Seasonal Differences in Greenhouse Gas Concentrations of Thaw Lakes: Central Yakutia, Russia

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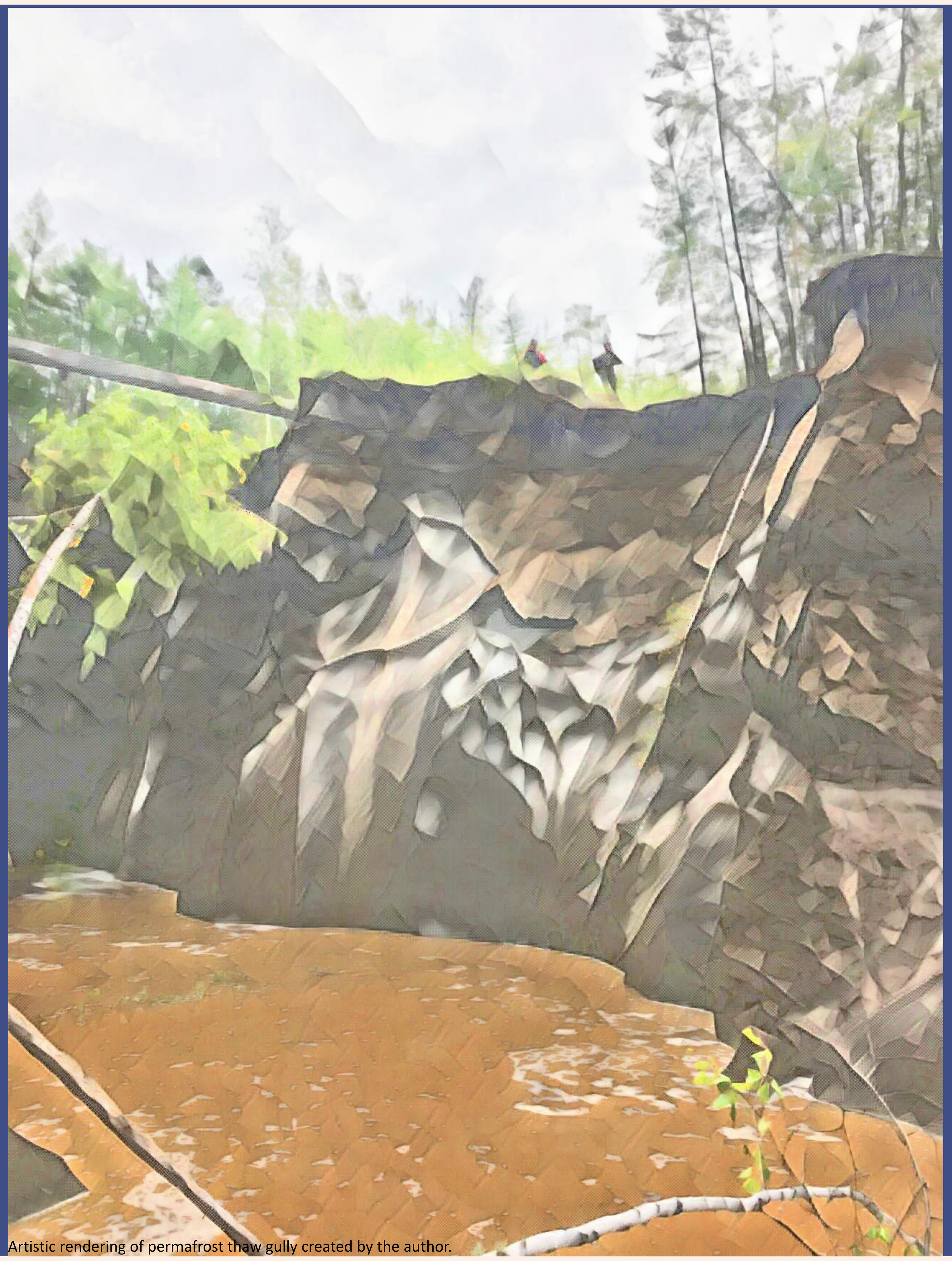


Artistic rendering of permafrost thaw gully created by the author.

