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 picophytoplankton 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%, 18%, 9%, 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 pigment found in *Synechococcus* and can be used to estimate the abundance of *Synechococcus* found in a sample.
- Changes in pigment content can be used as a measure of phytoplankton abundance.
- 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 over time.
- *Synechococcus* cells were filtered from the sediment traps and analyzed for phycoerythrin.
- Phycoerythrin (PE) export efficiency was calculated from sediment trap PE flux / integrated euphotic zone PE content x 100
- Phycoerythrin is a pigment found in *Synechococcus* and can be used to estimate the abundance of *Synechococcus* found in a sample.

**Vertical Export Measurements**

- In order to measure the vertical export of *Synechococcus*, drifting sediment trap array 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.
- The proportion of the flux that was fecal pellet decreased with distance from shore, while the proportion of aggregate flux increased.
- Zooplankton fecal pellet production and aggregate formation near shore may be responsible for higher phycoerythrin export efficiency closer to shore.

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**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.
- Zooplankton fecal pellet production and aggregate formation 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.

**Flow cytometry indicated diel cycles in cell growth and division**

**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.