Utrecht University
Faculty of Geosciences
Marine palynology and paleoceanography
Contact: s.hou@uu.nl
Programme twitter: @UU_oceaNice

Paleoceanography of the Southern Ocean during past warm intervals of the Neogene: Preliminary palynological and TEX_{86} results of ODP Site 1168

Suning Hou[1], Francesca Sangiorgi[1], Francien Peterse[1], Peter K. Bijl[1]

1 Utrecht University, Department of Earth Sciences, Utrecht, the Netherlands

Introduction:

Interactions between ocean circulation and the Antarctic ice sheet are strong factors in modern Antarctic ice sheet mass imbalance. However, these complex oceanography of the Southern Ocean is difficult to project in ice melt scenarios, consequently hampering accurate sea level rise projections. Previous studies suggested a large polar amplification factor of warming and vast ice sheets retreat in the warm intervals of the late Pliocene (2.8-3.6Ma) and mid Miocene (14.5-17 Ma), when atmospheric CO_2 concentrations were comparable to that of present-day or expected for second half of this century (Fig 1). However, the conditions, structure and dynamics of Anrarctic Circumpolar Current (ACC) of these past analogues are poorly understood. While the position of the subtropical front is crucial for the delivery of poleward heat today, its position in the warm Oligocene and Miocene is poorly understood. In my PhD research I will study both ice-proximal and subtropical front sediment cores to reveal past ocean conditions in the Southern Ocean (Fig2).Here I will present the first results from ODP Site 1168 on the Tasmanian Margin.

