Primary Productivity in sea ice and waters of the central Arctic during summer 2011

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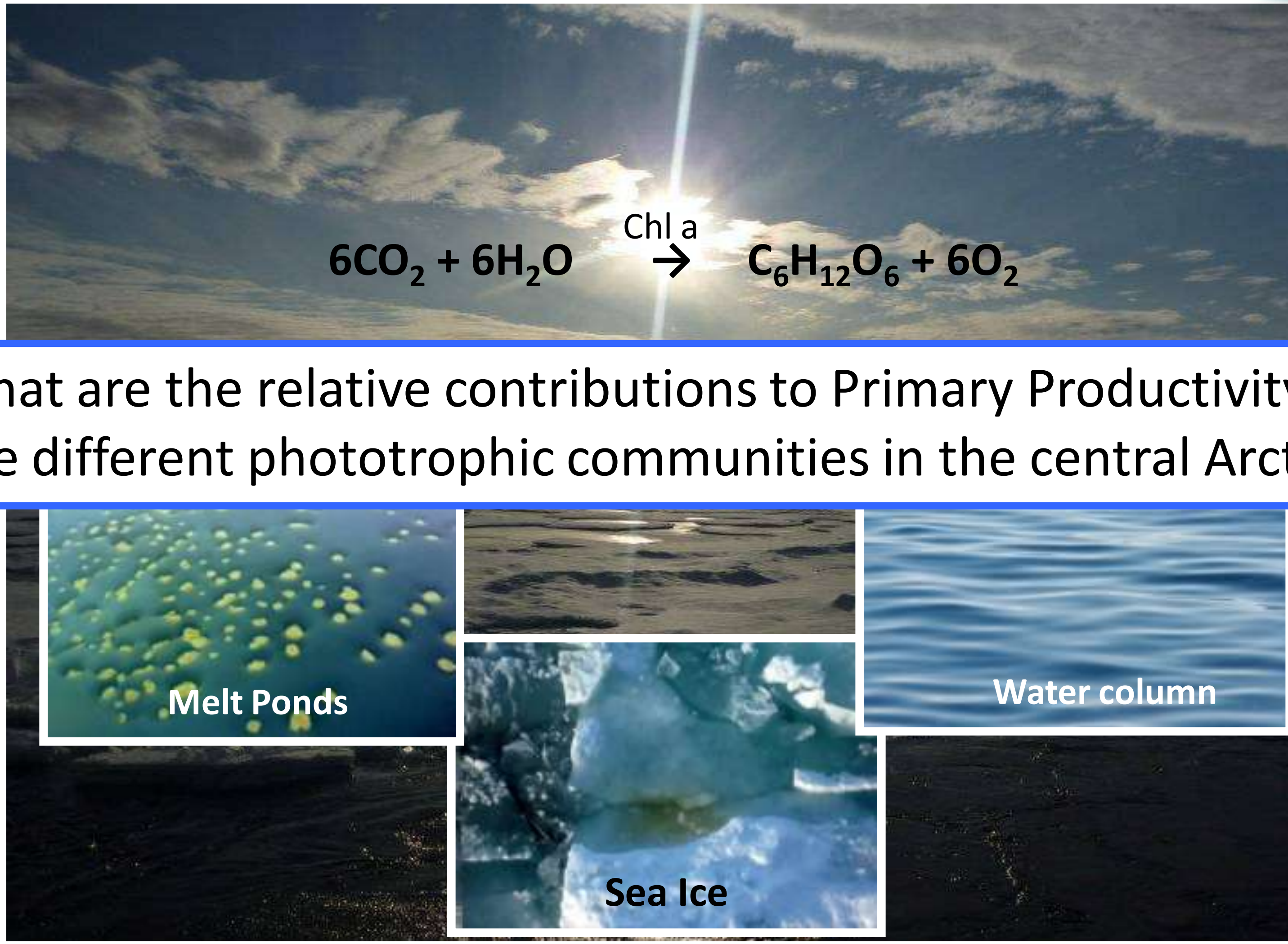
Introduction

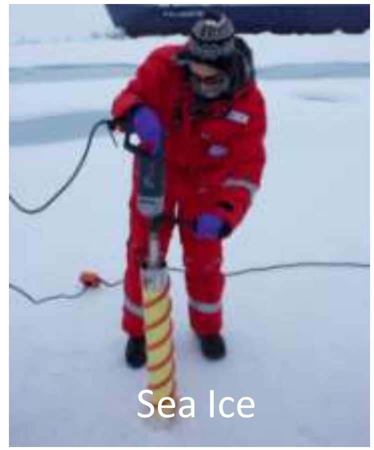
Primary Productivity in the central Arctic Ocean

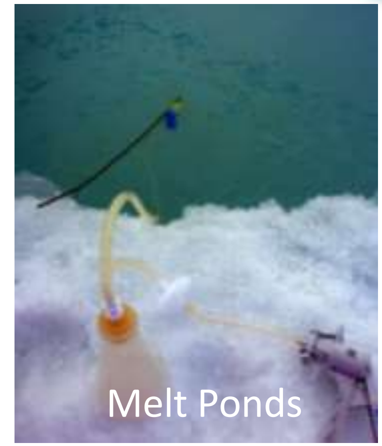


What are the relative contributions to Primary Productivity of the different phototrophic communities in the central Arctic?

