Greenhouse Gas Emissions in Relation to Moisture Content, Temperature and Landscape Position in a Subarctic Environment at Churchill, Manitoba

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Objective:

To determine the relation between major environmental conditions (temperature, moisture), landscape position and plant communities to greenhouse gas emissions.

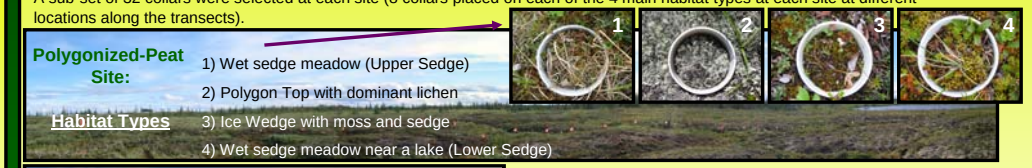
Introduction:

The Hudson Bay Lowland is the second largest contiguous peat accumulation in the world, the third largest wetland in the world and an important repository of organic carbon in both Canada and the world. The lowlands is expected to experience large increases in temperature and alteration in precipitation amount and patterns, associated with elevated levels of greenhouse gases, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The physical forcing of soil and surface waters in coastal Hudson Bay may increase as a result of already realized shorter ice cover period on Hudson Bay. Global warming is expected to alter hydrologic regimes, permafrost extent and vegetation dynamics in the area. Therefore, understanding the impacts and feedbacks of climate change in this subarctic ecosystem is extremely valuable.

Experimental Design:

Two transects of about 100 collars at 1.25 m spacing were set out in 2005; one grading downslope successively from wet-sedge meadow, polygonized-peat plateau, bottom-land to pond (Polygonized-Peat site); the other grading downslope from polygonized-peat plateau, *Sphagnum-Picea* forest, to Sedge-Moat surrounding a lake (Spruce site).

A sub-set of 32 collars were selected at each site (8 collars placed on each of the 4 main habitat types at each site at different locations along the transects).



Gas emissions were done using Static-Vented Dark Chambers with gas (CO_2, CH_4, N_2O) collection at 0, 10, 20 and 30 minute intervals on the sub-set of 32 chambers.

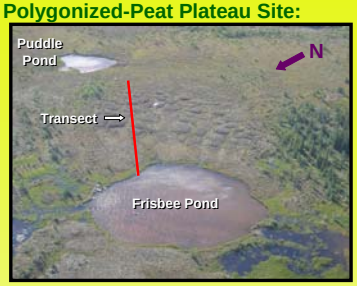
Chambers were sampled every week from snow melt to late summer with one sampling in late fall.

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

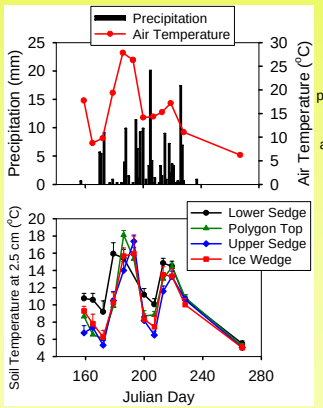
Plant community compositions within collars of the chambers and in the vicinity of collars was determined.

Soil samples were taken from near each sub-set collar every month.

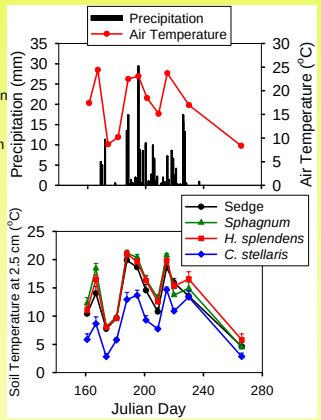
Polygonized-Peat Plateau Site:



Spruce Site:



