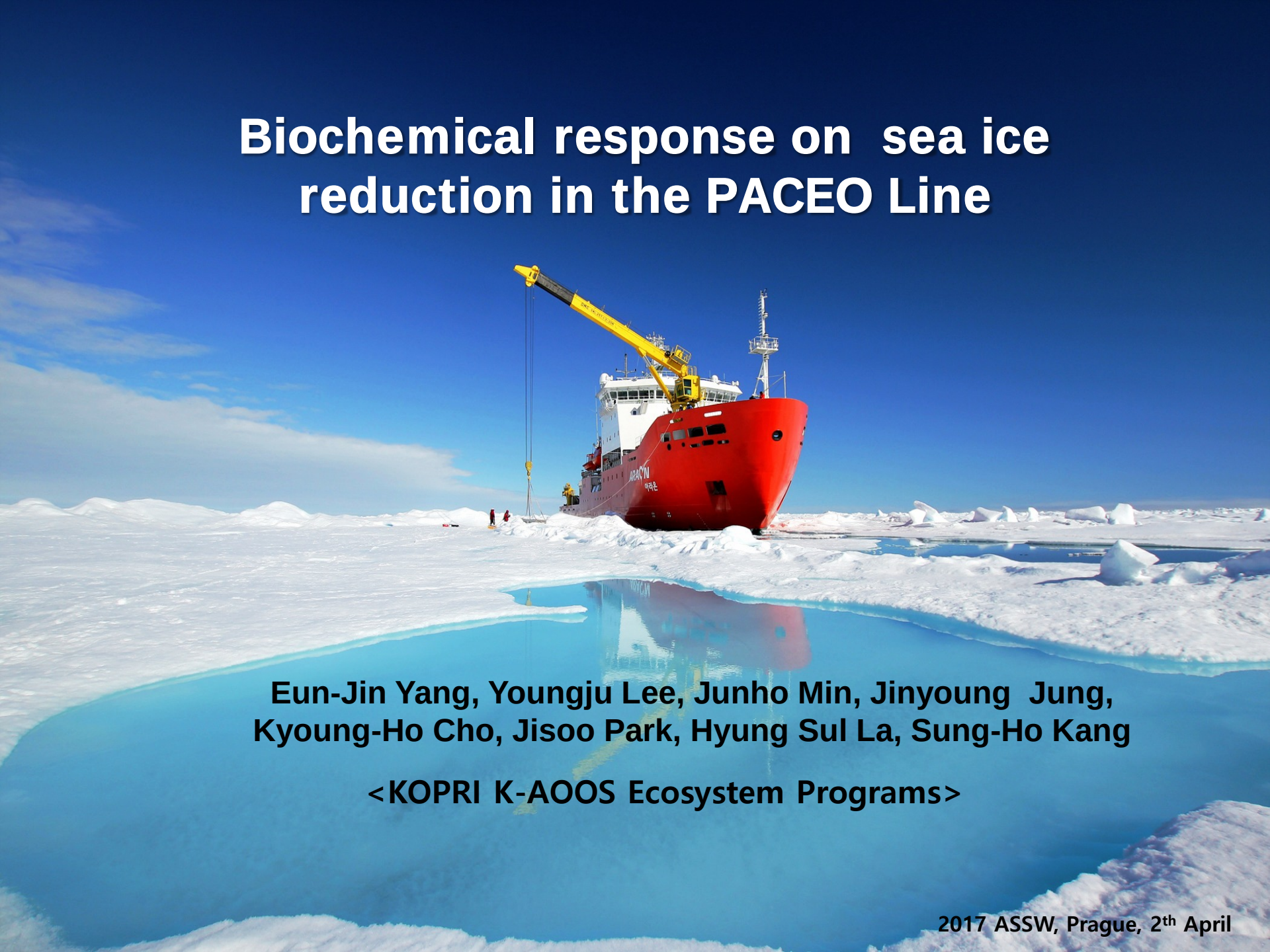
Biochemical response on sea ice reduction in the PACEO Line

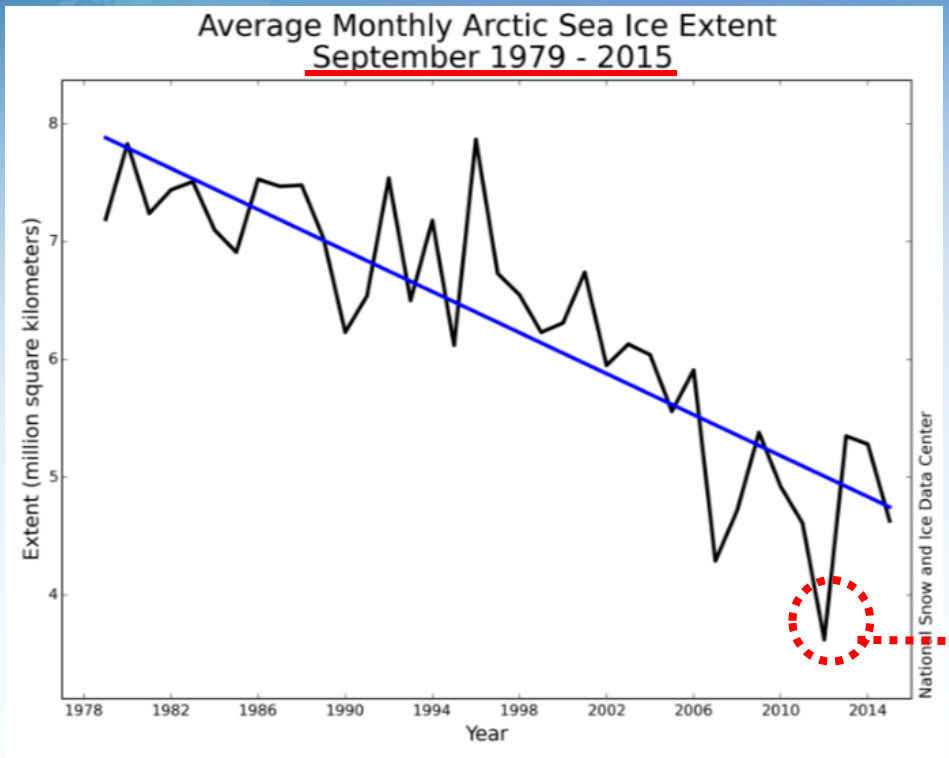


Eun-Jin Yang, Youngju Lee, Junho Min, Jinyoung Jung,
Kyoung-Ho Cho, Jisoo Park, Hyung Sul La, Sung-Ho Kang

