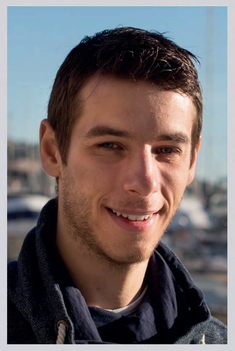
Springtime Coupling Between Arctic Sea Ice Export and Phytoplankton Blooms in the Greenland Sea

N. Mayot[1], P. Matrai[1], A. Arjona[1,2], C. Marchese[3], T. Jaegler[3] and S. Bélanger[3]

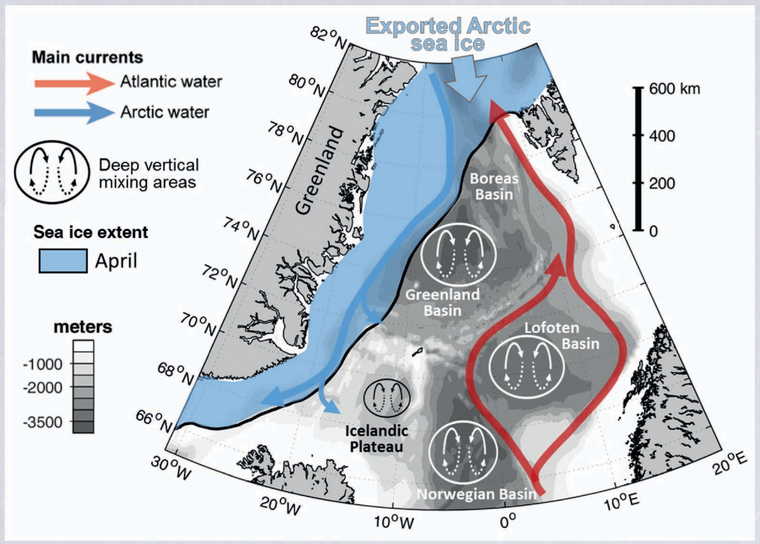
[1]Bigelow Laboratory for Ocean Sciences (nmayot@bigelow.org), [2]Harvard University, [3]ARCTUS inc.

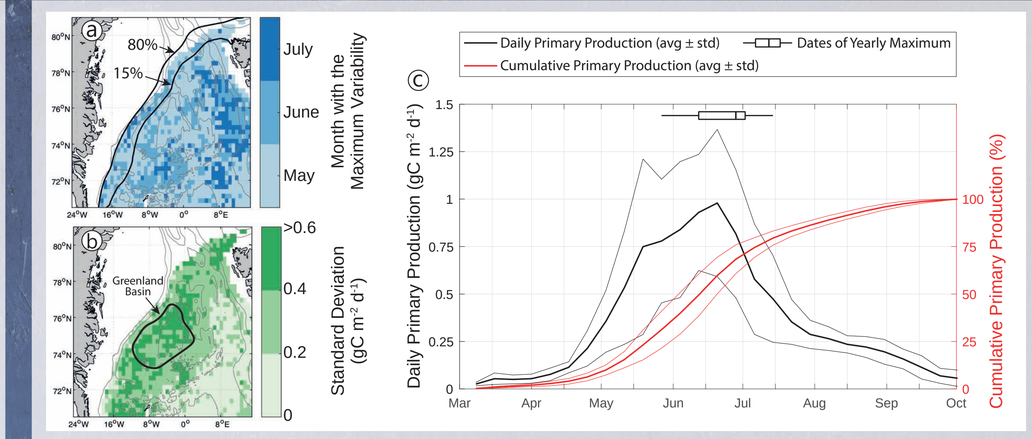


Introduction

The Greenland sector of the Arctic has large permanently open water areas and therefore, has the highest total annual phytoplankton production in the pan-Arctic (above 66°N)[1]. However, the Greenland Sea located in this sector is also exposed to major Arctic sea ice export. What are the impacts of the exported Arctic Sea ice on the regional ocean dynamics and primary production of the Greenland Sea?