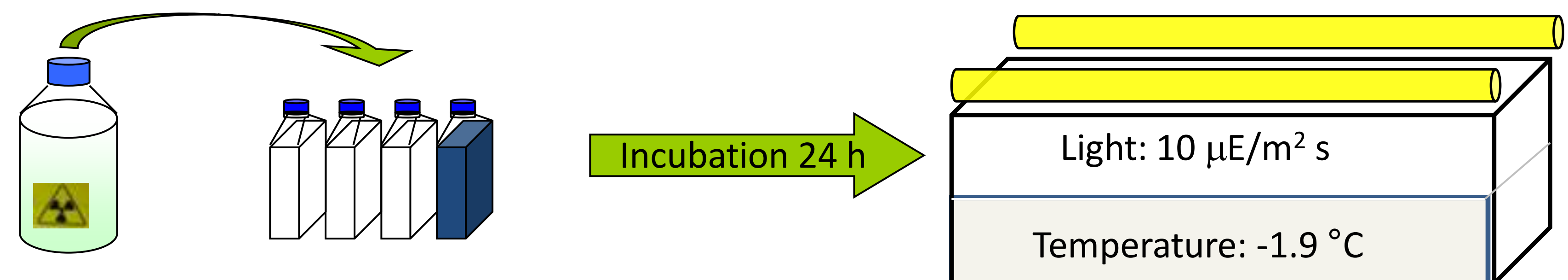
Methods

Sampling





^{14}C radioactive isotope

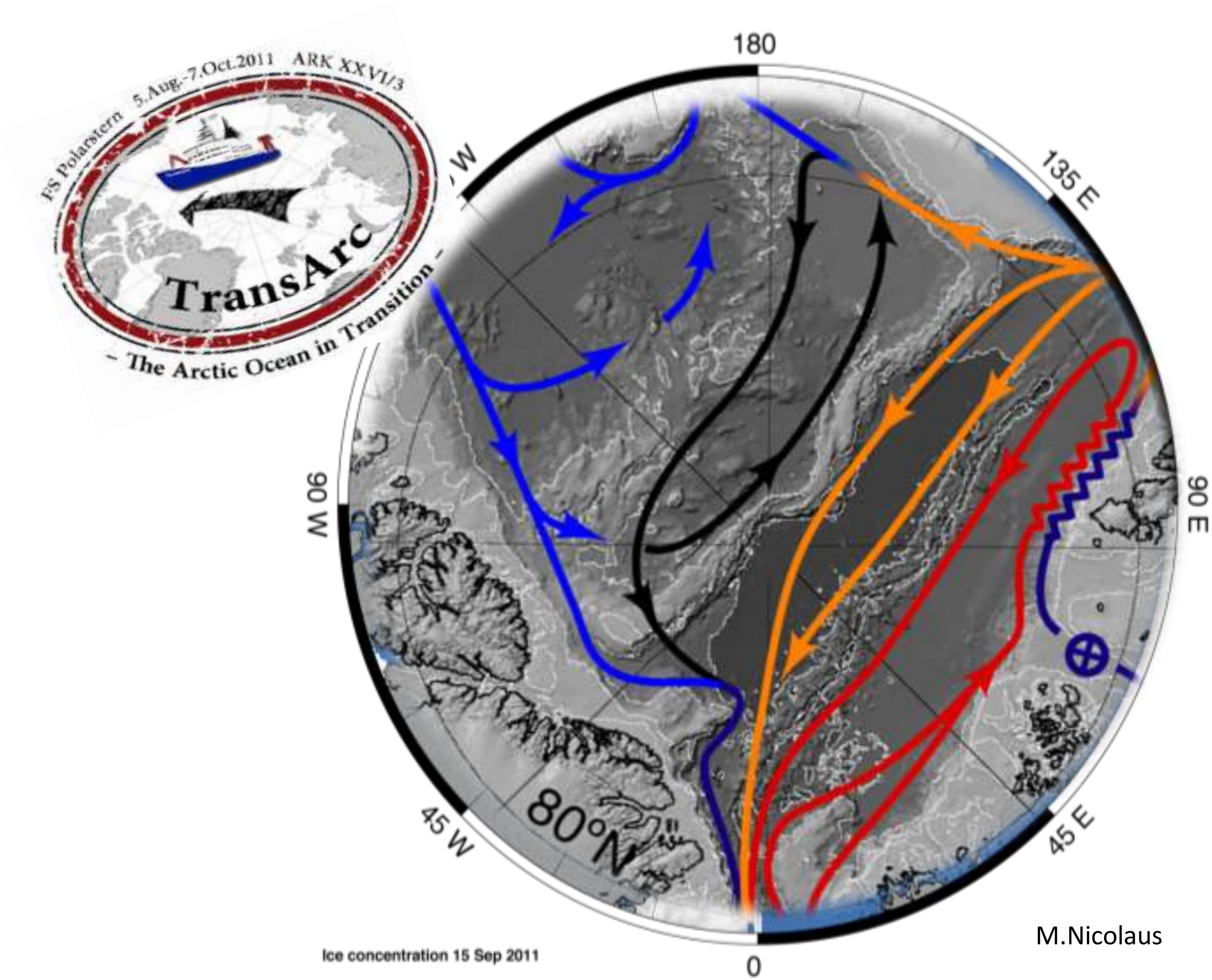


1 µCi/ml ^{14}C

20 ml

Potential Net Primary Production rate ($\mu g\ C\ L^{-1}\ d^{-1}$)

Results TransArc 2011

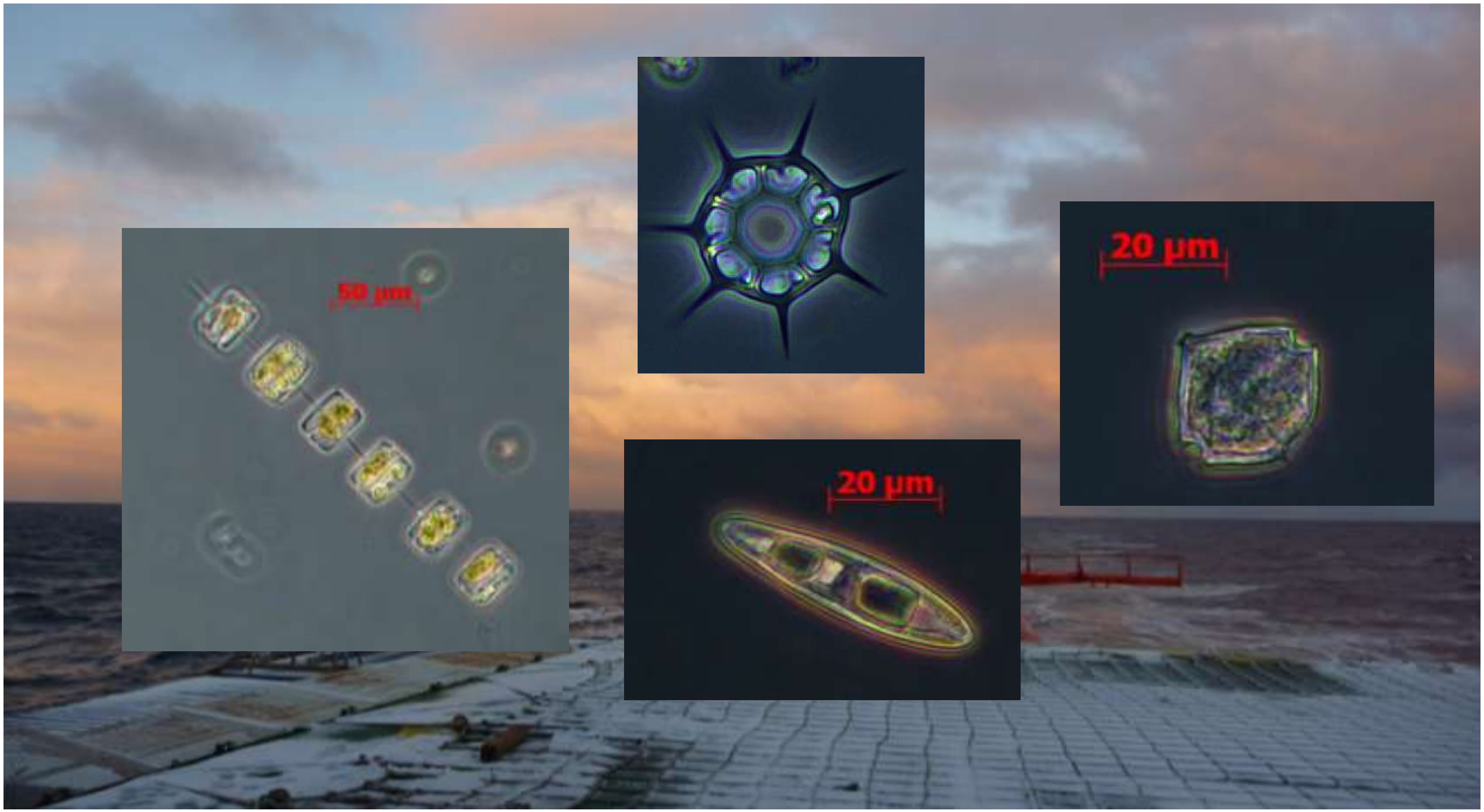


M.Nicolaus

Circulation in the subsurface and intermediate layers of the Arctic Ocean (Rudels et al. 2011)

