Are Greenhouse Gas Emissions Determined By Plant Community Composition or Edaphic Conditions at Churchill, Manitoba?

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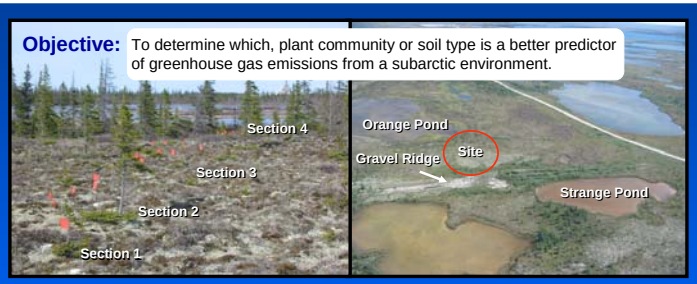
Introduction:

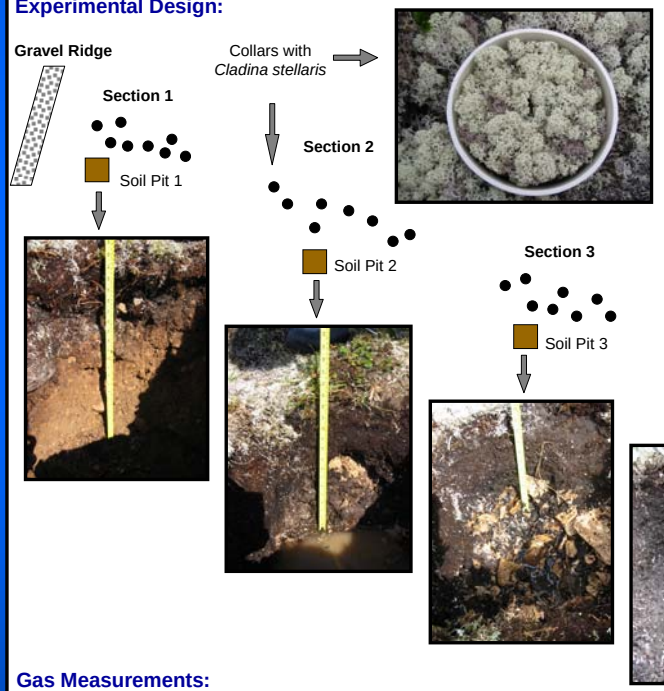
Regional estimates of greenhouse gas emissions of the Hudson Bay Lowlands are important as the area is a main store of organic carbon as peat, and has the potential for methane emissions. Plant community and edaphic conditions (soil characteristics), if related to greenhouse gas emissions are relatively quick and simple ways to scale to regional estimates of greenhouse gas emissions.

Objective:

To determine which, plant community or soil type is a better predictor of greenhouse gas emissions from a subarctic environment.



Experimental Design:



A transect was established in 2005 with 8 Static-Vented Dark Chambers deployed on *C. stellaris* lichen mats along each of the 4 transect sections. The transect contained an edaphic gradient with differences in moisture, active layer, peat accumulation, water table height and depth to permafrost in the downslope direction towards the pond's edge.

Soil pits of 0.25m^2 were dug July 31, 2005 at each of the 4 sections of the transect and soil samples were taken with depth.

Surface features, horizon differentiation including peat accumulation, bulk density, water table height and depth to permafrost were noted.

Gas Measurements:

Gas emissions were done using the chambers with gas (CO_2, CH_4, N_2O) collection at 0, 10, 20 and 30 minute intervals.

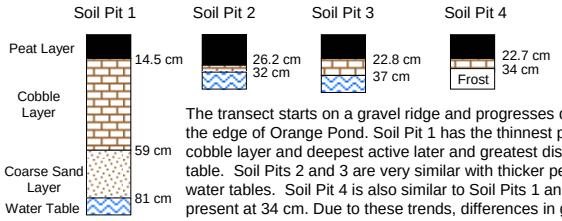
– Sampled every week from snow melt to late summer with one sampling in late fall.

– Environmental conditions (soil temperature, air temperature, soil moisture and active layer depth) determined for each chamber at each sampling.

Static-Vented Dark Chamber

Results and Discussion:

Soil Pits:



The transect starts on a gravel ridge and progresses downslope towards the edge of Orange Pond. Soil Pit 1 has the thinnest peat layer, thickest cobble layer and deepest active later and greatest distance to the water table. Soil Pits 2 and 3 are very similar with thicker peat layers and high water tables. Soil Pit 4 is also similar to Soil Pits 1 and 2, but it has frost present at 34 cm. Due to these trends, differences in greenhouse gas emissions would be expected for each section of the transect.

Greenhouse Gases:

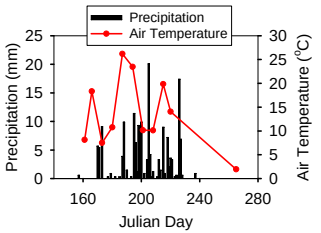
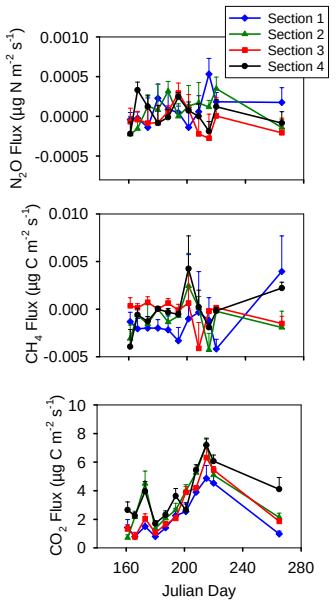


Figure 1: Daily precipitation and air temperature at the time of sampling.
Note: No precipitation data collected after Julian Day 237.

Active layer increased for all transect sections over the course of the field season with Section 1 increasing at a greater rate than the other three sections. Soil temperatures closely followed the trends seen for air temperature at the time of sampling. The summer of 2005 was also a particularly wet season in Churchill (Figure 1).

N_2O emissions were negligible for all transect sections, which is a common trend in peatlands. No N_2O consumption or production occurred (Figure 2). Some CH_4 production occurred for specific dates and CH_4 consumption occurred early in the season for Section 1 (Figure 3). Section 1 had the greatest distance to the water table and in organic soils this leads to reduced CH_4 emissions and increased CO_2 production.



Figures 2, 3 and 4: N_2O, CH_4 and CO_2 flux, respectively, for sections 1, 2, 3 and 4 of the transect (mean of n=8, ±1 se shown).

CO_2 production occurred at all sections of the transect and this production shows similar trends to that of the soil and air temperature later in the season. There is also a greater end of the season difference in CO_2 production. Section 4 had the most CO_2 production, while Section 1 had the least and sections 2 and 3 were at intermediate levels (Figure 4). Also, increased soil moisture and subsequently increased lichen and soil respiration can lead to increased CO_2 productions. CO_2 production relates closely to the soil and temperature the time of sampling. Increased temperature leads to increased CO_2 production resulting from increased heterotrophic and autotrophic respiration.

Conclusions:

Based on the results, edaphic conditions surprisingly did not exert great influence upon greenhouse gas emissions at least for emissions from within a similar lichen community. However, there were small differences in CH_4 and CO_2 emissions for the transect sections that are likely related to some soil characteristics, but these were not nearly as great as expected based on differing peat accumulation, water table height and active layer in the four soil pits. The ridge had lower CO_2 emissions whereas the lowest section had the largest emission. Further work needs to be done to separate lichen respiration and heterotrophic soil respiration as influenced by edaphic conditions at this site.

Acknowledgements:

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