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Supplement of

Estimating lateral nitrogen transfers over the last century through the global river network using a land surface model

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Table S1. Information of observational sites from literature.

Site	Lat	Long	Mean TN flow (Tg yr^{-1})	Periods	Reference
Rio Canague	8.03	-69.99	0.048	1990-1999	Lewis et al., 1999
Rio Caroni	6.00	-62.85	0.049	1990-1999	Lewis et al., 1999
Gambia River	13.32	-14.21	0.005	1990-1999	Lewis et al., 1999
Trombetas	0.02	-58.01	0.039	1990-1999	Lewis et al., 1999
Japura	-1.87	-67.00	0.258	1982-1990	Lewis et al., 1999
Madeira	-8.00	-62.87	0.550	1990-1999	Lewis et al., 1999
Negro	-0.01	-67.19	0.091	1990-1999	Lewis et al., 1999
Orinoco	7.00	-67.07	0.568	1990-1999	Lewis et al., 1999
Paraguay River	-19.03	-57.36	0.027	1990-1999	Lewis et al., 1999
Manacapuru	-3.15	-60.01	1.895	1990	Hedges et al., 1994
Içà	-1.40	-69.44	0.124	1982-1990	Hedges et al., 1994
Vargem Grande	-3.50	-69.33	1.242	1982-1990	Hedges et al., 1994
Purus	-4.10	-61.57	0.378	1982-1990	Martinelli et al., 2010
Óbidos	-1.93	-55.52	2.815	1969-1970	Salati et al., 1982
Han Jiang	30.51	113.09	0.170		
Yangtze river	30.76	117.68	1.820		
Huaihe	32.95	117.27	0.087	2014-2015	[a]
Tongtian river	33.01	97.26	0.110		
Yellow river	34.92	112.40	0.340		

[a] http://envi.ckcest.cn/environment/data_Integration/data_Integration.jsp

Table S2. Information of world's largest 20 rivers (Dai &Trenberth, 2002).

No.	Name	GRDC_ID	Lat	Long	Station, Country
1	Amazon	3629000	-1.95	-55.51	Obidos, Brazil
2	Congo	1147010	-4.30	15.30	Kinshasa, Congo
3	Orinoco	3206720	8.25	-64.25	Pte Angostu, Venezuela
4	Changjiang	2181900	30.77	117.62	Datong, China
5	Brahmaputra	2651100	25.18	89.67	Bahadurabad, Bangladesh
6	Mississippi	4127800	33.25	-91.25	Vicksburg, MS, United States
7	Yenisey	2909150	68.25	86.75	Igarka, Rusia
8	Parana	3265601	-32.67	-60.71	Timbues, Argentina
9	Lena	2903420	71.75	127.25	Kusur, Russia
10	Mekong	2469260	15.12	105.80	Pakse, Laos
11	Tocantins	3649950	-3.76	-49.65	Tucurui, Brazil
12	Tapajos	3629152	-5.15	-56.85	Jatoba, Brazil
13	Ob	2912600	66.57	66.53	Salekhard, Russia
14	Ganges	2646200	24.08	89.03	Farakka, India
15	Irrawaddy	2260500	22.25	95.75	Sagaing, Myanmar (Burma)
16	St. Lawrence	4143550	45.25	-75.25	Cornwall, ON, Canada
17	Amur	2906900	50.75	137.25	Komsomolsk, Russia
18	Xingu	3630050	-3.21	-52.21	Altamira, Brazil
19	Mackenzie	4208025	68.25	-133.75	Arctic Red, Canada
20	Xijiang	2186800	24.25	110.75	Wuzhou, China

