Dissolved methane and ebullitive emissions from water bodies in a thawing permafrost peatland

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Introduction

- Arctic regions have been undergoing rapid changes in response to climate change.
  - Permafrost thaw and formation of thaw ponds
  - Overall changes to hydrologic connectivity.
- Methane release can be through ebullition (bubbles), plant mediated or hydrodynamic diffusion of dissolved methane
  - Produced by methanogens in sediments
- These methane emissions create a positive feedback cycle with global warming
  - Warmer and longer summer seasons
  - More methanogens active for longer time periods
  - Higher methane emissions

Goal: To quantify ebullitive and dissolved methane emission from lakes, streams, and ponds and determine correlations with environmental variables

Figure 3:Lakes team sampling at Thaw pond F (PC: Alanna Nenadich)

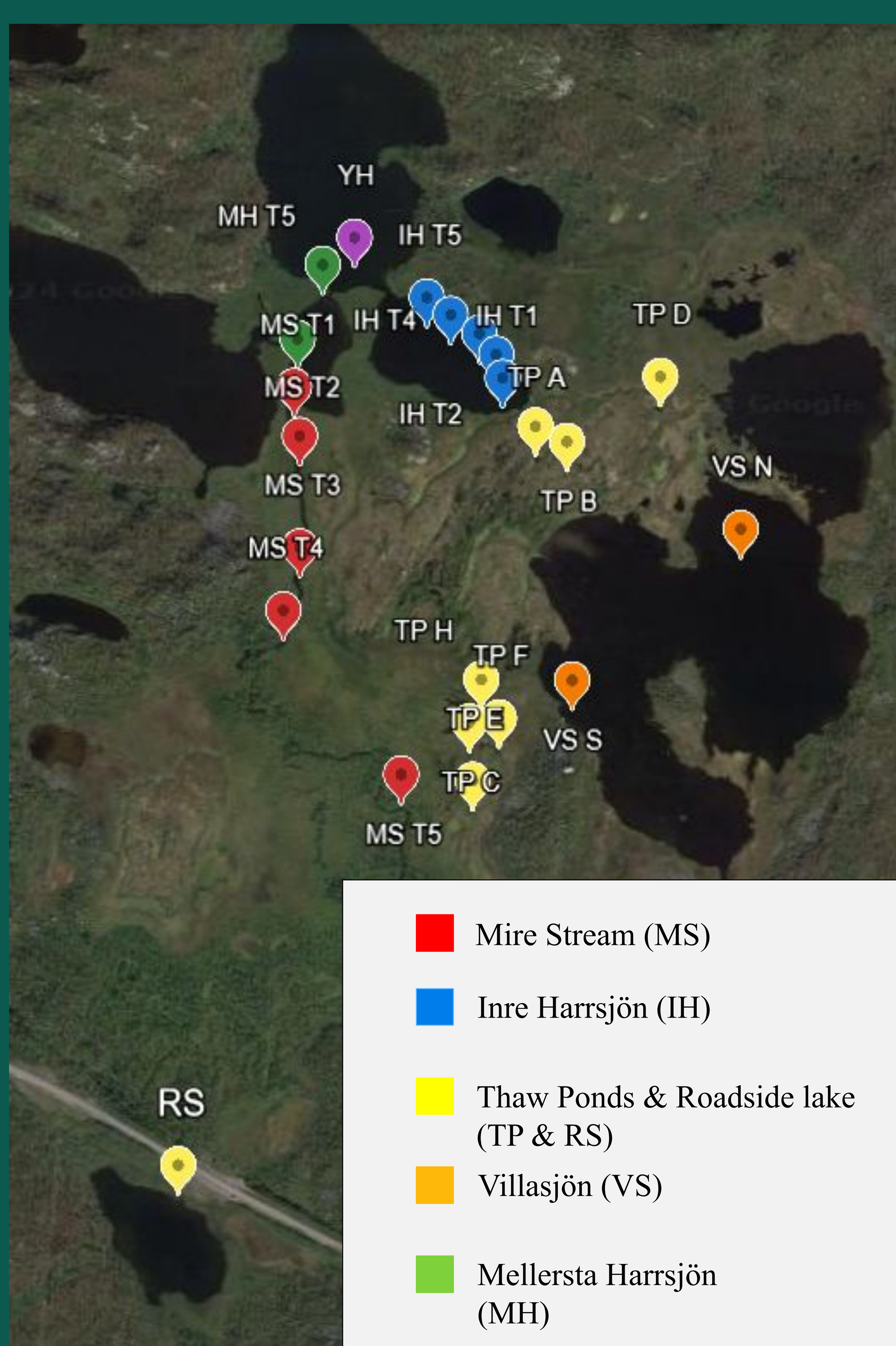

Figure 1: Map of all sampling sites at Stordalen Mire (Brayden King, Google Earth Images 2024)

Methodology

- Four water samplings over a four week period
  - Water parameters measured at each site (20 sites)
    - DO, pH, TDS, EC, Temperature
  - 1st sampling triplicates at surface and -10 cm pore water
  - The other samplings only surface waters were collected
- Dissolved methane sampling procedure
  - 30 mL of water sample combined with 30mL's of air
  - Shaken for two minutes and water was expelled
  - Methane concentration determine by gas chromatography with a flame ionization detector (GC-FID)
- Triplicate bubble traps were deployed at 12 total sites at IH, MH, and MS to capture ebullitive methane emissions.
  - Bubble traps were constructed with a 24 cm diameter funnel attached and sealed to a 10 mL syringe.
  - Larger traps (50 cm diameter) were placed at the deepest points (IHT4 & IHT5)
- Ebullition samples were collected every 2-4 days over a month period
  - Taking notes of the water parameters at each site and sampling time.
    - DO, pH, TDS, EC, Temperature
  - Bubble samples were diluted 50:1 with outside air and run on a GC-FID for methane concentration. Methane flux was calculated as mg/m^2/day

