Variation in Soluble Methane in Pools of a Eutrophic Sub-Arctic Fen at Churchill, Manitoba, Canada

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Introduction:

Previous studies have indicated that tundra fens are significant sources of methane (Rouse et al. 1995; Churchill, 2007). Methane emissions varied spatially and temporally because production and consumption depended upon soil conditions, ground water levels and pond depths. It is unclear if the spatial variation of methane emissions from pools is because of eduction of methane gas or from different production rates of methane in pools and release by diffusion to the atmosphere of soluble methane.

Objectives:

• To determine if soluble methane varies between pools of a eutrophic sub-arctic fen in the Churchill region and thus contribute to the spatial variation of pond methane emissions.

• To determine if pool conditions (depth, area, temperature, dissolved oxygen, pH, conductivity, oxidation-reduction potential, and dissolved organic carbon, cations and anions) are related to the variation in soluble methane.

Study Site:

The study was performed east of the Town of Churchill, Manitoba, Canada (69°49’ N 94°4’ W) within a eutrophic sub-arctic fen near the Twin Lakes (Figure 1). The site is located in the Hudson Bay Lowlands within the boreal-tundra transition zone, where boreal forest, wetlands, polygonized peat plateaus and tundra sedge meadows occur in close proximity to each other (Figure 1).

At the study site, the fen environment consists of peat hummocks, sedge lawns and pools. The vegetation is comprised mainly of sedges, grasses, mosses, and wter plants.

Methodology:

An initial study in June 2007 examined vertical and horizontal gradients in soluble methane in the pools. Nine water samples were taken from each of 3 pools at various depths and distances from the pool edges (Figure 3), and analyzed with a micro-gas chromatograph for concentrations of soluble methane and carbon dioxide using the "syringe stripping technique". Maximum pool depths (Figure 4), lengths and widths (Figure 5) were measured for the sample pools.

Results and Discussion:

Preliminary Study:

Table 1: Soluble CH₄ as a Function of Depth and Location for 3 Pools.

<table>
<thead>
<tr>
<th>Depth</th>
<th>Location</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td></td>
<td>0.277</td>
<td>0.052</td>
</tr>
<tr>
<td>Midway</td>
<td></td>
<td>0.215</td>
<td>0.014</td>
</tr>
<tr>
<td>Centre</td>
<td></td>
<td>0.533</td>
<td>0.109</td>
</tr>
</tbody>
</table>

Soluble CH₄ at water surface vs. dissolved SO₄²⁻.

Conclusions:

It has been observed that within the eutrophic sub-arctic fen in Churchill, Manitoba, soluble CH₄ varied within pools and between pools. Soluble CH₄ and CO₂ were both higher in concentration near the bottom of each pool and decreased in concentration closer to the water surface, forming a vertical gradient. No significant lateral gradients existed within the pools. It also has been observed that certain pool conditions are related to the variations in soluble CH₄ in the pools. Pool dimensions (length, width, depth, area, volume) were related to soluble CH₄ concentrations. Pool water showed the strongest relationship, indicating that increasing pool volume either slows CH₄ release to the atmosphere or increases anoxic conditions. At both surface and bottom increasing SO₄²⁻ lowered soluble CH₄ levels, likely by providing an alternate electron acceptor preventing CH₄ formation.

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References: