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THE FENNOSCANDIAN ICE SHEET AS A TRIGGER FOR DANSGAARD-OESCHGER CYCLES

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Dansgaard-Oeschger (D-O) cycles, which were prevalent during Marine Isotope Stage 3 (MIS3), are the most dramatic, frequent, and wide reaching abrupt climate changes of the past. On Greenland, D-O cycles are characterized by an abrupt warming of up to 15°C from a cold stadial to a warm interstadial phase, followed by gradual cooling before a rapid return to cold stadial conditions. The mechanisms responsible for these millennial cycles are not fully understood, but have been thought to involve abrupt changes in the Atlantic Meridional Overturning Circulation (AMOC) due to freshwater forcing.

Here we outline a new understanding of these abrupt climate changes supported by high resolution multi-proxy marine sediment core data and climate model simulations focused on the Nordic Seas. Based on analysis of oxygen isotopes and ice rafted debris from MIS3 in the Nordic Seas, the freshwater input is shown to be coincident with warm interstadials on Greenland and has a Fennoscandian, rather than Laurentide source.

Based on simulations with a climate model (MITgcm), the Nordic Seas are found to be highly sensitive to this surface freshwater input due to the formation of a fresh surface layer and expanded winter sea ice. Thus, triggering the transition from warm interstadials to cold stadials. The return to warm interstadial conditions is driven by the release of ocean heat stored below the fresh surface layer and rapid melting of sea ice in the Nordic seas.

In addition to the revised timing and origin of MIS3 freshwater forcing, the integrated proxy and model data suggest a new circulation scheme for the Nordic Seas, in which there is a continuous circulation of relatively warm Atlantic water beneath an expanded sea ice cover during cold stadials. This proposes a delicate balance between a fresh surface layer and warm Atlantic water below, suggesting the possibility of abrupt changes in high latitude sea ice cover. This is highly relevant for the modern Arctic Ocean, where changes in the balance between river runoff and warm Atlantic inflow could cause rapid transitions.