	0.94
MOD16A2	Monthly, HUC8	$ET$		0.41	0.85	0.93
GRACE	Monthly, major basin	$S, \text{total}$		0.75	0.78	0.86
USGS wells	Daily, point scale			0.14	0.46	0.7
ESACCI SM	Monthly, major basin	$S, \text{soil}$		0.56	0.72	0.81
SNOTEL	Daily, point scale	$S, \text{snow}$		0.88	0.92	0.97



## Scripting, specific to streamflow:

- Started with Laura's R scripts from 4? years ago
- Reorganized into three primary goals: download, organize, metrics/analysis/plots
- Organization: Returns matrix of  $n = \text{gauge IDs}$  by  $m = \text{days in simulation}$  for both CONUS and observed data. Functions available for subsetting by major basin, date, or shape file (HUC, etc.).
- **No additional gauges added.** Some gauges were decommissioned before 2002.
- Daily, weekly, monthly plots

# BAD RIVER NEAR ODANAH, WI



## Development

Disturbance Index: 7  
 Number of Dams 1990: 7  
 Dam Storage 1990 (1000 m<sup>3</sup>): 4632.6  
 Distance to nearest dam (km): 17.7  
 Withdrawals 95-00 (1000 m<sup>3</sup> per yr): 11338.6  
 Portion of Watershed Irrigated in 2002: 0%

## Drainage Area

Gages: 1619.8 km<sup>2</sup>  
 NWIS: km<sup>2</sup>  
 ParFlow: 1669.8 km<sup>2</sup>  
 Diff PF vs Gages: 3.1%

## Annual Flow Volume

ParFlow: 560.88 MCM per year  
 USGS Gage: 507.54 MCM per year  
 Bias: 53.29 MCM per year  
 Relative Bias: 10.5%

## Correlation

Daily Spearman rho: 0.79  
 Weekly Spearman rho: 0.79  
 Monthly Spearman rho: 0.91  
 Daily R<sup>2</sup>: 0.76  
 Weekly R<sup>2</sup>: 0.76  
 Monthly R<sup>2</sup>: 0.81

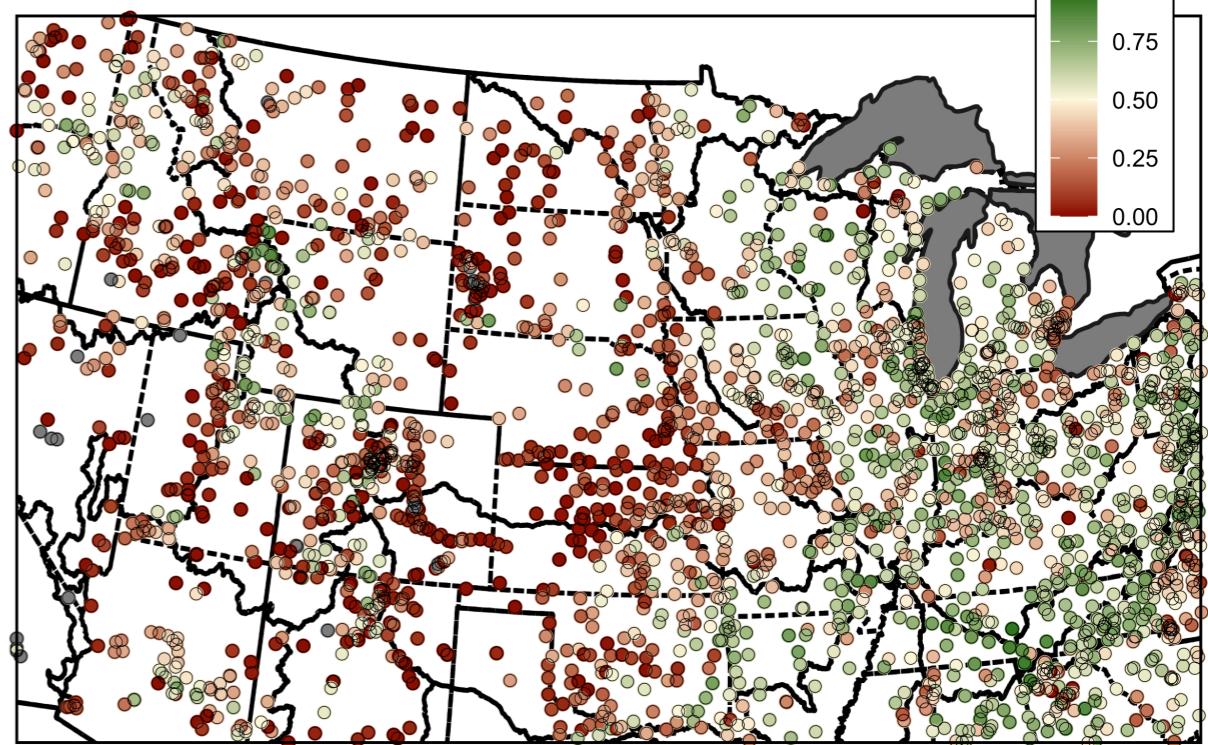
## Monthly RMSE

RMSE: 10.01  
 Range-scaled RMSE: 16%

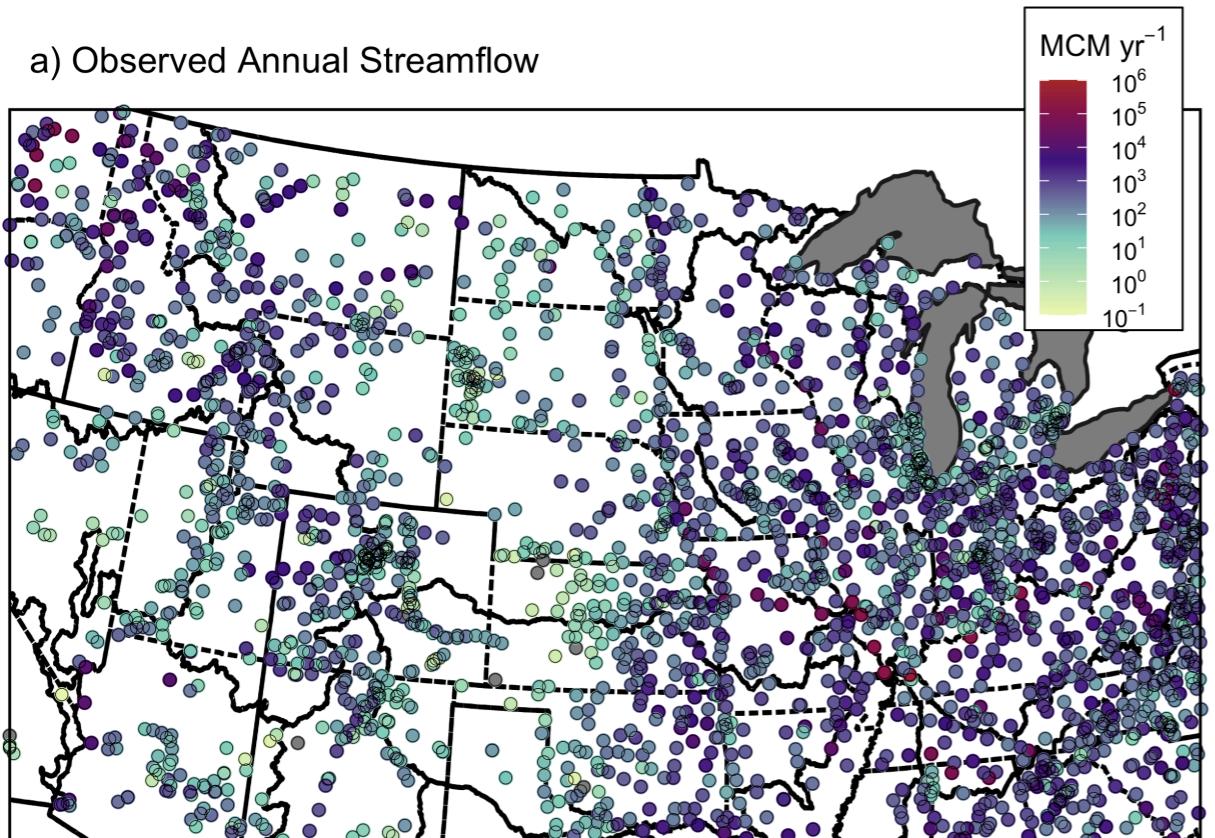
# Streamflow summary performance metrics

Metric	Percentile		
	25th	50th	75th
Relative absolute bias	0.18	0.433	1
Relative absolute bias RR	0.12	0.36	1
Daily rho	0.46	0.65	0.77
Weekly rho	0.46	0.69	0.8
Monthly rho	0.52	0.75	0.84
Daily R	0.18	0.39	0.59
Weekly R	0.28	0.57	0.73
Monthly R	0.38	0.65	0.8
Daily NSE	-5.6	-0.5	0.25
Weekly NSE	-5.3	-0.44	0.42
Monthly NSE	-4.4	-0.3	0.49
Daily RSR	0.86	1.23	2.6

