Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.5451

A Diffusion-Based Analysis of Soil Nitrous Oxide Concentrations and its Stable Isotope Composition

JENNIFER V MILLS[1] AND **RONALD AMUNDSON**[2]

[1]University of California, Berkeley

[2]University of California

Presenting Author: earthy@berkeley.edu

A mathematical model for interpreting the concentration and stable isotope composition of soil N_2O is presently unavailable. Here the processes that affect soil N_2O are embedded in a diffusion/reaction model. Numerical experiments are compared to published data to demonstrate how various soil processes influence depth profiles and surface fluxes of soil N_2O, $\delta^{15}N_{N2O}$, and $\delta^{18}O_{N2O}$.

Model predictions and empirical data suggest that the isotope composition of the net N_2O soil flux, in soils that have N_2O consumption, is a function of the net flux rate. Asymptotically large negative or positive $\delta^{15}N_{flux}$ values occur as the net soil N_2O flux approaches zero from positive or negative flux rates, respectively. The reverse occurs with $\delta^{18}O$ values. This implies that the isotopic imprint of soil fluxes to the global atmospheric N_2O pool is much more variable than previously suggested.

We demonstrate how modeling can be used to extract inferences of gross production/consumption patterns from depth profiles of $\delta^{15}N$ values and N_2O concentrations, and identify key sources of uncertainty that limit our ability to constrain them. Due to the effects of gross consumption, and multiple sources of N_2O, simple mixing models are unlikely to constrain the isotope composition of the biological sources of soil N_2O.

Like other soil gases, the concentration and isotope depth profiles of N_2O are largely uninterpretable without a physics-based model. Process-based interpretations have an ability to improve our ability to understand of the role of soil processes in the global N_2O biogeochemical framework.