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Spatial differences in Late Glacial paleohydrology along the continental margin of NW Europe: mechanistic insights from lacustrine lipid biomarker D/H records

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Rapid climatic changes, as occurred during the Late Glacial, can serve as an analogue for today's quickly changing climate: With a weaker thermohaline circulation during Greenland Stadial 1 (GS-1), NW Europe was starved of heat and moisture coming from the North Atlantic. A current hypothesis, as proposed by Isarin et al. (1998), states that sea ice in the North Atlantic acted to push prevailing wind systems southward, further depriving NW Europe from heat and moisture supply. Several recent studies suggest that the effect of reduced ocean circulation on the terrestrial environment was not coeval at different locations within Europe.

To further understand regional differences in the expression of Late Glacial abrupt climate change in Northern Europe we use the stable hydrogen isotopic composition (expressed as δD values) of sedimentary n-alkanes, to reconstruct changes in paleohydrology (water source, evapotranspiration) at three different sites along the North Atlantic coast: Sluggan Bog (N-Ireland), Quoyloo Meadow (Orkney, Scotland) and Kråkenes (Norway).

Sluggan Bog shows a rapid and major shift (50 ‰ δD) towards a more depleted nC23 alkane composition, occurring synchronous to the onset of GS-1 (within dating uncertainty). This pattern is mirrored by the terrestrial nC29 alkane, although of lower magnitude, suggesting evaporative enrichment of the latter under drier conditions throughout the Younger Dryas. Subsequent climatic amelioration does not start until the onset of the Holocene. We find an earlier transition into – and a later transition out of the Younger Dryas in Northern Ireland, relative to western Germany (Rach et al., 2014), supporting the hypothesis of N-S shifts of N Atlantic wind systems due to winter sea ice expansion.

In contrast, the two northernmost investigated sites Quoyloo Meadow and Kråkenes show an increase towards more positive δD values over the transition into the Younger Dryas, inconsistent with a cooling NE Atlantic moisture source, rather suggesting a change towards a more proximal water source. The latter half of the Younger Dryas at Quoyloo shows a gradual change towards more negative values of nC23 and nC29. More positive nC23 and nC29 alkanes in the early Holocene indicate a return to relatively wet conditions and local precipitation at that time.

Since we observed a similar pattern of isotopic change at Quoyloo Meadow and Kråkenes, we argue that this is not local phenomenon. A potential mechanism for regional differences between Sluggan Bog versus the northernmost records at Quoyloo Meadow and Kråkenes may be the strong influence of a high pressure system over the Fennoscandian Ice Sheet in the North, which outcompetes the weakening westerlies at the higher latitude sites.

Isarin, R.F.B., Renssen, H. and Vandenberghe, J. (1998) The impact of the North Atlantic Ocean on the Younger Dryas climate in northwestern and central Europe, JQS 13, p 447-453

Rach, O., Brauer, A., Wilkes, H. and Sachse, D. (2014) Delayed hydrological response to Greenland cooling at the onset of the Younger Dryas in western Europe, Nature Geoscience 7, p 109 - 112