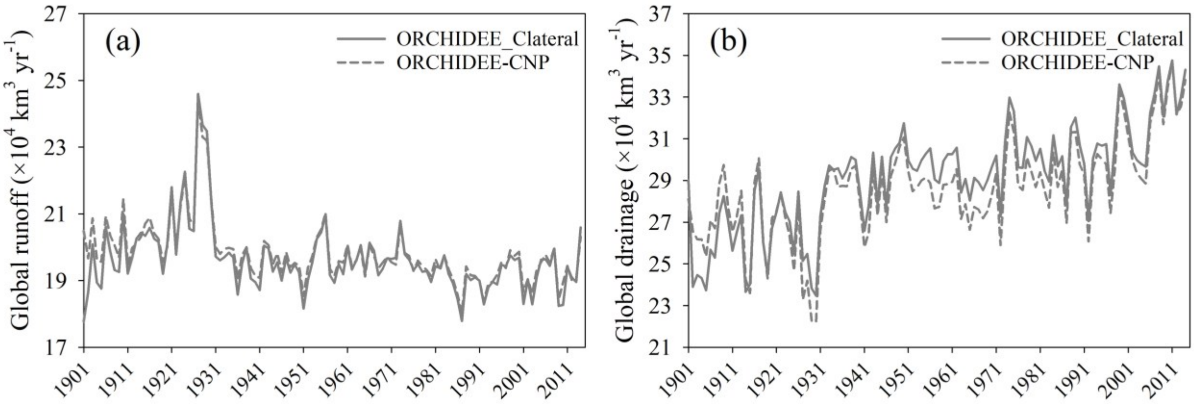

Figure S1. Comparison of global runoff (a) and drainage (b) simulated by ORCHIDEE-Clateral and ORCHIDEE-CNP.

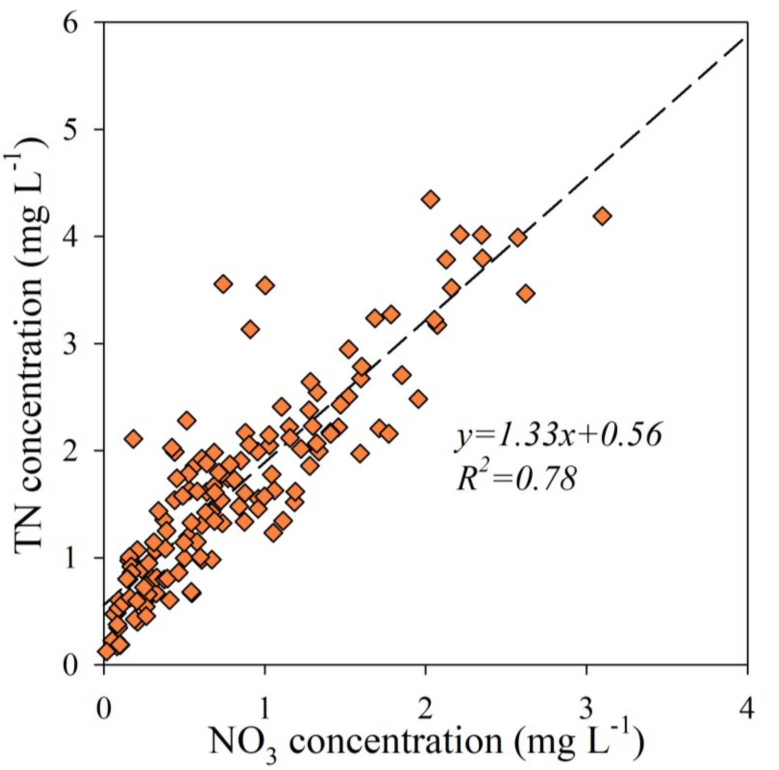

Figure S2. Linear regression relationship between TN concentration and NO_3^- concentration in rivers based on data from GRQA.

