A meta analysis of lake N_2O flux data

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2016/11/18

Background

- Inland waters (e.g. lakes and reservoirs) play important roles in global greenhouse gas cycling as they receive and retain plenty of nutrient (Harrison et al., 2008).

- Comparing with CO_2 and CH_4, nitrous oxide (N_2O) has received less attention as some of studies show that N_2O emissions from lakes are low and can be negligible (Huttunen et al., 2003; Miettinen et al., 2015).

- Are the Lakes important components of N_2O cycle?

Methods

25 papers

Latitude	Lake /Reservoir name	Region	Areas (km^2)	Mean depth (m)	Trophic state	Methods
	Lake Kivu	East-Africa	2220	240		FC
	Tucurui Reservoir	Brazil	2800	19	mesotrophic	FC
	Petit Saut Reservoir	French Guiana	300	10		FC
< 24	Samuel Reservoir	Brazil	420	5.7		FC
(n=7)	Fortuna Reservoir	Panama	10	15		FC
	Serra de Mesa Reservoir	Brazil	1784	6.7		FC
	Manso Reservoir	Brazil	427			FC
	Lake Wuxian	China	211	89.6	eutrophic	FC
	Lake Dianchi	China	297.9	2.93	eutrophic	FC
	Lake Erhai	China	249	10.17	mesotrophic	FC
	Lake Baroon	Australia	4			HE
	Hongjiadu Reservoir	China	80.5		mesotrophic-eutrophic	HE
	Gold Creek Reservoir	Australia	0.19			FC
	Wujiangdu Reservoir	China	47.8		mesotrophic-eutrophic	HE
	Lake Wivenhoe	Australia	109.4			HE
24-54	Little Nerang Dam	Australia	0.5			HE
(n=38)	Lake Poyang	China	3283	8.4	mesotrophic	FC & HE
	Lake Dongting	China	2432.5	6.39	mesotrophic	FC
	Three Gorges Reservoir	China	1084		eutrophic	FC
	Lake Chaohu	China	739.56	2.69	eutrophic	FC
	Lake Taihu	China	2338	1.9	eutrophic	FC & HE
	Jurong Reservoir	China	2.3	2.4	mesotrophic	HE
	Lake Hongze	China	1576.9	1.77	eutrophic	FC

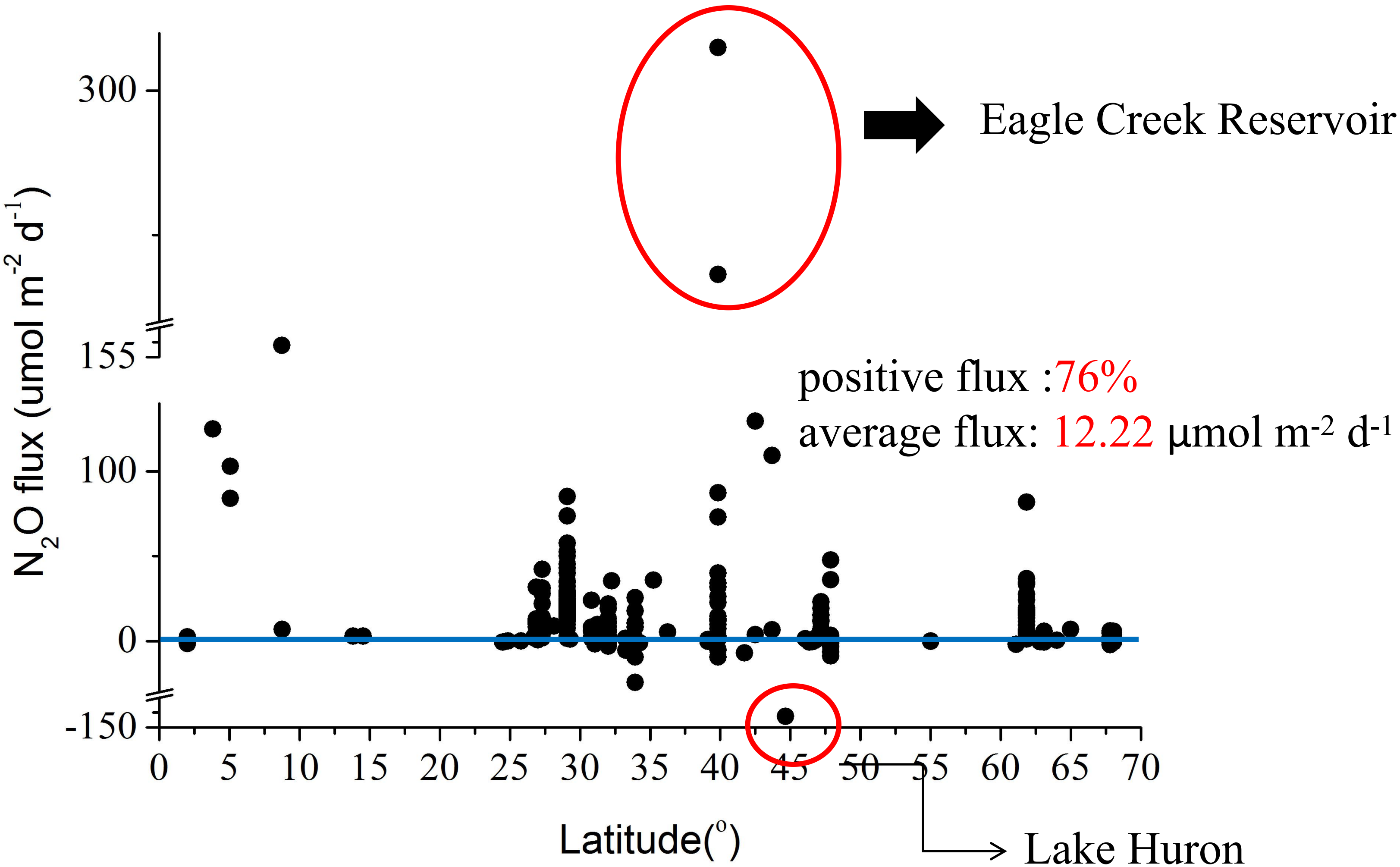
Methods: FC: floating chambers; HE: headspace equilibrium method