[1]Pabi *et al.*, *J. Geophys. Res.*, 2008



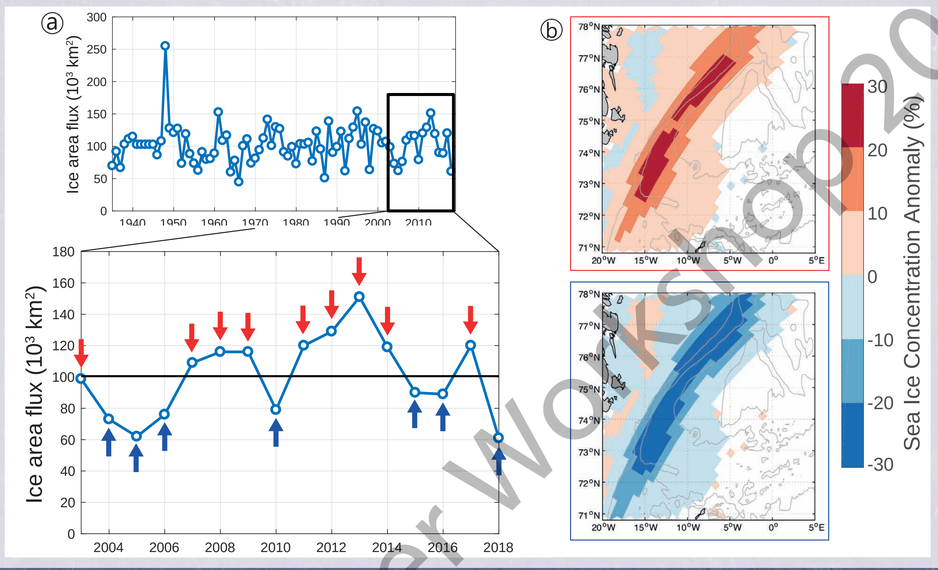


The primary production in the Greenland Sea. (**a**) Map of the month with the maximum standard deviation in daily primary production and (**b**) the associated values. (**c**) Climatological annual cycles in the Greenland Basin.

Relationship Between the Exported Arctic Sea Ice and the Sea Ice Distribution in the Greenland Sea

(**a**) Estimates of the exported Arctic sea ice in April through Fram Strait between 1935 to 2018. After 2003, estimates are only from Synthetic Aperture Radar (SAR) observations.

(**b**) Mean anomaly of the sea ice concentration in May, for the years with high (top, red arrows in **a**) and low (bottom, blue arrows in **a**) exported Arctic sea ice.



Results...

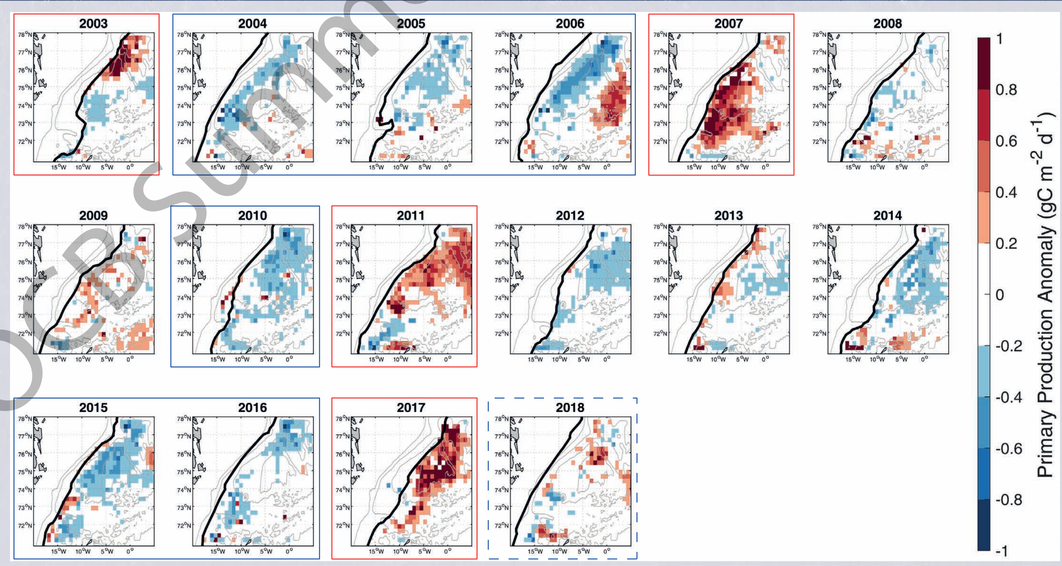
- A positive relationship in spring between the exported Arctic sea ice and the sea ice distribution
- A high interannual variability in the sea ice export and distribution
- The springtime export of Arctic sea ice influences the extent of the Seasonal Ice Zone in the Greenland Sea

Anomaly of the Spring (in May) Primary Production for Each Year Between 2003 and 2018

The primary production was estimated with a light photosynthesis model applied to satellite observations[2]. To reduce the number of missing values a Data Interpolating Empirical Orthogonal Functions method was applied.

