Phytoplankton biomass and production in a changing Arctic: contrasting summers of 2013, 2014 and 2016

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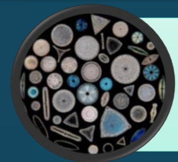
Introduction

Rapid changes in ice cover, freshwater input and sea temperature in the Canadian High Arctic are affecting phytoplankton communities (Blais et al. 2017). On the one hand , the higher exposure of sea surface to wind forcing could deepen the surface mixed layer, rendering it more difficult for phytoplankton to harvest light, but easier for them to access nutrients (Marchese et al. 2017, Tremblay and Gagnon 2009). On the other hand, a fresher and warmer sea surface could intensify the vertical stratification, making access to light easier, but limiting nutrient input to the euphotic zone (Li et al. 2009, Marchese et al. 2017). The effects of a changing light regime and stratification intensity on phytoplankton biomass, production and size-structure remain uncertain in northern Baffin Bay.



Objective: To link the variability of phytoplankton biomass, production and size-structure to physical variables in two contrasted hydrographic regions of northern Baffin Bay during the summers of 2013, 2014 and 2016.

Methods

Sampling was conducted in the North Water (NOW) and Nares Strait from 29 July to 2 Sept 2013, from 11 July to 12 Aug 2014, and from 16 July to 23 Aug 2016 onboard the CCGS Amundsen (Fig. 1). Variables measured include:

- Size fractionated phytoplankton biomass (chlorophyll *a*; Fluorometric method; Parsons et al. 1984)
- Subsurface chlorophyll maximum depth (SCM) (fluorescence probe on CTD-Rosette)
- Stratification intensity (difference in Sigma-*t* between 80 and 5 m; Tremblay et al. 2009).
- Size fractionated primary production (^{14}C-asssimilation method with in situ incubations; Knap et al. 1996)
- Euphotic zone depth (Z_{eu}) and light availability integrated over Z_{eu} (0.2 % threshold, K_d estimated with a radiometer)
- Sea temperature averaged over Z_{eu} (temperature probe on CTD-Rosette)

Two-way ANOVAs (type II) were used to detect significant spatio-temporal differences. Multiple and simple linear regressions were used to explore the influence of environmental factors presented in this poster on various biomass and production related ratios.

