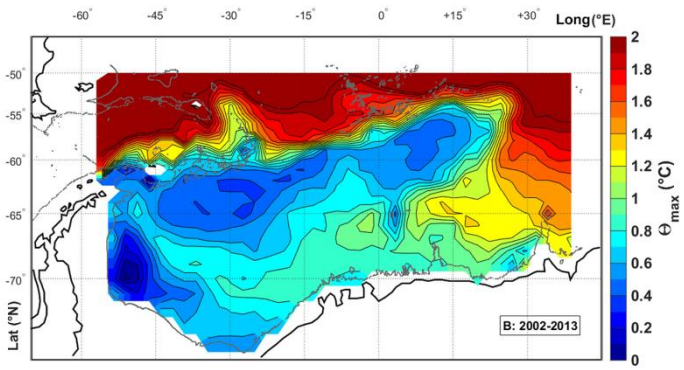
Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

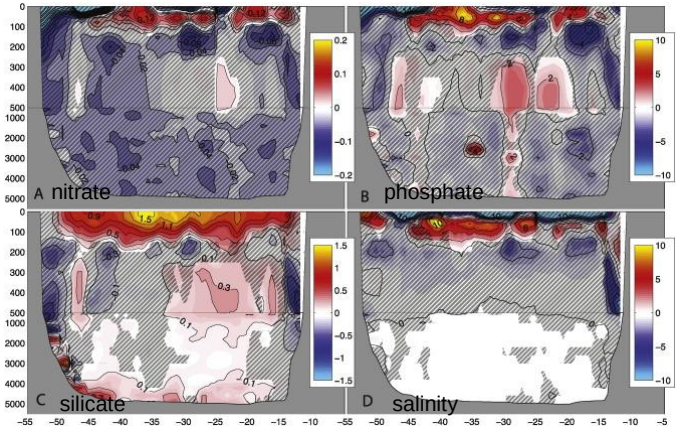
Challenge 1: *Assess variations in the physical and chemical environment in the Atlantic sector of the Southern Ocean through sustained observations.*

Float-Based Weddell Gyre Warm Water Inflow



Reeve, Boebel, Kanzow, Strass, Rohardt, Fahrbach. Earth Syst. Sci. Data, 2016

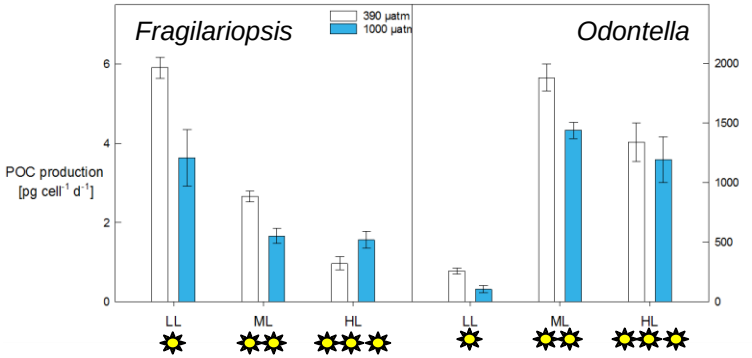
15-years Weddell Nutrient Trends from Repeat Stations



Hoppema, Bakker, van Heuven, Ooijen, de Baar. Marine Chemistry, 2015

Challenge 2: *Investigate the ecosystems' response to environmental changes for the different biogeographic provinces.*

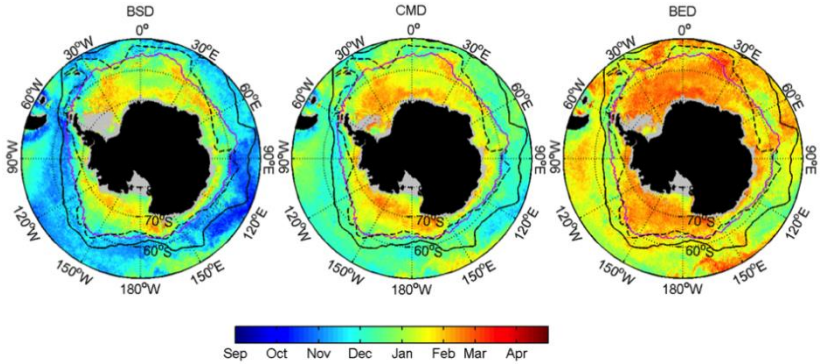
Lab Experiments with Phytoplankton Key Species



Heiden, Bischof, Trimborn,. Frontiers in Marine Science, 2016

Phytoplankton Phenology from Remote Sensing

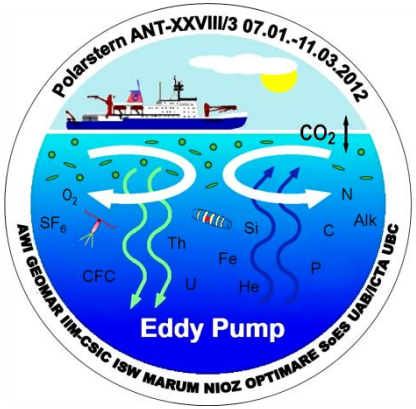
Soppa, Völker, Bracher. Remote Sensing, 2016



Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

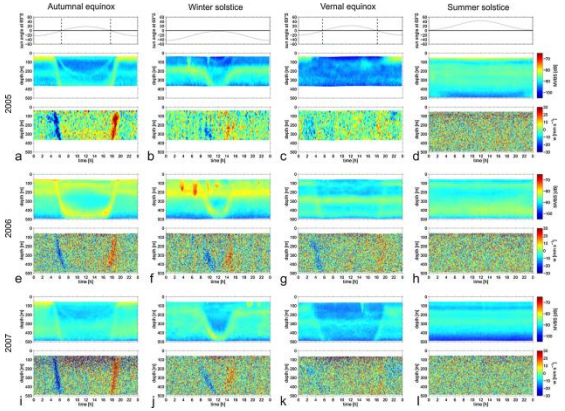
Challenge 3: *Identify the processes that couple the physical, chemical and biological realms and control biogeochemical fluxes.*

