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Drastic vertical and lateral ocean changes during times of interglacial climate warming

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Present global warming is amplified in the North Polar region through enhanced glacier melting and reduction of the seasonal sea ice cover. It is further understood that the northward propagation of oceanic and atmospheric heat and moisture from the adjacent North Atlantic region directly increases the rate of Greenland Ice Sheet (GIS) melting, sea ice loss in the Arctic and other feedback mechanisms related to these processes. Overregional reconstructions of warm climate intervals in the Upper Quaternary have unveiled pronounced differences in the expression of the meridional surface ocean temperature gradients between the polar North and the low-latitude North Atlantic sector. Using a sediment core from a key site in the Northeast Atlantic we reconstructed vertical stratification changes in temperature and salinity in the North Atlantic for a period some 400 ka ago (MIS11), an interglacial time analogue of a future climate. As inferred from a unique set of biogeochemical, geochemical, and faunal data, the internal upper ocean stratification across MIS 11 shows distinct depth-dependent dynamical changes related to vertical as well as lateral shifts in the upper Atlantic meridional circulation system. Importantly, transient cold events are recognized near the end of the long phase of postglacial warming at surface, subsurface, mid, and deeper water layers. These data demonstrate that MIS 11 coolings over the North Atlantic were initially triggered by freshwater input at the surface and entrainment of cold polar waters into the Subpolar Gyre. The cooling signal was then transmitted downwards into mid-water depths. While the cold events were likely related to continuous melting of GIS, the resulting freshening of the surface ocean caused fundamental structural changes in both ocean and atmospheric circulation, a lesson to be learned from MIS11 for the future climate state.