Supplementary Information

Spatial Variations of Soil N_2 and N_2O Emissions from a Temperate Forest: Quantified by the *In Situ* ^{15}N Labeling Method

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Figure S1. The sampling photos at the three slope positions (site 1) in the mixed forest of Qingyuan station in Northeast China.

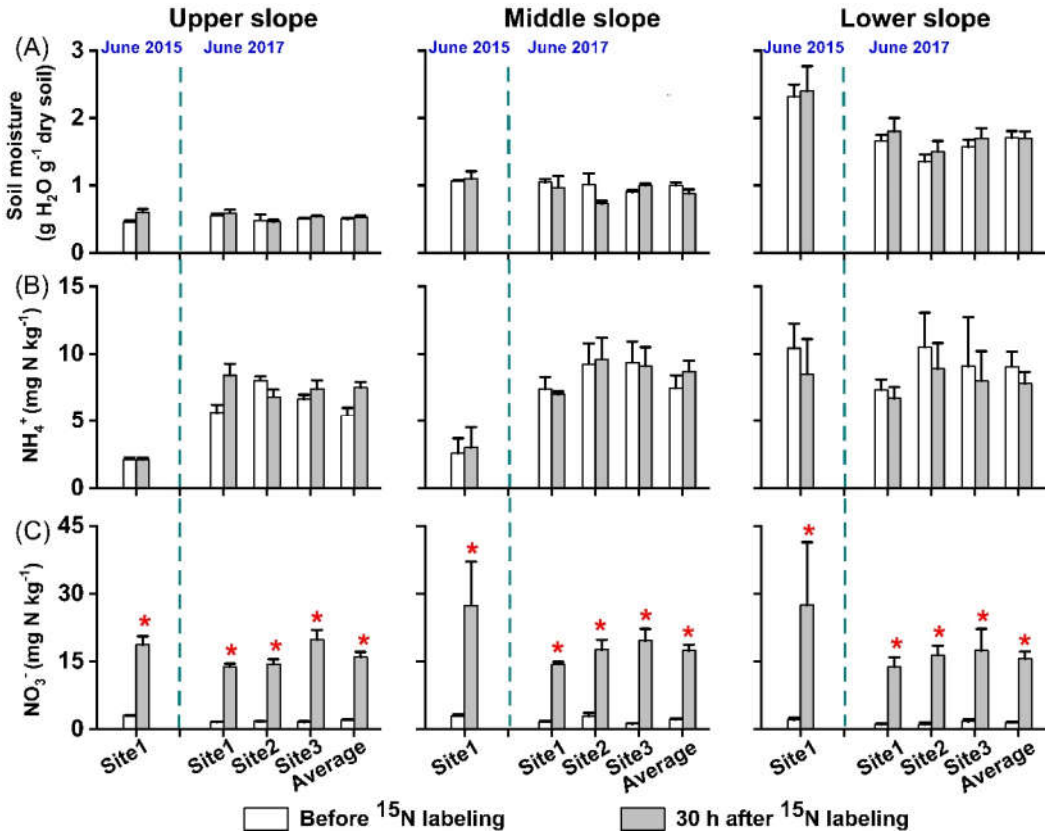

Figure S2. Changes of 0−20 cm soil moisture (A, express as gravity water content), ammonium (NH_4^+, B), and nitrate (NO_3^-, C) contents before and after ^{15}N labeling at different slope positions in the mixed forest of Qingyuan station in Northeast China. Differences were analyzed by T paired-sample test ($p < 0.05$).