Process Studies by Interdisciplinary Research Cruises



DSR-II Special Issue, Guest-Eds.: Strass, Wolf-Gladrow and Pakhomov, Containing 10 papers (co)authored by WP1.5 scientists, 2017

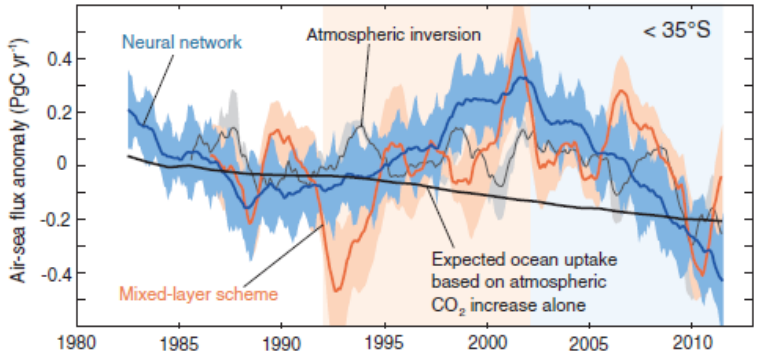
Zooplankton Dynamics from Multiannual Moorings



Cisewski & Strass. Progress in Oceanography, 2016

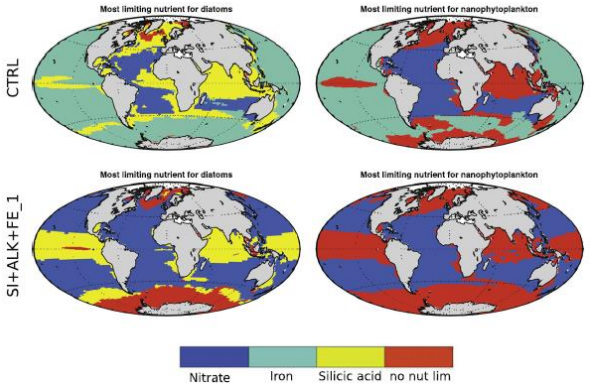
Challenge 4: *Determine the feedback mechanisms of the Southern Ocean system to the global climate.*

CO_2 Sink Evolution from Large-Scale Data Inversions



Land-schützer, …, Hoppema et al., Science, 2015

CO_2 Removal in Biogeochemical Model Simulations



Hauck, Köhler, Wolf-Gladrow, Völker. Environmeltal Research Letters, 2016

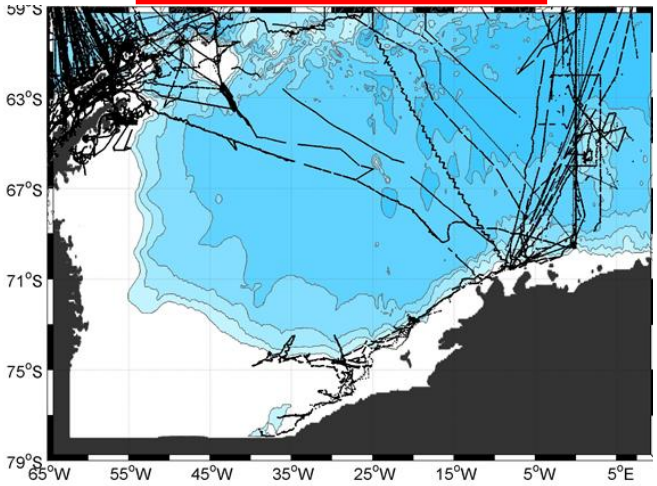
Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

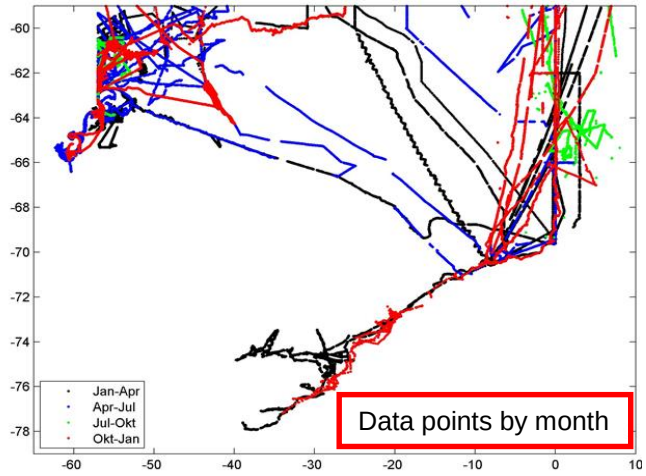
Partial pressure of CO_2 in the Weddell region / Mario Hoppema (AWI), Steven van Heuven (NIOZ)

