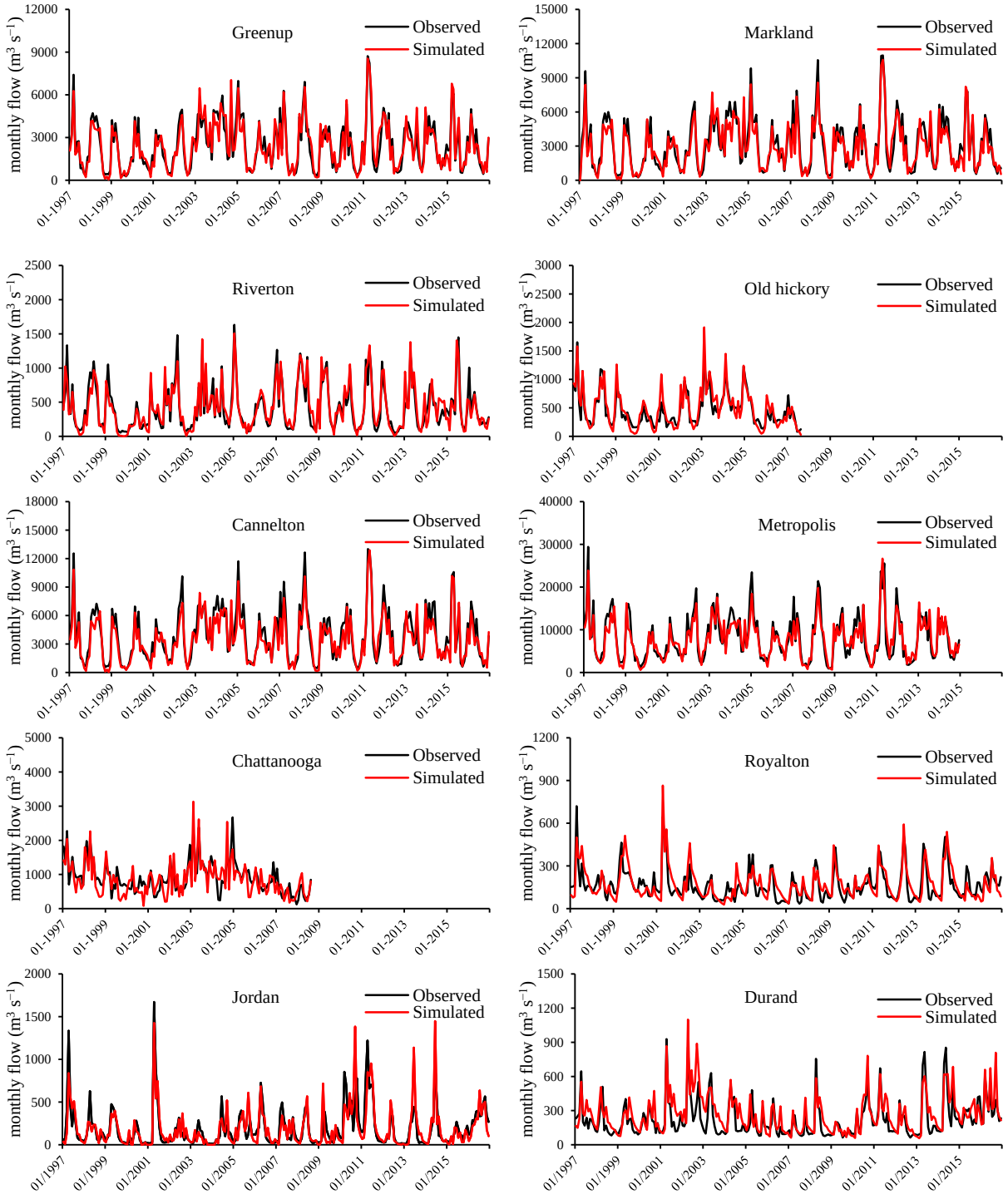
Table S1. Best estimates of hydrologic parameters at the Ohio-Tennessee River Basin (OTRB) and Upper Mississippi River Basin (UMRB).

Calibration Points	CN2	SOL_AWC(1)[a]	ESCO	GW_DELAY	ALPHA_BF	GWQMN	GW_REVAP	RCHRG_DP
Allowable range	−5-5	−0.2-0.2	0.7-1	0-300	0-1	0-300	0.02-0.2	0-0.5
Greenup	−5	−0.2	0.7	16	0.51	161	0.1	0.2
Markland	5	−0.2	0.98	16	0.51	161	0.1	0.2
Riverton	−5	−0.14	0.9	33	0.58	20	0.07	0.2
Old Hickory	−4	0.12	0.7	50	0.17	250	0.18	0.24
Cannelton	5	−0.05	0.98	13.5	0.14	30	0.03	0.2
Metropolis	−1	0.05	0.95	58.5	0.75	155	0.05	0.2
Chattanooga	−5	0.2	0.88	300	0.17	119	0.18	0.24
Royalton	−5	0.17	0.7	125	0.4	200	0.05	0.1
Jordan	0	0.05	0.85	60	0.8	150	0.1	0.1
Durand	−5	0.2	0.7	200	0.8	60	0.1	0.1
Clinton	−5	0.2	0.7	200	0.6	210	0.1	0.1
Augusta	5	−0.1	0.8	20	0.38	200	0.12	0.31
Wapello	0	0	0.87	94	0.53	200	0.16	0.01
Keosauqua	−5	−0.1	0.7	66	0.39	282	0.16	0.01
Grafton	5	0.18	0.82	50	0.64	200	0.12	0.05

[a] For SOL_AWC(1), allowable ranges and best estimates show the change from the default value as a fraction, for example, 0.1 corresponds to 10% increase and the allowable change of the parameters was within −0.2 and 0.2 of the default values.