Results TransArc 2011

Surface waters



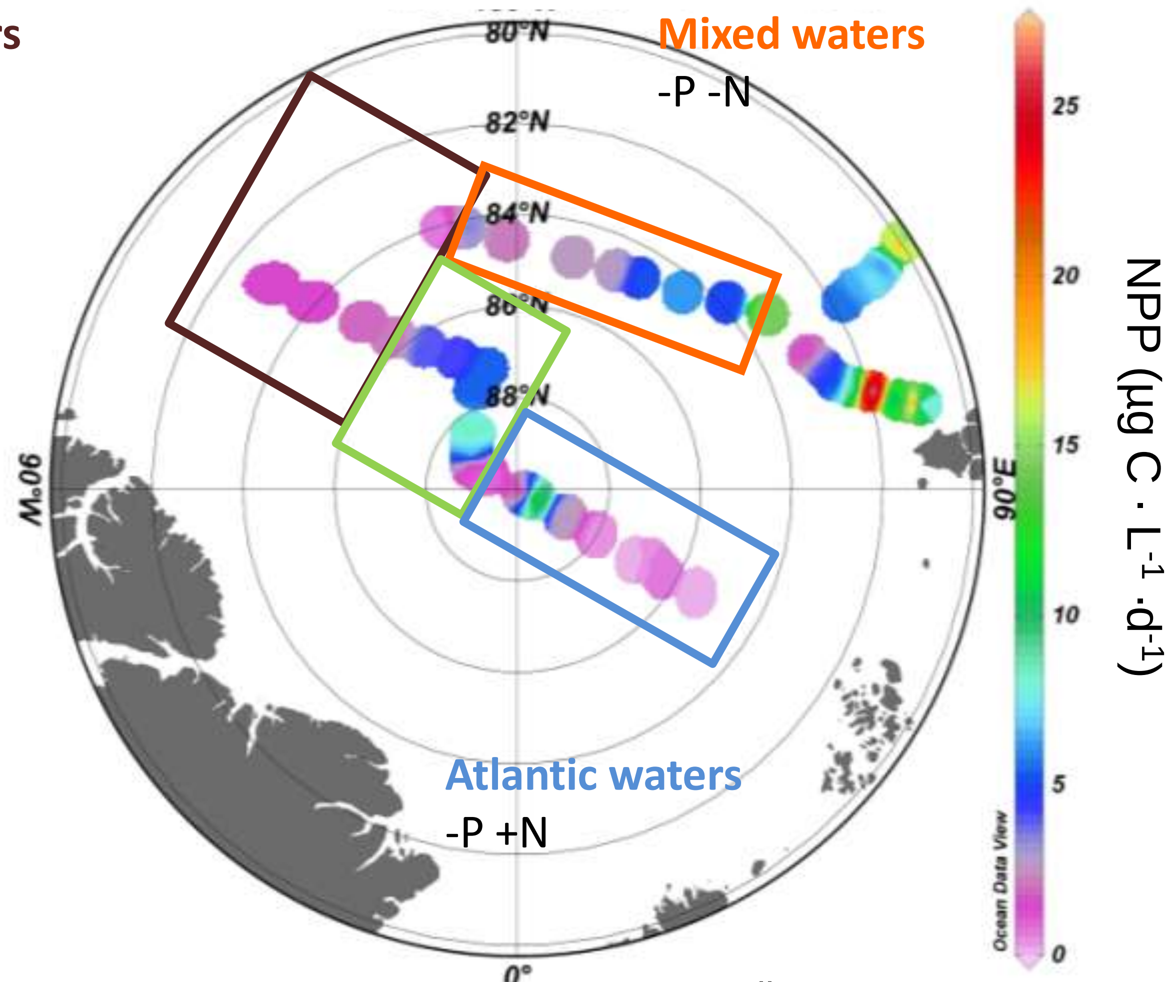
Microscopy pictures
by Henrieke Tonkes

Results TransArc 2011

Surface waters

Pacific waters
+P -N

Mixed waters
-P -N



Mixed waters
+P +N

Atlantic waters
-P +N

Ellen Damm

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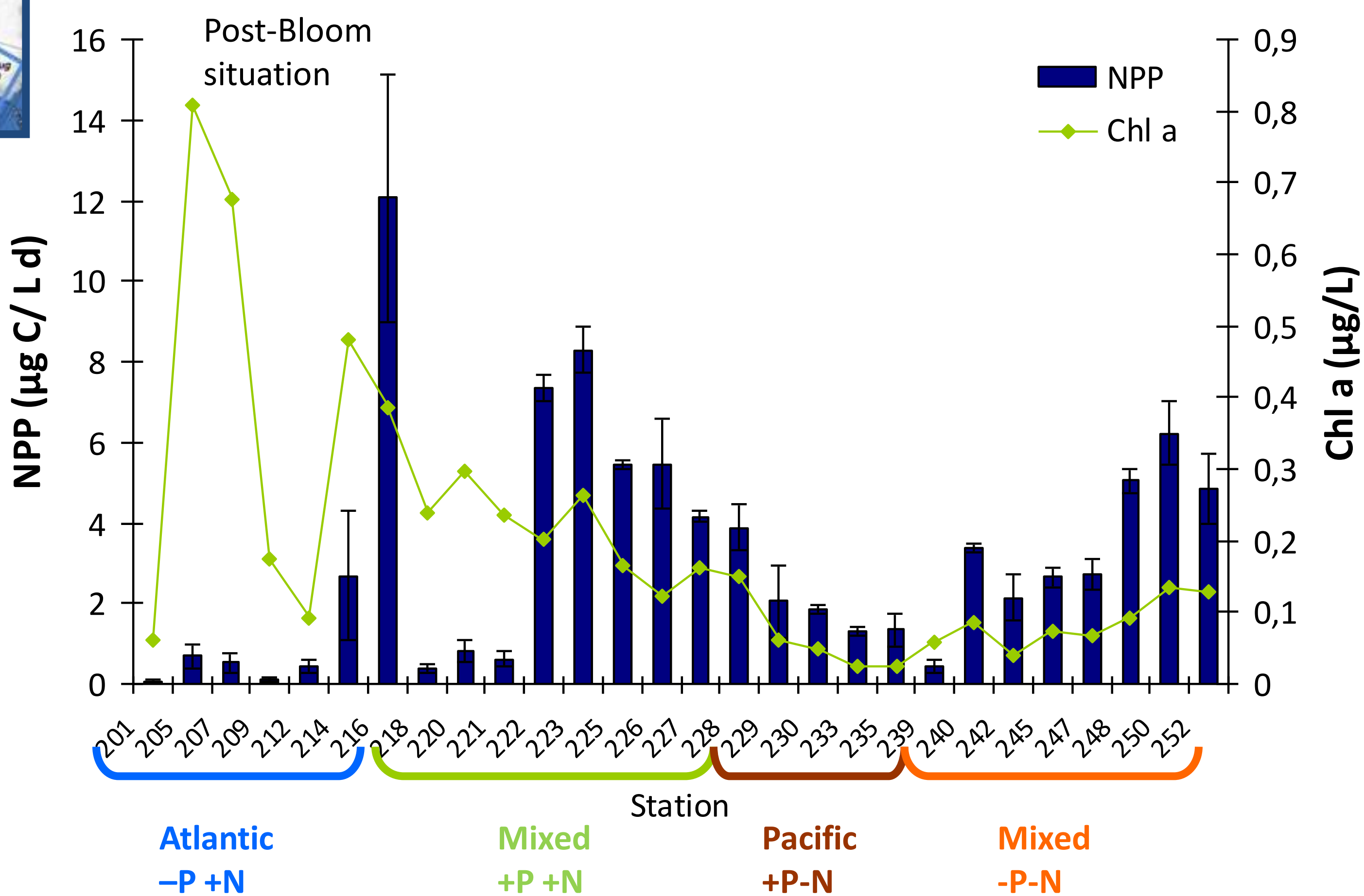
Surface waters



Atlantic region: high biomass but low activity.
Pacific region: low biomass high activity

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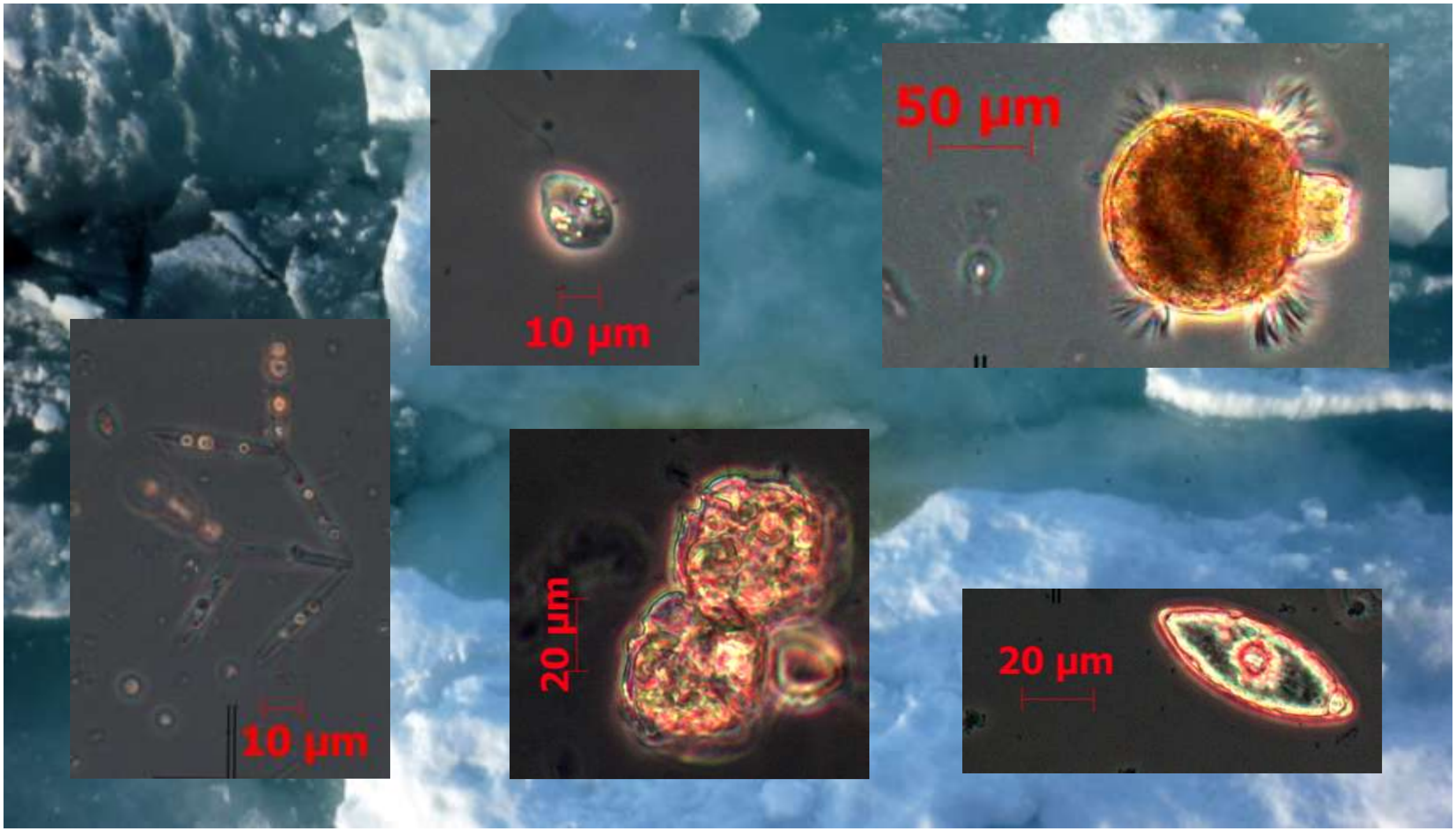
Ice

