The dynamics of greenhouse gas transport in Prairie ponds

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Background

- Pothole ponds, also called wetlands or sloughs, were historically not regarded as having value to society. There are millions of these ponds across the prairies.
- Carbon and nitrogen are actively transformed in these ponds. Each pond has the potential to be a source of or sink for greenhouse gases (GHG) in the atmosphere.
- Little is known about the factors that drive differences in biogeochemical cycling between pothole ponds – especially for gas fluxes, which exhibit high spatiotemporal variability.
- Dissolved gas in surface waters can be measured to indicate the intensity of GHG production in pond water and sediments.

Purpose

- **To provide enhanced estimates of regional water–atmosphere GHG exchange from pothole ponds.**

Objectives

To **(1)** quantify spring and summer dissolved GHG saturation levels and **(2)** identify physicochemical characteristics responsible for controlling CO_2, CH_4, and N_2O in these ponds.

Data Collection

Prairie ponds (n = ~150) were surveyed in spring and summer, 2018 and 2019. Sampling included:

- Field observations
- Water and sediment samples
- Dissolved gas concentrations (Figure 1)

Figure 1: Dissolved gas sampling, headspace equilibrium method.

Next Steps

Quantify GHG fluxes from other pathways (methods pictured in Figures 2–4) at select sites for the whole open water season.

Identify the relative roles of vegetative, ebullitive, and diffusive pathways.

Figure 2: Field sampling of gases released from exposed sediment around ponds.

Figure 3: Sampling of GHGs transported through vegetation (cattails).

Figure 4: Automated sensor for measuring gas bubbles released from sediments (ebullition) (Photo R.Helmle).

Preliminary Results

In 2019, all ponds sampled were supersaturated in CH_4, the majority of ponds were undersaturated in N_2O, and ponds were close to evenly split for CO_2. Overall, more ponds supersaturated in spring than in summer)

Table 1: Percent of under-saturated, saturated, and super-saturated ponds in spring (April/May) and summer (June/July) of 2019.

Date	Gas	Under (%) <95%	Saturated (%) 95–105%	Super (%) >105%
April/May 2019	CO_2	31	5	64
	CH_4	0	0	100
	N_2O	65	20	15
June/July 2019	CO_2	50	1	49
	CH_4	0	0	100
	N_2O	74	5	21

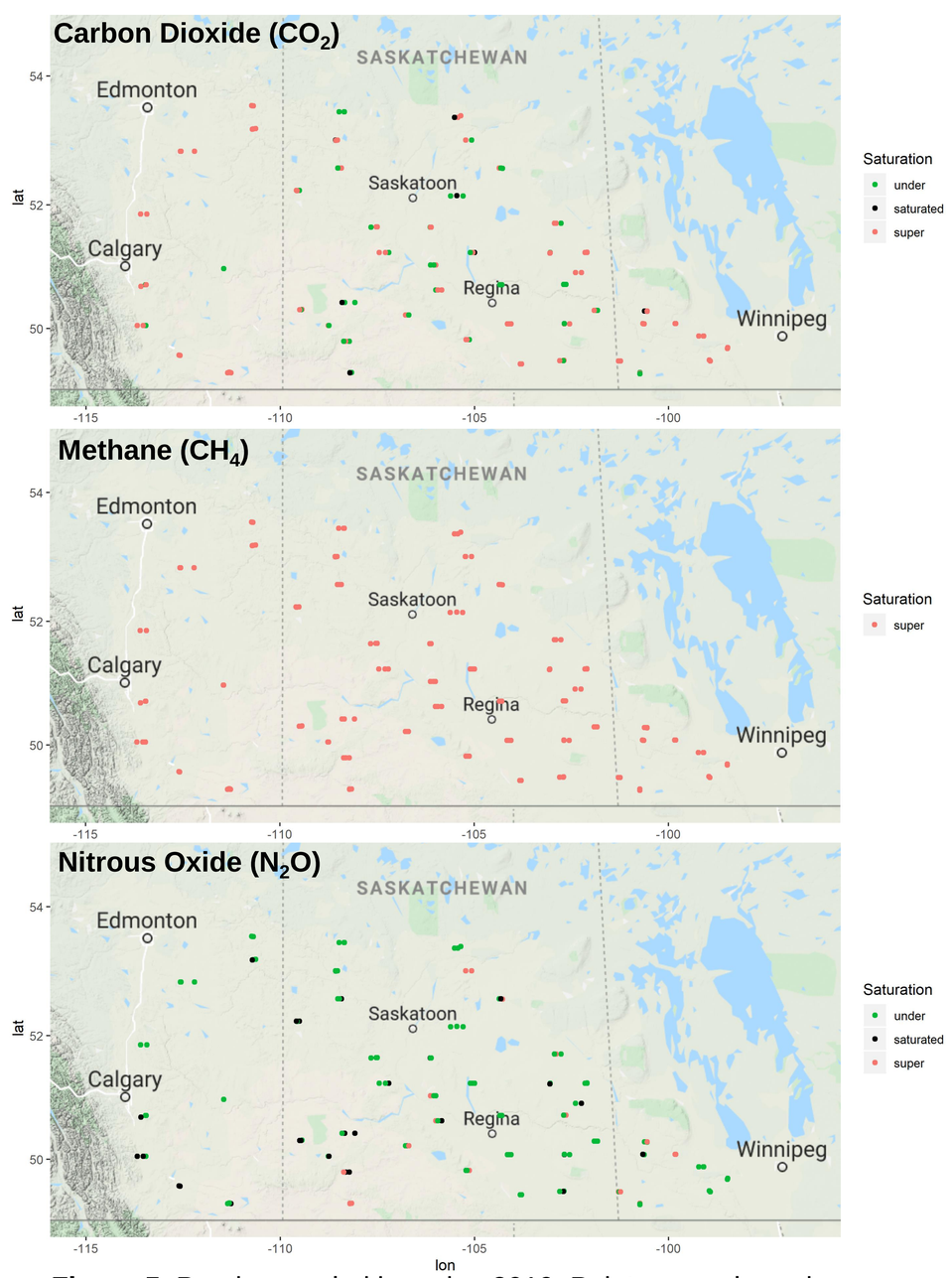

Figure 5: Ponds sampled in spring 2019. Points are coloured according to saturation level of the respective GHG.

Significance

- **Lack of gas flux measurements across diverse pathways in Prairie ponds limits attempts to describe regional GHG budgets. This research seeks to fill this gap.**
- **This research, used alongside knowledge from other disciplines (e.g., biology, economics), can inform water management decisions affecting wetlands or sloughs.**