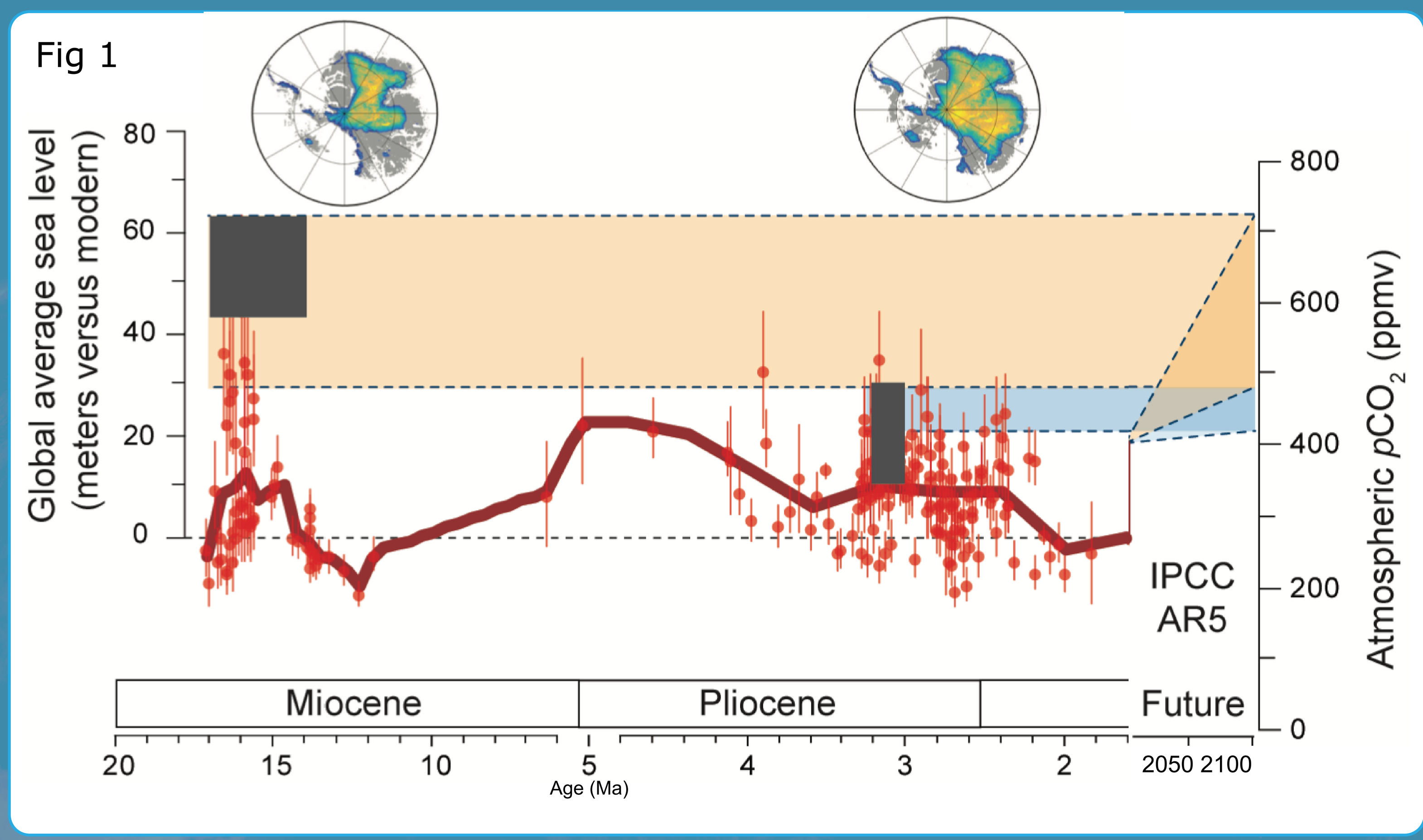


Fig 1. Miocene, Pliocene[1, 2] interglacial global average sea level above modern in black. Atmospheric CO2 from boron isotopes[3] and ice cores[4]. Simplified CO_2 projections between present-day and 2100 AD under strong (blue), and moderate (orange) emission mitigation scenarios[5]. Antarctic ice sheet model simulations illustrate possible ice sheet size[6]