Table S2. Best estimates of total suspended sediment (TSS), total nitrogen (TN), and total phosphorus (TP) parameters at the OTRB and UMRB.

Basin	Variable	Calibration Points	Definition	Allowable range	Value
OTRB	TSS	USLE_P	USLE equation support pra	0-1	0.75
	TN	ERORGN	Organic N enrichment ratio	0-5	5
		NPERCO	Nitrogen percolation coefficient	0-1	0.5
	TP	ERORGP	Organic P enrichment ratio	0-5	0.6
		PPERCO	Phosphorus percolation coefficient	10-17.5	10
UMRB	TSS	USLE_P	USLE equation support pra	0-1	0.7
		SPEXP	Exponent parameter for calculating sediment reentrained in channel sediment routing1	1-1.5	1.5
		SPCON	Linear parameter for calculating the maximum amount of sediment that can be reentrained during channel sediment routing	0.0001-0.01	0.00015
		CH_COV1	Channel erodibility factor	0-0.6	0.3
		CH_COV2	Channel cover factor	0-1	0.5
	TN	ERORGN	Organic N enrichment ratio	0-5	5
		NPERCO	Nitrogen percolation coefficient	0-1	0.2
	TP	ERORGP	Organic P enrichment ratio	0-5	0.5
		PPERCO	Phosphorus percolation coefficient	10-17.5	10


Greenup
Markland
Riverton
Old hickory
Cannelton
Metropolis
Chattanooga
Royalton
Jordan
Durand
Observed
Simulated
monthly flow (m3 s−1)

