Carbon Dioxide and Methane Fluxes in the Yukon-Kuskokwim Delta Permafrost

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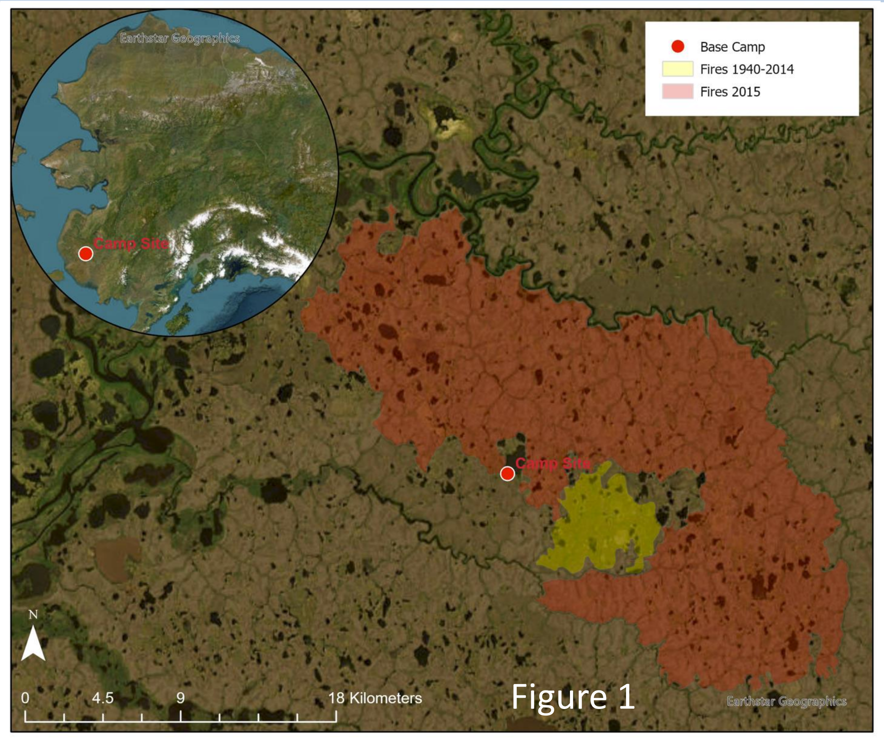
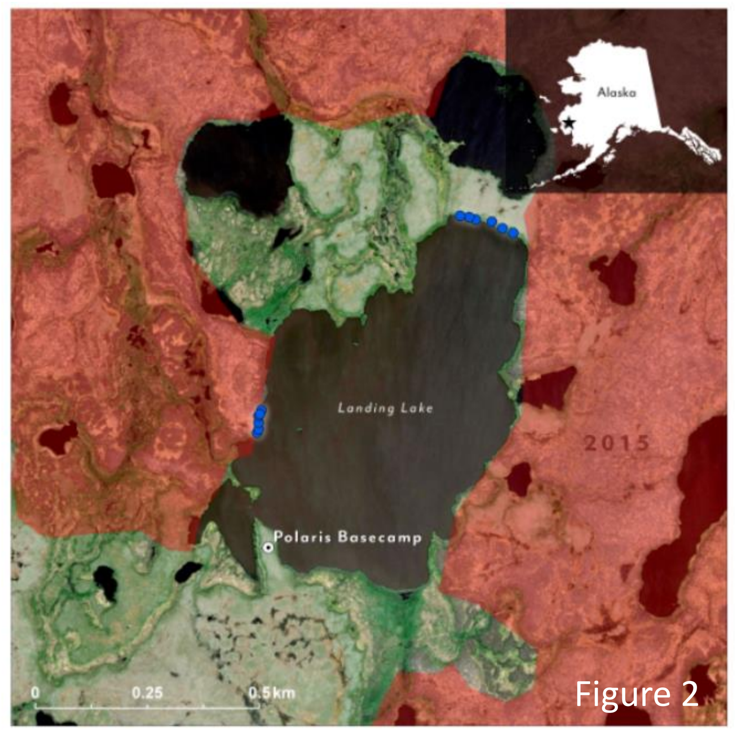
Study Area





