

Paradise melting away

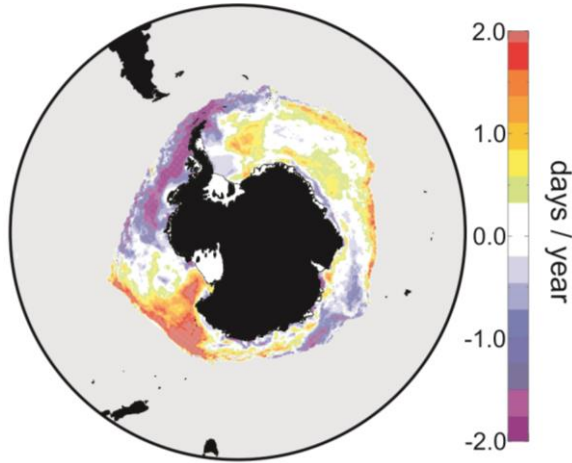


Understanding the functioning of sea-ice ecosystems in times of rapid climate change

H. Flores, C. David, B. Lange, D. Kohlbach, J. Ehrlich, G. Castellani, M. Vortkamp, F. Schaafsma, J.A. van Franeker, M. Nicolaus, C. Katlein, M. Graeve, I. Peeken, K. Metfies, B. Rabe, B. Niehoff, M. Losch, T. Krumpen, C. Haas a.m.o.

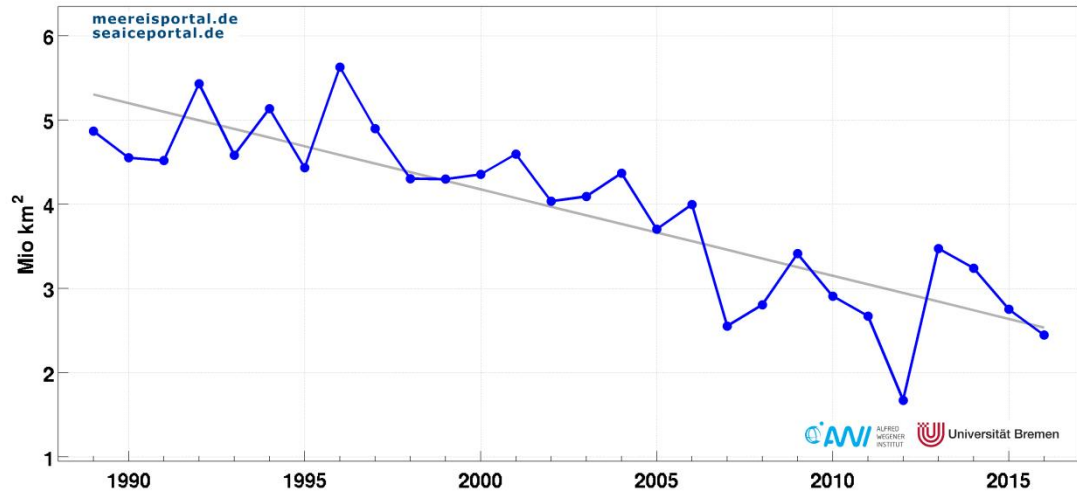
Changing sea ice habitats

Change in duration of sea ice season



Flores et al. (2012)
Mar Ecol Prog Ser

September-Mittel der Meereis-Fläche in der Arktis von 1989-2016



AWI ALFRED WESINGER INSTITUT Universität Bremen



Polar bear



Polar cod



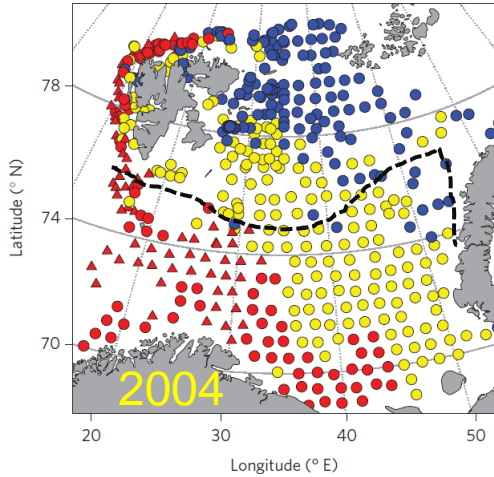
Ice amphipod



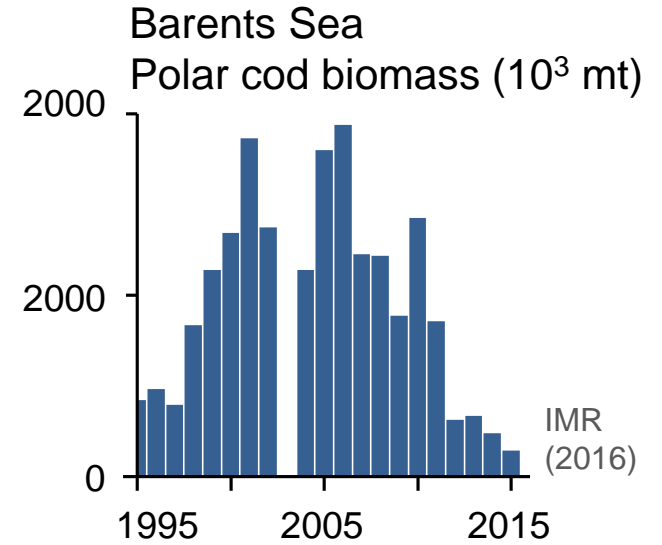
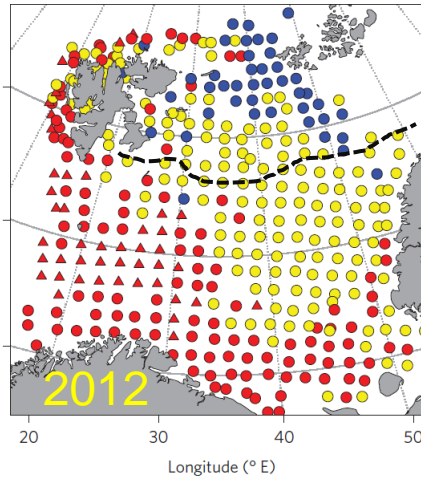
Ice algae



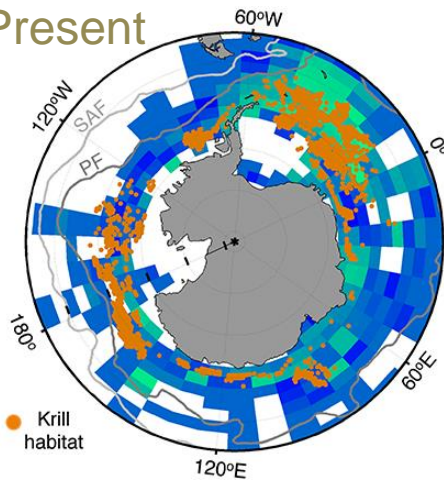
Changing sea ice habitats



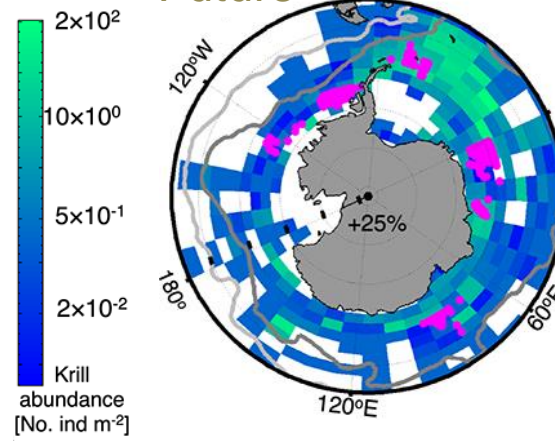
Ice edge
(March)



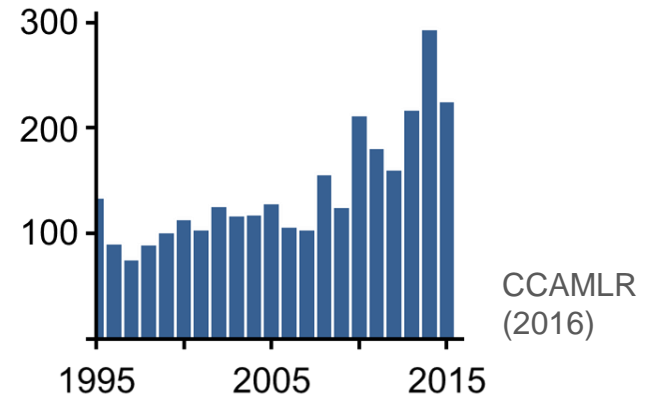
Present



Future



Krill catch (10^3 mt)



Changing sea ice habitats



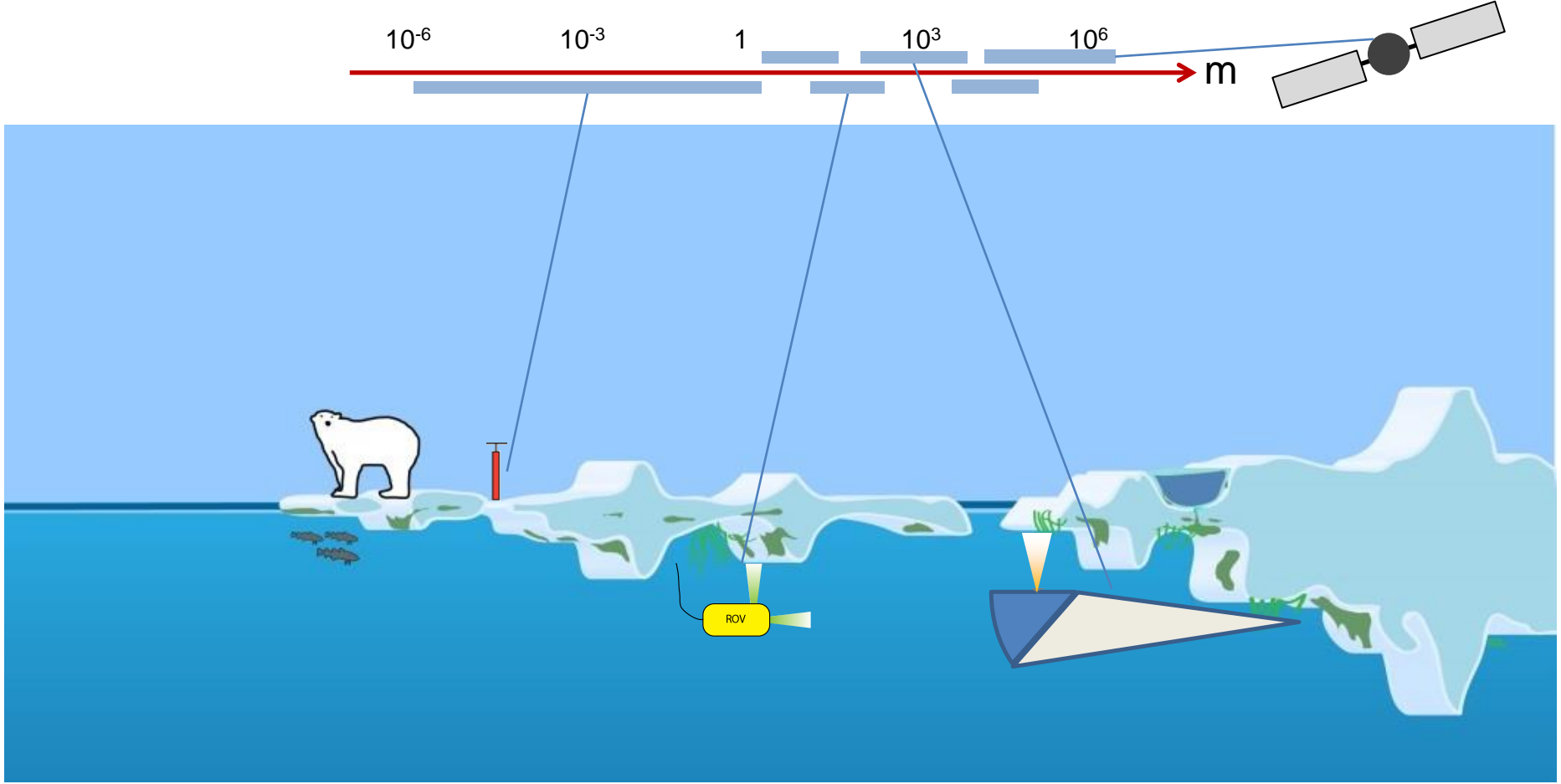
Motivation



To provide (...) understanding of the (...) consequences of variation in sea ice cover for the hydro-, bio- and geosphere of the Arctic Ocean and beyond

