Trends in Net Community Production and Surface pCO_2 during the Spring Ice Edge Bloom in Baffin Bay

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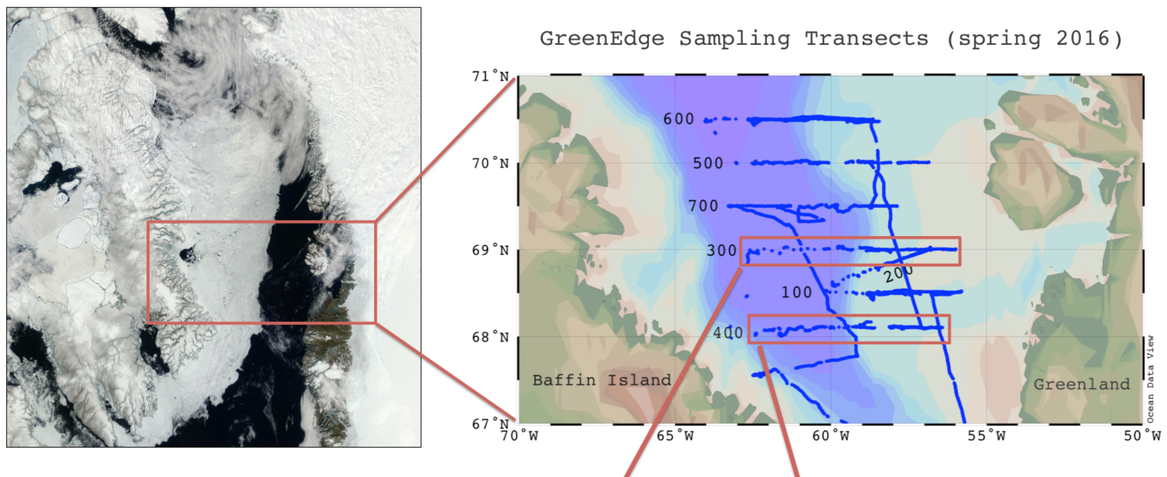
Introduction

During the spring 2016 GreenEdge scientific cruise aboard CCGS Amundsen, a series of transects were completed from open water, through the marginal ice zone, and into pack ice in Baffin Bay

Here, we investigate trends within the surface mixed layer of net community production (NCP) and pCO_2 along two of these transects (300- and 400-transects) as the sea-ice cover transitions.

NCP = gross primary production – community respiration



Data Collection

Underway pCO_2 System

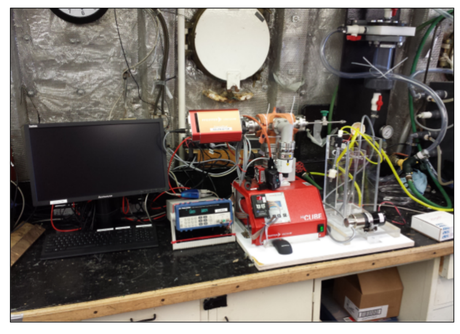
- Continuously measures the pCO_2, temperature, and salinity of surface seawater as the ship transits
- Calibrations preformed twice daily against WMO traceable standards

Sea Ice Concentration

- Utilize AMSR2 sea ice concentration product (Spreen et al., 2008)

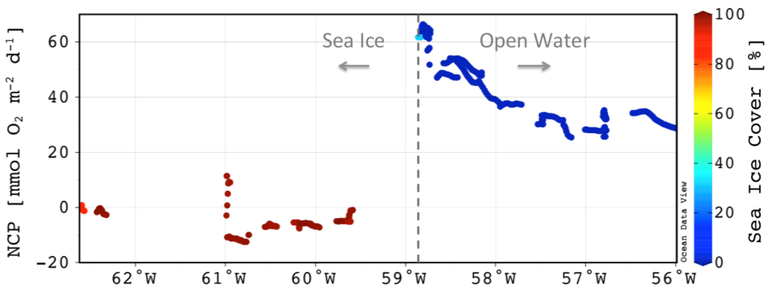
Equilibrator Mass Inlet Spectrometry (EIMS)

