The sensitivity of Nordic Seas upper-ocean stratification to freshwater input

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The Nordic Seas (Greenland, Iceland, and Norwegian Seas) are a site of open ocean convection that play an essential role in the Atlantic Meridional Overturning Circulation (AMOC), which profoundly affects surface heat transfer in the Northern Hemisphere, deep-ocean ventilation, and the global climate. Despite its global importance to Earth's climate, the fate of open-ocean convection is still unresolved, especially regarding the potential effects of freshwater inputs from the demise of the Greenland ice sheet. While it is generally accepted that freshwater would drastically decrease the surface water density, thus preventing convection, there are still gaps in our understanding of the sensitivity of this system to freshwater input.

By coupling sedimentary $\delta^{15}N$ measurement with planktic foraminiferal abundance we highlighted that decreased nutrient utilization during past interglacials (MIS 5e and 11) where concurrent to colder condition at around 50-150 m depth in the water column compared to the Holocene. Since these periods are thought be generally warmer and characterized by an active AMOC we hypothesized that the colder condition at sub-surface were indicative of freshwater input, probably linked with the demise of ice-sheet from the preceding glaciations, which are generally thought to be larger than MIS 2. This hypothesis is coherent with the isotopic composition of alkenones used to reconstruct salinity, which suggest the presence of freshwater in the sub-surface layer. To explain both $\delta^{15}N$ and foraminiferal assemblages we thus suggest the presence of a thick summer mixed-layer of meltwater origin that limited nutrient utilization. Modeling was used to test this hypothesis.

Thus, variation in Nordic Seas upper-ocean stratification between the three last interglacials highlights the sensitivity of the summer mixed-layer to large freshwater input. However, our results also raise questions about the exact link between upper-ocean stratification and convection in the Nordic Seas.