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Permafrost thaw **leads to increased transport of ancient, dissolved organic carbon** in soil pore and surface waters **after 14 years of degradation**

Introduction

Almost 2x as much carbon (C) is stored in permafrost soils as is stored in the atmosphere[1]. As permafrost thaws, it may be decomposed and respired as CO_2 however 50% of the carbon lost from permafrost soil is unaccounted for in studies of CO_2 release to the atmosphere alone[2] and evidence points to DOC as a significant pathway of permafrost C mobilization and loss.

The fate, magnitude, and age of this leached dissolved organic carbon depends on a range of environmental factors.

Methods

DOC age ($\Delta^{14}C$) and concentration were measured in soil pore water and surface water samples between 2007 and 2022.

Measurement sites included wells installed in experimentally-warmed tundra as well as a gradient of stream sites across a topographical slope.

Results

⬆ Warming increased carbon exchange with soil water, increasing DOC concentrations in warmed plots by an average of 52% to 65mg/L in warmed plots as compared to 43mg/L in control plots.

⬇ There was also an observed depletion in DOC-$\Delta^{14}C$ with warming, with $\Delta^{14}C$ values as low as -320‰. This value corresponds to a mean radiocarbon age of ~3,000 years, but is actually likely to represent a mix of modern and much older, permafrost C. The oldest DOC mixtures were from deeply thawed, warmed tundra whereas younger carbon from freshly decayed soils and plants was present in less deeply thawed portions of the tundra.

⬇ Permafrost carbon with values as low as -200‰ was also detected in surface water downstream from the experimental site later in the season, prior to large rain events.

In 2022, we also sampled talik pore water and found that this water had a large proportion of permafrost C dissolved (Δ14C-DOC: -550‰)

Fig. 1. Mean Seasonal 14C-DOC

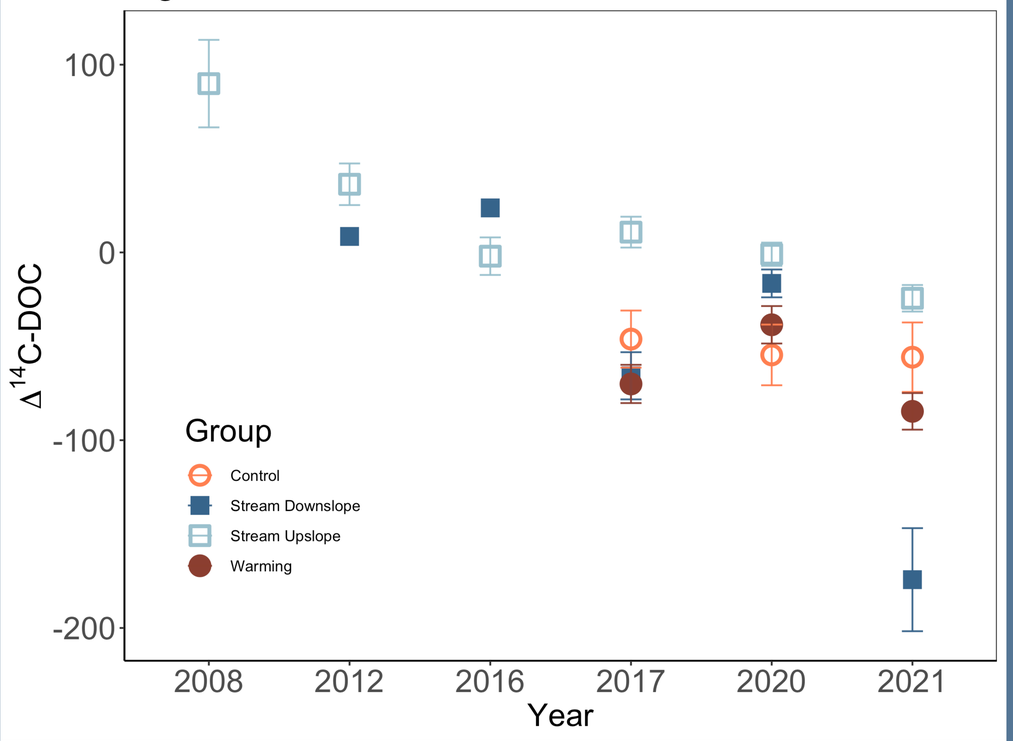

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Fig. 2. 14C-DOC at Stream and Well Sites by [DOC]