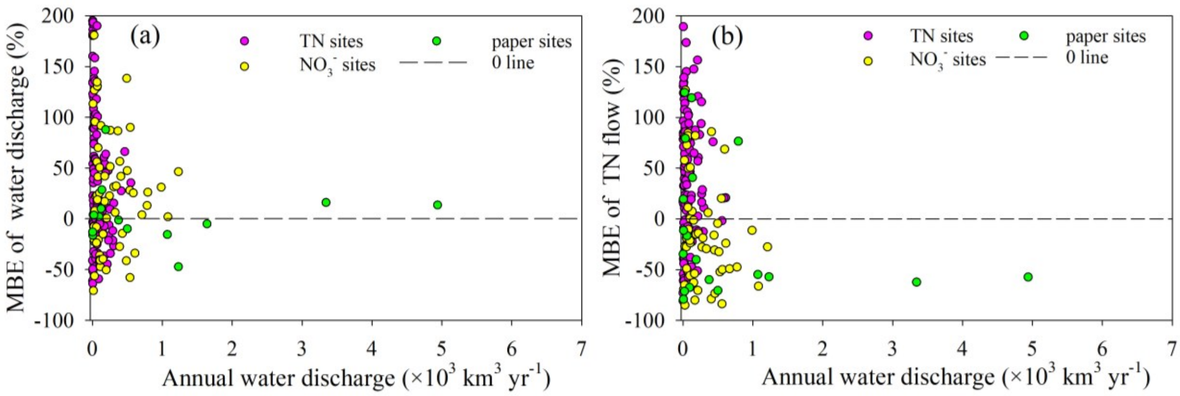

Figure S3. The mean bias error (MBE) of LSM_Nlateral_Off simulated water discharge (a) and TN flow (b).

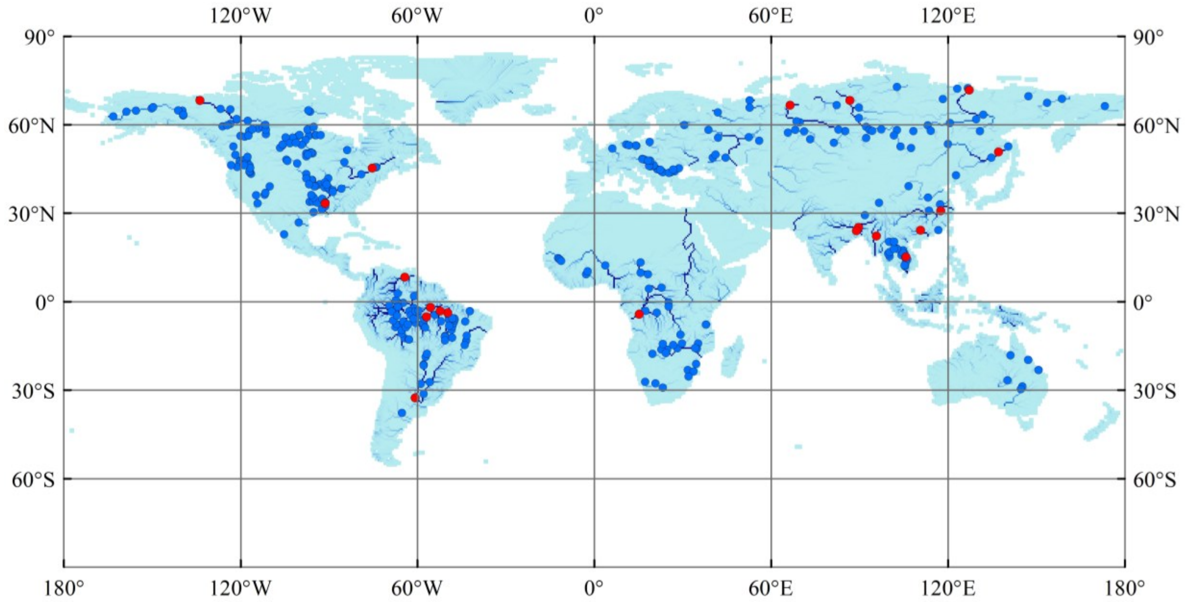

Figure S4. Location of observation sites for water discharge. Blue dots represent GRDC gauging stations with a catchment area greater than 50 000 km^2. Red dots represent gauging stations for the world's 20 largest rivers (Dai & Trenberth, 2002).