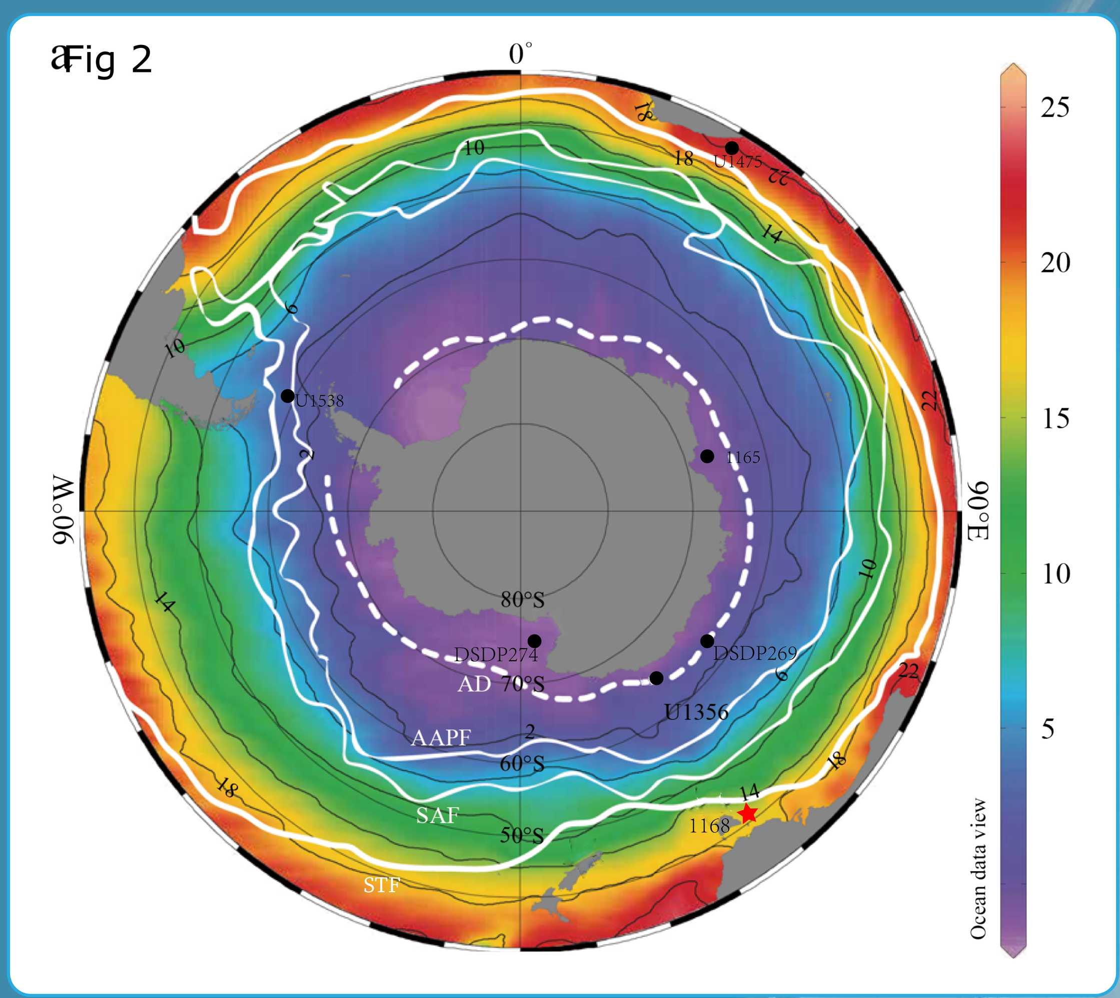


Fig 2. Sites to be used in the PhD study plotted on a map showing modern SSTs of the Southern Ocean[7] and ACC fronts.

Methods

1. Palynological study use dinocyst as quantitative fingerprint for past ocean conditions (sea ice, productivity, temperature) (Fig3)
2. Organic geochemical analyses based on GDGTs