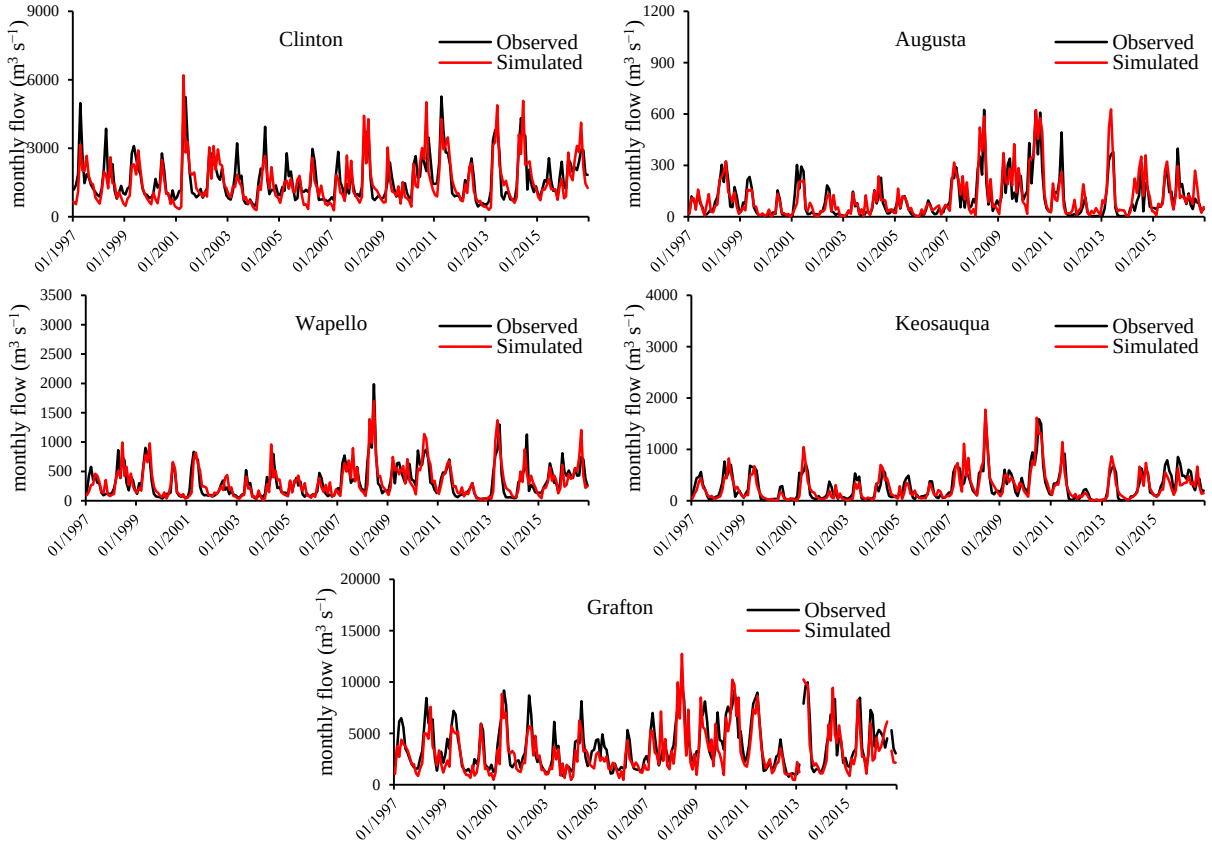
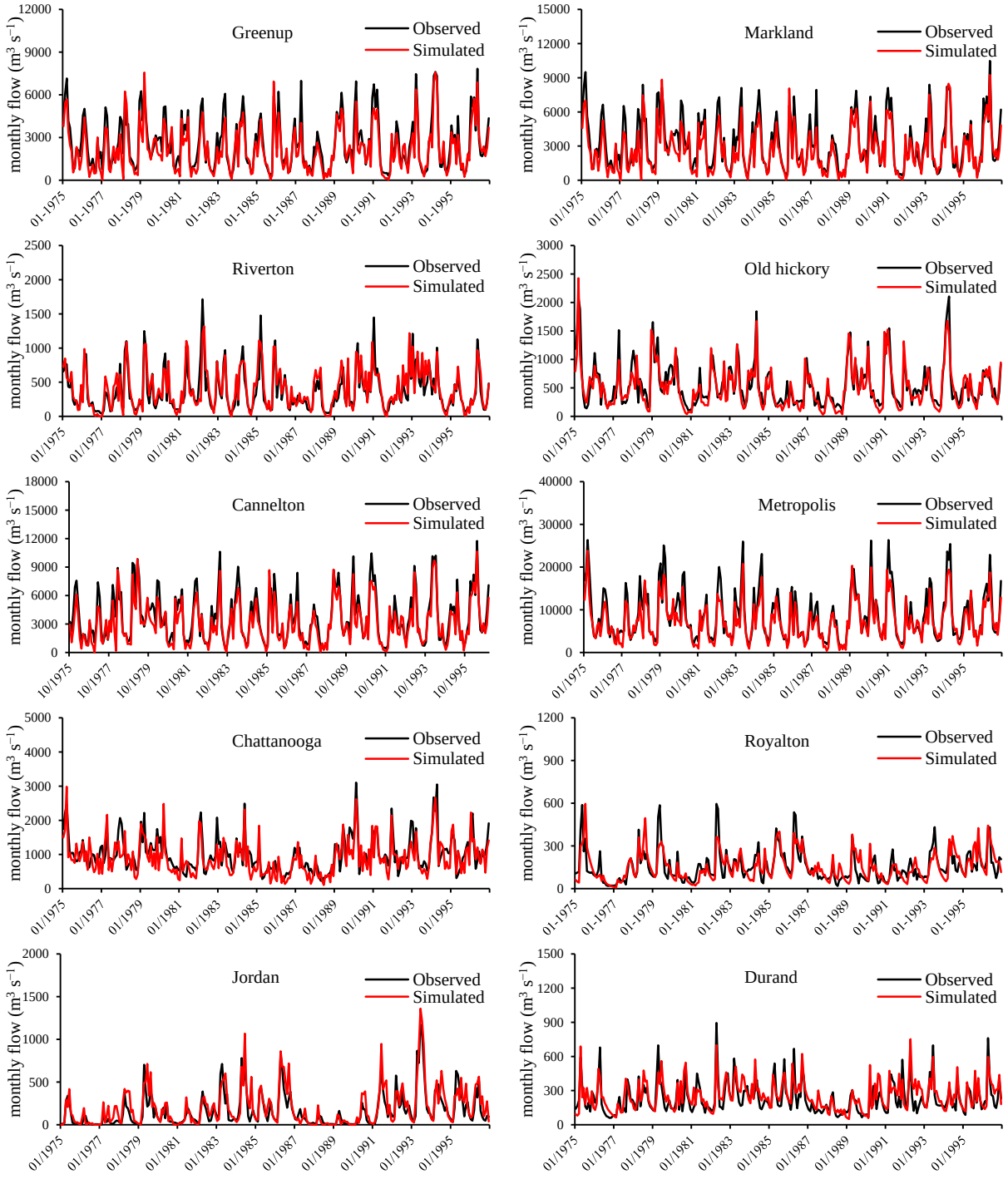


Figure S1. Monthly simulated versus observed flows (unit: $m^3\ s^{-1}$) during calibration period (1997−2016) at the OTRB and UMRB.


Greenup
Markland
Riverton
Old hickory
Cannelton
Metropolis
Chattanooga
Royalton
Jordan
Durand
Observed
Simulated
monthly flow (m3 s−1)

