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ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

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Thermokarst lake history and stable tundra vegetation since the 18th century in a Low Arctic setting

Yukon Territory, Canada

Research Questions

1. How did the **regional vegetation** react to recent climatic warming?
2. How did the **lake basin** develop during the last centuries?

Key findings

1. **Stable regional vegetation** during the last 300 years, slight increase of extraregional *Alnus* over the last century
2. Higher amount of lake marginal vegetation pre 1910 → **lake level changes**.

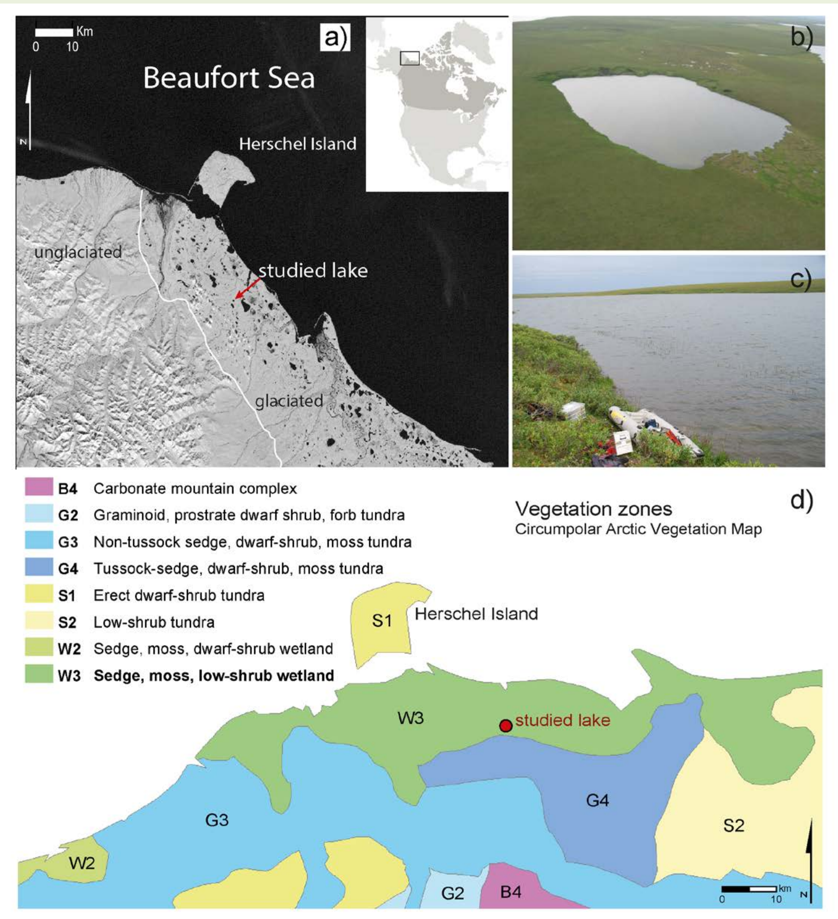


Figure 1 . Location of study area. (a) The studied lake is situated on the Yukon Coastal Plain within the reconstructed limit of Quaternary glaciation (white line). Map based on Landsat imagery. (b) Sedges, mosses and dwarf shrubs characterize the flat treeless landscape (photograph of studied lake: J. Wolter). (c) The short core was retrieved from a rubber dinghy using a gravity corer. (d) Vegetation zones of the wider study region (modified after Walker et al. 2005).

Study area

The Yukon Coastal Plain stretches over 200 km from the Yukon-Alaskan Border to the Mackenzie Delta along the Beaufort Sea coast (Fig. 1).It is part of a Low Arctic transition zone between low-shrub tundra and dwarf-shrub tundra, where the response of vegetation to warming is predicted to be fastest (Lantz et al. 2010). Wetlands and lakes cover about 25-50 % of the plain (Hagenstein et al. 1999), the typical vegetation consisting of sedges, mosses and dwarf shrubs or low shrubs (Fig. 1d, Walker et al. 2005).

Methods

We analyzed a short sediment core from a thermokarst lake (Fig. 1) for pollen, 210Pb/137Cs, AMS 14C, grain size distribution, stable carbon isotopes, and carbon and nitrogen contents.