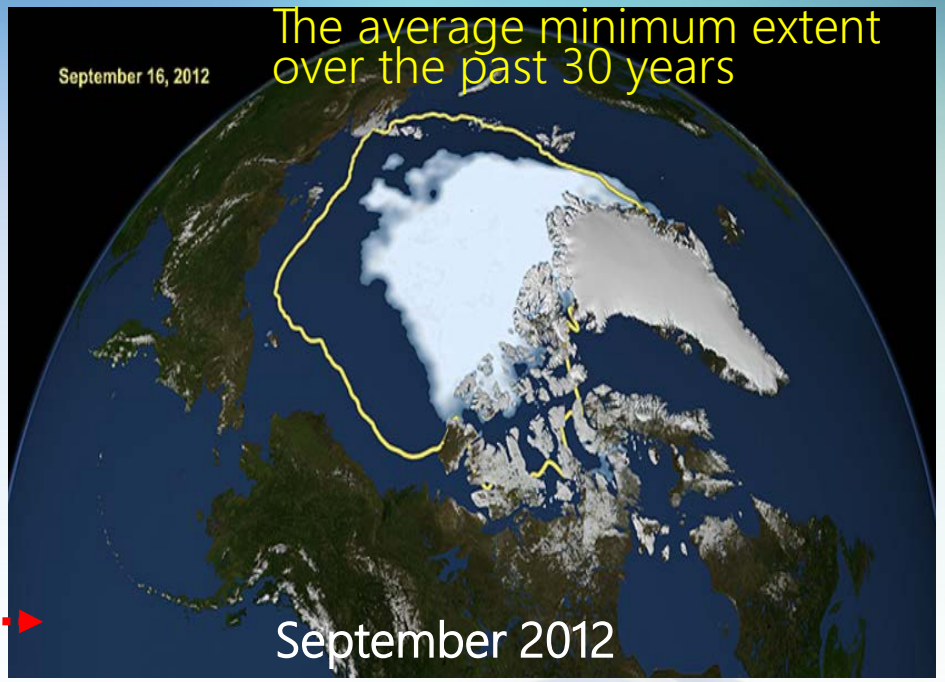
<KOPRI K-AOOS Ecosystem Programs>

2017 ASSW, Prague, 2th April

Arctic sea ice is melting



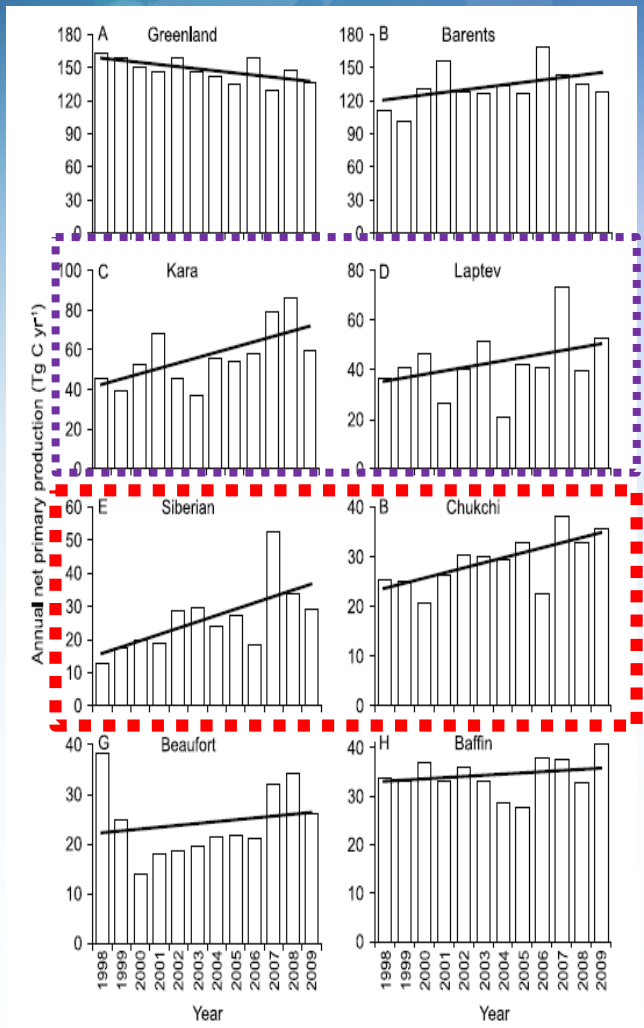
(Perovich et al., 2015)

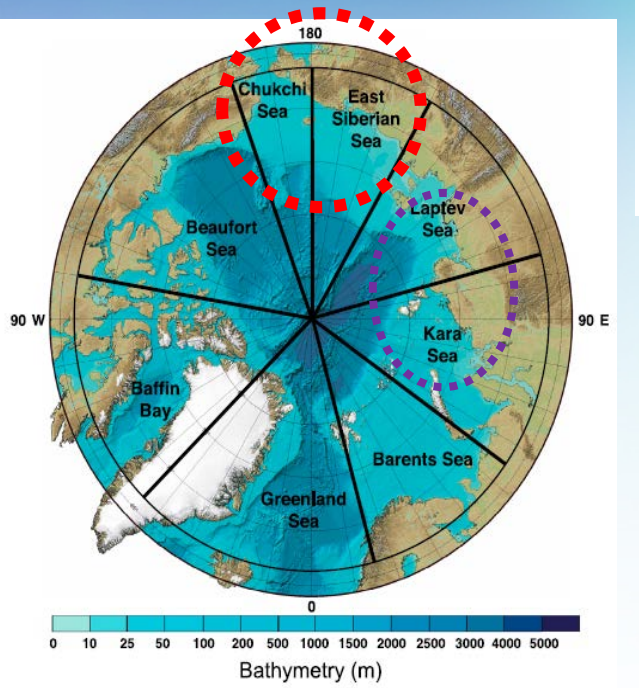


(NASA/Goddard Scientific Visualization Studio)