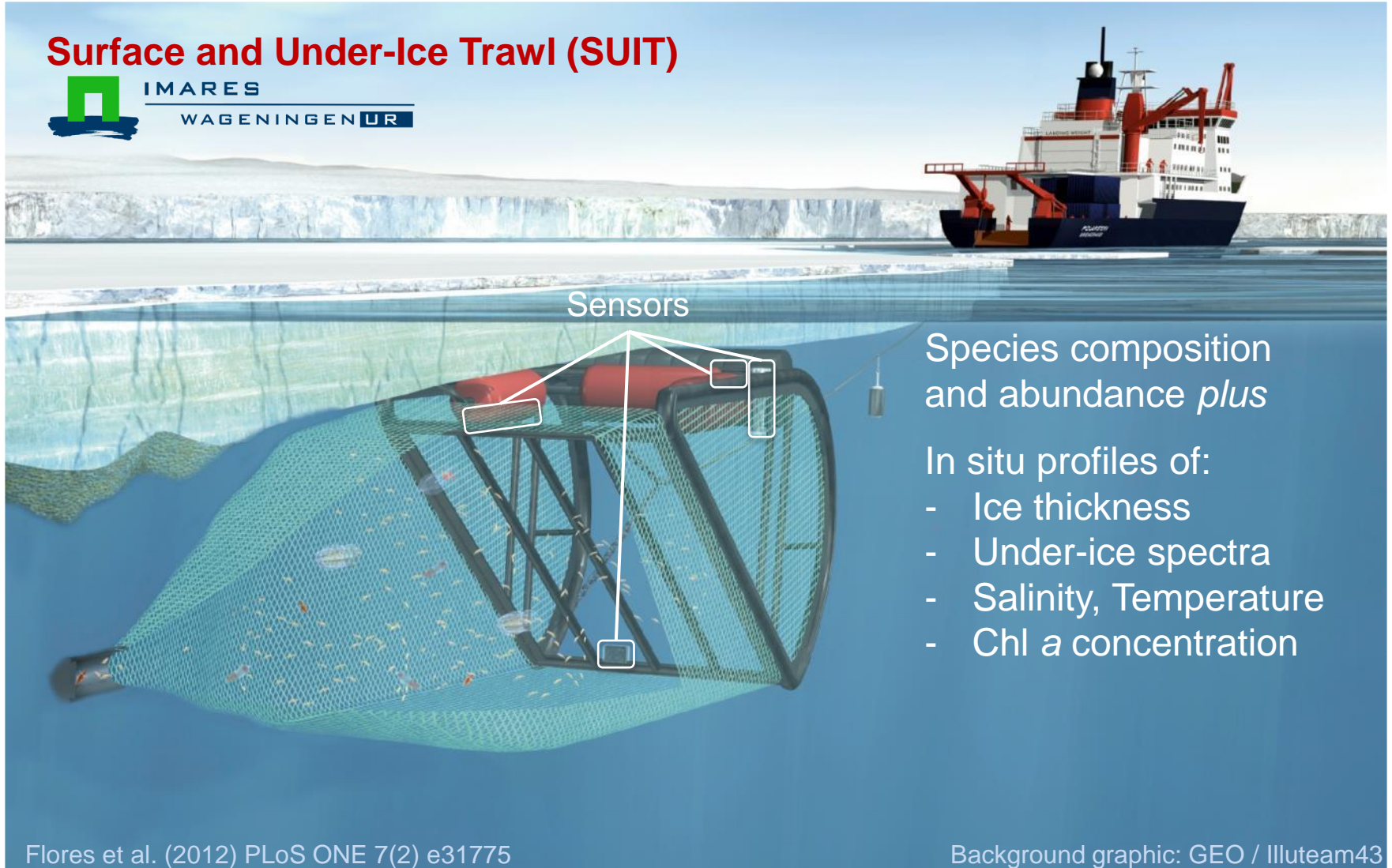
PACES II, WP 1.4 Mission statement

Scales of variability



Bio-environmental sampling

Surface and Under-Ice Trawl (SUIT)



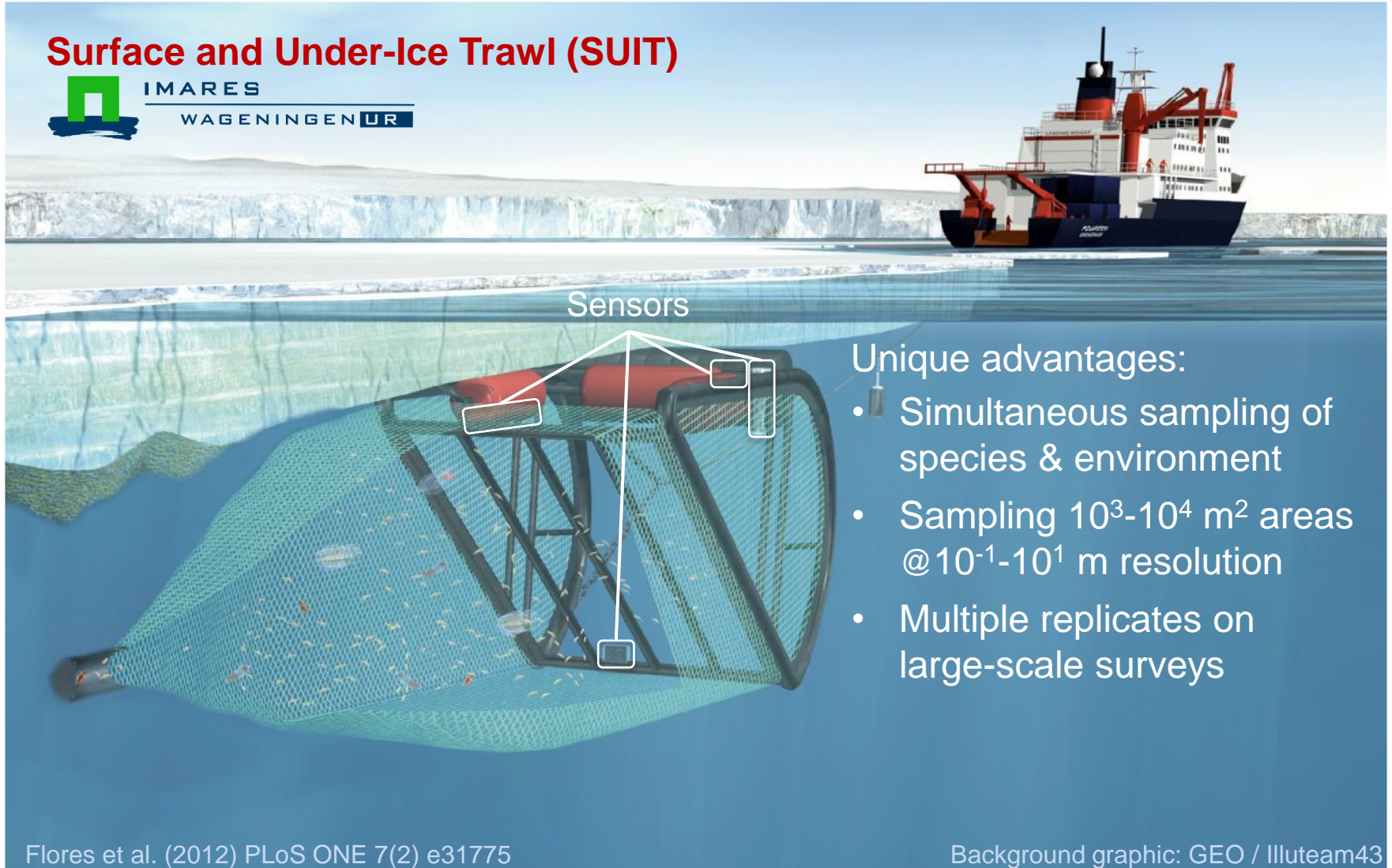
Species composition
and abundance *plus*

In situ profiles of:

- Ice thickness
- Under-ice spectra
- Salinity, Temperature
- Chl a concentration

Bio-environmental sampling

Surface and Under-Ice Trawl (SUIT)



Sensors

Unique advantages:

- Simultaneous sampling of species & environment
- Sampling 10^3 - 10^4 m² areas @ 10^{-1} - 10^1 m resolution
- Multiple replicates on large-scale surveys

Flores et al. (2012) PLoS ONE 7(2) e31775

Background graphic: GEO / Illuteam43

Under-ice fauna



Beroe sp.



Calanus glacialis



Clione limacina



Gammarus wilkitzkii



Beroe sp.



Boreogadus saida



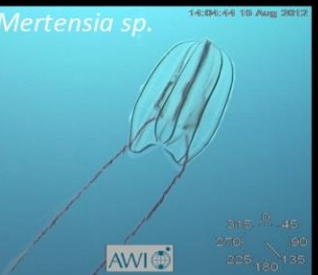
Limacina helicina



Calanus hyperboreus



Aethotaxis mitopteryx



Mertensia sp.



Eusirus microps



Clione limacina antarctica



Euphausia superba



Salpa thompsoni

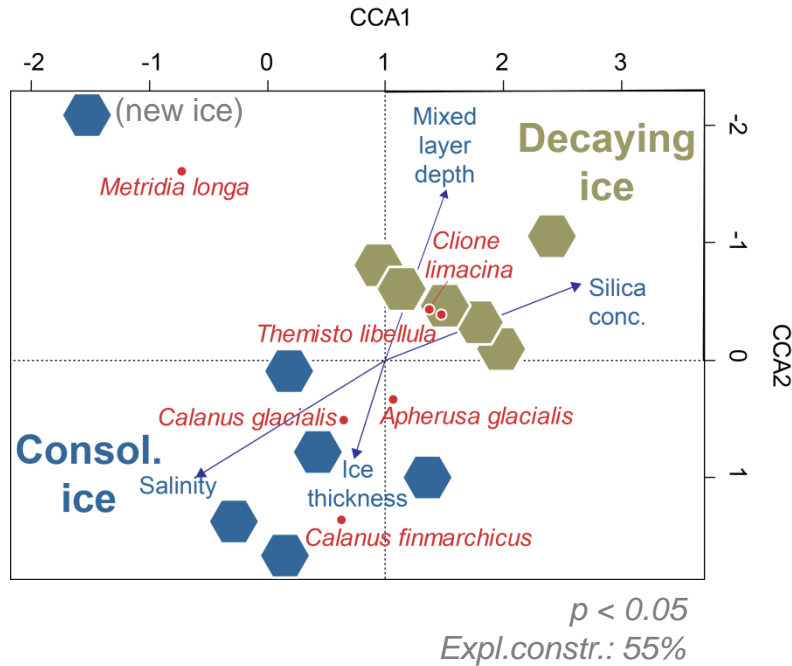


Tomopteris sp.

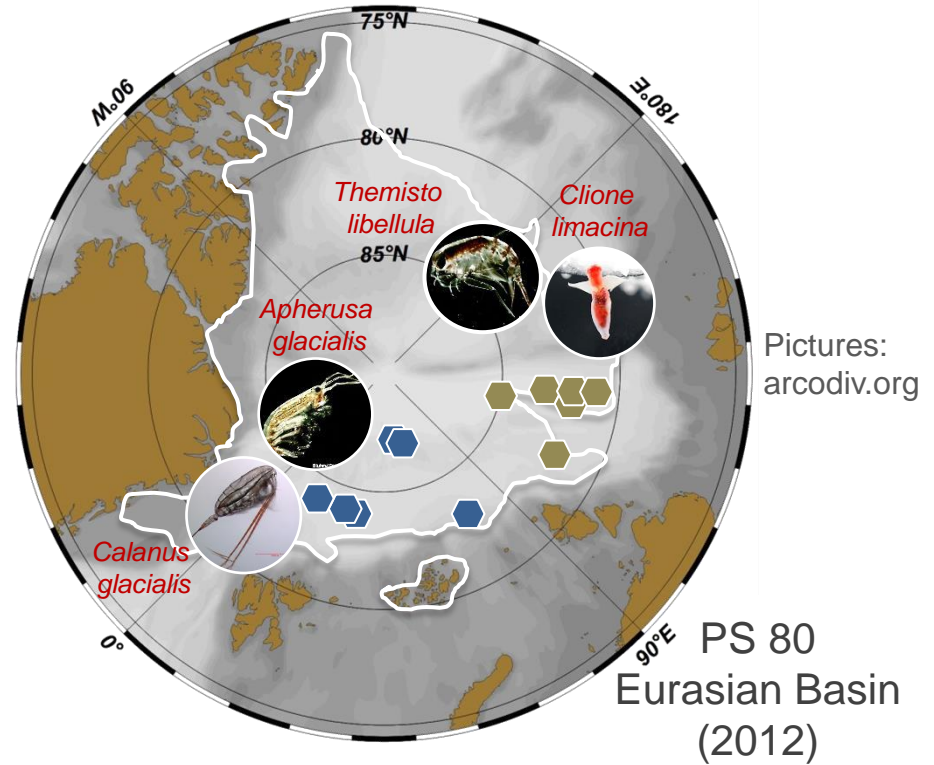
ARCTIC AND ANTARCTIC UNDER-ICE FAUNA

Photos: Carmen David, Christian Katlein, Jan Andries van Franeker, Julia Ehrlich, Hauke Flores

