Comparing primary production and vertical export of *Synechococcus* in the Northern Gulf of Alaska

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Background

- The Gulf of Alaska is experiencing more frequent warming events which leads to phytoplankton communities shifting to favor smaller organisms.
- Current paradigms imply that picophytoplankton (<3μm) do not contribute to a significant portion of vertical carbon export to deeper waters.
- However, in recent years, there has been evidence that picophytoplankton do significantly contribute to vertical carbon export.

Objectives

Estimate a "carbon budget" of primary productivity and vertical export for picophytoplankon in the Northern Gulf of Alaska, using the picophytoplankton *Synechococcus*, as our model organism.

Goals

1. Estimate the primary production of *Synechococcus* throughout the euphotic zone of the Northern Gulf of Alaska
2. Estimate vertical export rates of *Synechococcus*
3. Compare the ratio of primary productivity to vertical export for *Synechococcus* in the summer of 2023

Methods

Primary Productivity Measurements

- 2 sets of water samples were collected from 6 different light depths (100%,50%,30%,10%,5%,1%) spanning the euphotic zone at 5 stations along the Seward and Middleton Line
- *Synechococcus* were filtered out of one set of water samples and the phycoerythrin content was measured with a fluorometer.
- Phycoerythrin (PE) is a phycobilin pigments found in *Synechococcus* and can be used to estimate the abundance of *Synechococcus* found in a sample.
- The other set of water samples were placed in an on deck incubator for 24 h. Flow cytometer samples were taken every 2 h from each bottle to measure the change in size and abundance of the *Synchococcus* cells.
- *Synechococcus* growth rates will be calculated from the change in cell size over time.

Vertical Export Measurements

- In order to measure the vertical export of *Synechococcus*, drifting sediment trap arrays were deployed for ~24 h at the same Seward and Middleton Line stations where the primary productivity samples were taken.
- Water samples were filtered from the sediment traps and analyzed for phycoerythrin.
- By comparison with cell phycoerythrin content estimated from water column samples (see method at left), export flux of *Synechococcus* can be estimated.