General Oceanics pCO_2 system on board Polarstern since 2008

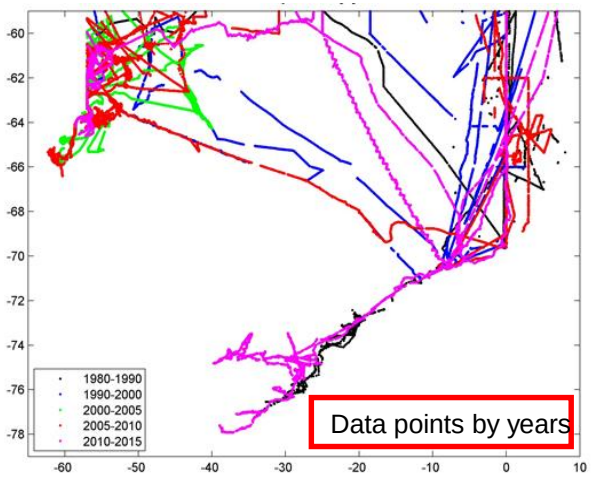
All data in SOCAT

All Weddell Sea data





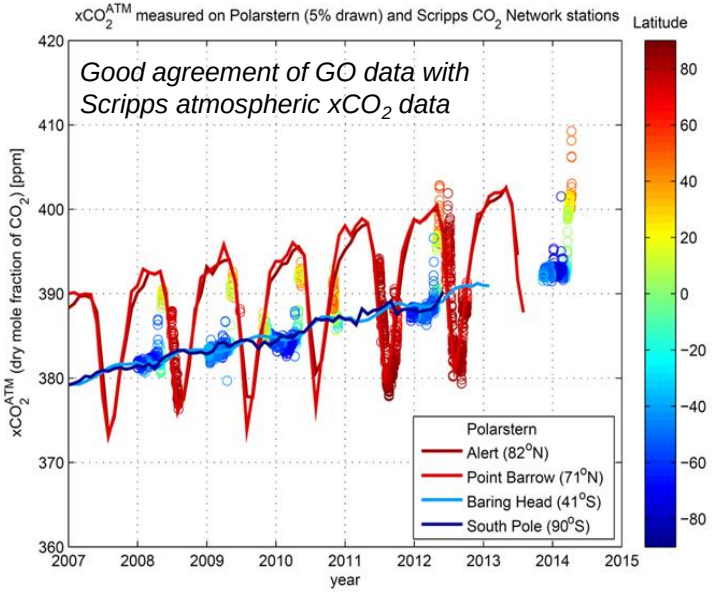
Data points by month



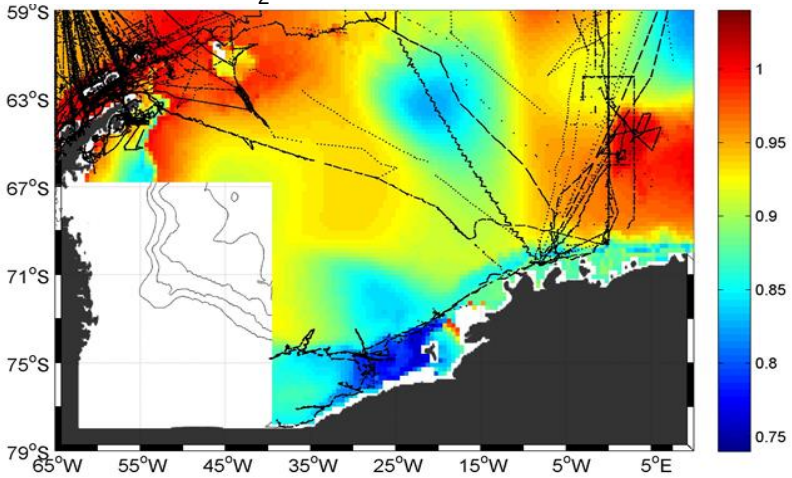
Data points by years

Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

Partial pressure of CO_2 in the Weddell region / Mario Hoppema (AWI), Steven van Heuven (NIOZ)



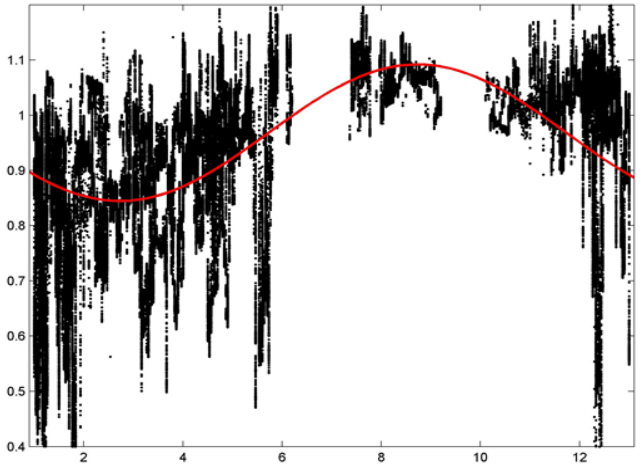
CO_2 saturation at surface



Multi-annual

Comp o-site

Annual cycle of CO_2 saturation



Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

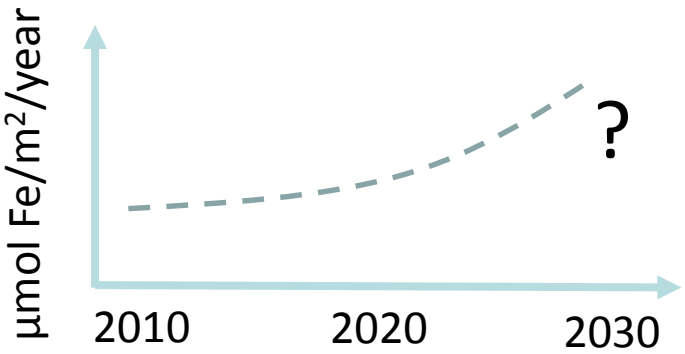
Tracers and trace element fluxes; Walter Geibert et al.