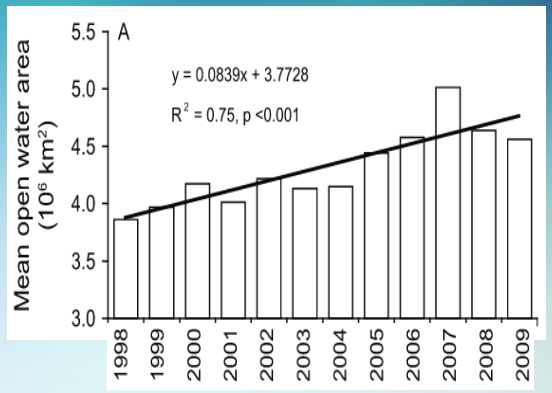
Increase in primary production

Annual primary production

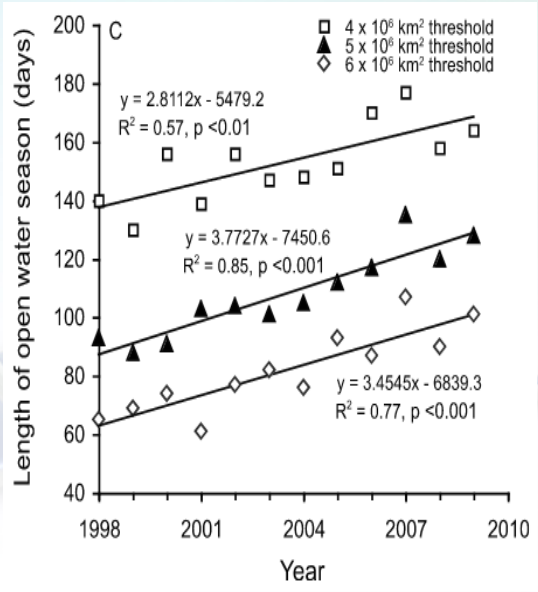




Open water area

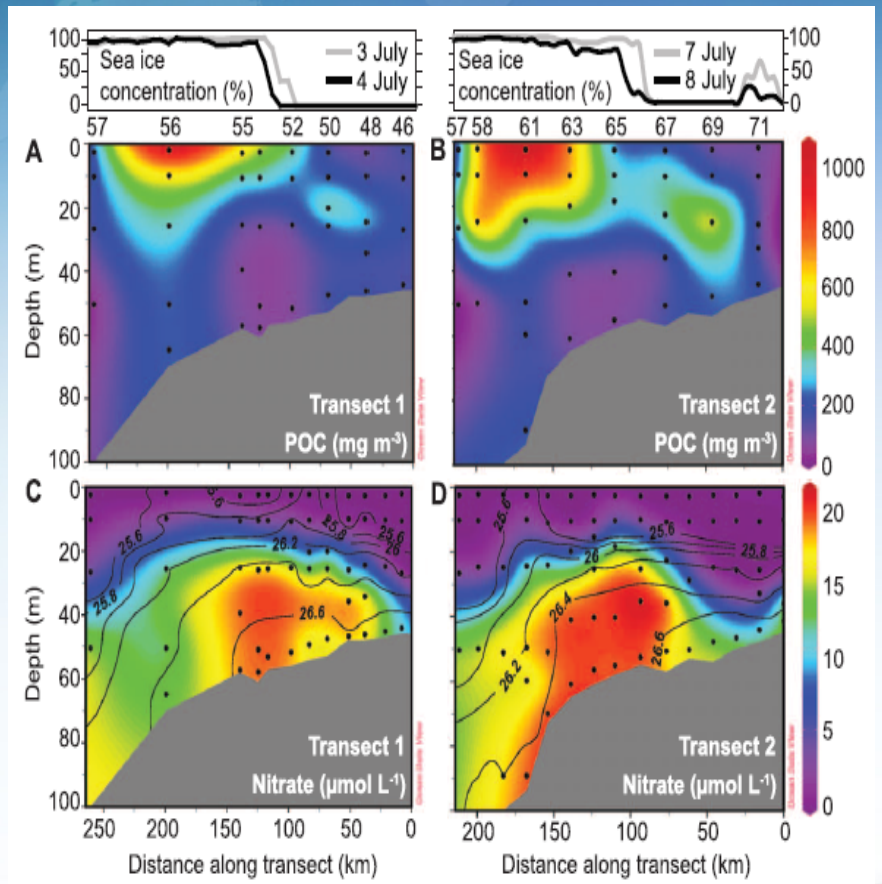


Duration of the open water season



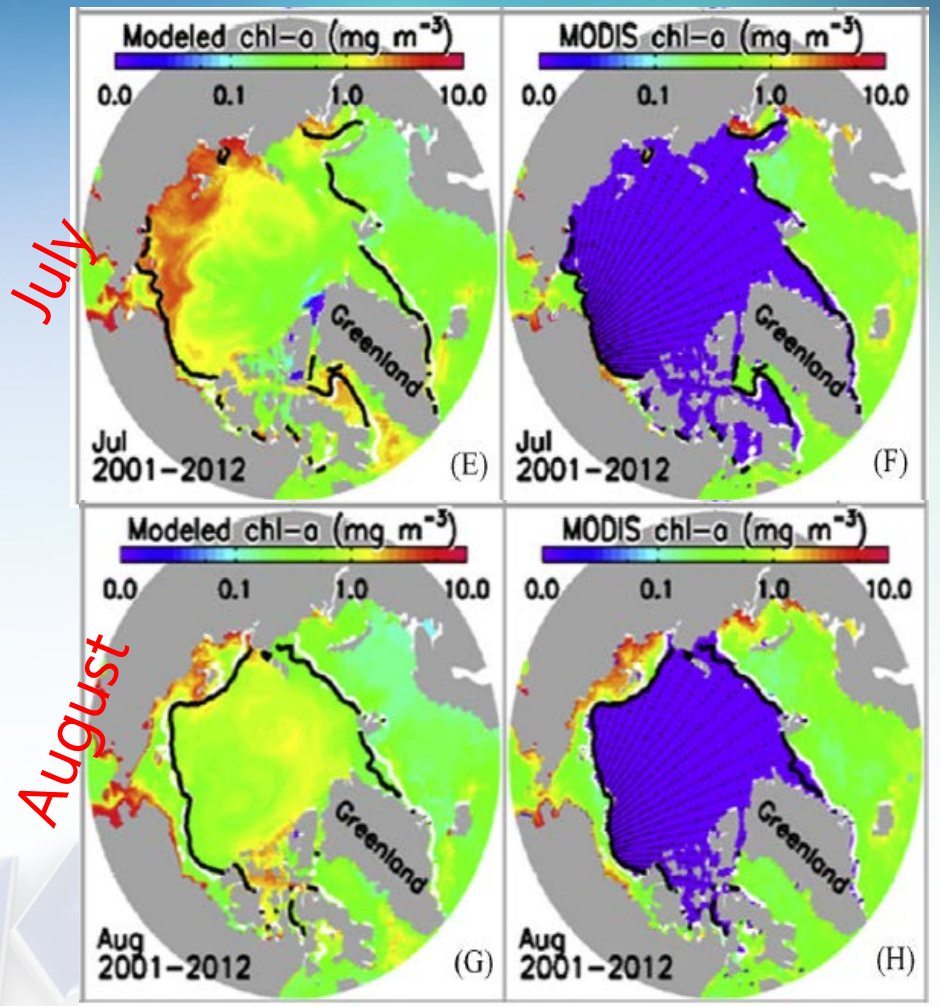
(Arrigo and van Dijken, 2011)

Under-ice phytoplankton blooms



(Arrigo et al., 2012)

Modeled chl-a MODIS chl-a

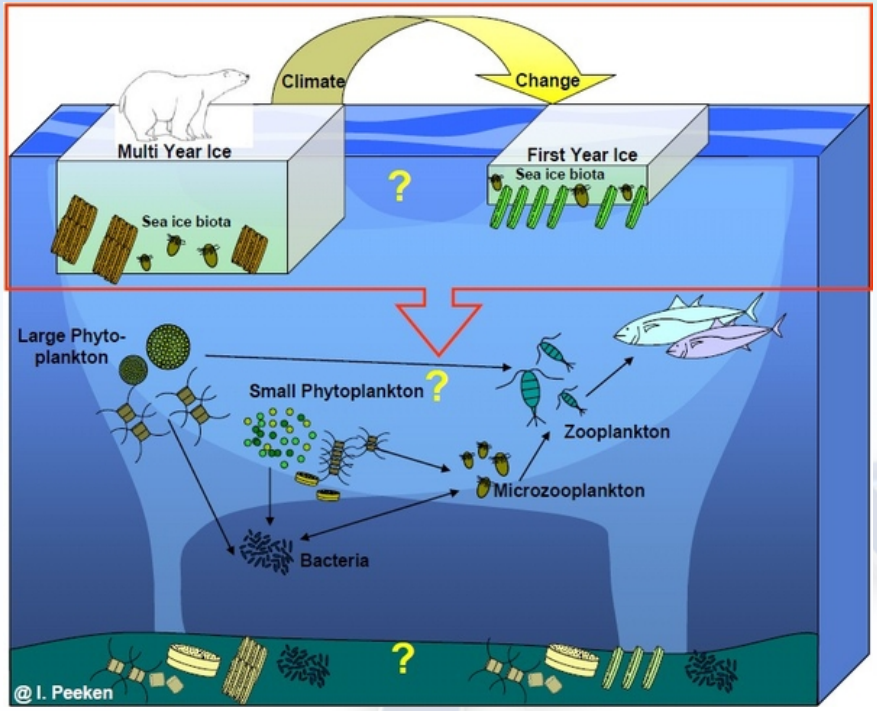


(Zhang et al., 2015)

The effects of changing sea-ice on Arctic marine ecosystem

Arctic is warmer and less saline = less extensive and thinner ice

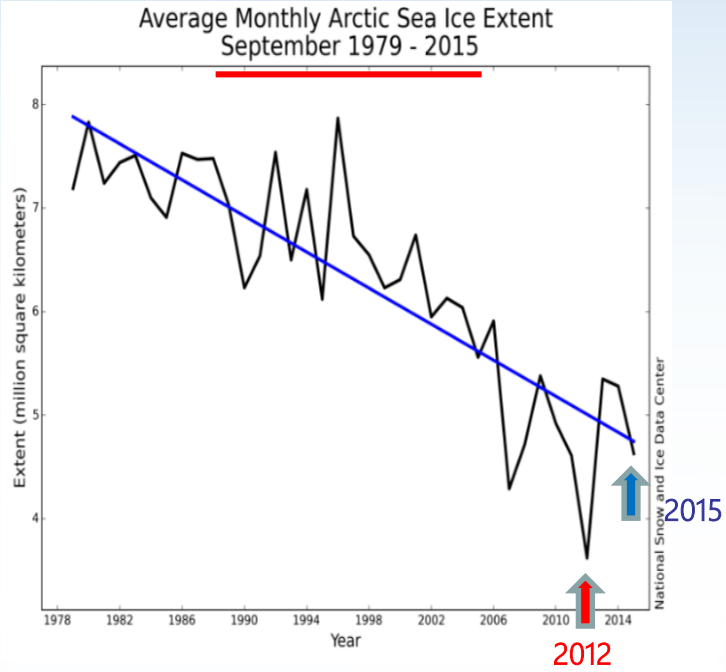
How does sea ice variability (melting/formation and recent inter-annually rapid decrease) affect plankton dynamics (i.e. composition, biomass, physiology and trophic interaction) and chemical process ?



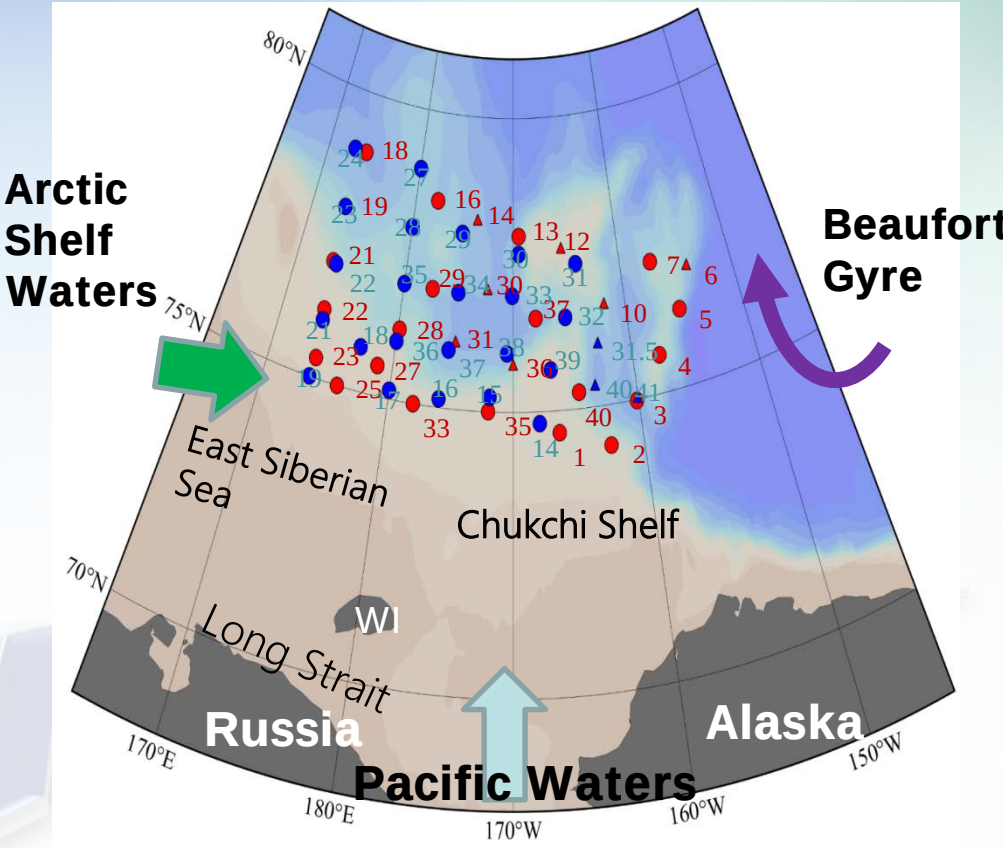
Impact of Climate Change on Arctic Sea Ice
(http//www.awi.de)

