Estmating greenhouse gas fluxes as a function of plant community in brackish tidal wetlands

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Background

Agricultural lands are being restored to tidal wetlands (preserves habitat, acts as a carbon sink)

Wetlands are natural sources of nitrous oxide, methane, and carbon dioxide and these gasses are produced by microorganisms under varying anaerobic and aerobic conditions

We analyzed how greenhouse gasses varied by plant community in a brackish wetland in Astoria, OR, and compared field flux measurements to lab incubation gas flux measurements

Hypotheses

1) Gas emissions will vary by plant community due to variations in microorganisms present
2) Gas fluxes calculated through field measurements should be correlated with those measured via lab incubation

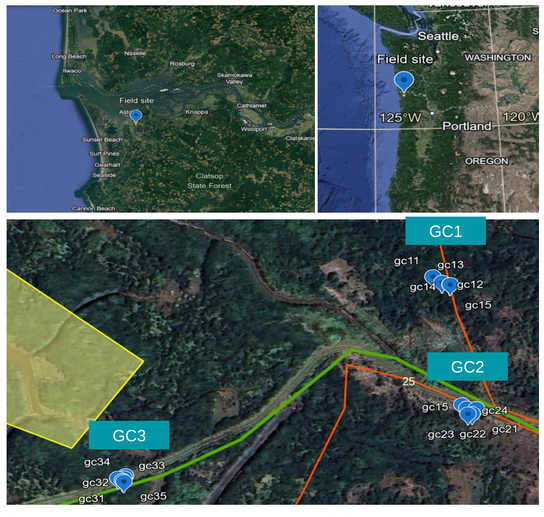


Figure 1: A map of our sites in Astoria, OR. Each gas chamber was seperated into three assemblages, GC1, GC2, and GC3. These areas are labeled to distinguish them. Each blue pointer referes to the location of an individual gas chamber, and the second number refers to its designation within the group. Used Google Earth Engine.

Methods

Site Characterization

- 3 assemblages, 5 enclosures per assemblage
- Enclosures categorized by dominant plant community
- Each assemblage is referred to as a GDL (gas data logger), gc stands for gas chamber

Lab Flux Analysis

- Filled tube with soil near each enclosure
- Homogenized soil samples
- Put soil in flask and made flasks anoxic
- Took gas samples at 0, 60, and 120 minutes to calculate flux



Cattail (CT) | Mudflat (MF) | Bullrush (BR)

Figure 2. A comparison of the different plant communities we identified. The leftmost is the cattail plant community, then mudflat, then bullrush. The abbreviations for each community is also listed above. Photos taken by Jen Morse.

Field Flux Analysis

- Put lid on enclosures/buckets
- Used syringe and collected gas from enclosures at four timepoints
- Used gas levels over time to calculate flux
- Samples were obtained on July 9th, 2024.

