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Multi-proxy reconstruction of mid to late Holocene sea-surface conditions offshore Newfoundland

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The Labrador Sea plays a crucial role for deep-water formation. Sea-surface temperatures and freshwater export from the Arctic strongly affect the intensity of the deep convection in the Labrador seas with major implications for the global thermohaline circulation and North Atlantic climate, as it affects the mid-latitude main core of the Gulf Stream warm-water transport route. This freshwater export is essentially coupled to the East Greenland Current and Baffin–Labrador Current system, transporting numerous icebergs and abundant sea ice towards the south into the region of the warm and saline North Atlantic Current. The coastal regions of Newfoundland form a crucial site for studying this Arctic sea ice and ice berg export.

The area is also very sensitive to changes in atmospheric circulation. The northwestern part of Newfoundland experiences the strongest winds in winter blowing from west and northwest, bringing Arctic air, while the southern coast more often receives warm, moist air from the Gulf Stream. In summer, winds are weakest and blow from the southwest over the entire island. Under a positive North Atlantic Oscillation (NAO) regime, northwesterly winds over the Labrador Sea are stronger and air temperatures decrease.

As part of an on-going multidisciplinary study of oceanic and atmospheric conditions of the Labrador Sea region, we present mid to late Holocene changes in sea-ice variability, regional sea-surface temperatures (SST) as well as atmospheric circulation changes in the Western Labrador Sea, off the coast of Newfoundland. Our results are based on high-resolution diatom records, dinoflagellate cysts, benthic foraminifera and exotic pollen, as well as geochemical and mineralogical proxies from sediment gravity cores retrieved from Newfoundland fjords during a research cruise on board the Russian research vessel Akademik Ioffe (2007).

Our study shows that fresh and cold conditions, probably accompanied by seasonal sea ice, prevailed both north and south of Newfoundland from ca. 5700-4000 cal. yr BP. This may be linked to intensified Labrador Current export of cold meltwater and/or sea ice from the Arctic, presumably related to warmer conditions in the northernmost latitudes and the prevalence of strong (north)westerly winds. After ca. 4000 BP, sea-surface conditions warmed up and sea ice decreased northeast of Newfoundland, but conditions were still cold south of Newfoundland. This suggests a decrease in Arctic meltwater export and westerly wind strength. Our data thus suggest a shift from more zonal (NAO+) atmospheric circulation to more frequent meridional (NAO-) circulation at $\sim$3000 BP. This change to a more meridional atmospheric circulation pattern is part of the general Northern Hemisphere neoglacial cooling. After 2900-2500 BP, only minor changes in sea-surface conditions affected the study sites.