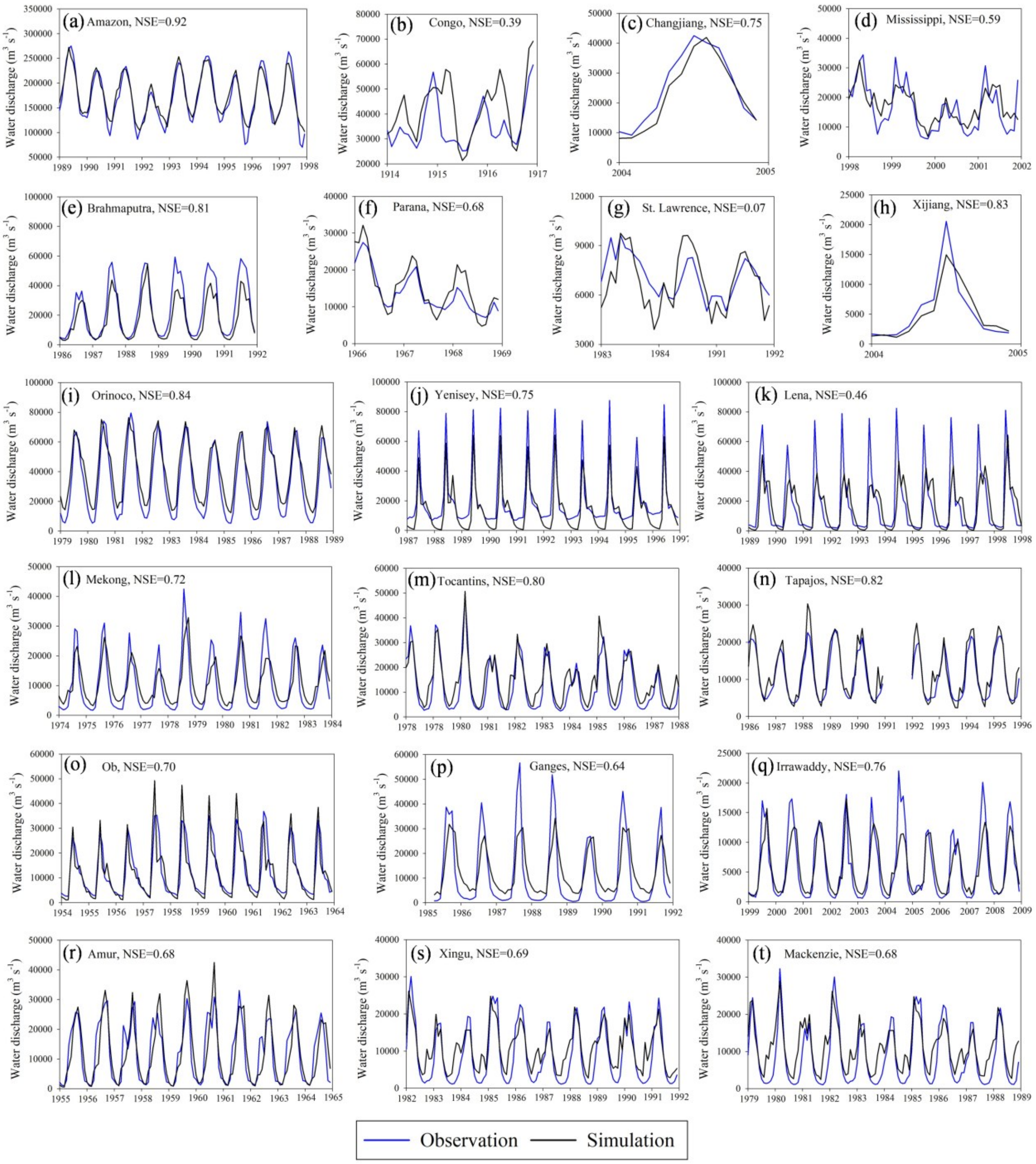

Figure S5. Comparison between simulated and observed time series of water discharge for the world's 20 largest rivers (Dai & Trenberth, 2002).

