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Holocene sea ice in the main Arctic gateway

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The Fram Strait, located between Greenland and Spitsbergen, plays a vital role in the subpolar North Atlantic climate system. This narrow deep-water passage does not only provide the major outlet for polar water and sea ice towards the North Atlantic, it also permits warm Atlantic water to enter the Arctic Ocean. The sea ice distribution in Fram Strait is thus intrinsically tied to the sea ice discharge in western Fram Strait and the advection of warm Atlantic water along the continental margin of Spitsbergen in eastern Fram Strait. Consequently, variations in the sea ice coverage relate to changes in this water mass exchange and may point to shifts in the oceanic and/or atmospheric circulation system. Organic geochemical and IRD data obtained from sediment cores from Fram Strait reveal that the sea surface conditions were prone to distinct environmental changes during the Holocene. By means of the biomarker IP25, a molecule associated with sea ice diatoms (Belt et al., 2007), and phytoplankton-derived biomarkers (indicative for open-water conditions) we reconstruct a long-term increase in (spring) sea ice occurrences from the Mid to the Late Holocene. Furthermore, we identify short-term sea ice fluctuations in eastern Fram Strait that are likely associated with recurring periods of a strengthened North Atlantic water inflow during the Late Holocene. These fluctuations also coincide with periods of changing glacier extents on Spitsbergen (Svendsen & Mangerud, 1997). At the inner continental shelf of East Greenland, the sea ice conditions, however, remained rather stable throughout the Holocene and a significant increase in sea ice discharge (IP25 accumulation) occurred only during the past 1,000 years. We find that the combination of IP25 with phytoplankton-derived biomarkers proves a valuable approach that helps to bypass ambiguous interpretations of the sea ice proxy record. In addition, this combinatory approach (PIP25; phytoplankton-IP25 index) may enable quantitative sea ice reconstructions (Müller et al., 2011).

References

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