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Response of N_2O and N_2 Emissions in Forest Soils to Temperature Change across China

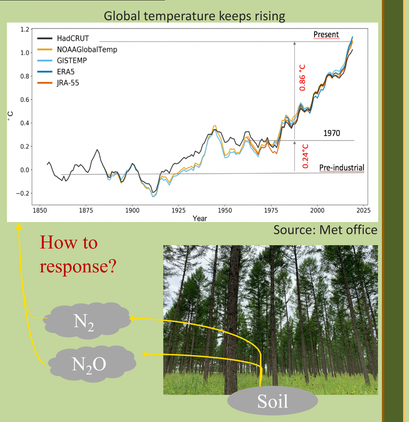
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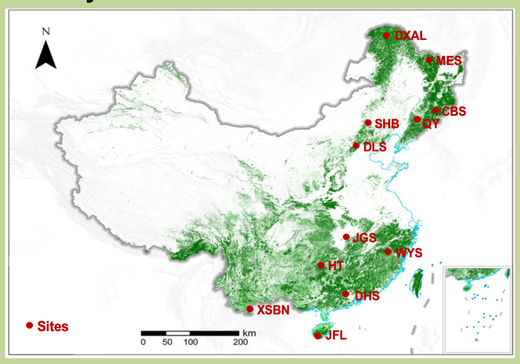
Introduction

- N_2O and N_2 Emissions from soil in terrestrial ecosystems is a crucial component of the global nitrogen (N) cycle. The response of these two gases emissions from forest soil to temperature change and its underlying mechanisms are essential for predicting N cycle to global warming.
- Despite the warming-induced effects on soil N cycle is considered to be positive in general, our understanding of temperature sensitivity (Q_{10}) of N_2O and N_2 emissions is rather limited.
- We quantified the Q_{10} of N_2O and N_2 emissions in forest soils and explored their major driving factors by conducting an incubation experiment using ^{15}N tracer ($Na^{15}NO_3$) with soil samples.



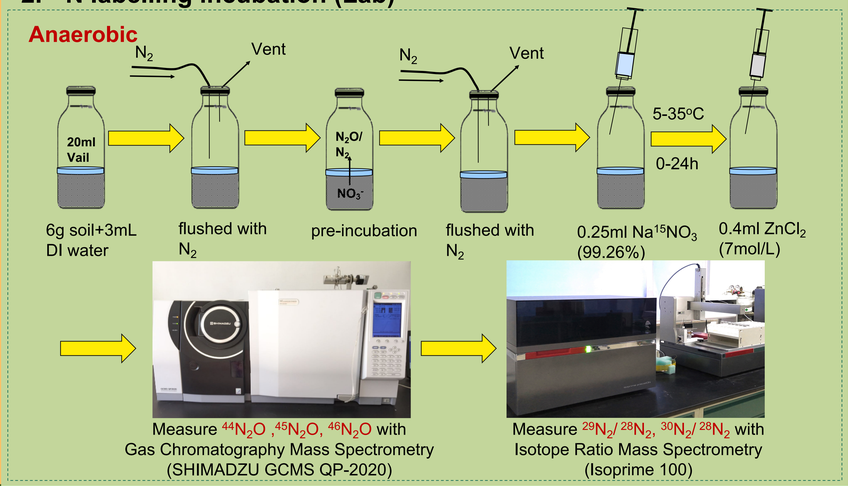
Materials and Methods

1.Study sites



- Soil samples were collected from the surface layer (0-10 cm) of nineteen forest sites from temperate to tropical zones. The environmental conditions largely varied: mean annual temperature (MAT) ranging from -4.5 to 21.5°C and mean annual precipitation (MAP) ranging from 300 to 2449 mm. The soil pH varied between 3.62 to 6.38.

2. ^{15}N labelling incubation (Lab)



Results and Discussions

- Soil Temperature strongly affected the production of N_2O and N_2 which increase as temperature rising. The production rates of N_2O and N_2 in temperate forest soil were higher than that of tropic forest soil. (Figure 1)
- The N_2O / (N_2O +N_2) decreased with increasing temperature in fourteen of nineteen forest soils, suggesting that warming accelerates N_2 emission. (Figure 2)
- The Q_{10} values of N_2 were higher than N_2O, implied that N_2 emission is more sensitive to temperature increase. And the N_2O emission in broadleaved forest showed a stronger response to temperature than other forests. (Figure 3)
- Under anaerobic condition, denitrification was the dominant pathway of N_2O and N_2 emissions and the contribution was keep increasing with temperature increase.