Results

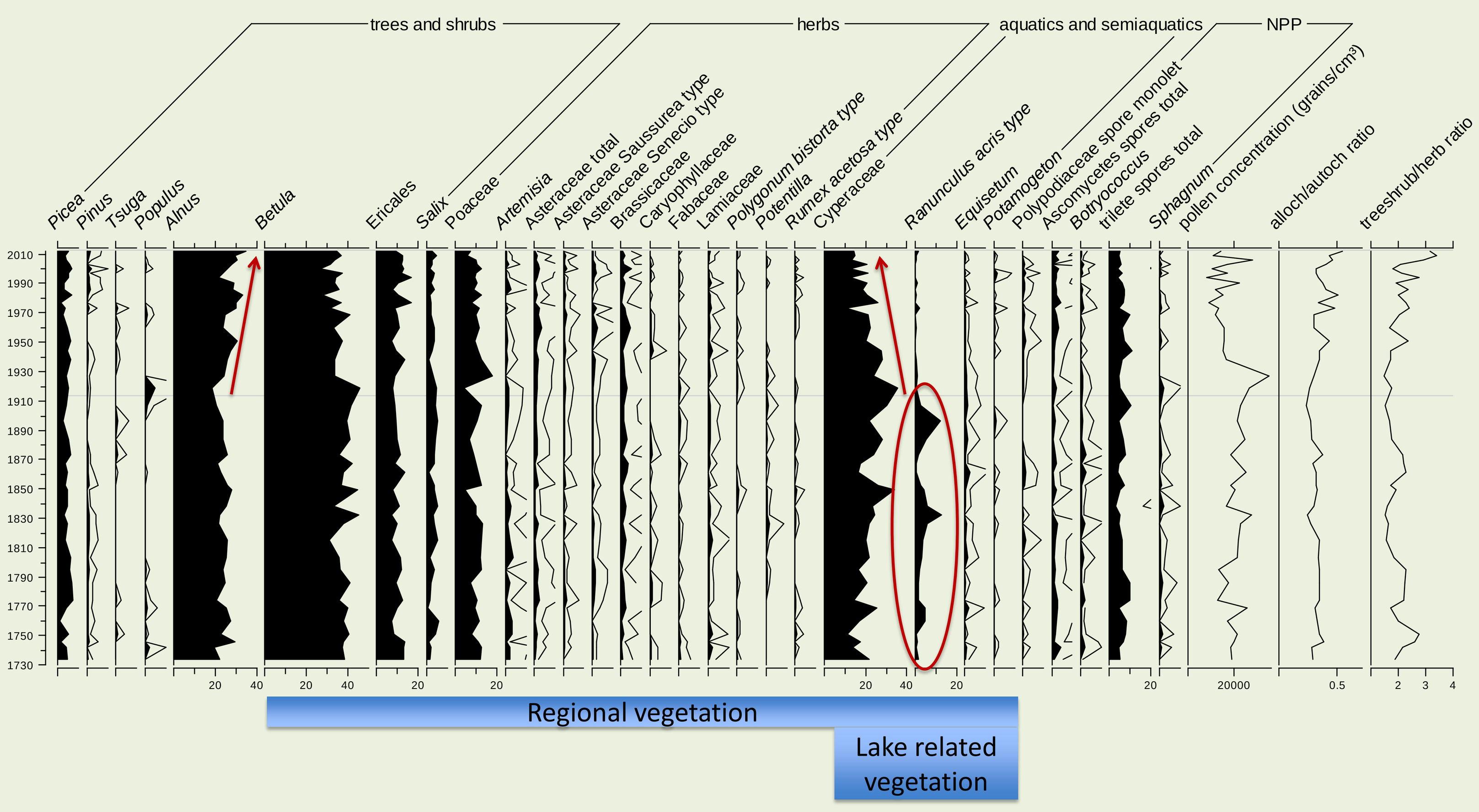


Figure 2. Pollen percentage diagram. The pollen sum is based on terrestrial pollen excluding Cyperaceae and Ranunculus acris type, which represent semiaquatic vegetation in the core.

