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SEASONAL VARIABILITY OF CENTRAL ARCTIC OCEAN SEA-ICE COVER: NEW BIOMARKER (IP_{25} AND PIP_{25}) DATA FROM SEDIMENT TRAPS DEPLOYED ON SOUTHERN LOMONOSOV RIDGE

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Introduction and Background

Sea ice plays an important role in the Arctic Ocean. Its cover is characterized by a strong seasonal variability especially in the marginal (shelf) areas (Fig. 1). Sea ice is a very critical component of the Arctic system that responds sensitively to changes in atmospheric circulation, incoming radiation, atmospheric and oceanic heat fluxes, as well as the hydrological cycle. Ice significantly reduces the heat flux between ocean and atmosphere; through its high albedo it has a strong influence on the radiation budget of the entire Arctic. Thus, sea ice certainly plays a substantial role in climate system variability. Hence, we focus on this important component by using the ice proxy IP_{25} in a sediment trap system deployed at the southern Lomonosov Ridge in the central Arctic Ocean and recording the seasonal variability in biomarker fluxes in 1994/1995 (Fahl and Nöthig, 2007).

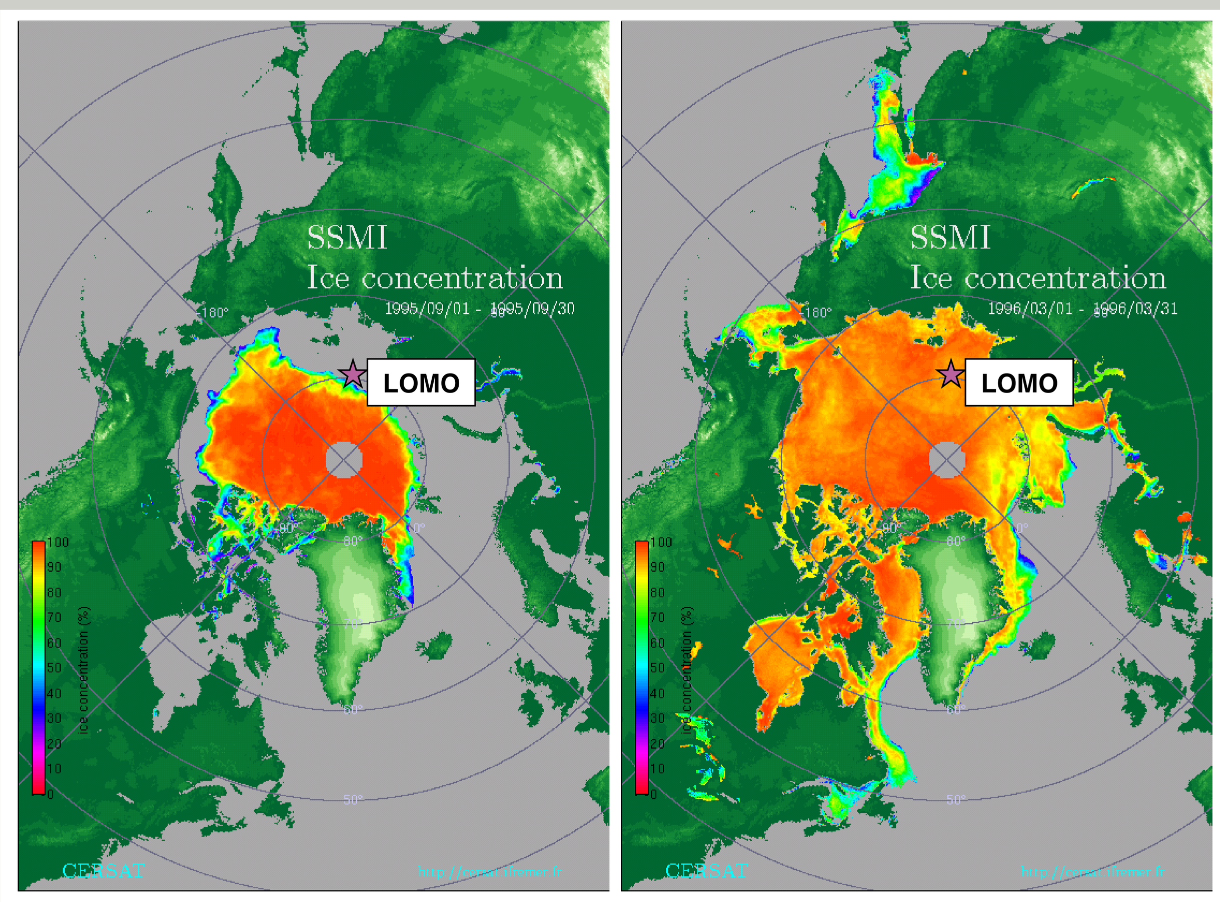

Fig. 1
Map with seasonal variability of modern sea ice (max and min situations; source: http://iup.physik.uni-bremen.de:8084/amsr/regions.html) and location of sediment trap LOMO2.

Ice Proxy IP_{25} and brassicasterol

A novel biomarker approach which is based on the determination of sea-ice diatom-specific highly branched isoprenoids (C_{25} HBI monoene = „IP_{25}“), has been developed by Belt et al. (2007). Very recently, Müller et al. (2009, 2011 and further references therein) demonstrated in their study of surface sediments from the subpolar North Atlantic and sediment cores from Fram Strait that the additional use of phytoplankton-derived biomarkers such as brassicasterol (or dinosterol) as an indicator for open-water conditions notably facilitates the environmental reconstruction as ambiguous IP_{25} signals (i.e. its absence, which may refer to either a lack of sea ice or, in contrast, a permanent and thick ice cover limiting any algal growth) can be circumvented (Fig. 2).

