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Early Holocene history of the Zachariae Ice Stream, NE Greenland: Evidence from geochemistry, grain size and sedimentary parameters

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The Arctic region exhibits some of the most visible signs of climate change globally. Arctic sea ice extent and volume has been declining sharply in recent decades; observations indicate a mean annual decrease of 3.2% since 1980. However, no extensive network of sea ice observations extends back further than the mid-18th century and satellite data since the late 1970s; this limits perspectives of sea ice variability on longer time scales. Thus, to understand the processes governing sea-ice cover and variability, predict how sea ice and ocean conditions will respond to anthropogenic climate change and to understand if the shrinking of Arctic sea ice is a unique and irreversible process, longer records of sea ice variability and oceanic conditions are required.

A multi-proxy approach, involving grain size, geochemical, foraminifera and sedimentary analysis, was applied to a marine sediment core from North East Greenland to reconstruct changes in sea ice extent and palaeoceanographic conditions throughout the early Holocene (ca. 12,400-7,800 cal. yrs. BP). The study aimed to improve the understanding of the interaction between ocean circulation, sea ice and fluctuations of the Zachariae Isstrøm (ZI), one of the main glacier outlets of NE Greenland. Four distinct zones have been identified: Zone 1 (12,400-11,600 cal. yrs. BP) covering the transition from the Younger Dryas into the Holocene which evidences a gradually warming climate, resulting in a retreat of the ZI; Zone 2 (11,600 – 10,300 cal. yrs. BP) which encapsulates two distinct cooling events as a result of cooler surface waters, rapid release of freshwater and local feedback mechanisms. This coincides with sudden re-advances of the ZI followed by gradual retreats; 3) Zone 3 (10,300 – 8,600 cal. yrs. BP) shows warm and stable conditions, with warm surface waters that resulted in the retreat of the ZI; 4) Zone 4 (8,600 – 7,800 cal. yrs. BP) which shows a rapid return to cooler conditions, with cold surface waters and rapid freshwater outbursts resulting in the re-advance of the ZI, forced by decreasing solar insolation and cold surface waters. Our investigation thus indicated that changes in oceanic conditions at the NE Greenland shelf had a significant impact on the extent and melting rate of the ZI glacier.

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