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Temperature Sensitivity of N_2O and N_2 Emissions from Ten Forest Soils

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Temperature sensitivity (Q_{10}) of soil N_2O and N_2 emissions from terrestrial ecosystems and its controlling factors are essential for predicting the effects of global warming on nitrogen(N) cycle. Although the warming-induced effects on soil N cycle is considered to be positive in general, our understanding of how N_2O and N_2 emissions respond to climate change is rather limited. To quantify the Q_{10} of N_2O and N_2 emissions in forest soils and to identify their major driving factors, we performed an incubation experiment using ^{15}N tracer ($Na^{15}NO_3$) with soil samples from ten forest sites with a large geographic distribution and a wide range of climate conditions. The sites stretched from temperate to tropical zones, with mean annual temperature (MAT) ranging from 3 to 21.5^{o}C and mean annual precipitation (MAP) ranging from 300 to 2449 mm. The soil pH varied between 3.57 to 6.27. The samples were incubated for 12 or 24 hours under anaerobic condition at temperature from 5 to 35^{o}C with an interval of 5^{o}C, respectively. Soil temperature strongly affected the production of N_2O and N_2; N_2O and N_2 production rates showed a positive exponential relation with incubate time and temperature for all forest soils. Our results showed that the Q_{10} values ranged from 1.31 to 2.98 for N_2O emission and 1.69 to 3.83 for N_2 emission, indicating a generally positive feedback of N_2O and N_2 production to warming. Higher Q_{10} values for N_2 than N_2O implies that N_2 emission is more sensitive to temperature increase. The $N_2O/(N_2O+N_2)$ decreased with increasing temperature in seven of ten forest soils, suggesting that warming accelerates N_2 emission. Strong spatial variation in Q_{10} were also observed, with tropical forest soils exhibiting high Q_{10} values and relatively low Q_{10} in temperate forest soils. This variation is likely attributed to the inherent differences in N biogeochemical cycling behavior between the microbial communities among sites. Despite soil temperature primarily controls the N_2O and N_2 emissions, we will further explore the effects of other factors such as pH and C/N, and perform additional experiments to elucidate the role of other factors on Q_{10}. In addition, we will partition N_2O and N_2 emissions to different microbial processes (e.g., denitrification, co-denitrification and anammox) and examine the temperature sensitivity of those different microbial processes, on the basis of the ^{15}N isotope pairing technique.

Key words: Temperature sensitivity, N_2O, N_2, Forest soil, Nitrogen cycle, Global warming