The observed sea-ice edge position over the Barents and Greenland Seas: Its temporal variability

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In addition to sea ice itself, sea-ice edges, which constitute the boundaries between the marginal ice zones and the open ocean, play an important role in the Earth's climate system (Dumont 2022). Intense surface heat fluxes near the sea-ice edge can induce ocean convection (Våge et al. 2018). Intense surface temperature gradients across sea-ice edges act to intensify the synoptic-scale atmospheric disturbances (Inoue et al. 2012). Also, the sea-ice edges can locally modulate sea-surface winds, leading to local enhancement in atmospheric updraft (Kawai 2021).

The sea-ice edge positions in the Arctic have been changing in association with the shrinking in the sea-ice extent. The present study investigated the variability and long-term trend in the sea-ice edge positions for 1980 – 2021. We developed an objective sea-ice edge detection method that automatically identify the sea-ice edge positions, which were defined as the 15 % isolines of sea-ice concentration. We used the satellite-observed sea-ice concentration provided by National Snow and Ice Data Center (NSIDC). In particular, we investigated the spatial relation between the sea-ice edges and surface ocean currents in the Barents Sea and Greenland Sea.

In the Barents Sea, the sea-ice edges advanced rapidly during October – December, reached the most southward position by January and maintained until May as shown in Fig. 1a for March. The sea-ice edge positions during January – May were well related to the narrow warm eastward ocean currents (Fig. 1b). Moreover, their interannual variability was also tightly related to the sea-surface winds. Although the sea-ice edges in October – December were typically located in the central Barents Sea until 2007, sea-ice edges in the recent decade were frequently identified along the continental slope on the north of the Barents Sea, where a warm ocean current was flowing eastward.

In the Greenland Sea, the sea-ice edges were located along the East Greenland Current in the cold season (from October to June) (Figs 1 c and d for March). The sea-ice edges tended to be located near the East Greenland Current even in the warm season (from July to September), thus, the seasonal variability was indistinct. After 2008, however, the sea-ice edges in the warm season tended to leave the East Greenland Current and frequently be identified on the continental shelf.

Thus, the sea-ice edges tend to be situated near the relatively warm ocean currents, in particular in the seasons when sea-ice edges are advancing or have advanced the most. Nevertheless, the relation has been rapidly changing under the recent global climate change.

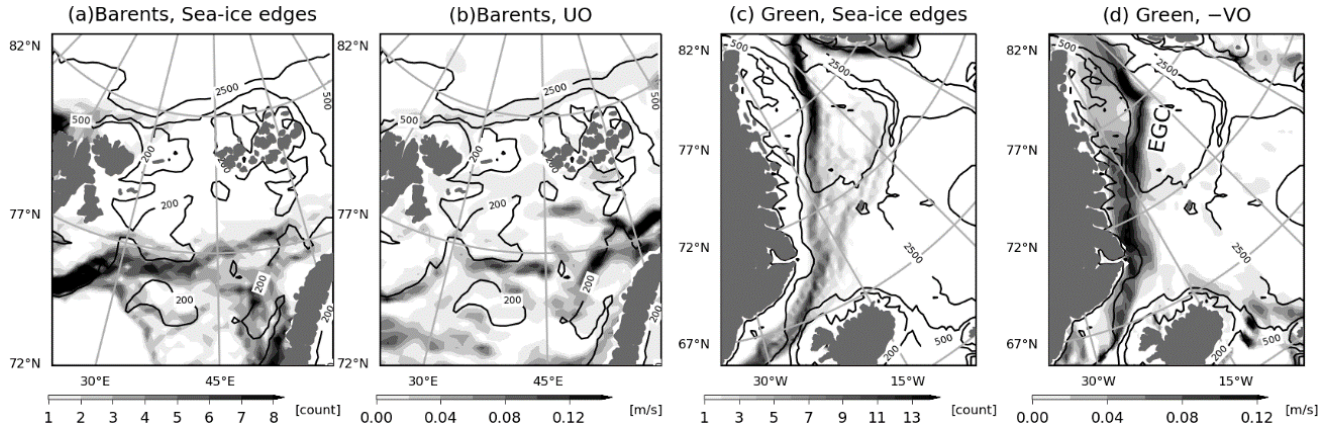

Figure 1. (a) The number of monthly-mean sea-ice edge occurrences per 25 km by 25 km grid cells for March during 1980 – 2021 over the Barents Sea. (b) Climatology in surface eastward ocean current speed for March averaged for 1980 – 2021. The East Greenland Current is labelled as EGC in (d). (c) As in (a), but over the Greenland Sea. (d) As in (b), but over the Greenland Sea for southward ocean current speed. The contours indicate bathymetry of 200, 500, and 2500 m.

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