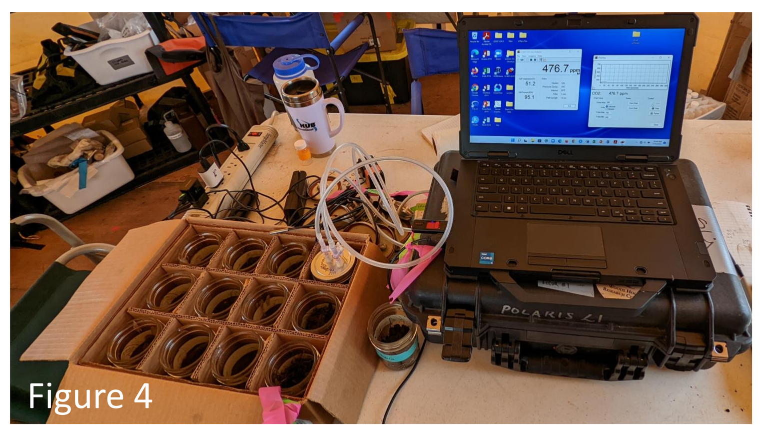
Equipment & Methods

Ebullition Flux

- We placed bubble traps placed above the lake bottom, in close proximity areas where bubbles have been observed, to capture and monitor ebullition rates over a one-week period in July 2022 (**Figure 3**). Traps were placed near thermokarst slumps and areas far from thermokarst slumps.
- Air volumes were measured daily, and methane fluxes were estimated using previously measured methane concentrations in lake bubbles.

Incubations

- Five different soil and sediment types were sampled from around the bubble traps: organic active-layer, lake sediment and mineral soils from thermokarst exposures (mineral-layer karst), lake sediment-dried, lsed+minkarst = lake sediment +mineral-layer karst.
- CO2 flux measurements were made using a LI-COR Gas Analyzer (**Figure 4**)



Results

- The organic active layer had the greatest flux at 6.54 µg of C/g of dry soil/hr. The lowest flux was in the mineral-rich soil at 0.921 µg of C/g of dry soil/hr (**Fig. 5**).
- The lake sediment had the second-highest flux yet had the lowest OC content (**Fig.6**).
- The seven-day average ebullition rates near the thermokarst landform were more than forty times greater than ebullition rates than undisturbed tundra (**Fig. 7**).

Introduction/Background

Rapid Arctic warming is thawing landscapes of the Alaskan tundra. This thawing can promote microbial decomposition of organic matter previously locked away in permafrost. Ground collapse due to the thawing of ice-rich permafrost (i.e. thermokarst) exposes organic-rich soils, potentially increasing soil respiration rates. Thermokarst processes along lakes can increase lake CO_2 and CH_4 emissions as a result of inputs of labile carbon from recently thawed soils. Here we examine organic matter composition and lability of a thermokarst feature and the impacts of thermokarst processes on lake ebullition by simulating thermokarst processes in the Yukon-Kuskokwim Delta by submerging tundra soils and lake sediments in fresh water and measuring CO2 production. We also measure ebullitive (i.e., bubble) methane flux near thermokarst slumps.