Figure 2: Two bubble traps deployed at MS-T5 PC: Erik Froburg

Results

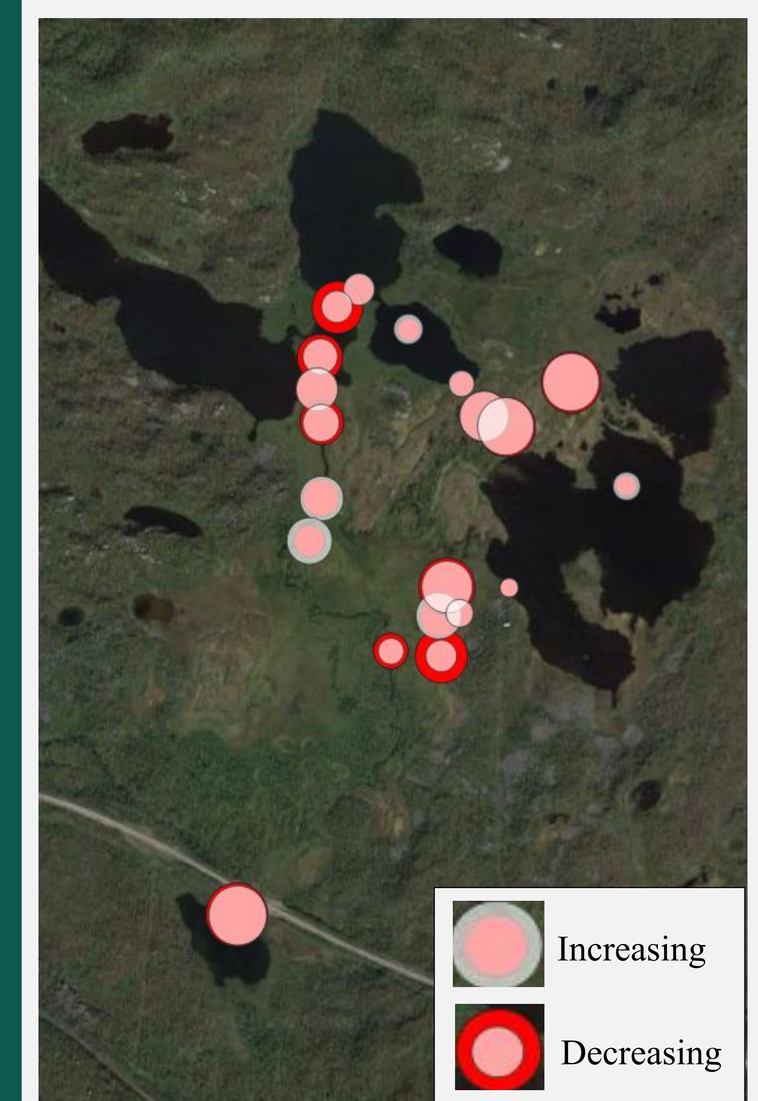

Figure 4:Map showing the 1st (red) and 4th (white) samplings overlapping to show change in dissolved methane as size of point is directly correlated with methane concentration. (Min 5.5 – Max 3220 ppm)

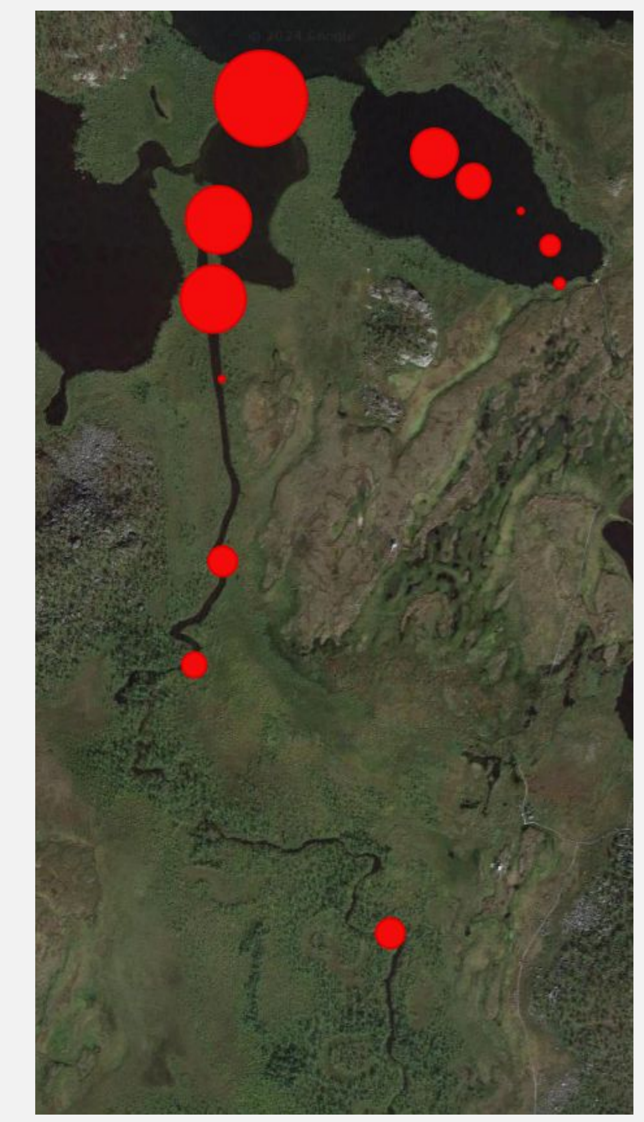

Figure 5: Map showing total average ebullitive methane flux across. Greater size is proportional to greater flux. (Min 0.03 – Max 64.2 $mg/m^2/day$)