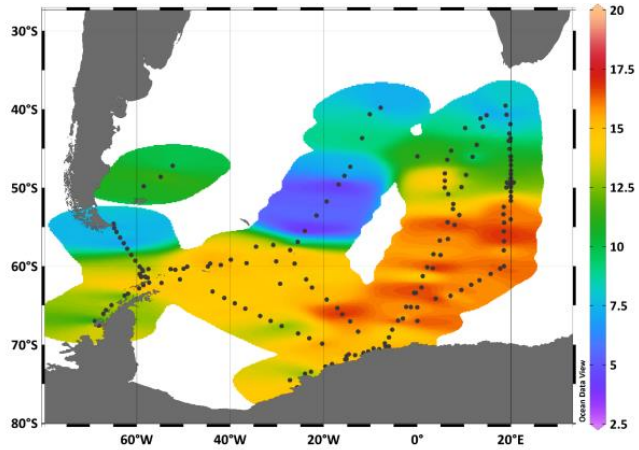
Aims:

Time series of natural radionuclide distribution to monitor circulation in the Weddell Gyre

Time series of trace element distribution in the Weddell Gyre to understand chemical limitation of productivity

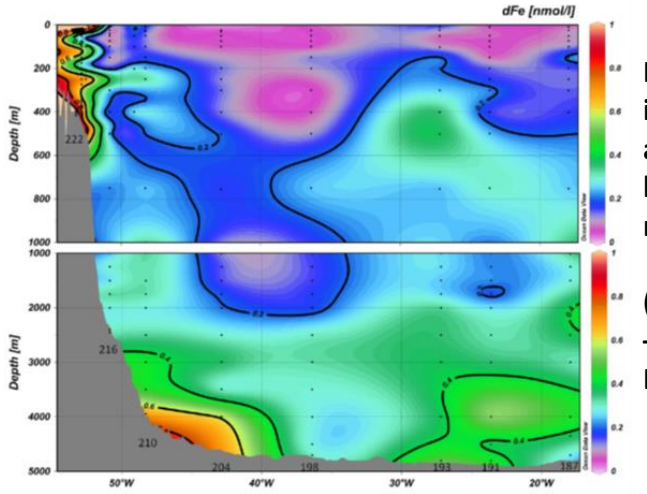
Merging radionuclide and trace element distribution to quantify changes in biogeochemistry due to changing environmental parameters





Radium-226 as an example of a tracer for deep upwelling.

(Vernet et al. in prep; data: Hanfland-AWI)



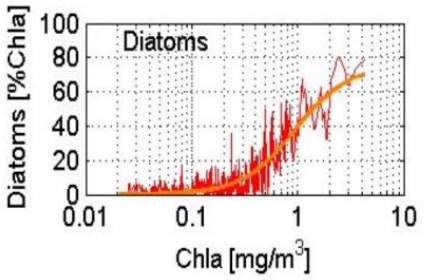
Dissolved iron in the Weddell Gyre as an example for a limiting micronutrient.

(Klunder et al. 2014 – NIOZ on Polarstern)

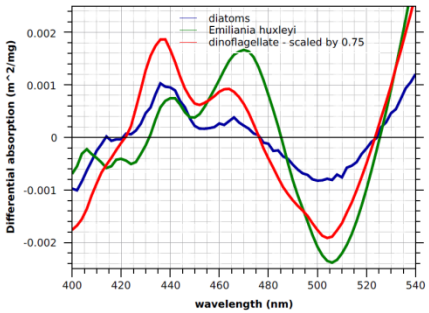
Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

PHYTOOPTICS; Astrid Bracher and Group

ESA- SynSenPFT: Combining hyper- (PhytoDOAS/SCIAMA-CHY) and multi- (OCPFT/OC-CCI)spectral satellite phyto-plankton group (PFT) data

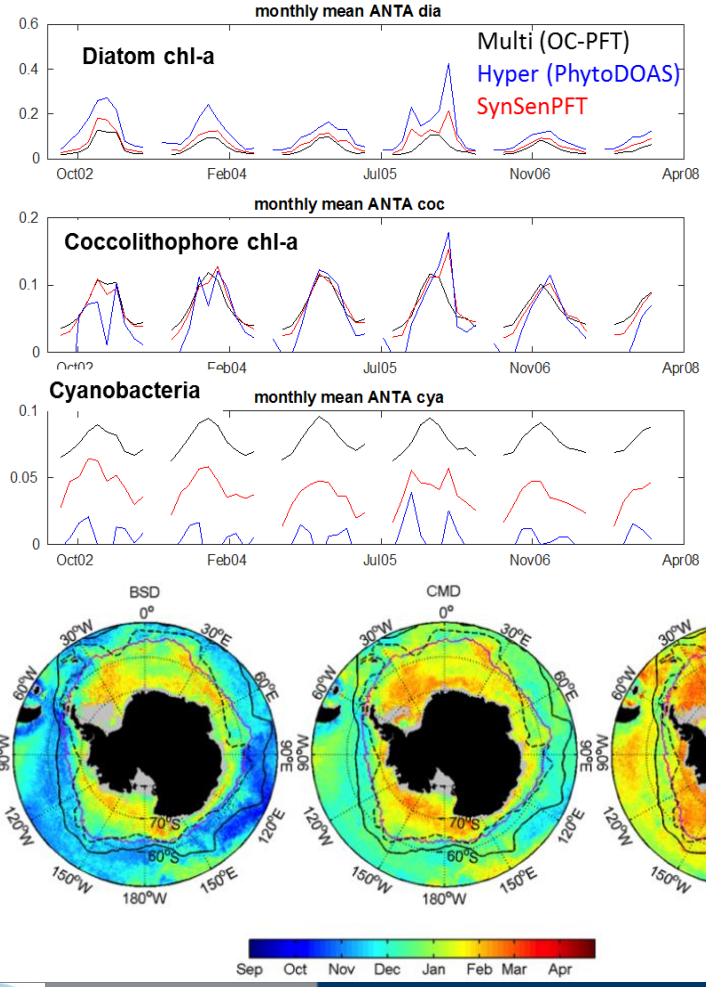


Multi-Spectral: OC-PFT abundance based method;
good resolution of common ocean color satellite data, but global relationships have high uncertainty locally



