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LONG-TERM DYNAMICS OF THE NORTH WATER POLYNYA BY MEANS OF PASSIVE MICROWAVE AND THERMAL INFRARED IMAGERY

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The North Water (NOW) polynya is a regularly forming area of open-water and thin-ice, located between north-western Greenland and Ellesmere Island (Canada) at the northern tip of Baffin Bay. Due to its large spatial extent, it is of high importance for a variety of physical and biological processes, especially in wintertime.

Here, we present a long-term remote sensing study for the winter-seasons 1978/1979 to 2013/2014. Polynya characteristics are inferred from (1) sea-ice concentrations (SIC) and brightness temperatures (T_b) from passive microwave satellite sensors (AMSR-E, SMMR, SSM/I), and (2) thin-ice thickness (TIT) distributions, which are calculated using MODIS ice-surface temperatures (IST) and ECMWF atmospheric reanalysis data in a 1-D thermodynamic energy balance model. Daily ice production rates are retrieved for each winter season from 2002/2003 to 2013/2014, assuming that all heat loss at the ice surface is balanced by ice growth. A coverage-correction scheme is applied on daily polynya area (POLA) and ice production (IP) values to account for cloud gaps in the daily MODIS composites.

Our results indicate that the NOW-polynya experienced significant seasonal changes over the last three decades considering the overall frequency of polynya-occurrences as well as their spatial extent. In the 1980s, there were prolonged periods of a more or less closed ice cover in northern Baffin Bay in winter. This changed towards an average opening on more than 85% of the days between November and March during the last decade. Noticeably, the sea-ice cover in the NOW-polynya region shows signs of a later-appearing fall freeze-up over the investigated period.

Different methods to obtain daily polynya area using microwave AMSR-E data and SSM/I data were applied: PSSM (Polynya Signature Simulation Method) and a SIC-threshold. A comparison with MODIS data (TIT ≤ 20 cm) shows that the wintertime POLA -estimates derived by MODIS are about 20% larger than those derived using PSSM with AMSR-E data. In turn, the POLA difference between PSSM and a SIC-threshold of 70% is fairly low (approx. 10%) when applied to AMSR-E data. For the coarse-resolution SSM/I data, this difference is much larger, particularly in November and December.

The calculated ice production reaches an average value of 268 km³ (2002/2003-2013/2014) and shows a non-significant trend of 6.2 km³/yr. This underlines the importance of the NOW-polynya considering its contribution to local deep water formation.