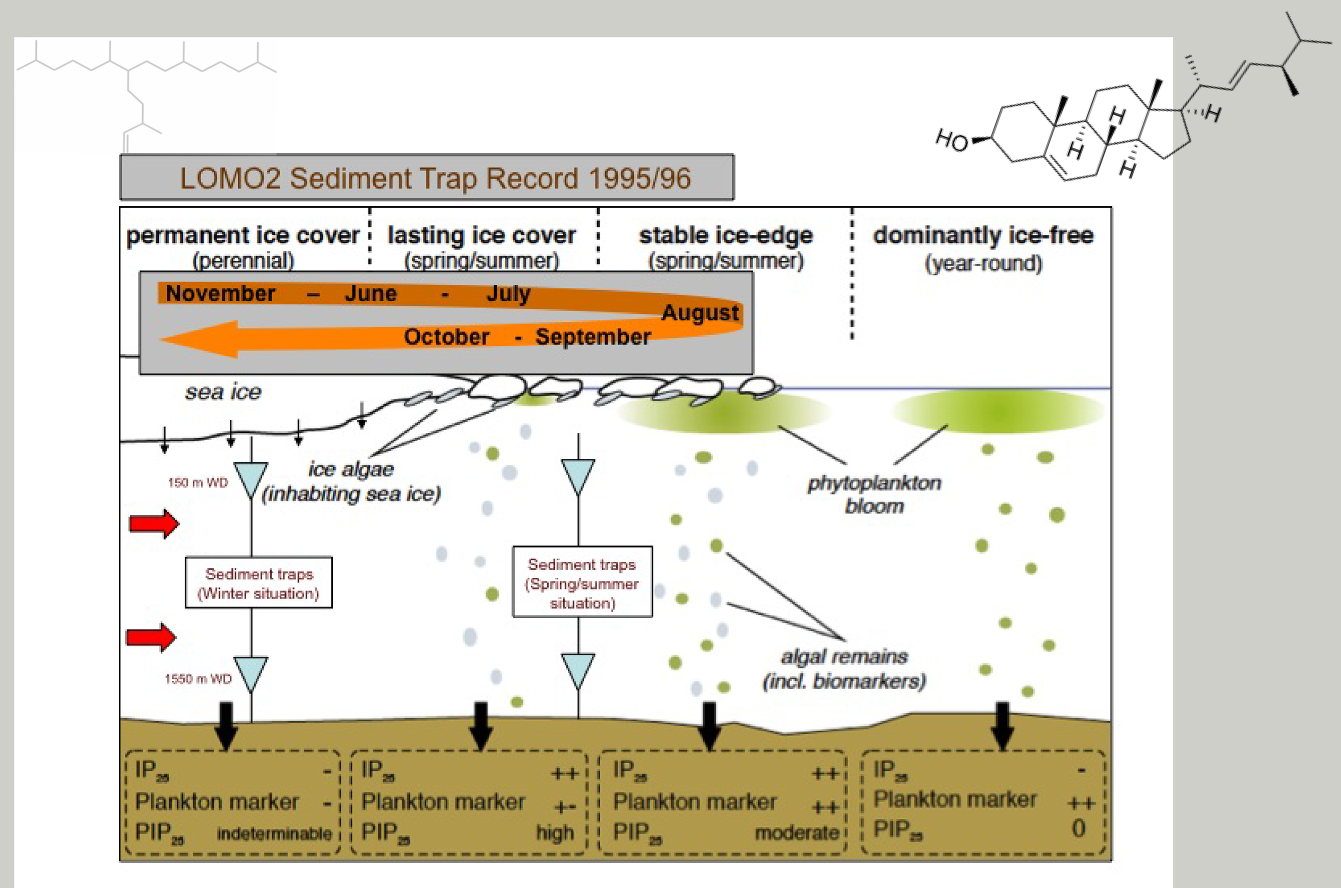

Fig. 2
Generalized scheme (1) illustrating distinct sea surface conditions and respective (spring/summer) productivities of ice algae and phytoplankton, and (2) indicating sedimentary contents of IP_{25} and the phytoplankton-derived biomarkers and resulting PIP_{25} indices for each setting (Müller et al. 2011, supplemented). Red arrows indicate possible influence of lateral transport.

