THAWING PERMAFROST INDUCES MORE ALLOCHTHONY IN SUBARCTIC PONDS

***Maxime Wauthy[1], Milla Rautio[1], Kirsten S. Christoffersen[2], Laura Forsström[3], Isabelle Laurion[4], Heather Mariash[5] and Warwick F. Vincent[6]**

[1] Département des sciences fondamentales, Université du Québec à Chicoutimi, Saguenay, Quebec, CANADA
[2] Freshwater Biological Laboratory, Department of Biology, University of Copenhagen, Copenhagen, DENMARK
[3] Department of Environmental Sciences, University of Helsinki, Helsinki, FINLAND
[4] Centre Eau Terre Environnement, Institut national de la recherche scientifique, Quebec City, Quebec, CANADA
[5] Environment and Climate Change Canada, National Wildlife Research Centre, Ottawa, Ontario, CANADA
[6] Département de biologie, Université Laval, Quebec City, Quebec, CANADA

*maxime.wauthy1@uqac.ca

INTRODUCTION

- Permafrost = one of the Earth's largest pools of organic carbon[1]
- Global warming ➔ permafrost thawing ➔ carbon released ➔ **ending up in arctic and subarctic freshwater systems** ➔ assimilated in aquatic food chain ➔ Greenhouse gas emission ➔ Global warming[2]
- Dissolved Organic Matter (DOM) ➔ complex mixture of degraded terrestrial and aquatic dissolved material
  ➔ expected to be mainly derived from terrestrial sources in ponds impacted by thawing permafrost
  ➔ linked to the thawing permafrost

Objective :

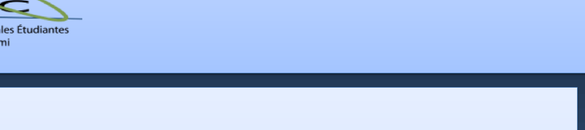
Explore the impact of thawing permafrost on the DOM composition of subarctic and arctic lakes

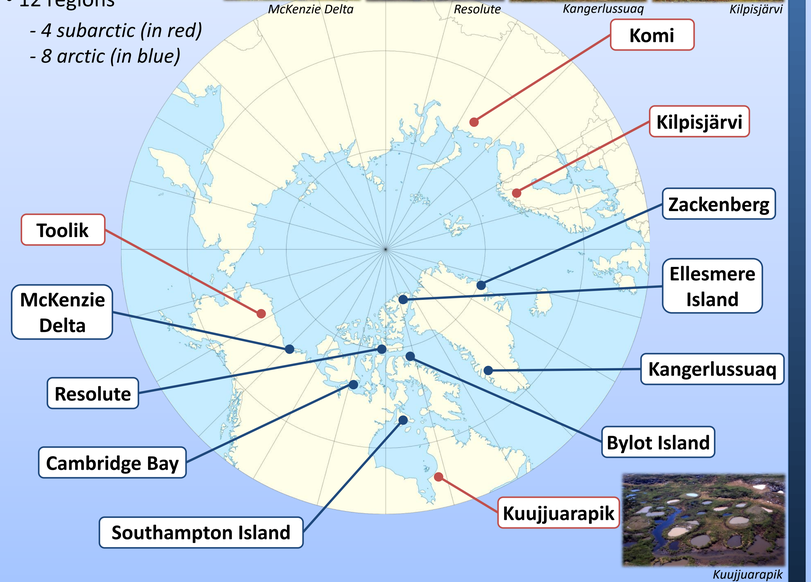
Hypotheses :

1. DOM is more terrestrial in thaw ponds than subarctic and arctic ponds not influenced by thawing permafrost
2. Climate warming and permafrost thaw will contribute to make northern freshwaters more terrestrial in the future

STUDY SITES

- 261 ponds sampled
- 12 regions
  - *4 subarctic (in red)*
  - *8 arctic (in blue)*


McKenzie Delta *Resolute* *Kangerlussuaq* *Kilpisjärvi*



Kuujjuarapik

RESULTS

Optical Analyses

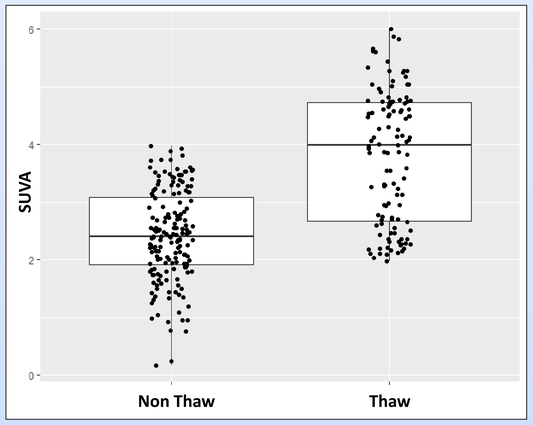


Figure 1. Boxplot of $SUVA_{254}$ values for ponds impacted and not impacted by thawing permafrost

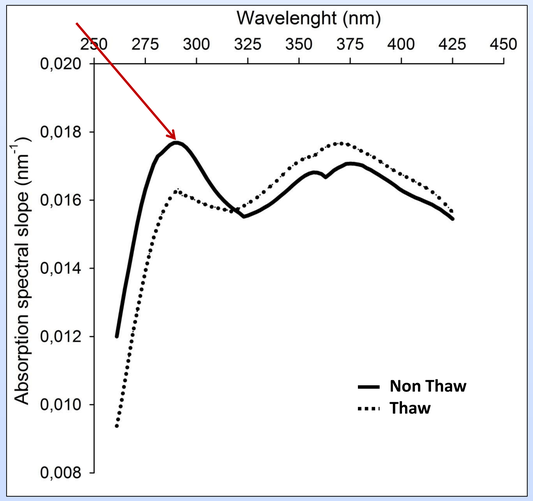


Figure 2. Absorption spectral slope curves (S_λ) of dissolved organic matter as an indicator of the presence of algal-derived carbon (peak at S_{289})

