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East Greenland lake sediments capture surface process response to Holocene climate transitions

Willem van der Bilt (1), Brice Rea (2), Matteo Spagnolo (2), Desiree Roerdink (1), Steffen Jørgensen (1), Tor Einar Møller (1), and Josten Bakke (1)

(1) University of Bergen, Earth Science, Bergen, Norway (willemvanderbilt@uib.no), (2) School of Geosciences, University of Aberdeen, Scotland

The Arctic warms twice as fast as the worldwide average. By spurring sea level rise and changing oceanic and atmospheric circulation patterns, this amplified regional response to on-going climate change has global implications. Paleoclimate data provide a key context to help unravel the longer-term consequences of these changes. Shaped by similar boundary conditions, the present Holocene interglacial represents the most relevant baseline to assess near-future change. Despite this potential, Holocene Arctic paleoclimate reconstructions remain scarce and sparse. Moreover, age control on most available datasets is neither sufficient to resolve change on human-relevant timescales nor identify lead-lag relations. As widely distributed and continuous archives of past change, Arctic lake sediments are well-placed to overcome these data limitations. Here, we present a well-dated full Holocene lake sediment sequence from Ammassalik Island on southeast Greenland. Its location, near the interface of key components of the Arctic climate system like the sea-ice limit, the Greenland Ice Sheet and the meeting of polar with Atlantic waters renders the area very sensitive to regional climate shifts. Holocene change is reconstructed using physical (grain size, organic content, density), visual (3-D Computed Tomography - CT) as well as geochemical (X-Ray Fluorescence - XRF, X-Ray Diffraction - XRD) proxy evidence. We show that three transitions characterize the Holocene development of Ymer Lake. First, between 10-9.5 cal. ka BP, rapid glacier loss from the lake catchment culminated in an outburst flood (GLOF). Next, following a quiescent Holocene climatic optimum, Neoglacial cooling, lengthening lake ice cover and shifting winds prompted in-lake avalanching of sediments. Finally, glaciers reformed in the catchment after 1.2 cal. ka BP. Timing of these shifts is consistent with the regional expression of deglaciation, Neoglacial cooling and Little Ice Age glacier growth, respectively. Using a state-of-the-art multi-proxy approach, this work links these climate transitions to shifts in surface processes.