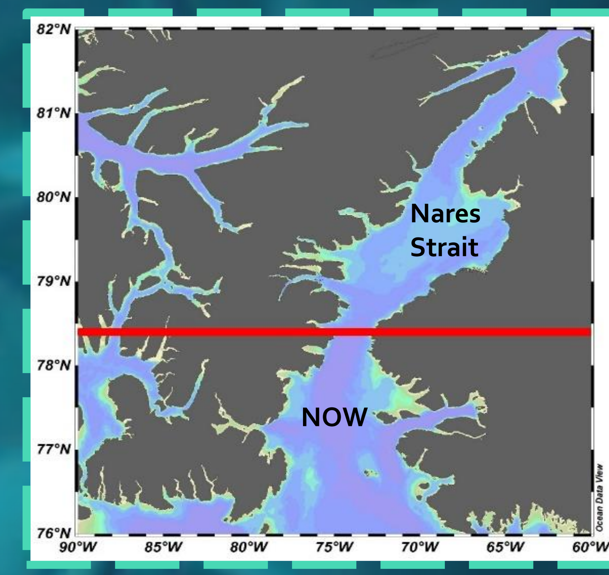
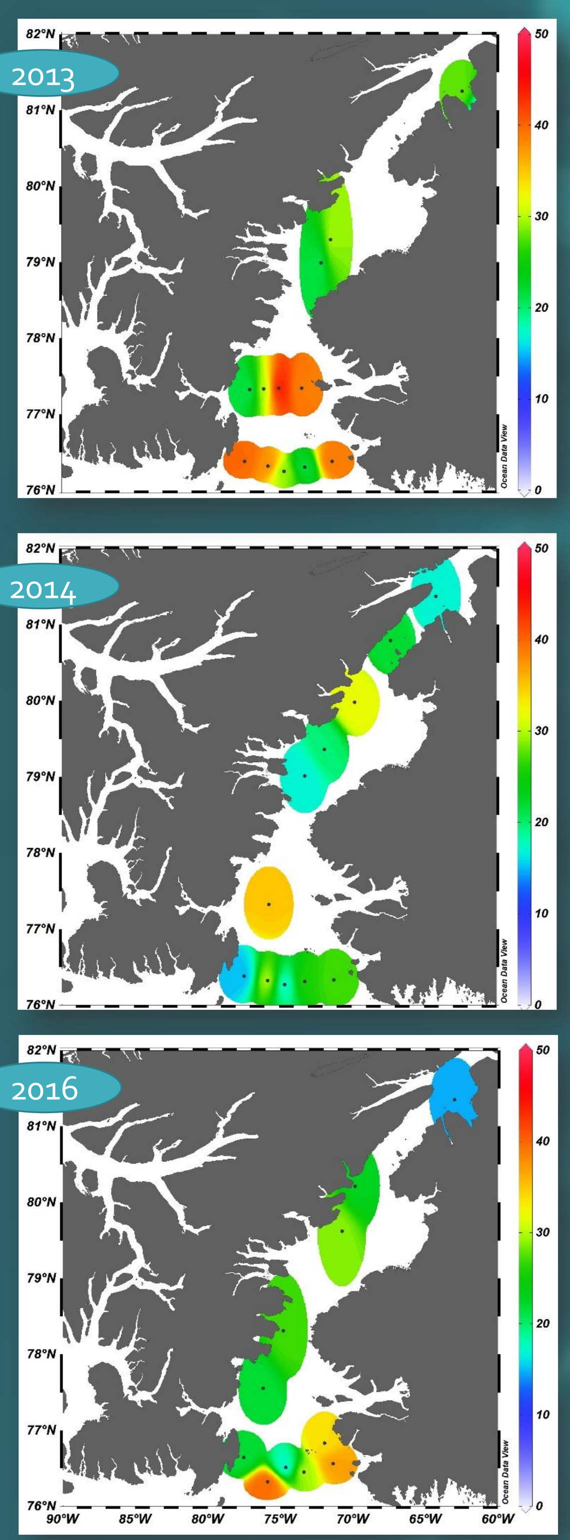


Fig 1. Northern Baffin Bay.