	Lake Huahu	China	1.6			FC
	7 lakes	Tianjin, China				HE
	Eagle Creek reservoir	USA	5.5	4.2	eutrophic	HE
	Lake Erie	Canada/USA	25821	17.7	eutrophic	HE
	Lake Cayuga	USA	172	55		HE
	Lake Ontario	Canada/USA	19009	86	eutrophic	HE
	Lake Huron	Canada/USA	59570	53		HE
	Lake Dix	Switzerland	4.3	93		HE
	Lake Zeuzier	Switzerland	0.85	60		HE
	Lake Grimsel	Switzerland	2.72	37		HE
	Long Lake	USA	65	0.54		FC
	Lake Lungern	Switzerland	2.01	32		HE
	Lake Wohlen	Switzerland	3.65	7	mesotrophic-eutrophic	HE
	Lake Baldegg	Switzerland	5.2	33	eutrophic	HE
	Lake Neusiedl	Austria	320	0.8	eutrophic	FC
	High C reservoir site	Ontario, Canada	0.0074	0.9		HE
	Medium C reservoir site	Ontario, Canada	0.005	0.9		HE
	Low C reservoir site	Ontario, Canada	0.0063	1.1		HE
	Lake Heinalampi	Finland	0.098		eutrophic	FC
	Lake Kuivajärvi	Finland	0.613		mesotrophic	HE
> 54	Lake Makijarvi	Finland	0.2	3.4	oligotrophic	FC
(n=11)	Lake Postilampi	Finland	0.03	3.2	eutrophic	FC
	Lake Kevaton	Finland	4.07	2.3	eutrophic	FC
	Lake Vehmasjarvi	Finland	0.41	3.9	eutrophic	FC
	Lokka Reservoir	Finland	417	5	eutrophic	FC
	Porttipahta Reservoir	Finland	214	6.3	mesotrophic	FC

