Multiproxy climate and sea ice reconstruction of the industrial era at the Western Antarctic Peninsula

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IMPORTANT NOTE:
I reduced the content of this presentation to the most important results. The full story can be found in the open discussion of the manuscript.
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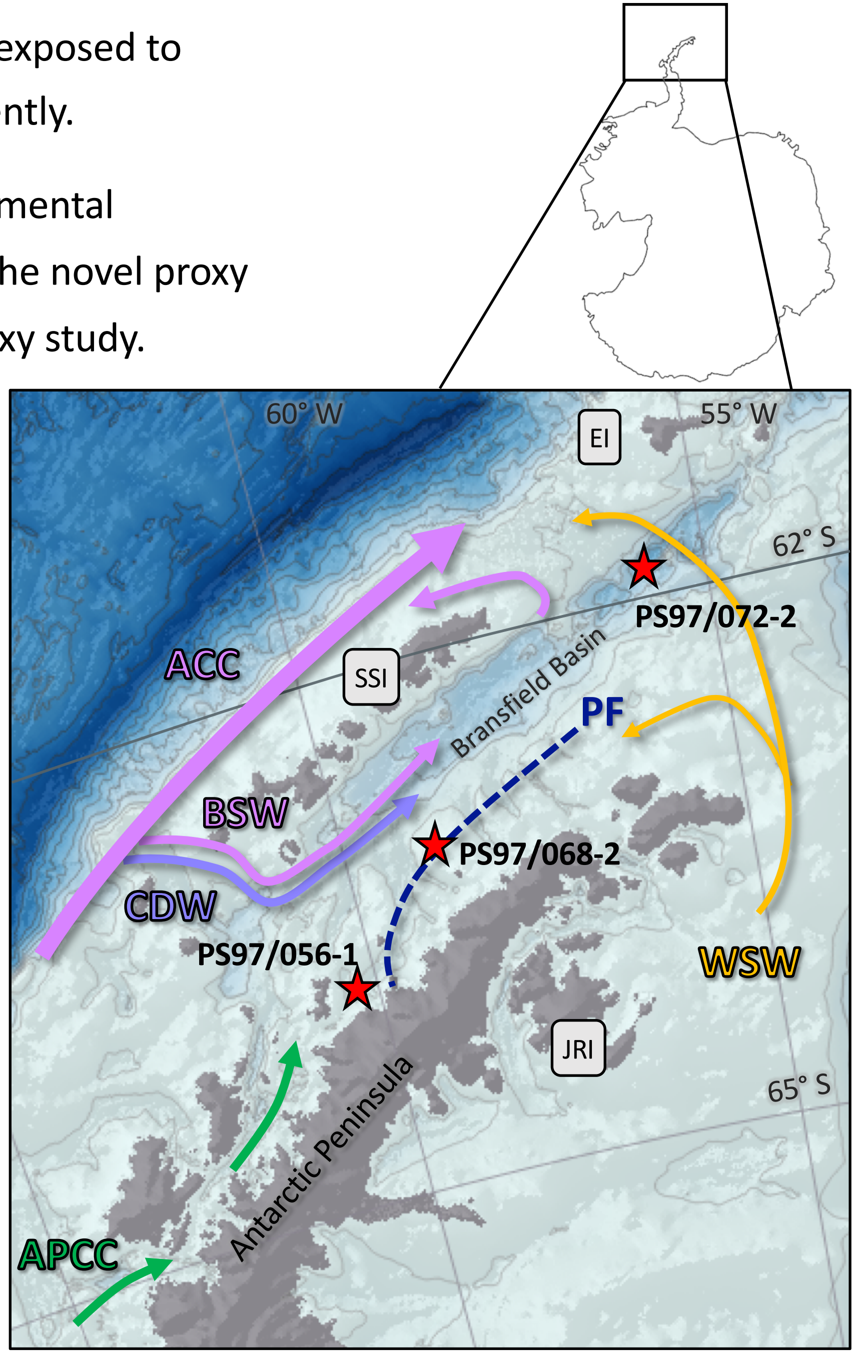
Introduction and study area

The Western Antarctic Peninsula (WAP) is a region heavily exposed to recent rapid warming that experienced sea ice retreat recently.