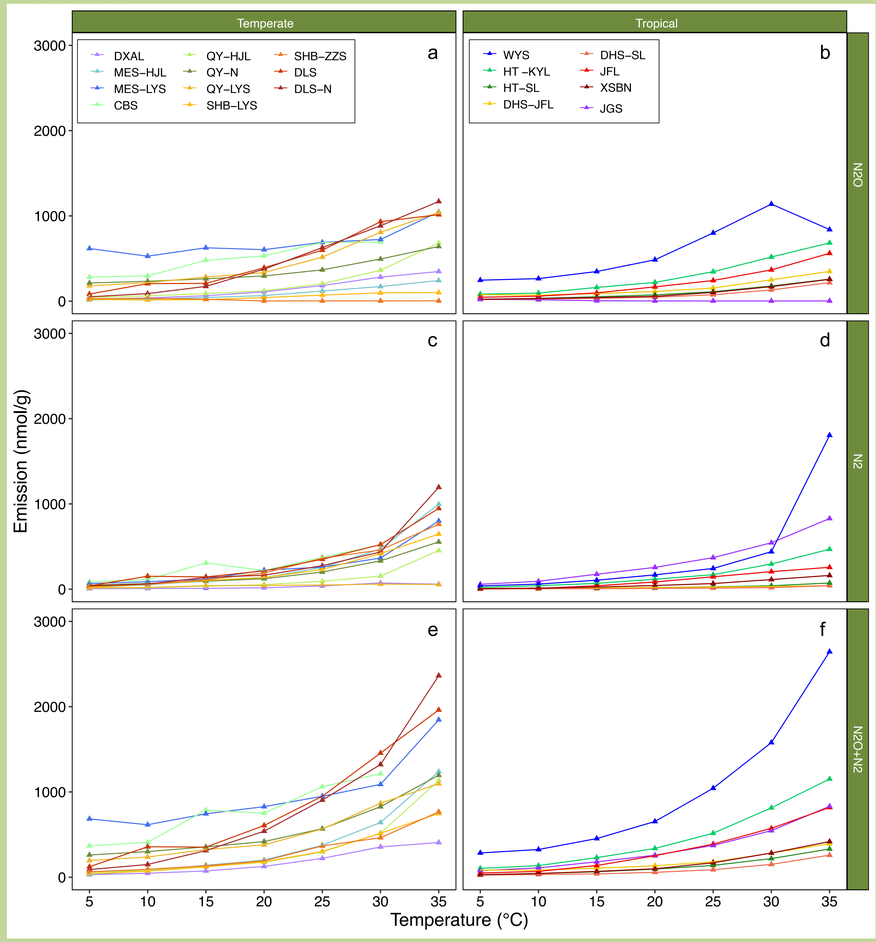


Figure 1. The accumulation emission of N_2O (a-b) ,N_2 (c-d) and N_2O + N_2 (e-f) in nineteen forest soils over incubation of 12h after $^{15}NO_3^-$ addition under anaerobic conditions. Each data point represent the mean of five replicates.

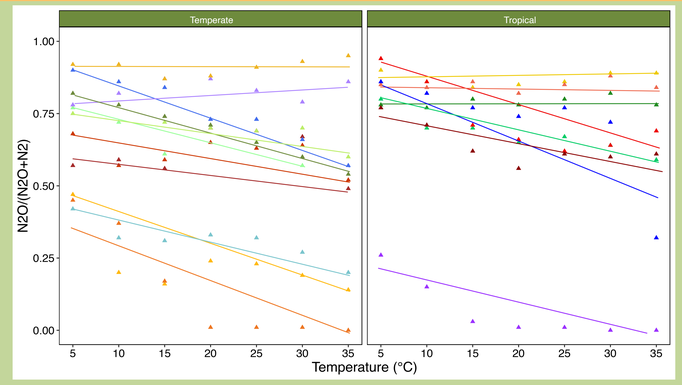


Figure 2. The ratio of N_2O / (N_2O + N_2) in nineteen forest soils over incubation of 12h after $^{15}NO_3^-$ addition under anaerobic conditions. Each data point represent the mean of five replicates.

Figure 3. The average temperature sensitivity (Q_{10}) values of N_2O ,N_2 and N_2O + N_2 emissions for soils in broadleaved, coniferous and coniferous-broadleaved mixed forests (a) and in different climate-zone categories (b).

Conclusion

- Temperature has a positive influence on N_2O and N_2 production.
- Warming promotes the formation of N_2, and reduces the proportion of N_2O emissions.
- N_2 is more sensitive to temperature change.
- Warming enhances denitrification processes under the anaerobic environment.

References

1. Baath, E., 2018. Temperature sensitivity of soil microbial activity modeled by the square root equation as a unifying model to differentiate between direct temperature effects and microbial community adaptation. Glob Chang Biol 24, 2850-2861.
2. Duan, P.P., Wu, Z., Zhang, Q.Q., Fan, C.H., Xiong, Z.Q., 2018. Thermodynamic responses of ammonia-oxidizing archaea and bacteria explain N2O production from greenhouse vegetable soils. Soil Biology & Biochemistry 120, 37-47.
3. Schipper, L.A., Hobbs, J.K., Rutledge, S., Arcus, V.L., 2014. Thermodynamic theory explains the temperature optima of soil microbial processes and high Q10 values at low temperatures. Glob Chang Biol 20, 3578-3586.
4. Wang, Q., Liu, S., Tian, P., 2018. Carbon quality and soil microbial property control the latitudinal pattern in temperature sensitivity of soil microbial respiration across Chinese forest ecosystems. Glob Chang Biol 24, 2841-2849.