The lability of different DOM sources on permafrost landscapes of Eastern Canadian Arctic

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INTRODUCTION

In northern regions, permafrost thawing mobilizes soil organic carbon (C) as dissolved organic matter (DOM) into aquatic systems, including into small stagnant water bodies that can occupy a large fraction of the landscape in certain areas[a]. The fate of that C pool is of great concern to the scientific community because its transfer to the atmosphere could accelerate climate warming through positive feedback effect if the mobilization of old C pools increases under climate change[b].

The mineralization of DOM into CO_2 by bacteria (biodegradation, BD) and sunlight oxidation (photodegradation, PD) are both at play in shallow, well-lit ponds[c]. Permafrost DOM was frequently reported as highly sensitive to BD[d], but we know less about its sensitivity to PD, and how it compares to other C pools that are also affected by climate change, including primary producers.

We hypothesize that discrepancies in lability to both BD and PD are mostly explained by DOM composition, and strongly linked to the local conditions. Specifically, we hypothesized that:

1) The DOM leaching from active layer, permafrost, primary producers and the one found in the ponds will show different composition affecting their lability

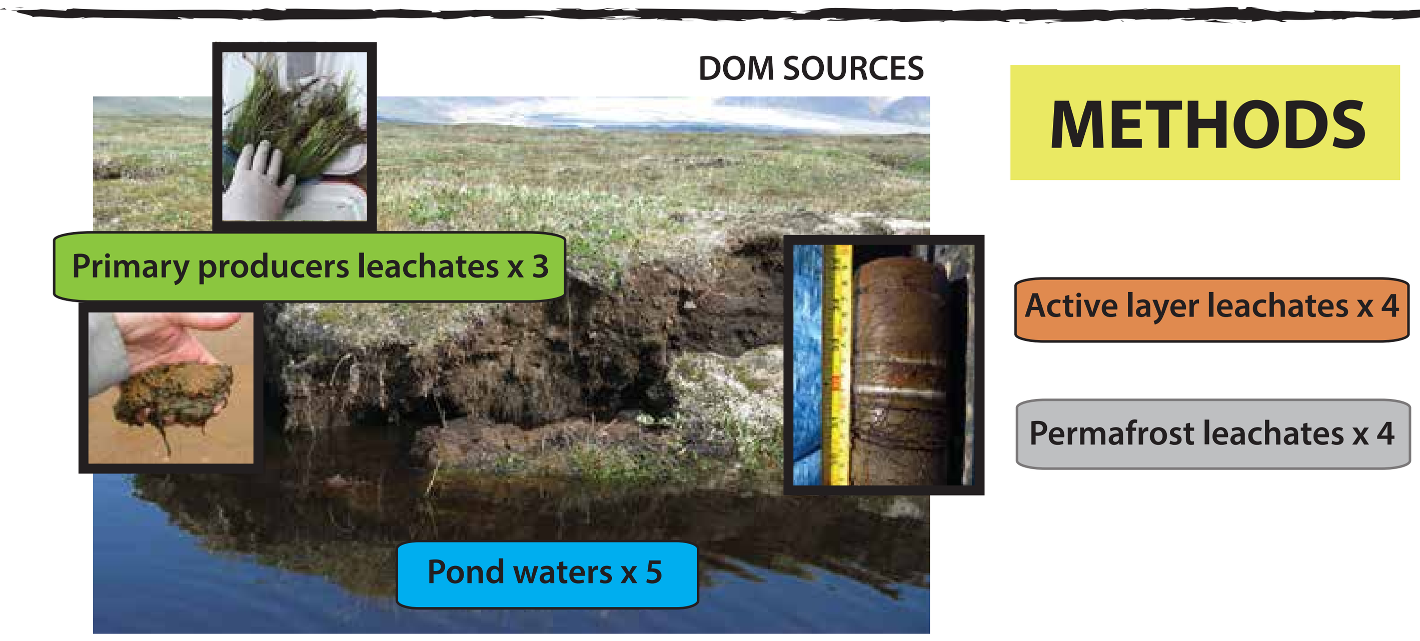
2) Permafrost DOM is particularly labile to BD but also to PD (balanced mixture of aromatic and aliphatic compounds)

3) Primary producers DOM is particularly labile to BD but not to PD (dominance by aliphatic compounds)

4) Active layer and pond DOM are less labile than permafrost DOM to both BD and PD (larger proportion of recalcitrant fraction remaining)

