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A benthic 14C record of peak glacial vs. deglacial deep-water formation in the Nordic Seas – AMOC implications

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A modest deep-water formation in the eastern Nordic Seas during the LGM is suggested by both empiric records and various model reconstructions, even though its mechanism and precise timing remain unknown. The Nordic Sea then was a partial source for the weakened North Atlantic Meridional Overturning Circulation (AMOC). Evidence is fully controversial regarding a possibly complete breakdown of deep-water circulation during the following Heinrich Stadial 1 (HS-1). AMOC was finally restored at the start of the Bølling/Allerød (B/A). We now present paired high-resolution 14C records of monospecific planktic (N. pachyderma s) and benthic foraminifera (Cassidulina teretis) from a core site on the western Voering Plateau (1727 m w.d.) in the Norwegian Sea, where sedimentation rates are 30-60 cm/ky. Local glacial-to-deglacial planktic 14C reservoir ages were derived by means of the 14C plateau-tuning technique. They ranged from 500 to 800 yr during LGM, rose up to 2,000 yr during HS-1, and dropped to 200-300 yr during B/A. During the LGM, benthic 14C ventilation ages are generally lower and, near to its end, much lower than the paired planktic reservoir age. Hence, paired benthic-planktic 14C age differences are negative which suggests vivid (seasonal) upper deep-water convection, active in open-sea regions near to the core site, over late peak glacial times. During HS-1, however, most benthic 14C ventilation ages tally with the paired, in part fairly high planktic reservoir ages, thus suggest a process of deep-water formation directly linked to local brine water formation due to seasonally enhanced sea ice formation without (much) exchange with the atmosphere. The HS-1 scenario ended abruptly with renewed vivid deep-water convection with the onset of the B/A, possibly with a weak precursor event at the onset of a Barents Sea melt water pulse ∼1000 yr afore.

This benthic 14C record is opposed to deep-water ventilation ages of ∼3,500-10,500 yr reported by Thornalley et al. (2015; Science 349, 706) for a very-low-sedimentation rate site at 2700 m w.d. in the western Nordic Seas. The contrast was possibly due to an extreme, maybe oblique-vertical deep-water stratification on top of an old Arctic deep-water mass and has major implications for the glacial-to-deglacial Atlantic MOC. Details of circulation geometries are, however, as yet little understood.