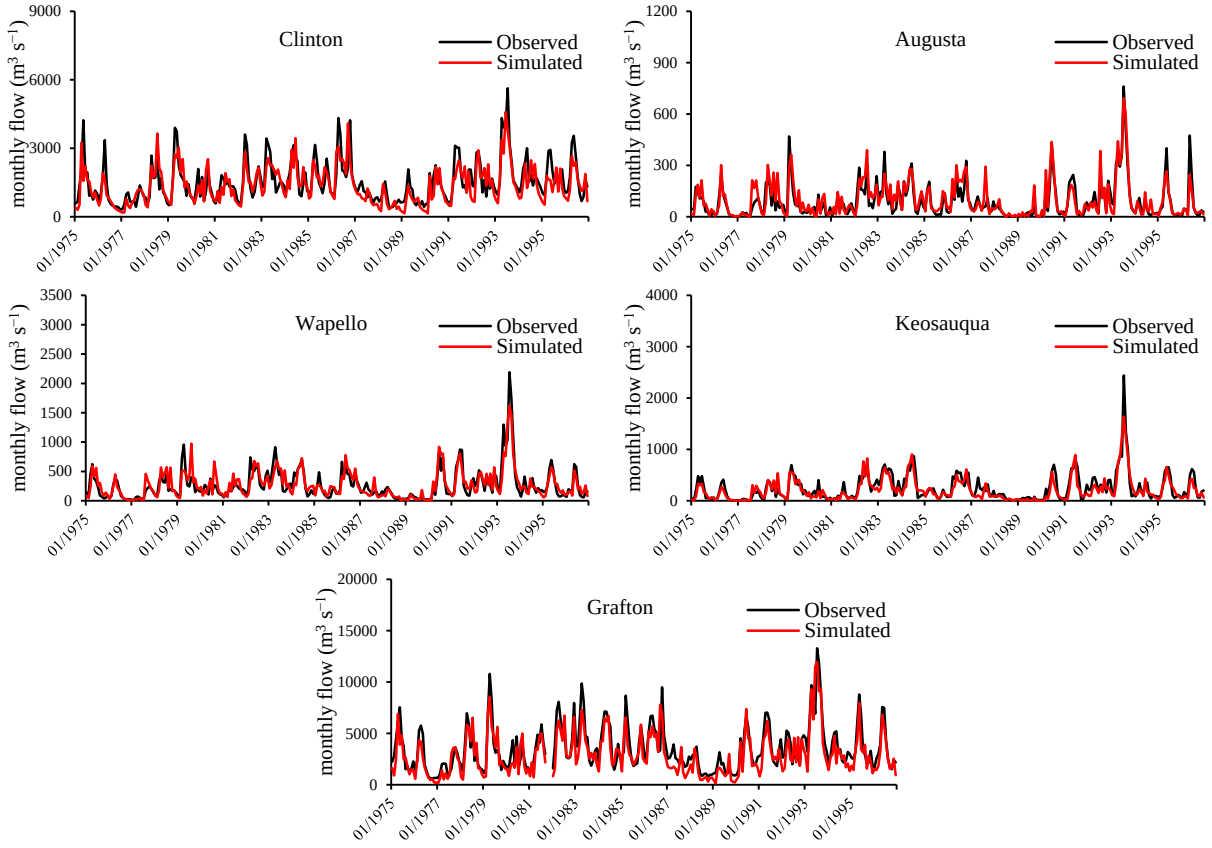
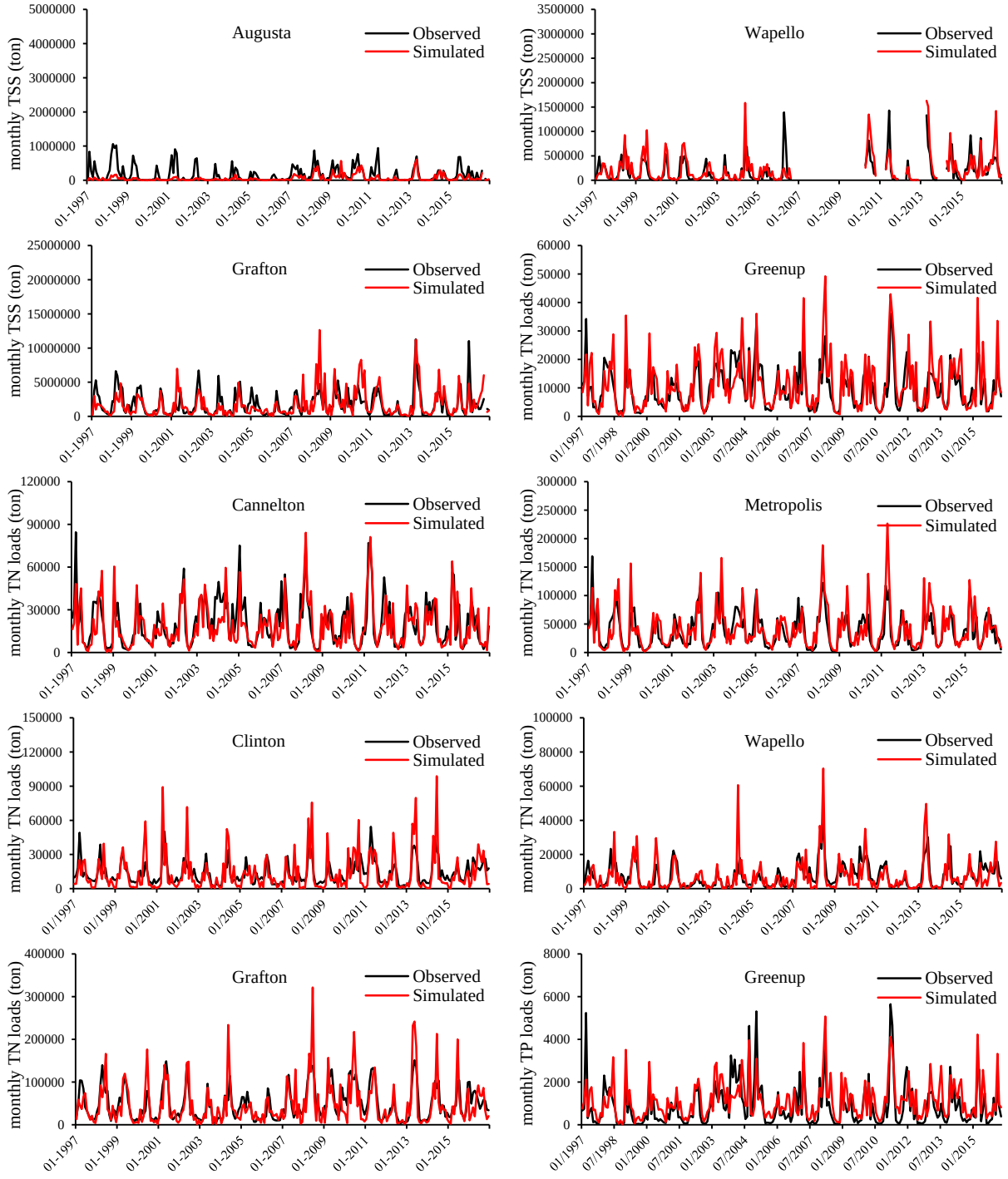