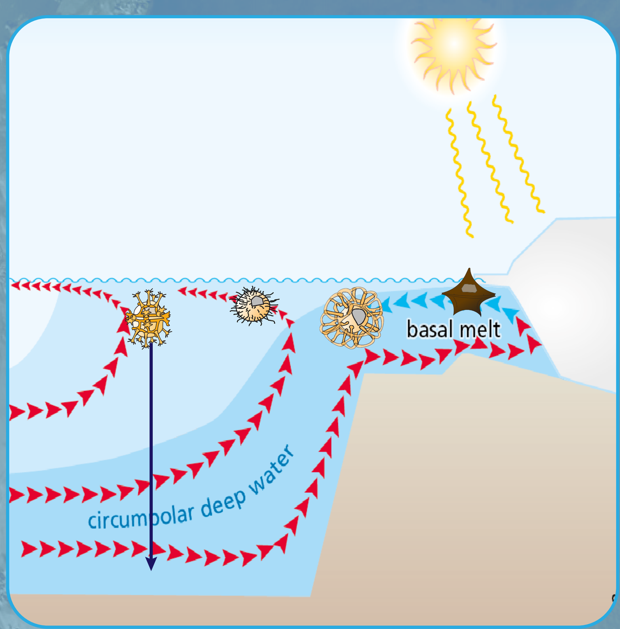


Fig 3. .Dinocyst assemblages as fingerprint for past ocean condition

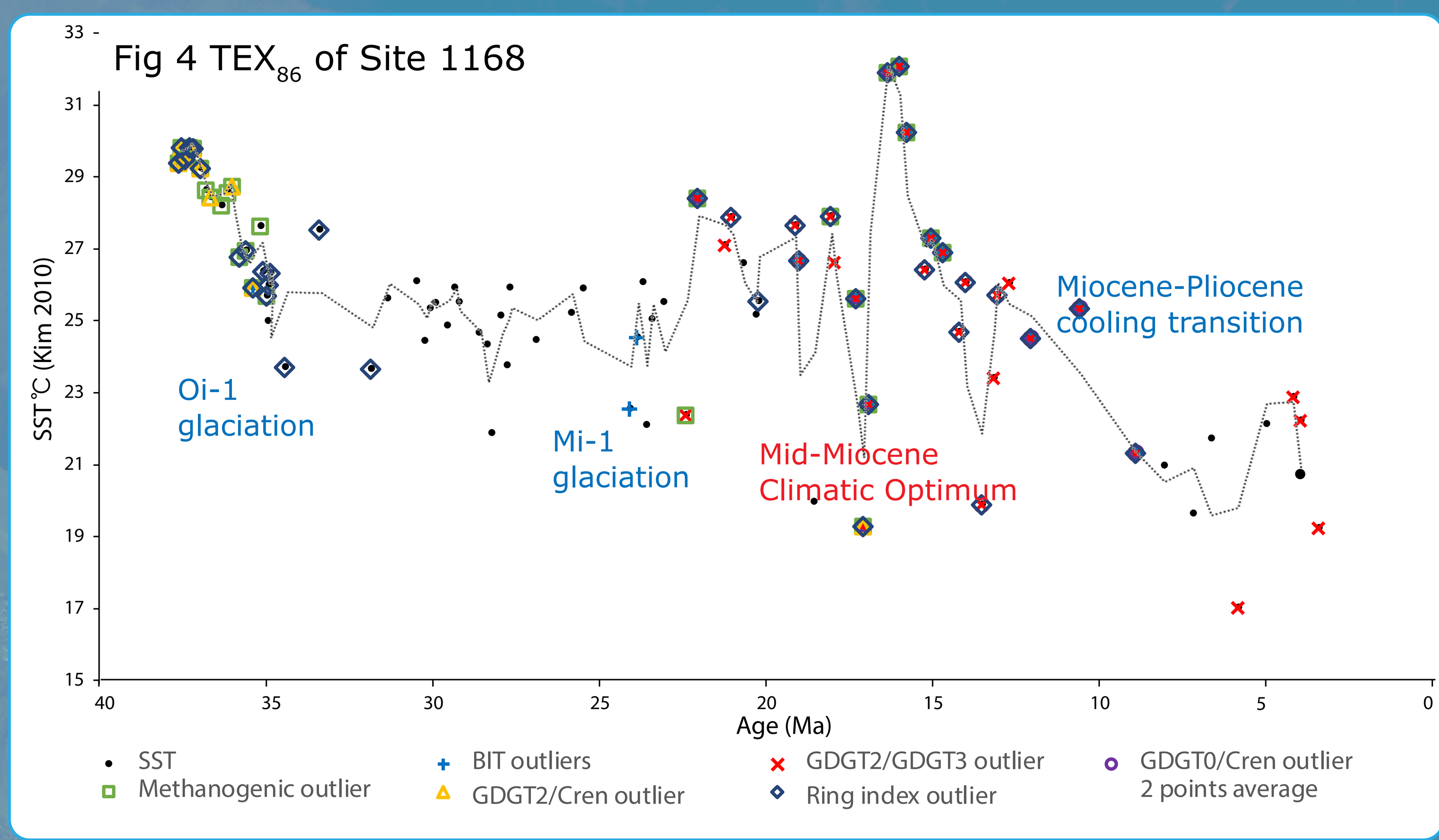
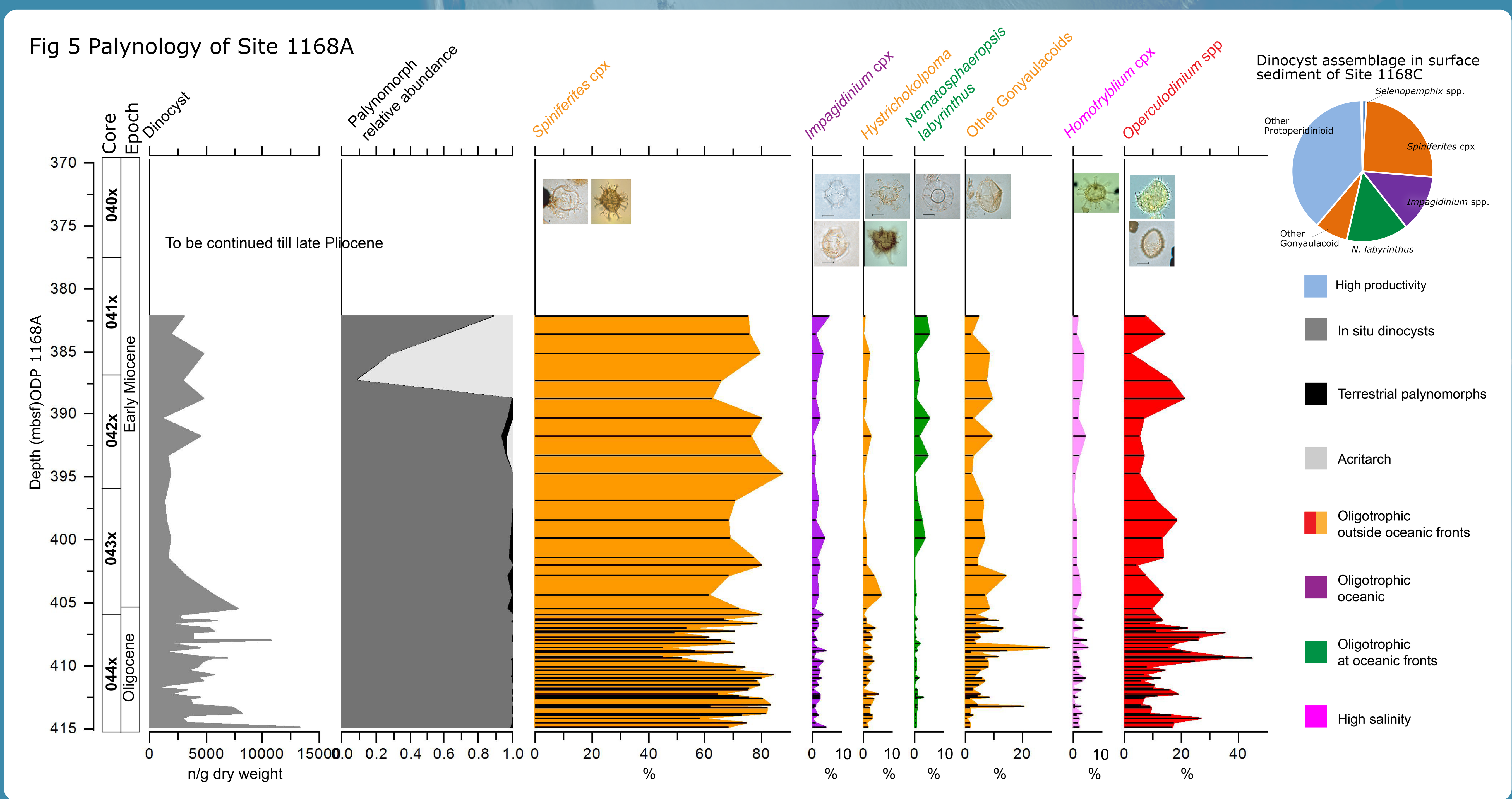


