Changes in Phytoplankton Community Size Structure Across the Continental Shelf of the Middle Atlantic Bight

Introduction:

The SPIROPA project is a multi-institution, interdisciplinary endeavor with the goal of understanding the dynamic processes that drive ecosystem variability in the region of the Middle Atlantic Bight continental shelf-break front. We used novel sampling techniques to collect high resolution data on phytoplankton biomass and community size structure across the continental shelf over three cruises spanning multiple years and time points in the seasonal cycle. These data will help us understand cross-shelf, seasonal, and interannual variability in the phytoplankton community and contribute to our understanding of the Middle Atlantic Bight continental shelfbreak ecosystem. Specifically, we have hypothesized that variability in phytoplankton community size structure will provide evidence of high productivity at the shelfbreak front even when an accumulation of phytoplankton biomass is not observed, possibly due to strong grazing which transfers increased productivity to higher trophic levels.

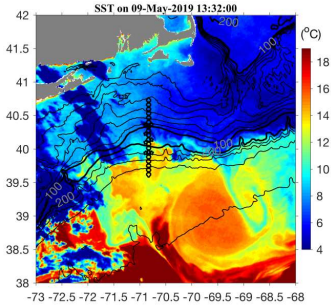
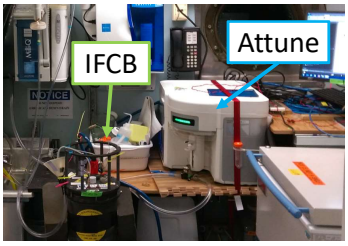


Fig. 1: Map of the SPIROPA study area showing the main cruise transect (black circles), regional bathymetry, and sea surface temperature (SST).

Methods:

We collected phytoplankton community size structure data using a traditional flow cytometer (Attune NxT, Thermo Fisher) and an Imaging FlowCytobot (IFCB, McLane). Both instruments were connected to the ship's underway seawater system making high resolution measurements of the surface phytoplankton community. Attune measurements of particle side-scattering were converted to equivalent spherical diameter using a calibration curve generated by running phytoplankton cultures in parallel to independent measurements of cell volume using a Coulter Counter. IFCB data were analyzed using image processing algorithms (see IS14D-3228 for details) which estimate the maximum Feret diameter from cell cross-sections. We synthesized a full-community particle size distribution by combining data from these two instruments.



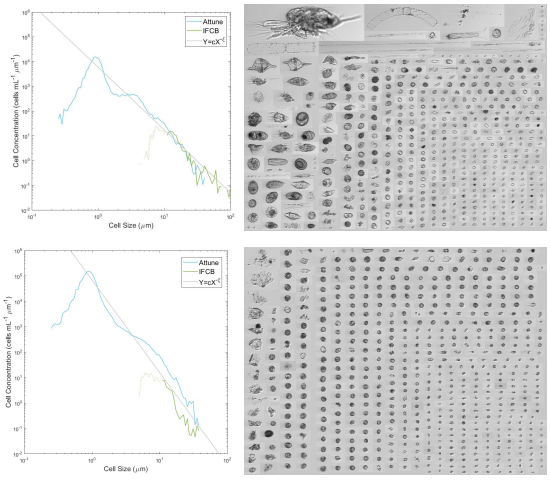


Fig. 2: Two examples of full-community particle size distributions generated by combining data from the Attune and IFCB. A power function ($Y=cX^{-\xi}$) was fit to the data where the exponent ξ was defined as the slope of the size distribution. A larger value of ξ indicates a more negative slope. Phytoplankton communities with smaller values of ξ (top) have greater abundances or large cells, while communities with larger values of ξ (bottom) are dominated by small cells.

Results:

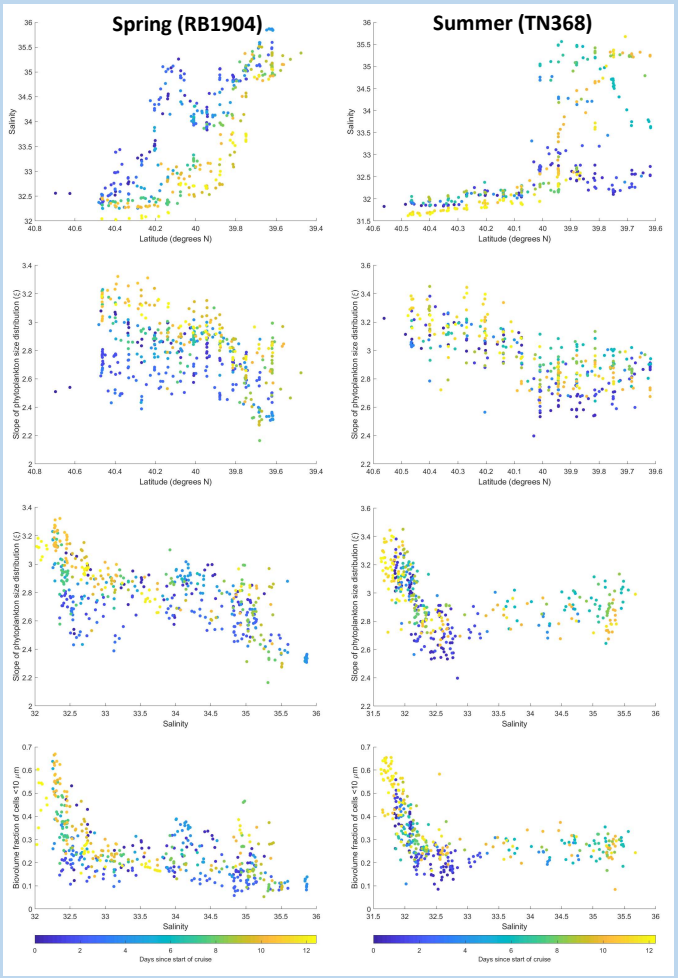


Fig. 3: Spatial patterns in phytoplankton community size structure for two cruises, RB1904 (May 12-25, 2019) and TN368 (July 5-19, 2019). Metrics of community structure are shown both as a function of latitude and salinity, which acts as a water mass tracer. Colors indicate number of days since the start of each cruise.

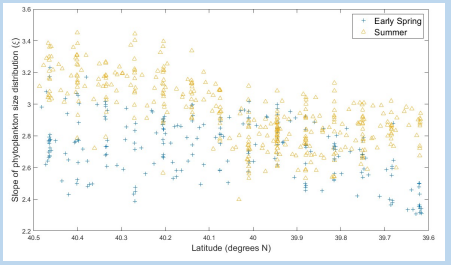


Fig. 4: Comparison of seasonal, cross-shelf patterns in phytoplankton community size structure. Early spring includes only data from the first half RB1904 while summer includes all data collected on TN368.

Conclusions:

- In early spring, the slope of the phytoplankton size distribution showed very weak spatial patterns across the continental shelf.
- A cross-shelf gradient was established in late spring, with communities dominated by smaller cells on the mid-shelf (inshore of the front) and higher relative abundances or larger cells on the slope (offshore of the front).
- This gradient became more strongly established by the summer.

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