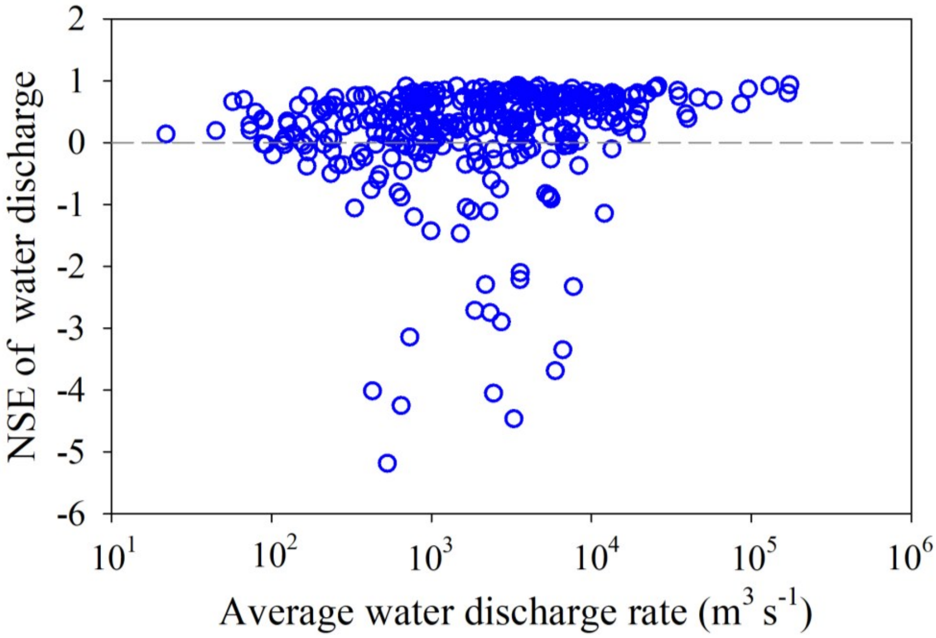

Figure S6. The Nash-Sutcliffe efficiency coefficient (NSE) of water discharge simulated by LSM_Nlateral_Off at 346 GRDC sites.