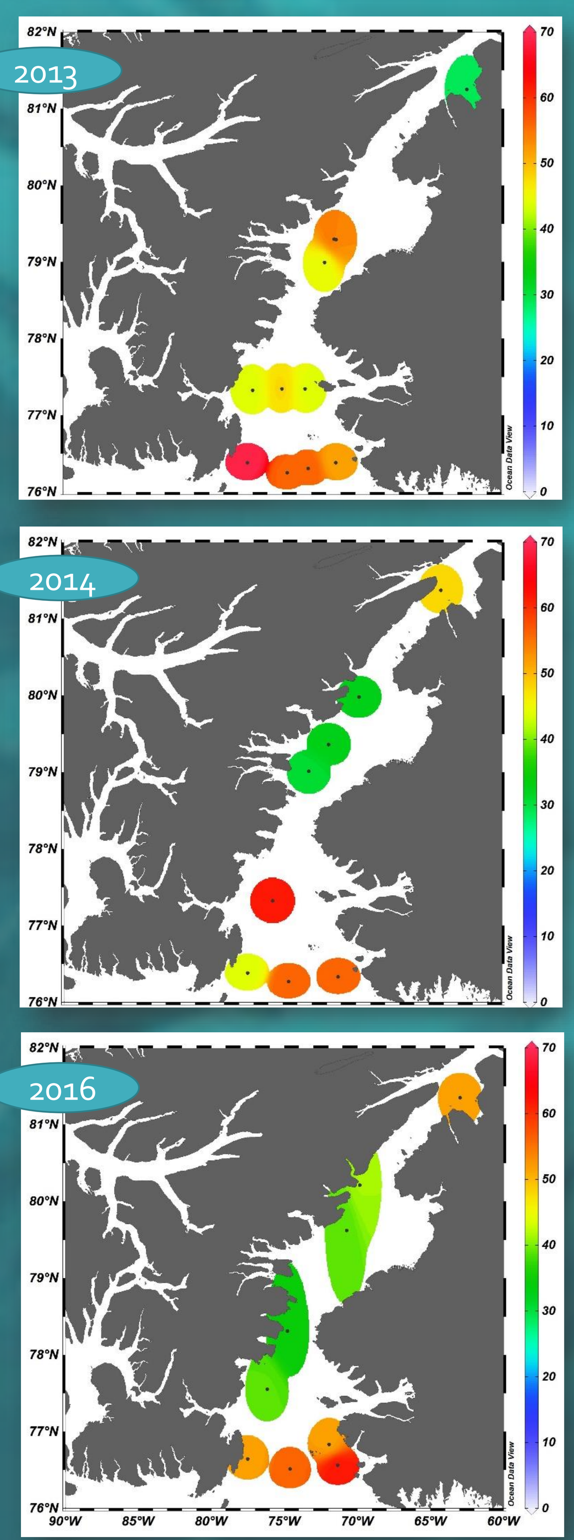
Results and Discussion

1. SCM depth (m)



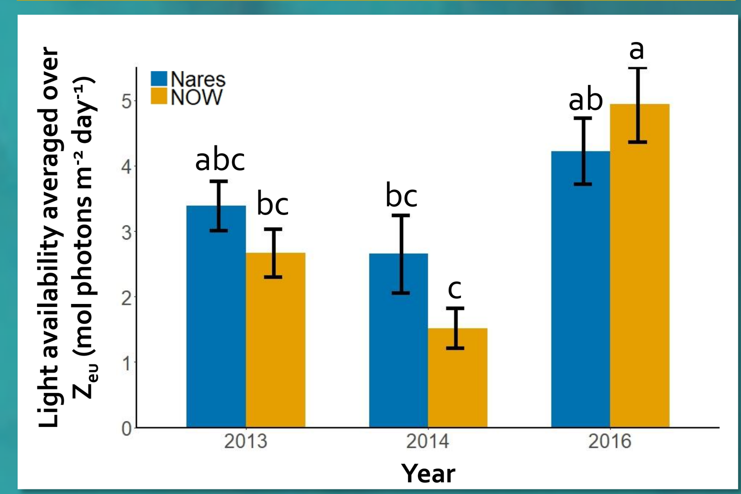
- SCMs significantly deeper in the NOW than in Nares Strait during the 3 sampling years ($p < 0.05$).
- Shallowest SCM during 2014 and deepest during 2013.

2. Z_{eu} (m)



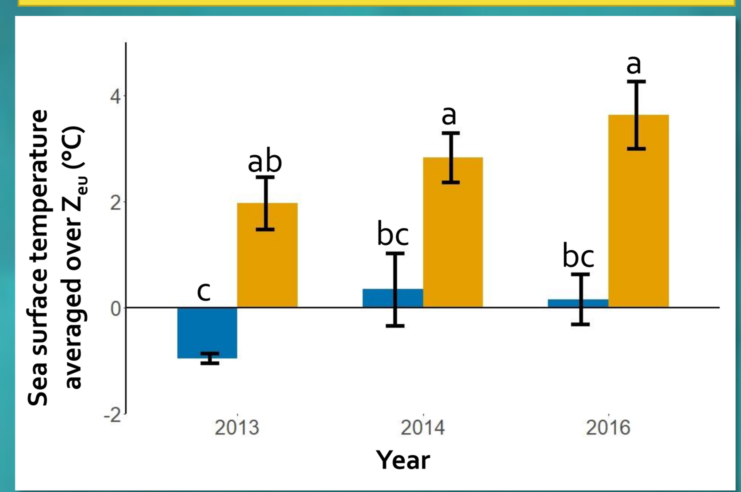
- No significant difference between years and regions.
- Z_{eu} often deeper in the NOW than in Nares Strait.