We studied the development of spring sea ice and environmental conditions in the pre-satellite era (about 240 years) using the novel proxy **$IPSO_{25}$** (Ice proxy for the Southern Ocean C_{25}) in a multiproxy study.

$IPSO_{25}$ is an organic biomarker derived from sea ice diatoms (Belt et al., 2016).

We reconstructed climate and sea ice conditions at the WAP using the three short marine sediment cores PS97/056-1, PS97/068-2 and PS97/072-2 and compared our findings with satellite sea ice observations, numerical modelled data and ice core data. Dating based on ^{210}Pb.



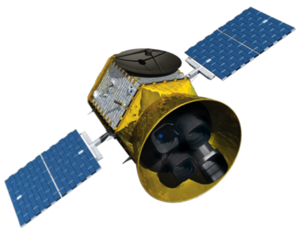
Oceanography		Islands	
ACC	Ant. Circumpolar Current	JRI	James Ross Island
APCC	Ant. Peninsula Coastal Current	SSI	South Shetland Islands
BSW	Bellingshausen Sea Water	EI	Elephant Island
CDW	Circumpolar Deep Water		
WSW	Weddell Sea Water		
PF	Peninsula Front		

Methods: Analyses

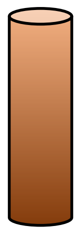
We analysed compound specific lipid biomarkers and diatom fossils.

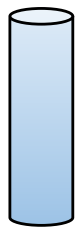
Biomarkers	Proxy for	Method
Highly branched isoprenoids (HBIs)	HBI diene = **$IPSO_{25}$** (Ice proxy for the Southern Ocean C_{25}) = spring sea ice proxy (Belt et al., 2016) HBI Z- and E-trienes = open marine proxies	Lipid extraction, GC-MS
Glycerol dialkyl glycerol tetraethers	Subsurface ocean temperature based on TEX^{L}_{86} and OH-GDGTs	Lipid extraction, HPLC
Diatom fossils	Winter sea ice cover (WSI) Summer sea surface temperature (SSST)	Microscope slides, identification, counting, transfer function

+ Satellite data + Numerical modelling + Marine Sediments + Ice Cores



AWI-ESM2



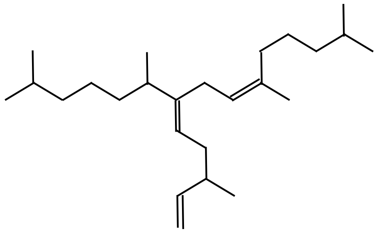


Methods: Concept of the sea ice index $PIPSO_{25}$

We applied a sea ice index for spring sea ice cover:

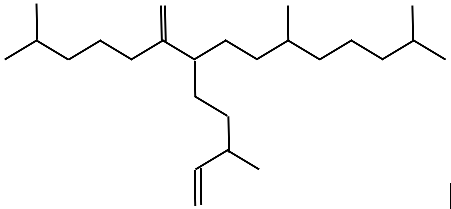
a combination of an open marine proxy with the sea ice proxy