The black line represents the location of the ice edge (sea ice concentration = 15 %) in May for each year studied.

[2]Bélanger *et al.*, *Biogeosciences*, 2013



Results...

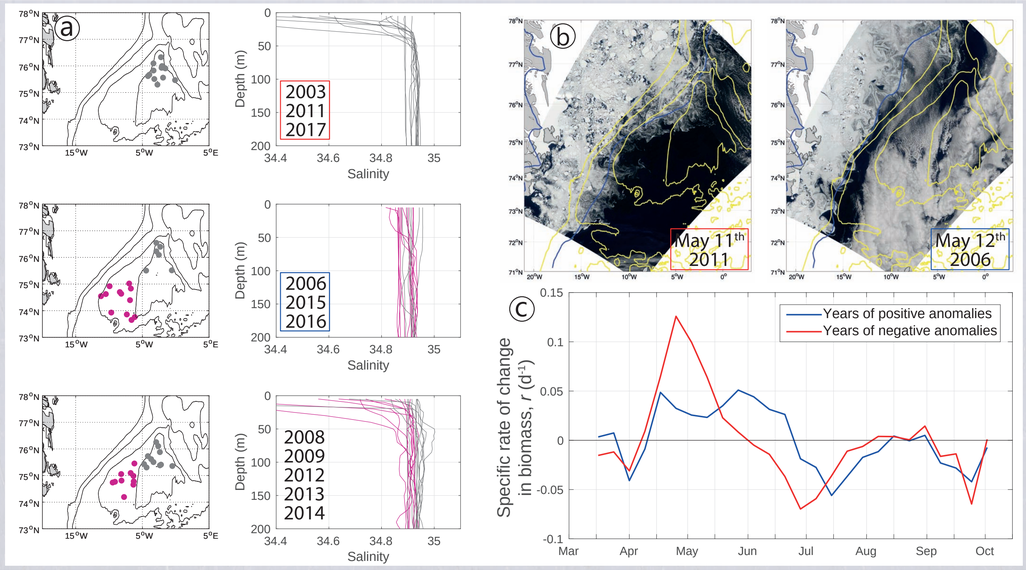
- Years with low exported Arctic sea ice display negative anomalies of spring primary production (except 2018, blue squares)
- Four years, with higher exported Arctic sea ice, have areas with high primary production anomalies (red squares)

Relationship Between Springtime Salinity, Sea Ice Distribution, and the Annual Phytoplankton cycles

(**a**) All salinity profiles available in May between 2003 and 2018 and divided into 3 groups: years with positive (top) and negative (middle) anomalies of spring primary production, and all the other years (bottom).

(**b**) Two MODIS Corrected Reflectance (True Color) images obtained in May, 2011 and 2006.

(**c**) Annual cycles of observed specific rate of change in phytoplankton biomass (*r*), derived from satellite chlorophyll-a concentration.



Results...

- Low exported Arctic sea ice flux reduces the freshwater content and stratification, mainly in the western part (magenta points and lines) of the Greenland basin
- The observed freshwater signal in the Greenland deep basin (magenta points and lines) could be from melted sea ice
- The springtime salinity stratification in the deep basin could have induced the observed abrupt spring bloom phenology (red line) and high primary production anomalies

Bigelow | Laboratory for Ocean Sciences

Ocean Biology and Biogeochemistry program

International Ocean Colour Science Meeting 2019

Acknowledgments

This work was funded by NASA Ocean Biology & Biogeochemistry (80NSSC18K0081). We thank K. Kloster and S. Sandven (Nansen Environmental and Remote Sensing Center) for their courtesy in providing ice area flux data.