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Holocene biomarker- and microfossil-based sea-ice reconstructions off the eastern North Greenland continental shelf (western Fram Strait)

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Understanding the processes controlling the natural variability of sea ice in the Arctic, one of the most dynamic components of the climate system, can help to constrain the effects of future climate change in this highly sensitive area. For the first time, a detailed multi-proxy study was carried out to reconstruct past sea-ice variability off eastern North Greenland. This area is strongly influenced by cold surface waters and drift ice transported via East Greenland Current, meltwater pulses from the outlet glaciers of the Northeast Greenland Ice Stream, the build-up of landfast ice, and the formation of the Northeast Water Polynya. For our study, we have used well-dated sedimentary sections of Kastenlot Core PS93/025 and Gravity Core PS100/270. These sites are ideally suited to identify and disentangle the driving mechanisms of sea-ice distribution in the western Fram Strait. As proxies for the reconstruction of sea-ice cover we have used the sea-ice proxy IP_{25}, a highly branched isoprenoid (HBI) monoene with 25 carbon atoms, in combination with specific open-water phytoplankton and terrestrial higher land plant biomarkers as well as specific microfossils (e.g., diatoms). Based on these high-resolution data sets we are able to reconstruct sea-ice variability, primary productivity, terrigenous input and seasonal formation of the NEW Polynya that evolved during the Holocene at the eastern North Greenland shelf.

The presence of IP_{25} throughout the core PS93/025 confirms that there has been seasonal sea ice in the area during the entire Holocene time interval. Our biomarker proxies indicate relatively rapid changes in sea-ice conditions at ~9 ka and ~1 ka, i.e., sea-ice conditions progressed through three major stages over the course of the Holocene. During the early Holocene we recorded a reduced, but variable sea-ice cover. Between about 9.3 and 5.5 ka, sea-ice coverage increased towards seasonal conditions. Based on terrigenous biomarkers and IRD we assume a stronger regional than local sea-ice signal at core site PS93/025, due to the high influence of drift ice transported from the central Arctic Ocean along the eastern North Greenland shelf. During the late Holocene, especially during the last 1 ka, our records reflect the seasonal formation of the NEW Polynya leading to stable sea-ice edge conditions and a fully developed polynya situation.

Probably, cyclic changes in the solar activity acted as trigger for the short-term variability in sea-ice cover during Holocene times.