HBI Z-triene



+

$IPSO_{25}$

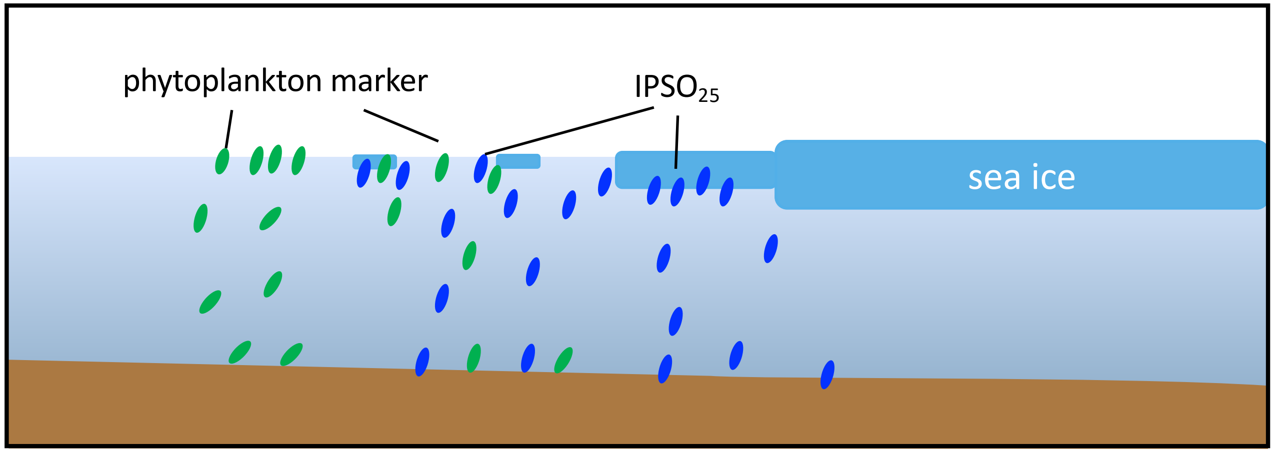


→

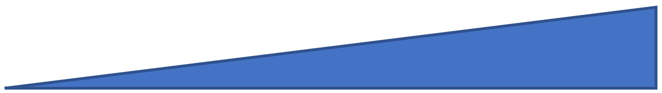
P_ZIPSO_{25}

$$PIPSO_{25} = \frac{[IPSO_{25}]}{([IPSO_{25}] + [HBI\ Z - triene])}$$

(after Vorrath et al., 2019; based on PIP_{25} from Müller et al, 2011)