Sediment Trap Array

Acknowledgments

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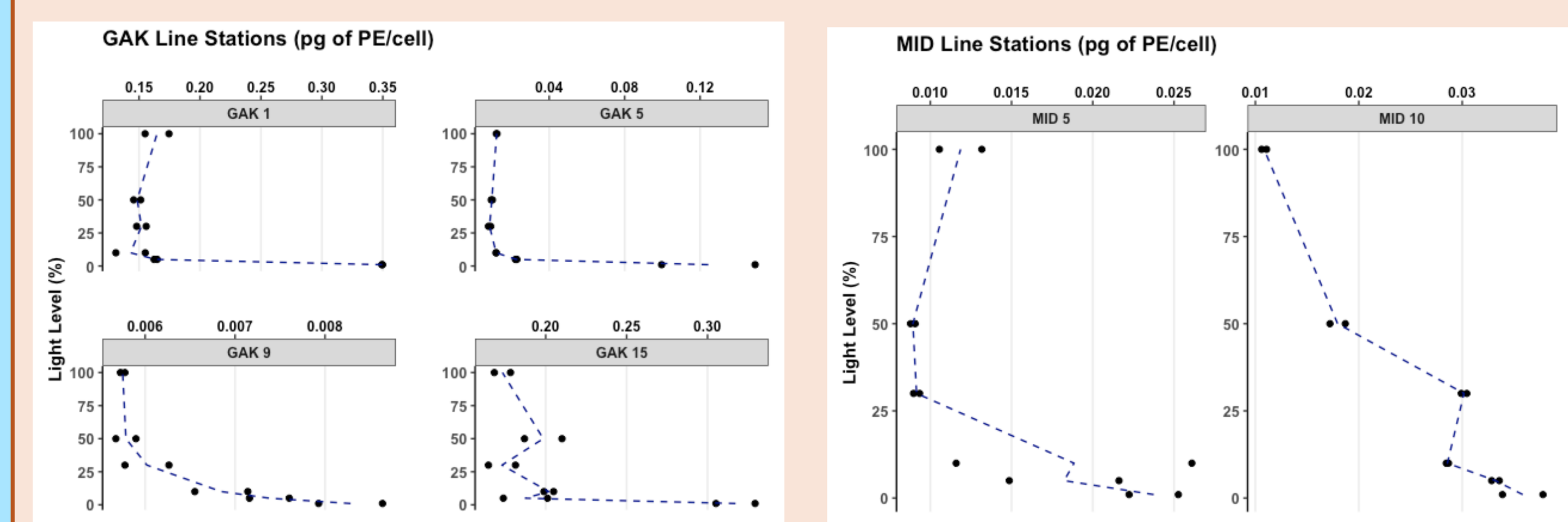
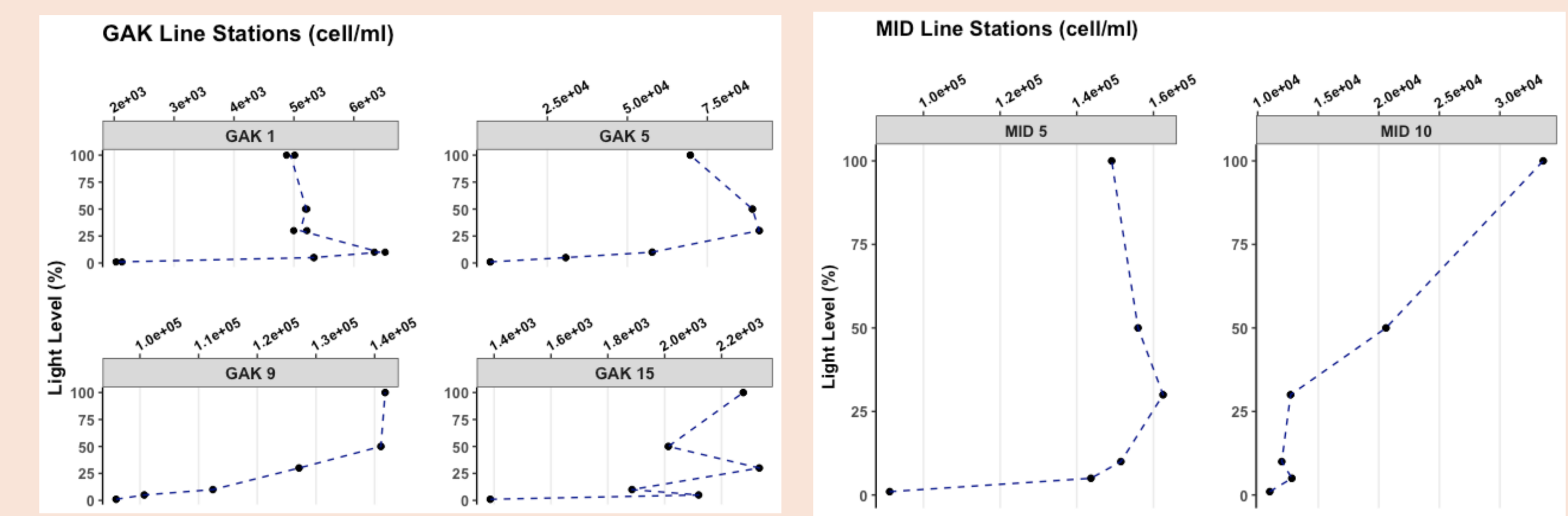
Synechococcus abundance and pigment content varied with location and depth