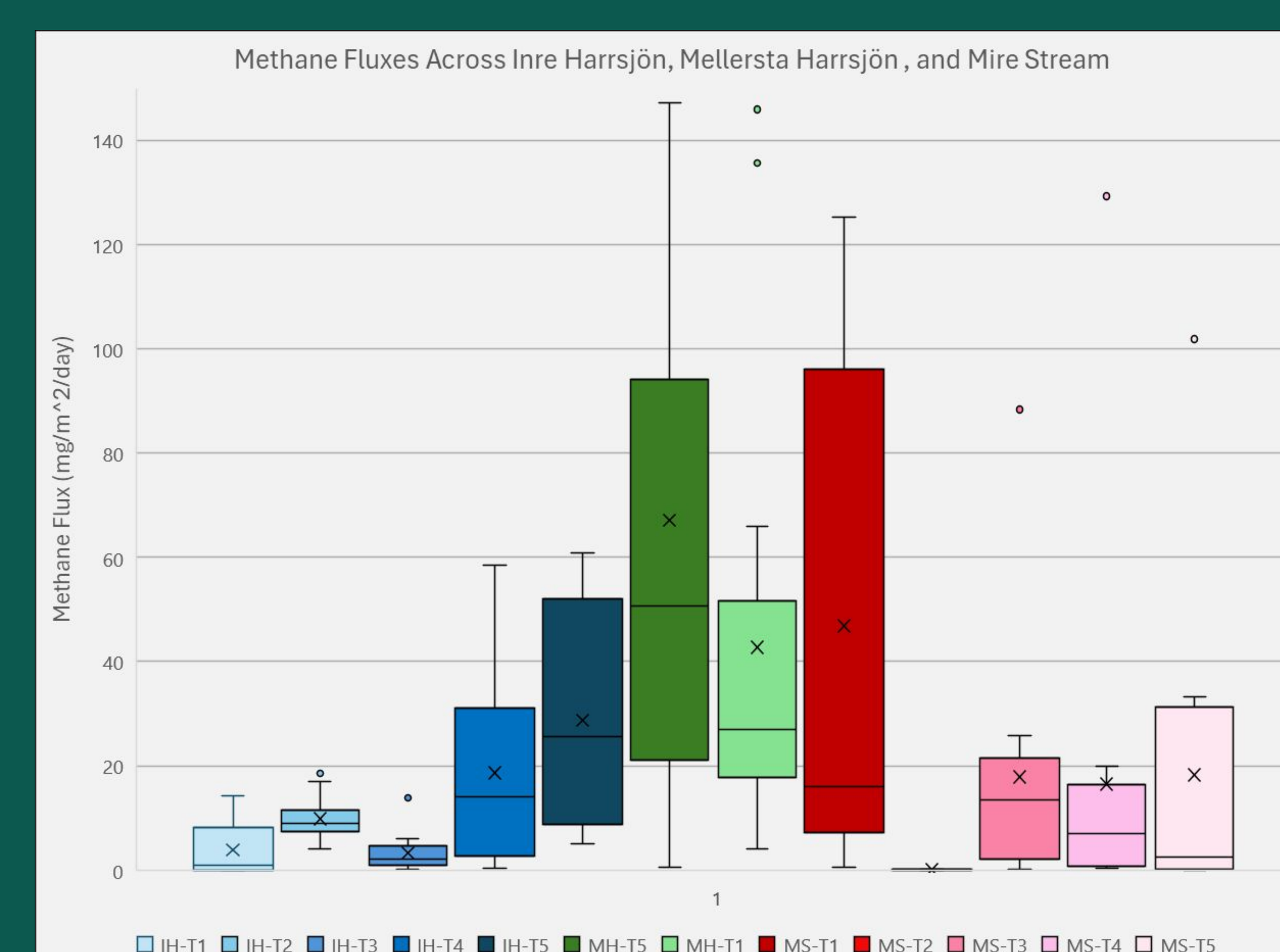

Figure 6: Plot of bubble trap flux data across mire. Note: MH-T5 has outlier point at 266 mg/m^2/day that was removed to visually enhance the plot

Next steps

Comparison of ebullitive methane flux with previous seasons

Find correlations between connectivity of the mire and dissolved methane.

Employ statistical tests to tests correlations of ebullitive methane flux with environmental parameters and dissolved methane concentrations.

Figure 7: Thaw pond D (PC: Brayden King)

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