P_ZIPSO_{25}



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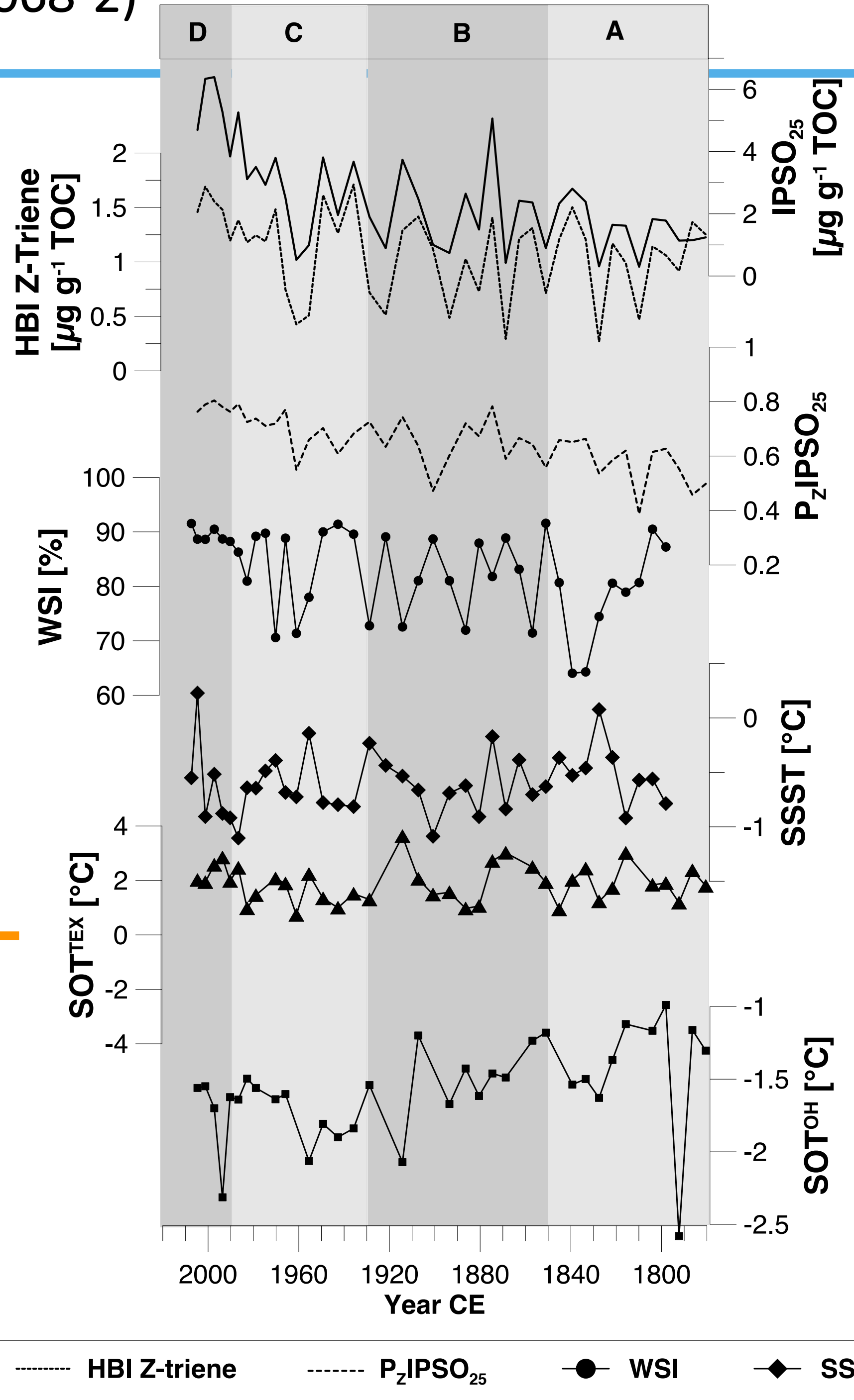
Results (only PS97/068-2)



