Methane Release from Wetlands in Canada's Prairie Pothole Region

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INTRODUCTION

- Inland freshwater ecosystems are an active component of the global carbon (C) cycle and are known sources of biogenic greenhouse gas (GHG) release to the atmosphere.[1–4]
- Microbes in pond and wetland sediments break down organic matter, producing methane (CH_4), carbon dioxide (CO_2), and nitrous oxide (N_2O).
- **Ebullition** is the transport of gases from sediment via bubbles and is the primary pathway for CH_4 release to the atmosphere but is less important for CO_2 and N_2O.[5,6]
- In the Prairie Pothole Region (PPR; Fig. 1) there are millions of shallow freshwater wetlands, yet quantification of CH_4 ebullition and controls on CH_4 production have not been studied in this region.

OBJECTIVES

1. Quantify CH_4 ebullition across ponds in Saskatchewan and Manitoba.
2. Identify the physicochemical controls (including sulfate (SO_4^{2-}) concentration and water temperature) on CH_4 production and release at these sites.

Figure 1. Map of study sites within the Prairie Pothole Region.

METHODS

- Bubble traps (Fig. 2) were deployed in shallow water (Fig. 3) at each site to measure ebullitive volume over several months (each) in two years.
- GHG concentrations of freshly-released bubbles — retrieved by manually disturbing sediments and storing in glass vials — were measured via gas chromatography.

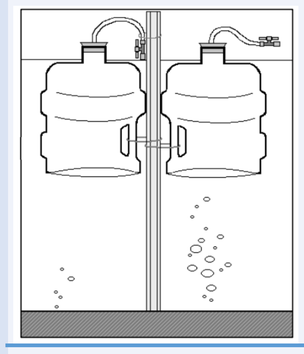

Figure 2. Schematic diagram of a bubble trap with two bubble collection chambers (courtesy of Lauren Dyck).

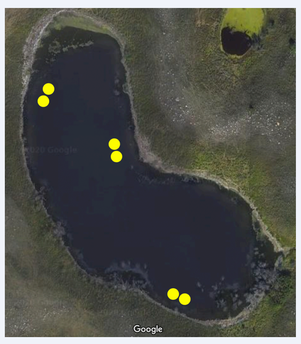

Figure 3. Aerial view of bubble trap locations at one Saskatoon site (Northeast Swale 3).

METHANE FLUXES FROM WETLANDS IN THE PPR ARE HIGHLY VARIABLE, BUT ARE IMPORTANT – WE NEED TO QUANTIFY THEM TO IMPROVE GHG BUDGETS