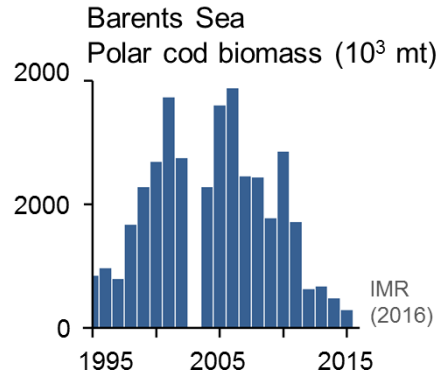
Community structure



Canonical Correspondence Analysis of under-ice community structure



Polar cod



Stock size (Barents Sea)

Mean: 766,000 mt
2015: 148,000 mt



Prey
Copepods
amphipods



Predators
Seals
seabirds

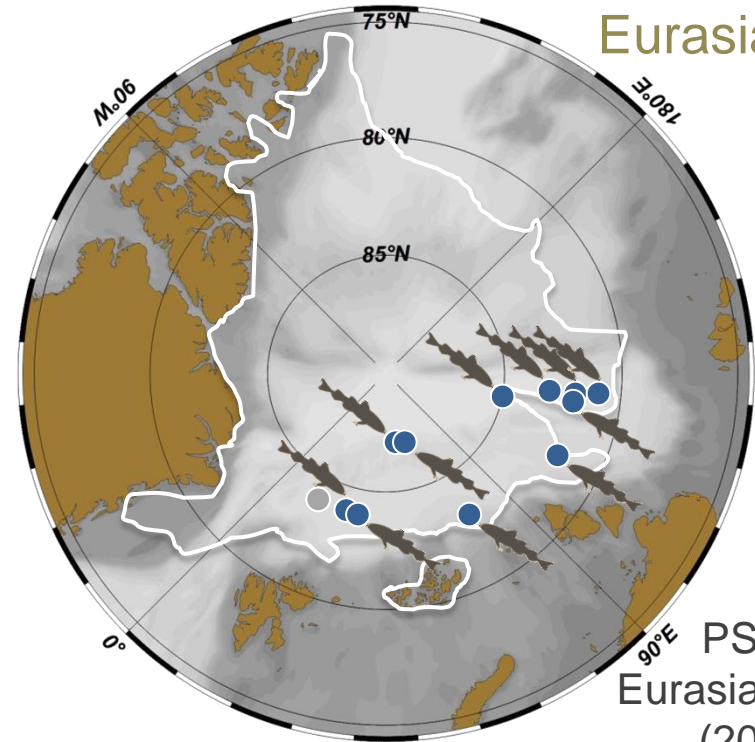
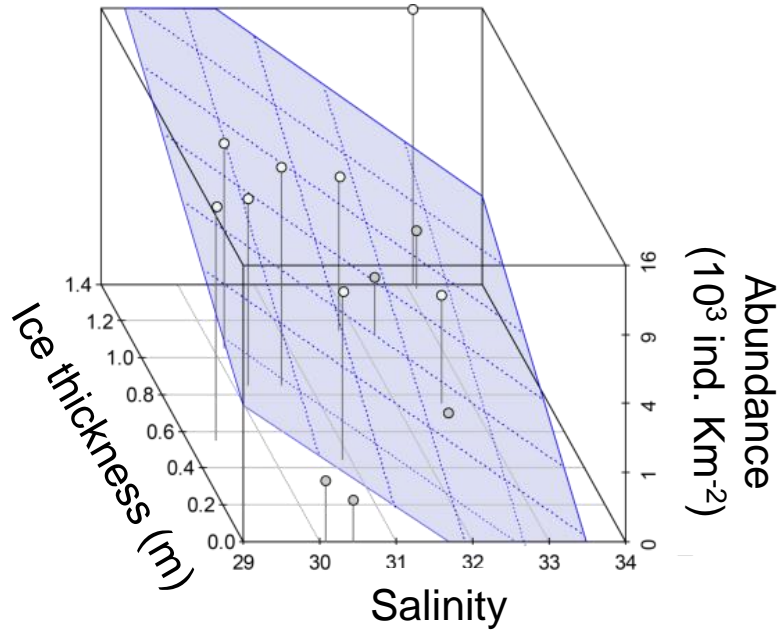


1st-year Polar cod
Boreogadus saida

Human value
Minor fishery
Artisanal hunting

Polar cod

PS 80
Eurasian Basin

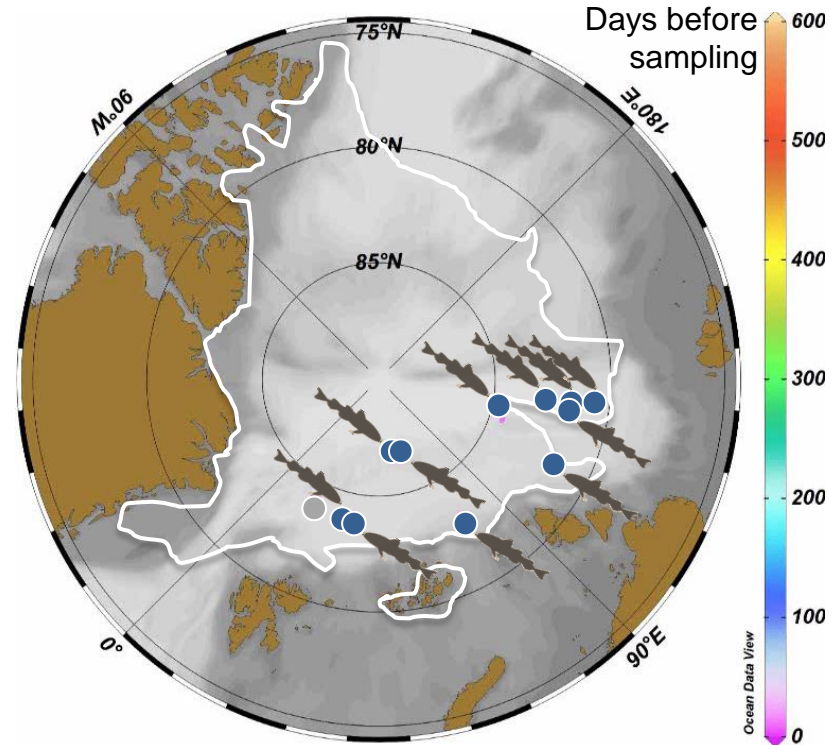
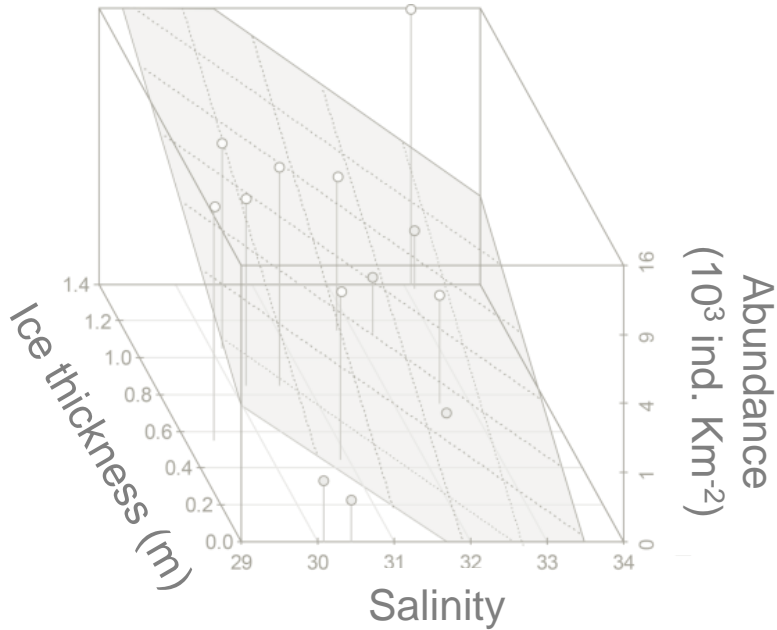


PS 80
Eurasian Basin
(2012)

Generalized Linear Model
Polar cod abundance as a function of
ice thickness and surface salinity

David et al. (2016) *Polar Biol*

Polar cod

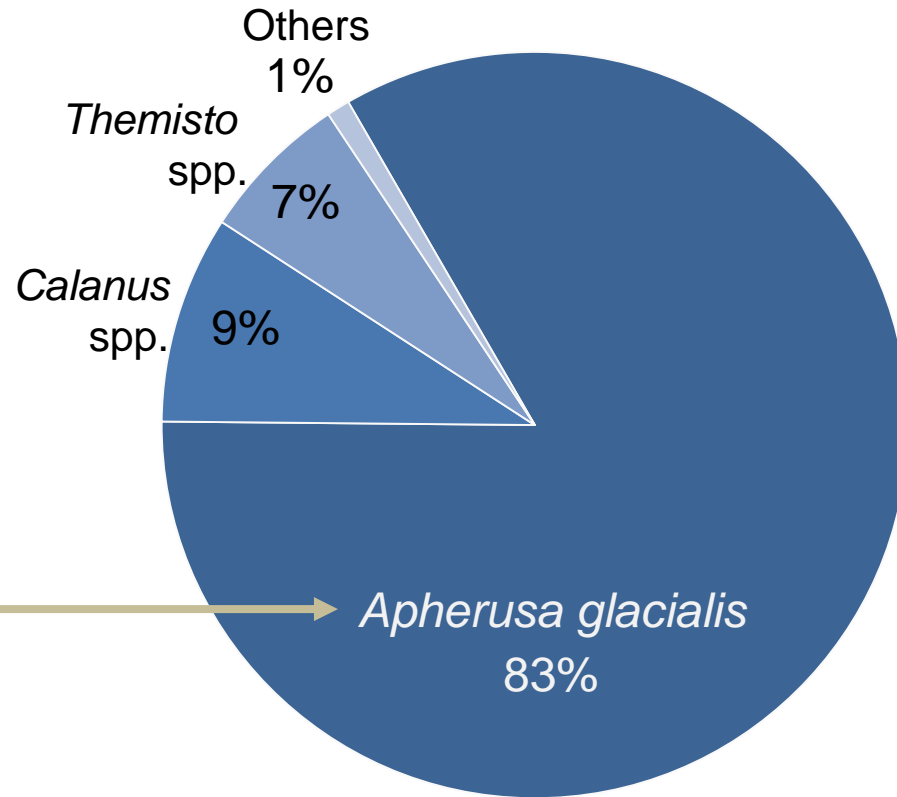
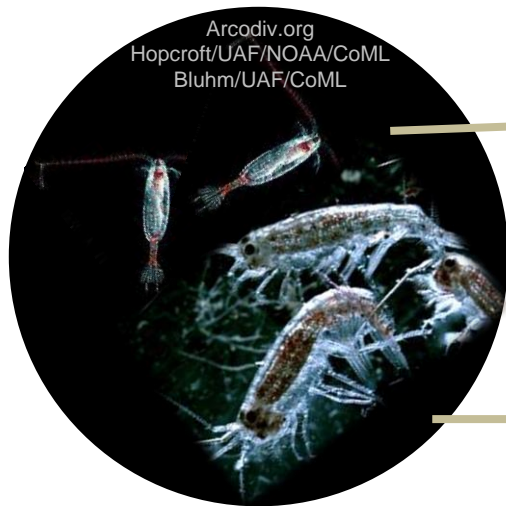


Generalized Linear Model
Polar cod abundance as a function of
ice thickness and surface salinity