statistics

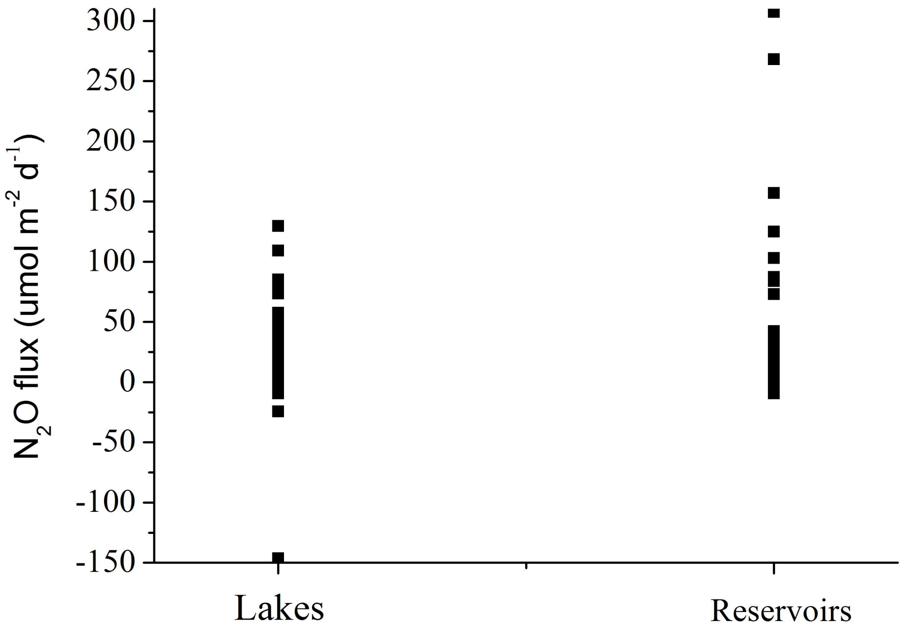
		Count.
Types	lakes	33
	reservoirs	23
Water depths	shallow lakes	12
	deep lakes	26
Trophic state	oligotrophic	1
	mesotrophic	6
	mesotrophic - eutrophic:	3
	eutrophic	18
Methods	floating chamber	28
	headspace equilibrium	32

Results



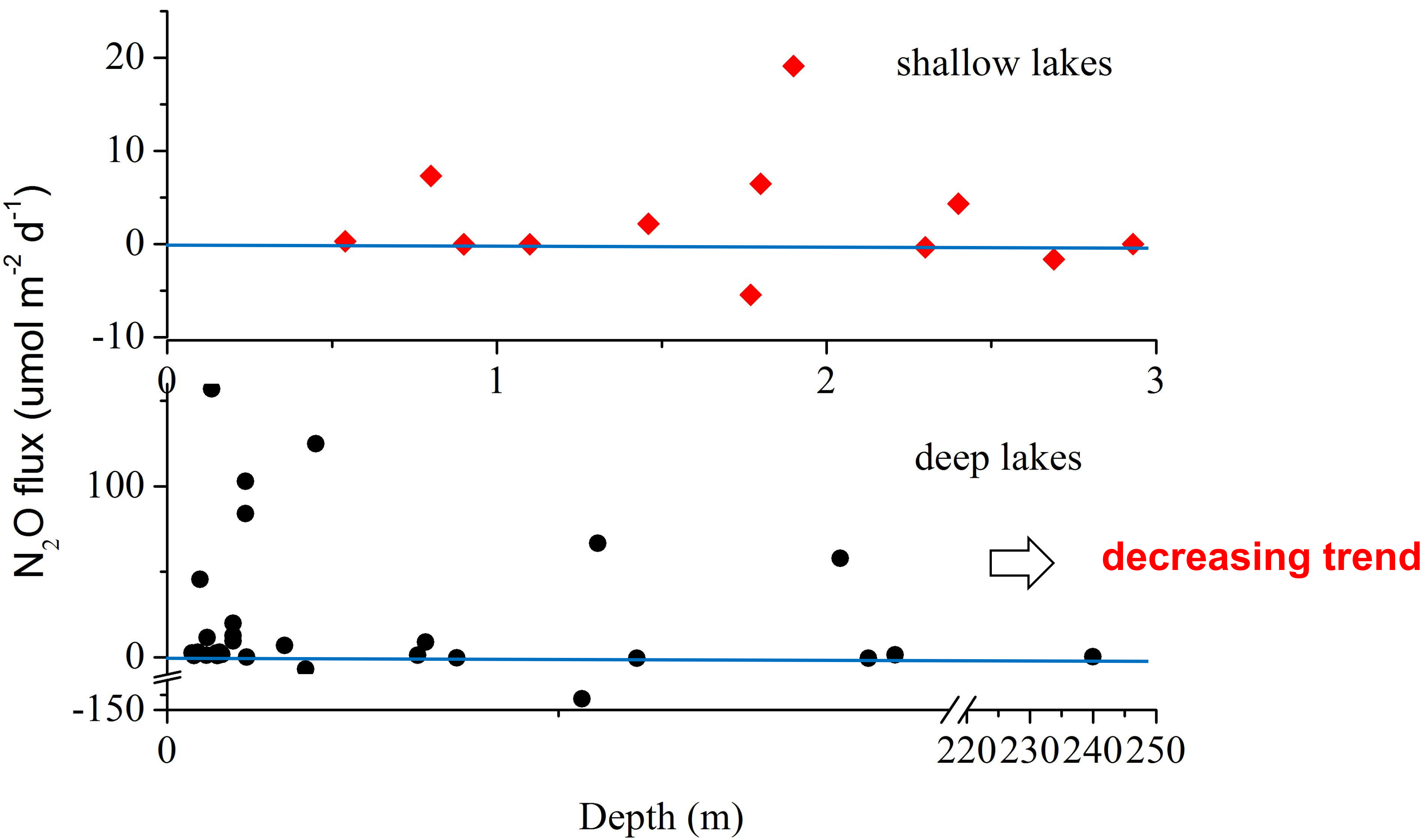
300
155
100
0
-150
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
N_2O flux (umol m^{-2} d^{-1})
Latitude(°)
Eagle Creek Reservoir
positive flux :76%
average flux: 12.22 μmol m^{-2} d^{-1}
Lake Huron