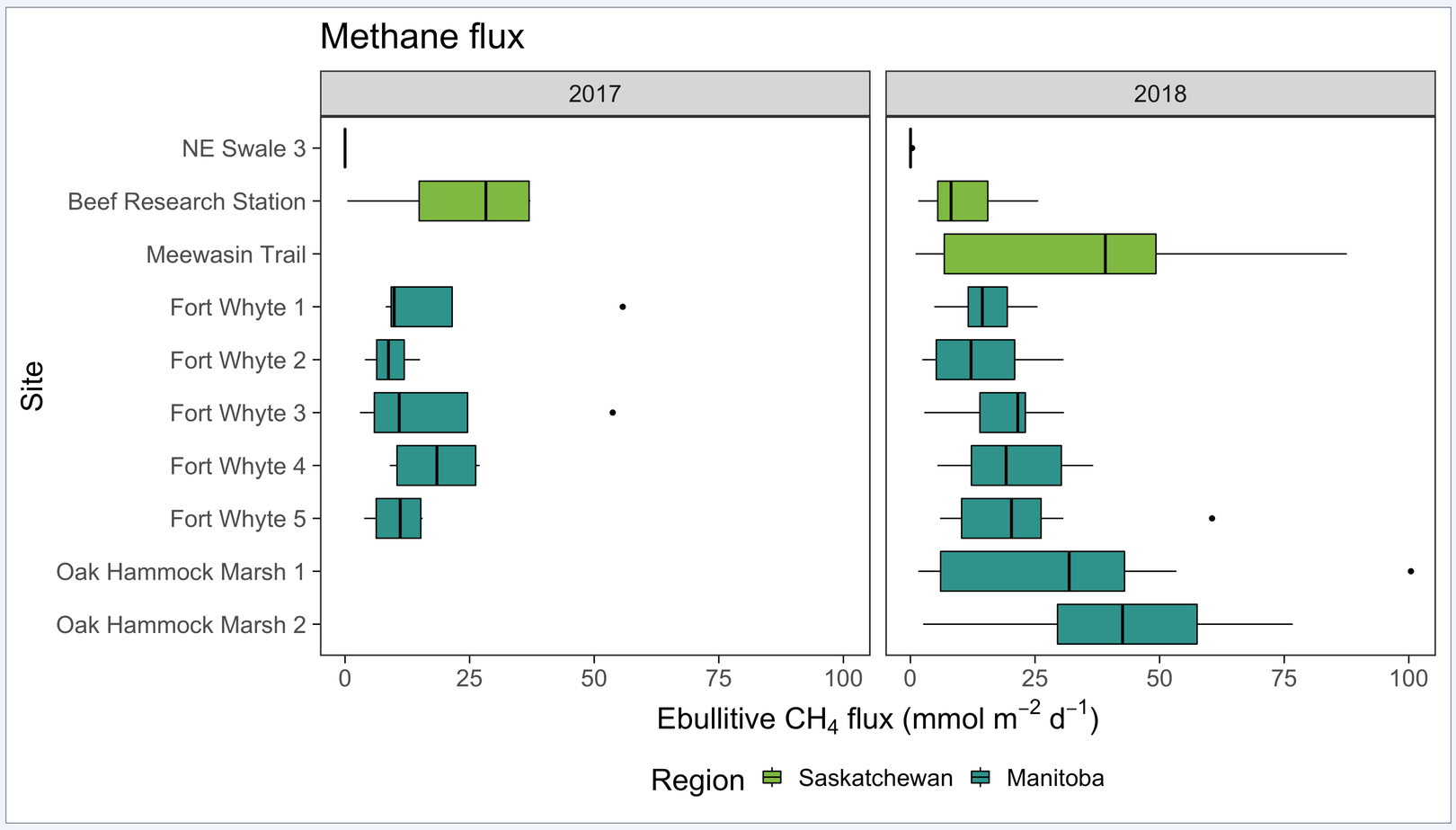

Figure 4. Sampling period ranges of ebullitive CH_4 fluxes for ponds and wetlands near Saskatoon, SK and Winnipeg, MB.

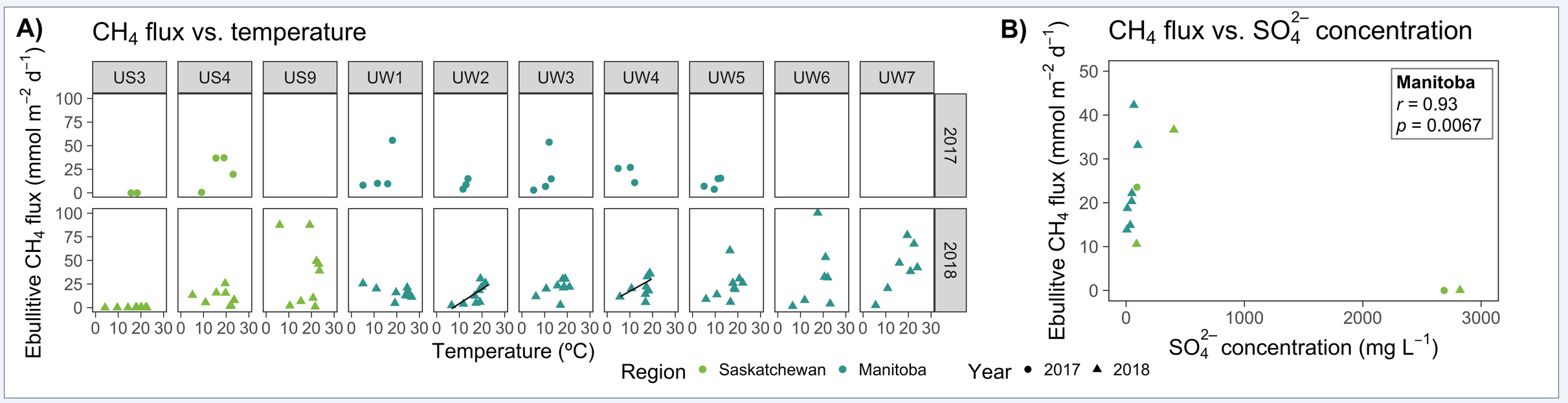

Figure 5. Physicochemical controls on CH_4 release: **A)** Water temperature (in the order of Fig. 4). Data shown are sampling period averages. Trendlines denote significance ($p < 0.05$). **B)** SO_4^{2-} concentration. Data shown are season averages.

CONCLUDING REMARKS

- Ebullitive CH_4 release varies considerably within and between sites, and over time, but these rates can be very high.
- Warm summer temperatures appear to stimulate CH_4 release at some sites whereas others see high CH_4 release at near-freezing temperatures late in the open-water season.
- Sulfate concentrations below 400 mg L^{-1} correlate positively with CH_4 release at Manitoba sites ($p = 0.0067$). At high SO_4^{2-} concentrations (> 2000 mg L^{-1}) in Saskatchewan, CH_4 production is suppressed.

SIGNIFICANCE

- This research provides the first multi-season record of CH_4 ebullition from shallow freshwater wetlands in Canada's PPR, contributing to the improved understanding of the role of ebullition in aquatic-atmosphere GHG exchange.

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