Introduction

- Permafrost in Central Yakutia (Siberia):
  - Continuous and up to 500 meters thick[1]
  - 50-90% ice rich
- Permafrost stores organic carbon[2, 3]
- Increases in temperature are causing:
  - Landscape changes[1]
  - Permafrost thaw and formation of thaw lakes[1]
  - Release of greenhouse gases (GHGs) (CO_2 and CH_4) from permafrost[3,4,5]

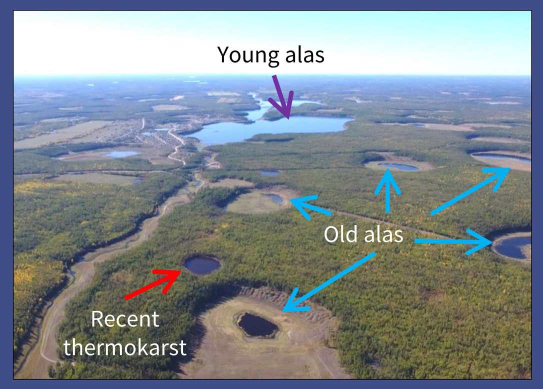
Hypothesis

There is significant heterogeneity in dissolved GHG concentrations and emissions between lake types and seasons.

Methods

Study Site

- Lake types:
  - Old alas (early Holocene)
  - Young alas (mid Holocene)
  - Recent thermokarst (last decades)



Basic Limnology

- YSI multi sensor limnological device
  - Conductivity
  - Dissolved oxygen
  - Temperature

Dissolved Greenhouse Gas Concentrations

- 2 L of lake water equilibrated with 20mL of ambient air
- Gaseous headspace analyzed by gas chromatography

- Dissolved GHG concentration at the surface (Csur)

$$Gas_{(aq)} = K_H \times pGas$$

where:
- K_H is Henry's law constant (M/atm)
- pGas is the partial pressure of the gas (atm)

- Sink vs. source

aqueous gas concentration – atmospheric gas concentration

Results

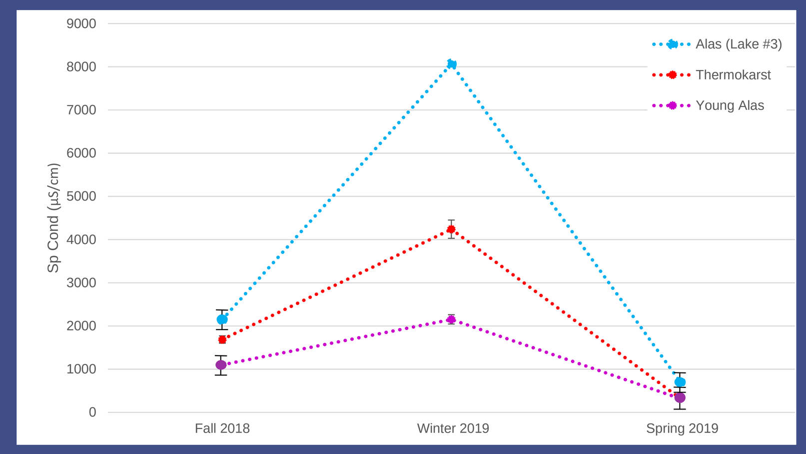


Fig. 1 Seasonal conductivity by lake type.

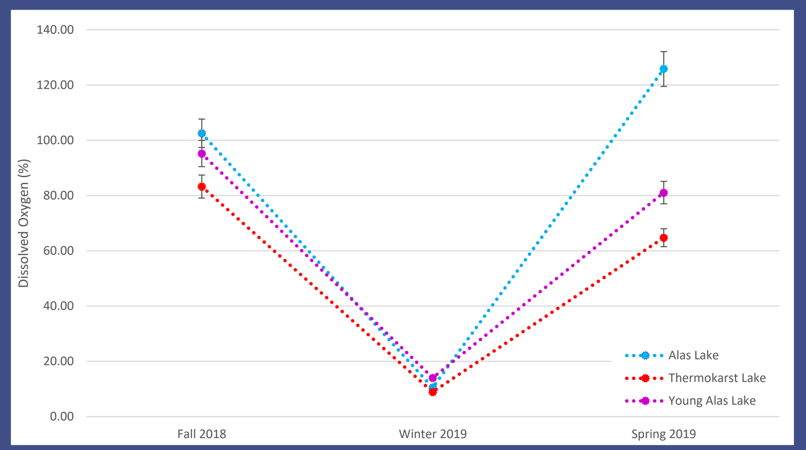


Fig. 2 Seasonal dissolved oxygen (%) by lake type.