Results

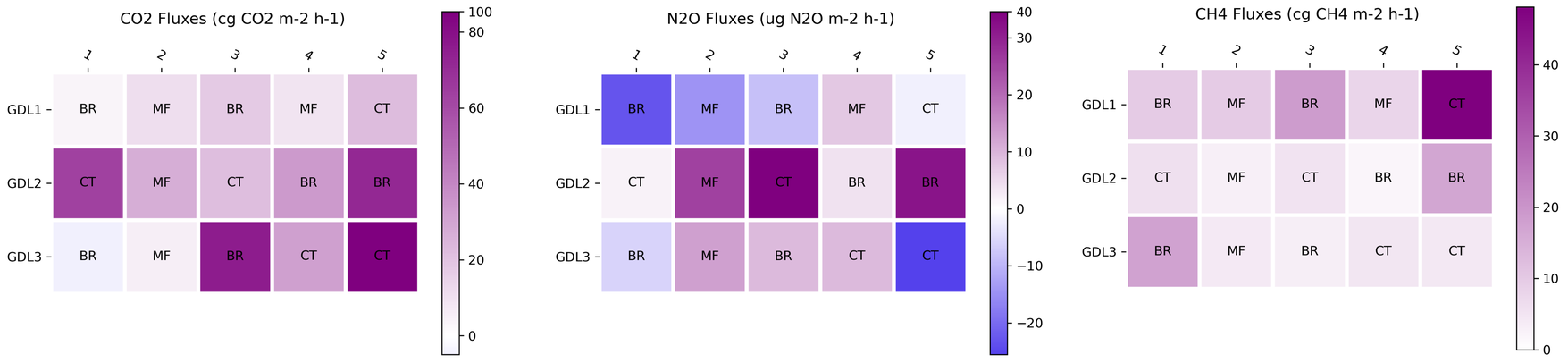


Figure 3. Gas Fluxes from Field Sampling .Heatmaps show gas fluxes from the field enclosures for a) CH4 flux (cg CH4 m-2 h-1), b) CO2 flux (cg CO2 m-2 h-1 and c) N2O flux (µg N2O m-2 h-1) fluxes by enclosure for a 40-minute sampling period. Box colors correspond to gas flux values: darker purple represents higher, positive fluxes, and darker blue represents higher, negative fluxes. BR (bulrush), CT (cattail), MF (mudflat).

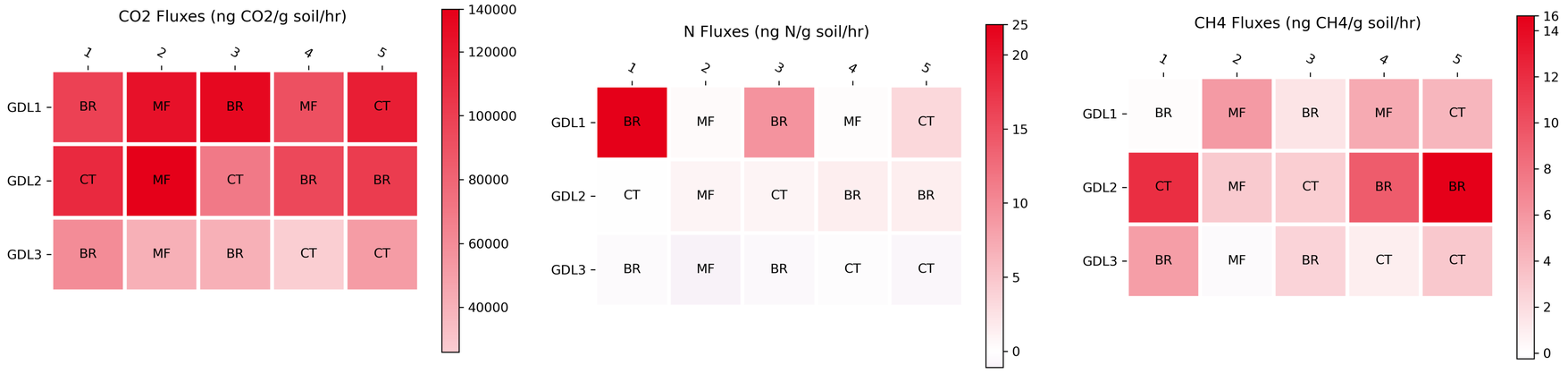


Figure 4. Laboratory Incubations in Anaerobic Conditions. Heatmaps show gas fluxes from the field enclosures for a) CH4 flux (ng CH4/g soil/hr), b) CO2 flux (ng CO2/g soil/hr) N2O flux (ng N2O/g soil/hr) through lab incubations over a two-hour period. The redder the data is, the greater the positive flux is. The more purple the data is, the greater the negative flux is. N levels were calculated instead of N2O levels. The first graph shows CH4 calculated fluxes, the second shows CO2 calculated fluxes, and third shows nitrogen levels based only on N2O levels. BR (bulrush), CT (cattail), MF (mudflat).

Key Findings

- Consistently positive fluxes for CO2 and CH4, but N2O also had negative fluxes → microorganisms such as denitrifiers and nitrifiers can both produce and consume N2O (Chapuis-Lardy et al., 2006)
- No correlation between dominant plant community and gas emissions → broader differences in distribution of microorganisms, plant zonation was not clear, forming mixed communities that were unexpected
- Statistical differences by location for CH4 and CO2 for lab determined fluxes and N2O for field fluxes → larger spatial differences in microorganisms or environmental variables
- No correlation between lab flux and field flux, suggesting that conditions in the lab differed greatly from field conditions.

Citations

- Chapuis-Lardy, L., Wrange, N., Metay, A., Chotte, J.-L., & Bernoux, M. (2006). Soils, a sink for N2O? A review. Global Change Biology, 13. https://doi.org/10.1111/j.1365-2486.2006.01280.x
- Derby, R. K., Needelman, B. A., Roden, A. A., & Megonigal, J. P. (2022). Vegetation and hydrology stratification as proxies to estimate methane emission from tidal marshes. Biogeochemistry, 157(2), 227–243. https://doi.org/10.1007/s10533-021-00870-z

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