EGU General Assembly 2024

EGU24-15461, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-15461
EGU General Assembly 2024

High Arctic lacustrine biomarkers suggest warmer-than-present Early Holocene and Younger Dryas summers

Sher-Rine Kong[1], Willem G.M. van der Bilt[1], William J. D`Andrea[2], and Pål Tore Mørkved[1]
[1]Department of Earth Science and Bjerknes Centre for Climate Research, University of Bergen, Norway (sher-rine.kong@uib.no)
[2]Lamont-Doherty Earth Observatory, Columbia University, Palisades, USA (dandrea@ldeo.columbia.edu)

The Arctic warms faster than any other region on our planet (Rantanen et al., 2021). This amplified response has global consequences as the region`s melting glaciers and ice caps are dominant drivers of sea-level change. Despite these consequences, predictions remain uncertain as on-going change exceeds the range of observations used to calibrate climate models. By providing empirical constraints on this uncertain future, paleoclimate data from warmer-than-present intervals are well-suited to close this critical knowledge gap (Fischer et al., 2018). Previous studies suggest that the Arctic last experienced warmer-than-present conditions during the Early Holocene (~11.7-8.2 ka BP). However, the exact magnitude and pace of warming remain contested as data remain scarce, often complicated by site-specific factors, and hampered by methodological limitations (Axford et al., 2021).

Here, we present a sub-centennial resolution reconstruction of deglacial to Early Holocene surface temperatures from the Svalbard archipelago – an Arctic climate change hotspot. To capture atmospheric conditions, we target a closed basin lake unaffected by glacial meltwater input. To robustly determine past temperature change, we determine alkenone unsaturation indices from phylogenetically fingerprinted Group I haptophyte algae that have extensively been calibrated against Arctic air temperature measurements (D'Andrea et al., 2016), also on Svalbard (van der Bilt et al., 2019). Terrestrial plant macrofossil-derived radiocarbon ages reveal that our reconstruction covers the past 12.7 ka BP, extending the terrestrial temperature history of Svalbard by multiple millennia. Our findings do not only confirm that the Early Holocene was marked by warmer-than-present surface temperatures, but also reveal that Younger Dryas summers were at least as mild. This discovery complements mounting evidence that this stadial was shaped by extreme winters rather than year-round cooling (Bromley et al., 2023; Schenk et al., 2018). Finally, we find evidence that freshwater forcing from melting ice sheets lowered temperatures between 11.5 and 9.5 ka BP despite high radiative forcing. Facing a future shaped by similar conditions, this finding is of relevance to help understand the emerging new Arctic.

Axford, Y., ... & Osterberg, E. C. (2021). Past Warmth and Its Impacts During the Holocene Thermal Maximum in Greenland. *Annual Review of Earth and Planetary Sciences*, *49*(1), 279-307.

https://doi.org/10.1146/annurev-earth-081420-063858

Bromley, G., … & Rice, D. (2023). Lateglacial Shifts in Seasonality Reconcile Conflicting North Atlantic Temperature Signals. *Journal of Geophysical Research: Earth Surface*, *128*(1). https://doi.org/10.1029/2022jf006951

D’Andrea, W. J., Theroux, S., … & Huang, X. (2016). Does phylogeny control U37K-temperature sensitivity? Implications for lacustrine alkenone paleothermometry. *Geochimica et Cosmochimica Acta*, *175*, 168-180.

Fischer, H., Meissner, K. J., . . . & Zhou, L. (2018). Palaeoclimate constraints on the impact of 2 °C anthropogenic warming and beyond. *Nature Geoscience*, *11*(7), 474-485. https://doi.org/10.1038/s41561-018-0146-0

Rantanen, M., Karpechko, A., … & Laaksonen, A. (2021). The Arctic has warmed four times faster than the globe since 1980.

Schenk, F., Väliranta, M., … & Wohlfarth, B. (2018). Warm summers during the Younger Dryas cold reversal. *Nature Communications*, *9*(1). https://doi.org/10.1038/s41467-018-04071-5

van der Bilt, W. G., D'Andrea, W. J., … & Bakke, J. (2019). Early Holocene temperature oscillations exceed amplitude of observed and projected warming in Svalbard lakes. *Geophysical Research Letters*, *46*(24), 14732-14741.