Objectives

- ✓ Understanding the influence of sea ice reduction on the plankton community, microbial composition, nutrient, DOC and POC distribution in the Chukchi and the East Siberian Seas.
- ✓ Comparison between 2012, Aug & 2015, Aug

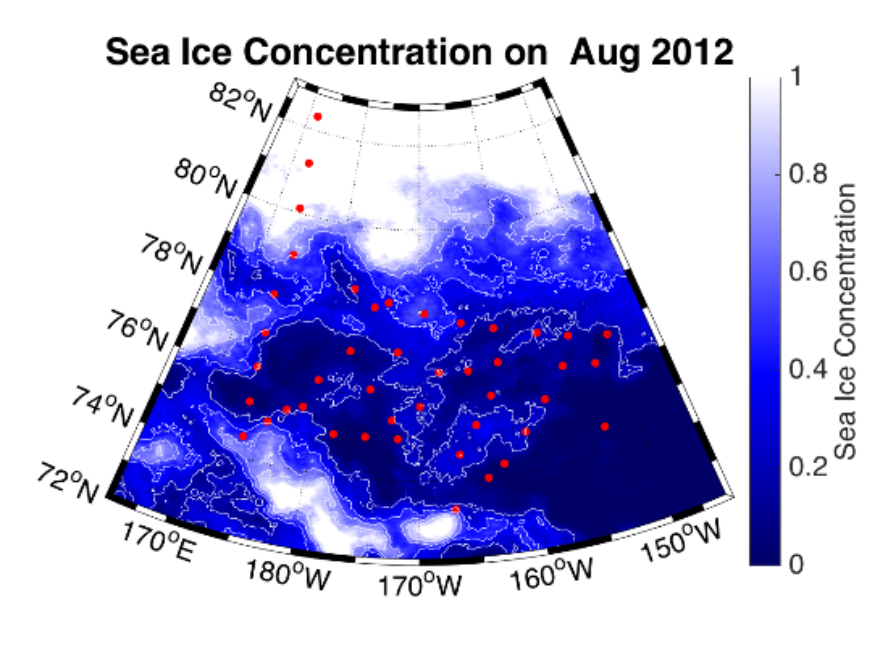


(Perovich et al., 2015)

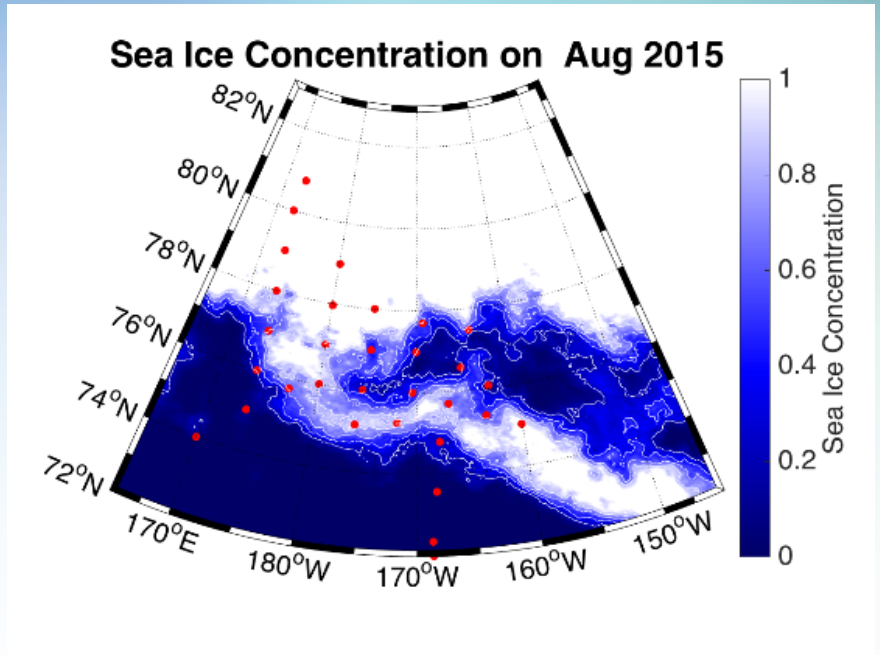


Sea ice concentration

August, 2012



August, 2015

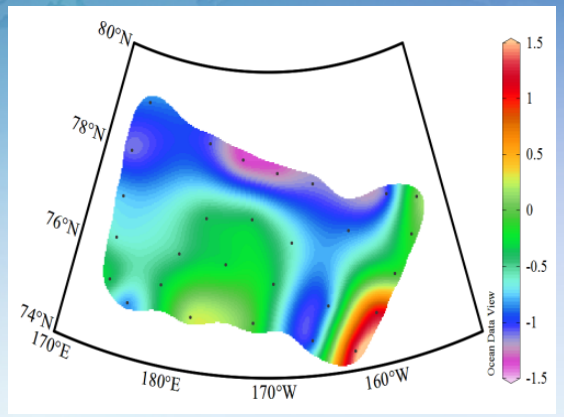


(Data source : http://www.iup.uni-bremen.de:8084/amsr2data/)

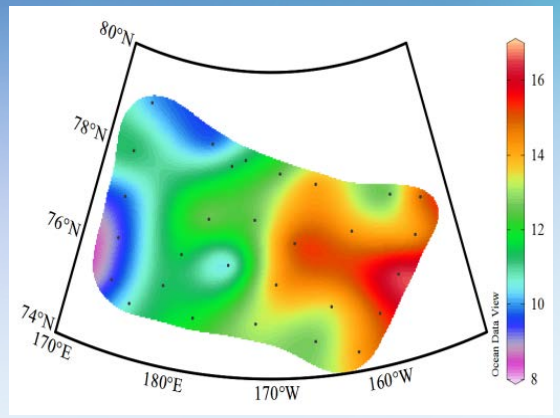
Physical variables

2012, Aug.

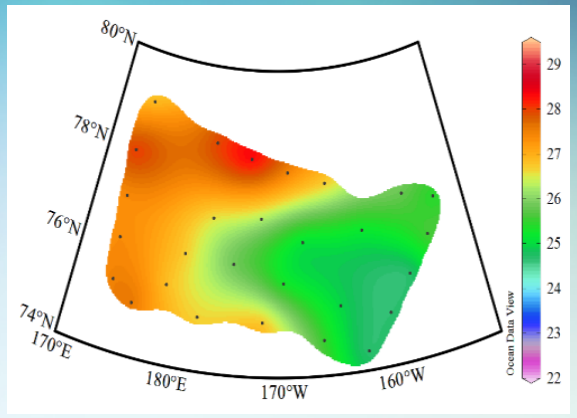
Sea surface temperature (ºC)



Freshwater content (upper 100m)

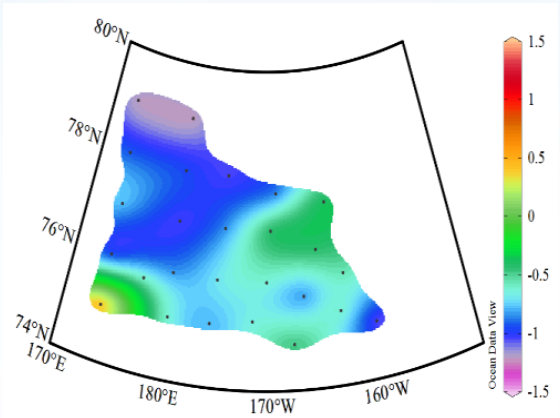


Sea surface salinity

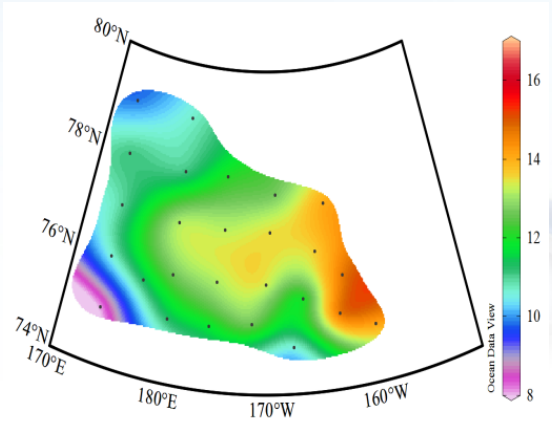


2015, Aug.