Lakes vs. Reservoirs

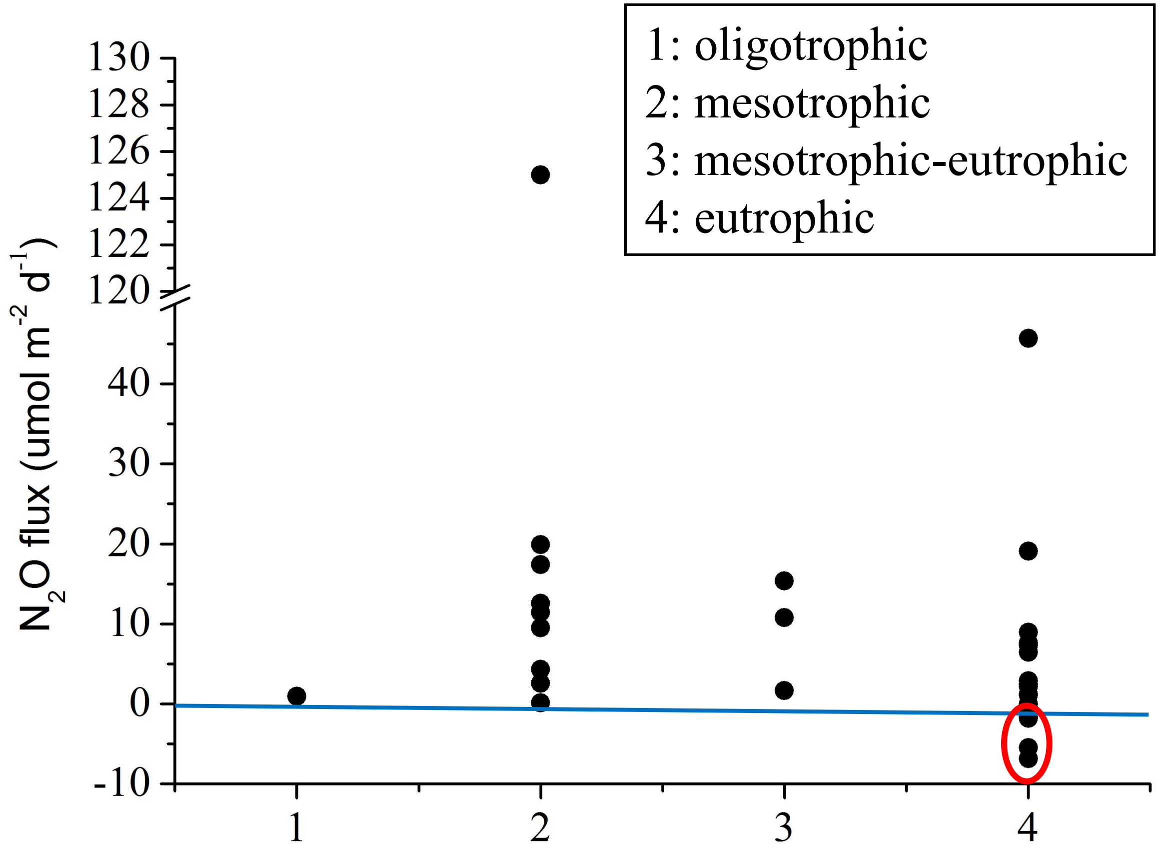


Types	Average N_2O flux (µmol m^{-2} d^{-1})	SD
Lakes	12.24	22.36
Reservoirs	12.20	37.57