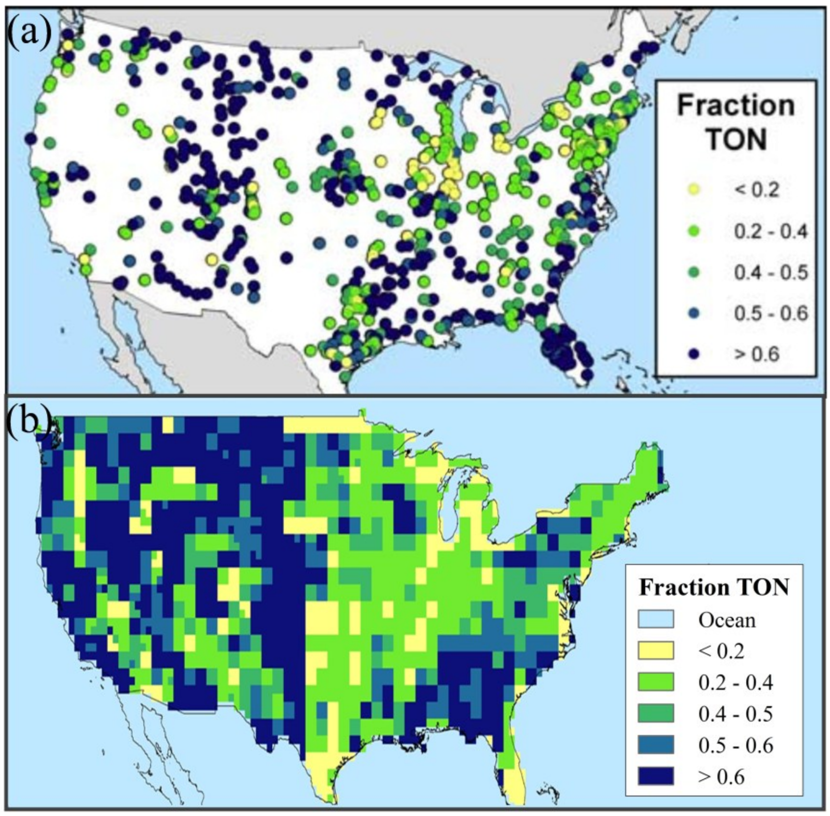

Figure S7. Spatial patterns of long-term (1975-2004) mean annual total organic nitrogen (TON) fractions: (a) observed TON fractions reported by Scott et al. (2007); (b) TON fractions simulated by LSM_Nlateral_Off.

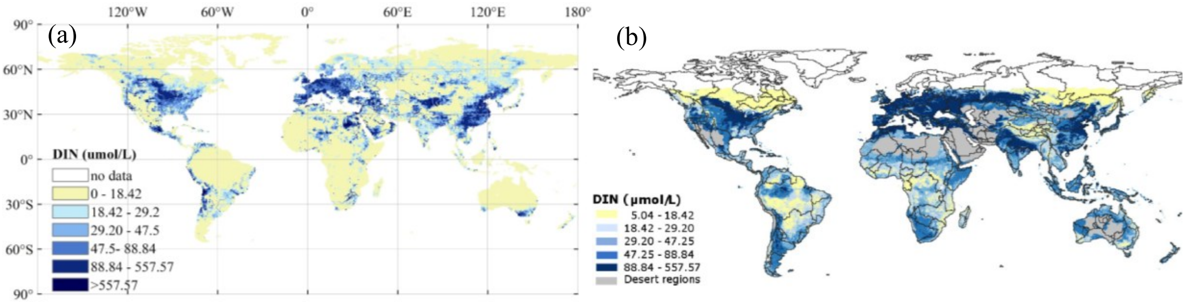

Figure S8. Spatial distribution of DIN concentration: (a) DIN concentration simulated by ORCHIDEE-NLAT; (b) DIN concentration simulated by semi-empirical (observation-based) model from Marzadri et al (2021).

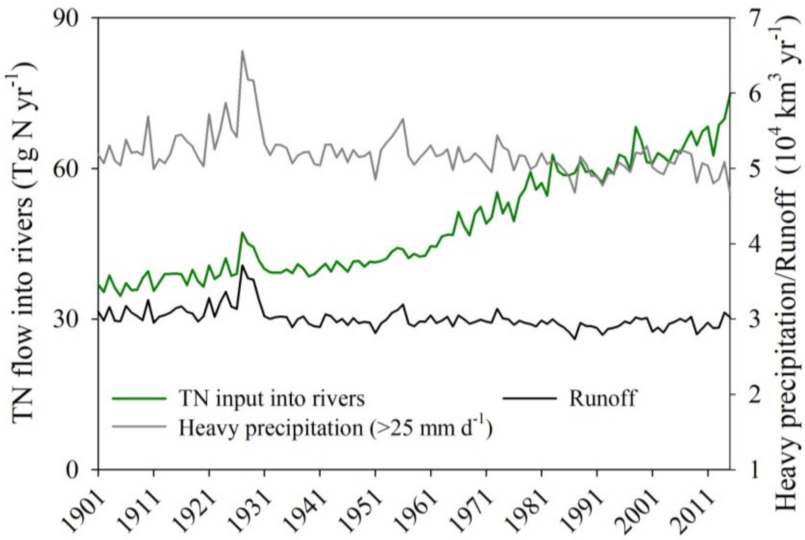

Figure S9. Global annual TN flow into rivers, runoff and heavy precipitation (> 25 mm d^{-1}) from 1901 to 2014.

