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Drivers of sea ice decline in the Fram Strait and north of Svalbard

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The Arctic Ocean is undergoing rapid change. Satellite observations indicate significant negative Arctic sea ice extent trends in all months and substantial reduction of winter sea ice in the Atlantic sector. One of the possible reasons can be sought in the observed warming of Atlantic water, carried through Fram Strait into the Arctic Ocean. Fram Strait, as well as the region north of Svalbard, play a key role in controlling the amount of oceanic heat supplied to the Arctic Ocean and are the place of dynamic interaction between the ocean and sea ice. Shrinking sea ice cover in the southern part of Nansen Basin (north of Svalbard) and shifting the ice edge in Fram Strait are driven by the interplay between increased advection of oceanic heat in the Atlantic origin water and changes in the local atmospheric conditions.

Processes related to the loss of sea ice and the upward transport of heat from the layers of the Arctic Ocean occupied by the Atlantic water are still not fully explored, but higher than average temperature of Atlantic inflow in the Nordic Seas influence the upper ocean stratification and ice cover in the Arctic Ocean, in particular in the north of Svalbard area. The regional sea ice cover decline is statistically significant in all months, but the largest changes in the Nansen Basin are observed in winter season. The winter sea ice loss north of Svalbard is most pronounced above the core of the inflow warm Atlantic water. The basis for this hypothesis of the research is that continuously shrinking sea ice cover in the region north of Svalbard and withdrawal of the sea ice cover towards the northeast are driven by the interplay between increased oceanic heat in the Atlantic origin water and changes in the local atmospheric conditions, that can result in the increased ocean-air-sea ice exchange in winter seasons. In the current study we describe seasonal, interannual and decadal variability of concentration, drift, and thickness of sea ice in two regions, the north of Svalbard and central part of the Fram Strait, based on the satellite observations. To analyze the observed changes in the sea ice cover in relation to Atlantic water variability and atmospheric forcing we employ hydrographic data from the repeated CTD sections and new atmospheric reanalysis from ERA5. Atlantic water variability is described based on the set of summer synoptic sections across the Fram Strait branch of the Atlantic inflow that have been occupied annually since 1996 under the long-term observational program AREX of the Institute of Oceanology PAS. To elucidate driving mechanisms of the sea ice cover changes observed in different seasons in Fram Strait and north of Svalbard we analyze changes in the temperature, heat content and transport of the Atlantic water and describe their potential links to variable atmospheric forcing, including air temperature, air-ocean fluxes, and changes in wind pattern and wind stress.