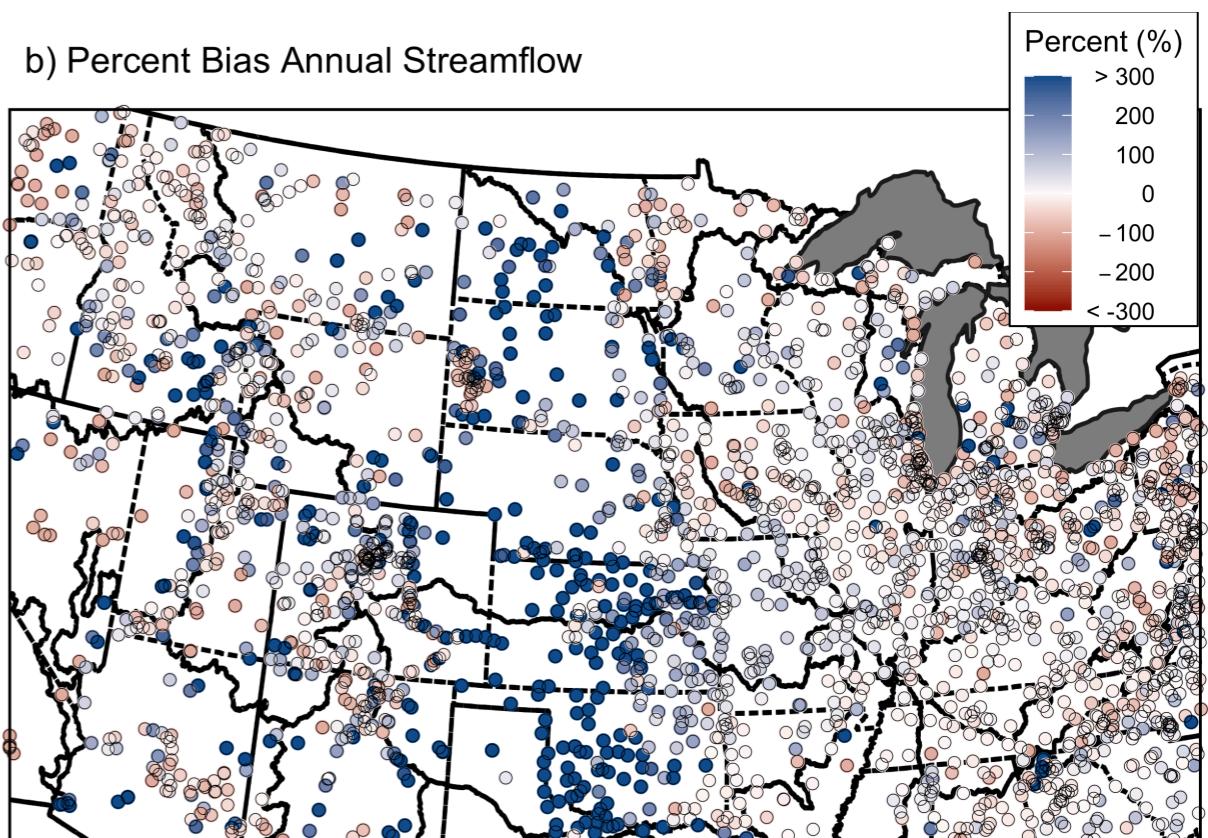
e) Spearman Correlation of Daily Flow



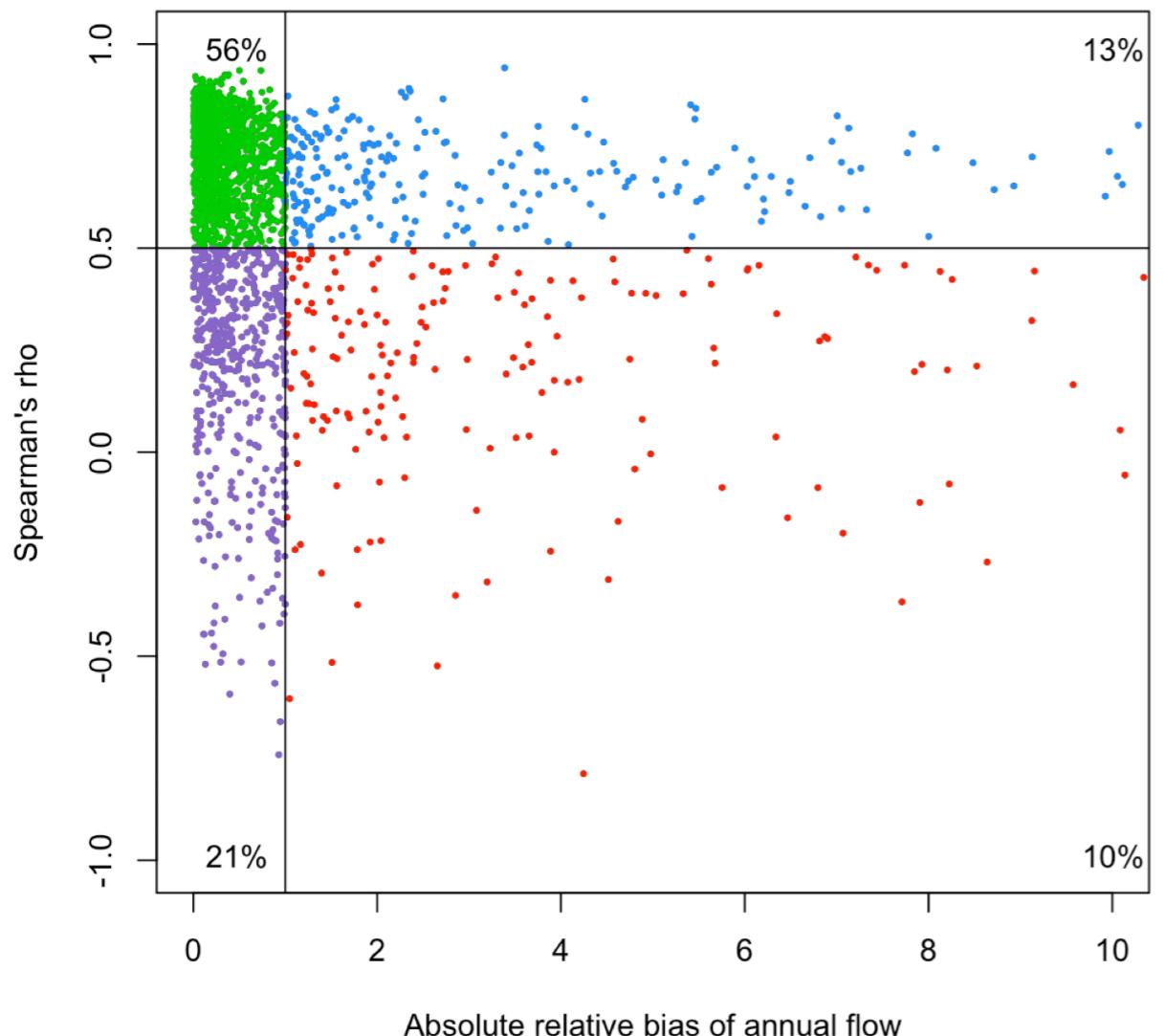
a) Observed Annual Streamflow



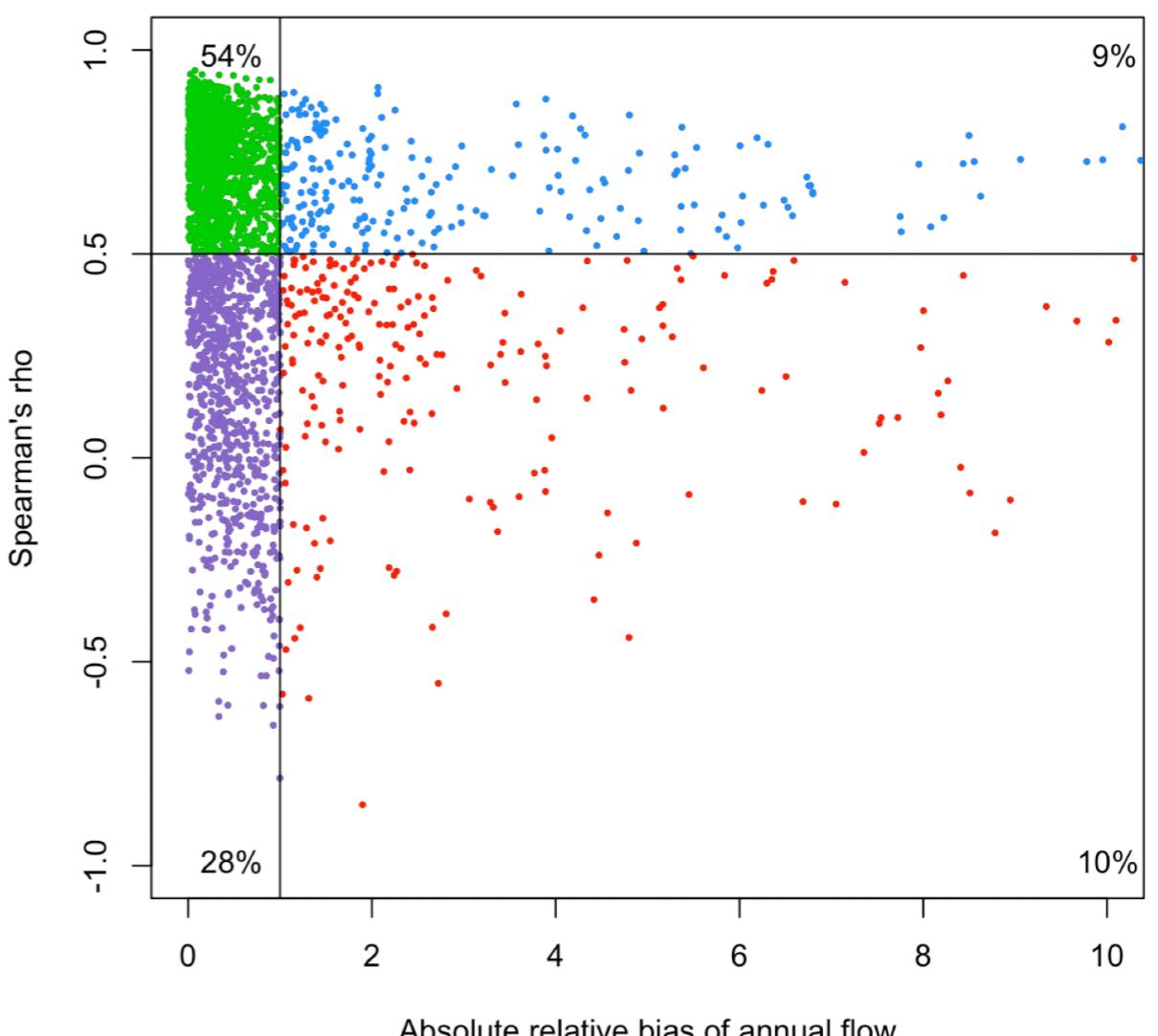
b) Percent Bias Annual Streamflow



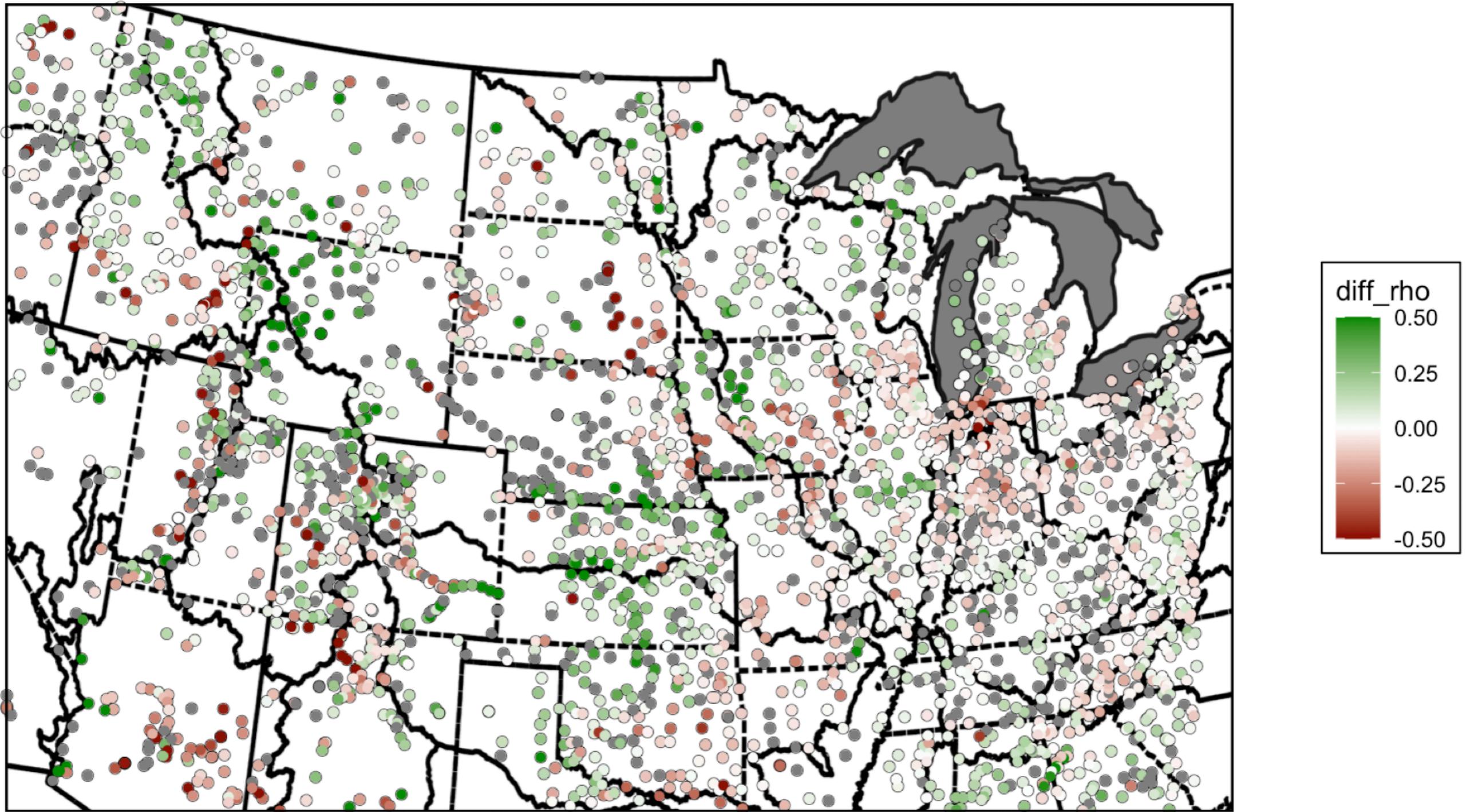
**WY2003-2005 N=2392**



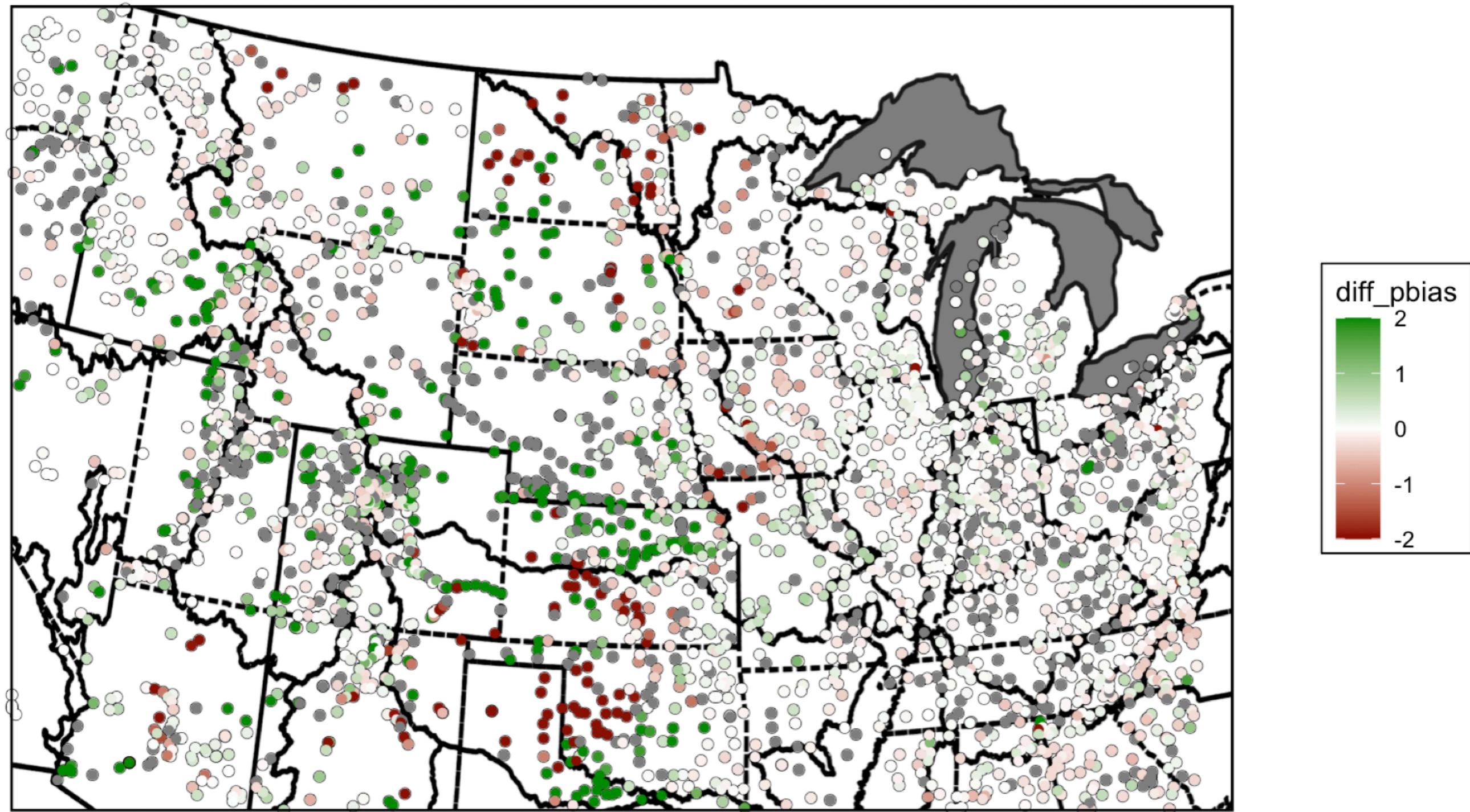
**WY1985 N=2992**



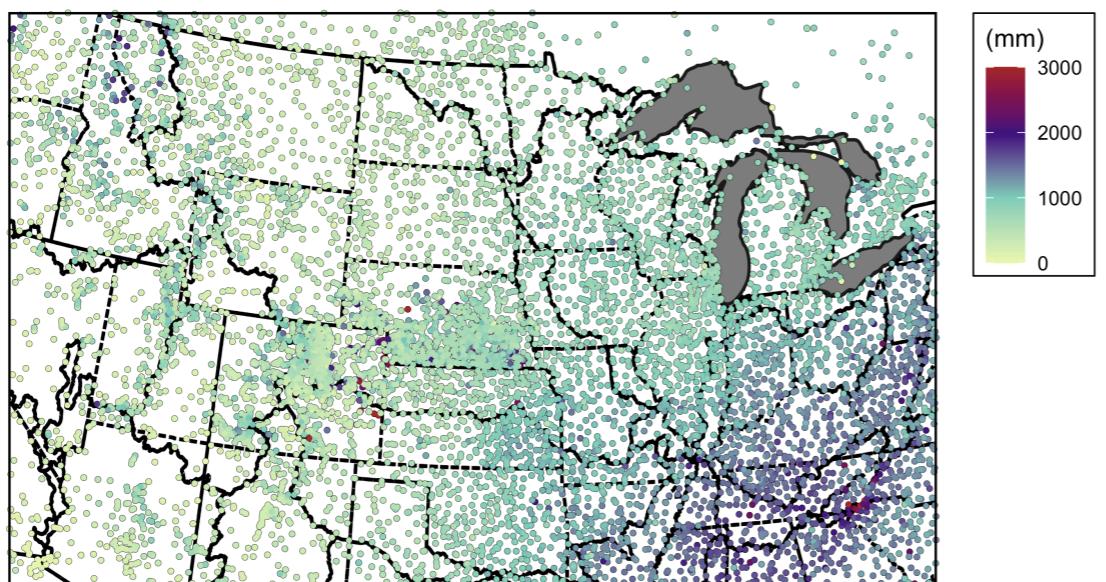
## 2002-2005 WYs - 1985WY Spearman rho



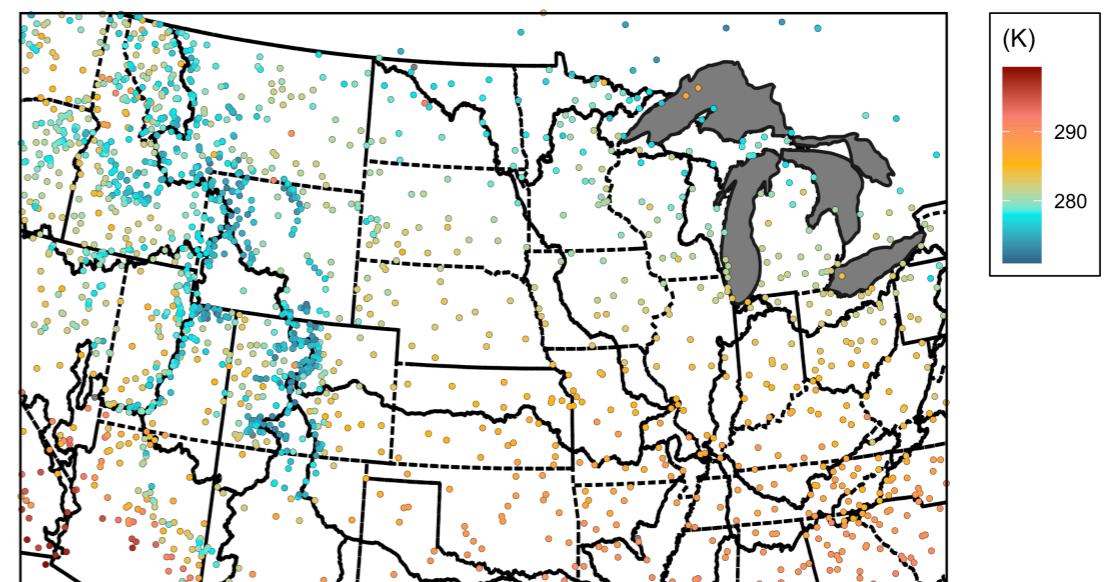