Soil Incubations

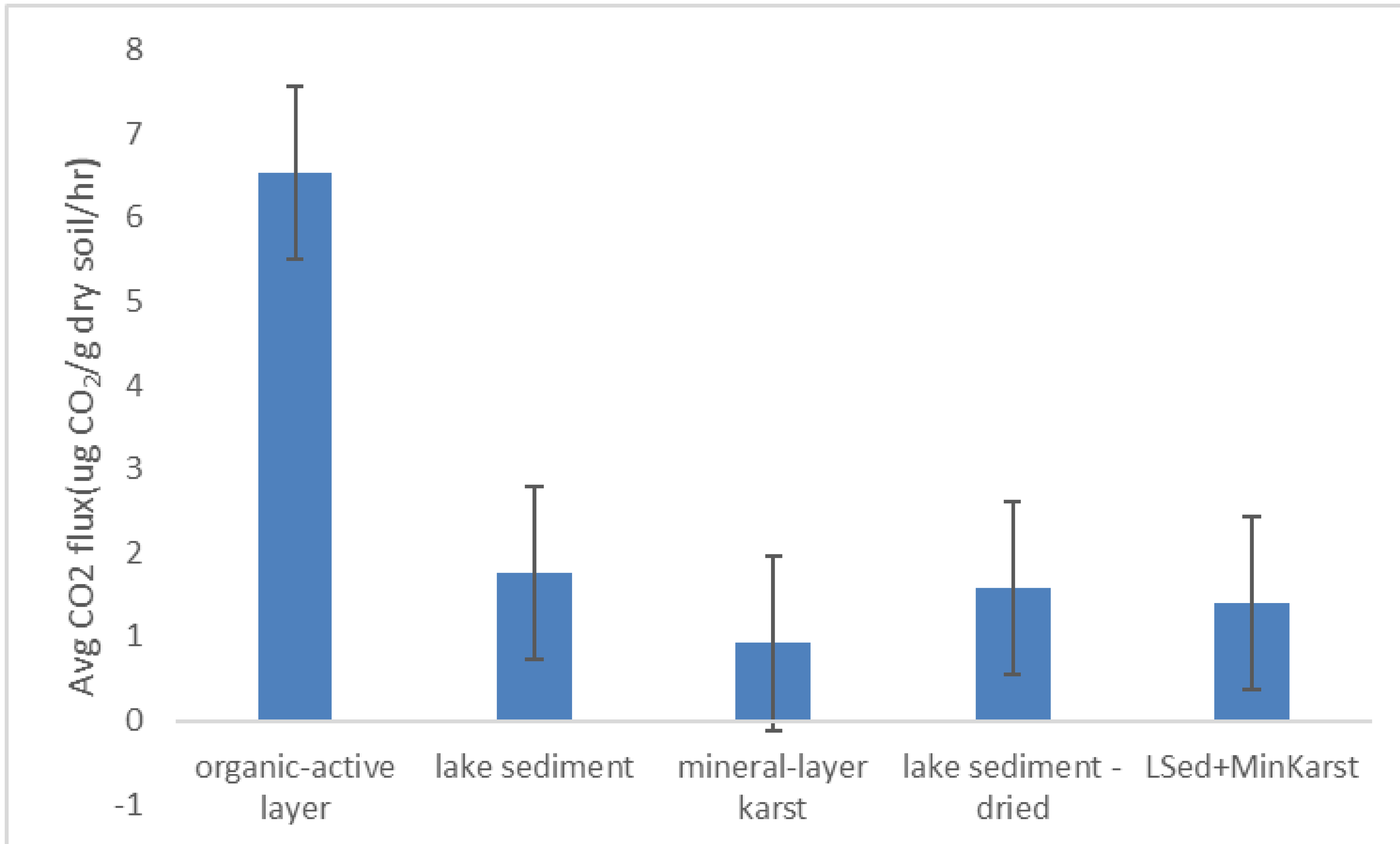


Figure 5: Average CO2 flux from each soil type, normalized to gram dry soil/sediment.