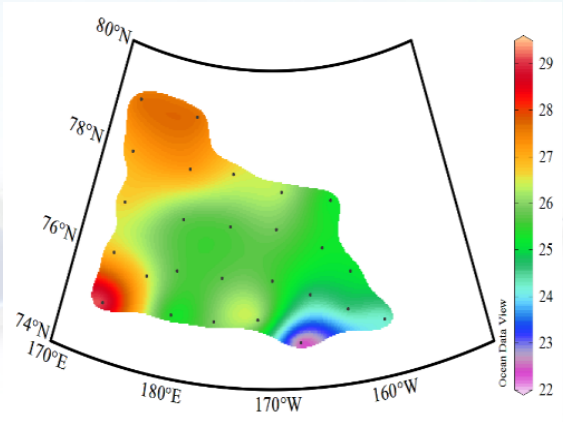
Sea surface temperature (ºC)



Freshwater content (upper 100m)



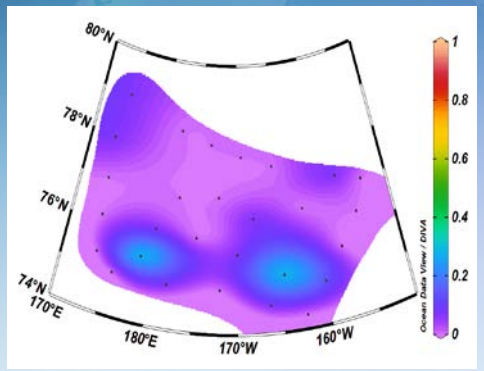
Sea surface salinity



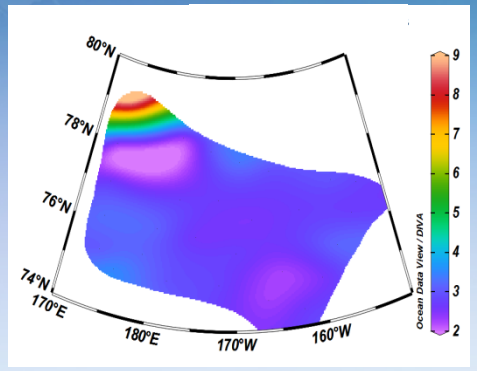
Nutrient and DOC concentration

2012, Aug.

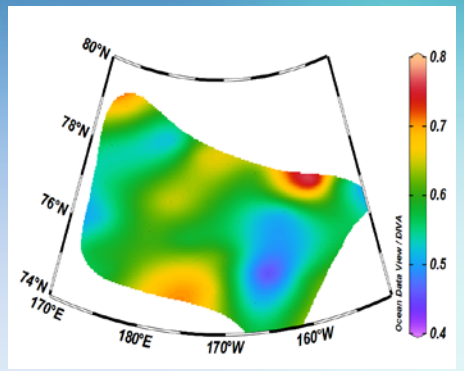
NO_2+NO_3 (μM)



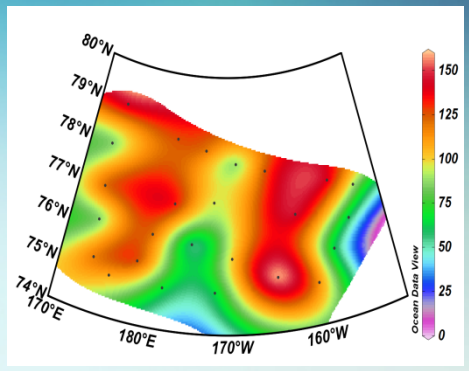
Silicate (μM)



Phosphate (μM)

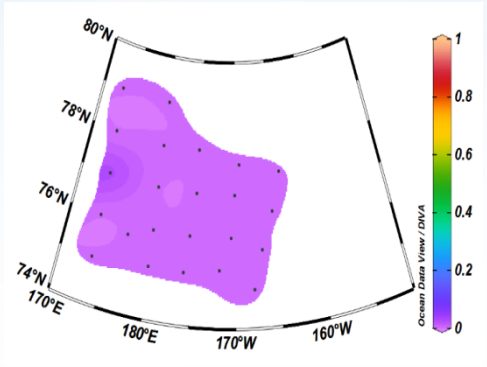


DOC (μM)

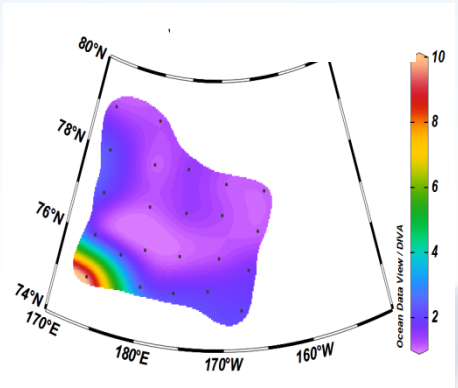


2015, Aug.

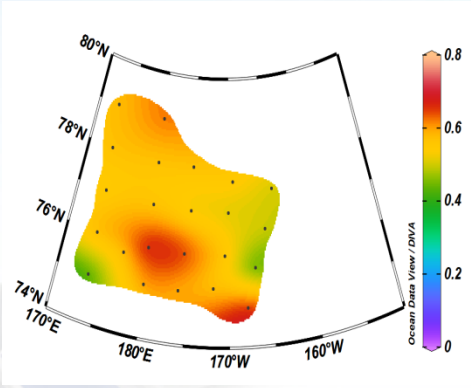
NO_2+NO_3 (μM)



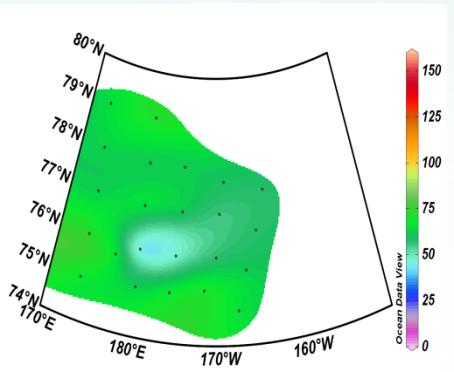
Silicate (μM)



Phosphate (μM)

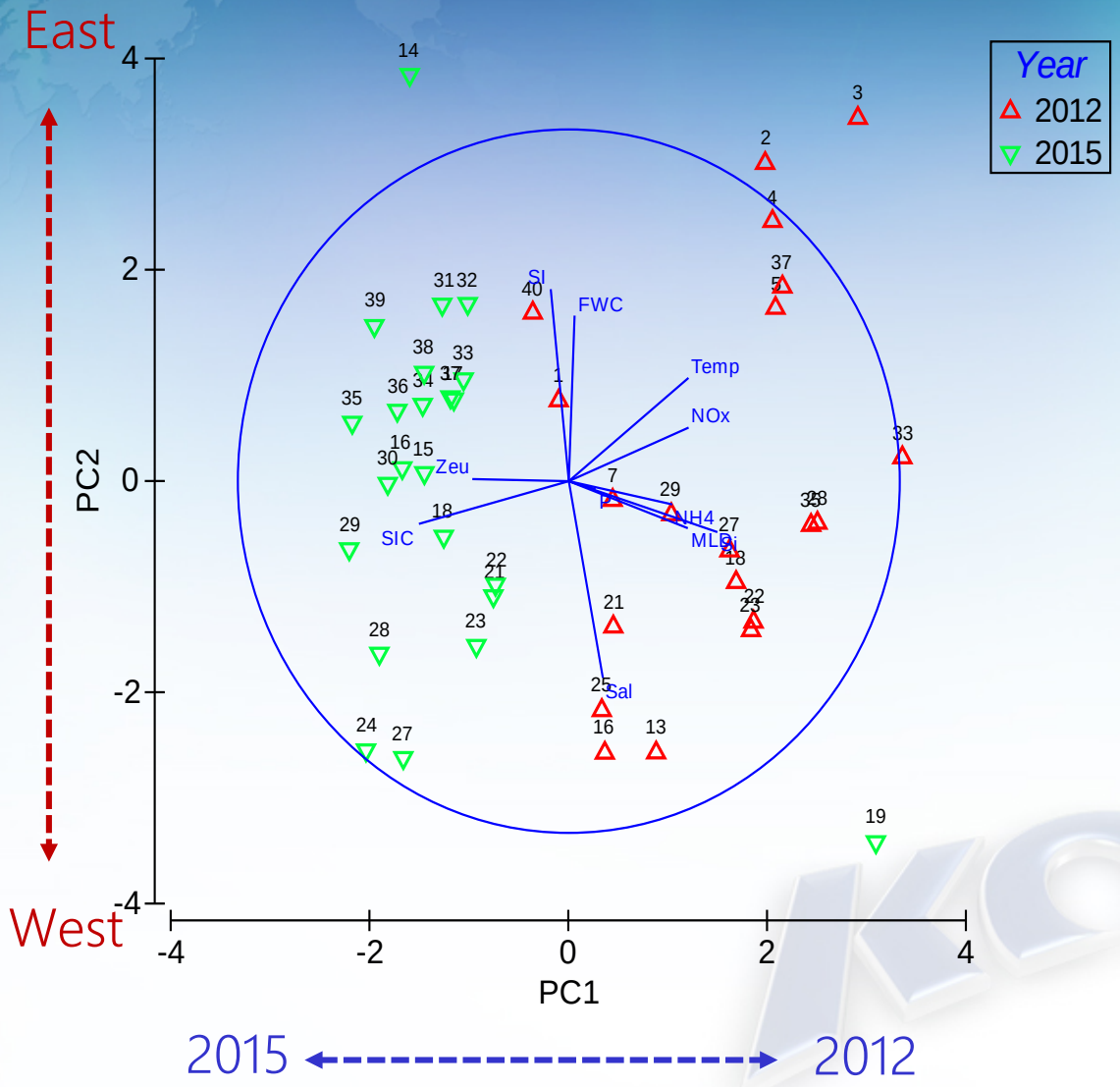


DOC (μM)



