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Identification of nitrous oxide producing pathways from isotopocule analysis

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Nitrous oxide (N_2O) is an important ozone-depleting substance and contributes to the greenhouse effect with a global warming potential approximately 300 times that of carbon dioxide. Challenges in mitigation of N_2O emissions from wastewater treatment systems rely on the identification of the N_2O producing processes and their controls. Nitrification and denitrification are major sources of N_2O. However, that produced from nitrifying pathway has been considered only recently.

The combined analysis of N_2O isotopocules and substrate isotopic composition ($\delta^{15}N$ and $\delta^{18}O$ of NH_4^+, NH_2OH, NO_2^-, NO_3^-, and H_2O) is a promising approach identifying the biotic, abiotic and hybrid origin of N_2O. Considerable efforts have been done to relate N isotope and ^{15}N-N_2O site-preference (SP-N_2O) to producing pathways in mixed microbial populations of activated sludge. However, data on N_2O emissions from biofilters are still scarce and the influence of high oxygenation on N_2O isotopocules is rarely considered. This work aims to fill these gaps by characterizing the isotopocules signature of N_2O produced during ammonia oxidation in nitrifying biofilter biomass. Reaction kinetics from batch incubations of nitrifying biofilters under oxic conditions were determined with input concentrations ranging from 10 to 40 mg N-NH_4^+/L. The different N species and their isotopic compositions were determined over the course of incubations.

Nitrous oxide producing pathways were identified and their relative contributions were discussed from the comparison between experimental data and numerical simulations performed from empirically-determined isotopic enrichment factors. Finally, the approach that combined well-constrained conditions, and isotopic analyses seems relevant to ultimately identify N_2O produced from nitrifying sources in complex environmental systems.