Stable Isotope Analyses (*only Kuujjuarapik region*)

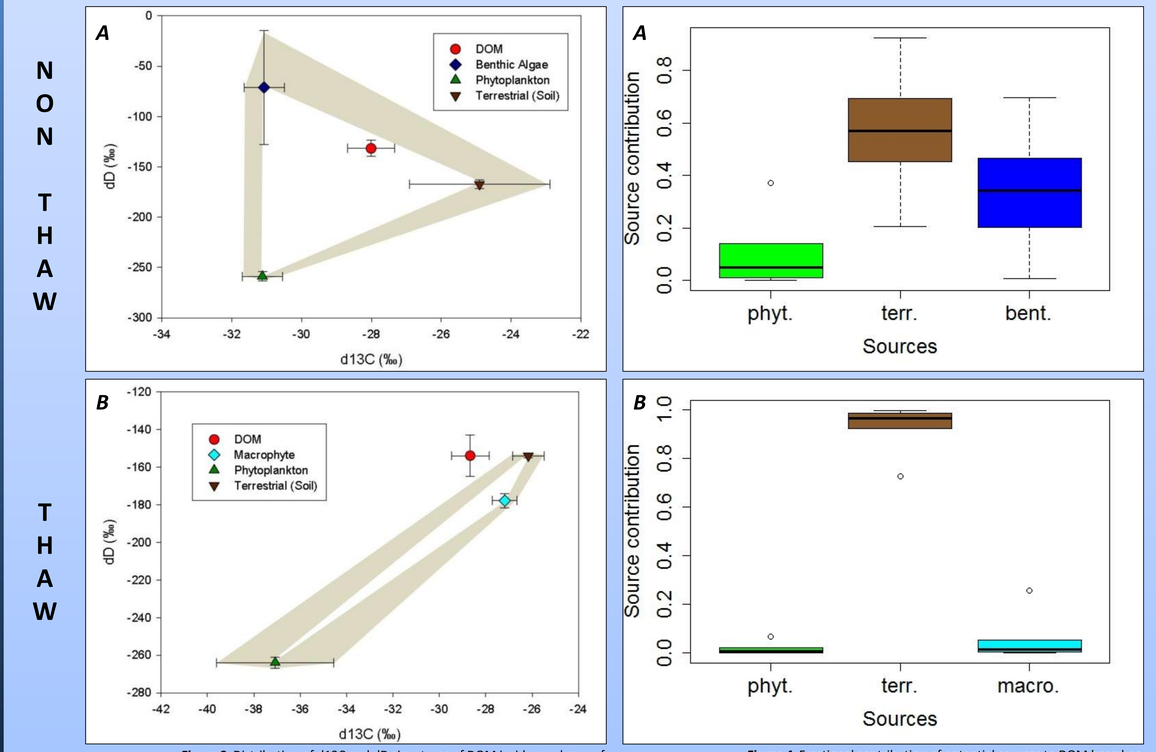


Figure 3. Distribution of d13C and dD signatures of DOM inside a polygon of potential sources + SD in non thaw (A) and thaw (B) ponds

Figure 4. Fractional contribution of potential sources to DOM based on Bayesian mixing model in non thaw (A) and thaw (B) ponds

INTERPRETATIONS

Optical Analyses

- $SUVA_{254}$ higher in thaw ponds (Three-way ANOVA, $p<0.01^{**}$)
  ➔ more aromaticity in thaw ponds
  ➔ indicator of terrestriality
- S_{289} lower in thaw ponds (Three-way ANOVA, $p<0.05^{*}$)
  ➔ less algal derived C in thaw ponds
  ➔ less aquatic origin

Stable Isotope Analyses

- Important contribution from terrestrial source and benthic bulk in non thaw ponds
  ➔ suggest imports from watershed and diffusion from sediments
- Terrestrial source is the major contributor of DOM in thaw ponds
  ➔ DOM terrestrial in thaw ponds

TAKE-AWAY MESSAGE

1. Importance of thawing permafrost
2. DOM is more terrestrial in thaw ponds than in ponds not directly influenced by thawing permafrost
3. Climate warming and permafrost thaw will contribute to make subarctic and arctic lakes more terrestrial in the future

ACKNOWLEDGEMENTS

Our gratitude goes to Pierre Carrier-Corbeil, David-Alexandre Gauthier and Guillaume Grosbois for their precious help in the field and the lab.

A special thanks to Paschale Bégin, Flora Mazoyer, Vilmantas Preskienis and Toni Roiha for their optical data contribution.

We also thank the Whapmagoostui – Kuujjuarapik Research Complex for the technical support during the sampling campaigns in Kuujjuarapik.

REFERENCES

[1]Schuur, E.A.G., *et al.* (2008) Vulnerability of permafrost carbon to climate change: Implications for the global carbon cycle. *BioScience*, **58**(8):701-714.

[2]Vonk, J.E., Sánchez-Garcia, L., van Dongen, B.E., Alling, V., Kosmach, D., Charkin, A., Semiletov, I.P., Dudarev, O.V., Shakhova, N., Roos, P., Eglinton, T.I., Andersson, A. and Gustafsson, Ö. (2012) Activation of old carbon by erosion of coastal and subsea permafrost in Arctic Siberia. *Nature*, **489**:137-140.