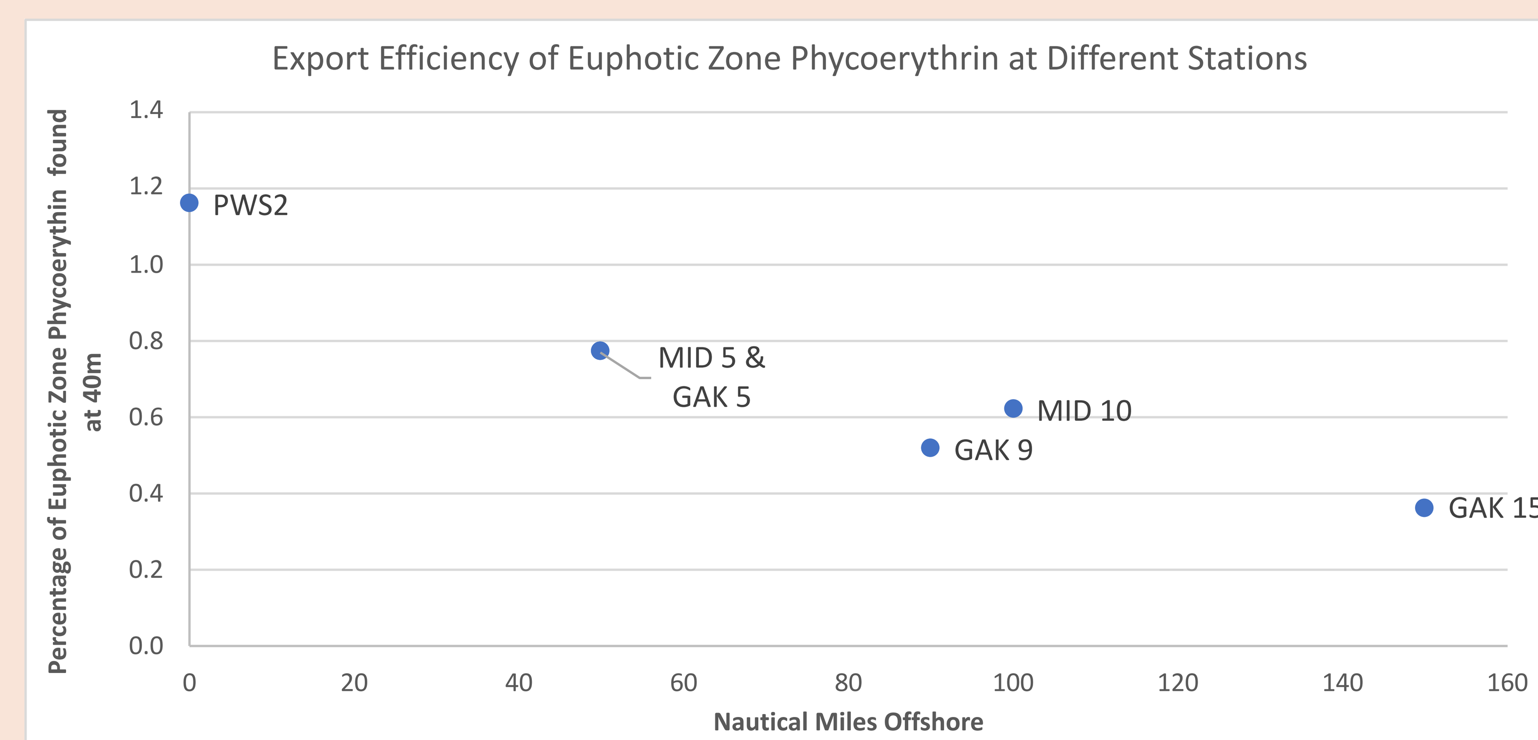


Synechococcus phycoerythrin content increased with depth at all stations. GAK 9 and MID 5 had the lowest phycoerythrin content while GAK 15 had the highest.



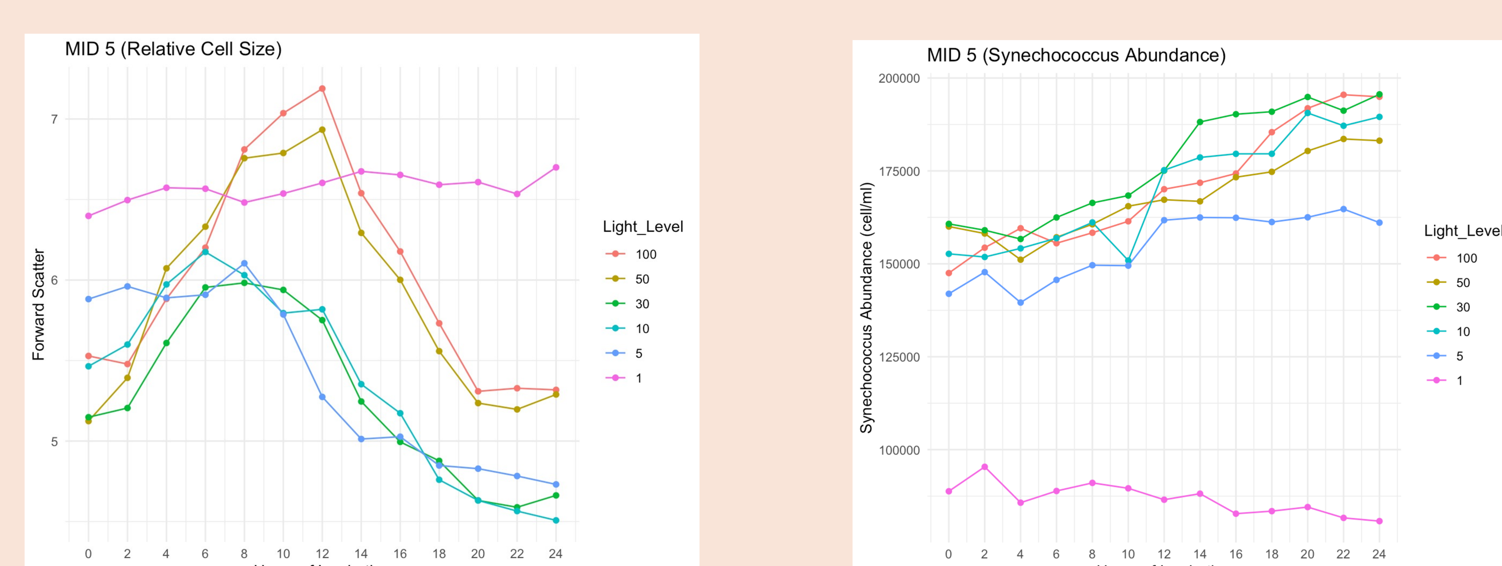
Synechococcus abundance decreased with depth at all stations. GAK 9 and MID 5 had the highest *Synechococcus* abundance while GAK 15 had the lowest.