## 2002-2005 WYs - 1985WY Percent Bias



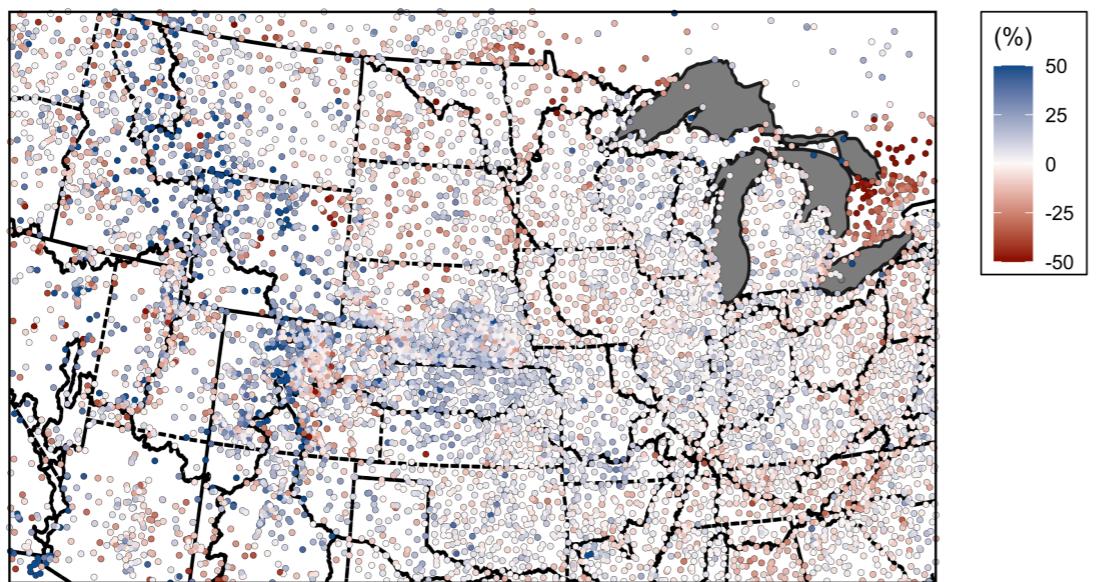
a) Observed Annual Precipitation



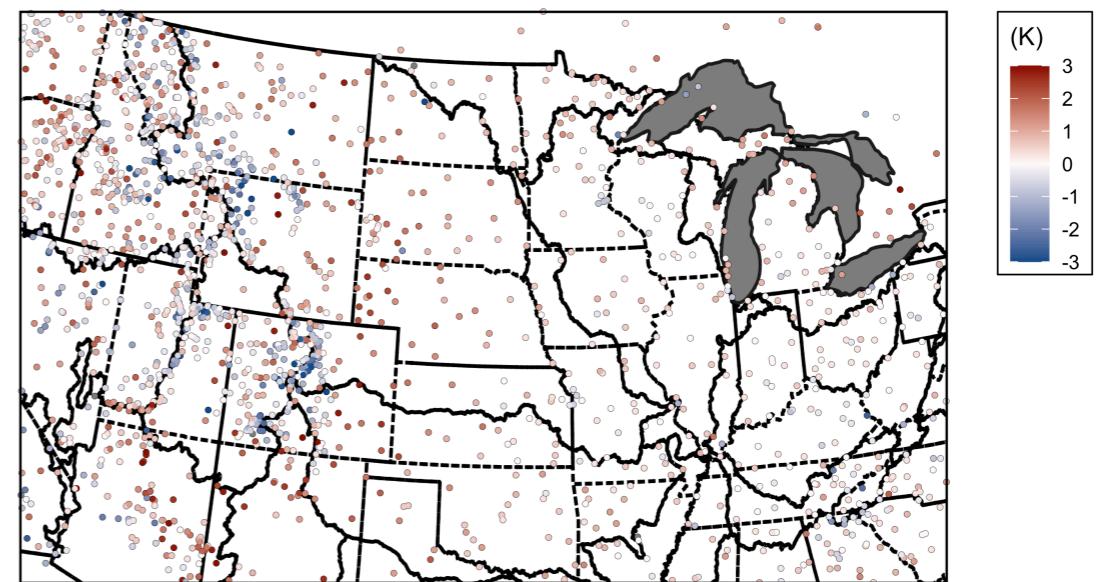
d) Mean Annual Temperature



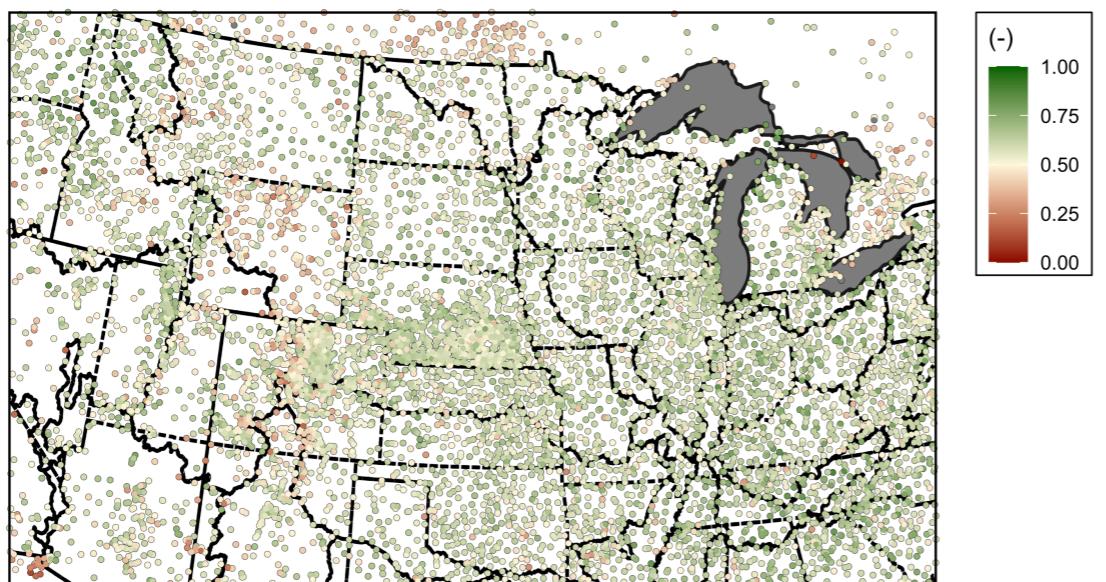
b) Percent Bias Annual Precipitation



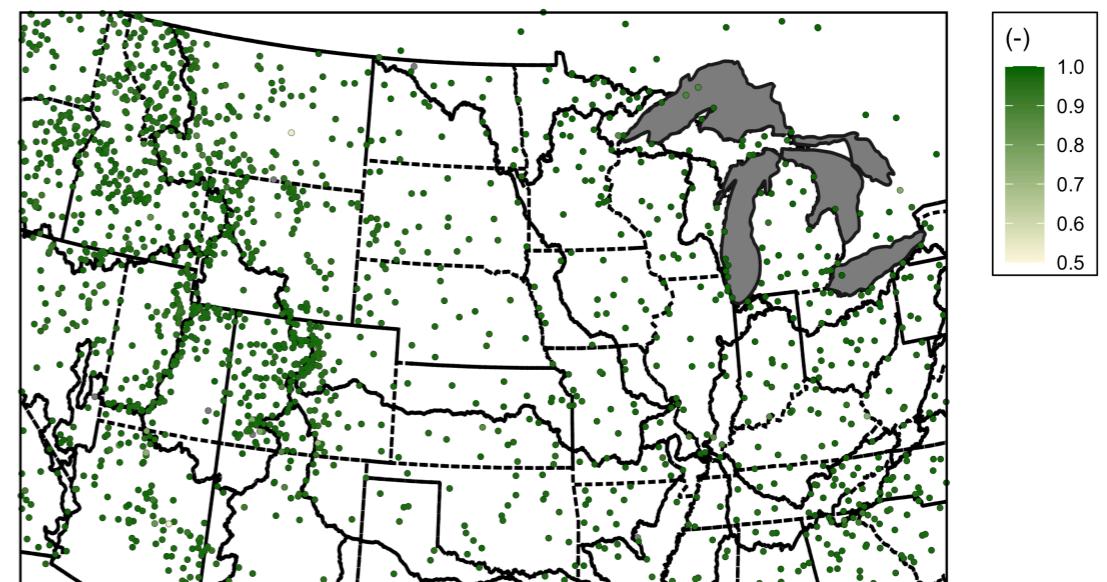
e) Bias in Mean Annual Temperature



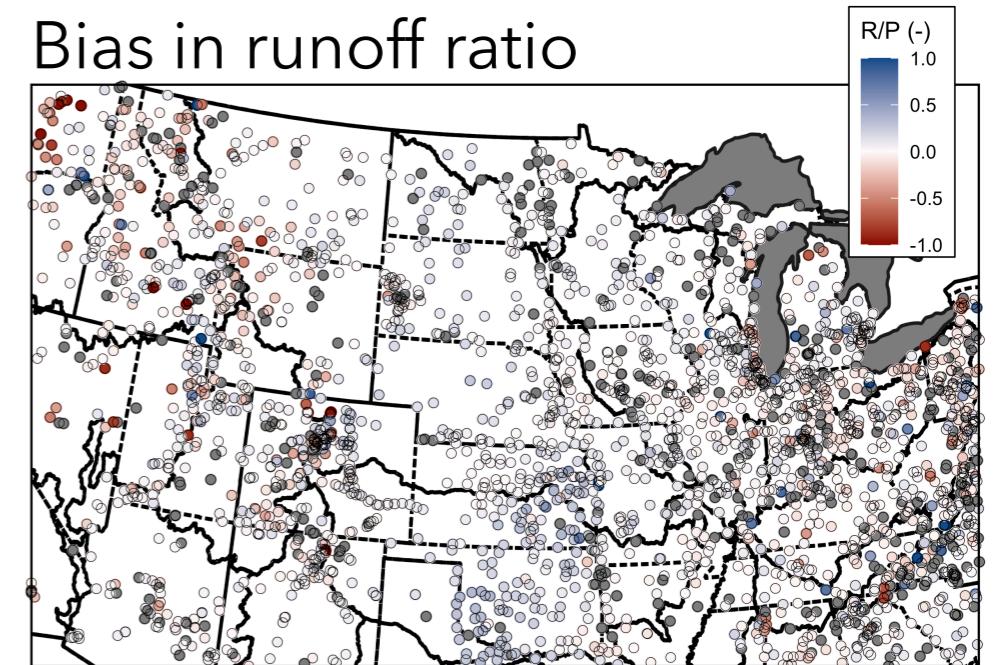
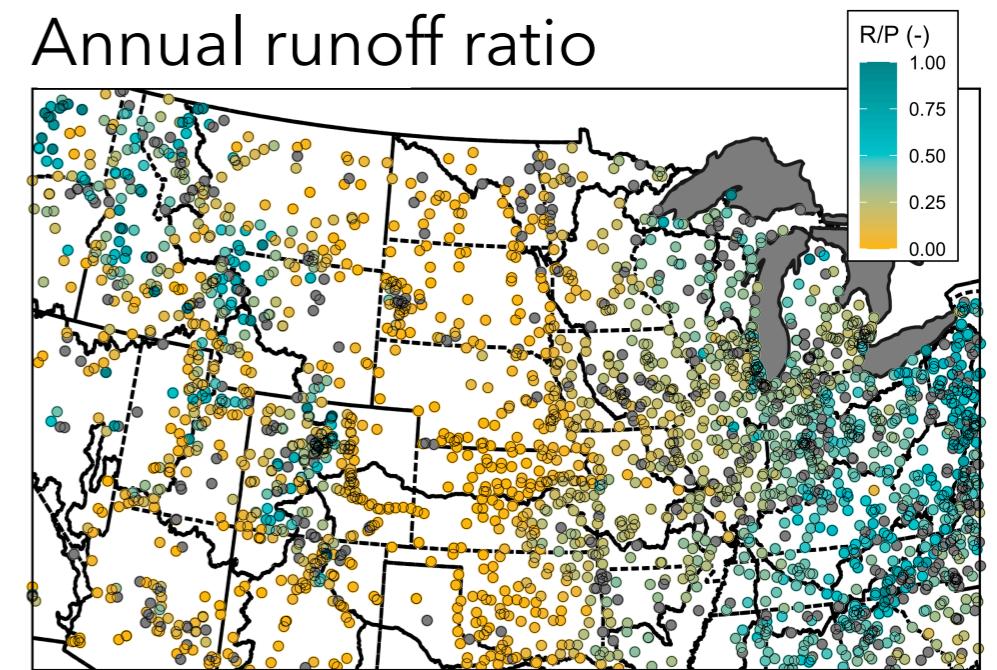
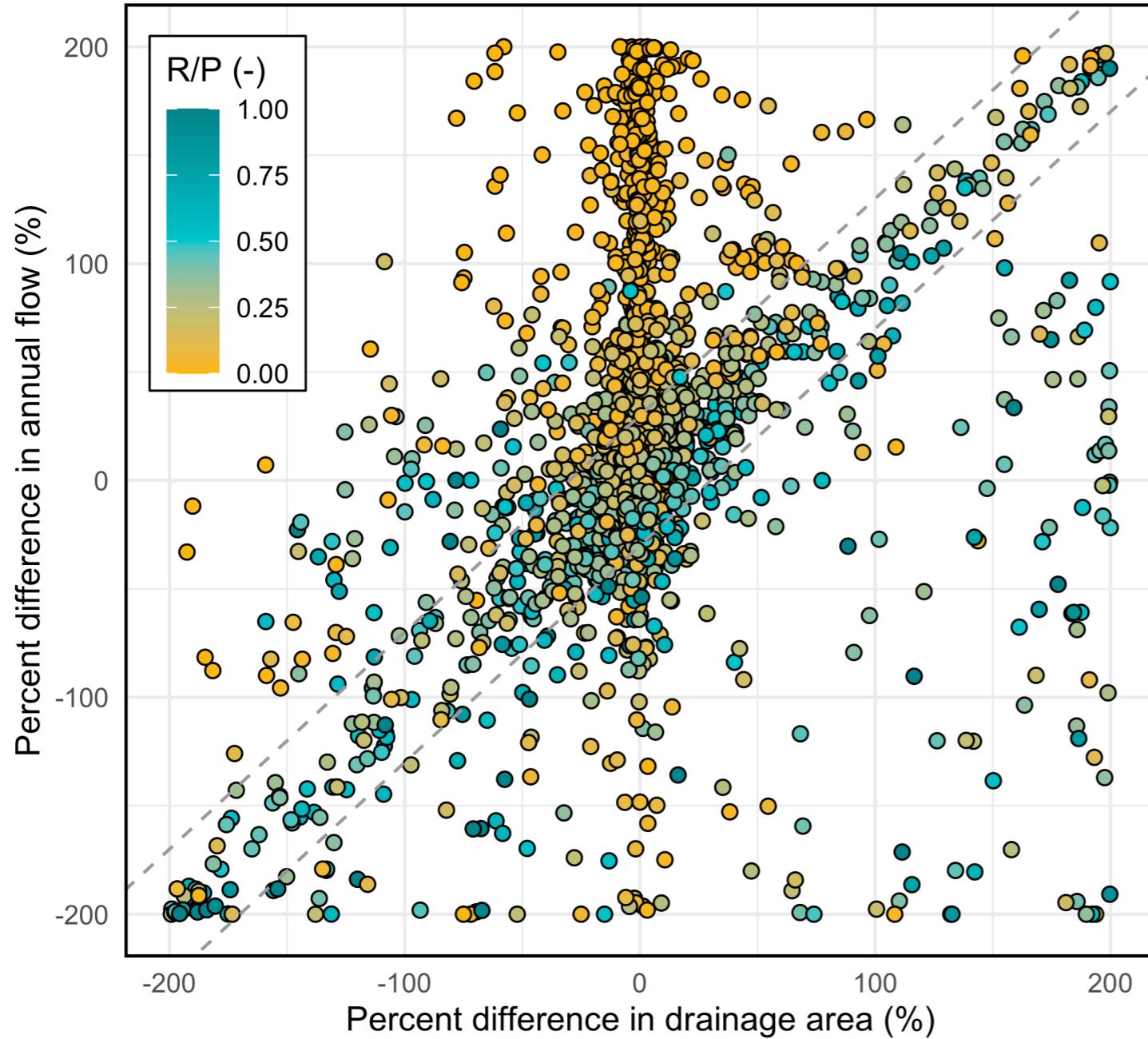
c) Spearman Correlation of Daily Precipitation



