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Holocene sea-ice dynamics in Petermann Fjord

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Today Nares Strait is covered by sea ice for 11 months per year. The seasonal sea-ice regime and formation of landfast ice depend on the development of ice arches. Historically a northern and southern ice arch have been observed in Robeson Channel and Smith Sound, respectively, with only the southern arch leading to a complete freeze up of the strait. In recent decades, the northern arch has become more prominent, indicating a regime shift in Nares Strait sea-ice dynamics with important consequences for the export of ice from the Lincoln Sea, the regional oceanography, and the ecosystem related to the annual opening of the North Water Polynya lee of the southern ice arch. Modelling studies suggest a link between mobile sea ice and enhanced Ekman transport of modified Atlantic Water to Greenland fjord systems bordering Nares Strait. Further, a reduction in the fjords' fast ice season, in response to Nares Strait sea-ice dynamics, might decrease its buttressing effect on the marine-terminating outlet glaciers in northern Greenland. One such glacier is Petermann Glacier, draining 4% of the Greenland Ice Sheet and terminating in a 48 km long ice tongue in Petermann Fjord.

The Petermann 2015 Expedition to Petermann Fjord and adjacent Hall Basin recovered a transect of cores from Nares Strait to under the 48 km long ice tongue of Petermann glacier. First results suggest that no ice tongue existed in Petermann Fjord for large parts of the Holocene, raising the question of the role of the ocean and the marine cryosphere in the collapse and re-establishment of the ice tongue. We present a multi-proxy study (sea-ice related biomarkers, total organic carbon and its carbon isotopic composition, and benthic and planktonic foraminiferal abundances) exploring the Holocene sea-ice dynamics at site OD1507-03TC-41GC-03PC in outer Petermann Fjord. Our results are in line with a tight coupling of the marine and terrestrial cryosphere in this region and, in connection with other regional sea-ice reconstructions, give insights into the Holocene evolution of ice arches and associated landfast ice in Nares Strait.