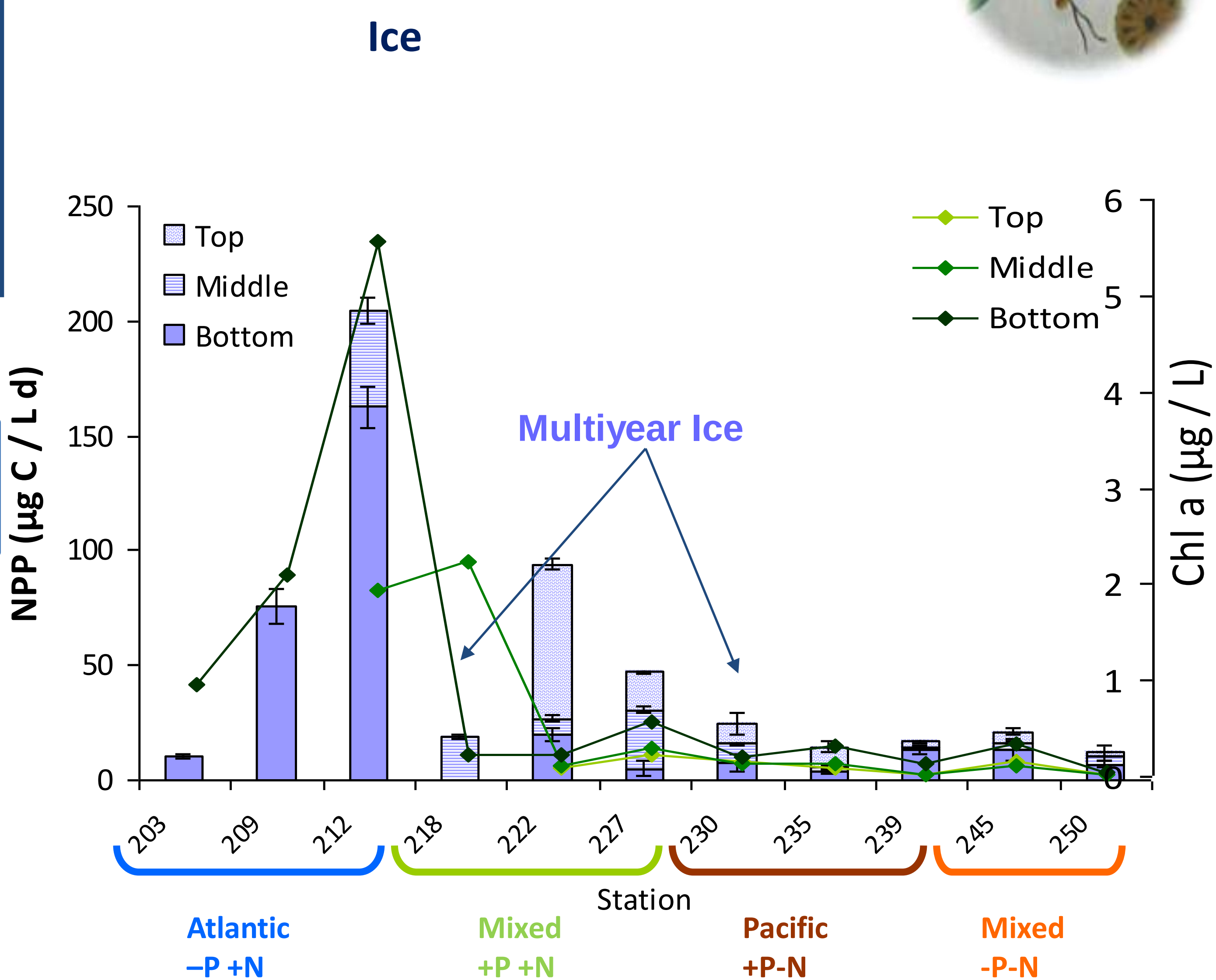


Microscopy pictures by
Kristin Hänselmann

Results TransArc 2011

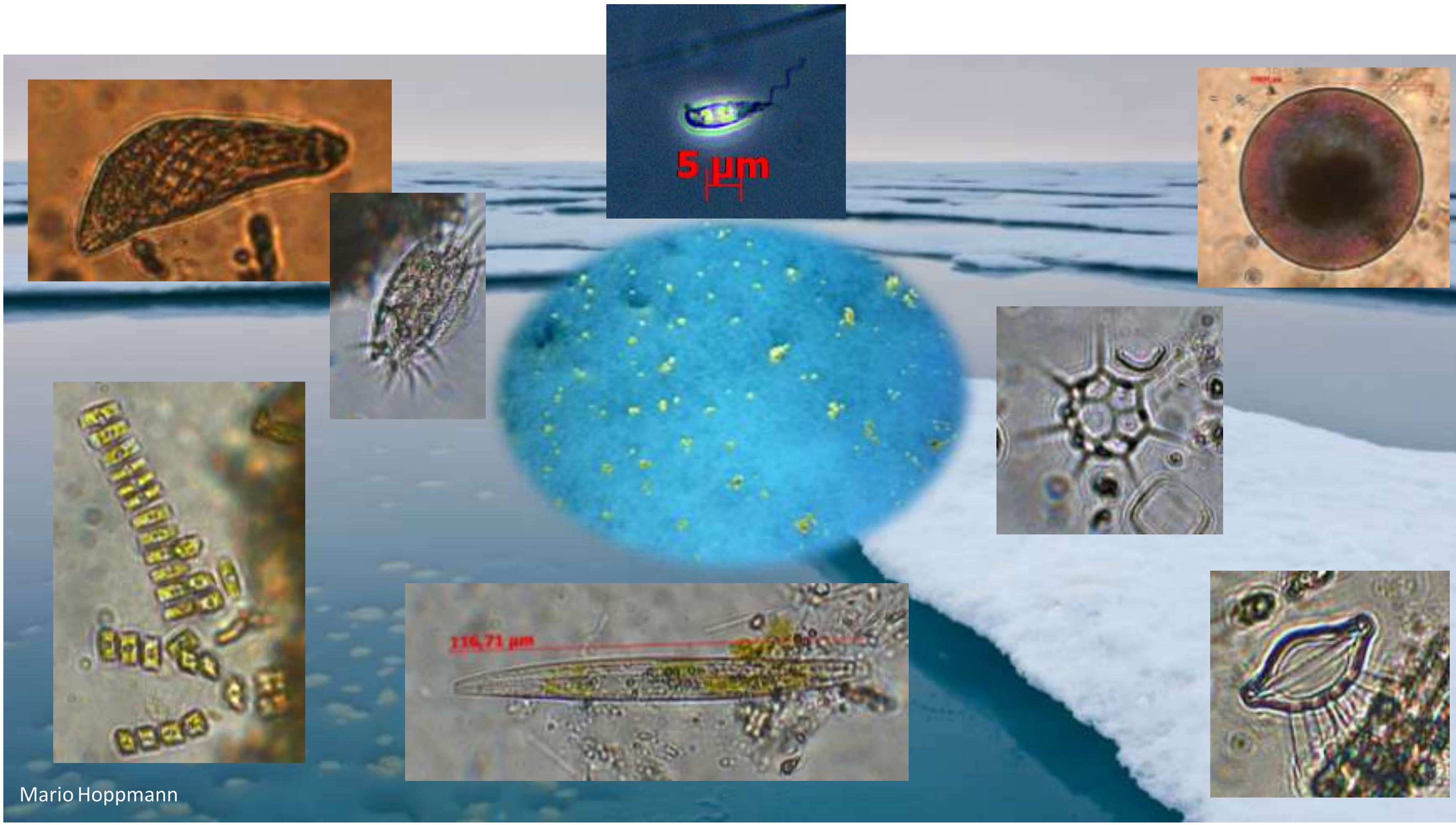
Higher activity in Atlantic region.