Fig 4. Low resolution sea surface temperature (TEX_{86}^{H})[8] for site 1168, including the bias by terrestrial input (BIT)[9], water depth (GDGT2/GDGT3)[10], anaerobic oxidation of methane(GDGT2/Cren)[11], lake-like in-situ production(GDGT0/Cren)[12], methanogenic indices[13] and the ring index[14]



TEX_{86} results (Fig4)

1. SSTs show the general climatic events regardless biases
2. TEX_{86} results are biased by AOM in the late Eocene and deep water production in the Miocene. Ring index and methanogenic overprint bias in both period. Results seem unbiased during most of the Oligocene

Palynology results (Fig5)

1. Dinocyst assemblage change occurred at Oligocene-Miocene transition.
2. Skolochorate acritarch anomaly bloom in the early Miocene
3. Subtrophical front approached to the site loction in the early Miocene

Fig 5. Core recovery,chronostratigraphic epochs, absolute palynomorph concentrations (number per gram of dry sediment), palynomorph relative content (dinocysts, acritarchs, terrestrial palynomorphs,and relative abundance of dinocyst eco-groups (in percent of dinocysts) for the Oligocene–Miocene of site 1168A and dinocyst assemblage in the surface sample of 1168C replotted from Prebble et al., (2013)[15]

Conclusions

1. SSTs at ACC subtropical front follow the deep ocean temperature derived from benthic foraminifera $\delta^{18}O$ stacks
2. Palynoloical results reveal environmental change at Oli-Mi transition and STF migration in the early Miocene, but the lack of Protoperidinioid is very different from the modern signal

Outlook and future research

1. Better TEX_{86} calibration for the polar region and correct from environmental bias
2. Scanning electron microscope study on acritarchs
3. Multi-sites compilation (Fig2)
4. Tentatively apply quantitative dinocyst assemblage proxy
5. Tentatively analyze single-species dinoflagellate (*Spiniferites* spp.) cyst $\delta^{13}C$

References

1.Stap et al., 2017 CP
2.Dutton et al., 2015 Science
3.Foster et al., 2017 Nature Com
4.Bereiter et al., 2015 GRL
5.Pachauri and Meyer, 2014 IPCC
6.Gasson et al., 2016 PNAS
7.Locarninir et al., 2013 NOAA
8.Kim et al., 2010 GCA
9.Hopmans et al., 2004 EPSL
10.Taylor et al., 2013 GPC
11.Weijers et al., 2011 3G
12.Blaga et al., 2009 JP
13.Zhang et al., 2012 EPSL
14.Zhang et al., 2016 Paleoceanography
15. Prebble et al., 2013 MM

Acknowlegements

This work is part of the ERC Starting Grant nominated to Dr. Peter Bijl. We also thank ICP13 committee for the travel grant to Suning Hou.