f) Spearman Correlation of Daily Average Temperature

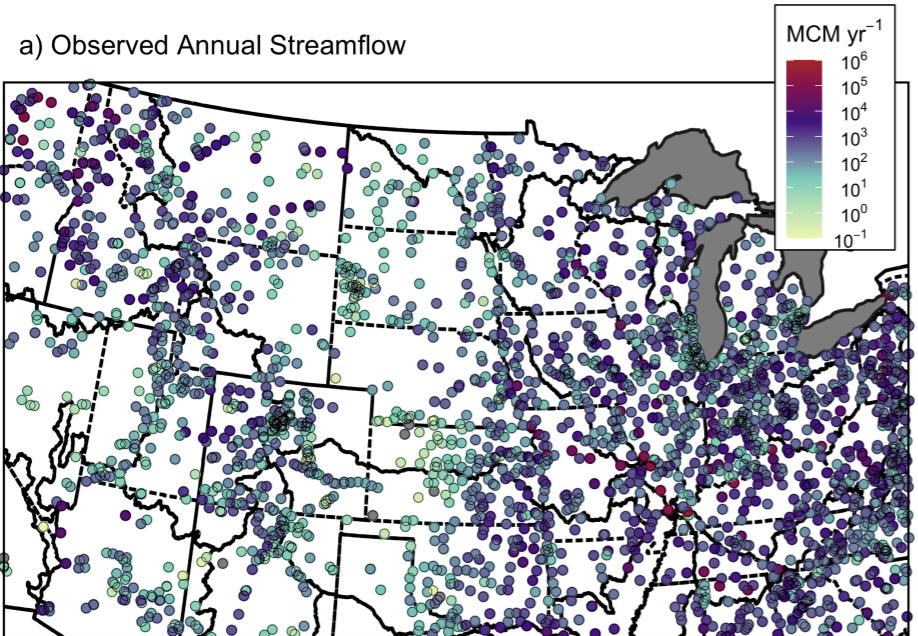


# Drainage area from topographic processing contributes to total streamflow bias.

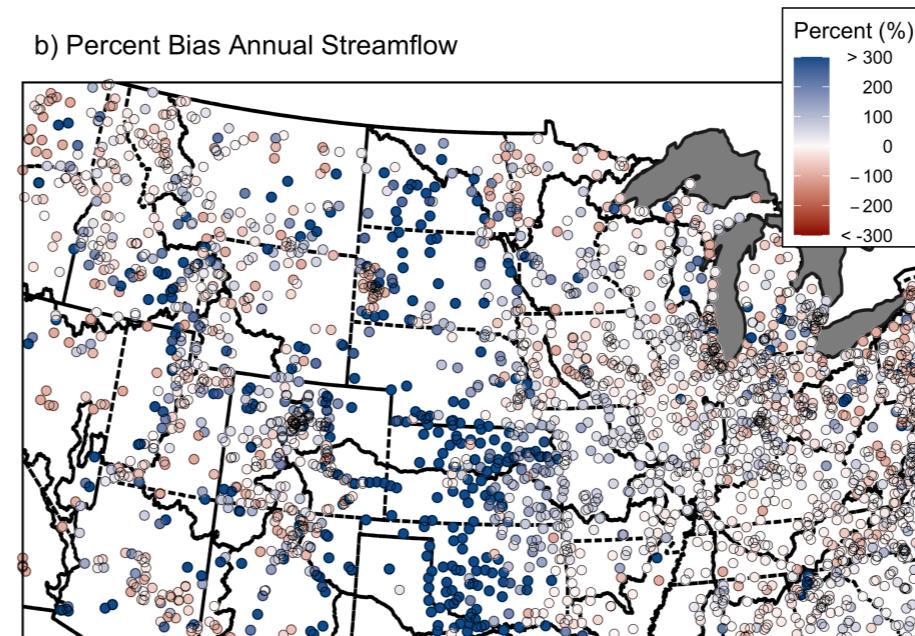




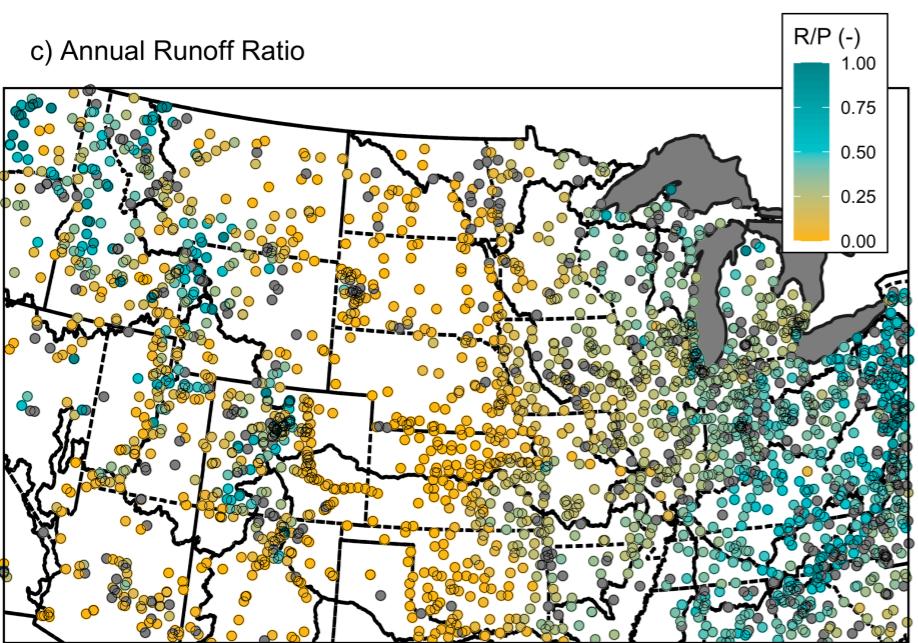
a) Observed Annual Streamflow



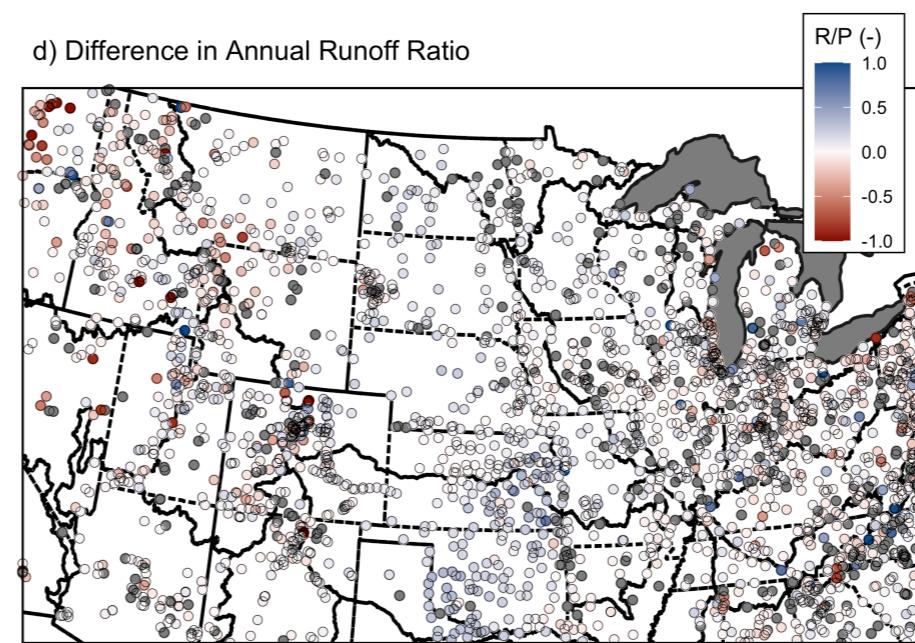
b) Percent Bias Annual Streamflow



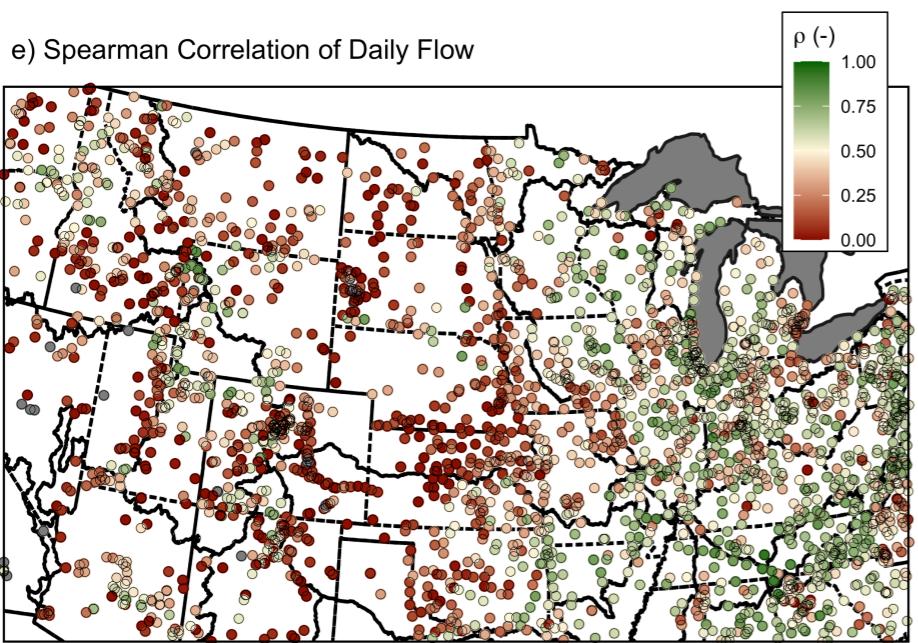
c) Annual Runoff Ratio



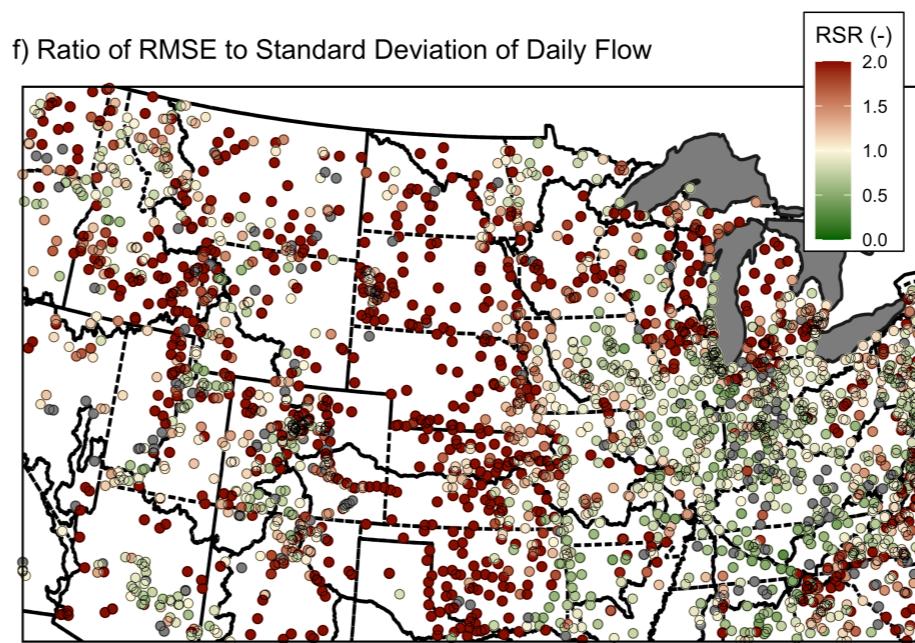
d) Difference in Annual Runoff Ratio



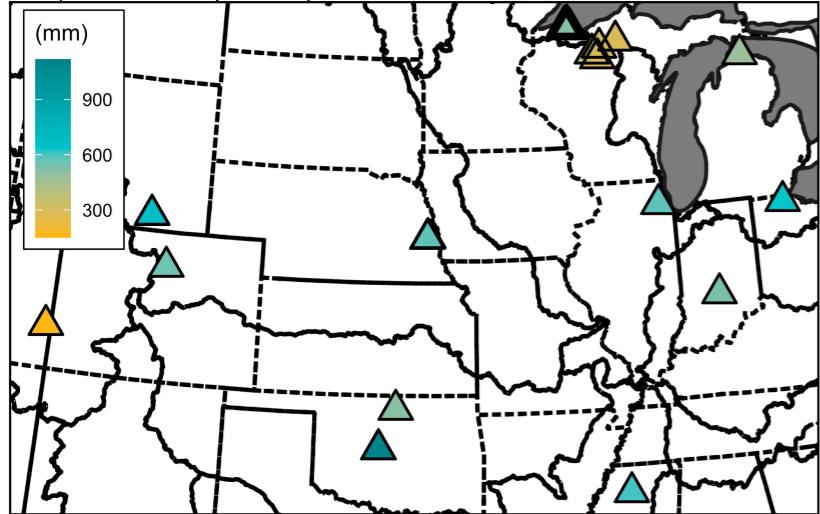
e) Spearman Correlation of Daily Flow



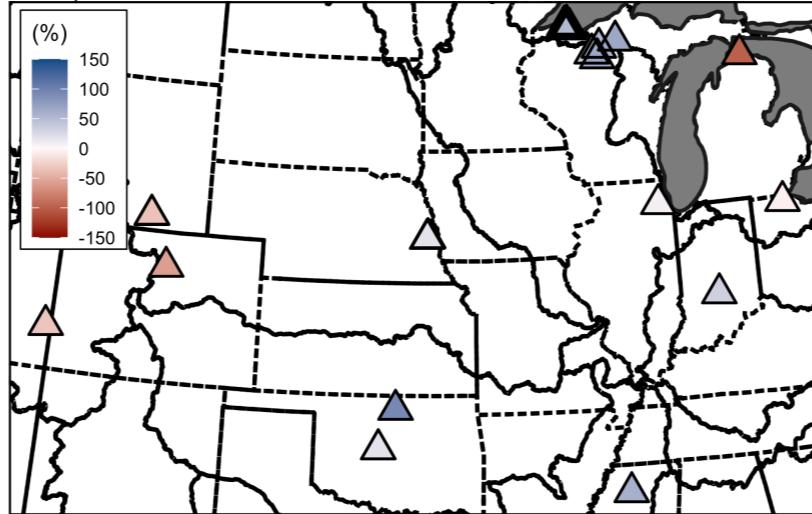
f) Ratio of RMSE to Standard Deviation of Daily Flow



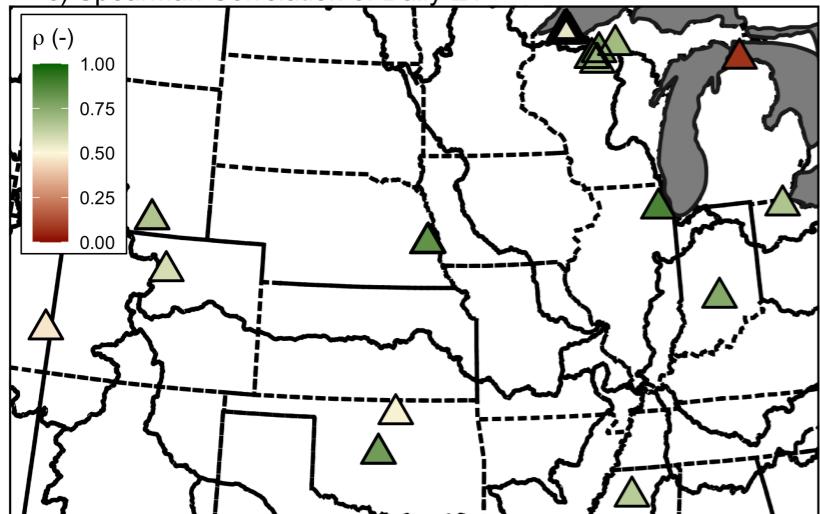
a) Annual Evapotranspiration, FluxNET



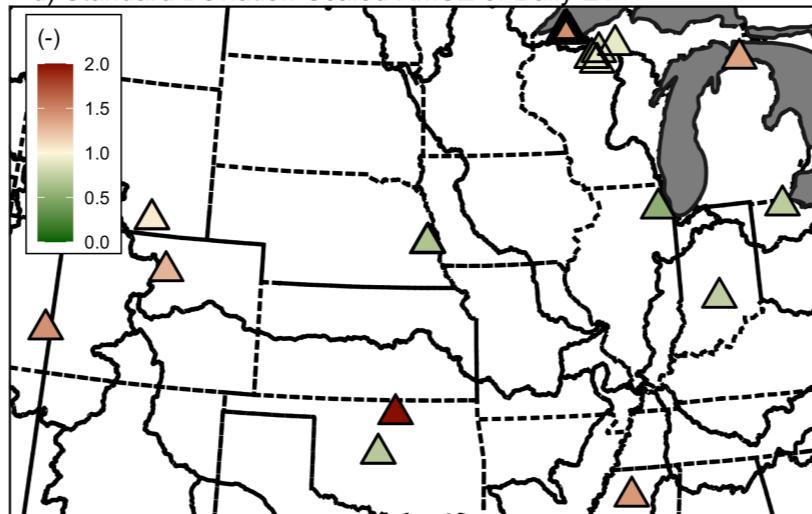
b) Percent Bias Annual ET



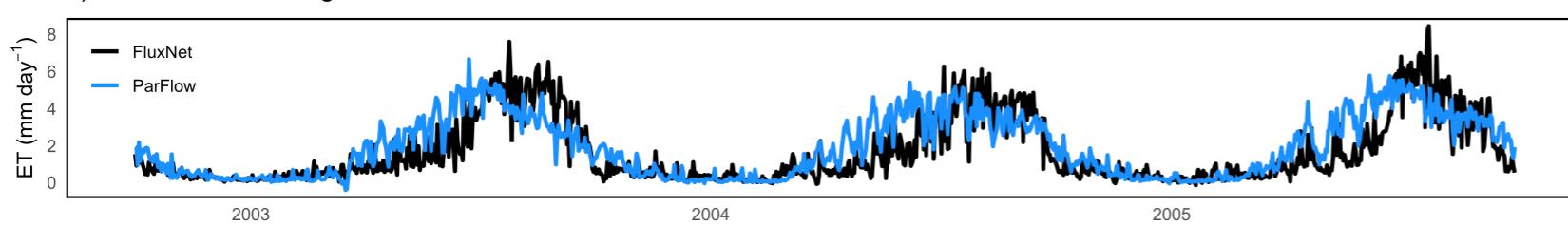
c) Spearman Correlation of Daily ET



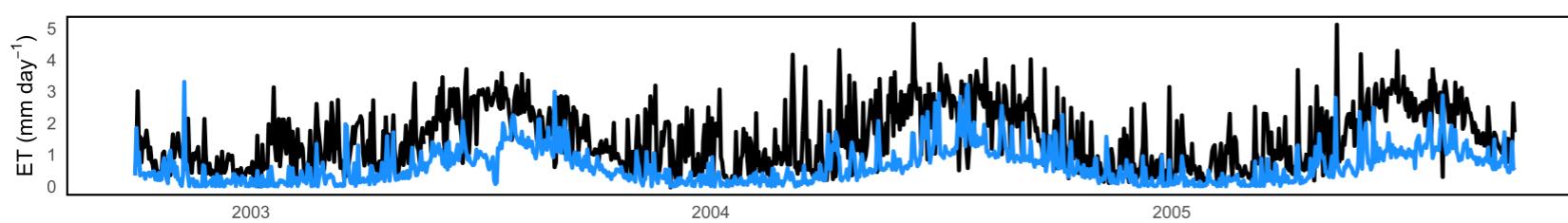
d) Standard Deviation-Scaled RMSE of Daily ET



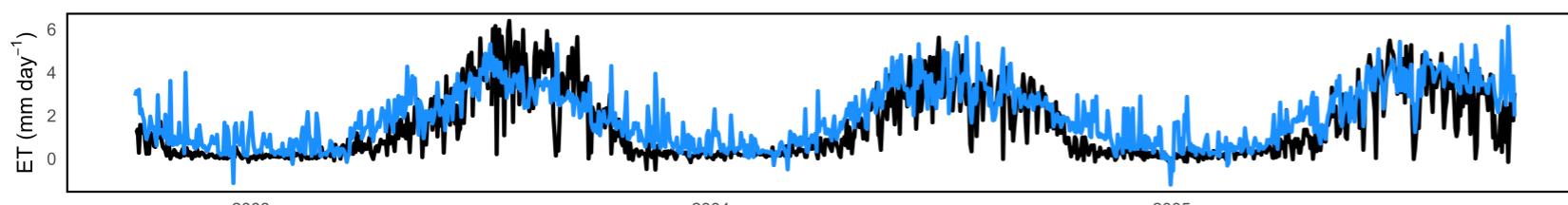
e) US-Ne1: Mead - irrigated continuous maize site, Nebraska