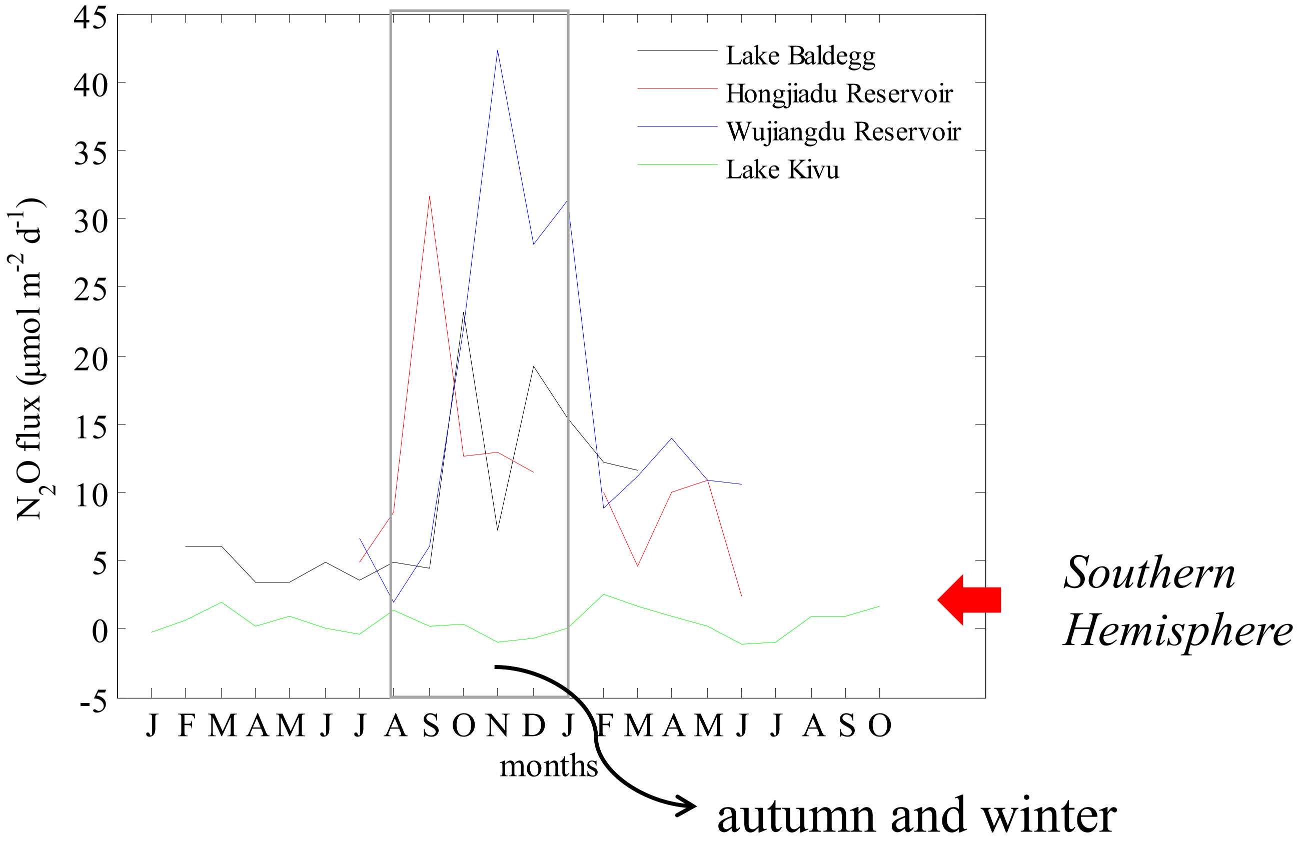
Results: Shallow lakes vs. Deep lakes



Results: Trophic state



Results: Seasonal variations



Conclusion

- ✓ Most of lakes act a souce for N_2O. The average N_2O flux is 12.22 μmol m^{-2} d^{-1} and the range of N_2O flux is so large (-146.325 - 307.5 μmol m^{-2} d^{-1}).
- ✓ The variation of N_2O flux in shallow lakes is small, but N_2O flux shows a decreasing trend with the increasing water depths in deep lakes.
- ✓ It seems that analyzing trophic state of lakes alone can not explain N_2O flux well. Seasonal variations of N_2O flux need further research as few studies have consecutive observed values.

shortcomings

- Did not considered the *littoral zone* of lakes as it is a hotspot of N_2O emission.

- Some of statistical data are incomplete which makes the conclusions less credible.

Comparisons

	Average N_2O flux ($\mu mol\ m^{-2}\ d^{-1}$)	Ranges ($\mu mol\ m^{-2}\ d^{-1}$)
Global lakes	12.22	-146.325 - 307.5
Chinese lakes	13.02	-24.22 - 85.139
Lake Taihu	7.36	-7.13 - 152.76

Thank you~