Bottom part of the ice is not always the most active.



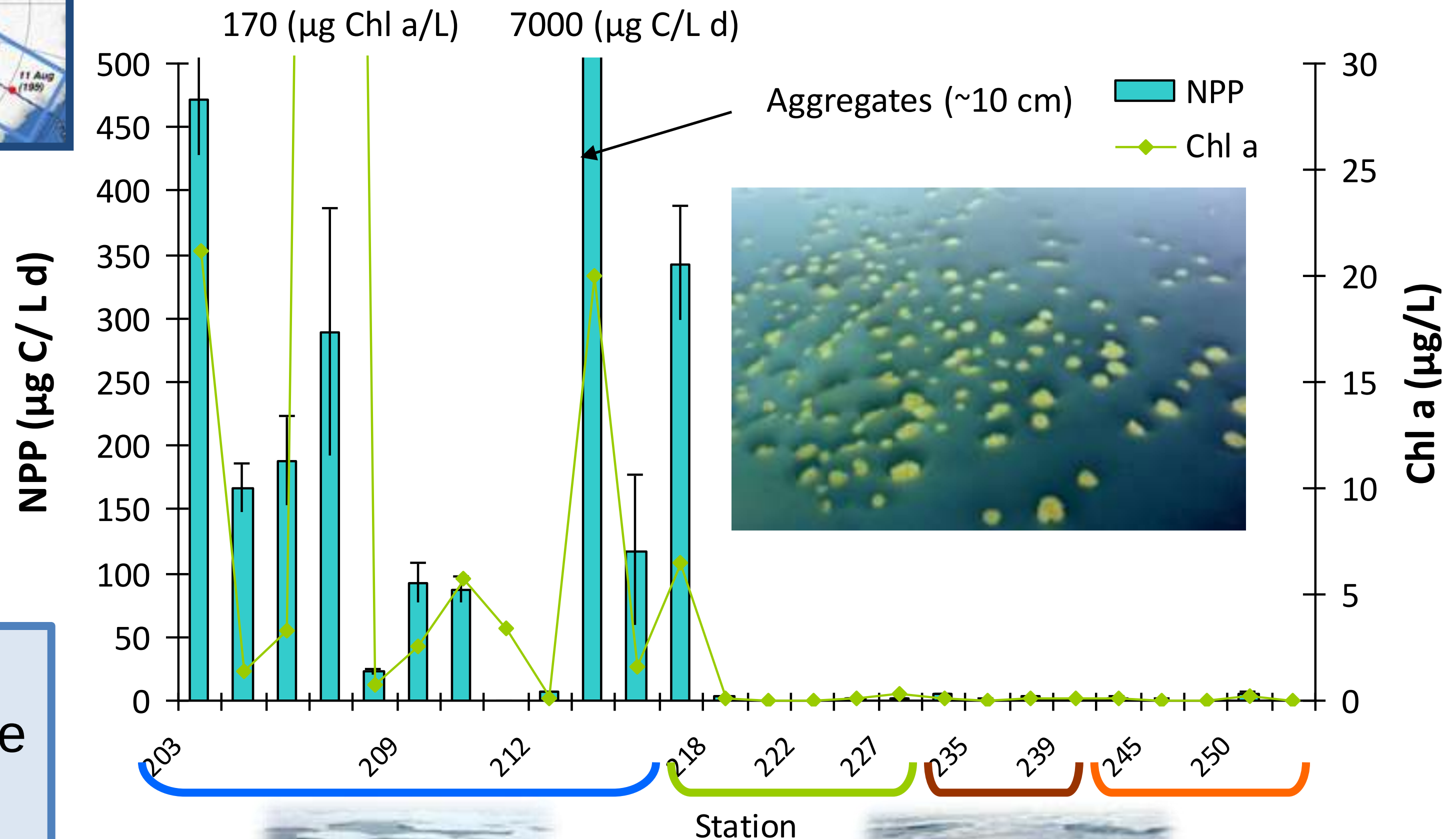
Results TransArc 2011

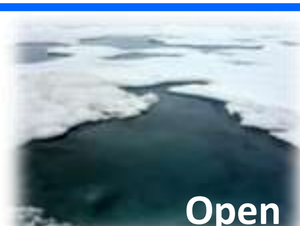
Melt Ponds



Results TransArc 2011

Melt Ponds





Melt pond algae are more active before reefreezing

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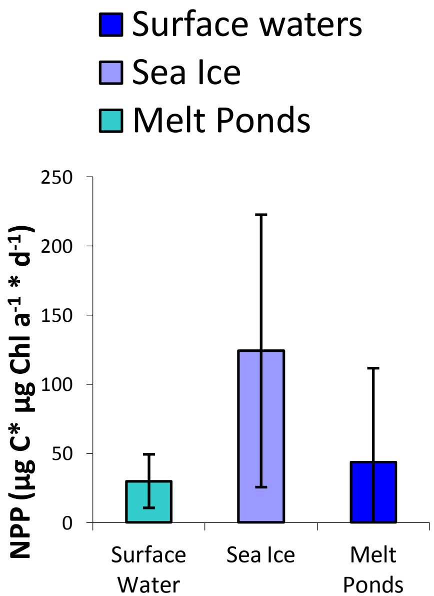
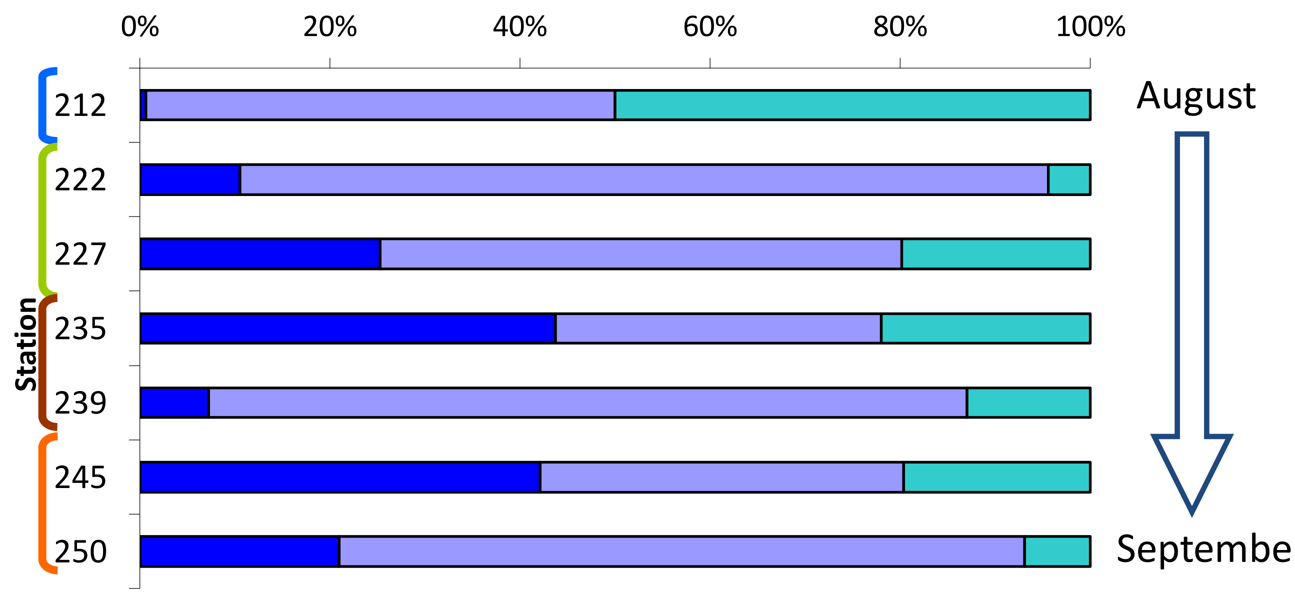
All

Biomass normalized rates: carbon uptake per Chl *a*



% NPP (µg C*µg Chl *a*$^{-1}$*d^{-1})