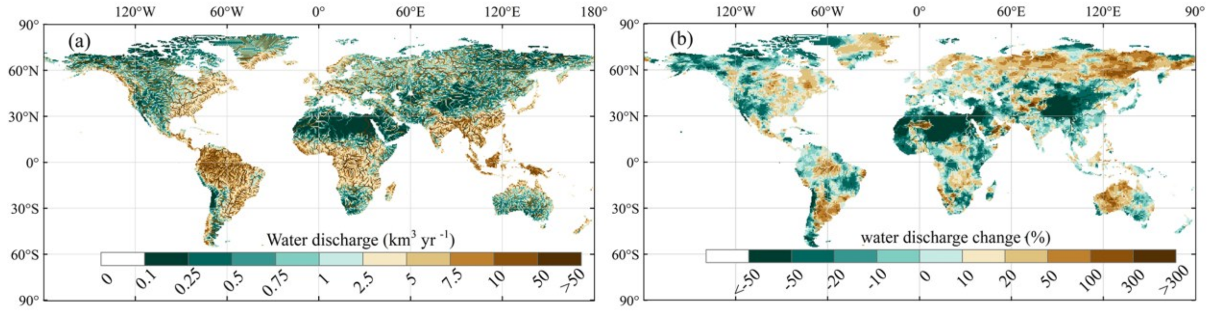

Figure S10. Spatial patterns of water discharge: (a) average annual water discharge over 1995-2014; (b) water discharge changes from the reference period 1901-1920 to 1995-2014.

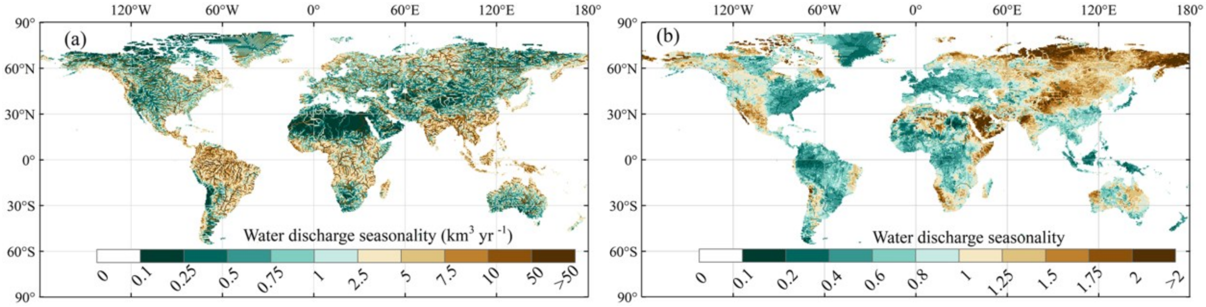

Figure S11. Spatial patterns of water discharge seasonality over 1995-2014: (a) water discharge seasonality; (b) normalized water discharge seasonality (=water discharge seasonality/ averaged annual water discharge).