Sea ice back-tracking

David et al. (2016) *Polar Biol*

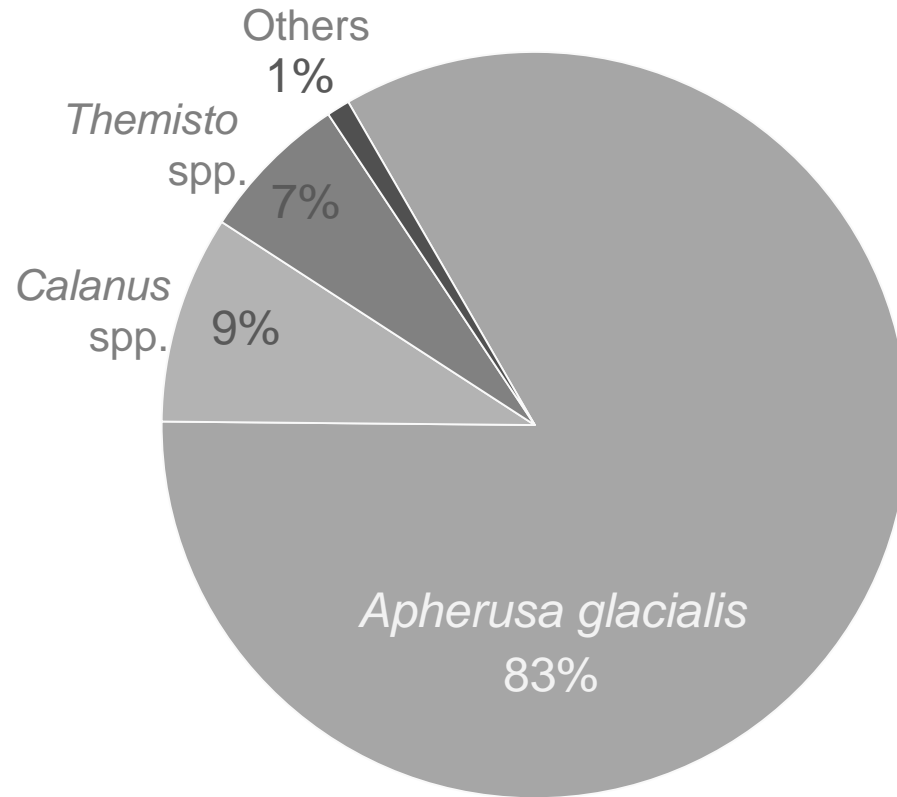
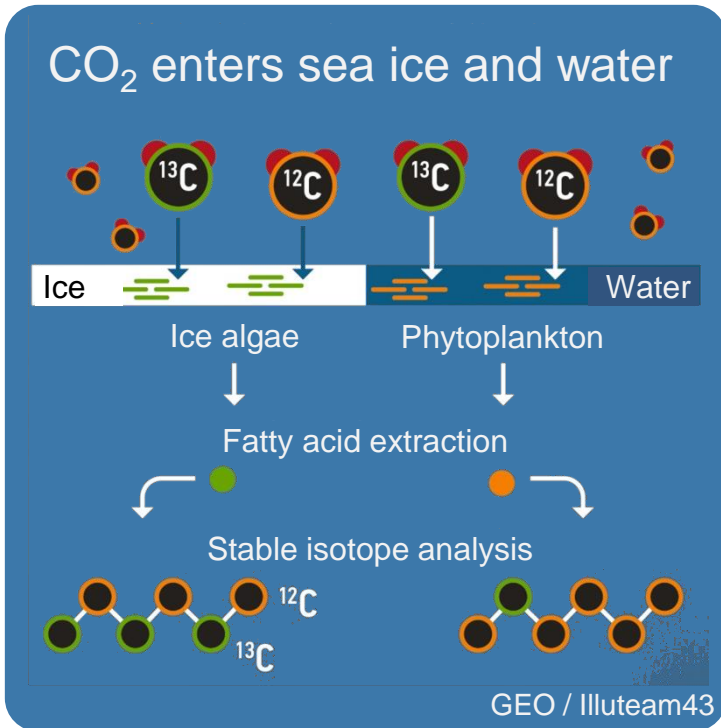
Polar cod



Proportional diet composition
by mass (%)

Kohlbach et al. (in review) *Progr Oceanogr*

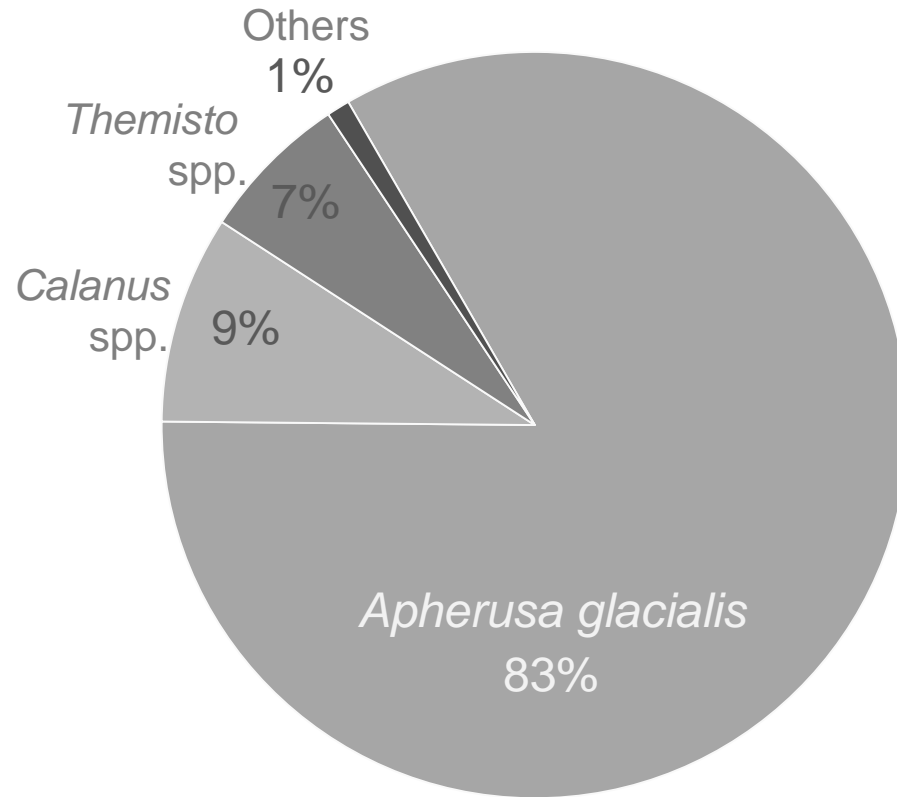
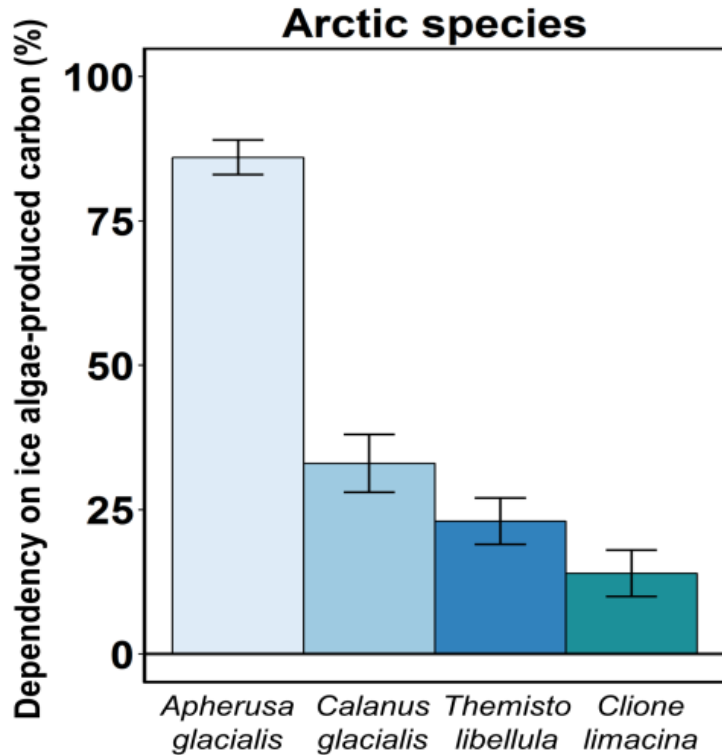
Ice-ecosystem carbon flux



Proportional diet composition
by mass (%)

Kohlbach et al. (in review) *Progr Oceanogr*

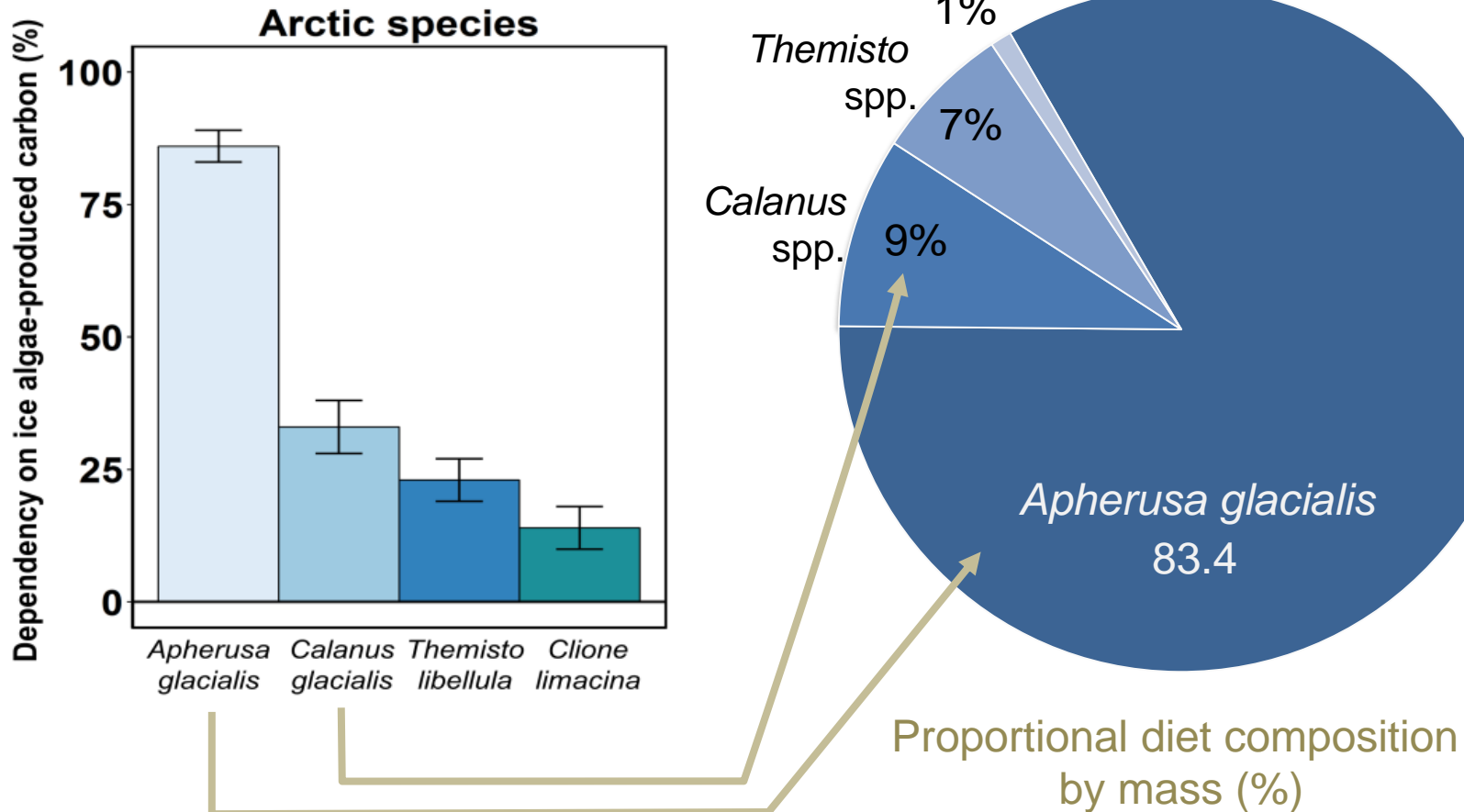
Ice-ecosystem carbon flux



Proportional diet composition by mass (%)

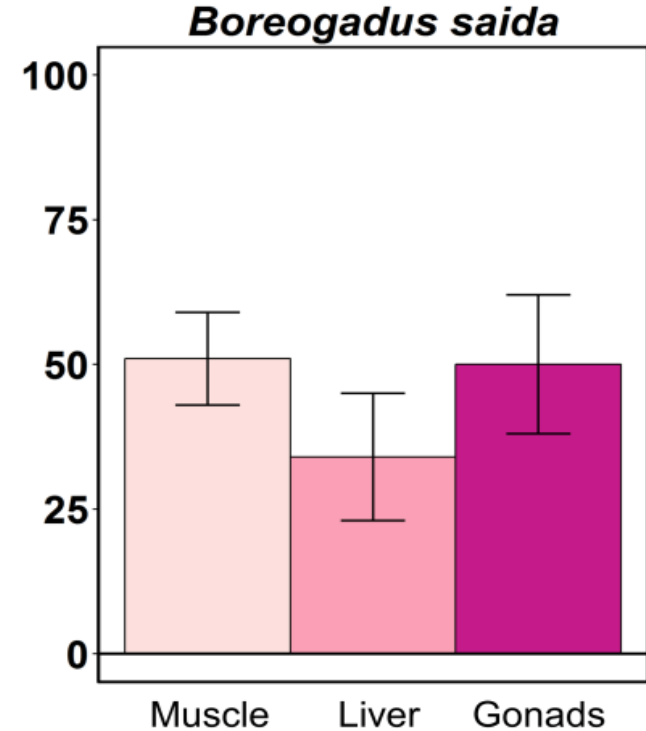
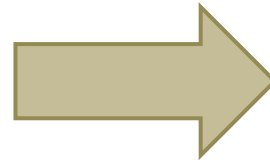
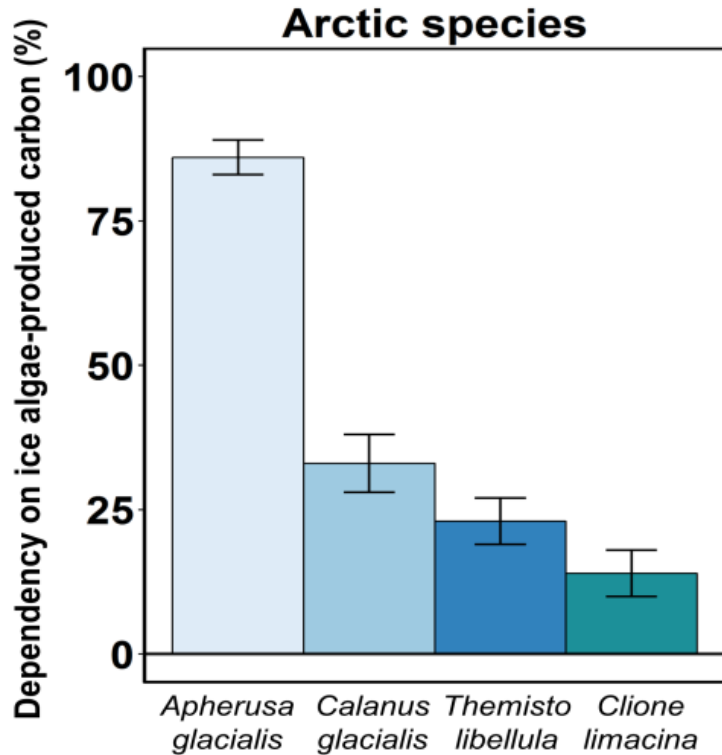
Kohlbach et al. (in review) *Progr Oceanogr*
Kohlbach et al. (2016) *Limn Oceanogr*

