Assessing Holocene deep water formation in the western Nordic seas based on microfossil assemblages

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The Nordic seas are one of the few regions where active deep water formation currently takes place. The study tries to assess millennial-scale variations in convection by evaluating the likeliness of favorable seasonal preconditioning to open ocean convection in the western Nordic seas during the Holocene. This was done by reconstructing surface to subsurface potential density (σ_θ) gradients calculated from dinoflagellate cyst assemblages and planktic foraminiferal (*Neogloboquadrina pachyderma*) stable oxygen isotopes ($\delta^{18}O_c$), at sites close to the presentday convection cells in the Nordic seas. The different calibrations that were used all linked *N. pachyderma* $\delta^{18}O_c$ to σ_θ values between 27.70 and 27.90, occasionally up to 28.00, suggesting a strong isopycnal calcite accretion zone and broadly matching the potential densities of modern Labrador Sea water and Nordic seas overflow waters. The calibrations show that from the early Holocene to ~7–6.5 ka BP relatively light surface waters occupied the western Nordic seas, retaining enough buoyancy to prevent vertical convection, especially in the westernmost area where the fresh water component was higher and persisted slightly longer. After ~6.5 ka BP the surface to subsurface σ_θ gradient decreased and regularly inverted, thus leading to conditions favorable for the development of active overturning cells in the basin, while intermittent eastward spreading of lower density surface waters continued to modulate the area of likely preconditioning. Superimposed on the long-term trend there is a marked local variability, which is more pronounced closer to the fresher and periodically ice-laden East Greenland Current. The timing of the onset of a typical full interglacial climate mode corresponds with the final exhaustion of Northern Hemisphere ice sheet meltwater supplies, while the intermittent eastward spreading of buoyant surface waters might have acted as an on-off switch for overturning cells causing a temporary enhancement or reduction of deep water formation since the mid-Holocene.

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