Enhancement of rates of net community production and gross primary production at the shelfbreak front

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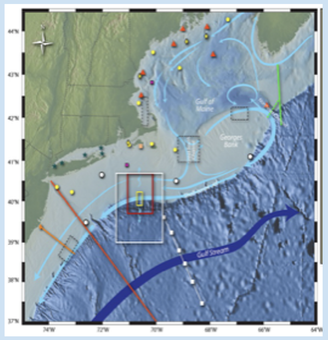
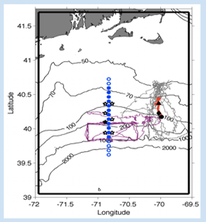
Background



Shelfbreak **P**roductivity **I**nterdisciplinary **R**esearch **O**peration at the **P**ioneer **A**rray **(SPIROPA).**



The SPIROPA Project conducted three research cruises designed to address the issue of whether there is a mean enhancement of productivity at the shelfbreak front of the Middle Atlantic Bight and which conditions promote enhancement. The project chose two consecutive Spring cruises to investigate annual variations as well as a Summer cruise to investigate seasonal differences.

Objectives

Questions:

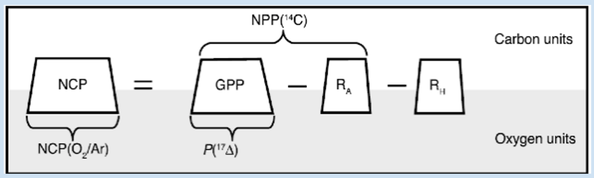
- Is there an enhancement in biological productivity at the shelfbreak front?
- How does the productivity vary on the shelf? What is the connection between net community production (NCP), gross primary production (GPP), and physical processes?

Methods

Net Community Production is the amount of energy produced by photosynthesis minus that consumed by respiration.

Gross Primary Production is the total amount of energy produced by phytoplankton through photosynthesis. Data will be reported as **Gross Oxygen Production** (**GOP**).

NCP/GOP is used to measure carbon cycling efficiency, also known as the export efficiency.



Because of mass independent fractionation, GOP was measured from triple oxygen isotope samples collected from discrete water samples.[1] We continuously measured O_2/Ar ratios in real time with an Equilibrator Inlet Mass Spectrometer (EIMS) to calculate NCP.[2]

Rates of Biological Productivity

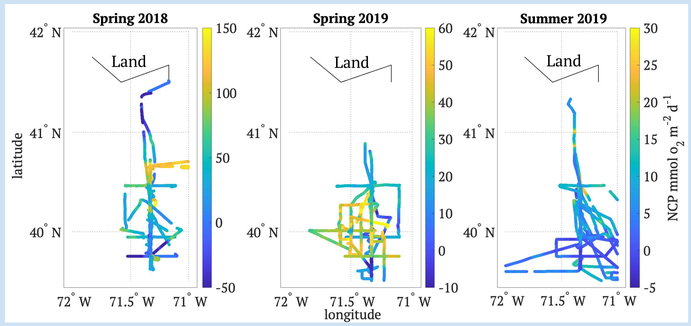
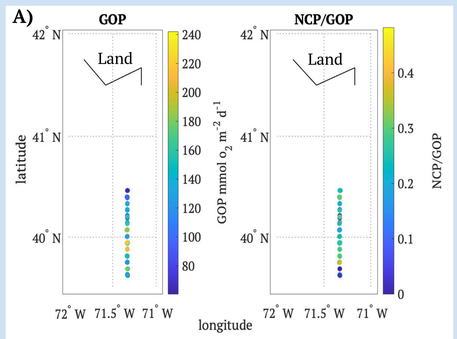


Figure 1: Spatial plots of NCP for each cruise (Spring 2018, Spring 2019 and Summer 2019) as a function of latitude and longitude.

Spring 2019



Summer 2019

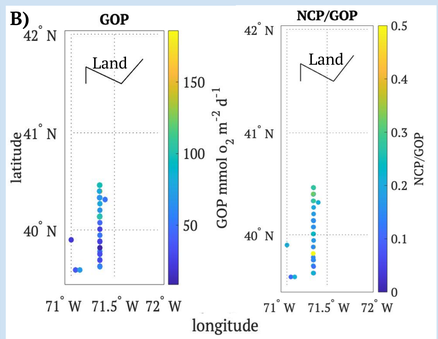
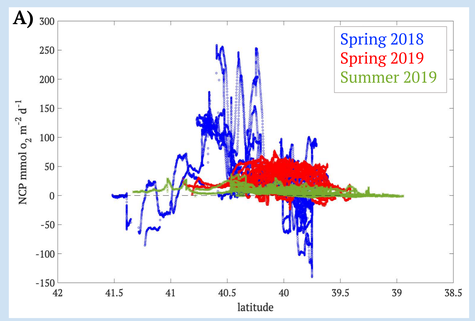


Figure 2: GOP and NCP/GOP along the longitude of the main transect for a) Spring 2019 cruise and b) Summer 2019 cruise. The same locations were sampled multiple times and only data from the final time are shown. Note the difference in scale.