Synechococcus vertical export efficiency decreased with distance from shore



Synechococcus export efficiency (percentage of euphotic zone pigment to vertical export flux pigment biomass) at 40 m ranged from 0.36% - 1.15%, and decreased with distance from shore.

Flow cytometry indicated diel cycles in cell growth and division

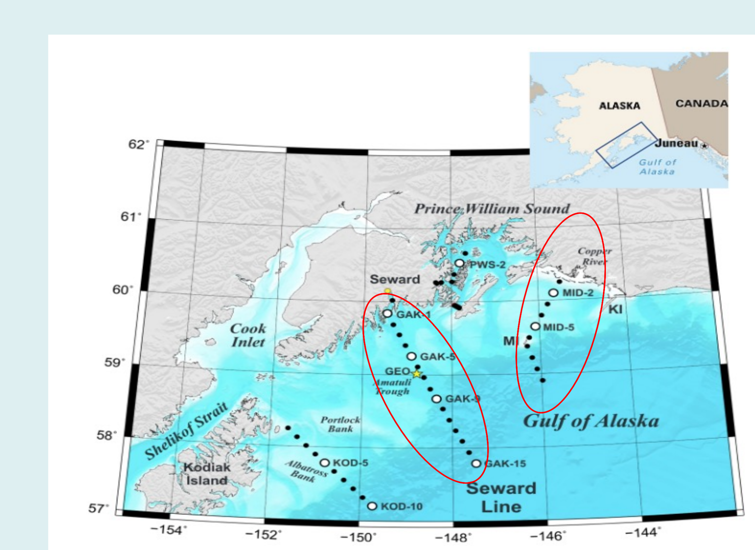


Forward scatter and cell abundance measurements from 24-h incubations indicate that different light depths had different rates of *Synechococcus* cell size change and division. On average, *Synechococcus* cell size increased until evening (8-10 h of incubation), then declined for the remainder of the incubation. Cell abundance for all depths (except the 1% light level) increased over the 24 h incubation period.

Main Findings

- *Synechococcus* pigment content increased with depth mostly likely due to photoacclimation in response to diminishing light availability.
- Abundance differences among stations might be due to differences in light, nutrients, and loss processes such as grazing.
- Stations that had higher cell abundances had lower pigment content per cell.
- Biological activities, such as zooplankton fecal pellet production, near shore may be responsible for higher phycoerythrin export efficiency closer to shore.
- Data from Station MID 5 show diel cycles in cell size at most light levels. Cell abundance increased faster during the same time period that the cell size decreased (beginning at 10 h), indicating coupled diel cycles in *Synechococcus* cell growth, division, and abundance increases.

Study Site



Northern Gulf of Alaska Long-Term Ecological Research (NGA LTER) Study Area. Data were collected along the Seward and Middleton Lines in the Summer of 2023.