Principal component analysis (PCA)

on the environmental variables in surface layer



In 2012
- ✓ Higher SST
- ✓ Higher MLD
- ✓ Higher DOC &nutrient

In 2015
- ✓ Higher SIC

Chukchi Sea
(Eastern area)
- ✓ Higher SI, FWC

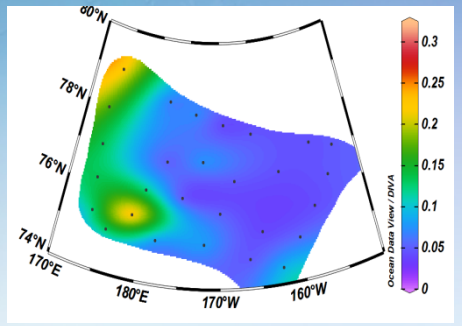
East Siberian Sea
(Western area)
- ✓ Higher SSS

*SI: Stratification index

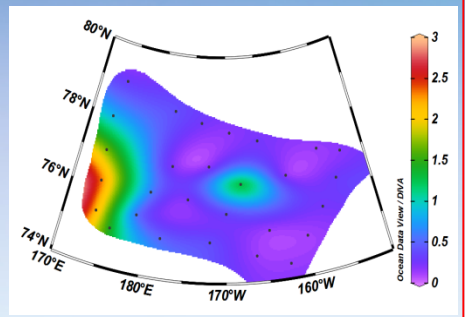
Phytoplankton biomass & Size group

2012, Aug.

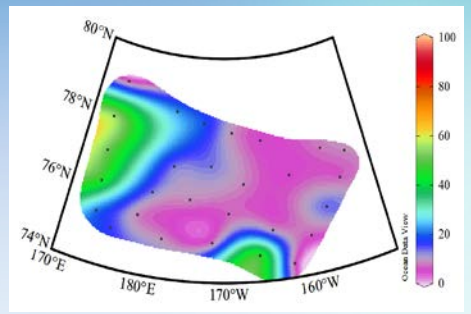
Surface chl-a (μg L^{-1})



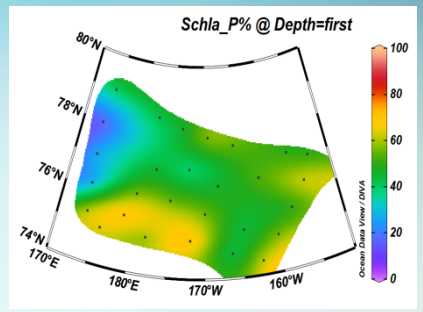
Depth-averaged chl-a (μg L^{-1})



Micro size chl-a % (>20μm)

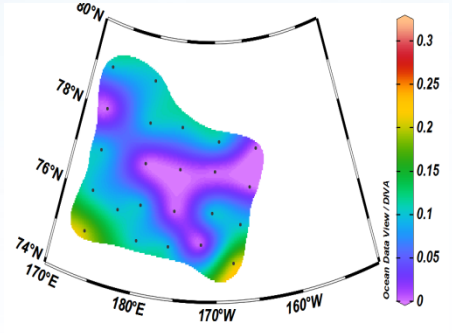


Pico size chl-a % (<2μm)

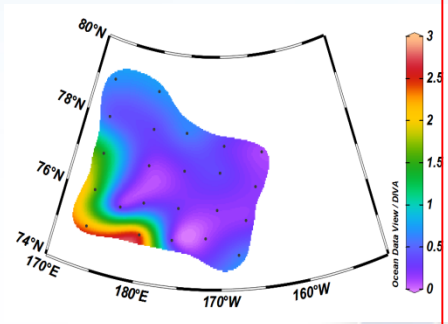


2015, Aug.

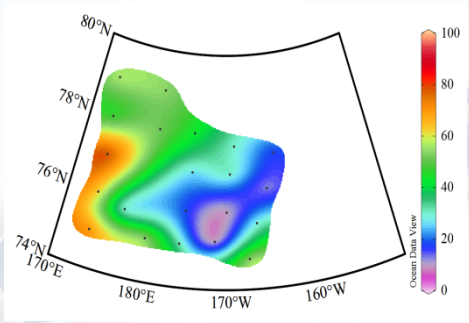
Surface chl-a (μg L^{-1})



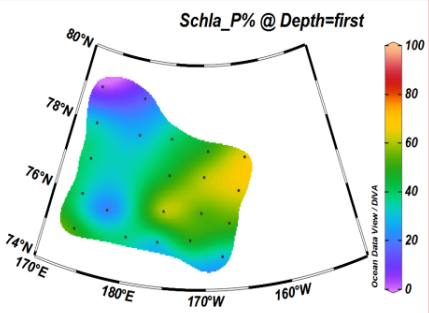
Depth-averaged chl-a (μg L^{-1})



Micro size chl-a % (>20μm)

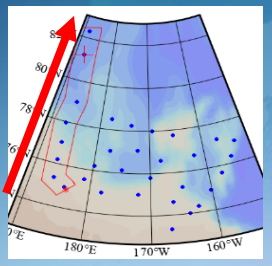


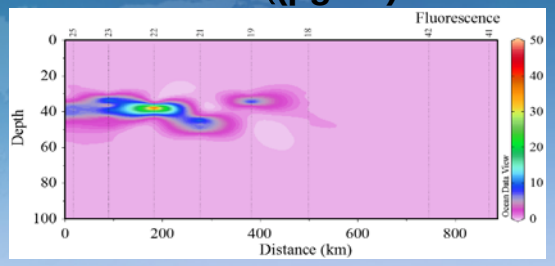
Pico size chl-a % (<2μm)



Vertical structure of Chl-a

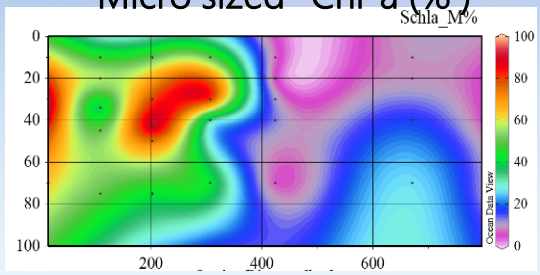
Chl-a ((μg L-1)

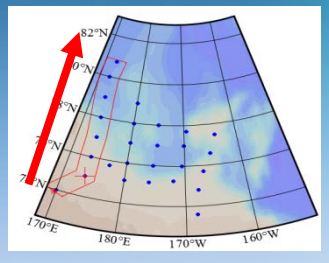




2012

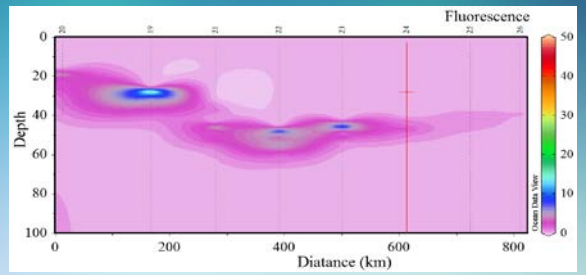
Micro sized -Chl-a (%)



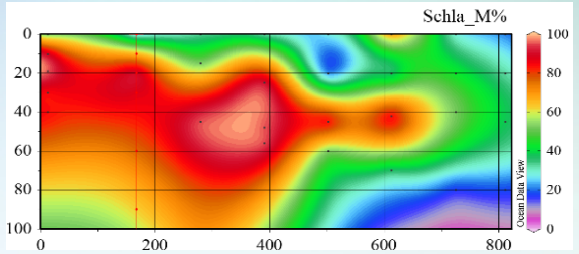


2015

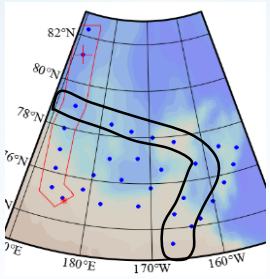
Chl-a (μg L-1)

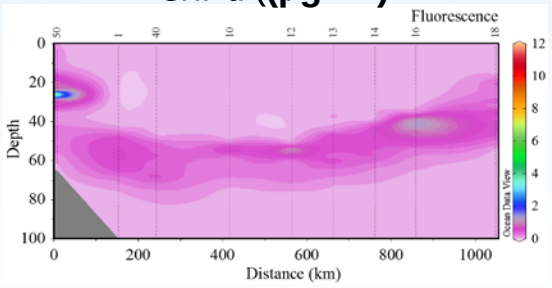


Micro sized -Chl-a (%)