3. Light availability over Z_{eu}



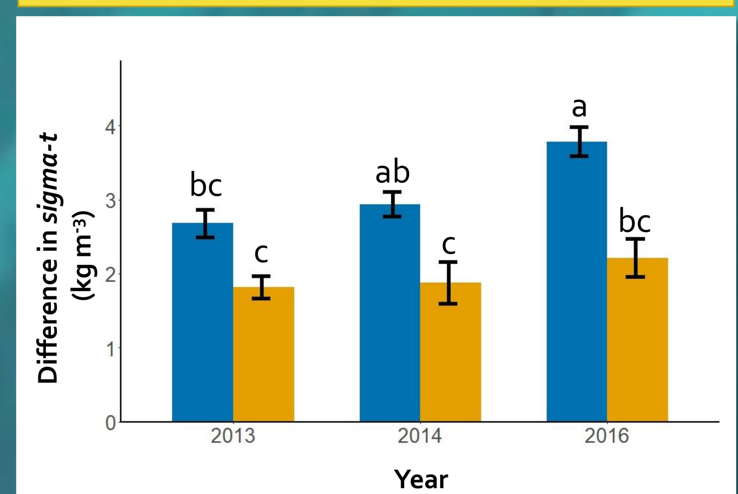
- In the NOW: Significantly higher in 2016 than in 2013 and 2014 ($p < 0.01$).

4. Sea surface temperature



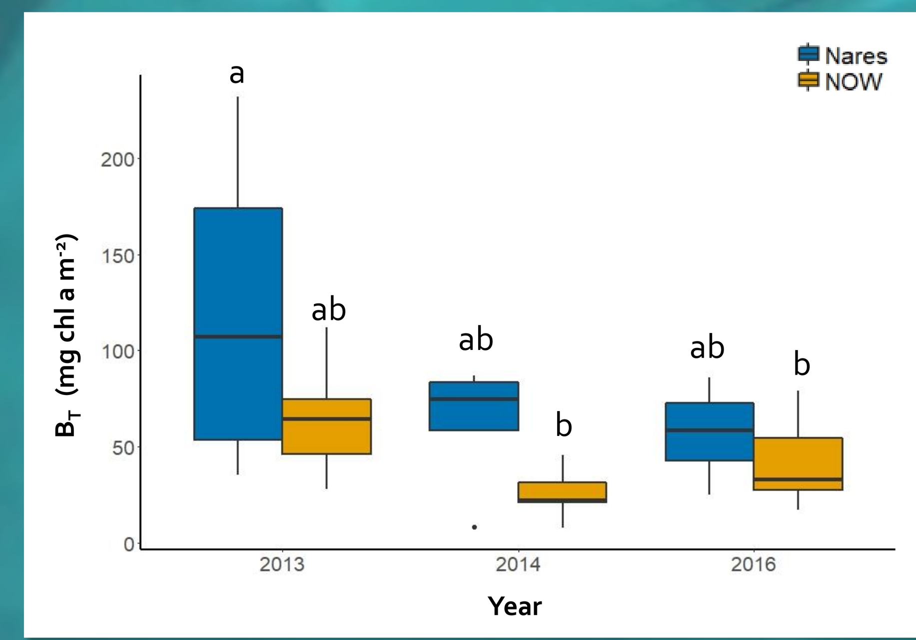
- Significantly higher in the NOW than Nares Strait during the 3 sampling years ($p < 0.0001$).