Seasonal Vertical Flux

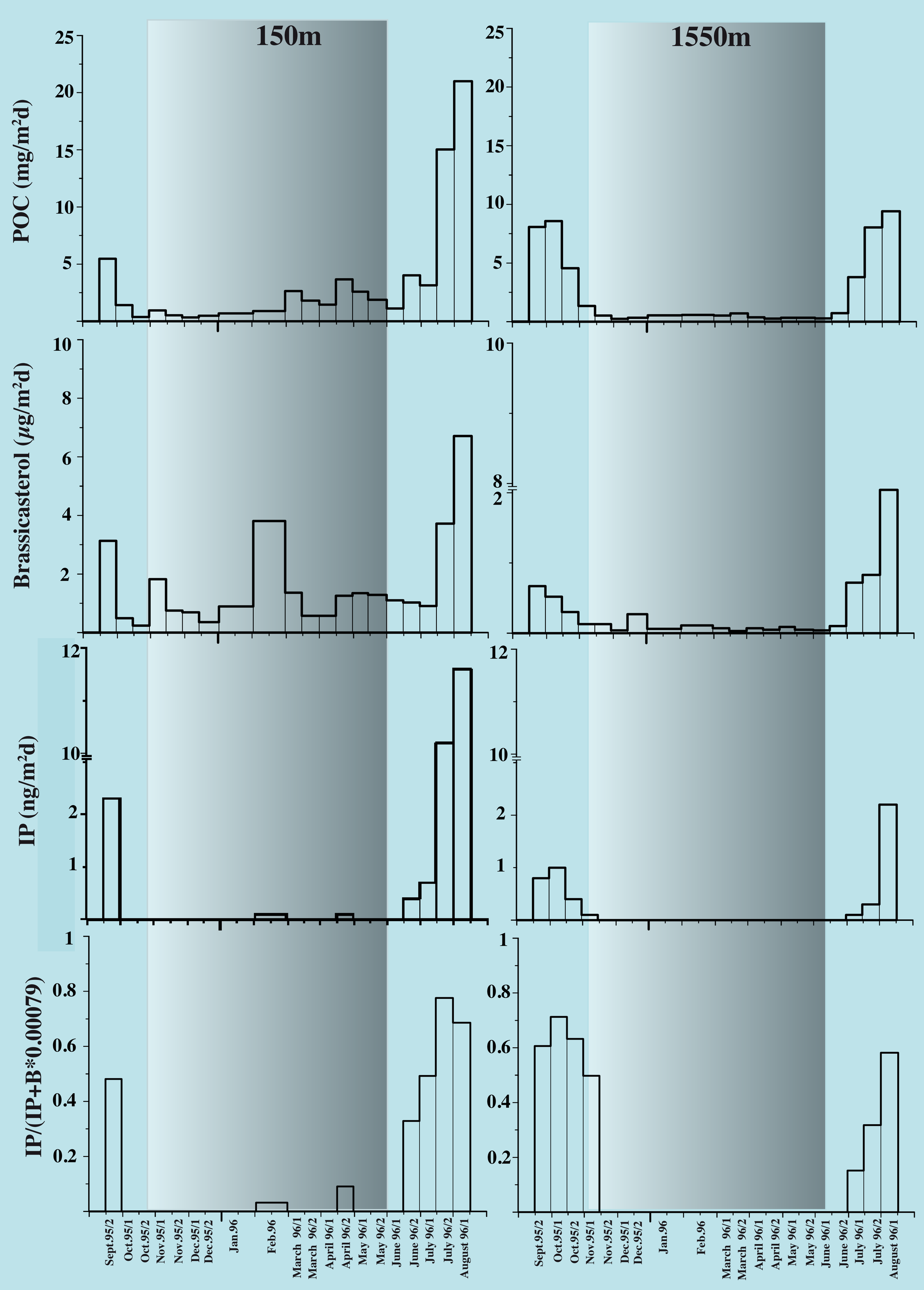

Fig. 3
Daily fluxes of (a) POC (mg m^{-2} d^{-1}), (b) the sum of the concentrations of fatty acids C16:1(n-7), C16:1(n-5), and C20:5(n-3) (µg m^{-2} d^{-1}), (c) the concentration of brassicasterol (µg m^{-2} d^{-1}), (d) the concentration of IP_{25} (ng m^{-2} d^{-1}), and (e) the PIP_{25} values from September 1995 to August 1996 at 150m and 1550m depth on the Lomonosov Ridge. (b) and (c) are used as proxies for (marine) phytoplankton productivity. (a) and (b) from Fahl and Nöthig (2007), (c) to (e) this study.

Our data from the long-term sediment traps representing the time interval from September 1995 to August 1996 reflect seasonality in all measured and calculated parameters (Fig. 2). We can distinguish two main, very different periods during the year:

(1) A period characterized by low productivity, low fluxes and extensive sea-ice cover (second half of November-May; Winter to spring phase). In April/May, first melting already starts, indicated by first increases in total flux and flux of particulate organic matter. The extensive sea-ice cover is reflected in the absence of IP_{25} and low brassicasterol fluxes (except February).

(2) A period characterized by intensive ice-melting, loose sea-ice cover and high biogenic matter flux (June-September; Summer to early autumn phase). A loose ice cover, nutrients and light result in elevated sea-ice algae as well as phytoplankton productivity, reflected in maximum IP_{25} and brassicasterol flux values. These fluxes result in PIP_{25} values (combining the IP_{25} with the phytoplankton biomarker brassicasterol, see Müller et al., 2011) of 0.5 to 0.8, indicating an „ice-edge situation“.

The sediment trap data presented in this poster are part of a manuscript submitted to EPSL (Fahl and Stein, 2012).

References

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