Sea Ice algae contribute the most to NPP activity per Chl *a*

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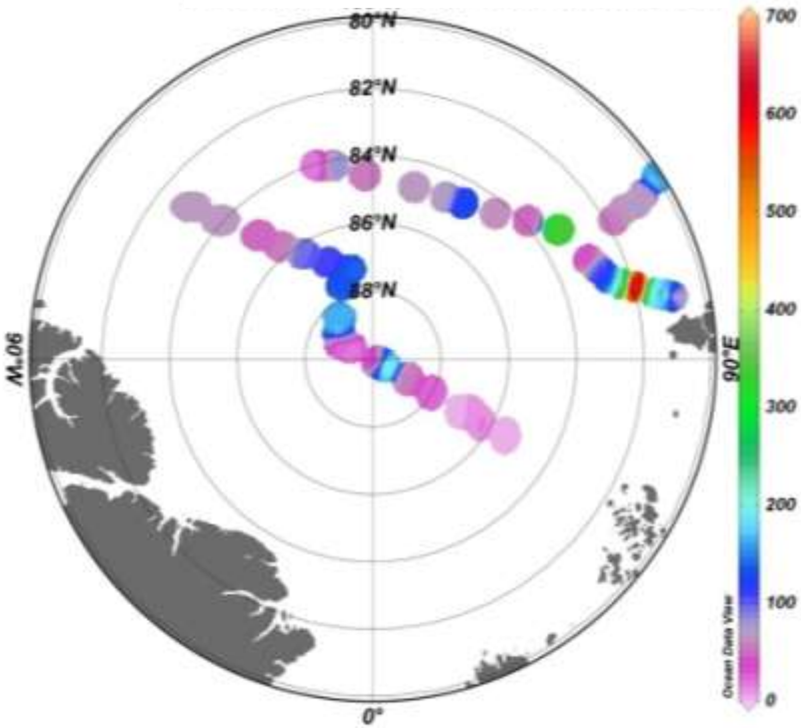
Integrated rates

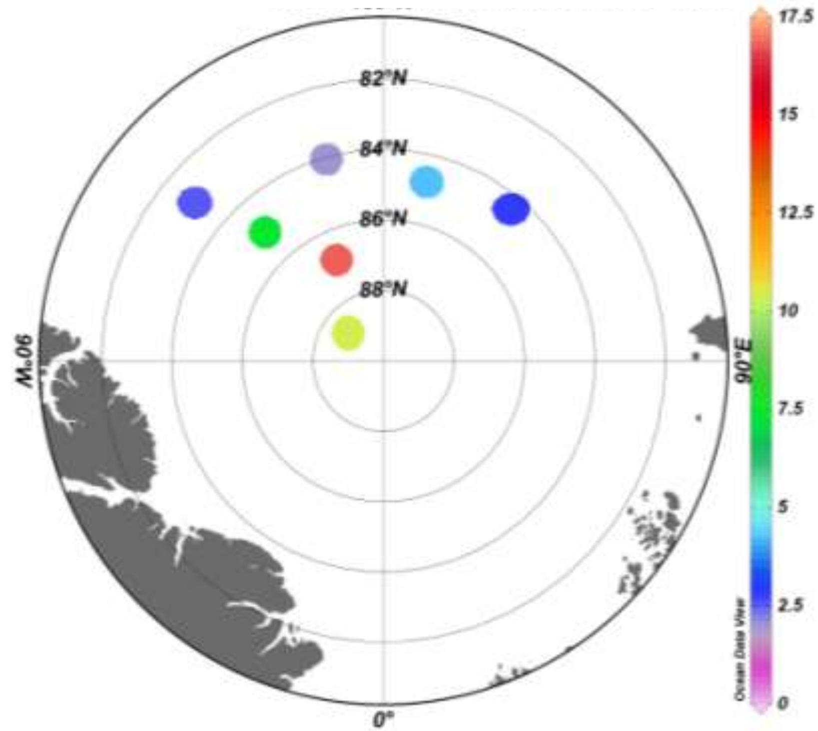
NPP (mg $C*m^{-2}*d^{-1}$)

One order of magnitude lower!

Water mixed layer



Sea Ice



Sea ice NPP integrated is one order of magnitude lower as the entire mixed layer.

Results TransArc 2011

Other variables

	Water	Ice	Melt Ponds
TEP (µg C/L)	0,09±0,03	0,48±0,14	0,11±0,3
POC (µg C/L)	92 ± 40	1788 ± 1862	7422 ± 20542
C:N molar ratio	7 ± 1	10 ± 3	11 ± 4
Nitrate (µM)	0,07 – 3,7	0,07 – 1,6	0,2– 8,1
Phosphate (µM)	0,09 – 0,8	0,02 – 0,2	0 – 0,6
Silicate (µM)	0,7 – 12,2	0,2 – 8,8	0 – 11,8

Kai-Uwe Ludwischowski

- Highest concentrations of carbon present in ice and melt ponds.
- C:N ratios in sea ice and melt ponds reflect detritus deposition.
- Nutrient concentrations are lower in the ice.
- Nitrate was never depleted in melt ponds.

Conclusions

- Comparing volumes of sea ice, melt ponds and surface waters, ice algae contribute most of the NPP.

- NPP is not limited to the bottom part of the ice in autumn.

- Before refreezing, melt ponds sustain the highest NPP rates.

- Phytoplankton in surface waters is more active in autumn in Mixed waters probably due to nitrate availability and less grazing.

- Comparing areal potential NPP rates (not considering light and nutrient limitation), sea ice contributes 1:9 of total productivity.

Outlook

- Infer the limiting factors for NPP by performing Photosynthesis-Irradiance curves and Nutrient bioassays.
- Upscaling NPP rates to the entire Arctic.
- Comparing surface water NPP rates with Net Community Production *in situ* measurements with O_2/Ar Method (N.Cassar)
- Reveal the key groups responsible for carbon fixation.
- Determine the carbon transfer rates from melt pond algae to bacteria.