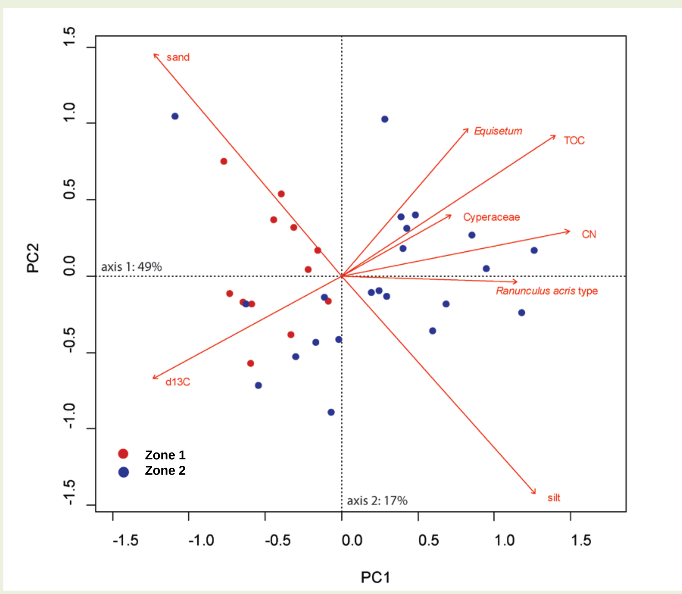


Figure 3. Principal component analysis biplot. The sample scores from the upper part of the core (Zone 2) differ from samplescores from the lower part (Zone 1).

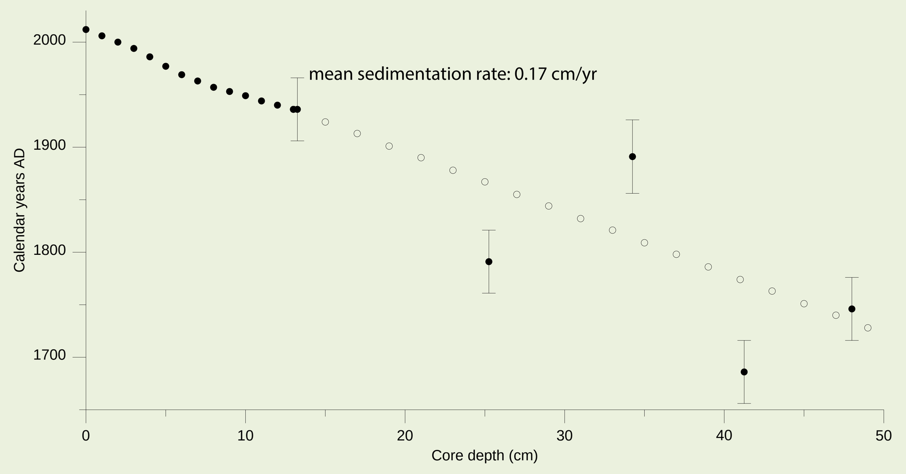


Figure 4. Age depth model based on $^{210}Pb/^{137}Cs$ dating. The filled dots represent $^{210}Pb/^{137}Cs$ dates, the open dots are extrapolated from the mean of dated samples. Dots with error bars represent AMS 14C dates which are within a similar range but show a much higher uncertainty and were not used in the age model.

