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Estimating N2 fluxes from denitrification using isotopologue signatures of N2O

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There is few information on N2 fluxes from denitrification in the field, because this process is difficult to measure in situ. Isotopologue signatures of N2O such as δ18O, average δ15N (δ15Nbulk) and 15N site preference (SP = difference in δ15N between the central and peripheral N positions of the asymmetric N2O molecule) can be used to constrain the atmospheric N2O budget and to characterize N2O turnover processes including N2O reduction to N2. However, the use of this approach to study N2O dynamics in soils requires knowledge of isotopologue fractionation factors (ε) for the various partial processes involved, e.g. N2O production by nitrification or denitrification, N2O reduction by denitrification and diffusive transport. The aim of our study was to investigate whether isotopologue signatures of soil-emitted N2O can be used to estimate N2O reduction, and accordingly N2 formation.

Two arable soils were fertilized with NO3- and incubated anaerobically in a closed laboratory system until all NO3- was converted to N2. Similar incubations were conducted with a water-saturated arable peat soil and sediment from a sandy aquifer.

The time courses of N2O and its isotopologues were monitored during the reaction progress of denitrification. N2 production was estimated from 15N2 accumulation during parallel incubation experiments, where materials were fertilized with 15N-labelled NO3-.

ε of the NO3-to-N2O step was derived from isotopologue signatures obtained from replicates where N2O reduction was absent under the presence of C2H2. ε of N2O reduction to N2 was estimated by modeling the time course of N2O and its isotopologues. For this purpose, ε of the NO3-to-N2O step and production rates of N2O and N2 were used as independent model parameters and ε of N2O reduction to N2 was estimated by fitting.

Fractionation factors of this study will be compared to literature data and the consequences for estimating N2 fluxes based on N2O isotopologues will be discussed.

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