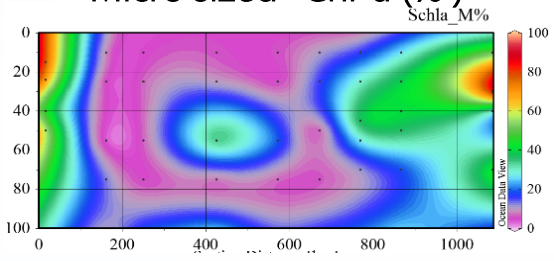
Chl-a ((μg L-1)

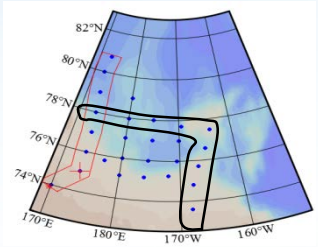




2012

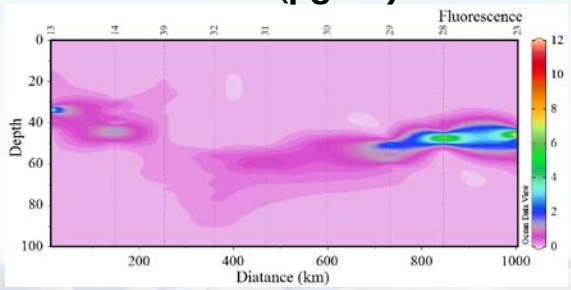
Micro sized -Chl-a (%)



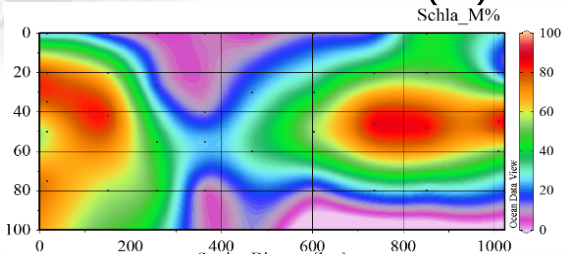


2015

Chl-a (μg L-1)



Micro sized -Chl-a (%)



Phytoplankton groups

By HPLC data

Statistical difference between two years (t-test)

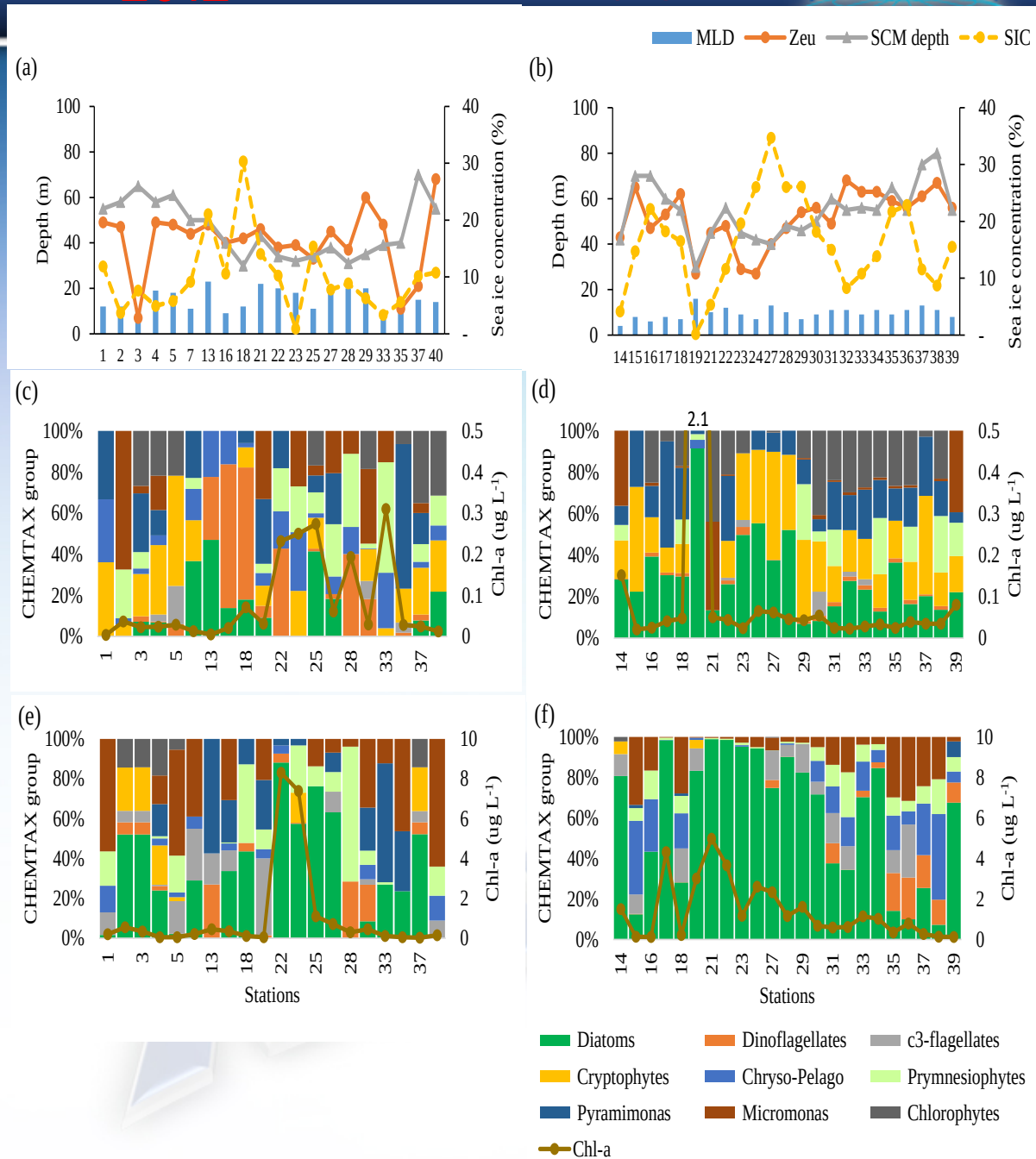
SIC ***
MLD ***
SCM depth *
Diatoms **
Pelagophytes **