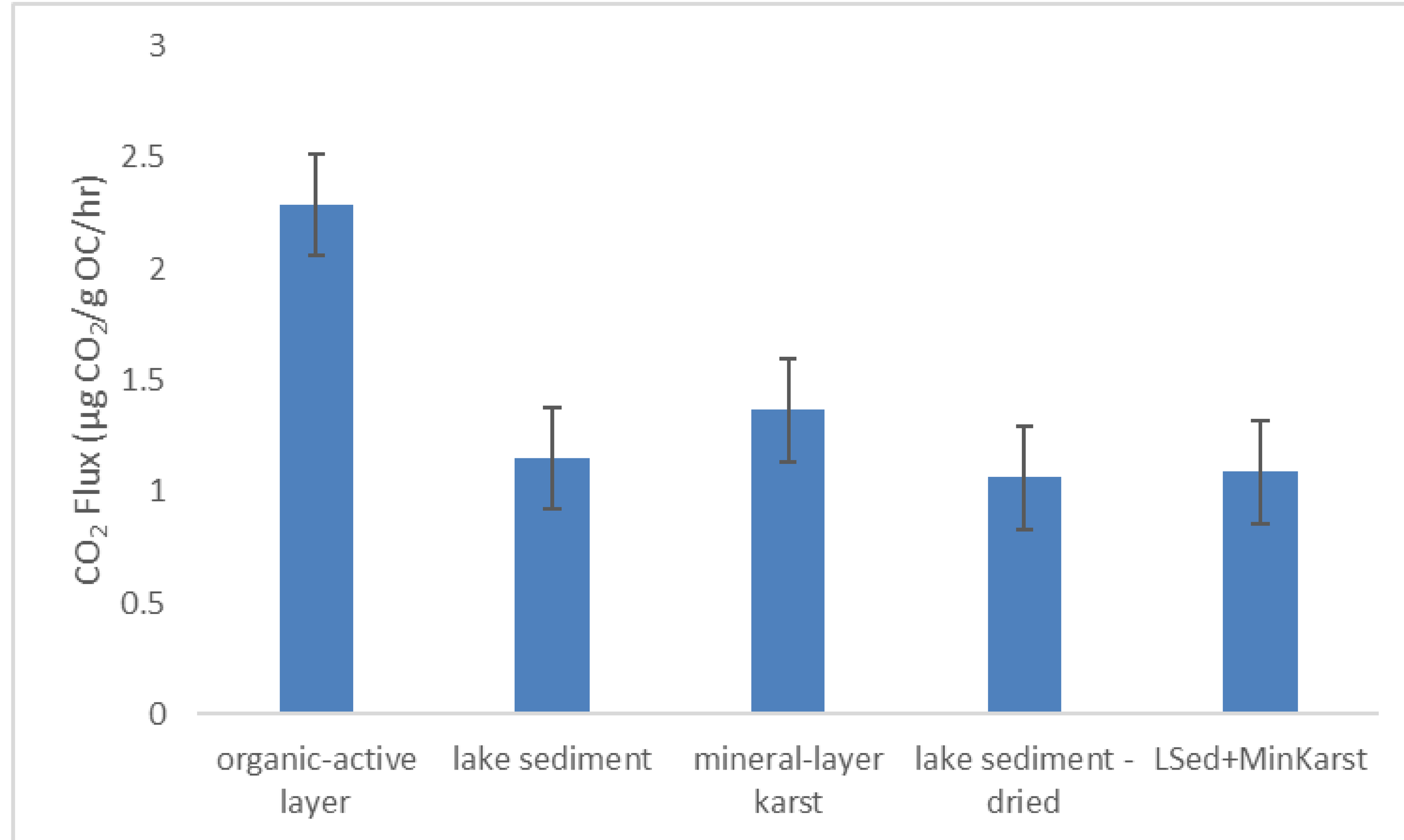


Figure 6: Average CO2 flux from each soil type, normalized to grams of soil/sediment organic carbon.