5. Stratification intensity



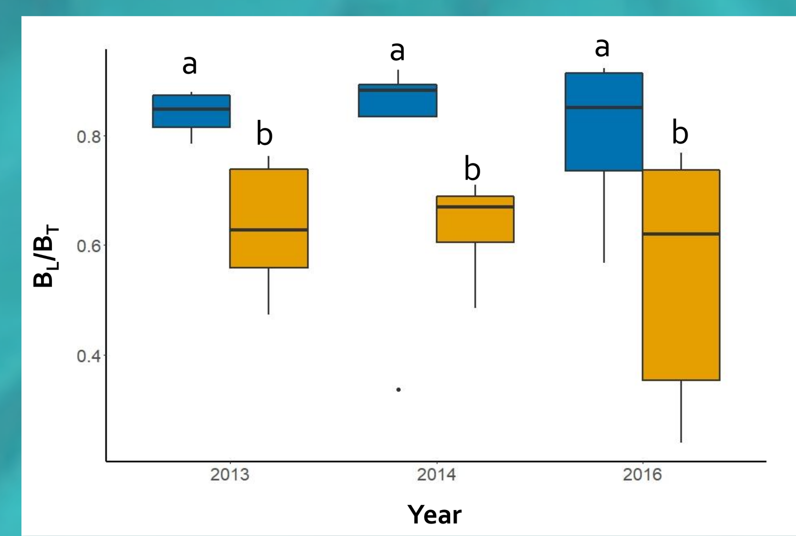
- Stratification intensity remained relatively constant in the NOW, but were significantly higher during 2016 compared to 2013 in Nares Strait ($p < 0.05$).
- A significant linear increase was detected in Nares Strait from 2013 through 2016 ($R^2 = 0.6$; $p < 0.01$).

A. Biomass integrated over Z_{eu} (B_T)



- B_T significantly higher in Nares Strait during 2013 than in the NOW during 2016 ($p < 0.01$).

B. B_L/B_T ratio: Multiple linear regression



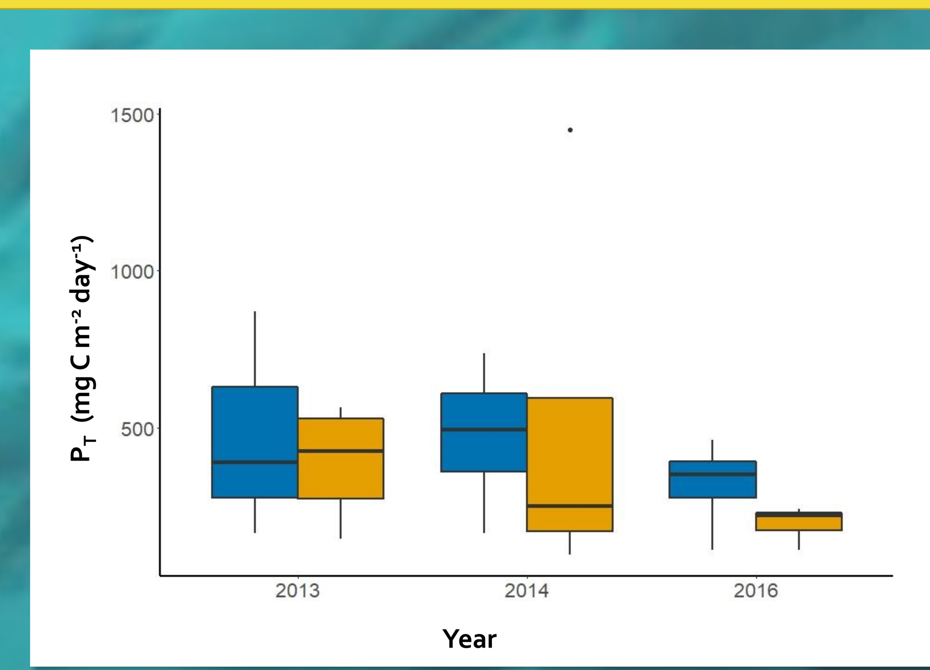
- Nares's ratios consistently higher in the NOW throughout the study period ($p < 0.001$).