Figure S2. Monthly simulated versus observed flows (unit: $m^3\ s^{-1}$) during validation period (1975−1996) at the OTRB and UMRB.


Augusta
Observed
Simulated
monthly TSS (ton)
Wapello
Observed
Simulated
monthly TSS (ton)
Grafton
Observed
Simulated
monthly TSS (ton)
Greenup
Observed
Simulated
monthly TN loads (ton)
Cannelton
Observed
Simulated
monthly TN loads (ton)
Metropolis
Observed
Simulated
monthly TN loads (ton)
Clinton
Observed
Simulated
monthly TN loads (ton)
Wapello
Observed
Simulated
monthly TN loads (ton)
Grafton
Observed
Simulated
monthly TN loads (ton)
Greenup
Observed
Simulated
monthly TP loads (ton)

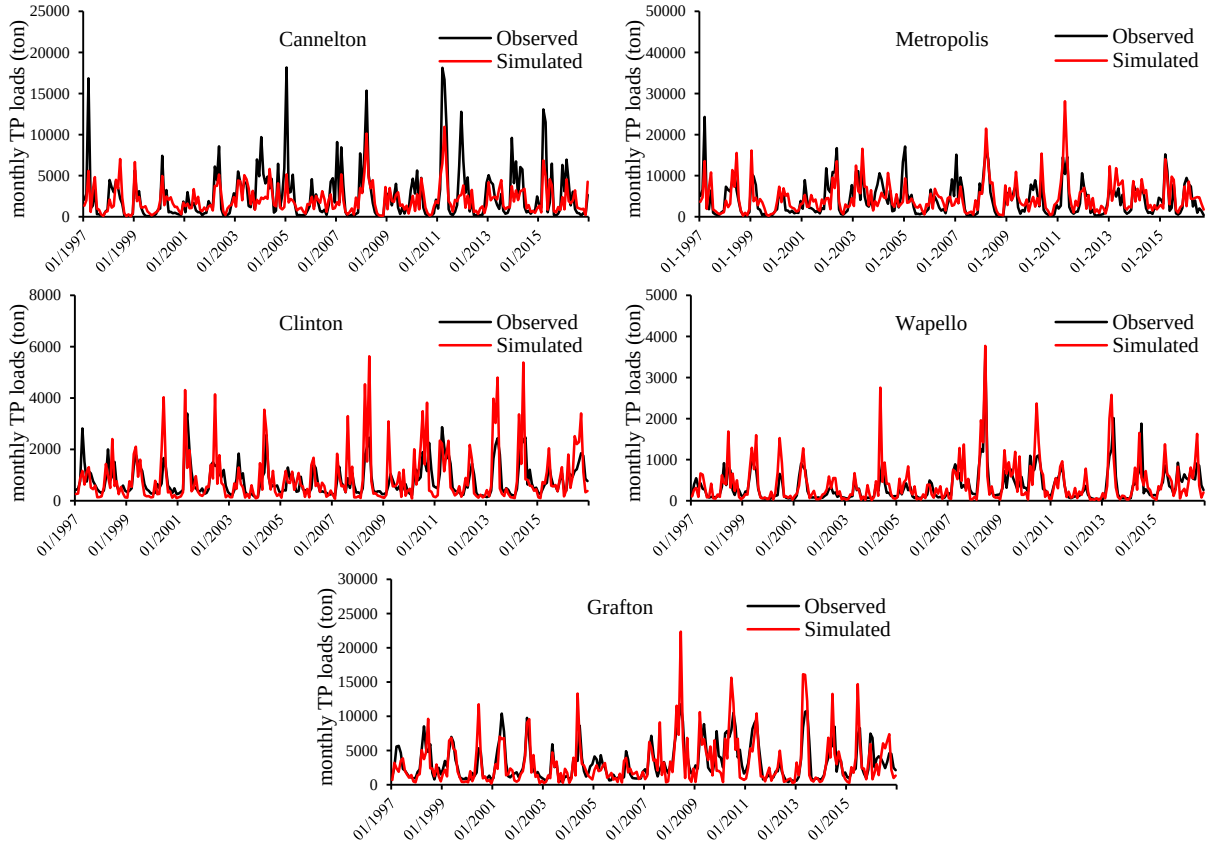
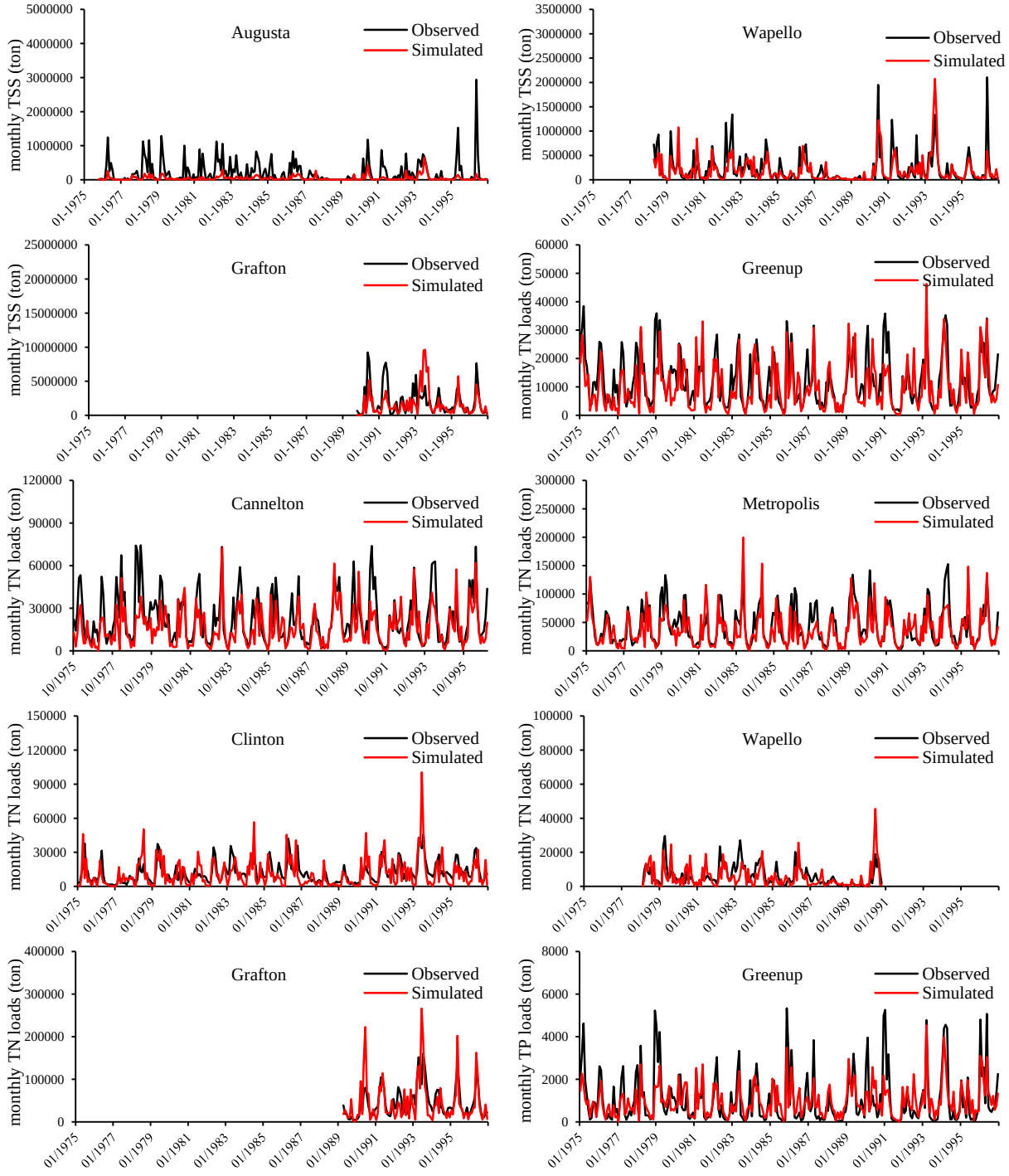


Figure S3. Monthly simulated versus observed TSS, TN, and TP (unit: metric ton) during calibration period (1997−2016) at the OTRB and UMRB.