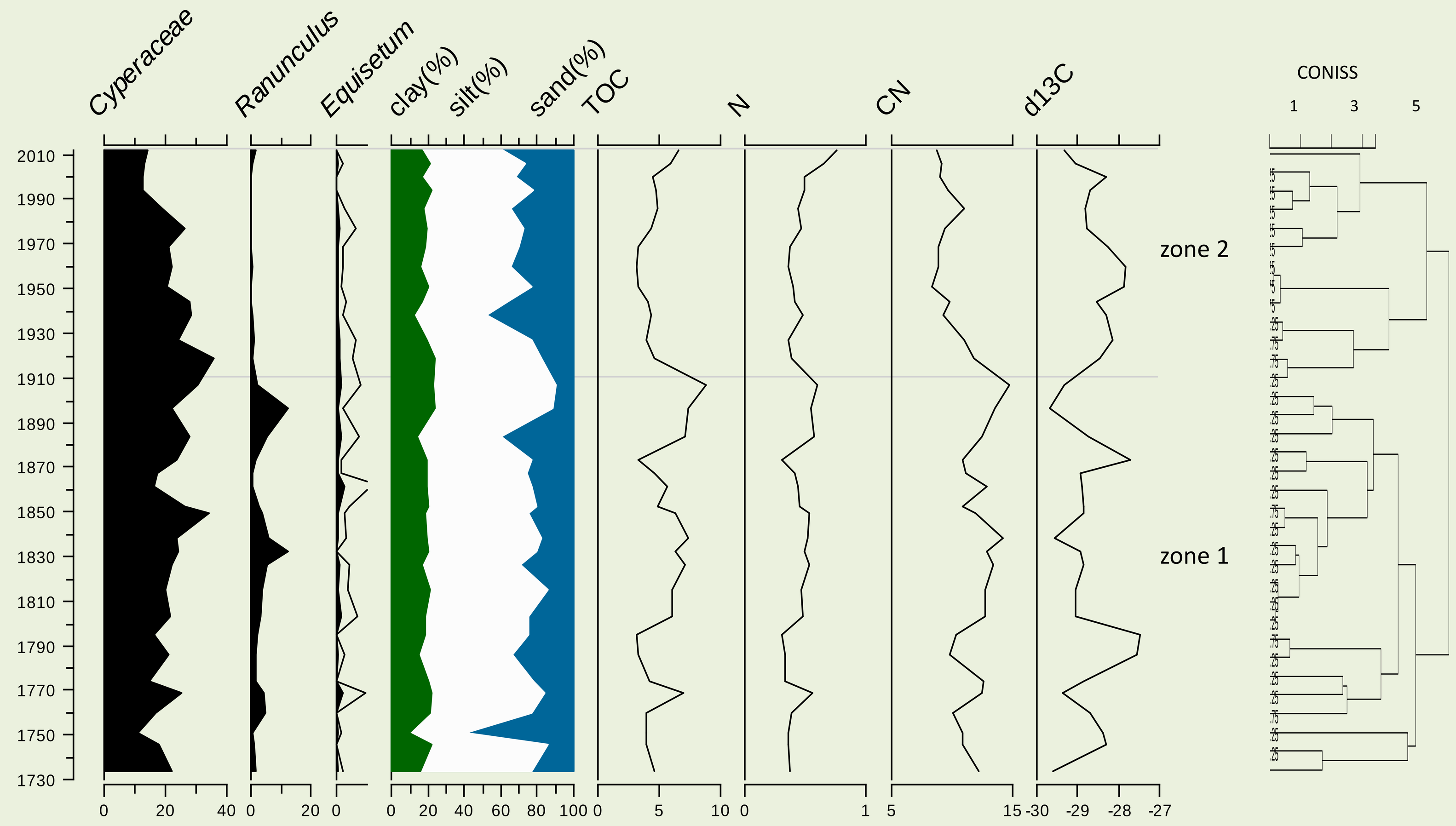


Figure 5. Stratigraphic diagram of semiaquatic and sedimentary parameters.

Discussion

1. Recent climatic warming and related vegetation change

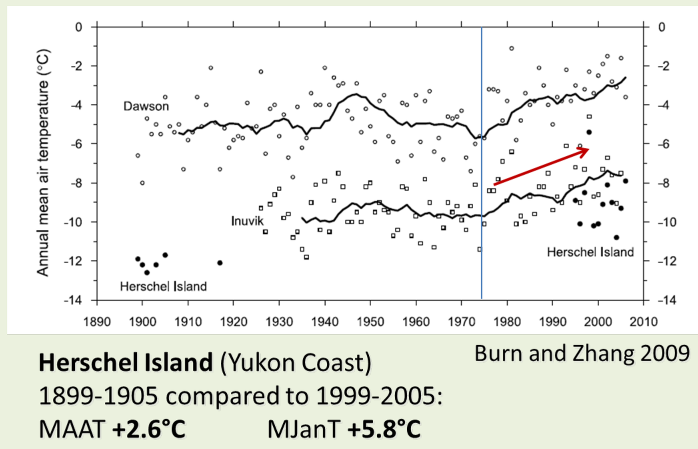


Figure 6. Climatic warming in the Western Canadian Arctic during the last 100 years (Burn and Zhang 2009).

The regional climatic warming that took place during the last century (Burn and Zhang 2009, Figure 6) is not well represented in the pollen record. The local to subregional vegetation largely remained stable. We attribute the slight increase in Alnus pollen since about AD1910 to either an approaching Alnus shrubline or an increase in Alnus within its current distribution range south and east of the study area.