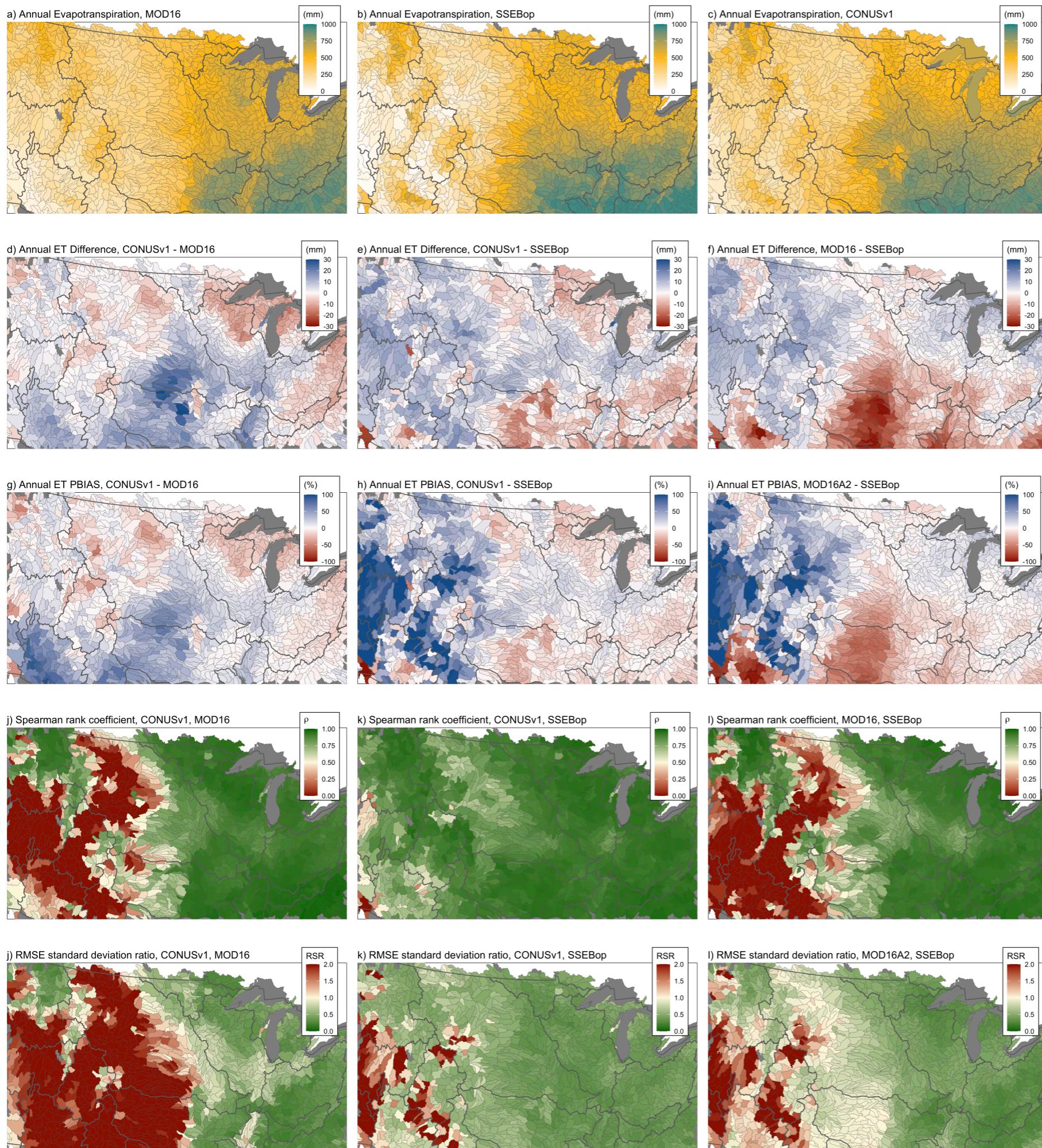


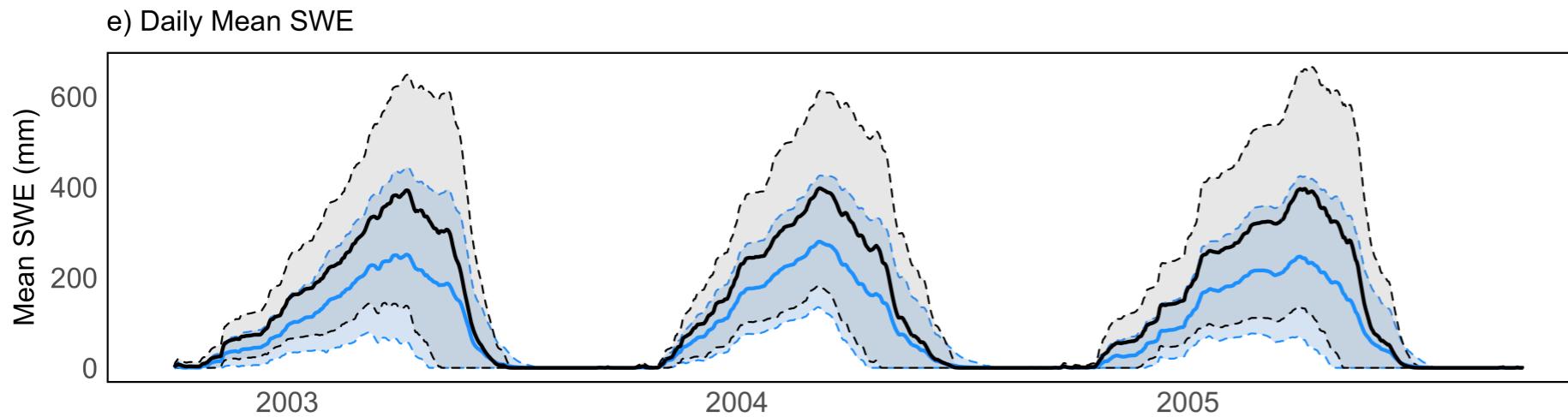
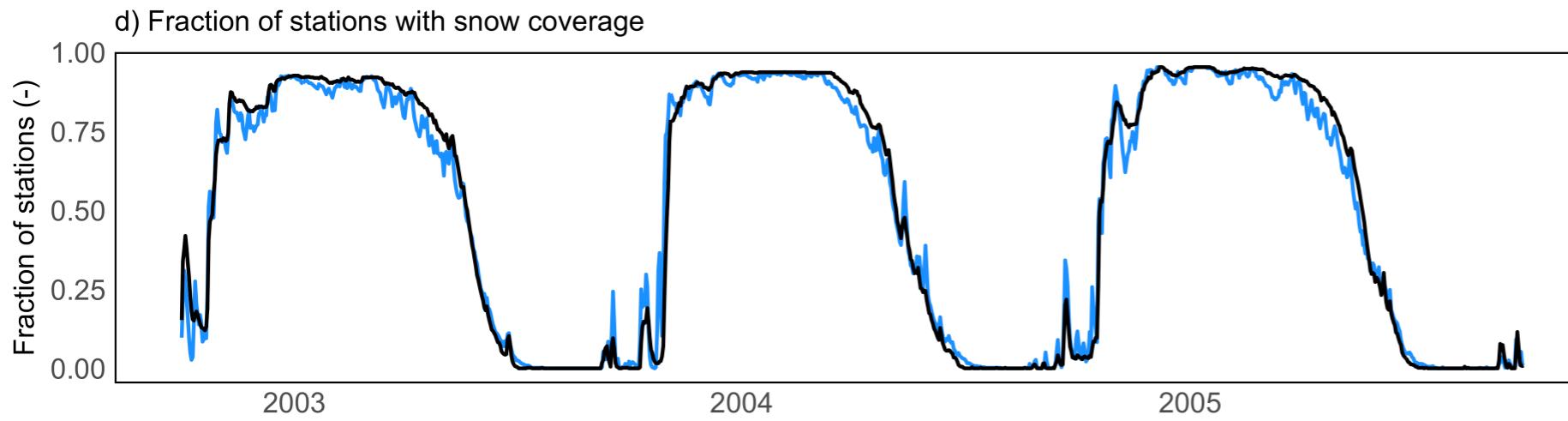
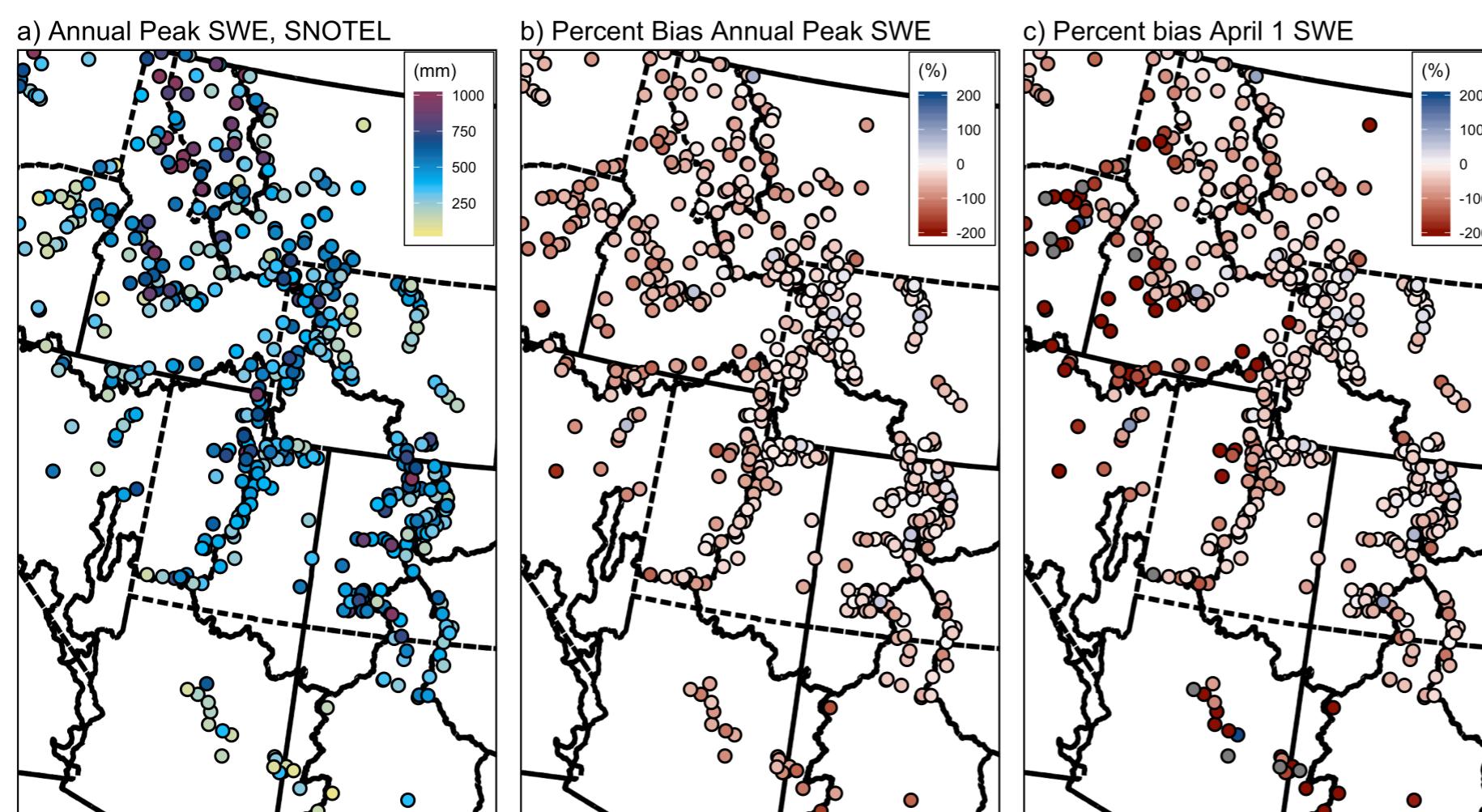
f) US-NR1: Niwot Ridge site, Colorado



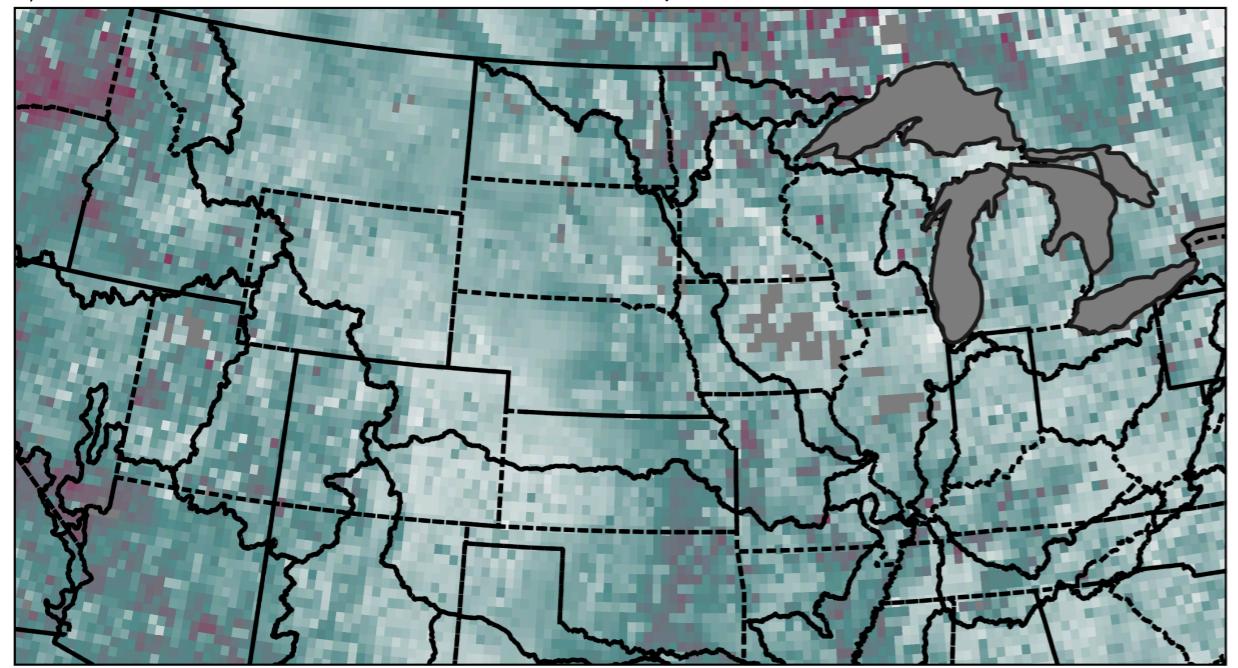
g) US-MMS: Monroe Morgan State Forest, Indiana



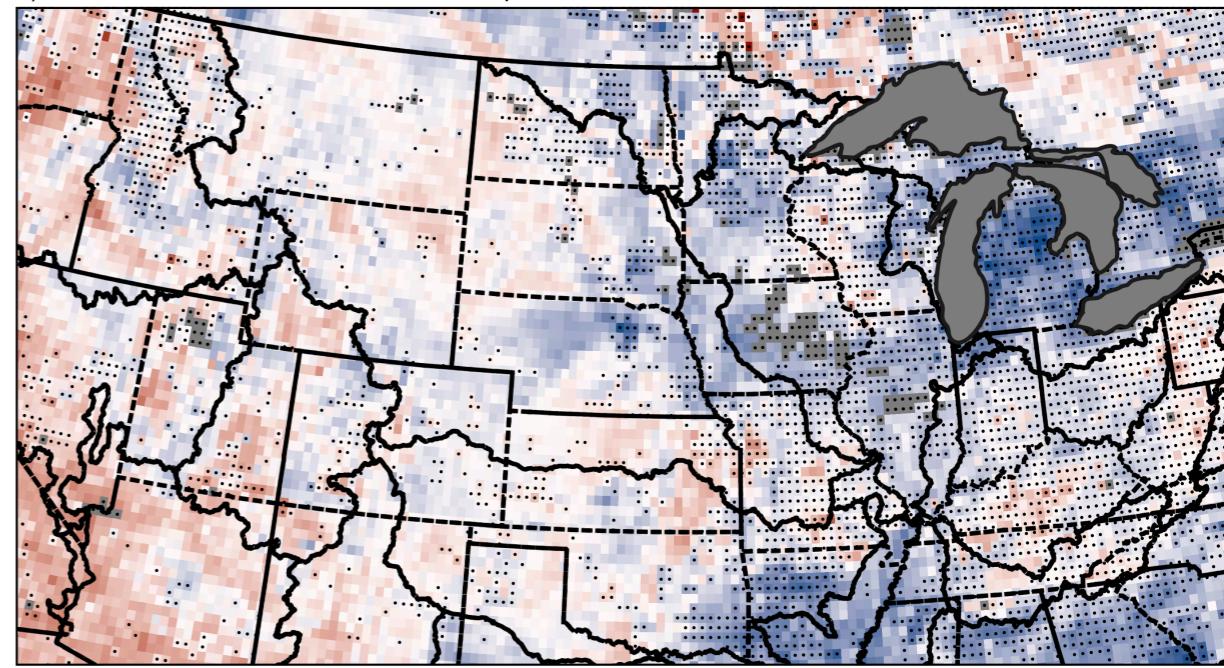




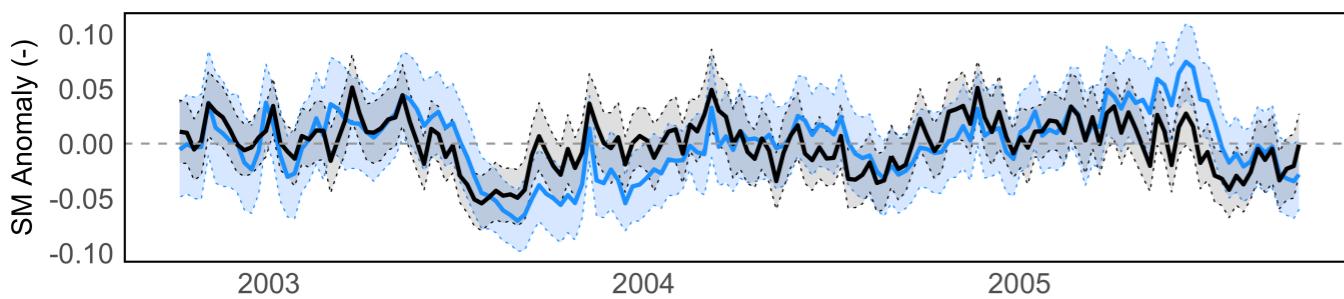
a) ESACCI Combined Active/Passive Soil Moisture Amplitude



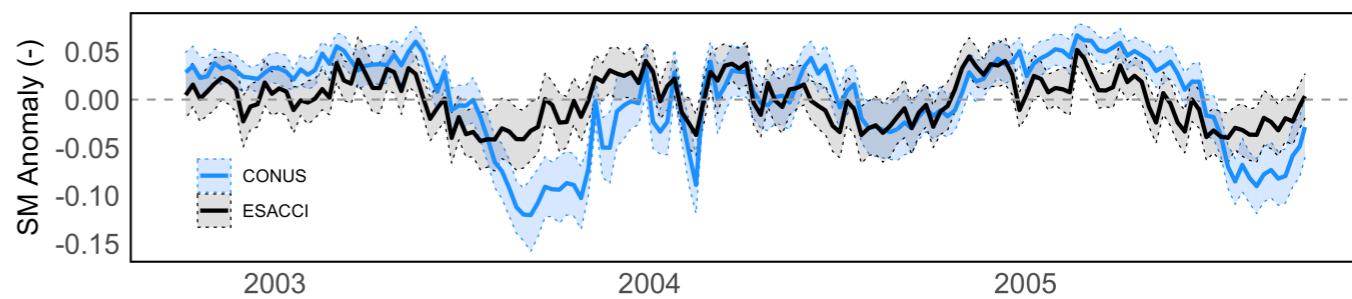
b) CONUSv1 - ESACCI Soil Moisture Amplitude