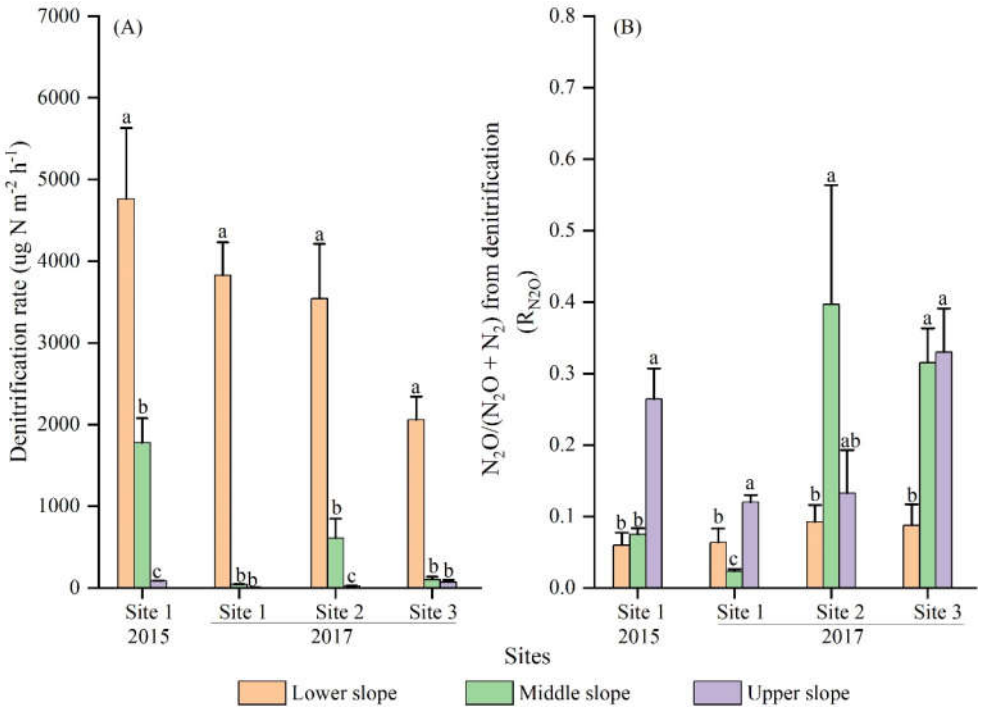

Figure S3. The rates (A) and $N_2O(N_2O + N_2)$ ratios (B) from denitrification over a 30 h incubation after *in situ* $^{15}NO_3^-$ addition (2.5 g ^{15}N m^{-2}) at different slope positions in the mixed forest of Qingyuan station in Northeast China. Values from different sites (1, 2, 3) and overall average were shown. Different lowercase letters indicate significant differences among slopes ($p < 0.05$).

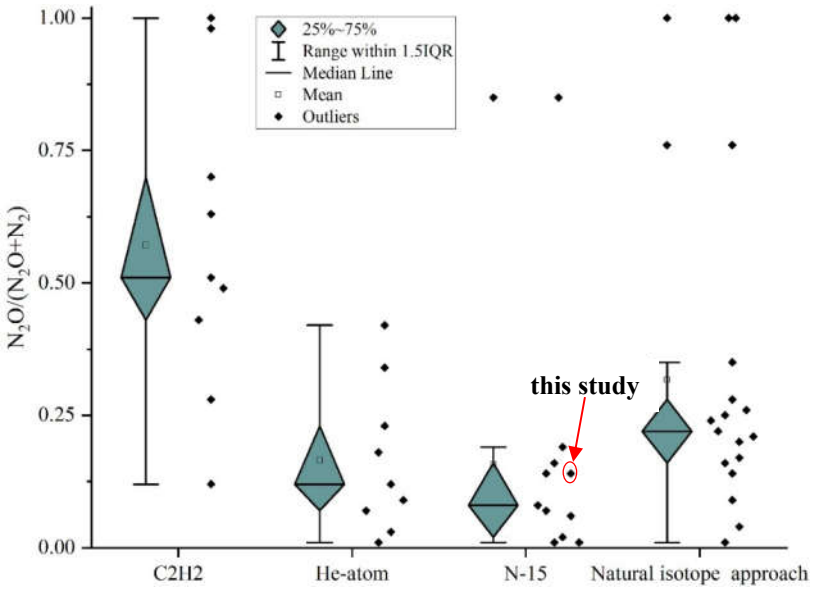

Figure S4. Comparison of $N_2O/(N_2O+N_2)$ ratios obtained by different methods for forest soils.