Ice-ecosystem carbon flux



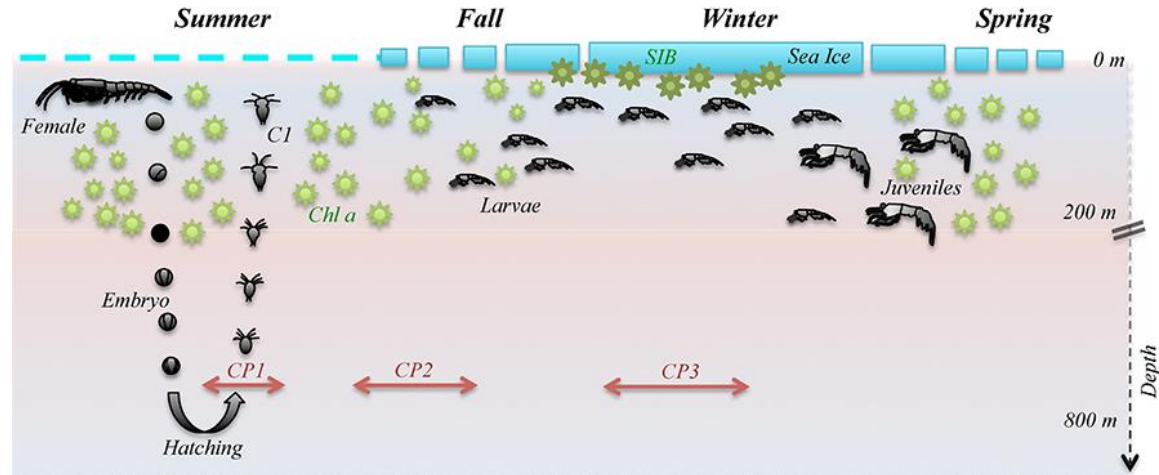
Kohlbach et al. (in review) *Progr Oceanogr*
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Ice-ecosystem carbon flux



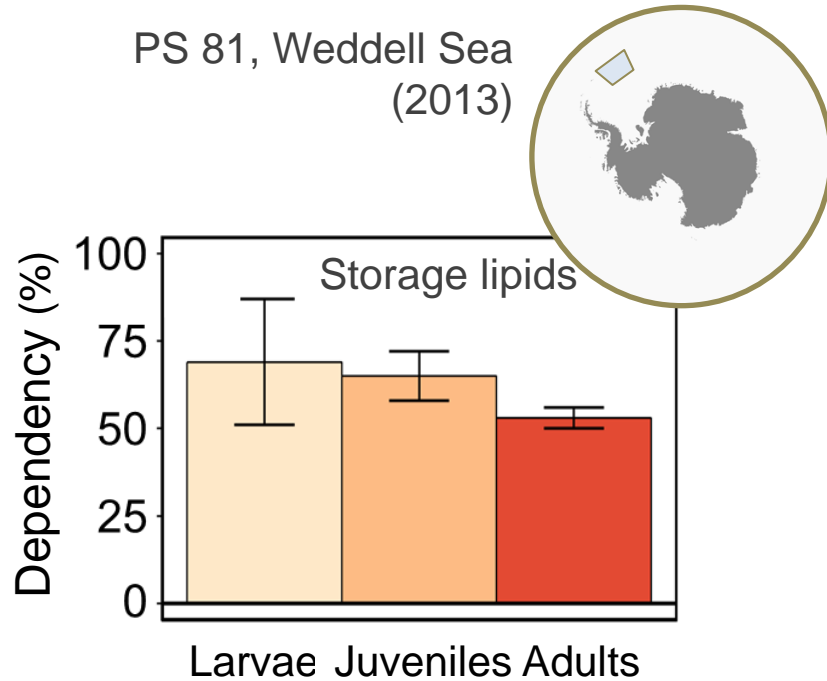
Kohlbach et al. (in review) *Progr Oceanogr*
Kohlbach et al. (2016) *Limn Oceanogr*

Ice-ecosystem carbon flux

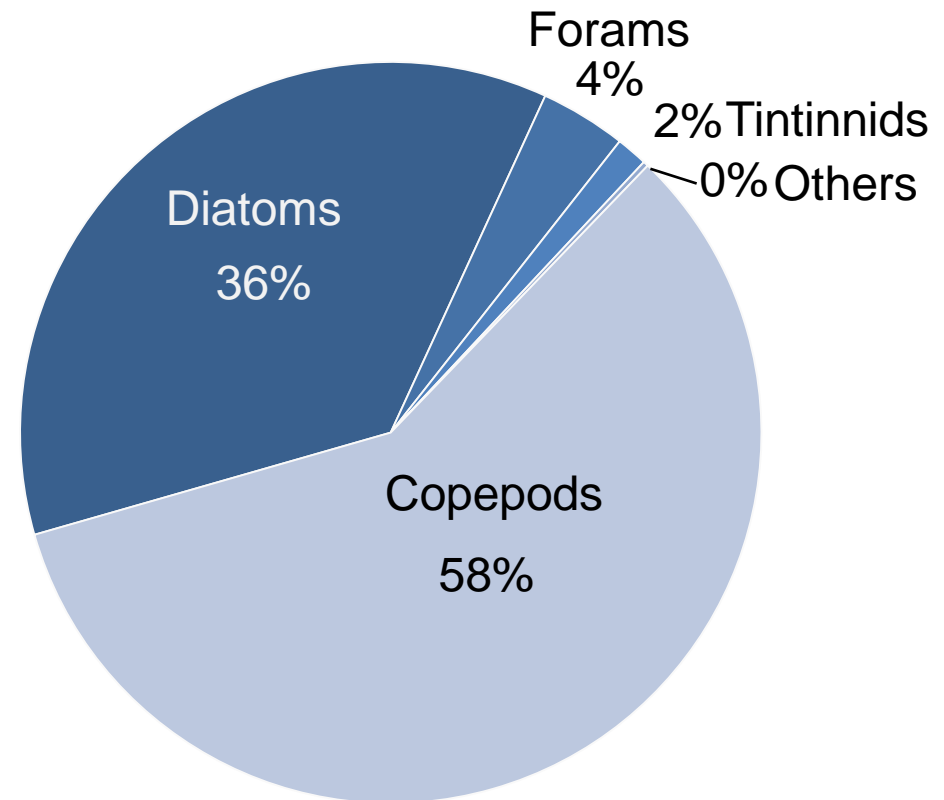


Pinones et al. (2017) *Geoph Res Let*

Ice-ecosystem carbon flux



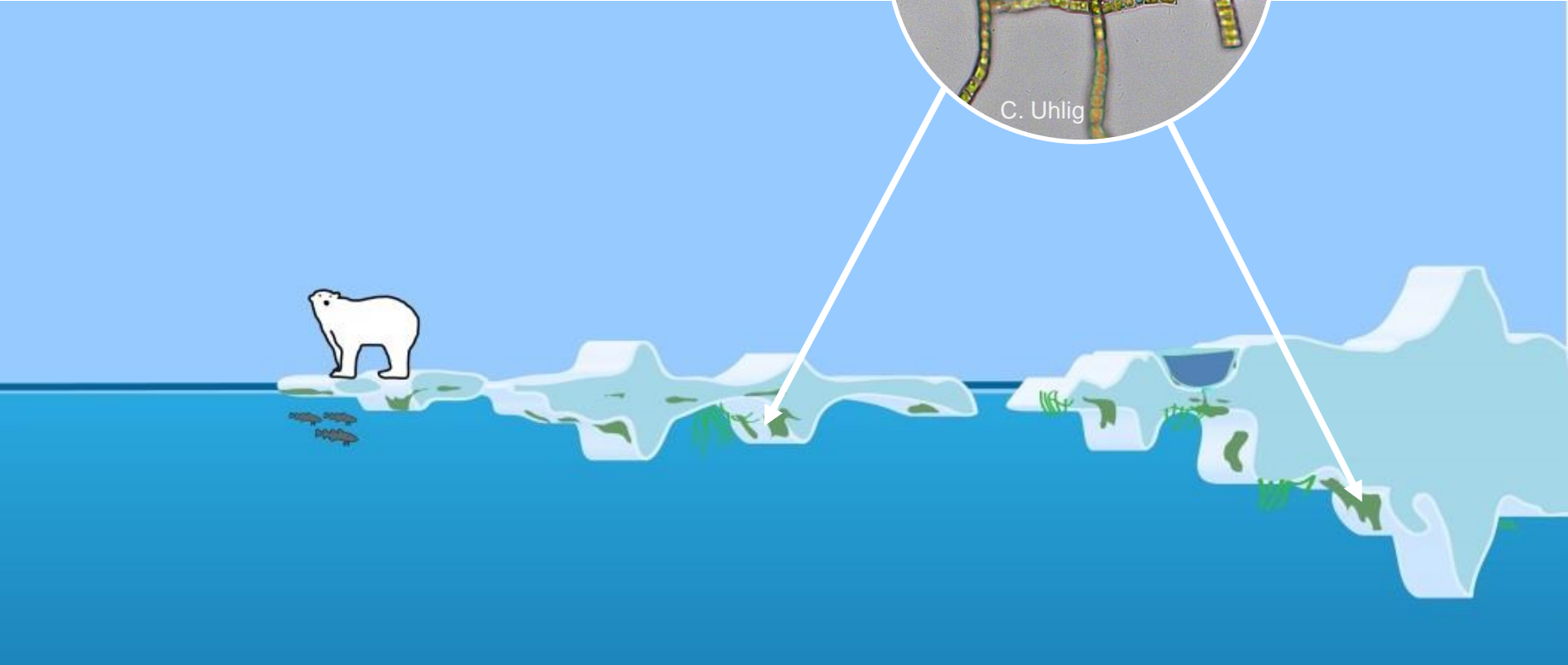
Dependency on ice algae-produced carbon in overwintering krill



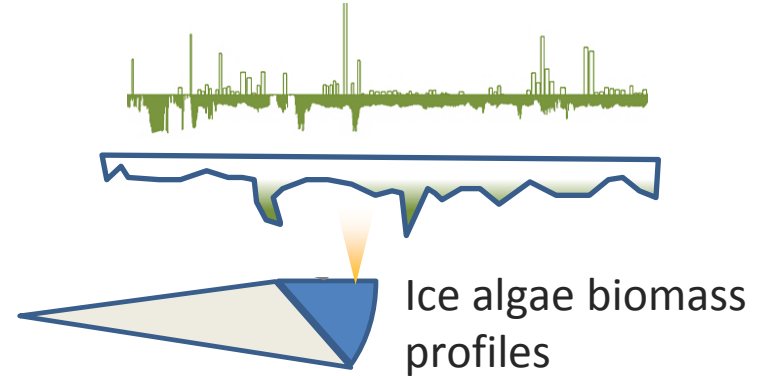
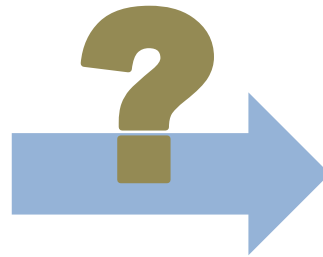
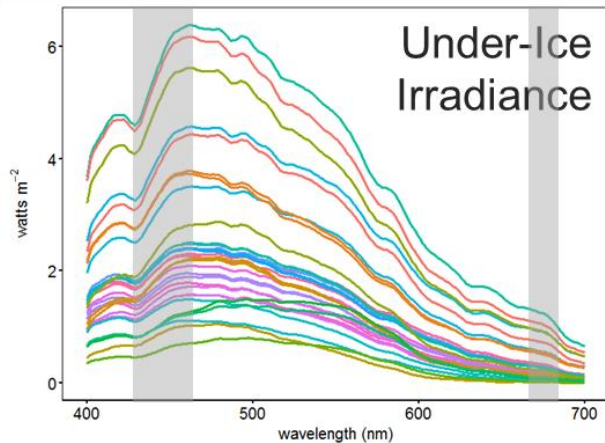
Proportional diet composition of Age-class 0 krill by volume (%)