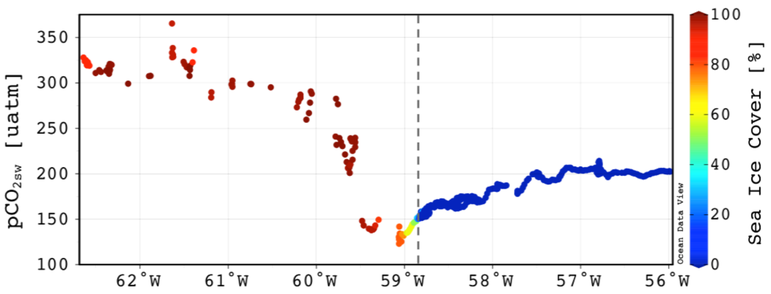
- Continuously measures the O_2/Ar ratio of the surface mixed layer as the ship transits
- Because Ar has similar solubility properties to O_2 it can be used to subtract the effect of physical processes on O_2 supersaturation, leaving only the biological signal

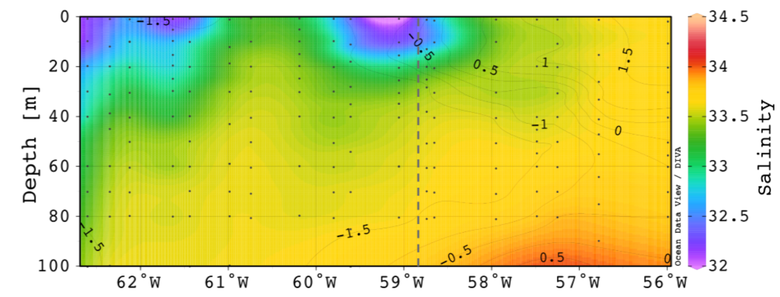


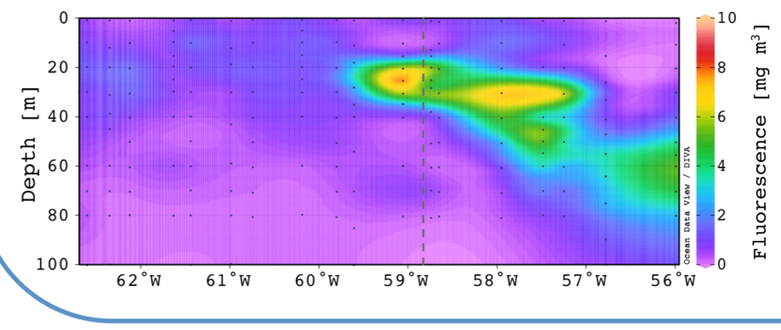
Results and Discussion

300-Transect

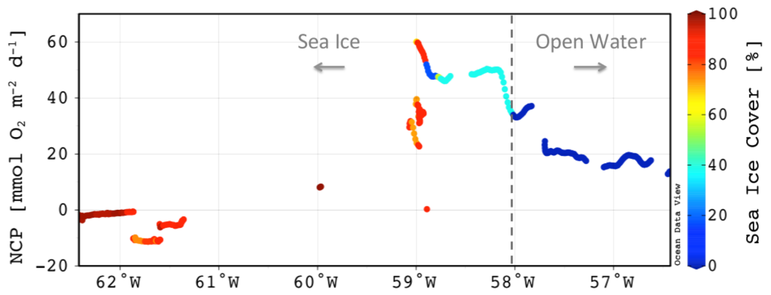


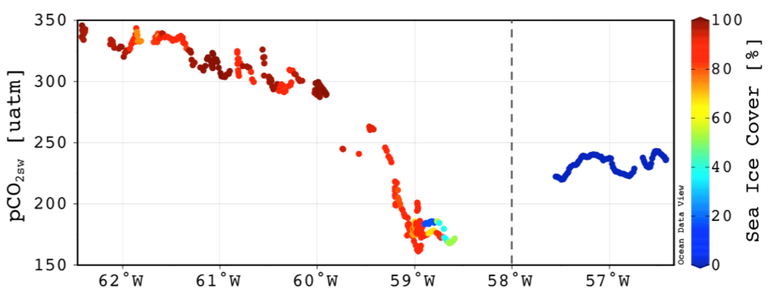


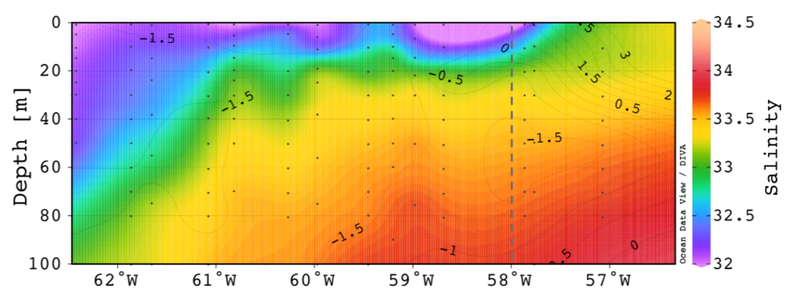


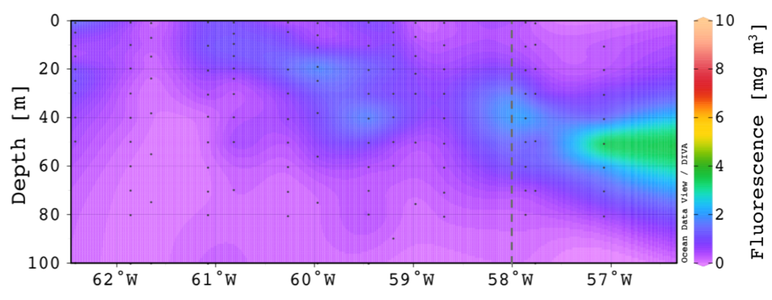


400-Transect









$$NCP \approx k[O_2]_{sat}\Delta(O_2/Ar)$$

Estimates of NCP indicate a net autotrophic environment at the ice-edge and in open water, with a slightly net heterotrophic environment under dense sea ice cover. The greatest rates of NCP are observed right at the ice-edge, and quickly drop off under ice cover, whereas NCP decreases more slowly with distance from the ice-edge into the open water environment.

Trends in pCO_2 match well with NCP estimates. pCO_2 is found to be highest under pack ice, lowest at the ice edge, and increases slightly in open water. Increasing pCO_2 in open water is likely due to greater air-sea CO_2 exchange and lower NCP. Surface seawater pCO_2 never exceeds atmospheric levels (~ 400 ppm) and therefore both transects represent overall sinks of atmospheric CO_2.

Surface plumes of cold low-salinity water are present at the ice-edge, and below thick sea ice cover. Warm seawater temperatures (contours) are present in eastern Baffin Bay due to the northward transport of modified-Atlantic waters. Cold waters at depth in western Baffin Bay are Arctic-outflow waters.

Using fluorometer measurements as a proxy for primary production (and the presence of phytoplankton), we can see blooms develop in the vicinity of the ice-edge. In open waters most of the surface nutrients have been depleted, and so the phytoplankton bloom migrates deeper in the water column forming a sub-surface chlorophyll maximum (SCM).

Conclusions and Future Work

- Rates of net community production (NCP) dramatically decrease from the ice-edge into dense sea ice cover, resulting in higher pCO_2 in the under-ice environment
- High rates of NCP at the ice-edge promote net air-sea fluxes of CO_2 in open water and the marginal ice zone
- Plan to compare these estimates of spring bloom NCP with overall warm-season NCP in Baffin Bay, in order to determine how much of the annual NCP is accounted for solely by the spring bloom. Underway O_2/Ar and pCO_2 measurements from September 2016 will allow for the determination of total warm-season NCP

Acknowledgements

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