Hyperspectral:
PhytoDOAS optical method;
Current satellite data only coarse resolution (Monthly; 30x60 km)

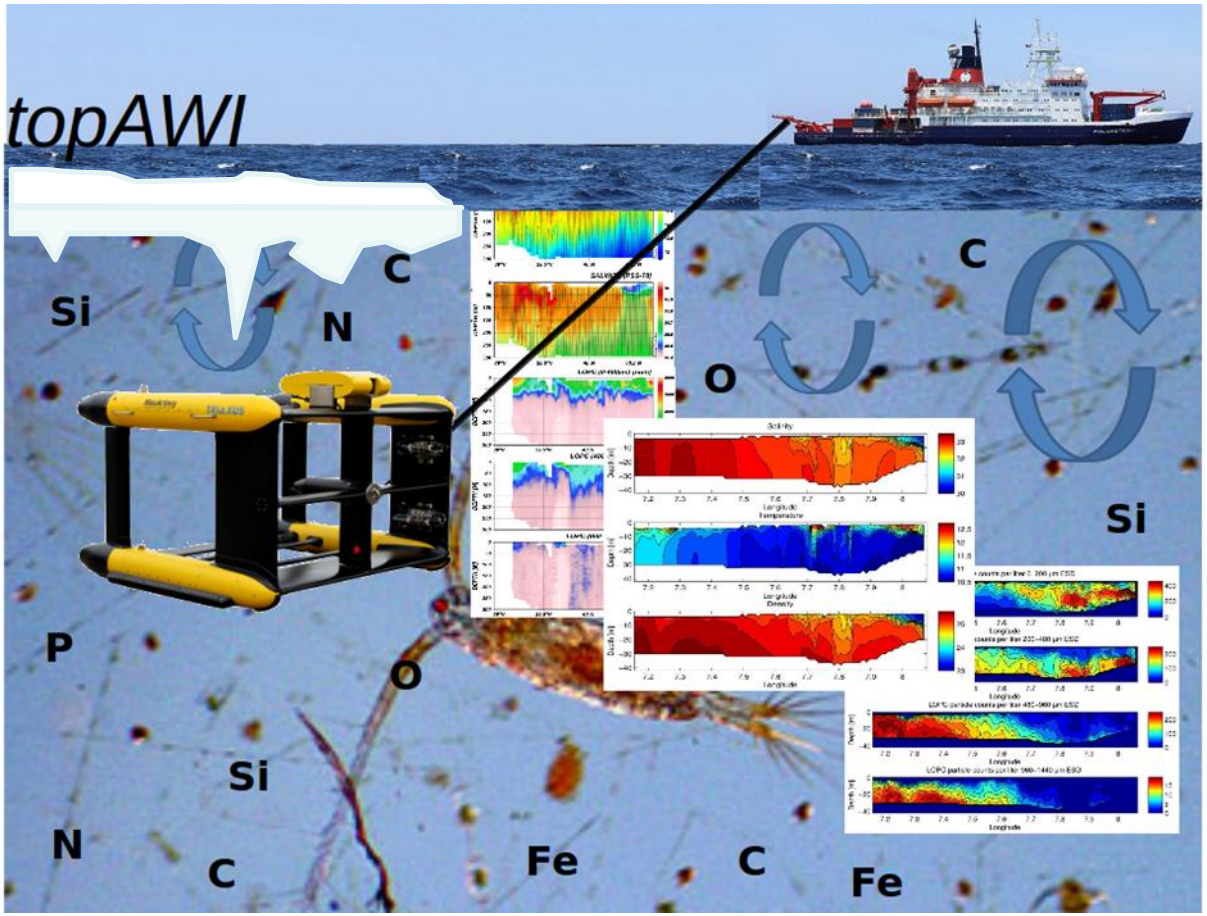
Use SynSenPFT product: Phytoplankton groups phenology



