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Research Article

Seasonal Variations in N_2O Emissions in a Subtropical Forest With Exogenous Nitrogen Enrichment are Predominately Influenced by the Abundances of Soil Nitrifiers and Denitrifiers

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Abstract

Elevated nitrogen (N) deposition has induced substantial impacts on the emissions of nitrous oxide (N_2O) from forest ecosystems, but how soil microbes regulate the production/consumption of N_2O under elevated N deposition remains poorly understood, particularly in high N deposition subtropical forests that are characterized by distinct wet-dry seasonality. We established a field N addition experiment in a subtropical forest in southern China to explore the influences of low, medium and high (35, 70, and 105 kg N ha^{-1} yr^{-1}, respectively) N addition on N_2O efflux and its associated microbial functional genes [*amoA* for nitrifiers (ammonia-oxidizing bacteria (AOB) and ammonia-oxidizing archaea (AOA)) and *nirK* and *nosZ* for denitrifiers]. The results showed the following: (1) The N_2O emissions were stimulated by N addition in the dry season but were depressed in the wet season. (2) The *nirK* and *nosZ* abundances were generally stimulated by N addition, whereas the AOB-*amoA* and AOA-*amoA* abundances showed divergent responses to N addition. (3) Based on the results of principal component and Pearson correlation analyses, N_2O effluxes were associated with microbial biomass in the wet season but with *nirK* and *nosZ* abundances in the dry season. Structural equation modeling analyses further indicated that both nitrifiers and denitrifiers under N addition contributed to the generation of N_2O in the dry season, whereas the decreased production of N_2O in the wet season was primarily caused by denitrifiers. Therefore, seasonally specific strategies should be developed to mitigate the emissions of N_2O from subtropical forests with distinct seasonal precipitation patterns.

Plain Language Summary

Tropical and subtropical forests are considerable sources of nitrous oxide (N_2O), one of the greenhouse gases mainly produced via microbial nitrification and denitrification in soil. In recent decades, the emissions of N_2O have been influenced by increasing nitrogen (N) deposition due to enhanced atmospheric reactive N derived primarily from human activities. Moreover, among the types of N deposition, wet N deposition depends greatly on precipitation. This dependence makes predicting future change trends in N_2O emissions challenging, especially in tropical and subtropical forests in southern China due to the large amount of natural N deposition and the distinct wet-dry seasonality caused by unevenly distributed annual precipitation in this region. We studied the responses of N_2O emissions to increasing N deposition by establishing a field N addition experiment in a subtropical forest in southern China. We explored the responsive differences in N_2O emissions between wet and dry seasons from microbial regulation aspects. The N addition depressed N_2O emissions in the wet season but stimulated N_2O emissions in the dry season. Moreover, microbial biomass in the wet season and denitrifier abundance in the dry season were the indicators of N_2O emissions in response to elevated N deposition.

Supporting Information

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