Kohlbach et al. (in prep.)
Schaafsma et al. (in prep)

Spatial variability of ice algae



Spatial variability of ice algae

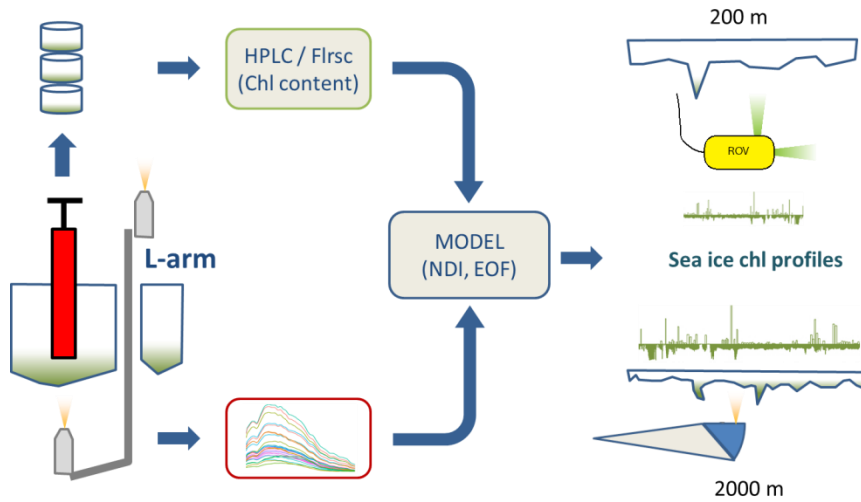


In our dataset:

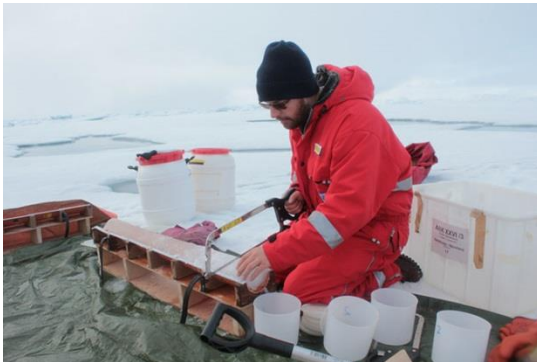
High variability of environmental conditions, e.g.

- Snow
- Meltponds
- Weather
- Latitudinal &
- Seasonal change in light intensity

Spatial variability of ice algae

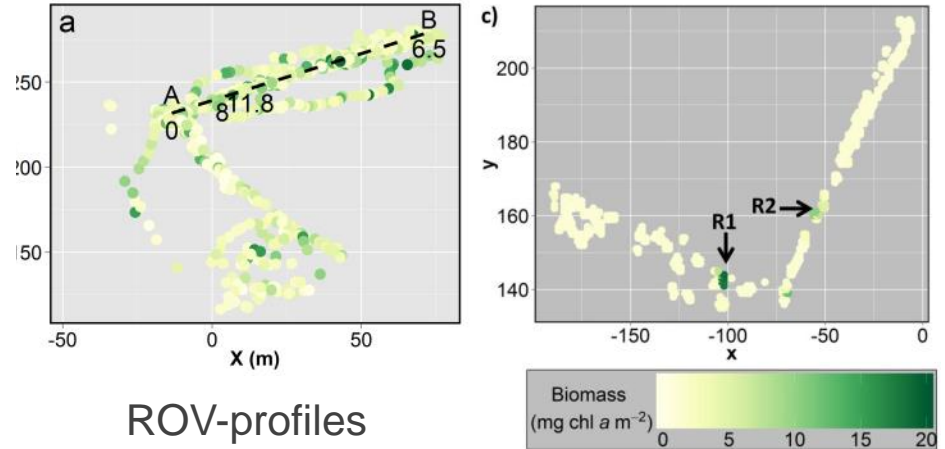
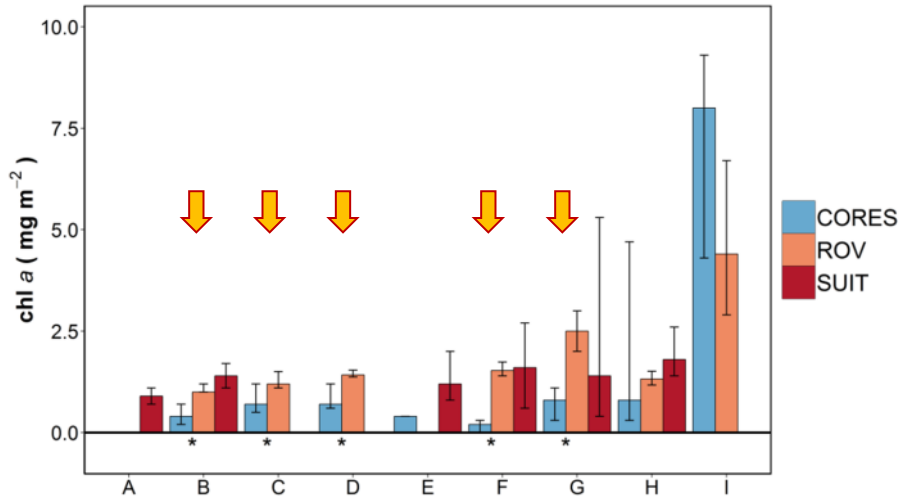


Bio-optical determination
of chl *a* concentration in
sea ice

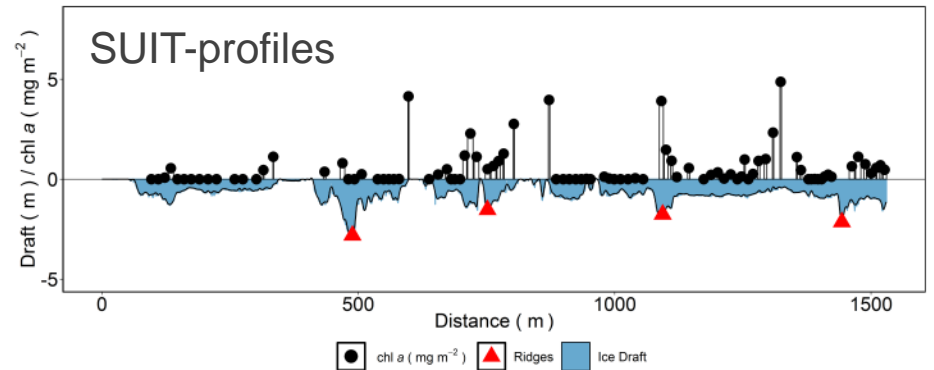


Lange et al. (2016) *J Geoph Res Oc*

Spatial variability of ice algae



ROV-profiles



SUIT-profiles

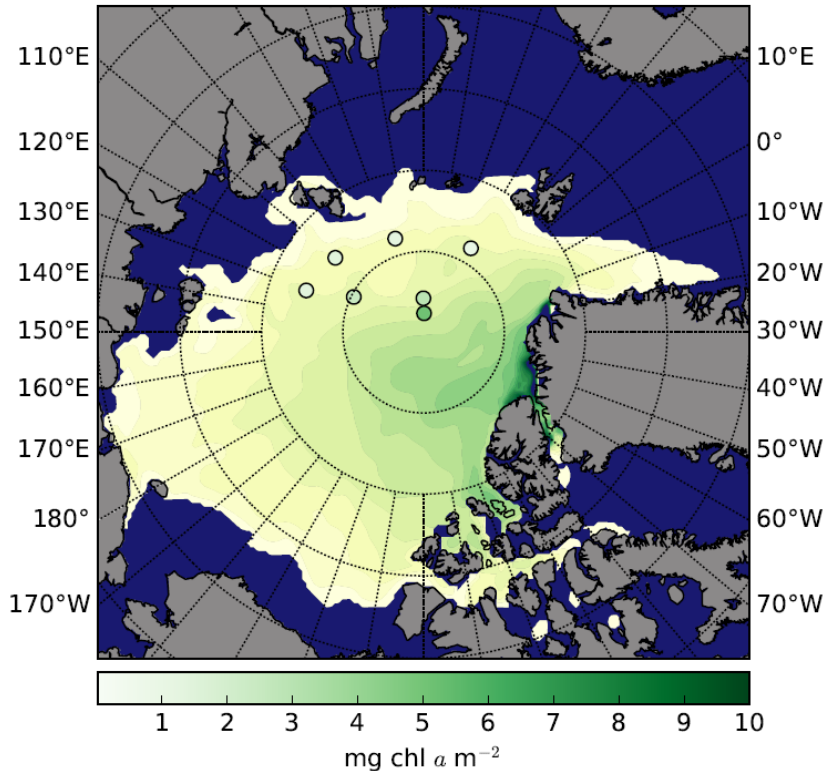
Lange et al. (2016) *J Geoph Res Oc*

Lange et al. (in prep)

Fernandez-Mendez et al. (2015) *Biogeosci*

Ice algae modeling

September 2012



MITgcm dynamic-thermodynamic sea ice model

Modelled processes:

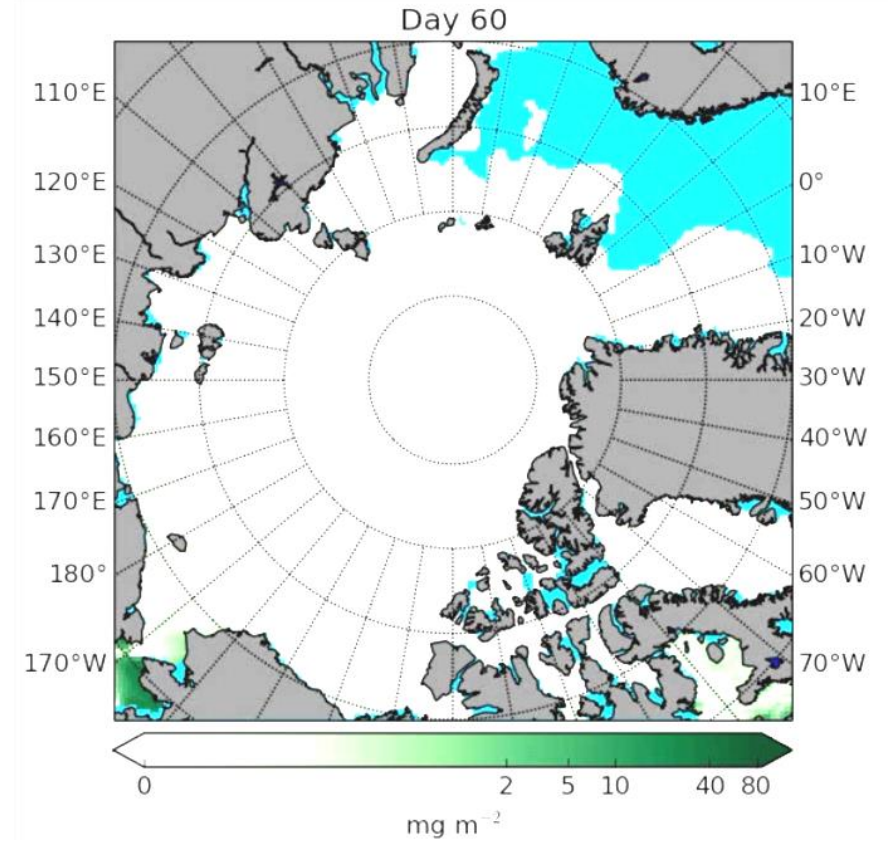
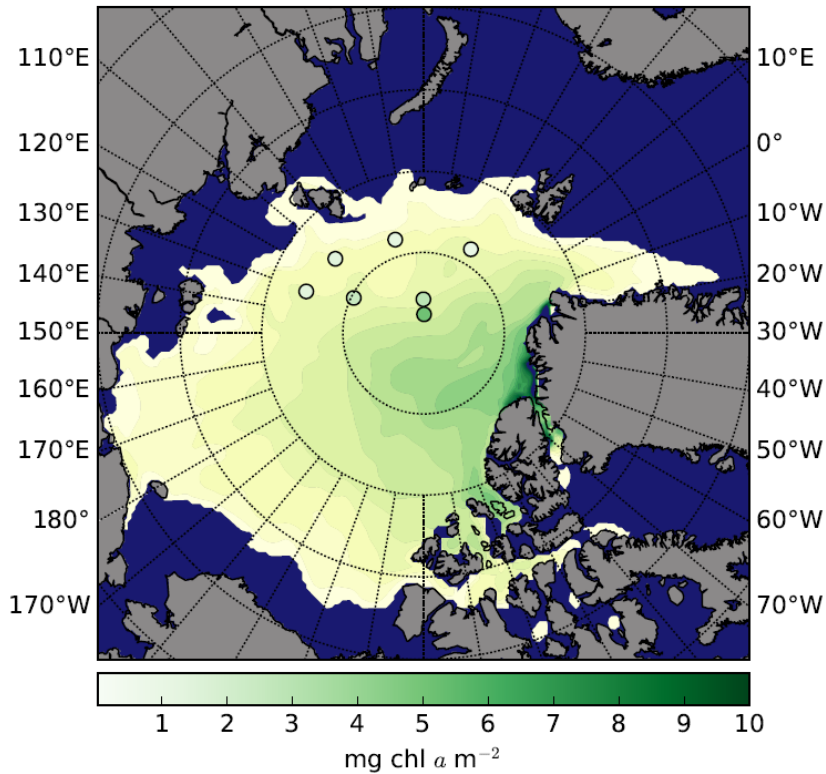
- Nutrient supply
- algal growth
- Mortality
- melting

Ice algae biomass

Castellani et al. (in prep.)