Acknowledgements

Ursula Schauer

Kristin Hänselman

Gerhard Dieckmann

Erika Allhusen

Ellen Damm

Elisabeth Helmke

Estelle Kilias

Kai Uwe Ludwischowski

Marcel Nicolaus

Christian Katlein

Crew RV Polarstern

Thank you for your attention

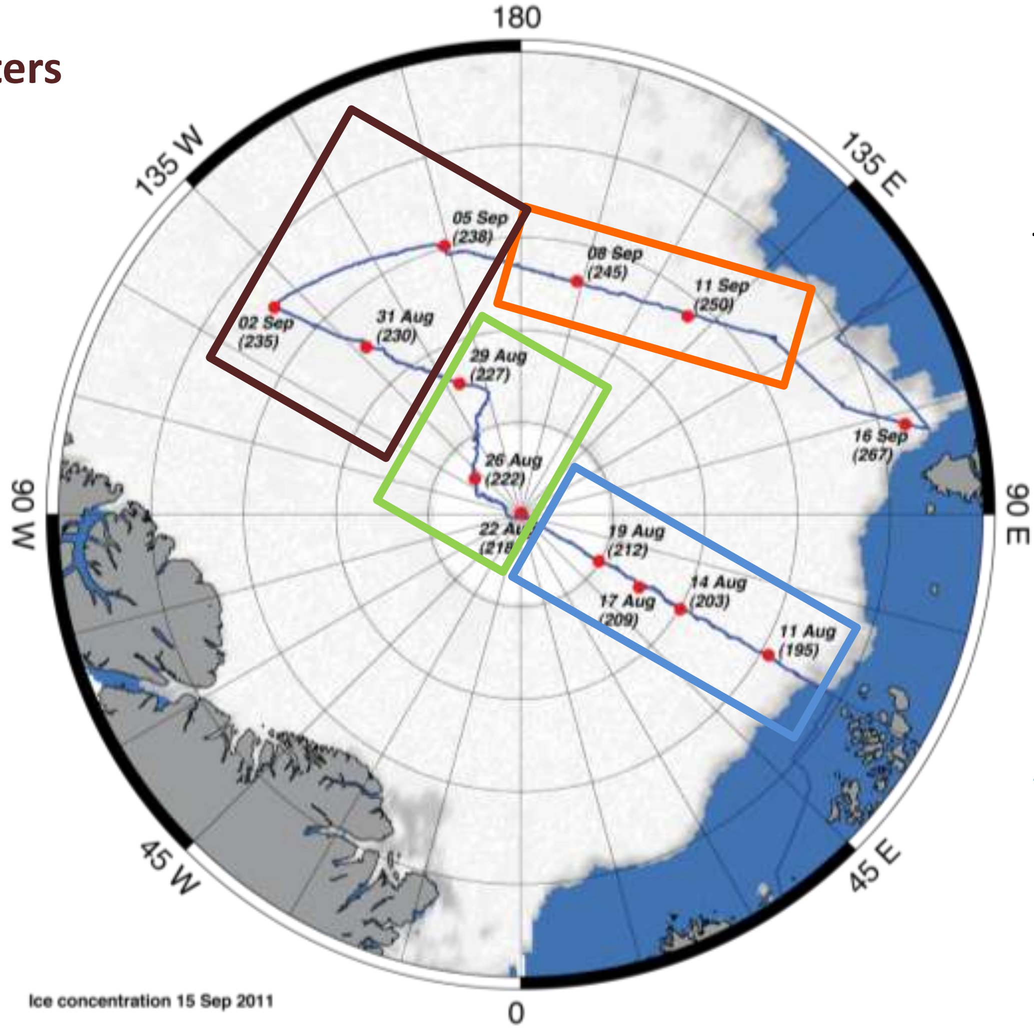
Results TransArc 2011

Pacific waters
+P -N

Pacific waters
-P -N

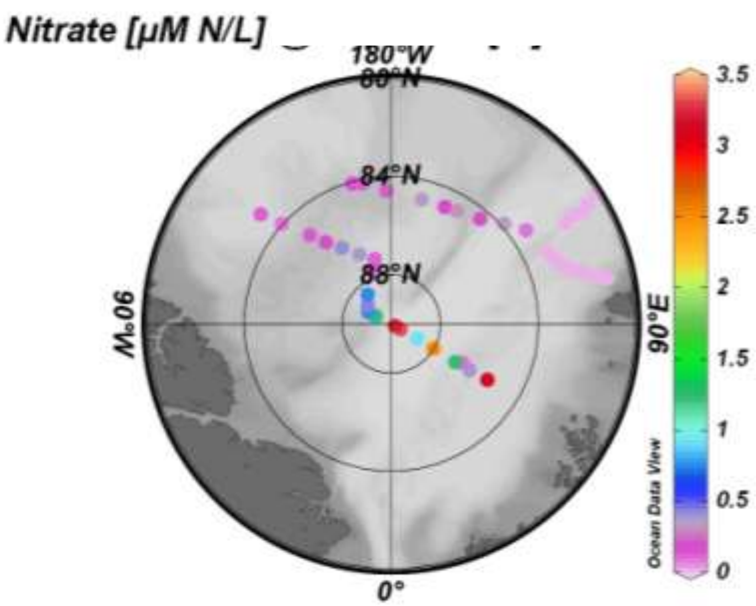
Mixed waters
+P +N

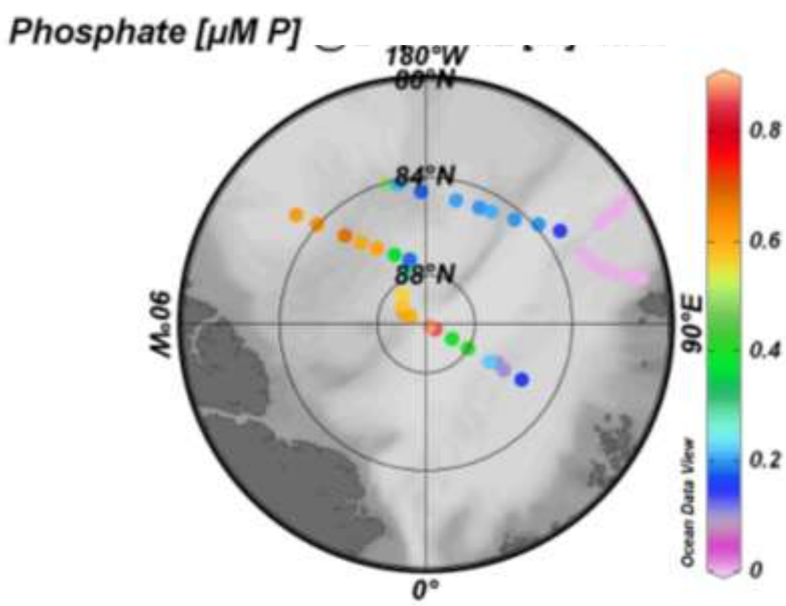
Atlantic waters
-P +N



Results TransArc 2011