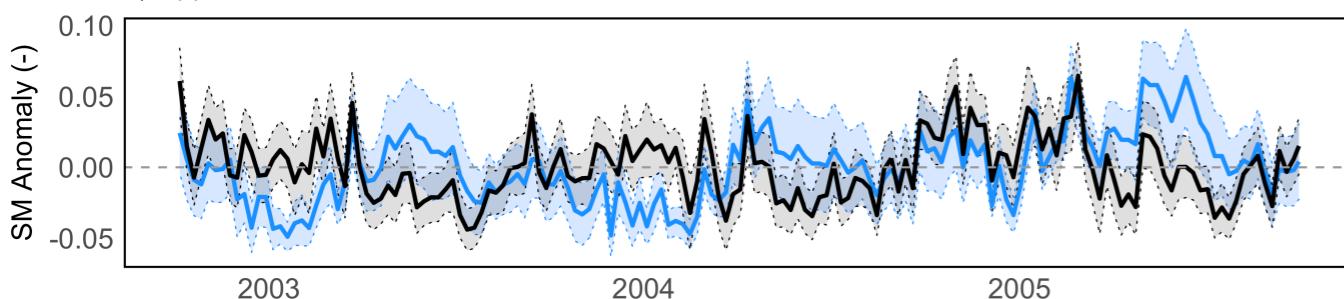
c) Missouri River Basin: Weekly soil moisture anomaly