All Cruises



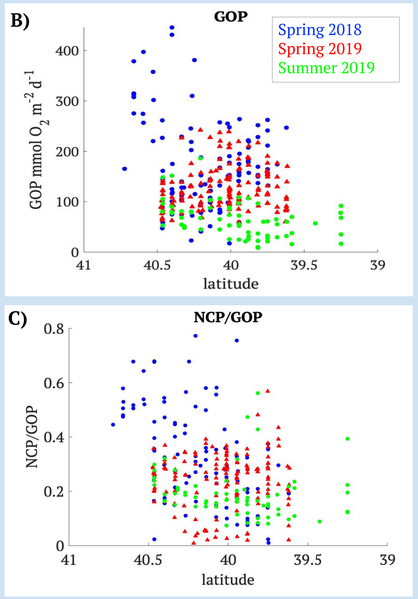


Figure 3: a) NCP, b) GOP, and c) NCP/GOP plotted for all three cruises as a function of latitude.

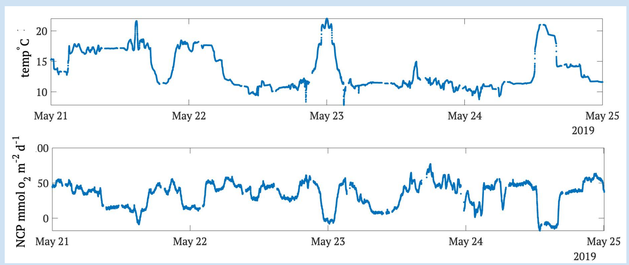
- Large variability in NCP, GOP, and NCP/GOP observed during Spring 2018 cruise due to a regional bloom of *Phaeocystis*.

Causes of Variability in Rates

Temperature

Figure 4: Temperature and NCP plotted over the course of four days during the Spring 2019 cruise.

- NCP is inversely related to sea surface temperature.
- Dramatic changes in temperature occurred as the cruise crossed the shelfbreak front.



Salinity

- Only in Summer 2019, very high export efficiencies occur at the salinities associated with the shelfbreak front.
- However, not much change in NCP at salinities associated with the shelfbreak front.

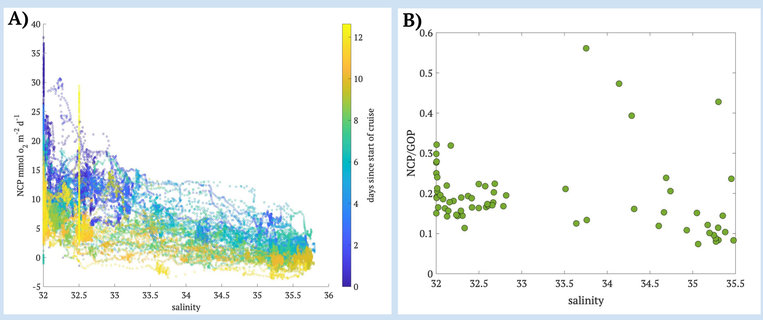


Figure 5: a) NCP, and b) NCP/GOP plotted as a function of salinity for Summer 2019 cruise.

Distance from the Front

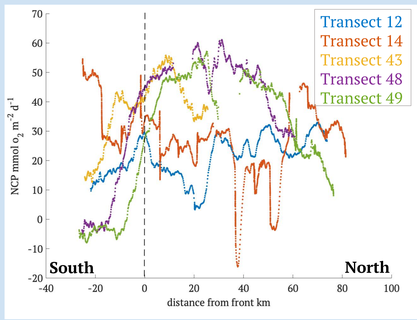


Figure 6: NCP plotted as the distance from the shelfbreak front for the Spring 2019 cruise.

- On some but not all transects, we see enhancement at the shelfbreak front.

Shelfbreak Eddy Behavior

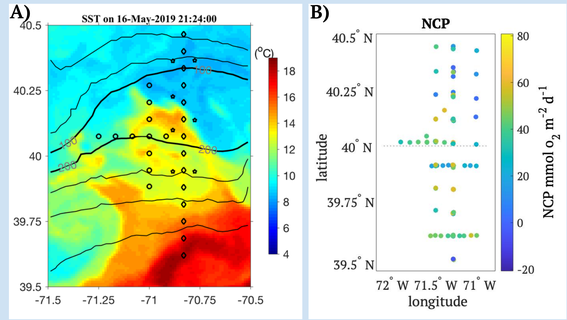


Figure 7: a) Spatial map of sea surface temperature reveals a shelfbreak eddy during the Spring 2019 cruise. Black circles reflect sample locations. b) NCP at those sample locations shows elevated NCP within the eddy.

Conclusions/Future Directions

- Occasional, but not consistent, enhancement of biological productivity and export efficiencies was observed at the shelfbreak front.
- The spring cruises had larger GOP, and NCP, but similar NCP/GOP compared to the summer cruise, and all three cruises show different spatial patterns of the rates.

Next Steps: Connect observed variations in productivity rates to physical features (eddies, streamers, etc.) and to phytoplankton community structure

Acknowledgements:

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References:

[1]Juranek, L. W. & Quay, P. D. in Annual Review of Marine Science, Vol 5. Annual Review of Marine Science (eds C. A. Carlson & S. J. Giovannoni) 503-524 (Annual Reviews, 2013).

[2]Cassar, N. et al. Continuous High-Frequency Dissolved O-2/Ar Measurements by Equilibrator Inlet Mass Spectrometry. Analytical Chemistry 81, 1855-1864 (2009).