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Isotopomer mapping approach to determine N_2O production pathways and N_2O reduction

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Stable isotopomer analyses of soil-emitted N_2O (δ^{15}N, δ^{18}Oand SP = ^{15}N site preference within the linear N_2O molecule) may help to distinguish N_2O production pathways and to quantify N_2O reduction to N_2. Different N_2O forming processes are characterised by distinct isotopic characteristics. Bacterial denitrification shows significantly lower SP and δ^{18}Ovalues when compared to fungal denitrification and nitrification processes. But SP and δ^{18}Ovalues are also altered during N_2O reduction to N_2, when the residual N_2O is enriched in ^{18}Oand centrally located ^{15}N, resulting in increased δ^{18}Oand SP values. Hence, the interpretation of these isotope characteristics is not straightforward, because higher δ^{18}Oand SP values may be due to admixture of N_2O from fungal denitrification or nitrification, or due to N_2O reduction to N_2. One of these processes, either admixture or reduction, can be quite well quantified if the other one is determined with independent methods. But usually both processes are unknown and the ability to estimate both of them simultaneously would be very beneficial.

Here we present an attempt to determine both the admixture and the reduction simultaneously using the isotopomer mapping, i.e. the relation between δ^{18}Oand SP. The measured sample points are typically situated between the two lines: reduction line with a typical slope of about 0.35 and mixing line with a higher slope of about 0.8. Combining the reduction and the mixing vector allows for the determination of both processes based on the location of the sample point between the lines.

We tested this new approach for laboratory incubation studies, where a reference method for N_2O reduction quantification was applied, i.e. ^{15}N gas flux method or incubations in He atmosphere. This allowed us to check how well the calculated amounts for N_2O reduction agree with the results provided by the reference method. The general trend was quite well reflected in our calculated results, however, quite often we deal with significant underestimation of N_2O reduction. This may be due to numerous sources of uncertainties, especially for the assumed slopes for mixing and reduction lines. The slope of the mixing line depends on the endmembers isotopic signatures which are represented by quite wide ranges of values. The slope of the reduction line depends on the isotope effects associated with N_2O reduction which also represent possible ranges of values.