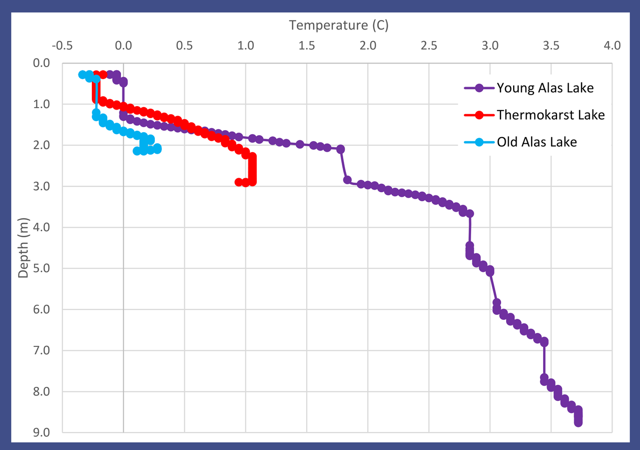


Fig. 3 Winter temperature profile for each lake type.

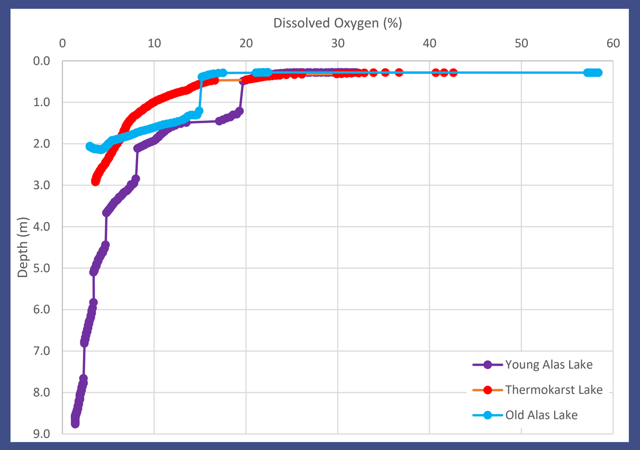


Fig. 4 Winter dissolved oxygen profile for each lake type.