S. Losa et al., Frontier in Marine Science (revised)

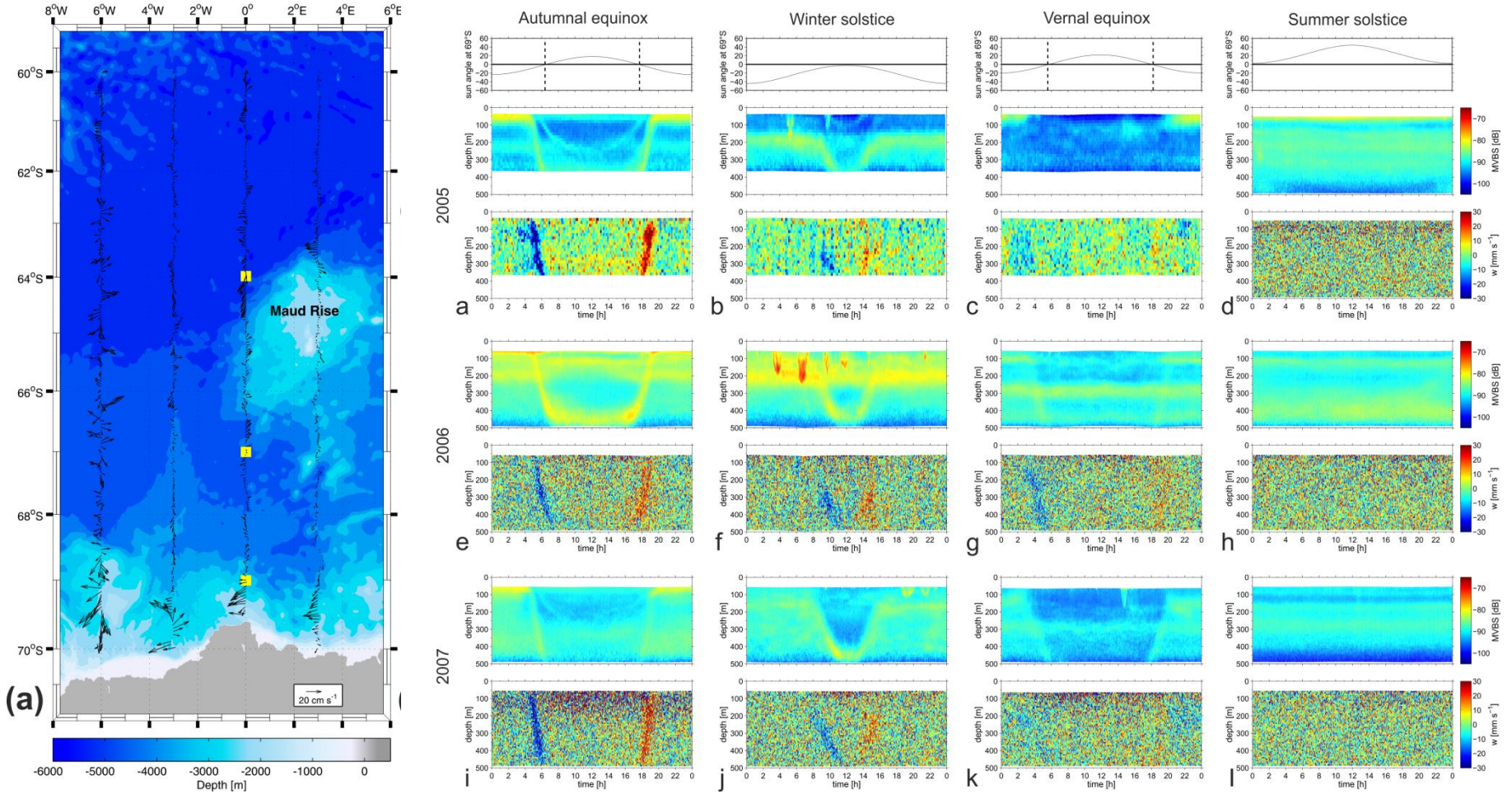
Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

Repeat multi-disciplinary transects employing the new towed ocean profiler of the AWI (topAWI)



Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

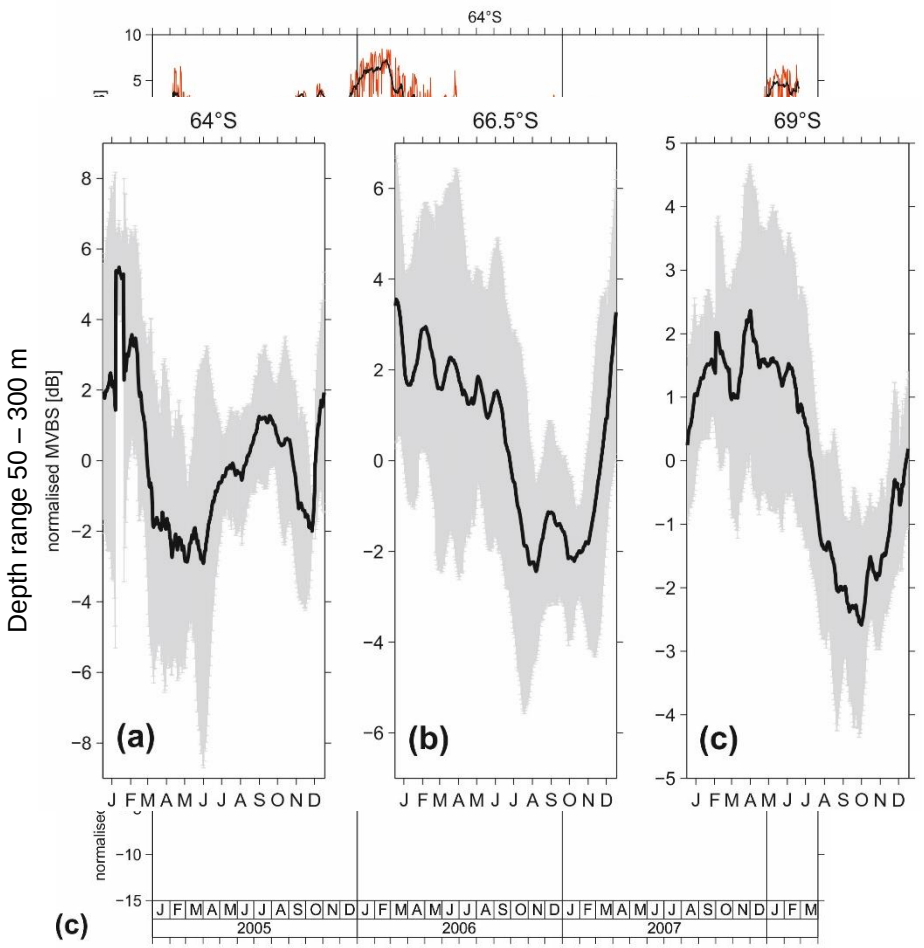
Zooplankton Dynamics from Multiannual Moorings