Augusta
Observed
Simulated
monthly TSS (ton)
Wapello
monthly TSS (ton)
Grafton
monthly TSS (ton)
Greenup
monthly TN loads (ton)
Cannelton
monthly TN loads (ton)
Metropolis
monthly TN loads (ton)
Clinton
monthly TN loads (ton)
Wapello
monthly TN loads (ton)
Grafton
monthly TN loads (ton)
Greenup
monthly TP loads (ton)

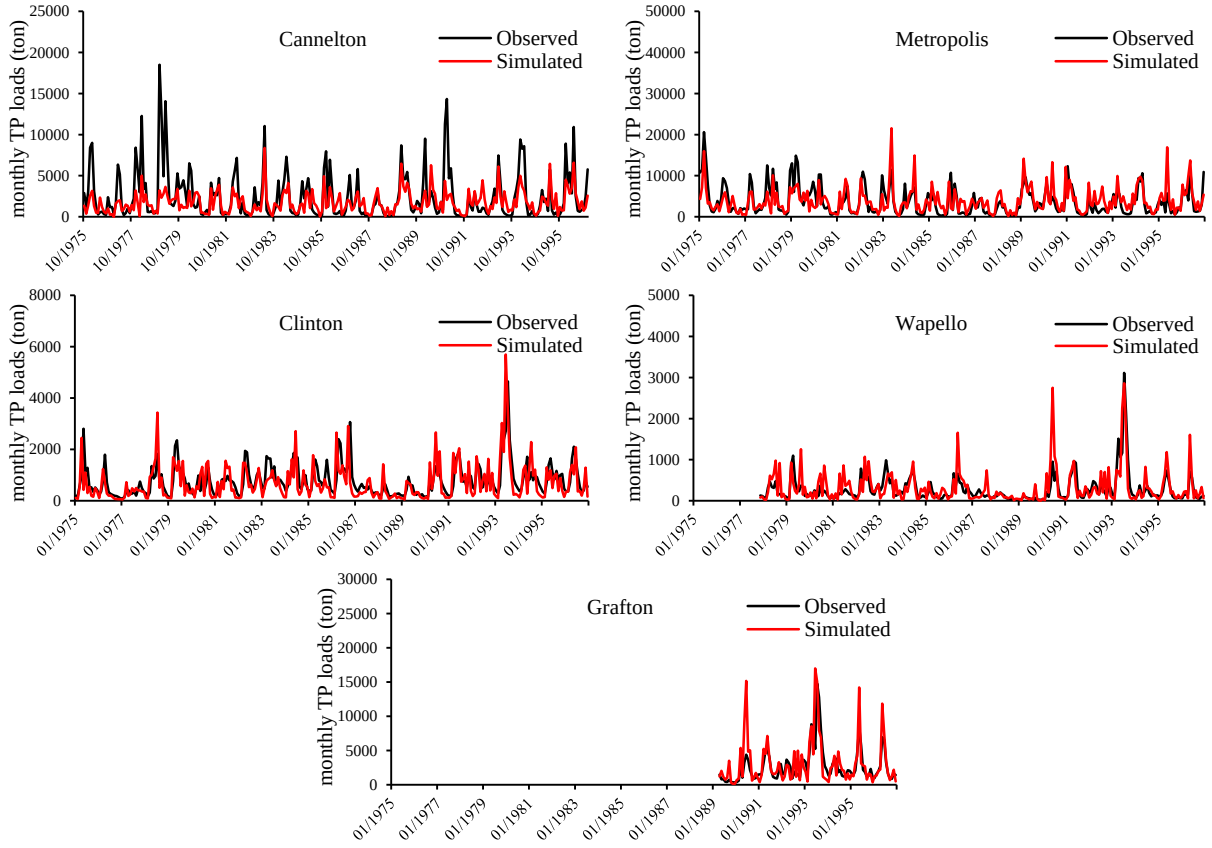


Figure S4. Monthly simulated versus observed TSS, TN, and TP (unit: metric ton) during validation period (1975−1996) at the OTRB and UMRB.