Ice algae modeling

September 2012



Ice algae biomass

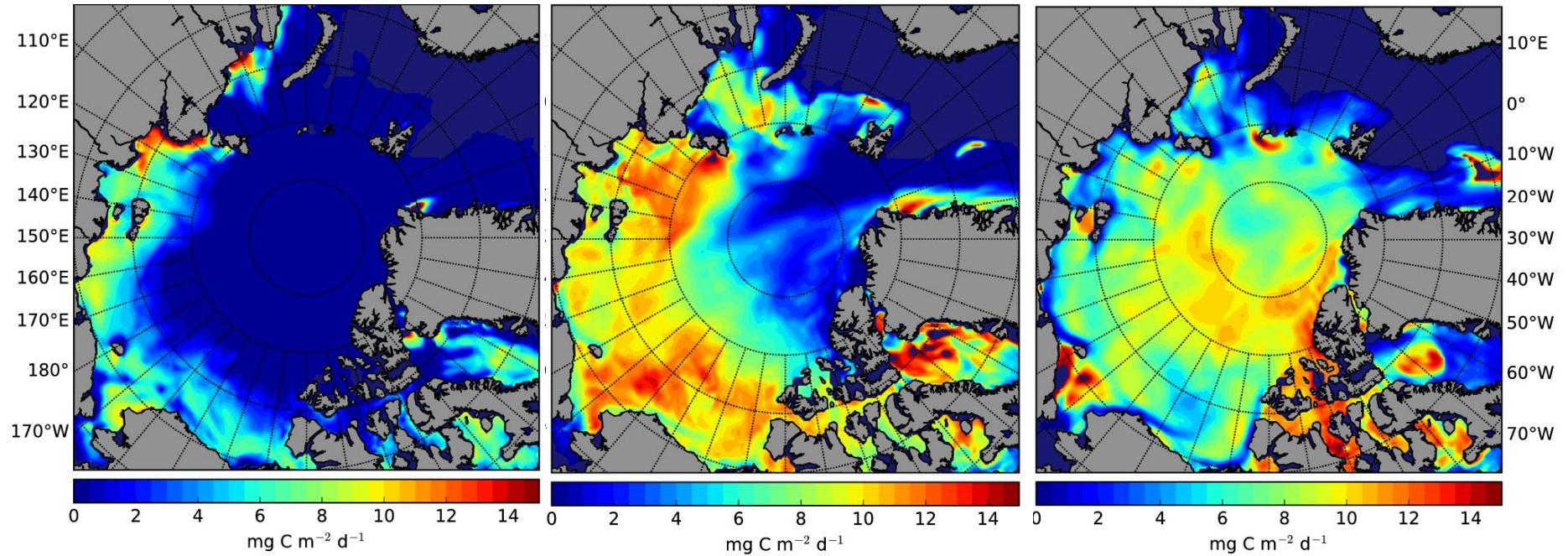
Castellani et al. (in prep.)

Ice algae modeling

April

May

June



Net primary production

Castellani et al. (in prep.)

Achievements (Highlights)

First basin-scale **survey of under-ice fauna and polar cod** in the Arctic Ocean

A new approach to **estimate ice algae biomass from under-ice light spectra**

Multi-scale comparisons of ice algae biomass highlight importance of spatial variability

Large-scale quantification of the **dependency of Arctic under-ice fauna on ice algae-produced carbon**

First quantification of the **dependency of Antarctic krill** on ice algae-produced carbon

A mechanistic, coupled **bio-physical model of ice algae** growth and decay for the Arctic Ocean

Where to go

AWI strategic goals:

- Arctic-wide estimate of primary production (PACES II)
- Drivers and impacts of change in Arctic and Antarctic sea ice
- Identify the contribution of ice algae to higher trophic levels
- Understanding sea ice as a habitat
(AWI long-term strategy)

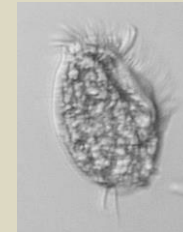
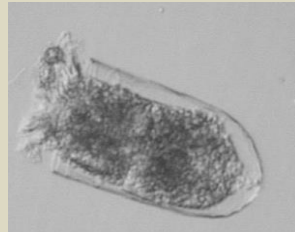
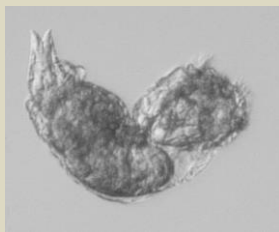
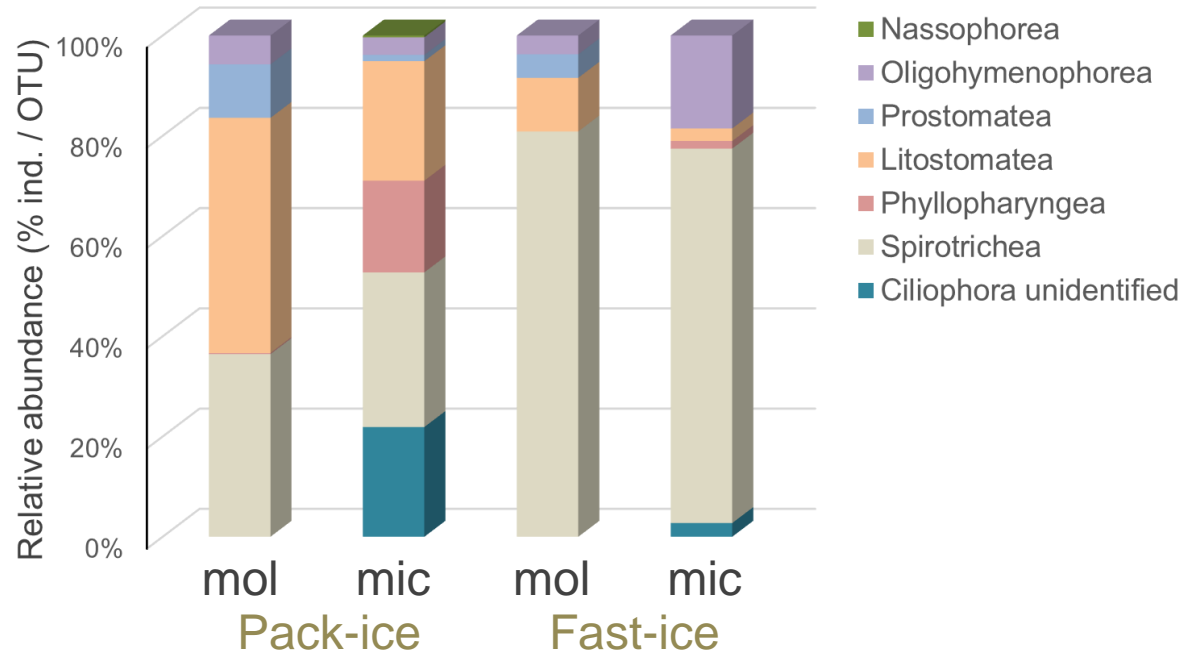
Where to go

Sea ice meiofauna molecular & microscopic Analysis

(Weddell Sea & Atka Bay)

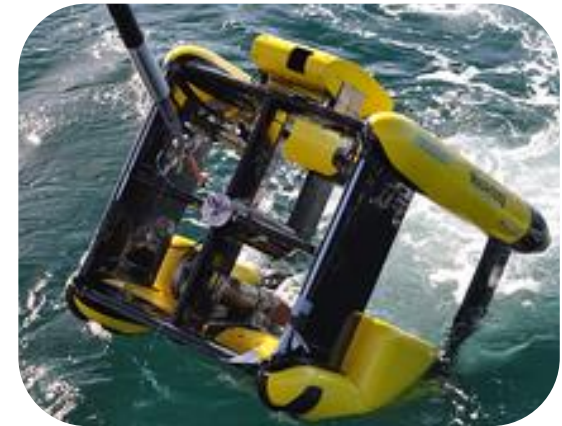
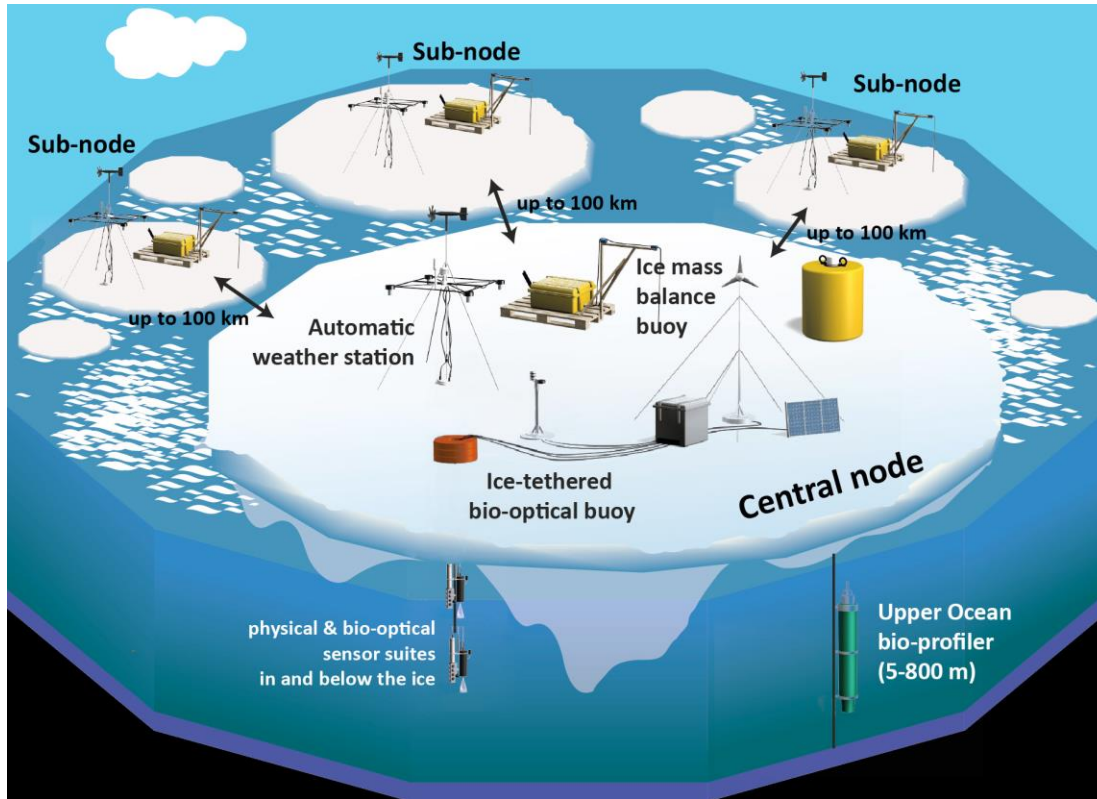
J. Ehrlich, S. Wietkamp,
K. Metfies, A. Cornils, H. Flores

Ciliophora
microscope vs. molecular



Where to go

Multidisciplinary Ice-based Distributed Observatory

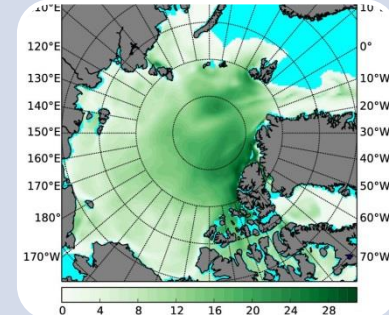
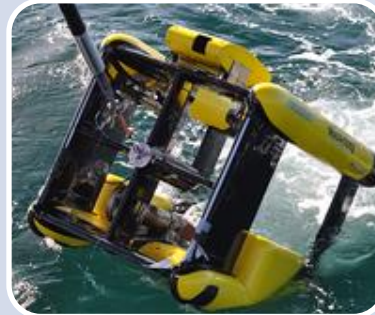


TopAWI

S. Krägefsky, H. Flores, V. Strass,
B. Niehoff, W.-J. van Apen a.m.o.

B. Rabe, M. Nicolaus, M. Hoppmann

Where to go



Food webs, BGC, biodiversity

Ice algae
Sea ice
Communities
Key species
Processes

Scale- bridging technology

SUIT
ROV
TopAWI
MIDO

Tools

Models
Biomarkers
Experiments
Molecular

MOSAiC

An unsettling realization many of us came to at the end of 2016 is that (...) facts don't always matter (...)