The study site of Bylot Island, Arctic, 73°N

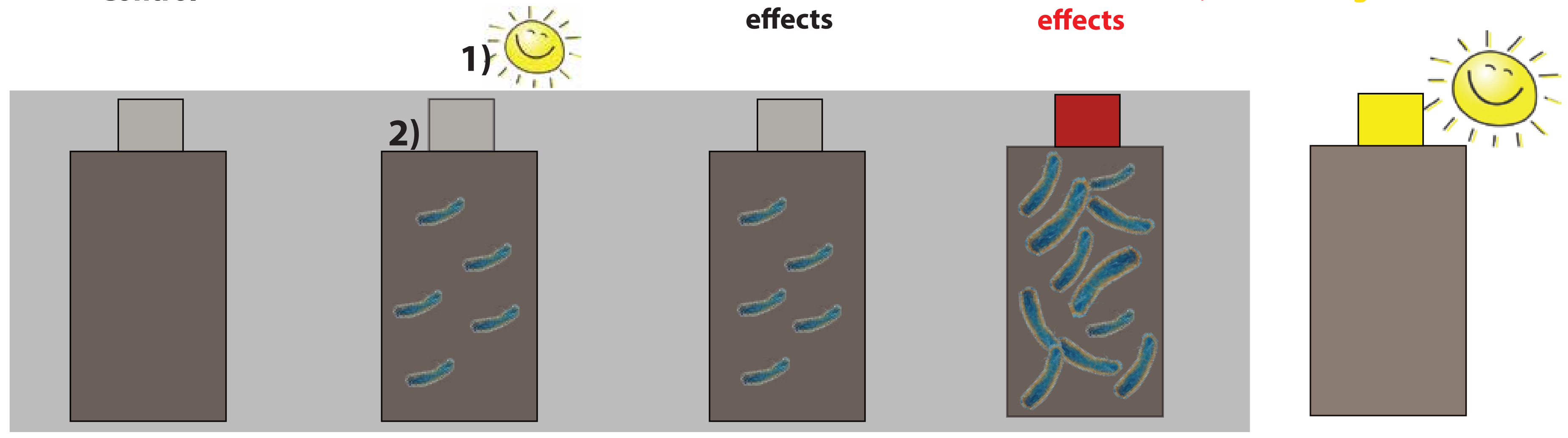
METHODS



- One site on polygonal landscape, continuous permafrost, 73°N and one site on organic palsa landscape, sporadic permafrost, 55°N
- 4 kinds of DOM sources tested
- 7-days equivalent incubation
- Beginning and end triplicates
- Light incubations in a solar incubator
- Dark incubations in an environmental chamber at 14°C

5 TREATMENTS

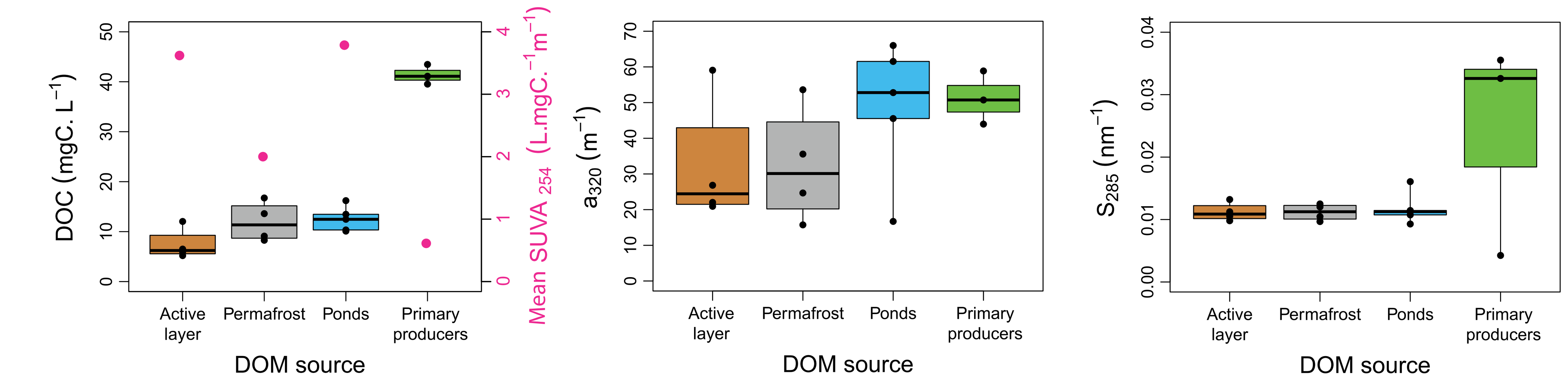
0.2 µm filtered dark	0.2 µm filtered light exposed bacteria inoculum 3% dark	0.2 µm filtered bacteria inoculum 3% dark	2.7 µm filtered dark	0.2 µm filtered light
Control	**Bacteria and sunlight synergy**	**Bacterial inoculum effects**	**Bacterial community effects**	**Sunlight effects**