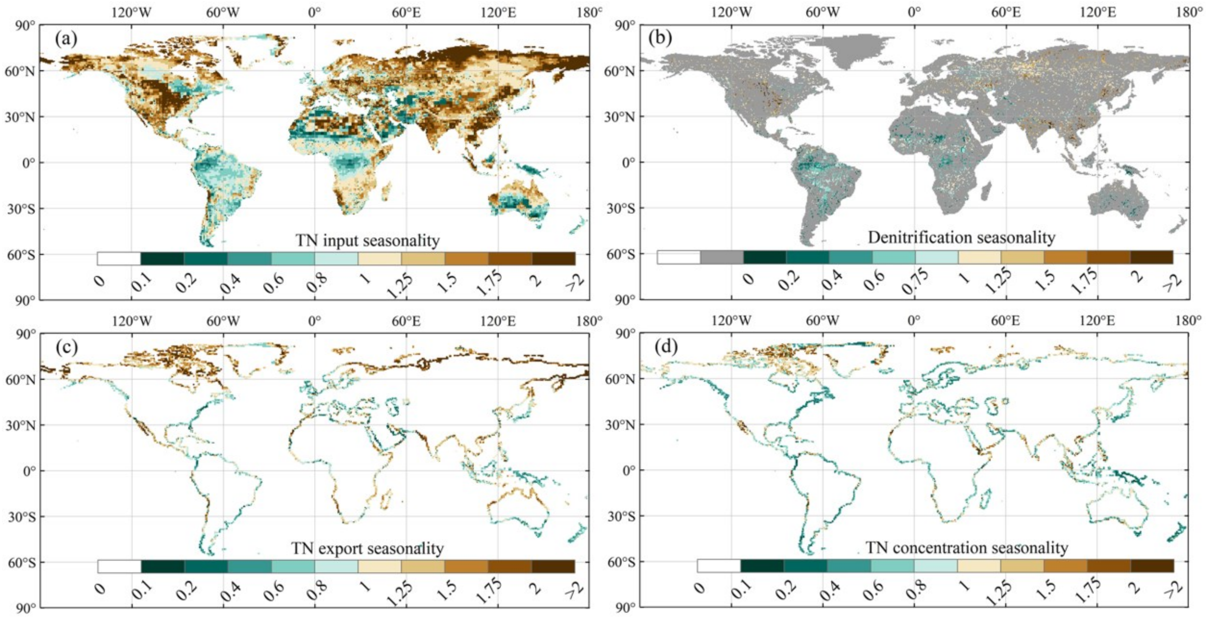

Figure S12. Spatial distribution of normalized seasonality for TN and denitrification over 1995-2014: (a) TN inputs into rivers; (b) denitrification rates; (c) TN export to oceans; (d)TN concentrations at rivers' mouths. The normalized seasonality of TN or denitrification = seasonality of TN or denitrification /averaged annual values of TN or denitrification.

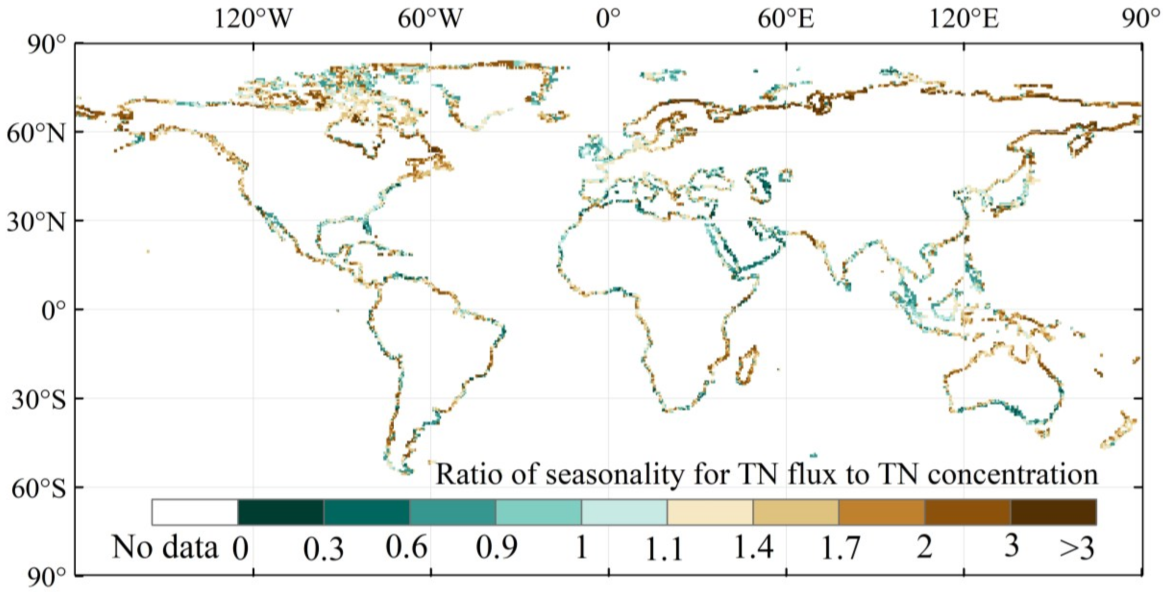

Figure S13. Spatial distribution of the ratio between normalized seasonality of TN flux and TN concentration during 1995-2014.”

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