Title:
Dataset associated with "Using isotope pool dilution to understand how organic carbon additions affect N_2O consumption in diverse soils"

Abstract:

Nitrous oxide (N_2O) is a formidable greenhouse gas with warming potential ~300x greater than CO_2. However, its emissions to the atmosphere have gone largely unchecked because the microbial and environmental controls governing N_2O emissions have proven difficult to manage. The microbial process N_2O consumption is the only know biotic pathway to remove N_2O from soil pores and therefore reduce N_2O emissions. Consequently, manipulating soils to increase N_2O consumption by organic carbon (OC) additions has steadily gained interest. However, the response of N_2O emissions to different OC additions are inconsistent, and it is unclear if lower N_2O emissions are due to increased consumption, decreased production, or both. Simplified and systematic studies are needed to evaluate the efficacy of different OC additions on N_2O consumption.

We aimed to manipulate N_2O consumption by amending soils with OC compounds (succinate, acetate, propionate) more directly available to denitrifiers. We hypothesized that N_2O consumption is OC-limited and predicted these denitrifier-targeted additions would lead to enhanced N_2O consumption and increased nosZ gene abundance. We incubated diverse soils in the laboratory and performed a $^{15}N_2O$ isotope pool dilution assay to disentangle microbial N_2O emissions from consumption using laser-based spectroscopy. We found that amending soils with OC increased gross N_2O consumption in six of eight soils tested. Furthermore, three of eight soils showed **I**ncreased N_2O **C**onsumption and **D**ecreased N_2O **E**missions (ICDE), a phenomenon we introduce in this study as an N_2O management ideal. All three ICDE soils had low soil OC content, suggesting ICDE is a response to relaxed C-limitation wherein C additions promote soil anoxia, consequently stimulating the reduction of N_2O via denitrification. We suggest, generally, OC additions to low OC soils will reduce N_2O emissions via ICDE. Future studies should prioritize methodical assessment of different, specific, OC-additions to determine which additions show ICDE in different soils.

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Description:

This dataset includes information about eight soils collected from Colorado, New Mexico, and Minnesota. All soils were collected from June – July 2019. Five soils were collected in Colorado (two in Rocky Mountain National Park, one from a cornfield near Greeley, CO, one from a grassland near Nunn CO, and one from a lawn at Colorado State University). One soil was

collected in New Mexico, from the Sevilleta National Grassland. Two soils were collected from Minnesota (one from a coniferous forest near Ely, MN, and one from a cornfield near Elrosa, MN). We subsampled these soils to analyze their soil chemical and microbial genetic properties, and we also subsampled these soils to analyze their nitrous oxide (N_2O) emission and isotopic composition. The purpose of these analyses was to determine how amending soils with organic carbon influenced their capacity to produce and consume N_2O. All of these analyses occurred at Colorado State University, from July – September 2019.

File format(s): Excel files (xlsx) or Comma Separated Value (csv) files.

Spatial Coverage:

Rocky Mountain National Park, CO
Fort Collins, CO
Nunn, CO
Greeley, CO
Socorro, NM
Ely, MN
Elrosa, MN

Temporal Coverage: 2019-06 – 2019-09

File information:
The dataset includes one .xlsx file, which contains 8 sheets including a metadata sheet with descriptions of the column headers. Each sheet is also included as a .csv file to facilitate long-term usability:

- N2O consumption_manuscript_GCB_data repository.xlsx
- Metadata.csv
- Genetic data.csv
- inorganic N data.csv
- N2O consumption rate data.csv
- N2O production rate data.csv
- SOC and SON data.csv
- Soil pH data.csv

Associated publications:

Stuchiner, ER, Weller, ZD, von Fischer, JC. An approach for calibrating laser-based N_2O isotopic analyzers for soil biogeochemistry research. *Rapid Communications in Mass Spectrometry*, 2020;35(3): e8978. https://doi.org/10.1002/rcm.8978

Stuchiner, E. R. (2021). Revealing the controls of microbial nitrous oxide (N_2O) production and consumption using stable isotope methods. [Doctoral dissertation, Colorado State University]. https://hdl.handle.net/10217/234303

Stuchiner, E. R., & von Fischer, J. C. (2022). Using isotope pool dilution to understand how organic carbon additions affect N2O consumption in diverse soils. *Global Change Biology*, 00, 1– 17. https://doi.org/10.1111/gcb.16190

Stuchiner, E. R., & von Fischer, J. C. (2022). Characterizing the importance of denitrification for N_2O production in soils using natural abundance and isotopic labeling techniques. *Journal of Geophysical Research: Biogeosciences*, 127, e2021JG006555. https://doi.org/10.1029/2021JG006555