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Editorial: Paleoceanographic Conditions in High Northern Latitudes During Quaternary Interglaciations

Evgenia Kandiano[1], Kirstin Werner[2], Juliane Müller[2] and Thomas M. Cronin[3]*

[1] GEOMAR Helmholtz Center for Ocean Research Kiel, Kiel, Germany, [2] Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany, [3] U.S. Geological Survey, Florence Bascom Geoscience Center, Reston, VA, United States

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Editorial on the Research Topic

Paleoceanographic Conditions in High Northern Latitudes During Quaternary Interglaciations

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Steven L. Forman,
Baylor University, United States

****Correspondence:***
Evgenia Kandiano
ekandiano@geomar.de

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The northern subpolar regions and the Arctic are particularly important for global climate, as they are considered critical for the Atlantic Meridional Overturning Circulation (AMOC) intensity which strongly depends on the behavior of Atlantic Water advected into the high northern latitudes (e.g., Sévellec et al., 2017). Geological data and modeling experiments have shown that the AMOC can considerably weaken or even completely shutdown in response to fresh water input (Bond et al., 1993; Rahmstorf, 1995; Clark et al., 2002). The modern rapid atmospheric and ocean water temperature rise in the Arctic and the subpolar regions (e.g., Chylek et al., 2009; Screen and Simmonds, 2010) promotes sea-surface freshening through a chain of feedback mechanisms such as an enhanced seasonal sea-ice loss (e.g., Comiso et al., 2008; Stroeve et al., 2008), the drastic diminishing of the Greenland Ice Sheet (Rignot et al., 2011; Applegate et al., 2015), and enhanced Arctic river runoff (Wagner et al., 2011). A longer-term perspective obtained through reconstructing past interglacial climates helps to assess and model ongoing changes in the high northern latitudes.

Reconstructions of various sea-water parameters in the high latitudes are especially challenging, however conventional paleoceanographic methods reach the limits of their sensitivity due to: (1) strongly reduced biogenic material; (2) reduced diversities in some faunal groups used in paleoceanography; and (3) the large volume of fresh water at the sea surface. Furthermore, these limitations can affect chronology and stratigraphic correlations of Arctic sediments. Planktic foraminiferal assemblages, ubiquitously used as a sea-(sub-)surface temperature proxy, often become almost monospecific in the Nordic Seas and the Arctic (Kellogg, 1980, 1984) in the size fraction >150 μm recommended for research (Kucera et al., 2005) and, therefore, can hide subtle temperature fluctuations in the high northern latitudes (Kandiano and Bauch, 2002). Also, the traditional application of stable oxygen isotopes in calcareous shells as a proxy for temperature is hampered by the huge impact of fresh water to the sub-Arctic and Arctic Ocean as it overrides the temperature signal in the stable oxygen isotopes record.

In the last few decades, a number of new methods and approaches have been developed to refine the paleoceanography state-of-the-art in high latitudes. It has been demonstrated that planktic foraminiferal assemblages in mesh-size fractions smaller than 150 μm reveal changes in the intensity of Atlantic Water advection and sea- (sub-) surface temperatures in the Nordic Seas and the Arctic (Hebbeln et al., 1994; Dokken and Hald, 1996; Nørgaard-Pedersen et al., 2007; Taldenkova et al., 2010; Husum and Hald, 2012; Werner et al., 2016). Moreover, the analysis of smaller-sized foraminiferal fractions unveiled drastic differences in the character of Atlantic Water advection in the Nordic Seas during the Holocene climate optimum and the Marine Isotope Stages (MIS) 5e and 11—which are the interglacial time periods suggested as close analogs for the forthcoming climate (Bauch et al., 2011; Cronin et al., 2013; Kandiano et al., 2016). The biogeochemical marker IP_{25}/PIP_{25} is now being applied by many research groups to identify the extent of the sea-ice cover in the past (Belt et al., 2007; Müller et al., 2009, 2011; Müller and Stein, 2014; Belt, 2018). Changes in stable nitrogen isotope composition ($\delta^{15}N$) of bulk sediment are used as a proxy for nitrate utilization related to the depth-level of Atlantic Water inflow in the Nordic Seas (Thibodeau et al., 2017). This Research Topic comprises articles focusing on new approaches for deciphering paleoclimates in the Nordic Seas and the Arctic that brings our understanding of climate evolution and mechanisms to a new level. It represents a collection of original research papers and a review describing the last achievements in reconstructing past interglacial conditions in high northern latitudes.

Doherty and Thibodeau devote their article to the most intriguing late Quaternary interglacial, the MIS 11, and reviewed recent literature to reconcile enhanced AMOC but with freshened and relatively cold ocean surface in the Nordic Seas during this period. This controversy might be explained by a persistent subduction of saline and relatively dense Atlantic waters below a freshwater cover in the Nordic Seas. Further analysis by the authors led to the conclusion that the formation of the freshwater lid might neither be due to iceberg discharge nor to Greenland ice-sheet melting, but likely had an external origin. Elevated Arctic sea-ice export and an enhanced Eurasian river runoff were suggested by the authors as potential external sources of melt water in the Nordic seas.

Risebrobakken and Berben describe changes in water-mass circulation in the Barents Sea during the last late deglaciation and the Holocene, since 12,000 years (12 ka) to the present. The reconstructions are based on planktic foraminiferal diversities in the >150 μm size fraction but also smaller size fractions of the studied sediment cores. Emphasis is on the Arctic Front migration from its submeridional western position during the late deglaciation to the present position which the Arctic Front reached at ca 7.4 ka.

Ye et al. analyze paired manganese (Mn) and cerium (Ce) distribution in a sediment core taken from the Alpha Ridge covering the time period from MIS 3 to MIS 10, and in near-modern surface sediments from the western Arctic Ocean and adjacent shelves. The authors showed that Mn contents and Ce anomalies follow a distinct stratigraphic pattern with overall low and high values in glacial and interglacial intervals, respectively. This was linked to glacial-interglacial sea-level changes. Transportation of Mn was related to cross-shelf and mid-depth oceanic currents. The co-variation in the distribution of both elements Mn and Ce has been demonstrated here for the first time.

O'Regan et al. establish a consistent Pleistocene stratigraphy of six sediment cores taken along 575 km of the Lomonosov Ridge. In two of them, stratigraphic occurrences and the morphology of subpolar planktic foraminiferal genus *Turborotalita* were analyzed in small-sized sediment fractions. The invasions of *Turborotalita* were attributed to MIS 5.1 and 5.5, MIS 9/10, and MIS 11. All found planktic foraminifer specimens resemble the species *T. quinqueloba* despite the fact that in the western Arctic environment another morphological type of *Turborotalita*, *T. egelida*, is considered as a stratigraphic marker for MIS 11.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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