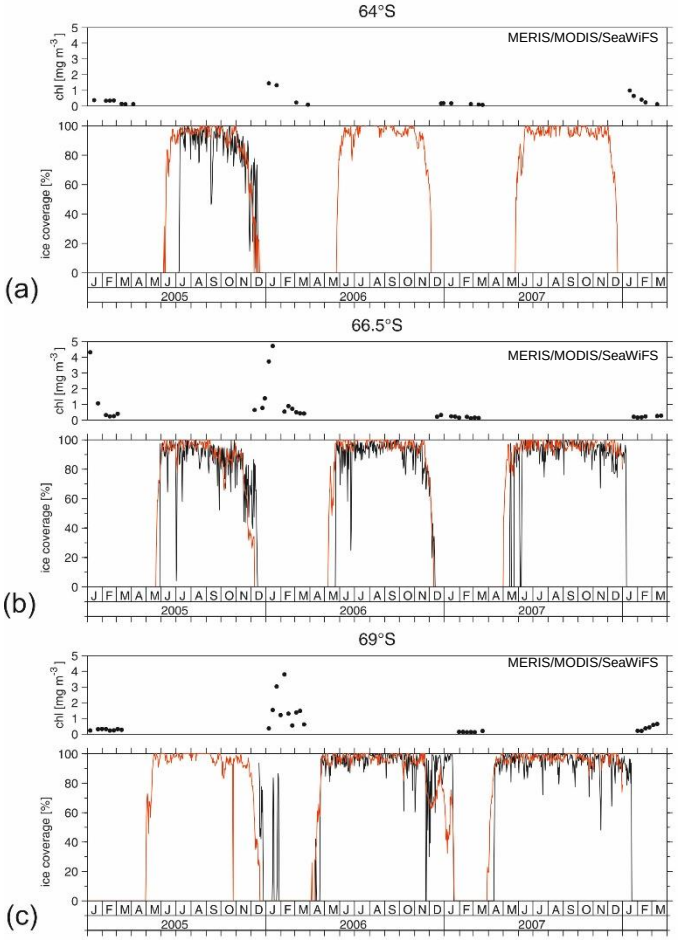


Cisewski & Strass (2016). Acoustic insights into the zooplankton dynamics of the eastern Weddell Sea. Progress in Oceanography

Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

Zooplankton Dynamics from Multiannual Moorings

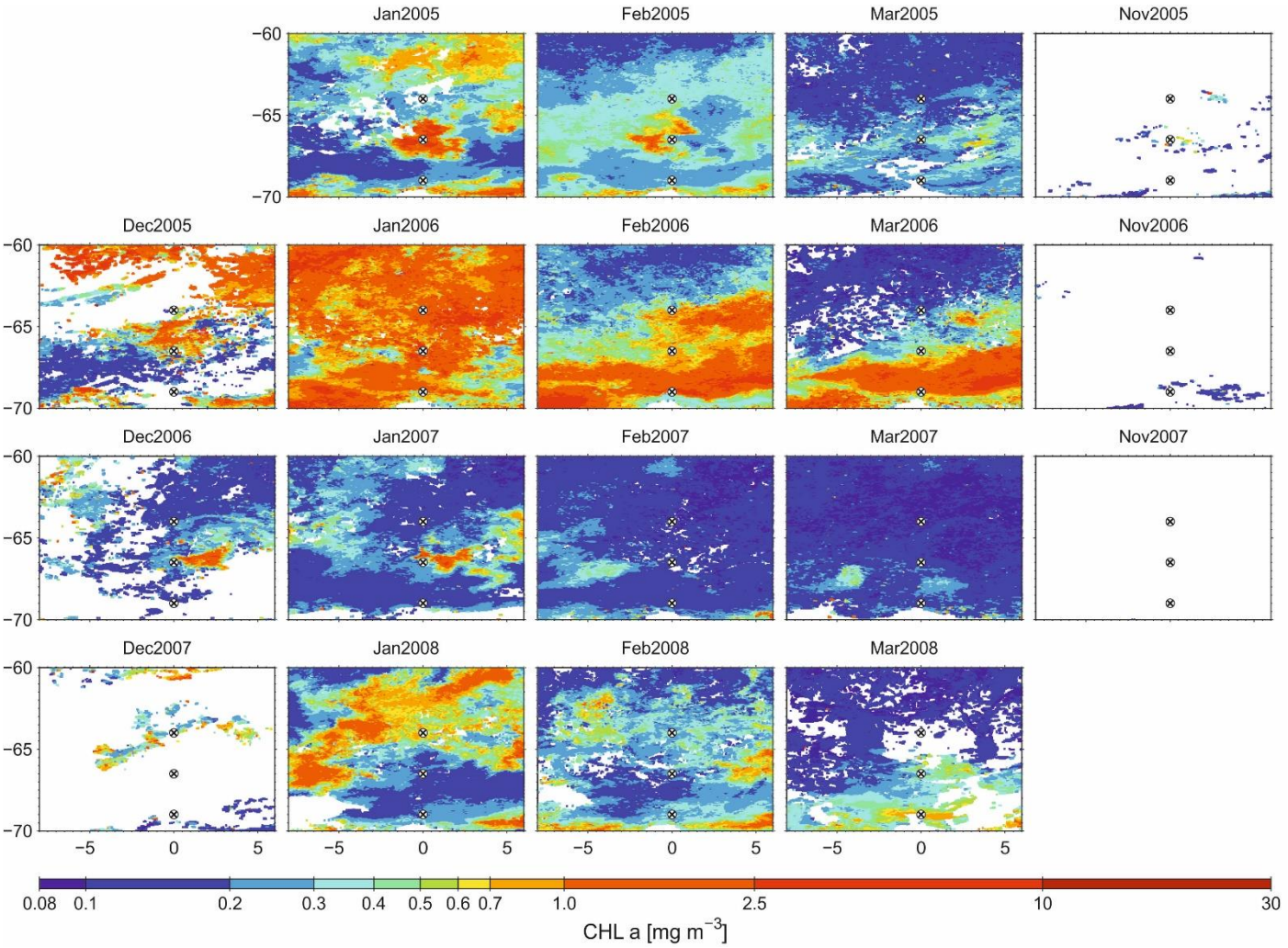




Cisewski & Strass (2016). Acoustic insights into the zooplankton dynamics of the eastern Weddell Sea. Progress in Oceanography