Ebullition Rates

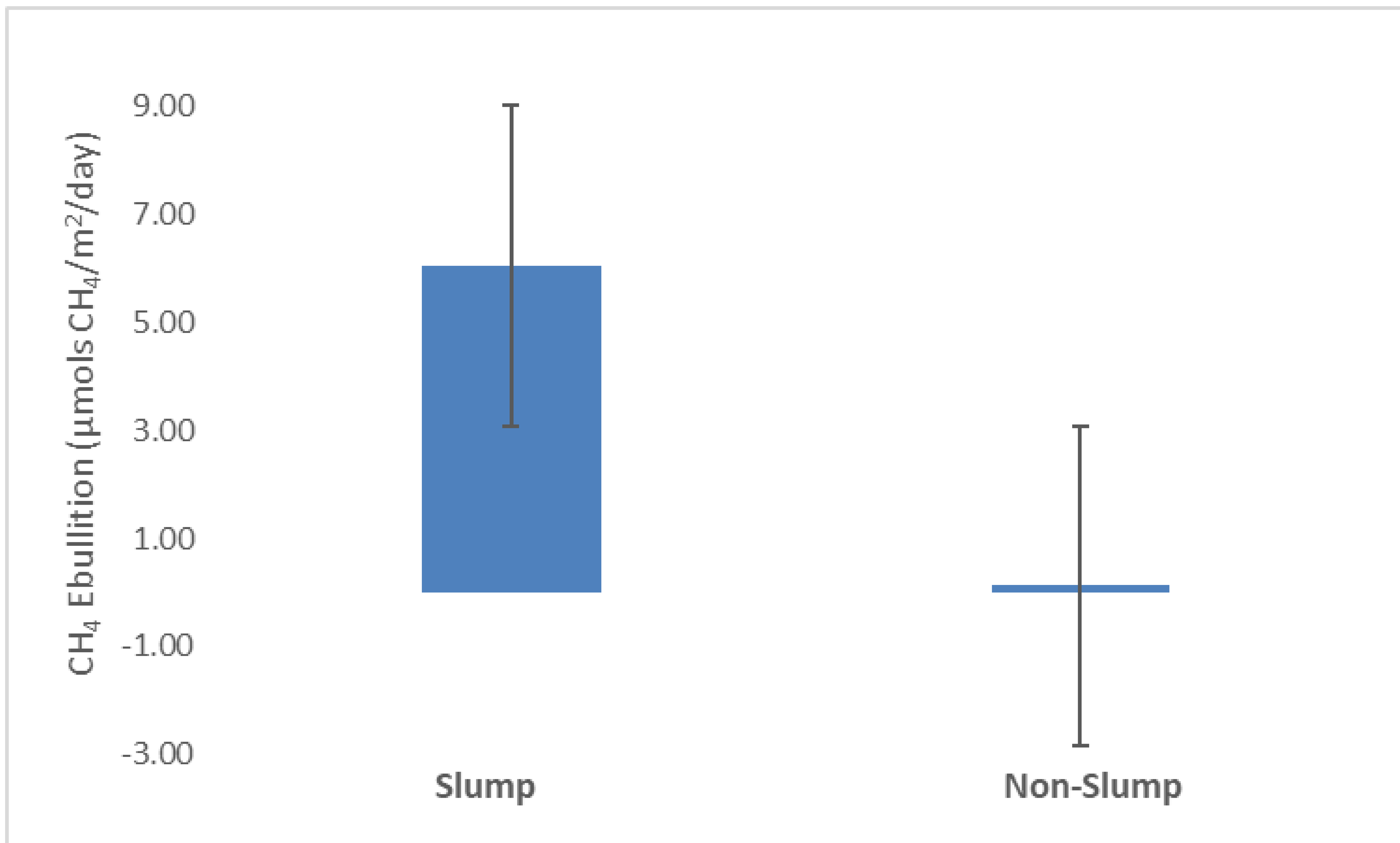


Figure 7: Average ebullitive methane fluxes for areas of the lake near and far from thermokarst slumps.

Acknowledgments

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Discussion/ Future Work

- The high organic matter and organic carbon content are responsible for the active-layer soil having the highest CO_2 flux rates.
- Ebullition rates are higher near the thermokarst slump, possibly because of the intrusion of organic-rich active layer soil.
- In the lake, organic matter degradation causes sediment anoxia, which drives microbial methanogenesis
- Thermokarst likely contributes labile carbon to lake sediments, driving greenhouse gas emissions. This highlights the potential for abrupt thaw events to increase carbon emissions from the Arctic.
- In the future, I would like to deploy more bubble traps around this and other lakes better to quantify tundra lake's contribution to global CH_4.