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The Nordic Seas: could inflow variability be driven by atmospheric circulation changes over the past millennium?

A.D. Tegzes (1), E. Jansen (1,2), R.J. Telford (3,4)

(1) UNI Bjerknes Centre, Bergen, Norway (andrea.tegzes@uni.no), (2) Department of Earth Science, University of Bergen, Bergen, Norway, (3) Department of Biology, University of Bergen, Bergen, Norway, (4) Bjerknes Centre for Climate Research, Bergen, Norway

The large heat transport of the Atlantic Meridional Overturning Circulation (AMOC) makes it important for climate. How it might respond to changes in external forcing is one of the key uncertainties of future climate change (AMOCINT project proposal).

The Norwegian Atlantic Current (NwAC) represents the northernmost reaches of the surface current system within the AMOC. The eastern branch of the NwAC, the Norwegian Atlantic Slope Current (NwASC), starts as a shelf edge current above the Irish-Scottish continental shelf, and after passing through the Faeroe-Shetland Channel, continues northwards along the Norwegian shelf edge towards the Arctic, with a branch bifurcating into the Barents Sea (Orvik and Niiler 2002).

Orvik and Skagseth (2003) show that the North Atlantic wind stress curl (NAWSC) is a major forcing for the interannual variability of the NwASC. It has also been shown in instrumental data that the strength of the NwAC tends to correlate with indices of the North Atlantic Oscillation (NAO, Orvik et al. 2001) and other modes of atmospheric variability.

A similarly strong correlation between atmospheric circulation patterns and the strength of the NwASC can potentially be inferred from proxy data for at least the past approximately 1,000 years. A sub-decadal to decadal resolution sortable silt record has been produced for the NwASC from sediment cores JM97-948/2A and MD95-2011 from the Vøring Plateau, off Norway and compared with the sub-decadal carbonate oxygen isotope data of Holmes et al. (2010) from Lough-na-Shade, Co. Armagh, Northern Ireland. While the sortable silt record is thought to represent changes in the flow strength of the NwASC, Holmes et al. (2010) conclude that their record represents changes in atmospheric circulation over northwest Europe. The two records are remarkably similar suggesting that major shifts in atmospheric circulation were accompanied by changes in the strength of the NwASC.

The NAO and other modes of atmospheric variability can offer a possible mechanistic explanation. In its simplest form, during phases of positive NAO Northern Ireland receives isotopically heavier precipitation from a more southerly North Atlantic source with stronger westerlies driving a stronger NwASC, while during phases of negative NAO Northern Ireland receives isotopically lighter precipitation from a northern North Atlantic source with a weakening of westerlies resulting in a weaker NwASC. Hence, the inferred changes in the strength of the NwAC appear to be driven by contemporanous changes in atmospheric circulation over the last millennium.

References

AMOCINT project proposal

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