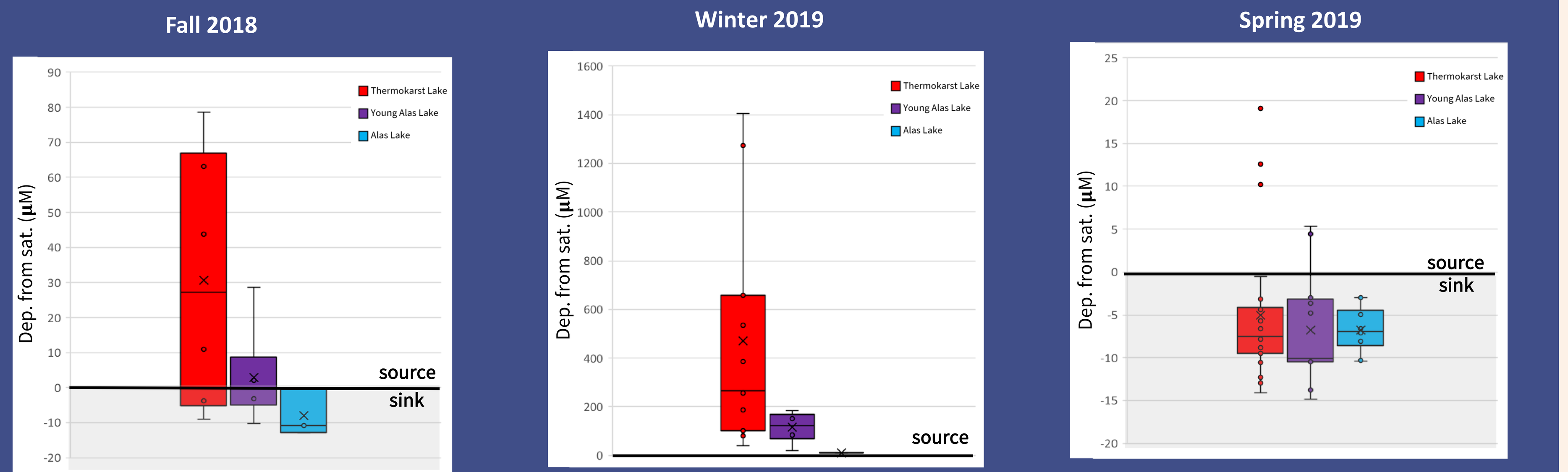


Fig. 5. Departure from saturation for dissolved CO_2 concentrations by lake type and season.

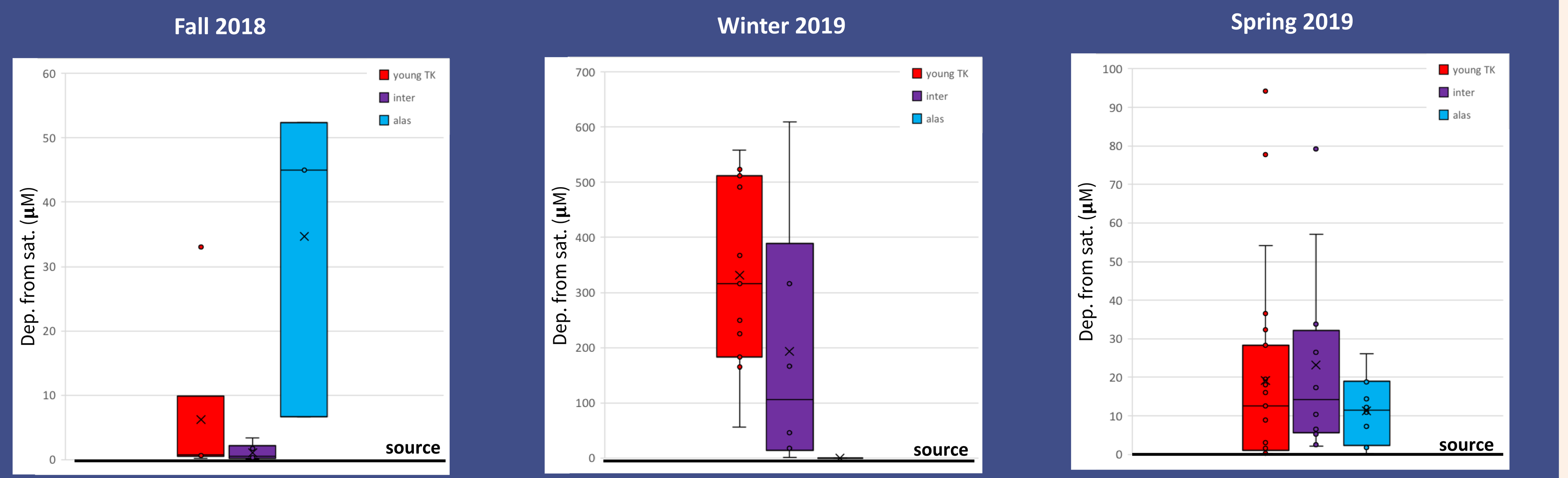


Fig. 6. Departure from saturation for dissolved CH_4 concentrations by lake type and season.

Conclusions

- Heterogeneity in limnological characteristics and dissolved GHG concentrations:
  - Between lake types
  - Between seasons
- Seasonal changes in limnology are contributing to seasonal differences in GHG concentrations

Future Work

- Incorporate GHG emissions from ebullition
- Integrate present day measurements with paleoenvironmental perspective
- Incorporate data retrieved from long term limnology sensors

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3. Walter, K. M., Edwards, M. E., Grosse, G., Zimov, S. A. & Chapin III, F. S. Thermokarst Lakes as a Source of Atmospheric CH4 During the Last Deglaciation. *Science (80-.).* 318, 633–636 (2007).
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