Carbon accumulation in thermokarst lakes

- A biogeochemical comparison between Alaskan boreal and tundra lake deposits -

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Running for PYRN Permafrost Researchers Young Network the PYRN Award

Motivation

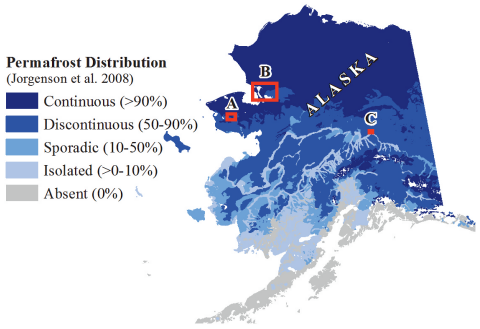
Thermokarst lakes amplify deep thaw by talik development. During the thawing process, previously preserved organic matter is decomposed and potentially released as greenhouse gases. In the course of lake development and shoreline expansion, both, younger near-surface and older organic matter from slumping shores are potentially deposited in the lake basin and complemented by lake internal bioproductivity.
This study aims at identifying differences in carbon accumulation in three different thermokarst lake settings in Northwest and Central Alaska.

Key message

Carbon accumulation can widely range in lakes in different environmental settings.

Tundra lakes in West Alaska had a wide range but generally higher amount of organic matter than boreal lakes in Central Alaska.

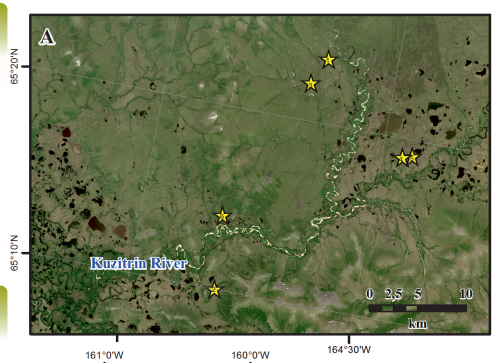
Amounts of organic carbon are high in lakes in drained lake basins and deltaic lakes, as well as in initial lake phases.

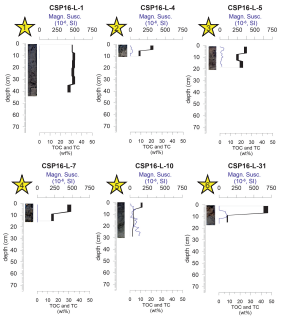


A. Central Seward Peninsula

Environmental setting
- border of the continuous-discontinuous permafrost
- dynamic lake systems
- mostly lakes in drained lake basins and with multiple lake generations

Results
- high organic carbon content of 20 wt% TOC on average
- well preserved organic matter in shallow depth

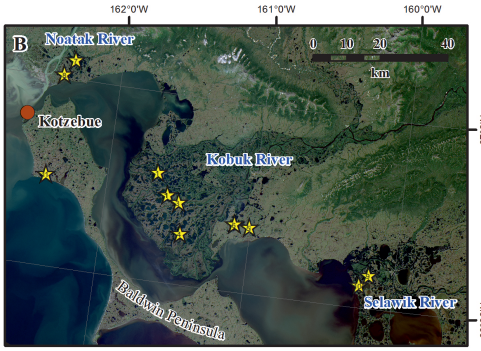


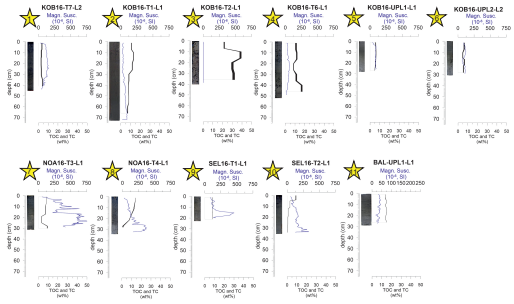


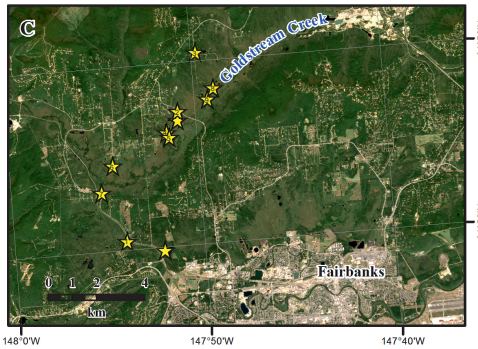
B. Noatak, Kobuk and Selawik River Delta

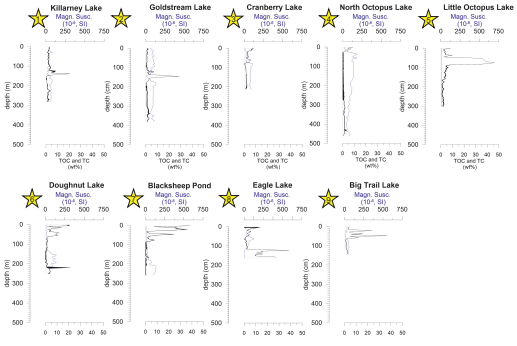
Environmental setting
- continuous permafrost in dynamic delta systems
- lakes in deltaic deposits and presumably not yet redeposited uplands
- tundra communities with only individual erect shrubs and trees

Results
- very variable organic carbon content in the Kobuk River Delta with 2.3-42 wt% TOC (only 5.5 wt% TOC in uplands)
- Selawik and Noatak River Delta lakes have low TOC of 0.6-14 wt%
- A 2nd generation yedoma lake on Baldwin Peninsula has a uniform organic carbon content averaging at 14 wt% TOC









C. Goldstream Valley in Central Alaska

Environmental setting
- boreal, discontinuous permafrost valley with open and closed talik systems
- length of cores likely reaches into taliks

Results
- very low organic carbon content of <10 wt% TOC for lakes older than 60 years
- peat layer with 20-30 wt% TOC may indicate lake onset for some lakes
- young lakes with presumably variable lake level have high amount of poorly decomposed organic matter

Methane

Substantial numbers of CH_4 producing microorganisms and pore water CH_4 concentrations were detected in lake sediments. CH_4 concentrations in sediments of West Alaska varied between 10 and 1000 µM (mean: 376 µM). The surface sediments had similarly high mean CH_4 concentrations (387 µM), thus the data suggests that thermokarst lake sediments in West Alaska are a source of CH_4 to the water column. Similar findings in CH_4 concentration in Central Alaska suggest that catchment characteristics influence the potential of thermokarst lakes to contribute to the global carbon cycle.

Methods

Lake sediment cores were retrieved in August 2016 (left) and March 2017 (right) by using different coring systems: A piston corer operated from the floats of a floatplane enabled retrieval of 17 short cores of up to 73 cm length. A vibracorer operated from the lake ice allowed for retrieval of 9 up to 473 cm long cores. Cores were stored cool but unfrozen and transported to laboratories at AWI Potsdam. They were opened, described and subsampled for carbon and nitrogen analyses. Selected sediment samples were taken to detect CH_4 concentration in pore water at the GFZ Potsdam.

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