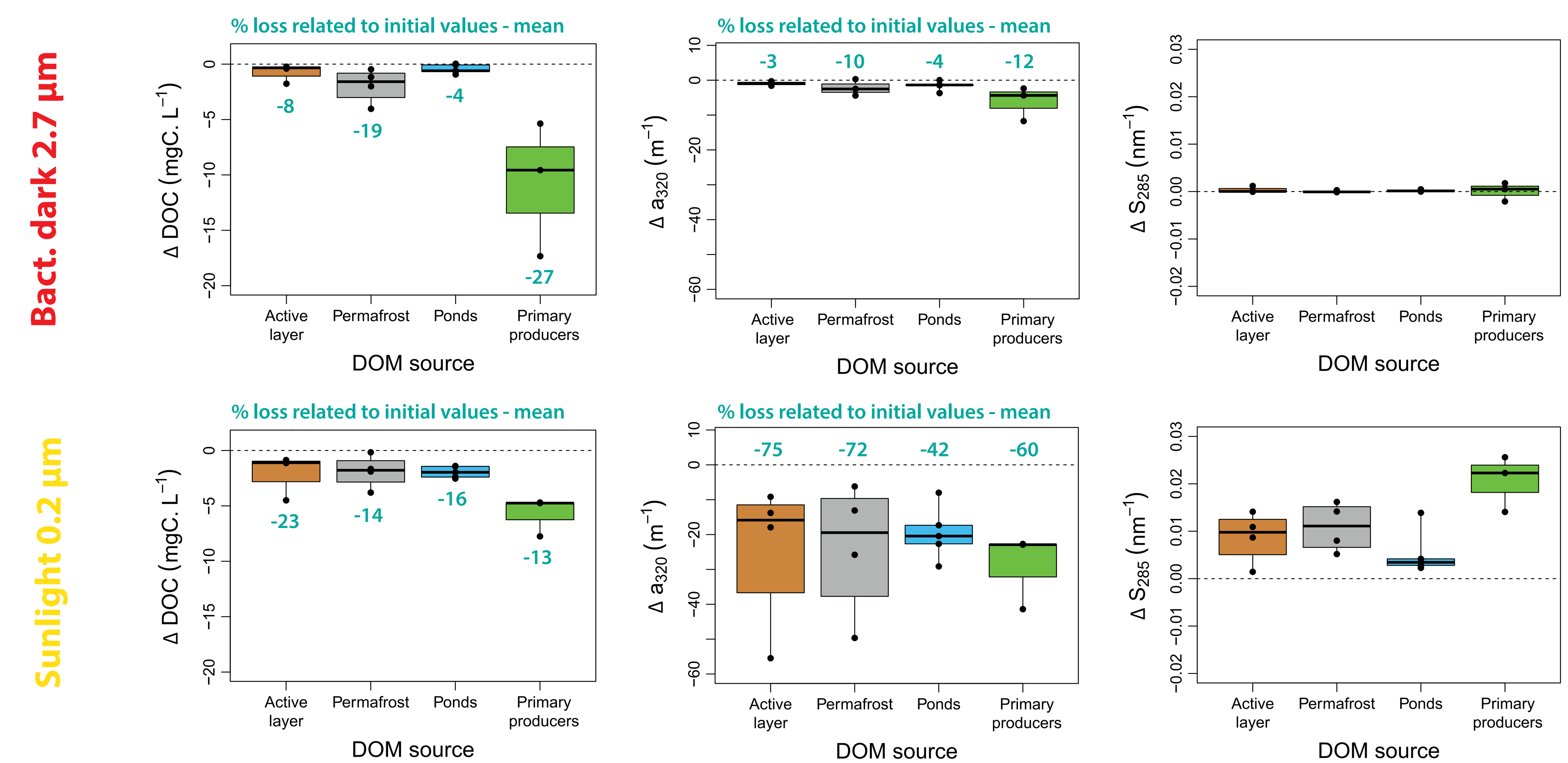


Variables analysed
- DOC
- CDOM absorption spectra

Analyses to be completed
- FDOM EEMs and PARAFAC
- DOM composition with FT-ICR-MS
- CO_2 concentration with GC
- O_2 concentration with Fibox
- Bacterial abundance with flow cytometry
- Bacterial production with ^3H leucine

SOME RESULTS





HIGHLIGHTS

- Permafrost DOM was found to be biolabile but not as much as freshly produced DOM (from primary producers: plants and benthic microbial mats). The % DOC loss was the highest for primary producers DOM (-27%), followed by permafrost DOM (-19%), active layer DOM (-8%) and ponds DOM (-4%).
- Bacteria quickly consumed the non-chromophoric fraction of DOM leached from primary producers (limited changes in CDOM and absorption slope but high DOC loss over 1 week). We hypothesize that FDOM will show larger changes.

- In comparison to bacteria, sunlight induced less mineralization of DOM presenting low $SUVA_{254}$ (primary producers and permafrost), and more mineralization of DOM with high $SUVA_{254}$ (active layer and ponds).
- Contrary to bacteria, sunlight induced extensive changes in CDOM from all sources: from 42 to 75 % loss of a_{320} and an overall reduction in molecular size (increase of S_{285}).

- The DOC leaching yield (gram of DOM leached per gram of material; not shown) was much higher for primary producers than for active layer and permafrost. This may suggest that in natural environments, rain runoff regularly brings pulses of fresh and biolabile DOM into ponds, inducing a very dynamic seasonality for such small water bodies.

REFERENCES

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[b] Schuur et al. 2015, *Nature*, 520, 171-179
[c] Cory and Kling 2018, *Limnology and Oceanograhy Letters*, 3, 102-116
[d] Abbott et al. 2014, *J. Geophys. Res. Biogeosci.*, 119, 2049-2063

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