Year (model)	Equation	Adjusted R²	P-value
2013	$Y = 1.1 + (-0.11 * X_4) + (-0.15 * X_3)$	0.6677	0.009
2014	$Y = 1.4 + (0.19 * X_4) + (-0.16 * X_2)$	0.9645	0.0001
2016	$Y = 1.2 + (0.01 * X_1) + (-0.02 * X_2)$	0.7117	0.01

Were X's subscript corresponds to the variable number presented in this poster.

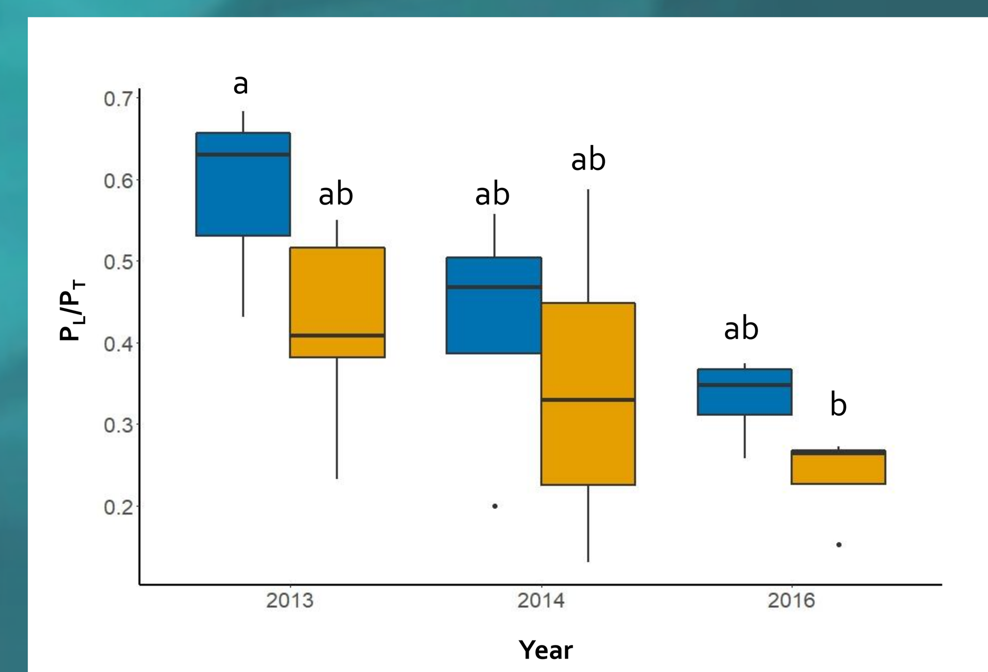
- All models significant ($p < 0.01$) with adjusted $R^2 > 0.5$.
- In 2013, variables 3 and 4 had a significant influence on B_L/B_T (B = -0.11 and -0.15; $p < 0.05$ and 0.01).
- In 2014, variables 2 and 4 influenced significantly B_L/B_T (B = 0.19 and -0.016; $p < 0.001$ and 0.0001).
- In 2016, variable 2 negatively correlated to B_L/B_T (B = -0.015; $p < 0.01$).

C. Primary production integrated over Z_{eu} (P_T)



- No significant difference between years or regions for P_T. Summer 2016 exhibited the lowest primary production rate for both regions.

D. P_L/P_T ratio



- Large cell contribution significantly higher in Nares Strait during 2013 compared to the NOW during 2016 ($p < 0.05$).
- Significant linear trend detected between years for both regions studied ($R^2 = 0.3$; $p < 0.05$).

Conclusion

- Large regional and interannual differences in phytoplankton biomass and size-structure.
- Higher contribution of large cells to biomass in Nares Strait which is generally characterized by shallower SCM, more intense stratification and colder sea surface temperature.
- The contribution of large cells to total phytoplankton biomass varied according to the euphotic zone depth, the light availability and the water temperature.

Acknowledgments
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