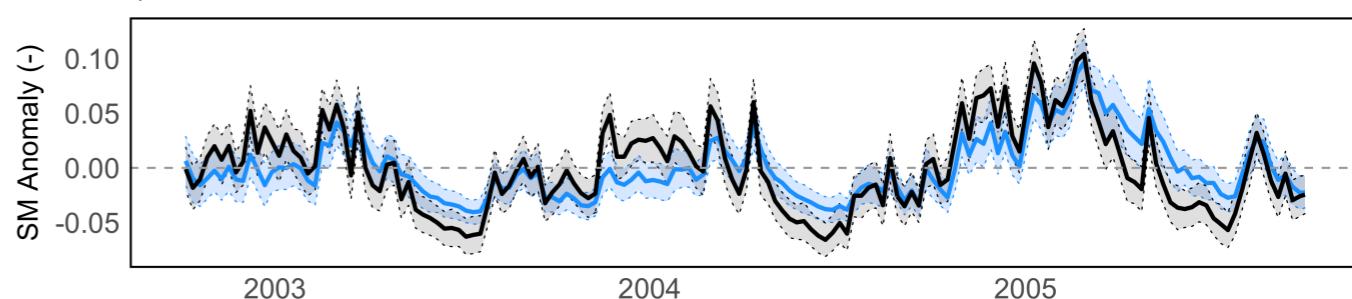
d) Upper Mississippi River Basin



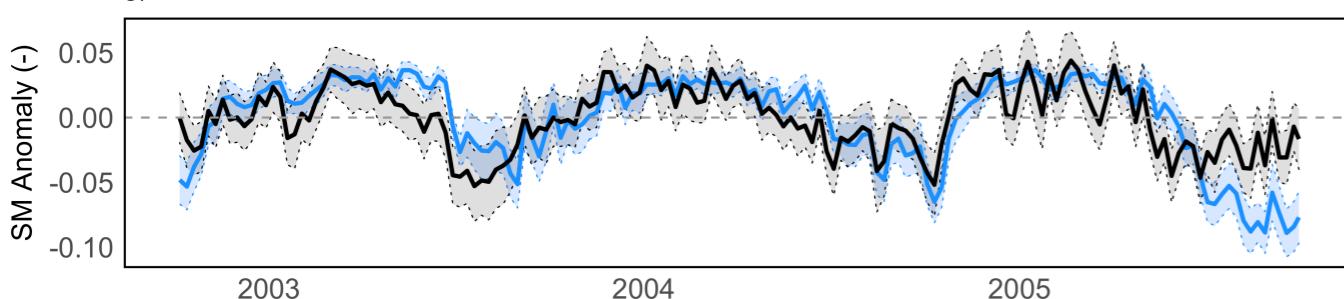
e) Upper CO River Basin



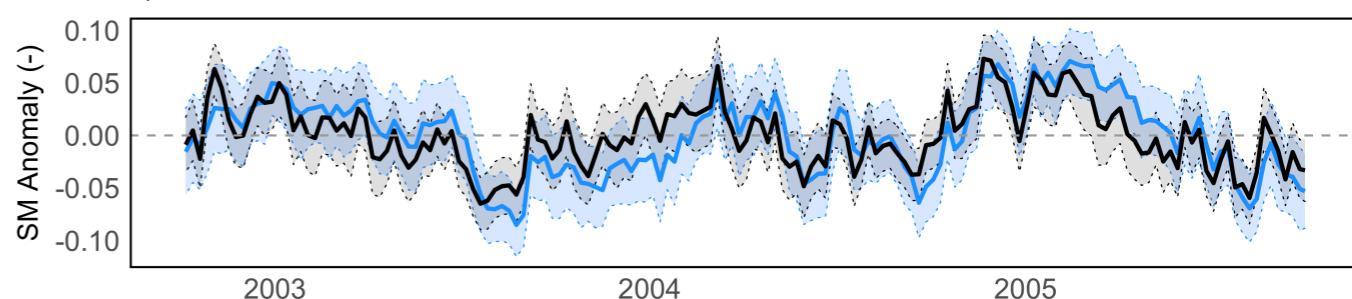
f) Lower CO River Basin



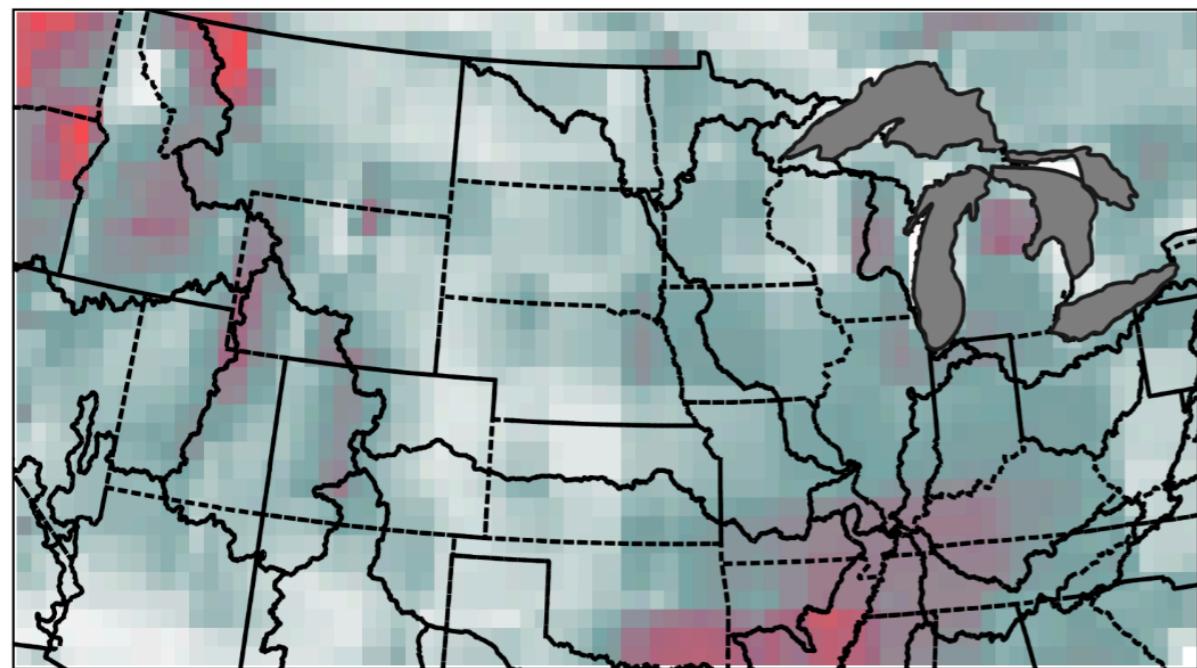
g) Ohio River Basin



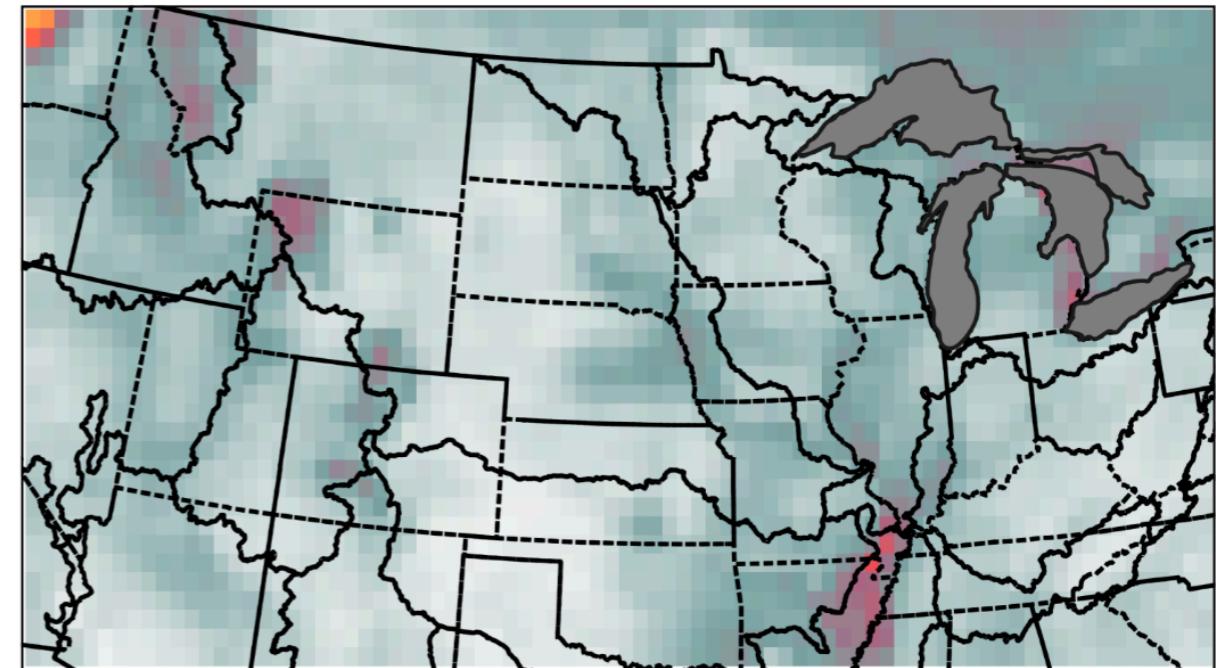
h) Arkansas-Red-White



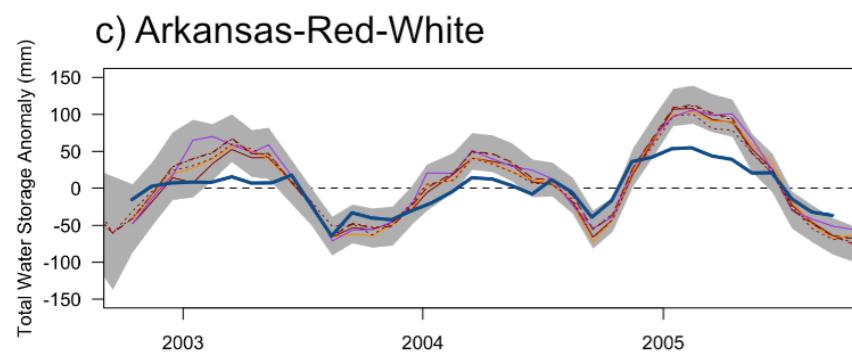
a) JPL Mascon Amplitude, gain-corrected



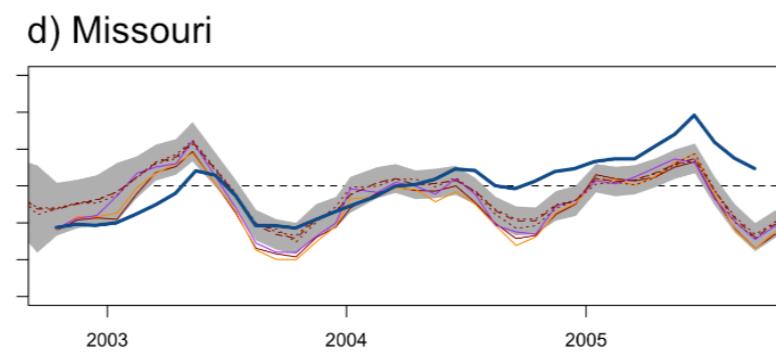
b) CONUSv1 Amplitude



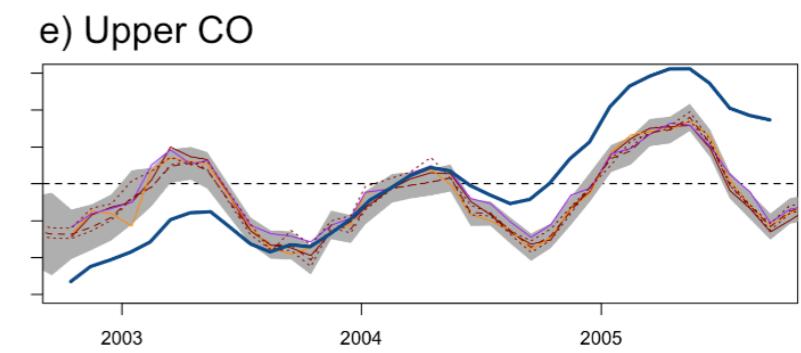
c) Arkansas-Red-White



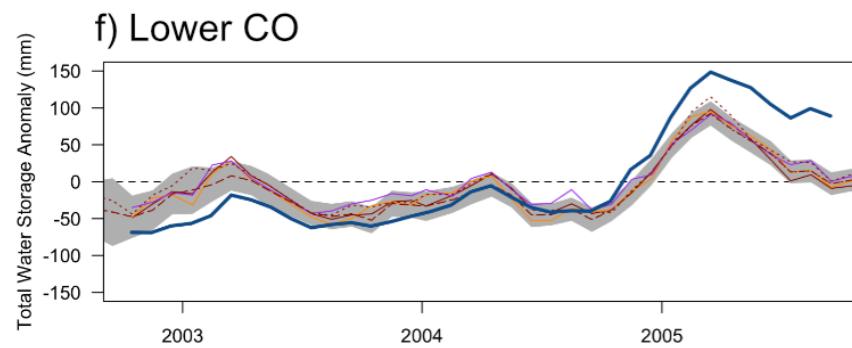
d) Missouri



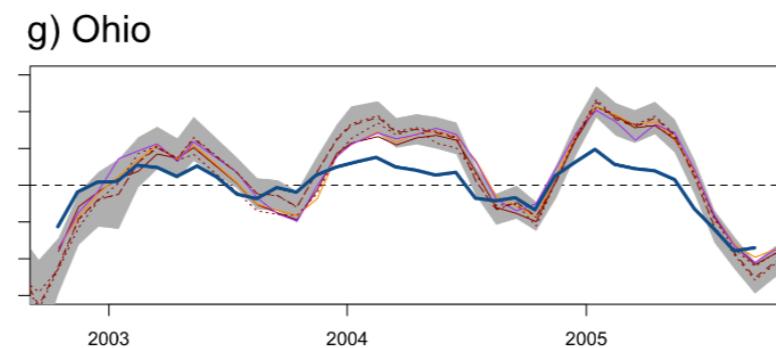
e) Upper CO



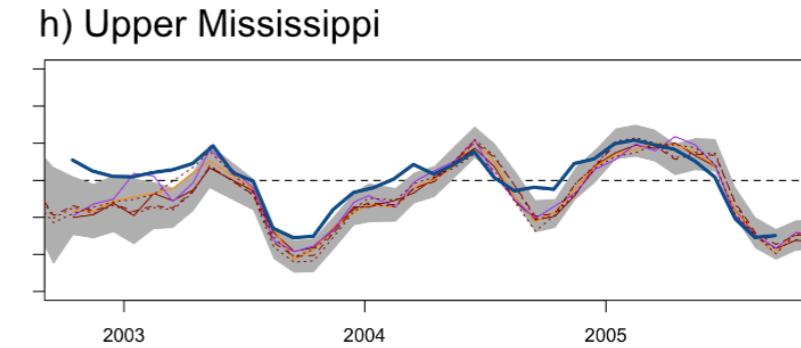
f) Lower CO



g) Ohio



h) Upper Mississippi



CSR

CSRm

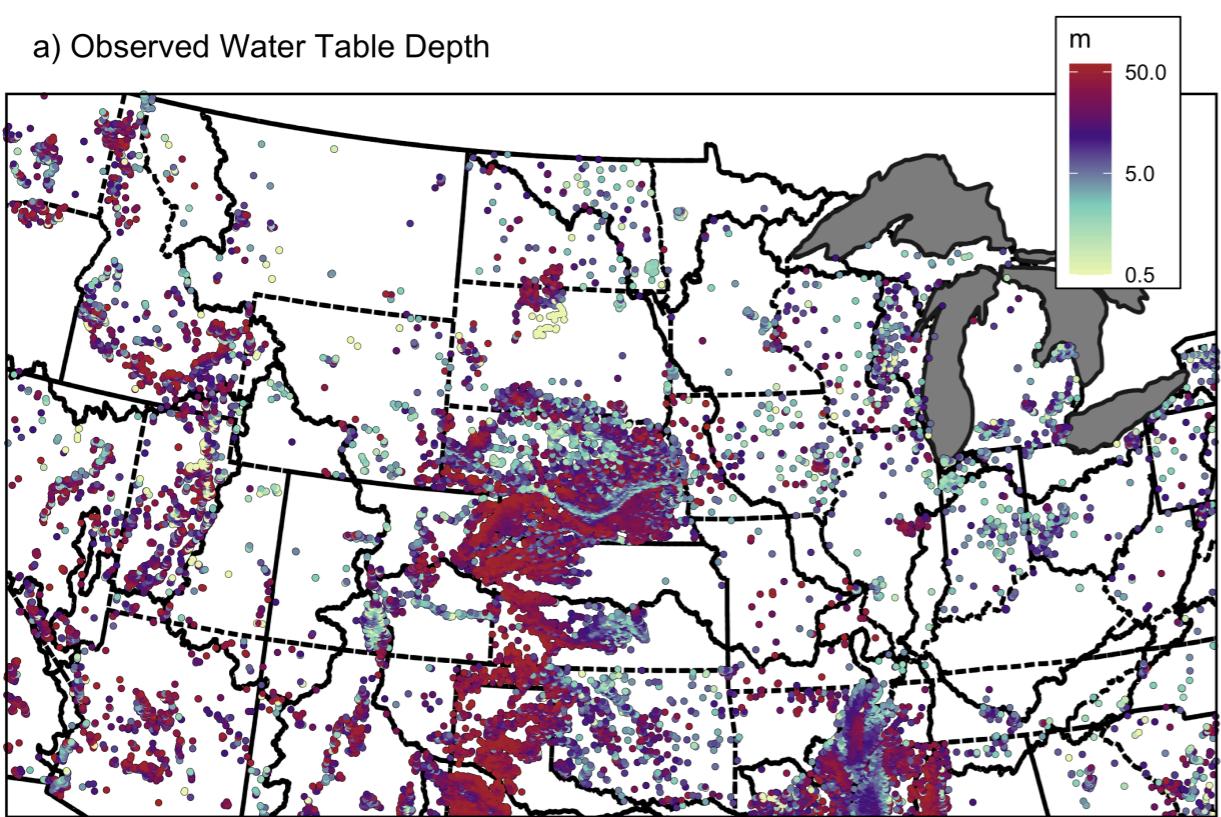
JPL

JPLm

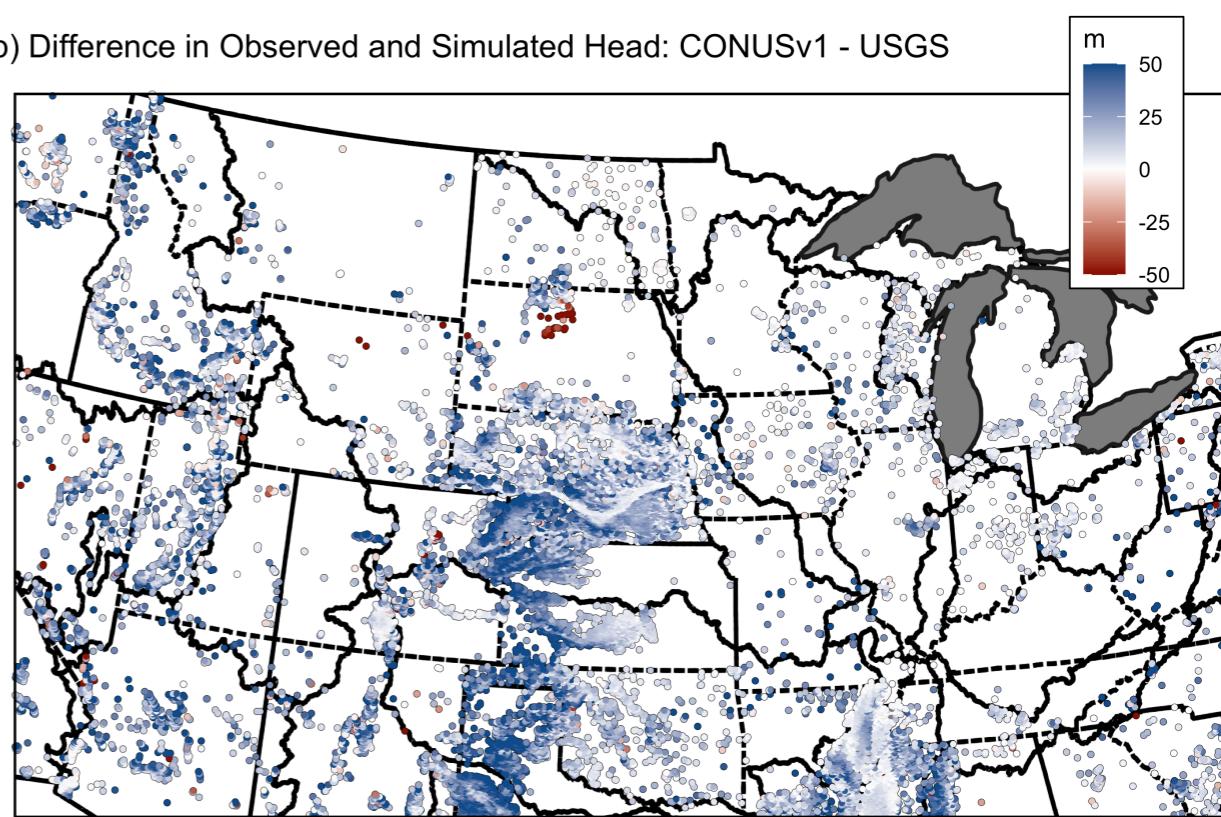
GFZ

CONUSv1

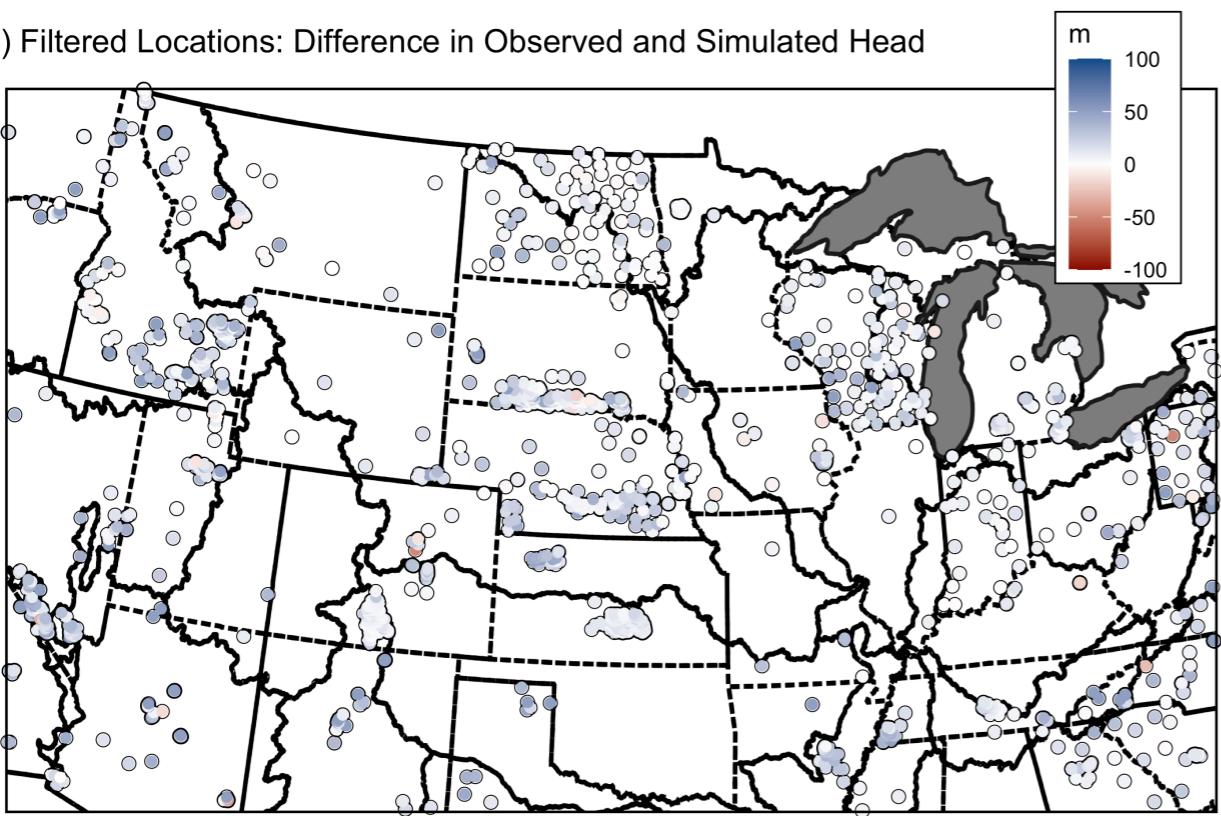
a) Observed Water Table Depth



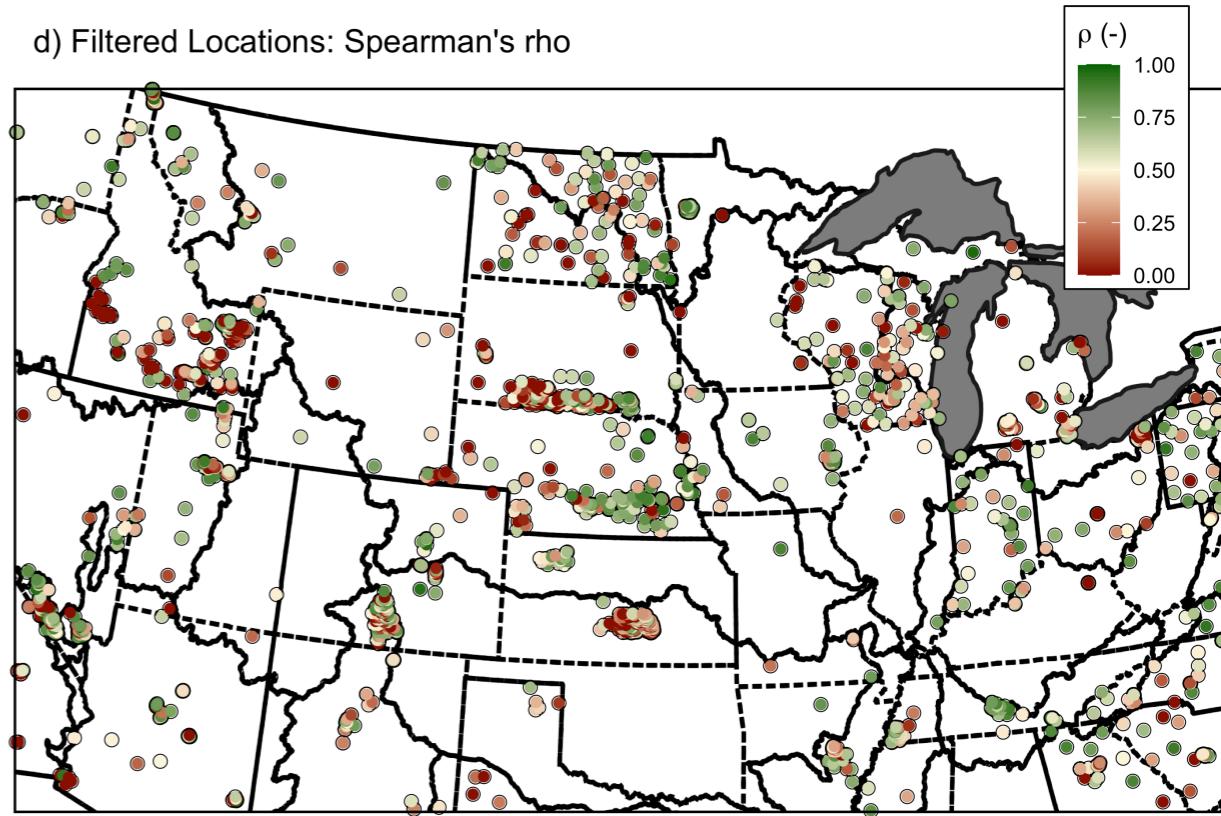
b) Difference in Observed and Simulated Head: CONUSv1 - USGS



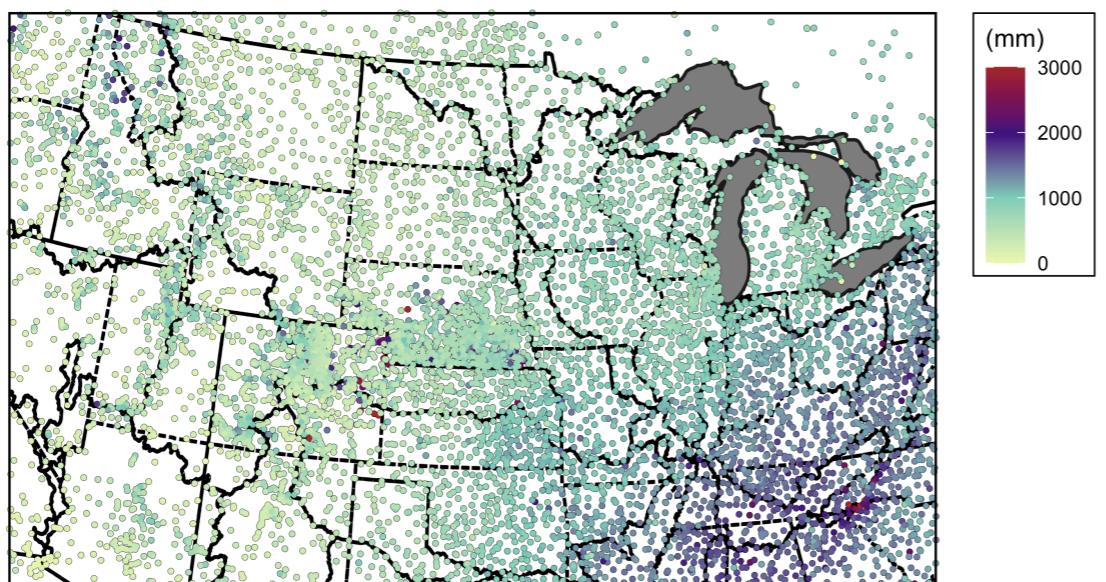
c) Filtered Locations: Difference in Observed and Simulated Head