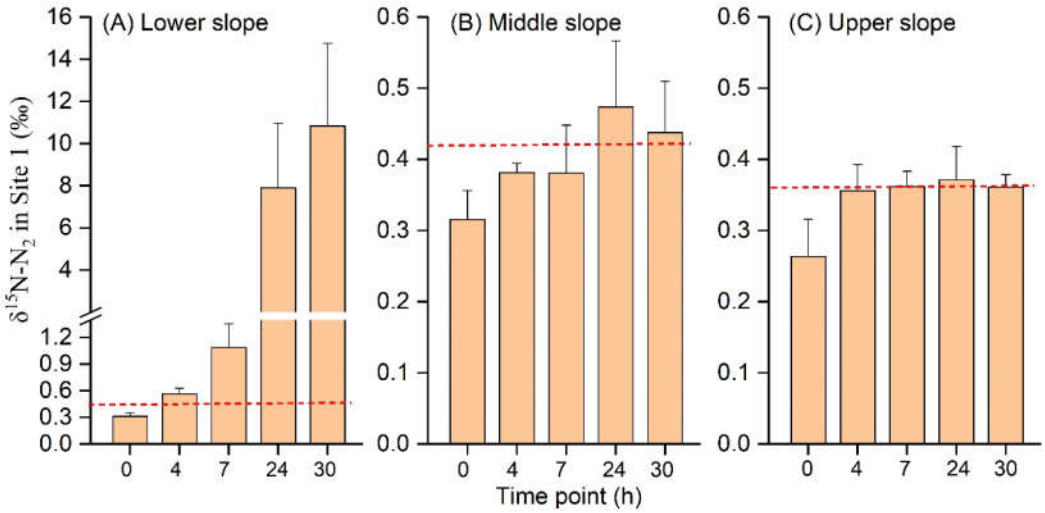

Figure S5. Changes of $\delta^{15}N\text{-}N_2$ (‰) value with incubation time at the lower (A), middle (B), and upper (C) slope in site 1, respectively, after soil was labelled with $^{15}NO_3^-$ addition (2.5 g ^{15}N m^{-2}) in the mixed forest of Qingyuan station in Northeast China. The red dotted line indicates the minimum detectable change for $\delta^{15}N$ (0.11‰) and the error bars represent standard errors.

Table S1. Recompilation of the values of $N_2O/(N_2 + N_2O)$ ratio in natural forest soils.

Location	Forest type	Methods	$N_2O/(N_2+N_2O)$	Notes	References
Kiel, Germany (Temperate)	Beech forest	C_2H_2	1.00	Field study	16, 24
	Alder forest	C_2H_2	0.70	Field study	
Tuttlingen, Germany (Temperate)	Beech forest	He-atm	0.23	Lab study	
		He-atm	0.03	Lab study	
Munich, Germany (Temperate)	Beech forest	He-atm	0.12	Lab study	
	Spruce forest	He-atm	0.34	Lab study	
Mississippi, America (Temperate)	Hardwood forest	C_2H_2	0.28	Lab study	
		C_2H_2	0.12	Lab study	
Gottinger, Germany (Temperate)	Beech forest	N-15	0.85	Lab study	
Solling, Germany (Temperate)	Beech forest	N-15	0.19	Lab study	
Michigan, America (Temperate)	Sugar maple forest	C_2H_2	0.98	Lab study	
	Silver maple forest	C_2H_2	0.63	Lab study	
America (Temperate)	Hardwood forest	N-15	0.16	Lab study	
Northeast China (Temperate)	Pine forest	C_2H_2	0.49	Field study	26
America (Temperate)	Wetland forest	N-15	0.02	Lab study	7
America (Temperate)	Hardwood forest	N-15	0.008	Field study	27
		He-atm	0.01	Lab study	
Puerto Rico (Tropical)	Cloud forest	N-15	0.06	Lab study	8
England (Temperate)	Deciduous woodland forest	N-15	0.07	Field study	28
	Mixed woodland forest	N-15	0.01	Field study	
America (Temperate)	Hardwood forest	He-atm	0.18	Lab study	9
Canada (Temperate)	Hardwood forest	He-atm	0.09	Lab study	10
America (Temperate)	Hardwood forest	He-atm	0.42	Lab study	
America (Temperate)	Hardwood forest	He-atm	0.07	Lab study	

