New insights into the application of the PIP_{25} index in the Arctic Ocean

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Introduction:

In this study we investigated suspended particulate matter (SPM) collected along a transect from the East Sea of Korea to the Bering Sea from 18 to 28 July in 2015 and a multicore (ARA01B-3MUC) retrieved from the Chukchi shelf region. We analyzed the samples for the Arctic sea ice proxy IP_{25} together with a tri-unsaturated highly branched isoprenoid (HBI triene) and two sterols (epi-brassicasterol and dinosterol) to assess the suitability of these compounds for the so-called PIP_{25} index in the Arctic region as a proxy for sea ice change in the past.

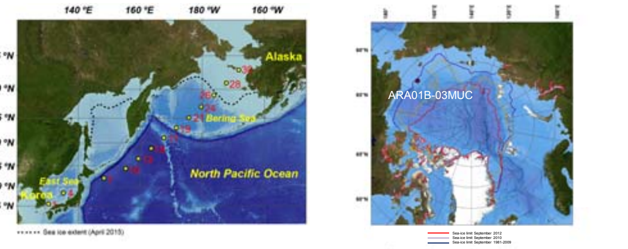

Fig. 1. Map showing the sampling sites along a South-North transect from the East Sea to the Bering Sea and the core position of ARA01-03MUC with pan-Arctic September sea ice distributions for 1981-2009, 2010 and 2012 (National Snow and Ice Data Center). Dashed lines indicate the sea ice extent in April 2015.

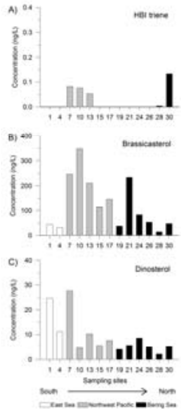

Fig. 2. Histograms of the concentrations of (A) HBI triene, (B) brassicasterol, and (C) dinosterol in ng/L.

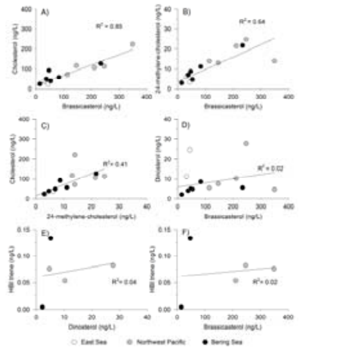

Fig. 3. Scatter plots of phytoplankton-derived lipid biomarkers.

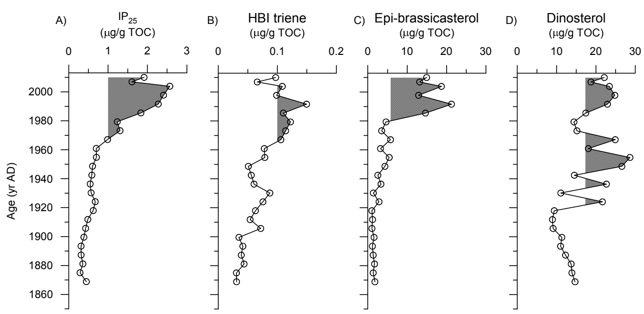

Fig. 4. Downcore profiles of (A) IP25, (B) HBI triene, (C) epi-brassicasterol, and (D) dinosterol concentrations for ARA01B-03MUC. The areas above the mean core values for each biomarker are shaded in grey.

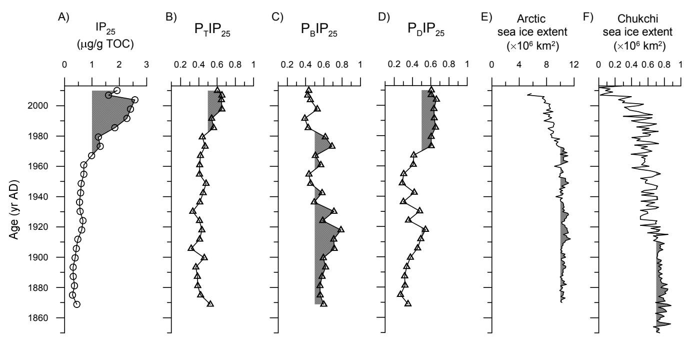

Fig. 5. Downcore profiles of (A) IP_{25} concentration, (B) P_TIP_{25}, (C) P_BIP_{25}, (D) P_DIP_{25}, (E) late summer sea ice extent record for the entire Arctic (Kinnard et al., 2011), and (F) September sea ice for the Chukchi Sea (Walsh et al., 2016). Note that the P_BIP_{25} and P_DIP_{25} records based on the global c-factors (Xiao et al., 2015) are shown as red lines.

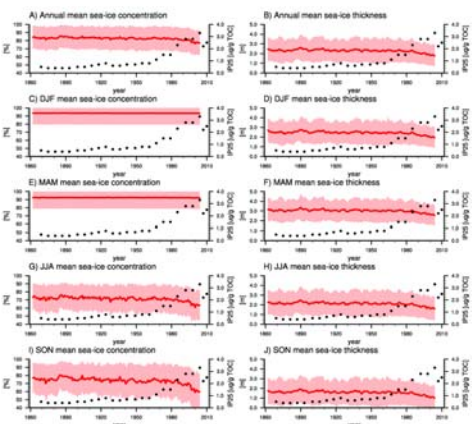

Fig. 6. Annual and seasonal variations of sea-ice concentrations and sea-ice thicknesses from the CMIP5 historical runs by 42 climate models. Red lines and pink regions in each figure indicate the ensemble mean and $\pm1\sigma$ range of sea-ice properties by climate models, respectively. Black dots indicate IP_{25} concentrations.

Conclusions:

Our results highlight that the use of HBI triene, epi-brassicasterol, and dinosterol, as strict phytoplankton markers for the PIP_{25} index (i.e. P_TIP_{25}, P_BIP_{25} and P_DIP_{25}, respectively), might result in misleading outcomes. Accordingly, our study highlights that more work is needed to better constrain the use of HBI triene, epi-brassicasterol, and dinosterol, as strict ice-free, open ocean phytoplankton biomarkers when applying the PIP_{25} index for reconstructing past sea ice changes.

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