Phytoplankton biomarker rise

Sea ice biomarker rise

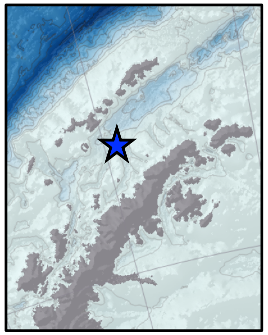
Sea ice index rise

Winter sea ice rise

Summer SST no trend

Subsurface ocean temperature no trend

Subsurface Ocean temperature decrease

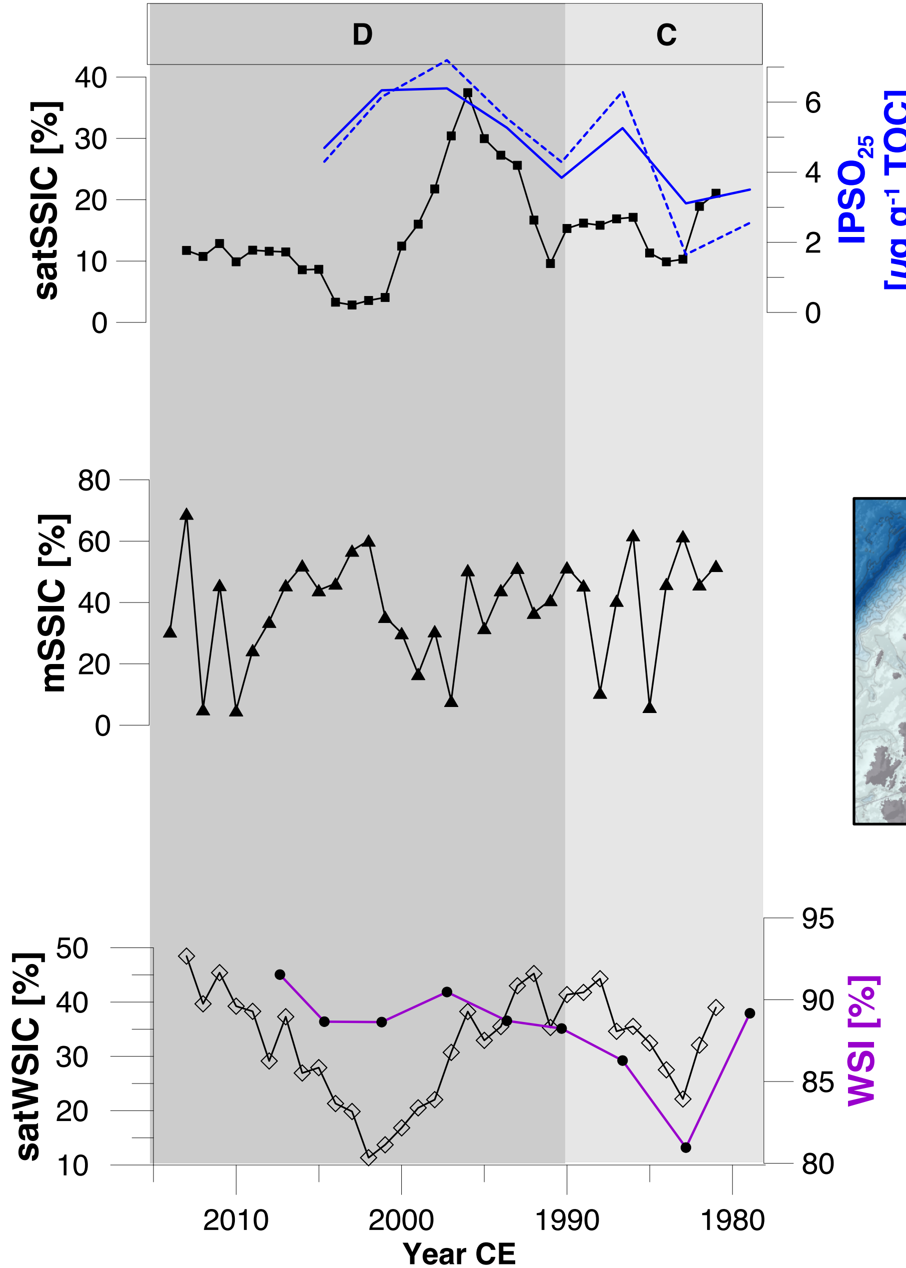


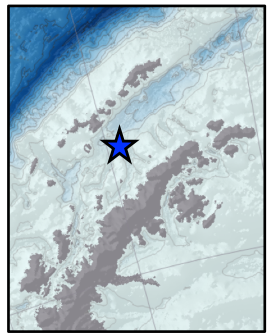
Sea ice biomarker vs. satellite sea ice observations vs. modelled sea ice

- ✓ Spring Sea ice biomarkers ($IPSO_{25}$, $PIPSO_{25}$) correspond to spring satellite sea ice cover (satSSIC)

- ✕ Modelled spring sea ice cover (mSSIC) does not compare well to any of the biomarkers or satellite data

- ✓ Winter sea ice (WSI) derived from diatoms corresponds to winter satellite sea ice cover (satWSIC)