Note: No precipitation data collected after Julian Day 237

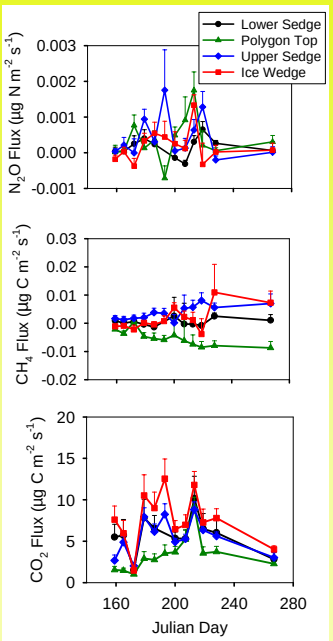


Figures 1 and 2: Daily precipitation and air temperature at the time of sampling, and soil temperature at 2.5 cm depth, respectively, at the Polygonized-Peat site (mean of n=8, ±1 se shown).

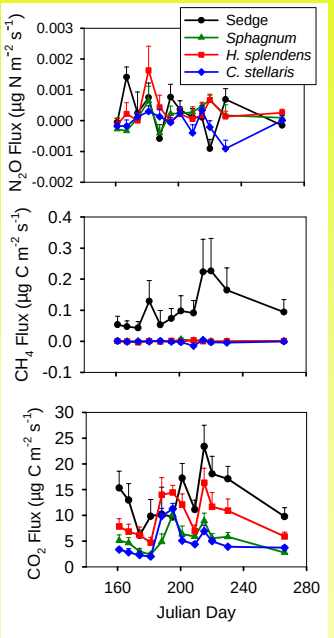
Figures 3 and 4: Daily precipitation and air temperature at the time of sampling, and soil temperature at 2.5 cm depth, respectively, at the Spruce site (mean of n=8, ±1 se shown).

Results and Discussion:

Polygonized-Peat Plateau Site:



Spruce Site:



Figures 5, 6 and 7: N_2O, CH_4 and CO_2 flux, respectively, for the four habitat types at the Polygonized-Peat site (mean of n=8, ±1 se shown).

Figures 8, 9 and 10: N_2O, CH_4 and CO_2 flux, respectively, for the four habitat types at the Spruce site (mean of n=8, ±1 se shown).

For both sites N_2O flux is negligible, which is common in peatlands (Figures 5 and 8).

Slight CH_4 production in Ice Wedge and Upper and Lower Sedge areas, and CH_4 consumption on the polygon tops occurred at the Polygonized-Peat site (Figure 6). CH_4 consumption occurring on the polygon tops is likely due to the drier conditions and subsequently greater distance to the water table. Whereas at the Spruce site there was significant CH_4 production ranging from 0.043 to 0.227 μg C m^{-2} s^{-1} in the Sedge-Moat habitat surrounding Lake Stanley (Figure 9). Decreased distance to the water table, increased moisture content and the sedge itself, which leads to increased carbon in the soil, may have led to this increased CH_4 production.

CO_2 production occurred at both sites and production was lowest in the lichen dominated areas (Figures 7 and 10). The release of CO_2 from organic matter by heterotrophic and autotrophic respiration appears to be correlated with air and soil temperature, with higher production occurring with periods of higher temperatures. The habitats with increased moisture content, such as Ice Wedge and Lower Sedge area of the Polygonized-Peat plateau and the Sedge-Moat and *H. splendens*/*P. glauca* habitats of the Spruce site have increased CO_2 production. We expect, increased soil moisture will lead to increased soil and plant respiration, which will increase CO_2 production.

Acknowledgements:

Thanks to Stanley Yee, Ashley Gade, Glenn Scott, and Tali Neta for all their help in the field this summer.

Conclusions: Temperature, moisture, landscape position and plant community composition all combined to alter greenhouse gas emissions in both the sites. N_2O showed no significant consumption or production regardless of landscape position. Increased moisture content for the Sedge-Moat related to dramatically greater CH_4 production and lower moisture at Polygon Top related to CH_4 consumption. Later in the season CH_4 related to increased temperature. Increased moisture and temperature coincided with increased CO_2 production.