Nutrient concentrations in surface waters

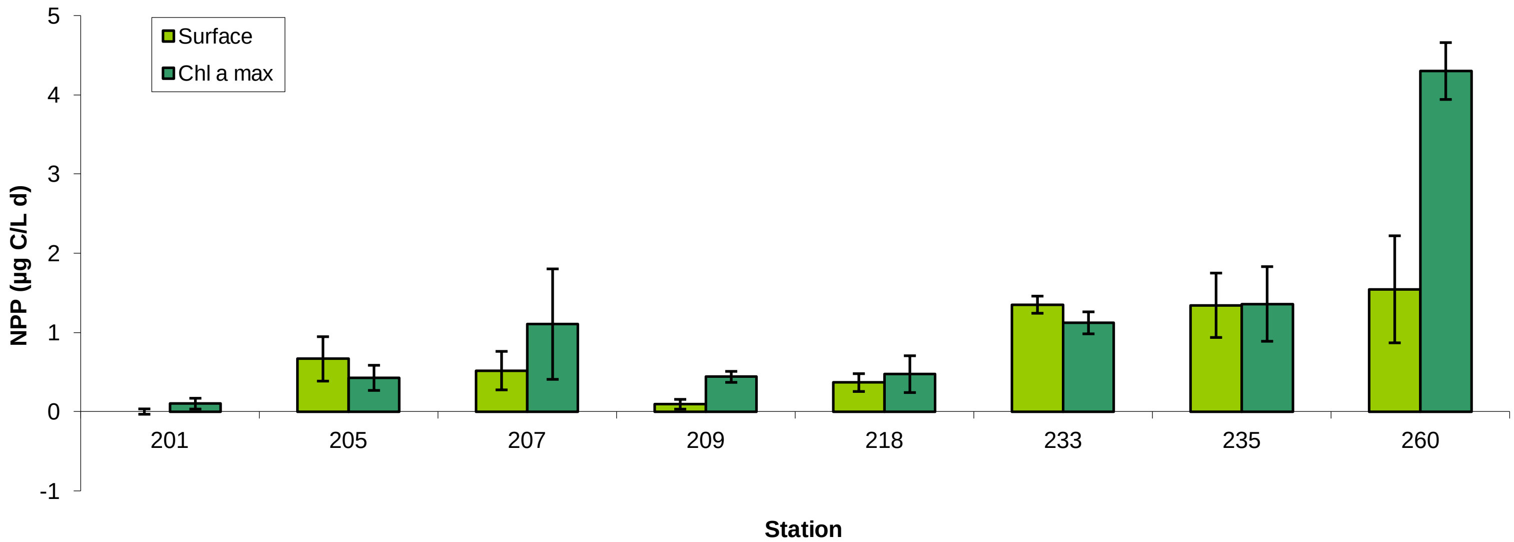


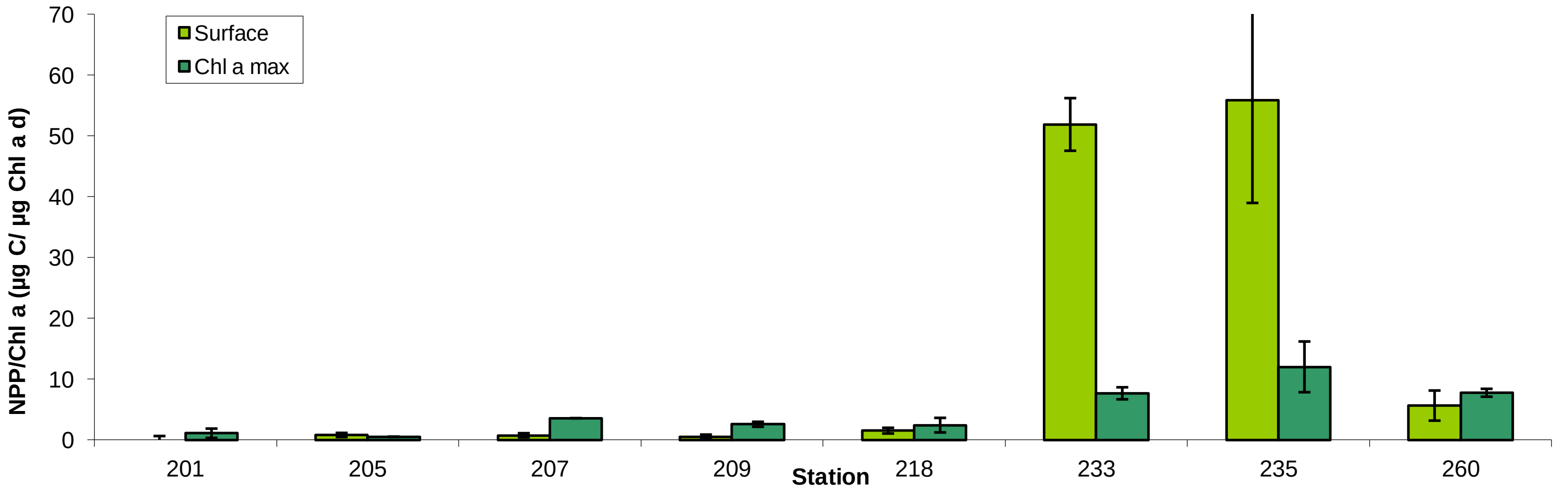


Nutrients courtesy of Kai Uwe Ludwischowski

Results TransArc 2011

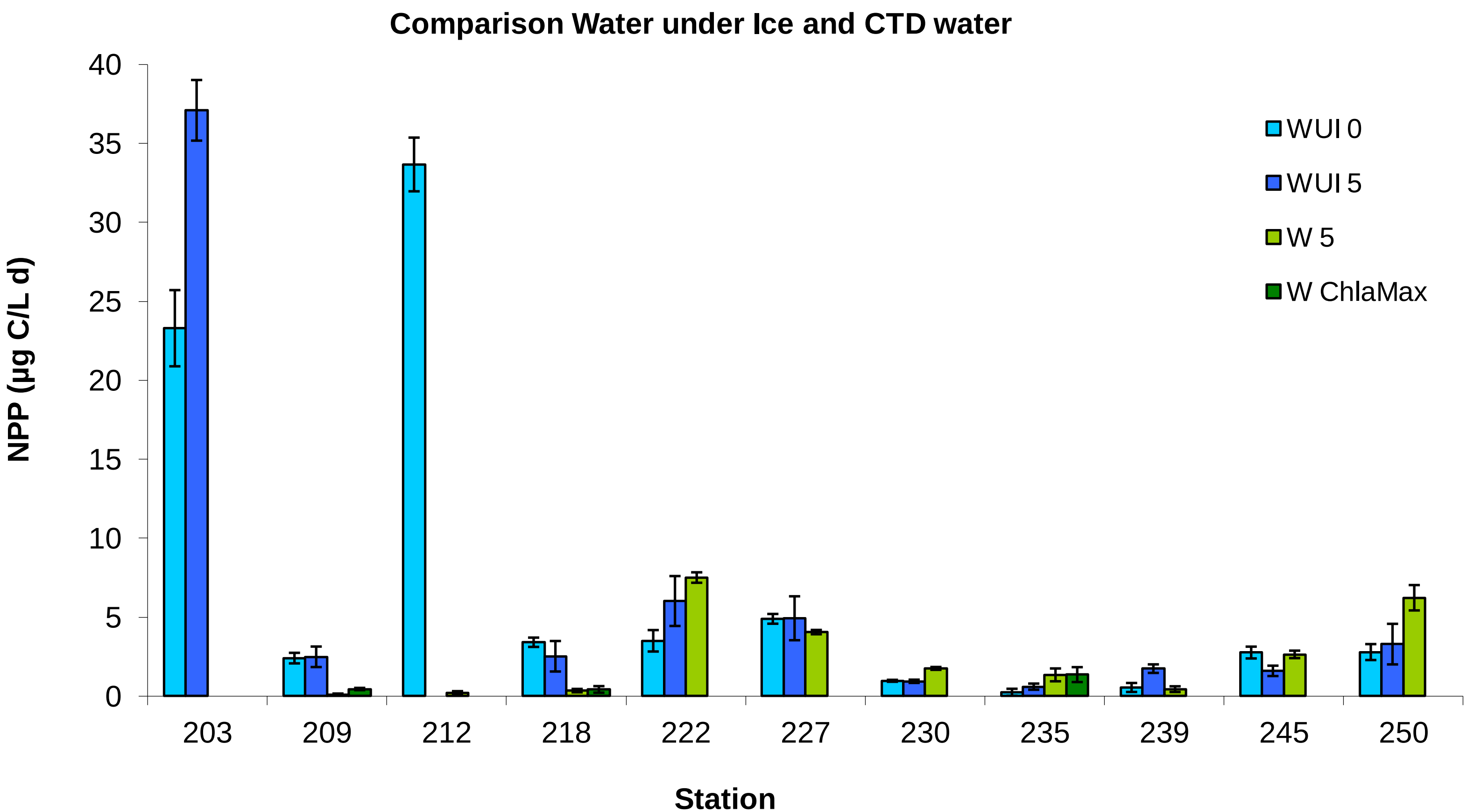
Surface vs Chl *a* max



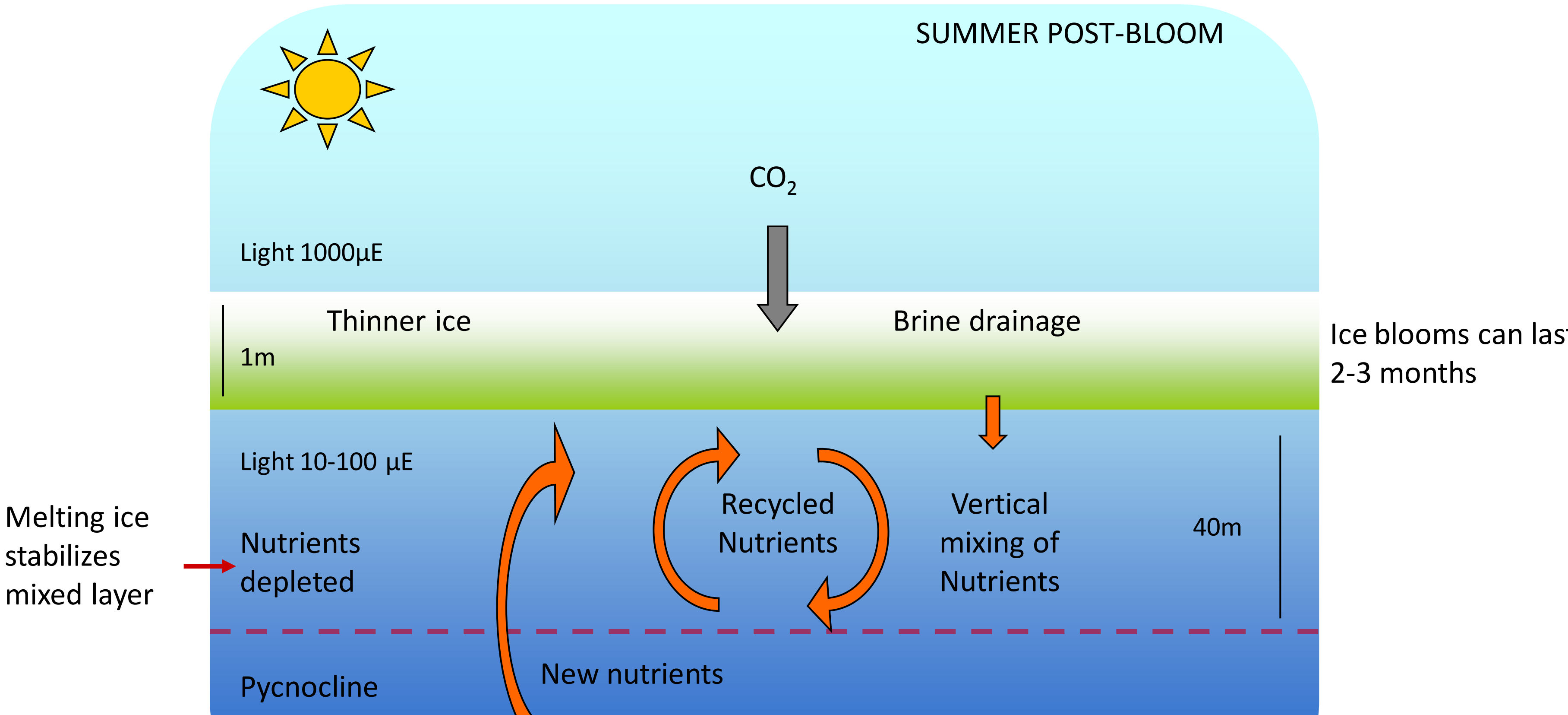


Results TransArc 2011

Water under the ice



1. Limitation of PP in sea ice algae



Will higher light intensities due to thinner ice boost PP in the ice in summer or will it be limited by nutrient supply?