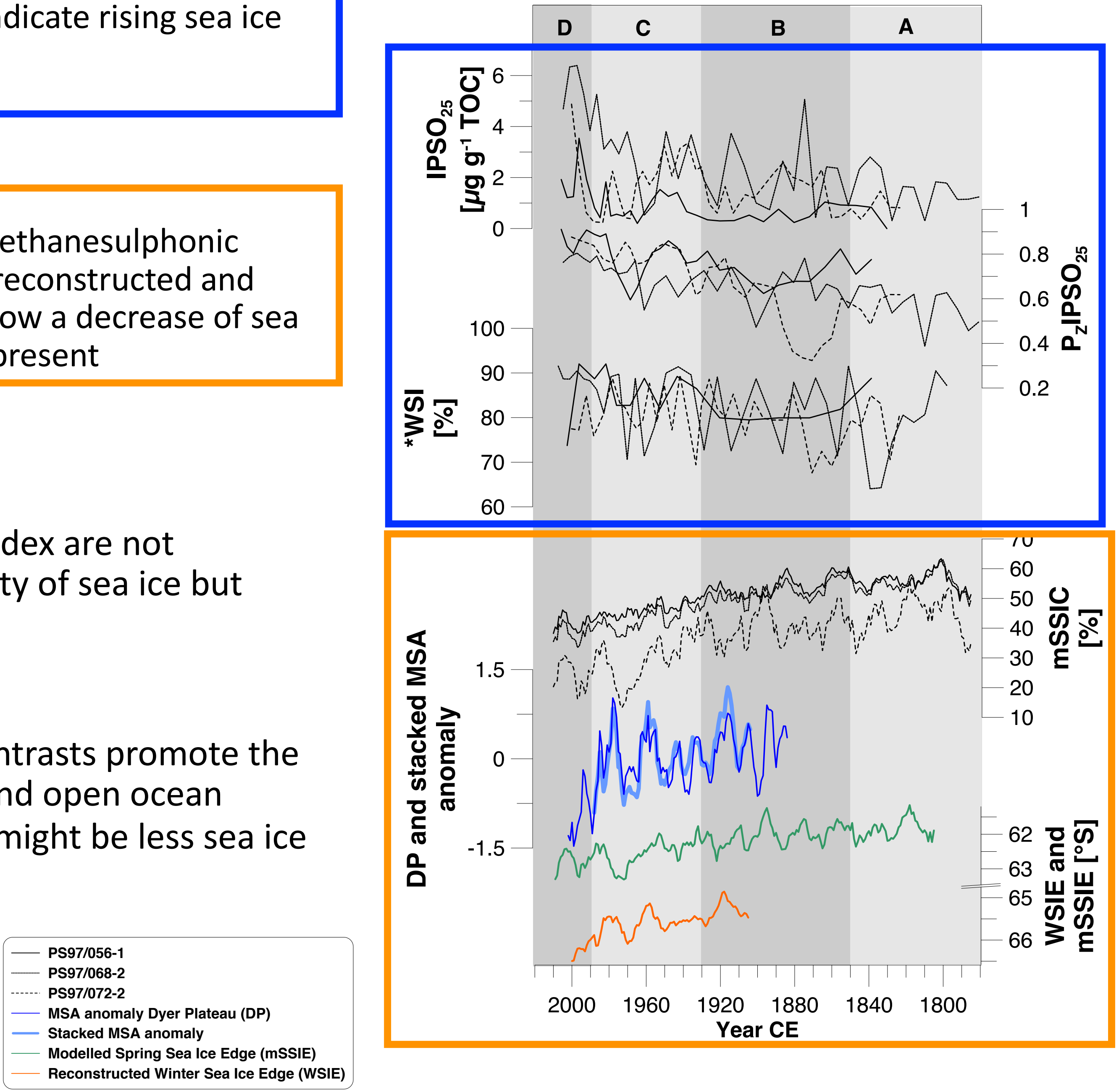
A close look on sea ice from the last 240 years (all cores)

↖ $IPSO_{25}$, $PIPSO_{25}$ and WSI indicate rising sea ice cover towards present

↙ Modelled sea ice, MSA (methanesulphonic acid, Abram et al., 2010), reconstructed and modelled sea ice edges show a decrease of sea ice cover/extent towards present

= Sea ice biomarker and index are not significant for the quantity of sea ice but more for the quality