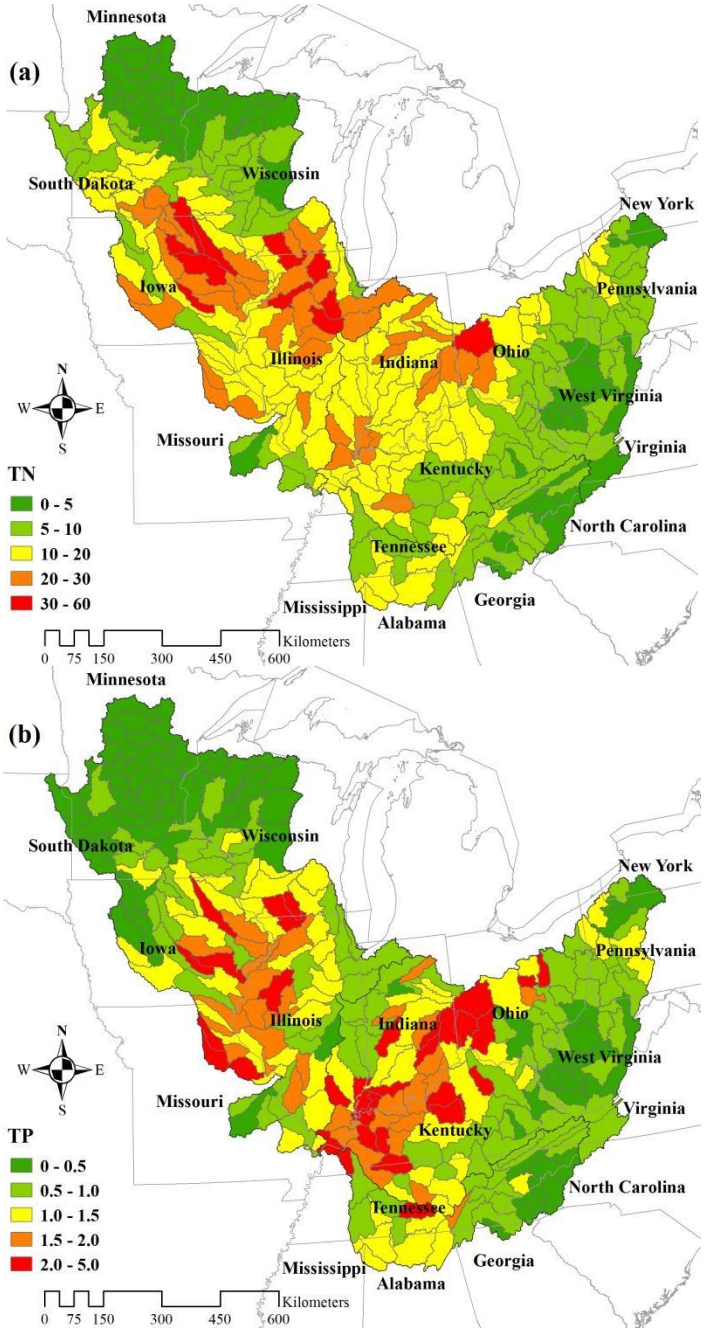


Figure S5. Spatial distributions of annual (a) TN, (b) TP (unit: kg ha^{-1}) at the OTRB and UMRB.

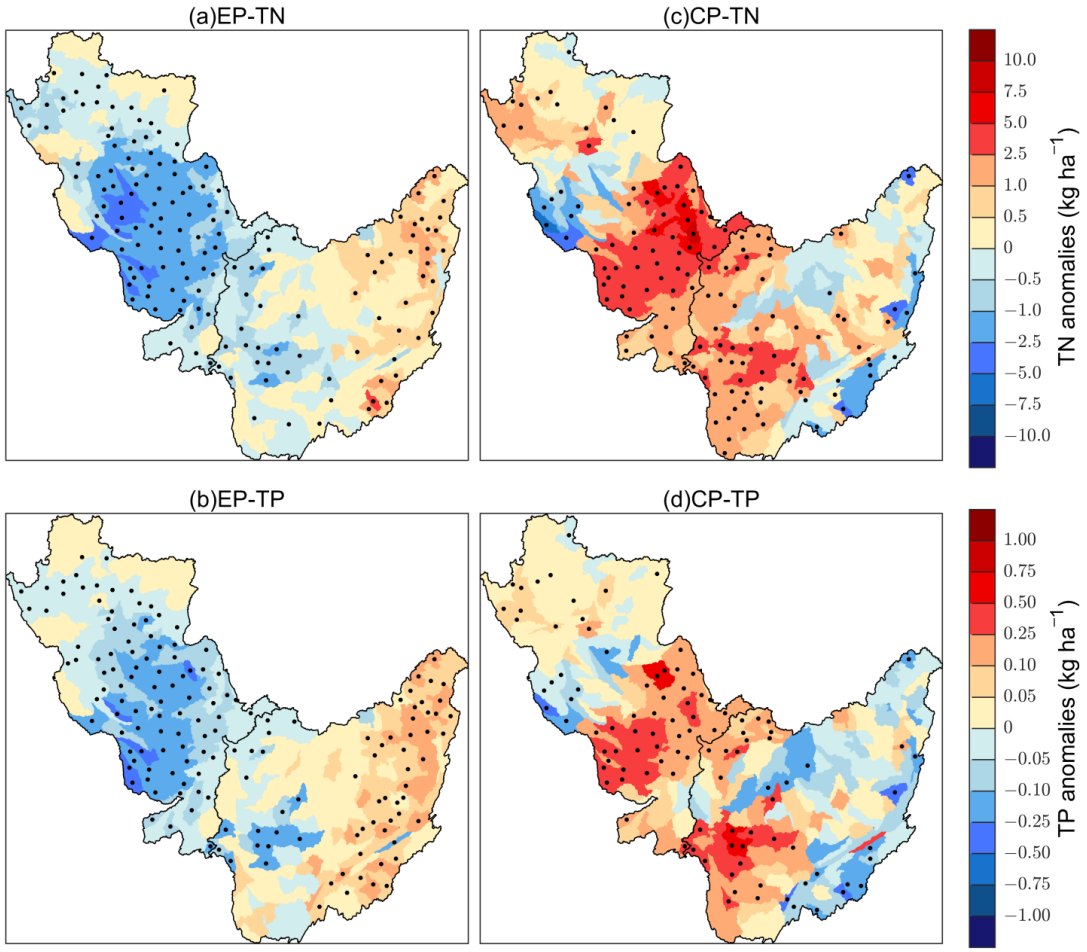


Figure S6. Composite results of annual TN and TP anomalies (unit: kg ha^{-1}) in eastern Pacific (EP)-El Niño years (a and b) and in central Pacific (CP)-El Niño years (c and d) during the period of 2050−2099. Stippling denotes anomalies significantly different from zero at the 95% confidence level based on the Monte Carlo test.