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Early Holocene ocean conditions off the Zachariæ Isstrøm, Northeast Greenland

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The polar regions exhibit some of the most visible signs of climate change globally; annual mass loss from the Greenland Ice Sheet (GrIS) has quadrupled in recent decades, from 51 ± 65 Gt yr^{-1} (1992-2001) to 211 ± 37 Gt yr^{-1} (2002-2011). This can partly be attributed to the widespread retreat and speed-up of marine-terminating glaciers. The Zachariae Isstrøm (ZI) is an outlet glacier of the Northeast Greenland Ice Steam (NEGIS), one of the largest ice streams of the GrIS (700km), draining approximately 12% of the ice sheet interior. Observations show that the ZI began accelerating in 2000, resulting in the collapse of the floating ice shelf between 2002 and 2003. By 2014, the ice shelf extended over an area of 52km^2, a 95% decrease in area since 2002, where it extended over 1040km^2. Paleo-reconstructions provide an opportunity to extend observational records in order to understand the oceanic and climatic processes governing the position of the grounding zone of marine terminating glaciers and the extent of floating ice shelves. Such datasets are thus necessary if we are to constrain the impact of future climate change projections on the Arctic cryosphere.

A multi-proxy approach, involving grain size, geochemical, foraminiferal and sedimentary analysis was applied to marine sediment core DA17-NG-ST8-92G, collected offshore of the ZI, on the Northeast Greenland Shelf. The aim was to reconstruct changes in the extent of the ZI and the palaeoceanographic conditions throughout the Early to Mid Holocene (c.a. 12,500-5,000 cal. yrs. BP). Evidence from the analysis of these datasets indicates that whilst there has been no grounded ice at the site over the last 12,500 years, the ice shelf of the ZI extended as a floating ice shelf over the site between 12,500 and 9,200 cal. yrs. BP, with the grounding line further inland from our study site. This was followed by a retreat in the ice shelf extent during the Holocene Thermal Maximum; this was likely to have been governed, in part, by basal melting driven by Atlantic Water (AW) recirculated from Svalbard or from the Arctic Ocean. Evidence from benthic foraminifera suggest that there was a shift from the dominance of AW to Polar Water at around 7,500 cal. yrs. BP, although the ice shelf did not expand again despite of this cooling of subsurface waters.