Location	Forest type	Methods	$N_2O/(N_2+N_2O)$	Notes	References
Southern China (Tropical)	Primary forest	C_2H_2	0.51	Lab study	30
		N-15	0.14	Lab study	
	Second forest	C_2H_2	0.43	Lab study	
		N-15	0.08	Lab study	
Southern China (Tropical)	Primary broad-leaved forest1	natural N and	0.09		24, 52
	Second broad-leaved forest	O isotope approach	0.35		
	Primary broad-leaved forest2		0.14		
Northern China (Temperate)	coniferous forest (old-aged)		0.01		
	coniferous broad-leaved		0.04		
America (Tropical)	Tropical rain forests1	Natural isotope approach	0.76	Precipitation gradient	53
	Tropical rain forests2		0.28		
	Tropical rain forests3		0.25		
	Tropical rain forests4		0.20		
	Tropical rain forests5		0.16		
	Tropical rain forests6		0.17		
	Tropical rain forests1		1.00	Chronosequence	
	Tropical rain forests2		1.00		
	Tropical rain forests3		0.22		
	Tropical rain forests4		0.26		
	Tropical rain forests5		0.24		
	Tropical rain forests6		0.21		
Northeast China (Temperate)	Broad-leaved forest	N-15	0.16[a]	Field study	**This study**
			0.15[b]		
Mean			**0.30**		

Note: The references can be seen in the main text. [a] indicates ratio of $N_2O_{denitrification}$ to $N_2O_{denitrification}$ plus $N_{2denitrification}$; [b] indicates ratio of bulk N_2O to bulk N_2O plus total N_2.

Table S2. Pearson correlations between soil properties in the mixed forest of Qingyuan station in Northeast China.

	Bulk density	pH	WFPS	TOC	TN	C/N ratio	NH_4^+	NO_3^-	NH_4^+/NO_3^- ratio
Bulk density	1.00	0.01	-0.07	-0.42**	-0.39**	-0.30*	-0.32*	0.22	-0.25
pH	0.01	1.00	-0.15	-0.13	-0.09	-0.23	0.22	-0.23	0.31*
WFPS	-0.07	-0.15	1.00	0.37*	0.25	0.60**	0.24	-0.09	0.23
TOC	-0.42**	-0.13	0.37**	1.00	0.91**	0.62**	0.77**	-0.20	0.51**
TN	-0.39**	-0.09	0.25	0.91**	1.00	0.37*	0.77**	-0.30*	0.54**
C/N ratio	-0.30*	-0.23	0.60**	0.62**	0.37*	1.00	0.31*	0.11	0.18
NH_4^+	-0.32*	0.22	0.24	0.77**	0.77**	0.31*	1.00	-0.19	0.58**
NO_3^-	0.22	-0.23	-0.09	-0.20	-0.30*	0.11	-0.19	1.00	-0.75**
NH_4^+/NO_3^- ratio	-0.25	0.31*	0.23	0.51**	0.54**	0.18	0.58**	-0.75**	1.00

* and ** represent correlation significance at $p < 0.05$ and $p < 0.01$, respectively.