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The decoupling of surface vs. subsurface water conditions in the Arctic during the Holocene: a ground for a re-assessment of sea ice conditions in the NW North Atlantic during the LGM and Heinrich events?

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Dinocysts from cores collected in the Chukchi Sea were used to reconstruct changes in sea-surface conditions and sea ice cover using modern analogue techniques. Holocene sequences from shallow sites suggest high-frequency centennial oscillations of sea-surface conditions, and a significant reduction of the sea ice at ca. 6000 and 2500 cal. years BP. Older deeper sequences indicate an early postglacial optimum with minimum sea ice cover prior to 12 000 cal. years BP, which corresponds to a terrestrial climate optimum of the Bering Sea area. An extensive sea ice cover ($>$10 months/years) persisted from 12 000 to 6000 cal. years BP. It was followed by a general trend of decreasing sea ice and increasing sea-surface salinity conditions, superimposed on large amplitude millennial-scale oscillations. In contrast, δ^{18}O data in mesopelagic foraminifers (*Neogloboquadrina pachyderma,* left and right coiled – Npl & Npd) reveal maximum sub-surface temperature, thus maximum inflow of the North Atlantic water around 8000 cal. years BP, followed by a trend towards a cooling of the sub-surface to bottom water masses. The isotopic data that show a reverse size-dependent ^{18}O gradient in Npl and Npd also indicate the persistence of a reverse thermocline between surface and subsurface water masses. Sea-surface to sub-surface conditions estimated from dinocysts and δ^{18}O data in foraminifers thus suggest a decoupling of hydrographic trends between the surface water layer and the intermediate North Atlantic Water (NAW) mass, and the presence of a sharp halocline and enhanced reverse thermocline before 6000 years BP. The overall data are consistent with strong sea ice convergence in the western Arctic during the early Holocene, as suggested on the basis of climate model experiments including sea ice dynamics, matching a higher inflow

rate of North Atlantic Water into the Arctic. The overall offset in ^{18}O-content of core top planktic foraminifers, with estimated isotopic equilibrium values, ranges from $\sim 1‰$ to $\sim 3‰$, from the Eastern to the Western Arctic. It has been tentatively linked to sea-ice growth with continuous production of brines, although the actual process leading to light ^{18}O-values in planktics is still uncertain. Nonetheless, the absence of such an offset and of a reverse size-dependent ^{18}O gradient in planktics from Last Glacial Maximum sediment of the NW Atlantic suggests conditions differing drastically from those of the modern Arctic Ocean, and indicate more largely spread ice-free conditions, and/or a continuous export of isotopically fractionated sea ice and resultant brines. However, the large ^{18}O shifts in Npl marking ice-rafting episodes of Heinrich events could be seen either as an indication for dilution of surface water (as in current interpretation) or as the development of an isotopic offset in Npl populations with enhanced sea-ice formation, and an overall lesser Atlantic Meridional Overturning.