



A proglacial lake record of Late Holocene High Arctic glacier behaviour, Zackenberg, Northeast Greenland

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With Arctic air temperatures currently rising at twice the global average rate, understanding Arctic glacier and ice cap sensitivity to past climate change is important for predicting future retreat patterns. Geomorphological records of glacier behaviour, such as moraines and alluvial sequences, can become eroded and fragmented. However, proglacial lakes offer continuous, high-resolution archives of glacier and environmental change, but they have not been widely used in the High Arctic.

We present a sedimentary record from Madsen Lake, Northeast Greenland (74°N), 60 km east of the Greenland Ice Sheet, and one of the highest latitude proglacial lake records available in Greenland. The lake is situated downstream of Slettebreen, a small ice cap close to Zackenberg. A combination of high-resolution sediment geochemistry, particle size, magnetic susceptibility, carbon analysis, and radiocarbon ages is used alongside geomorphological mapping to constrain glacier response to Late Holocene environmental change, over the last 1,500 years.

All datasets are in good agreement, and PCA results indicate one strong primary trend inferred to reflect changes in glacial sediment input. We identify two periods of enhanced glacial sediment deposition from c. 1322-1276 cal BP and c. 950-755 cal BP. These are a result of two phases of glacier advance, when outlet glaciers from Slettebreen coalesced and extended downvalley. These phases correspond to periods of glacier advance recorded elsewhere in the Arctic (including Svalbard and Canada) in response to cooling at around 1,000 years BP. A period of highly variable minerogenic-organic sediment input to the lake after c.700 cal BP, is considered a result of dynamic glacier retreat over the last few hundred years and continued minerogenic input from a rapidly exposed foreland, inhibiting sustained biological productivity in the lake. Our analysis provides detailed insights into Late Holocene glacier activity in Northeast Greenland, at a level of detail not recorded in the geomorphological archive.