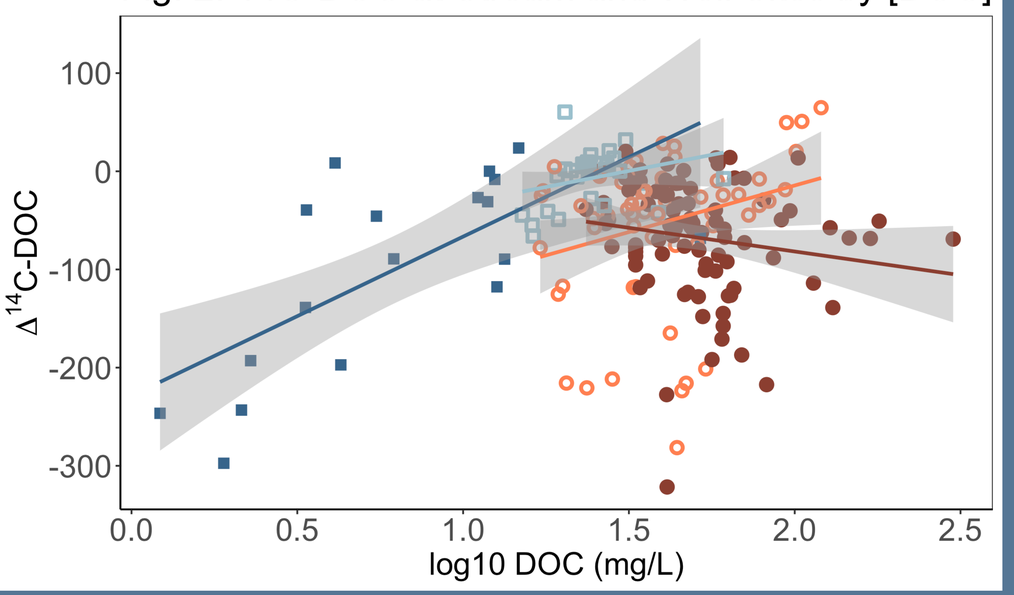

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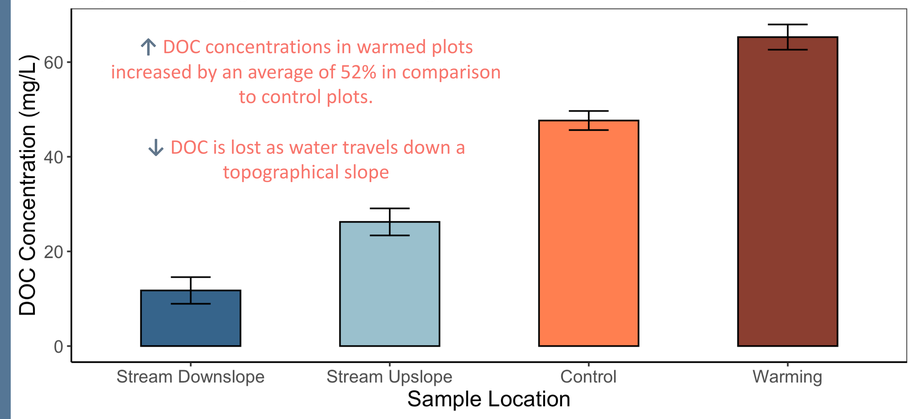
Fig. 3: Growing Season Average DOC Concentration



***Talik pore water (from control plots): -550‰**
Control pore water from the same site: -46‰

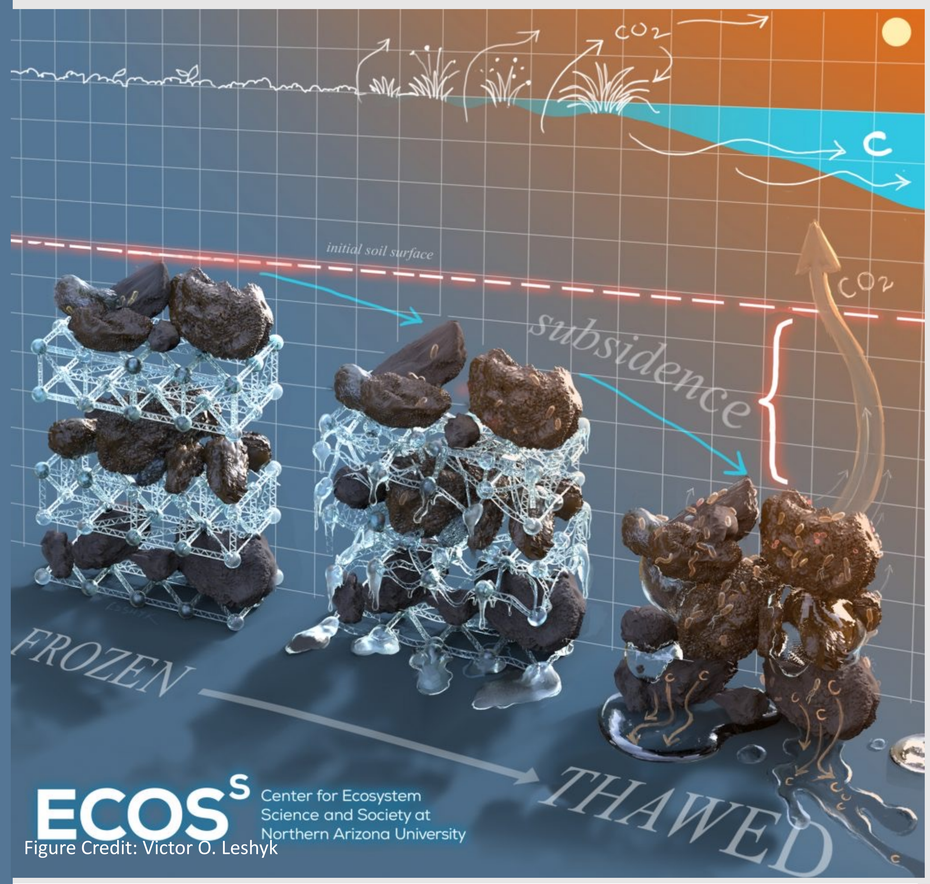
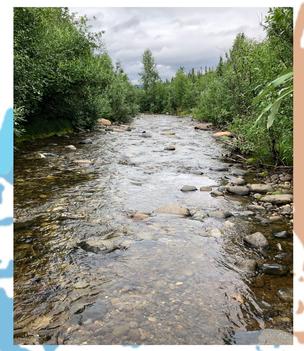


Figure Credit: Victor O. Leshyk



References
[1]Schuur and Mack Annual Reviews of Ecology and Systematics 2018
[2] Plaza et al. Nature 2019