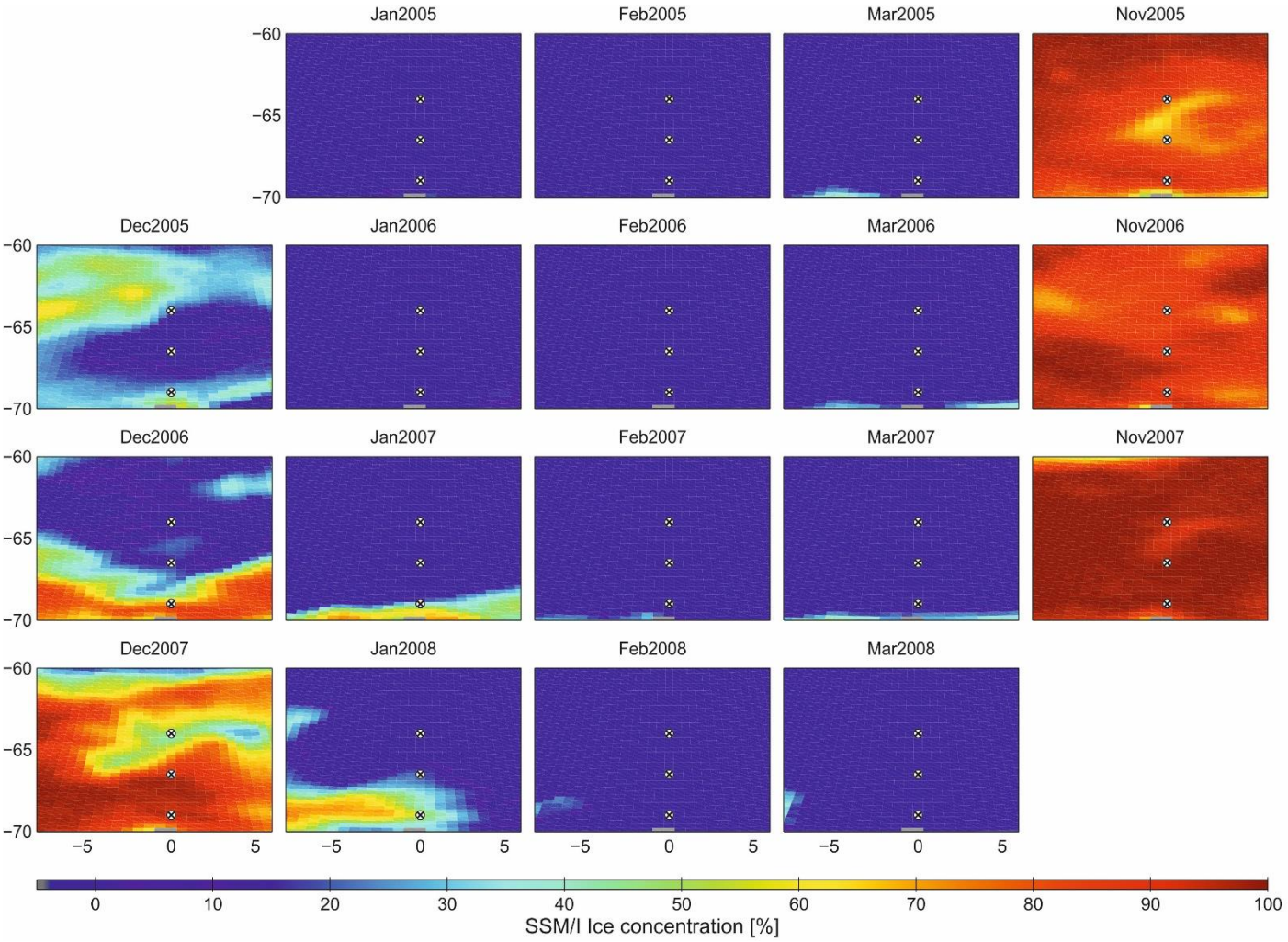
Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

Zooplankton Dynamics from Multiannual Moorings



Cisewski & Strass (2016). Acoustic insights into the zooplankton dynamics of the eastern Weddell Sea. Progress in Oceanography

Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate



Zooplankton Dynamics from Multiannual Moorings

- All observed phytoplankton blooms occured within shallow mixed layers left behind the retreating sea ice.
- But blooms did not develop wherevever the mixed layer was shallow.

⟹ Why ?

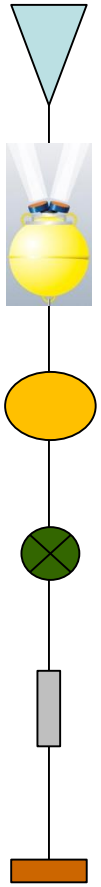
Interannual variability due to top-down control?

Hypothesis:

Phytoplankton spring development can be curbed by grazing when the zooplankton had attained high abundance by growth during the preceding summmer (match-mismatch problem).

Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

Need for multi-disciplinary long-term moorings



sediment trap (@AWI: Christine Klaas) and/or ULS

ADCP

multi-frequency zooplankton sounder

current meters

ct recorders

Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

Observations to link

SOOS

pogo

OASIIS

with

ICED

Integrating Climate and Ecosystem Dynamics in the Southern Ocean

SCAR

International Council for Science

SCOR

Scientific Committee on Oceanic Research