= High seasonal sea ice contrasts promote the growth of both sea ice and open ocean diatoms although there might be less sea ice in total

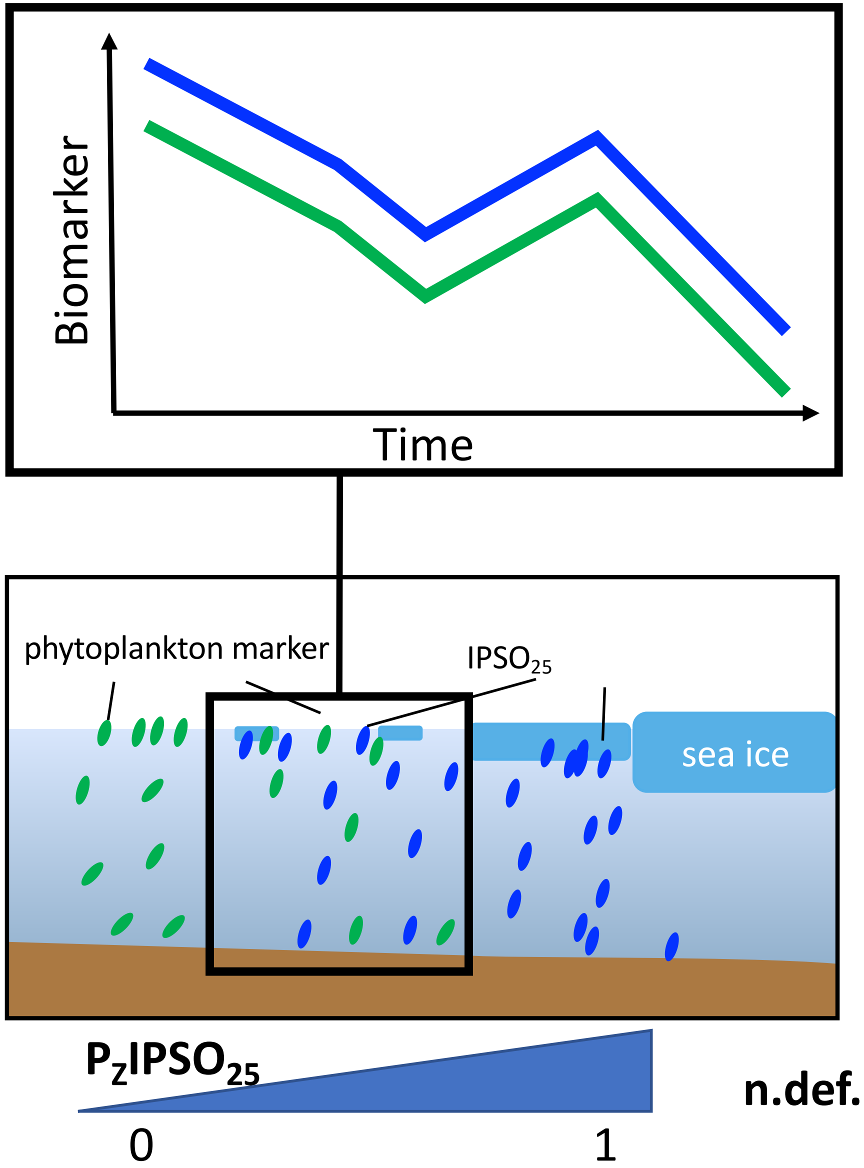


Conclusion

- If the pattern of sea ice and phytoplankton biomarker are similar, sea ice conditions have been favorable for both sea ice diatoms and phytoplankton

Higher biomarker concentrations remain from:

- Melting of sea ice releases nutrients
- Primary production is high at sea ice edges
- Freshwater input stabilizes the water column
- Thinner sea ice allows a higher light penetration and higher sea ice diatom growth



At the Western Anatarctic Peninsula, seasonal sea ice contrasts have significantly increased since the 1930s

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