* p<0.05
** p<0.01
*** p<0.001

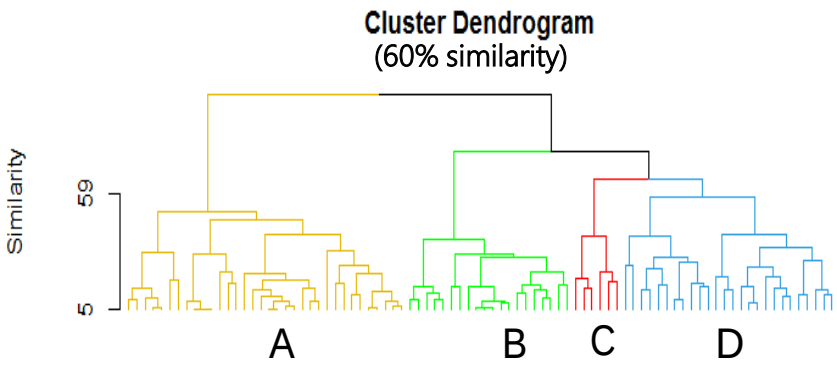
2012 2015

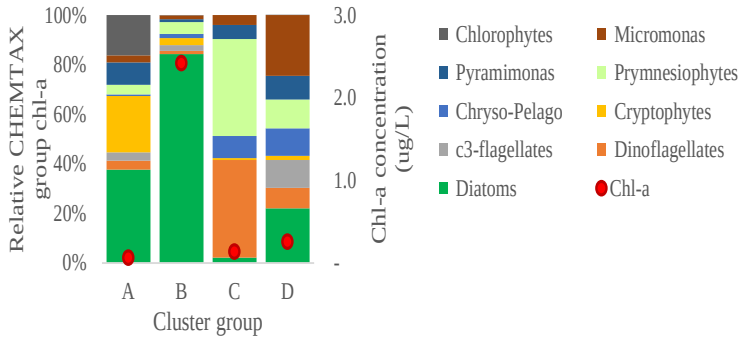
Surface

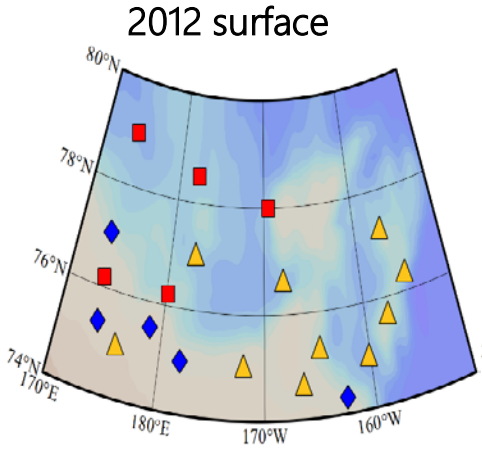
SCM

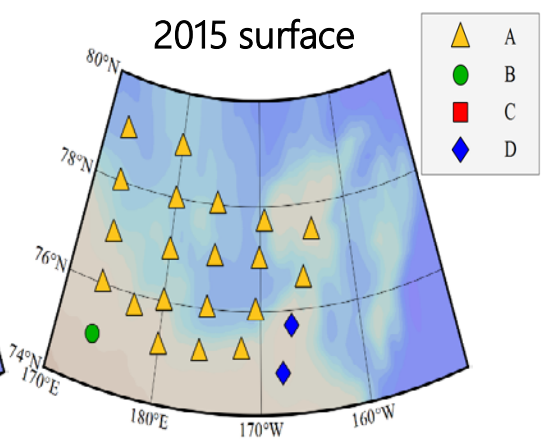


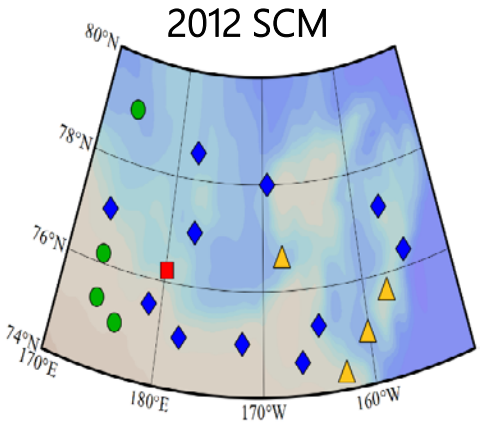
Cluster groups of phytoplankton community structure

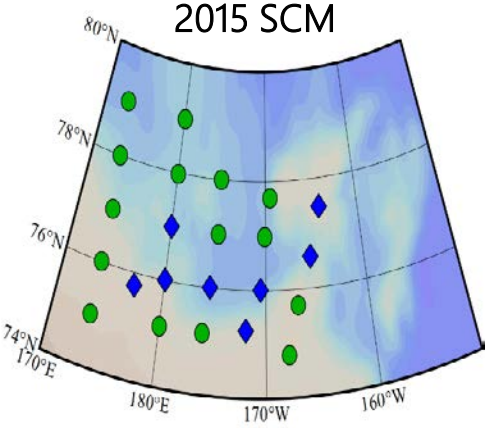












Group A: Diatom and cryptophyte

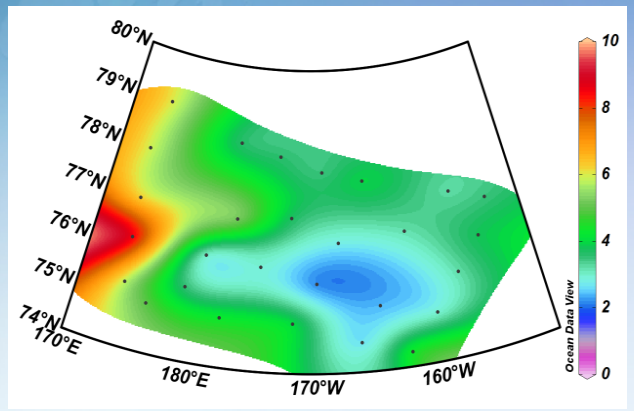
Group B: diatom

Group C & D : prymnesiophyte and dionoflagellate

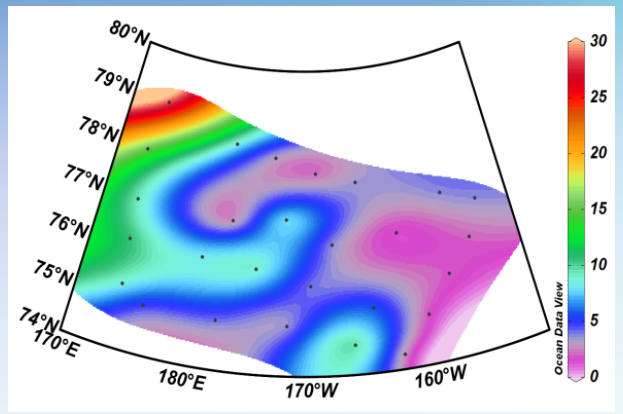
Microbial community & POC

2012, Aug.

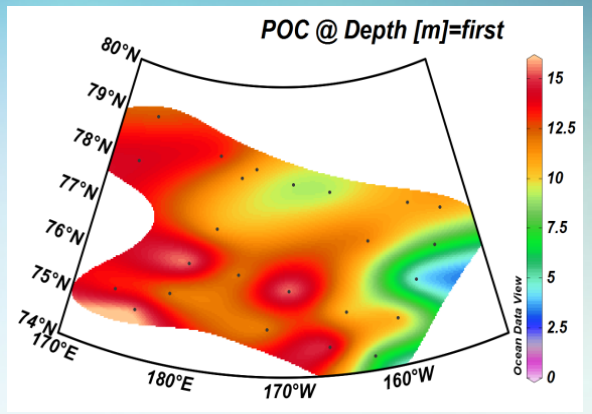
Bacteria (10^5cells mL^{-1})



Microzooplankton(µgC L^{-1})

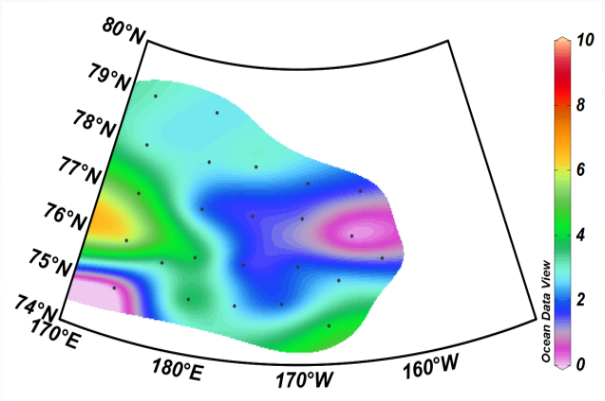


POC (µM)

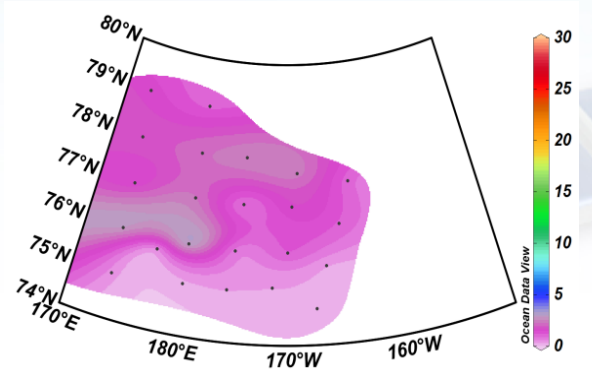


2015, Aug.

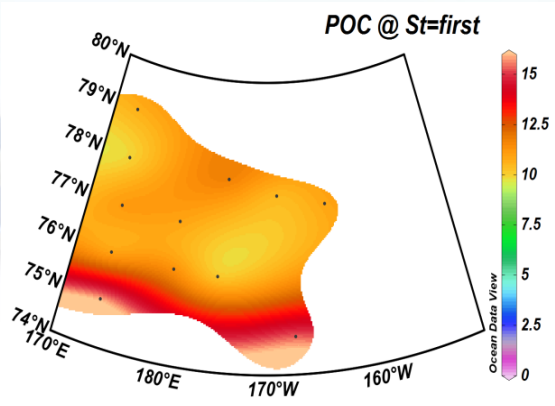
Bacteria (10^5cells mL^{-1})



Microzooplankton(µgC L^{-1})



POC (µM)



Summary

	August 2012	August 2015
Environmental variables		
Sea ice concentration***	Lower	Higher
SST	Slightly higher	Slightly Lower
Surface nutrient ***	Nitrate higher Phosphate lower	Nitrate lower Phosphate higher
DOC***	Higher	Lower
MLD***	Deeper	Shallower
Phytoplankton		
Phytoplankton biomass	A little difference of the average phytoplankton biomass	
Size structure***	Pico-size dominated	Micro-size dominated
Dominant phytoplankton**	Prymnesiophytes, prasinophytes, dinoflagellates, cryptophytes	Diatoms
Heterotrophic community and POC		
Heterotrophic bacteria	Higher	
Microzooplankton	Higher	
POC	Higher	

Future Study

- Phytoplankton groups may appear to be controlled mainly by seeding from sea ice -> Diatom composition necessary !!
- Trophic interaction in planktonic food web
- The east-west gradients of some abiotic and biotic variables need to be taken into consideration for future study on the effect of water mass on bio-chemical components
- Long-term continuous monitoring using mooring system attached biochemical sensors (Chl-a, PAR, nitrate..)


Thank you