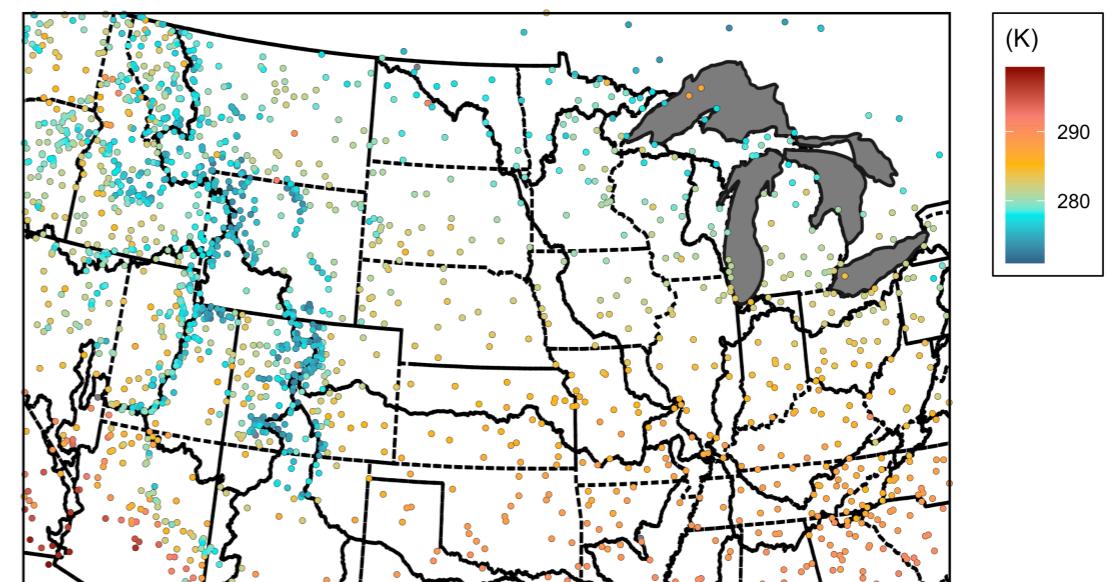
d) Filtered Locations: Spearman's rho



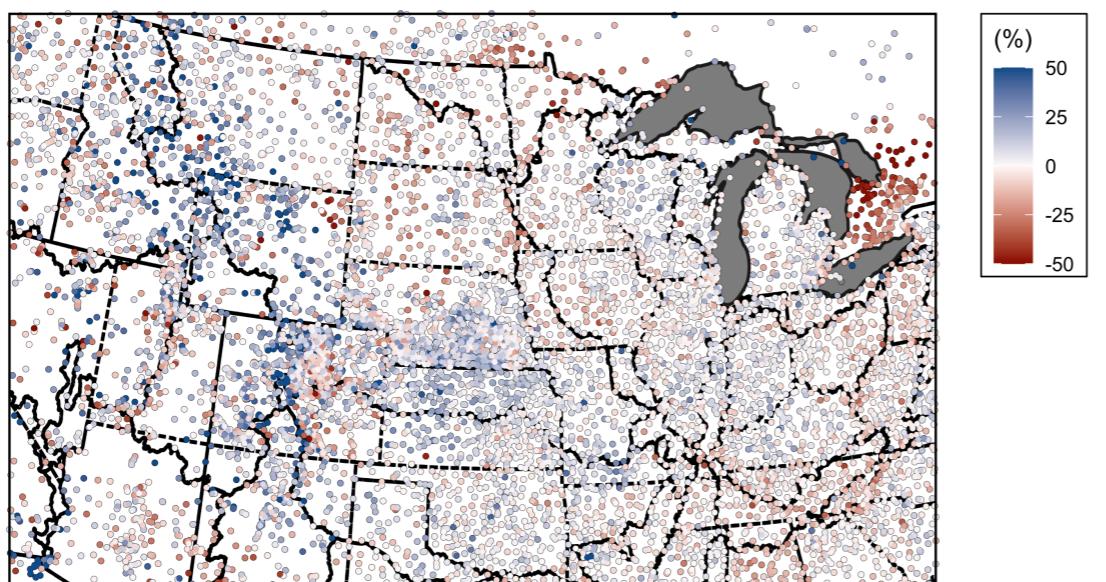
a) Observed Annual Precipitation



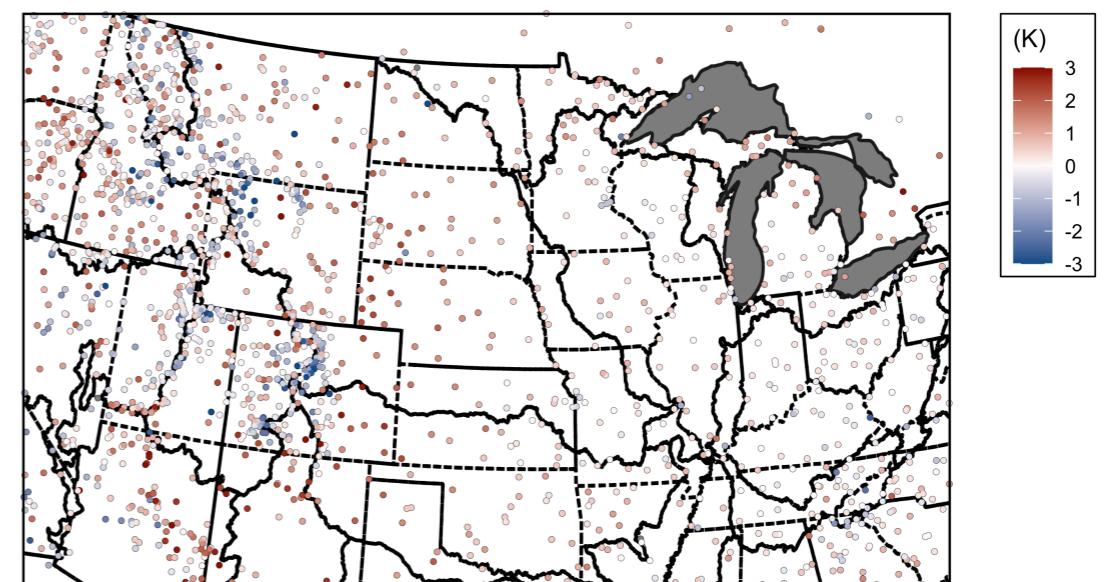
d) Mean Annual Temperature



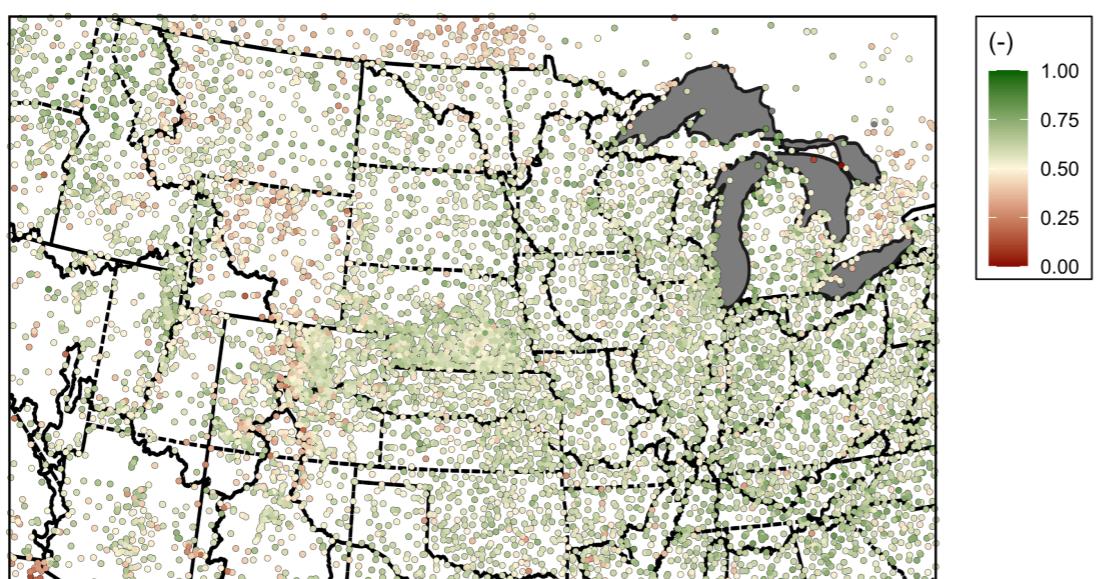
b) Percent Bias Annual Precipitation



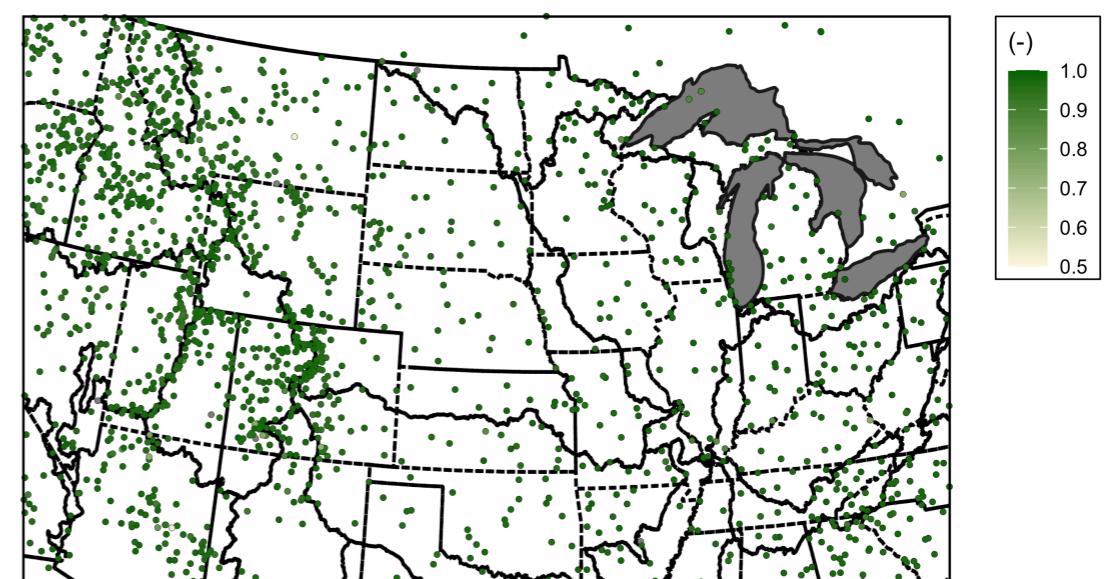
e) Bias in Mean Annual Temperature



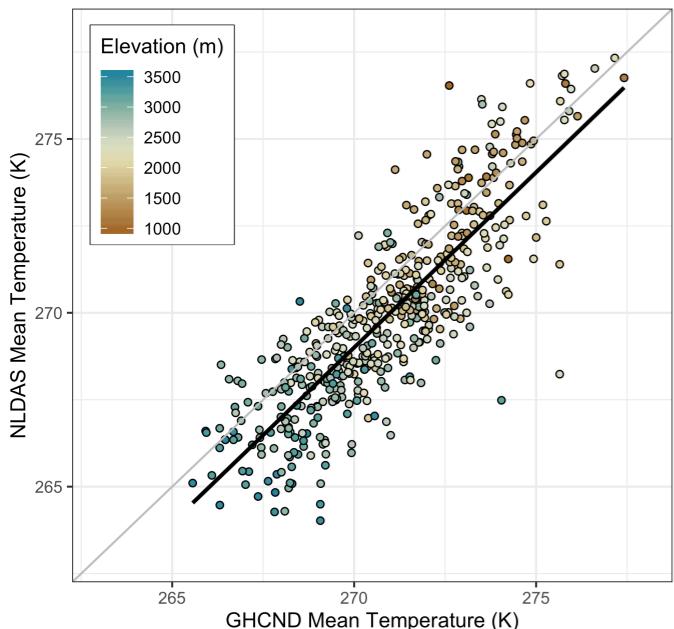
c) Spearman Correlation of Daily Precipitation



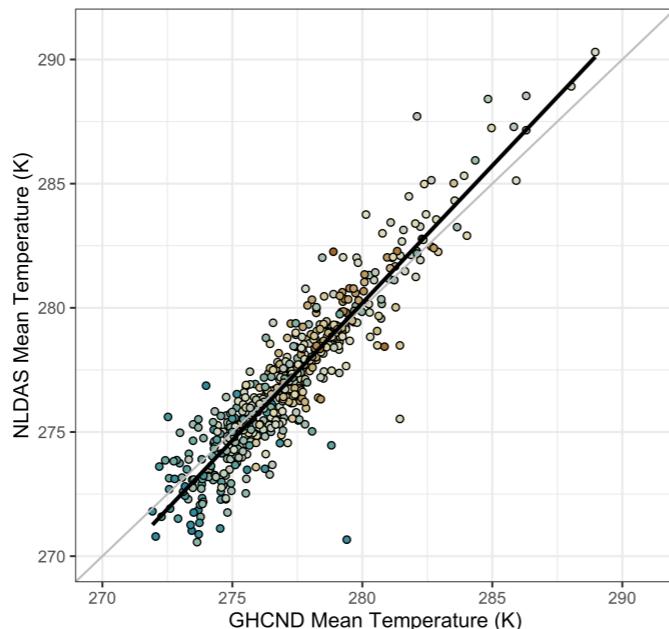
e) Spearman Correlation of Daily Average Temperature



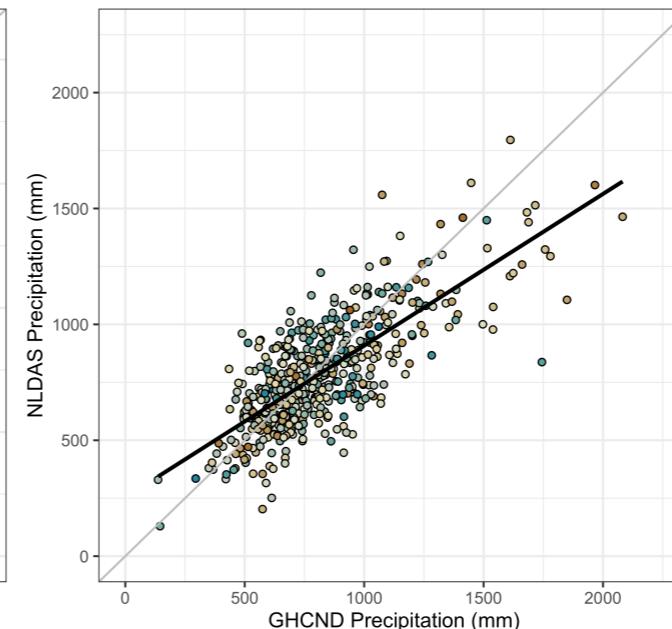
a) SNOTEL: Annual Cool Season Temperature



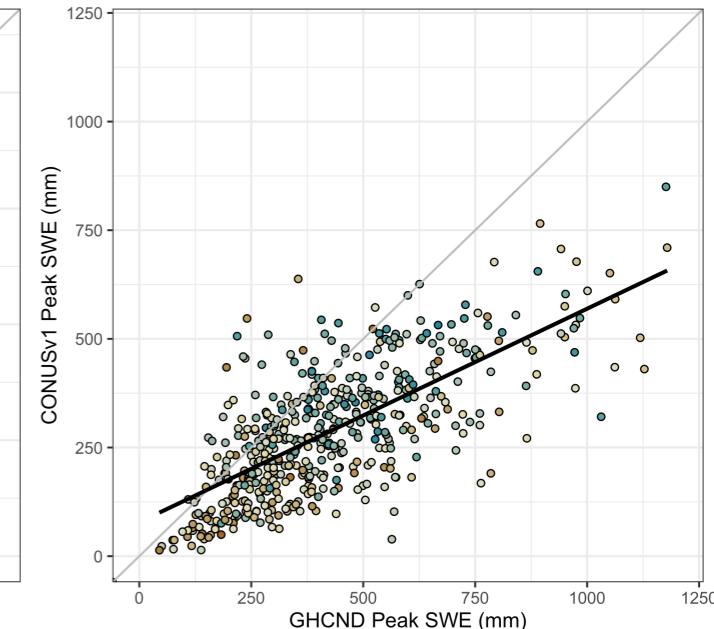
b) SNOTEL: Annual Temperature



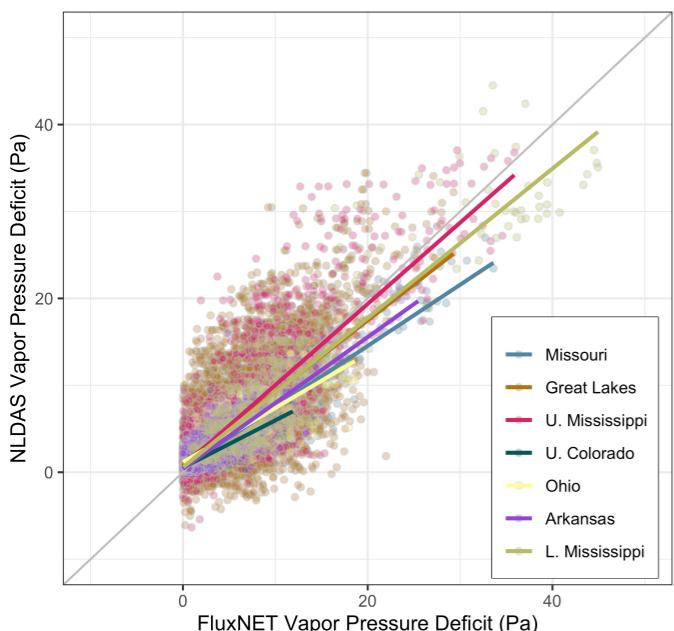
c) SNOTEL: Annual Cumulative Precipitation



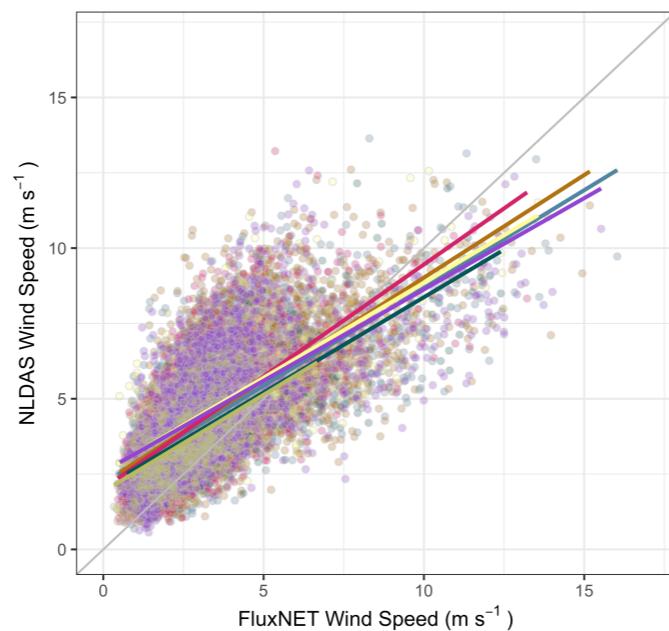
d) SNOTEL: Annual Peak SWE



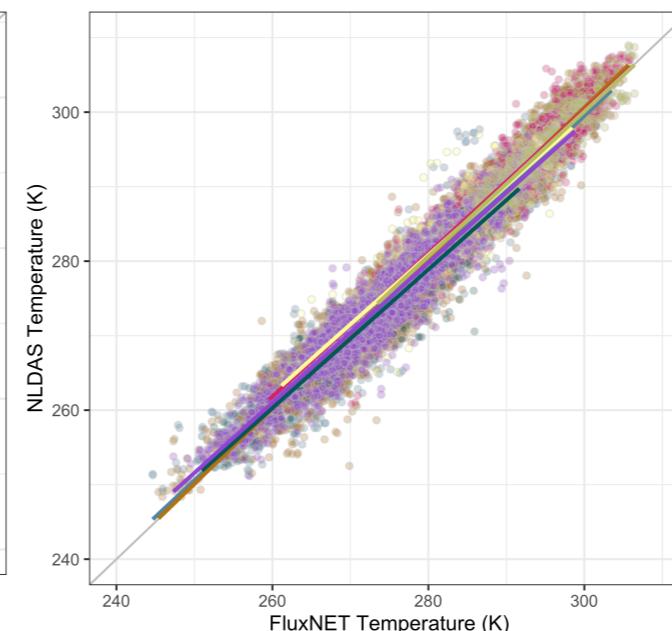
e) FluxNET: Daily Vapor Pressure Deficit



f) FluxNET: Daily Near-surface Lateral Wind Speed



g) FluxNET: Daily Air Temperature



h) FluxNET: Daily Evapotranspiration