We must speak for them (...) in a way in which they can be heard, questioned, understood, and accepted.

ASLO Public Policy Committee

The living ice



Photos: Carmen David, Christiane Uhlig, Christian Kallein, Jan Andries van Franeker, Julia Ehrlich, Bluhm et al. (2007) Pol. Biol.

Thank you

Communicating Science



Education

- Thesis supervision
- Academic lectures
- Public lectures, workshops,...



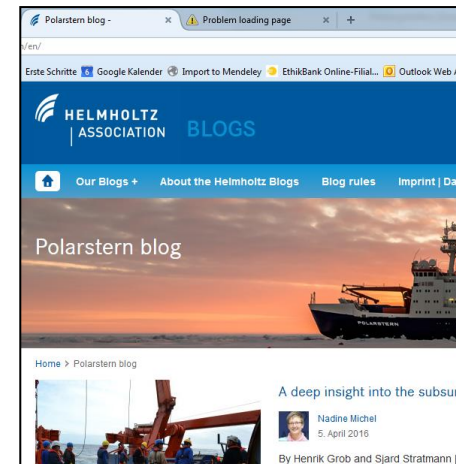
Outreach

- Magazines
- Newspapers
- Radio, TV
- (Expedition) blogs
- Books, exhibitions,
- arts, ...



One of the reasons many of us came to at the end of 2016 is that (...) facts don't always matter (...)
in (...) in a way in which they can be heard, questioned, understood, and accepted.

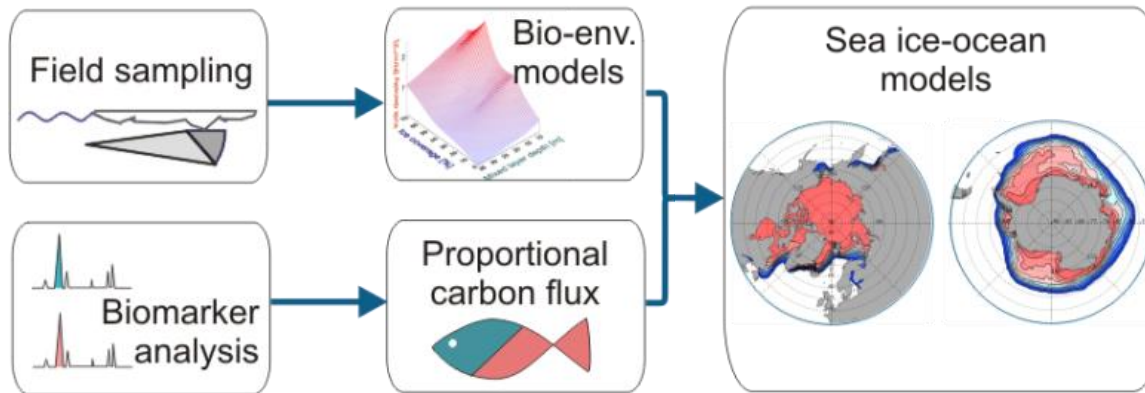
Advisory Committee



Thank you



Iceflux in a nutshell

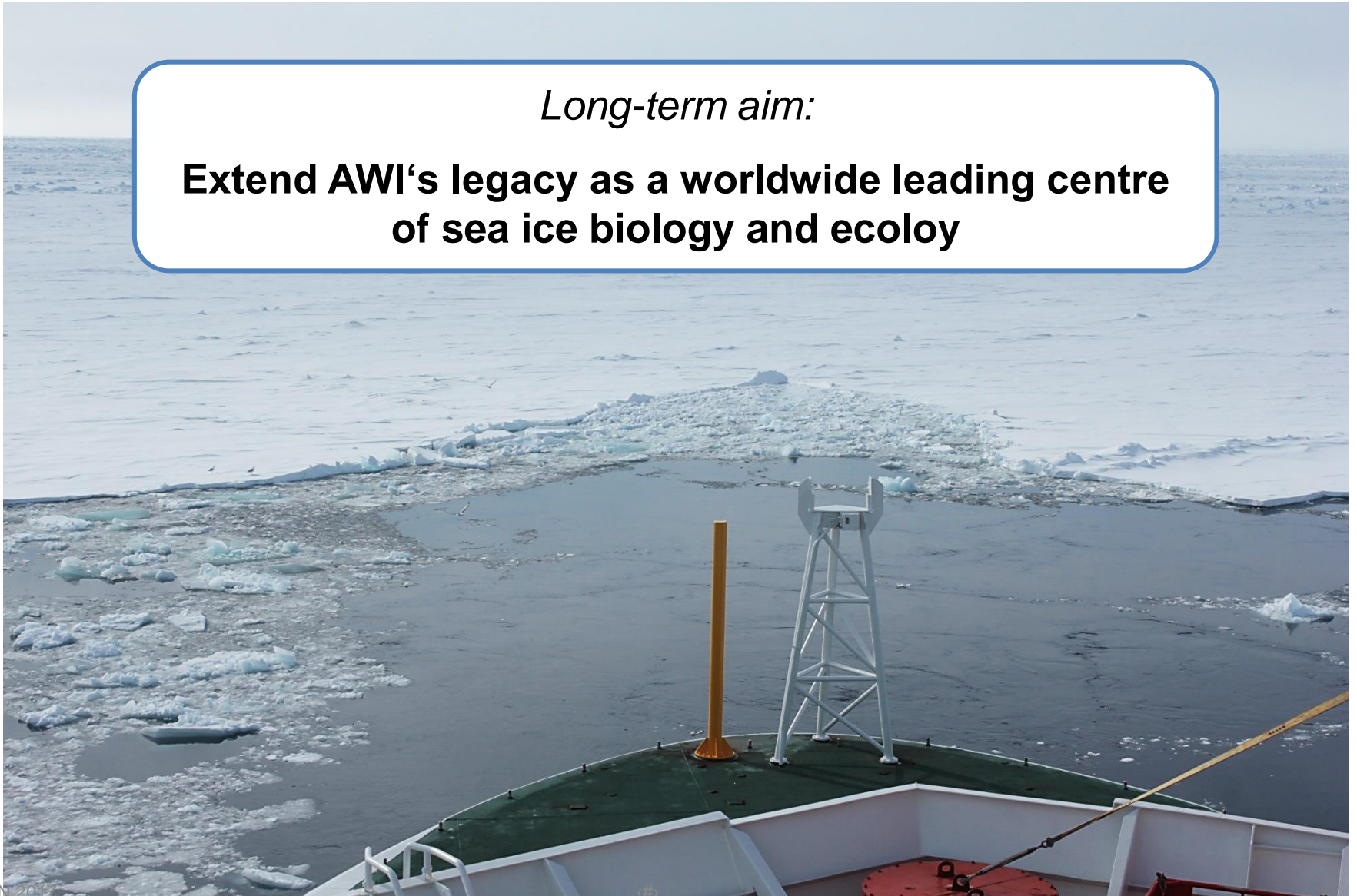


Where to go

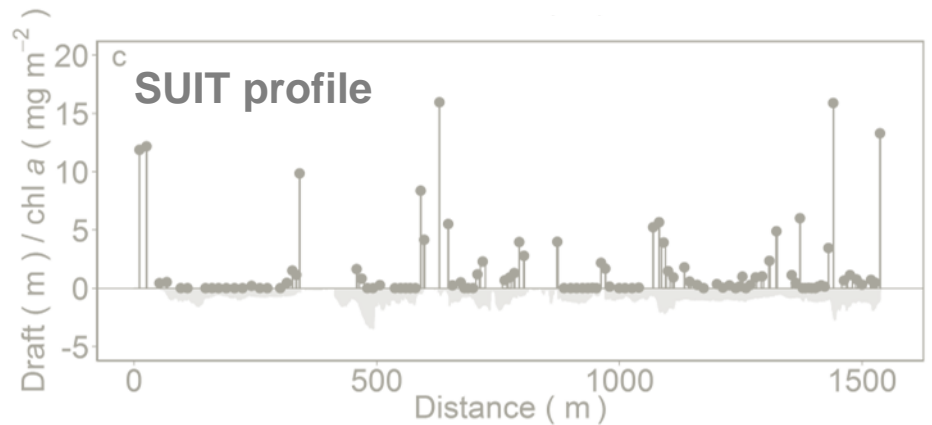
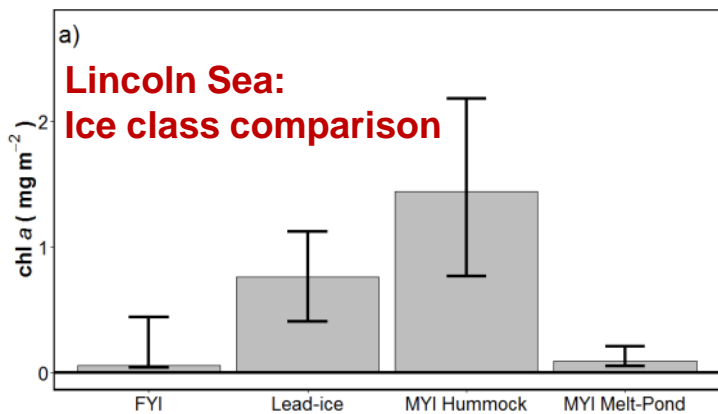
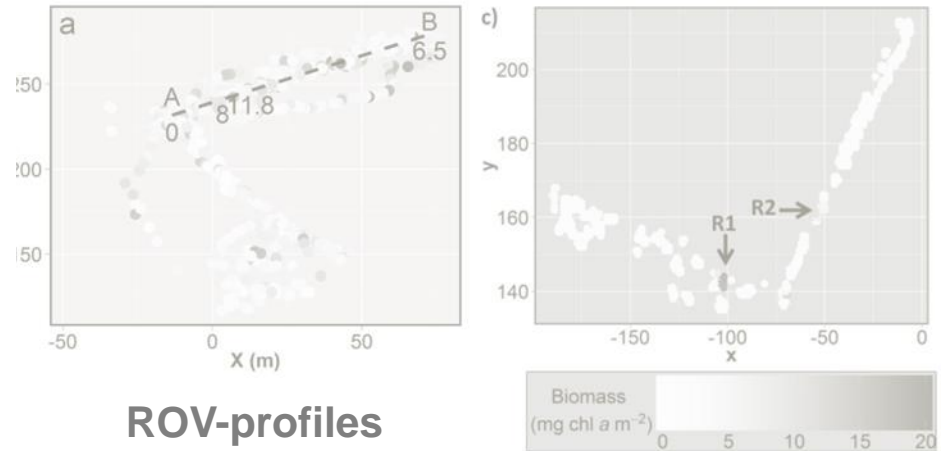
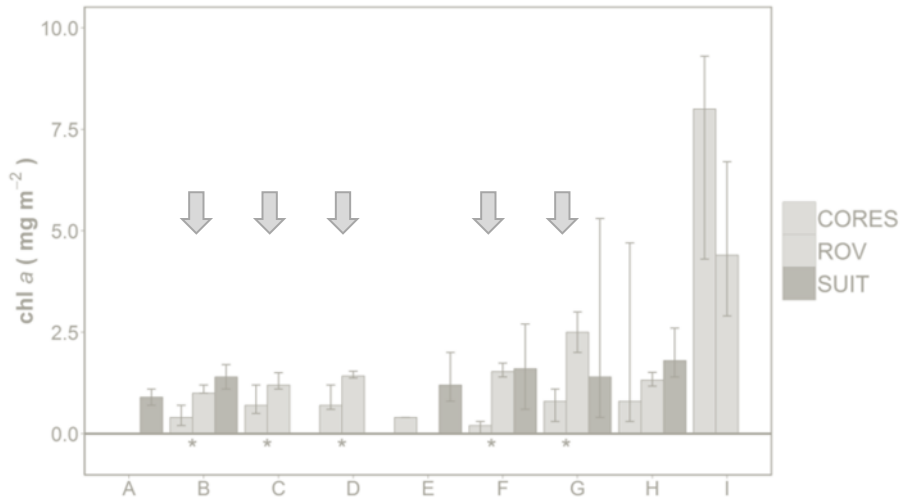


Long-term aim:

**Extend AWI's legacy as a worldwide leading centre
of sea ice biology and ecology**



Spatial variability of ice algae



Lange et al. (2015) *PLoS ONE*
Lange et al. (in review)

Spatial variability of ice algae