2. Lake level changes

Changes in organic carbon content and carbon to nitrogen ratio are in accordance with changes in pollen from semiaquatic vegetation (Fig. 5). We attribute this to changes in lake marginal vegetation productivity and fluctuations in the ratio of aquatic to terrestrial vegetation debris. We suggest that either partial draining and refilling (Fig. 7b) or to geomorphological change caused by thawing permafrost (Fig. 7c) led to a lower and more variable lake level.

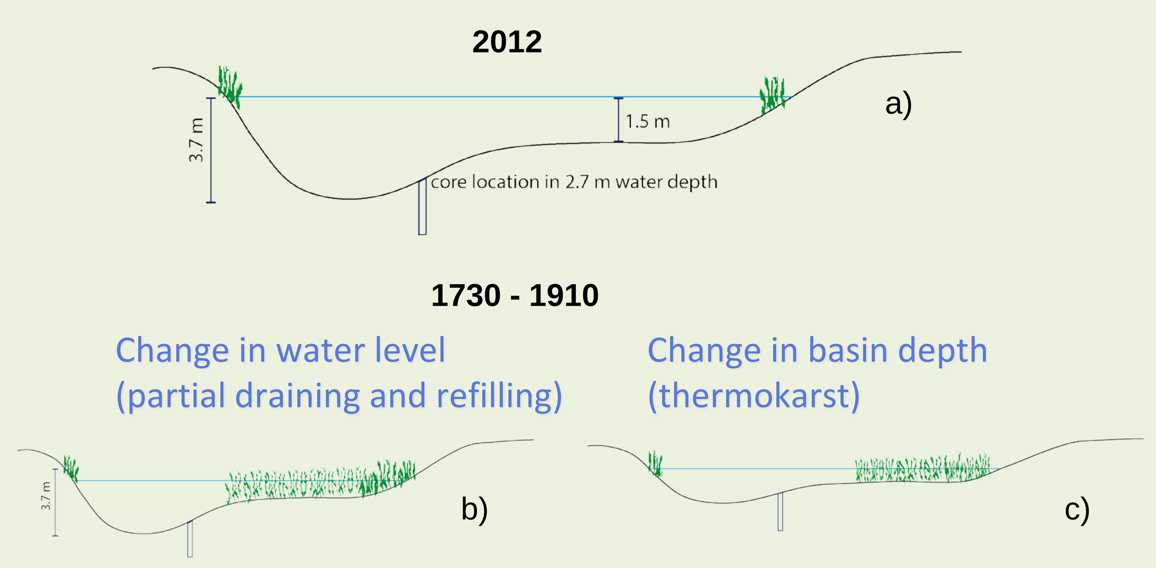
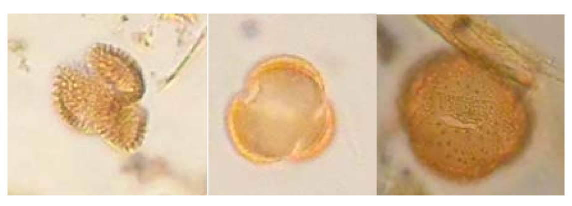


Figure 7. Conceptional sketch of lake development. (a) Present lake basin and water level. Changes in amount of lake marginal vegetation are brought about by either (b) Draining and refilling of lake water or © thermokarst-induced changes in lake basin depth.

References
Frost GV & Epstein HE (2014) Tall shrub and tree expansion in Siberian tundra ecotones since the 1960s, Global Change Biology, 20, 1264-1277.
Hagenstein R, Sims M, Mann G, Ricketts TH (1999) Arctic Coastal Tundra. In T. H. Ricketts, (ed.): Terrestrial Ecoregions of North America: A Conservation Assessment. 398pp. Washington, DC, USA: Island Press.
Lantz T, Gergel S, Kokelj S (2010) Spatial Heterogeneity in the Shrub Tundra Ecotone in the Mackenzie Delta Region, Northwest Territories: Implications for Arctic Environmental Change. Ecosystems, 13, 194-204.
Tape KD, Sturm M, Racine C (2006) The evidence for shrub expansion in Northern Alaska and the Pan-Arctic. Global Change Biology, 12, 686-702.
Walker DA, Raynolds MK, Daniëls FJ, Einarsson E, Elvebakk A, Gould WA, Katenin AE, Kholod SS, Markon CJ, Melnikov ES (2005) The circumpolar Arctic vegetation map. Journal of Vegetation Science, 16, 267-282.



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