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Nitric and nitrous oxide emissions from N-saturated subtropical forest in Southwest China

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Acidic subtropical forest soils, receiving high atmogenic nitrogen (N) deposition, are characterized by fast N turnover and are potential “hot spots” for NO emissions. Moreover, soils in monsoonal climate are expose to rapid soil moisture fluctuations and high soil temperatures. We measured in situ fluxes in different landscape positions of the Tieshanping forest, Chongqing, SW China, in the summers of 2015 and 2016 and conducted controlled dry-out experiments using a dynamic chamber system in the laboratory. In the wet summer of 2015, the monthly mean NO flux from Acrisols on hill slopes was 44.3 μg N m-2 h-1 with the highest flux (231.5 μg N m-2 h-1) observed at the foot of the hill slope (HS). Significantly larger NO fluxes (88.4 μg N m-2 h-1) were observed in the drier summer of 2016 than the wetter summer of 2015. Monthly mean NO flux in a groundwater discharge zone (GDZ) near the stream (26.4 μg N m-2 h-1) was lower than on the hillslope. In both summers, the NO fluxes were negatively correlated with soil moistures ($P < 0.001$). In the laboratory experiment (30 0C), maximum NO production rates in hill slope soils (7.7 - 32.0 ng N kg-1 s-1) were observed at 21% WFPS (water filled pore space), while soils from the groundwater discharge zone had their maximum NO emission at 15% WFPS ($\sim$ 5.6 ng N kg-1 s-1). Whereas NO emission response to dry-out showed one maximum in the dry soil moisture range, N2O release from HS soils showed two distinct maxima, one (1.3 - 4.5 ng N kg-1 s-1) at high and one (0.5 - 2.8 ng N kg-1 s-1) at low soil moisture, attributable to denitrification and nitrification, respectively. For GDZ soils, maximum N2O release rates ($\sim$ 22 ng N kg-1 s-1) were observed at 150% WFPS, reflecting the high denitrification potentials in these riparian soils. Results from a short-term in situ labelling experiment with $15NH414NO_3$ and $14NH415NO_3$ indicated that more than 80% of the NO emitted on the hillslope originates from nitrification. In conclusion, our results support the notion that N-saturated subtropical forest soils are an important source for NO and N2O, mainly controlled by soil moisture fluctuations in a warm humid climate.