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Contrasting isotope patterns of NO_3- and N2O in polluted ombrotrophic peat bogs help to explain negligible N2O emissions

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A quantitative assessment of N2O production and consumption in soils under various environmental conditions is needed for the formulation of efficient mitigation strategies. In an era of climatic change, wetlands may serve as a major source of N2O for the atmosphere, and thus contribute to further warming. We studied N cycling in three high-elevation, rain-fed, Sphagnum-dominated peat bogs in the Czech Republic (Central Europe). Despite a history of medium-to-high N deposition rates (10-40 kg N/ha/yr), we found negligible N2O emission rates in the Eagle Mts. and Sumava Mts. At a depth of 60 cm, the least N-polluted site, exhibited nearly 7 times higher porewater N2O concentrations, compared to the most N-polluted site. This was probably related to the higher denitrification potential, expressed in the abundance of nirK and nirS genes. Upcore, N2O concentrations dramatically decreased, while delta15N-N2O values systematically increased. At one mountain-top peat bog in the Ore Mts., we simultaneously determined vertical delta15N trends in peat porewater NO_3- and N2O. Our study, the first in its kind, revealed a strong negative correlation between these two variables at depths where most N2O is formed (30-60 cm below peat surface). N2O concentrations in the peat pore water were 20 % lower than in the lowermost atmosphere, indicating that the peat serves, at least intermittently, as a sink for atmospheric N2O, not as a N2O source. Upcore, higher delta15N values of N2O were accompanied by lower delta15N values of NO_3-. We suggest that such N isotope systematics can help to distinguish between N2O diffusion in peat pore water, N2O production from NO_3- via denitrification, and N2O consumption via further reduction to harmless N2. Heavier N2O-N upcore corresponded to residual N2O following partial reduction to N2 and a loss of warming potential. Upcore, increasing proportion of atmospheric N2O was also isotopically detected.