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Data Analysis Project Description:

Project Title: The Individually Sinking Cell and Its Role in the Biological Pump

Background: The ocean's biological pump ultimately determines how much carbon dioxide(CO_2) gas the ocean is able to take-up in surface waters and export to deep waters where it can be isolated from the atmosphere on timescales of hundreds to thousands of years (Volk and Hoffert, 1985). The result of this sequestering of carbon is that CO_2 gas concentrations in the atmosphere are lowered, which tempers the warming of our planet (Kiørboe, 2017; Alldredge and Silver, 1988).

Predicting how global climate and marine and coastal resources may change tomorrow as a result of a changing biological carbon pump, depends on attaining a more nuanced and robust understanding of the biological pump as it functions today.

The largest export pathway in the biological C pump takes the form of sinking detrital particles-- particulate organic carbon (POC)--which includes the carcasses of tiny protists and animals. Despite decades of research, POC flux in the mesopelagic has been particularly difficult for oceanographers to parameterize. Challenges arise from the myriad physical and ecological interactions which determine the fate of POC as it travels through the mid-ocean.

One often overlooked POC pathway is that of individually sinking cells, the prevailing assumption being that they are too small to sink very deeply before being consumed or remineralized. Nevertheless, these individual cells have appeared in sediment traps of both past and present studies (Durkin et al. 2015; Wiedmann et al. 2014; Bodel et al. unpublished), and because of this, clearly merit further investigation.

This study aims to quantify the export flux of individual cells sinking through the mid-ocean and assess the relative importance of this pathway. Models of the biological pump which exclude individual cells may be underestimating the amount of carbon reaching sequestration depths. This project also links the taxonomic identities of sinking cells to specific attenuation patterns and quantities of POC flux, as both the sinking particle type as well as the organisms responsible for that export ultimately determine the magnitude and efficiency of the biological pump (Eppley and Peterson, 1979; Ducklow et al., 2001).

Individual cells (rhizaria and phytoplankton) found in sediment traps contribute in important ways to the export of carbon.

Specifically:

- **H1** The carbon export of individually sinking cells constitutes a substantial fraction of the total export of particulate organic carbon (POC)

H2- Rhizaria in the mesopelagic are predicted to export more carbon than they attenuate.

The taxonomic identities of individual cells (rhizaria and phytoplankton) found in sediment traps influences the export and attenuation of POC.

Specifically:

H3: - rhizaria and phytoplankton have distinct roles in C flux and attenuation that are reflective of different life strategies and physiologies.

Sediment Trap Sample Collection:
In August 2018, as part of a NASA led field campaign (EXport Processes in the Ocean from RemoTe Sensing (EXPORTS) a team of scientists deployed multiple sediment traps in tandem near station P (50°N 145°W) in the northeast Pacific. In three repeats over a 27-day period, traps drifted at five key depth levels, for 3-5 days duration, collecting sinking particles. Sinking particles settled either into a nonpoisonous viscous matrix made of polyacrylamide gel (Gels) or into formalin (Bulk Carbon).

Enumeration of Cells:
Once retrieved, subsamples of Gel trap contents were manually scanned via light microscopy at 115x magnification as well as photographed Fall 2018/2019. Individual cells (i.e.: not incorporated into aggregates or fecal pellets) were identified, categorized and counted. Extrapolation to whole Gel populations were made from these subsampled sections. Entire Gels were also scanned at 7x, 20x and 32x and any organisms belonging to of the superorder rhizaria, were categorized taxonomically and counted.
Bulk carbon measurements from sediment traps involved the summing of both particulate organic carbon (POC) and particulate inorganic carbon (PIC). The particles for these analyses were collected in sediment trap tubes with a formalin preservative at the bottom.
Planned Data Analysis Project: Export and Attenuation Profiles of Individually Sinking Cells

Overarching Project Goals: Visualize cell count data as cell flux data. Observe and interpret

taxa-specific patterns of export flux and attenuation with depth.

Visualization of Cell Flux Data:

1) Visualize individual cell fluxes from 2018 cruise:
Observe any platform differences by comparing collections from Neutrally Buoyant Sediment Traps (NBSTs) versus Surface Tethered Traps (STTs). Can achieve this through creating depth profile plots of measured fluxes by trap type.

1st) Separate by Epoch

2nd) Integrate Epochs and plot integrated result.

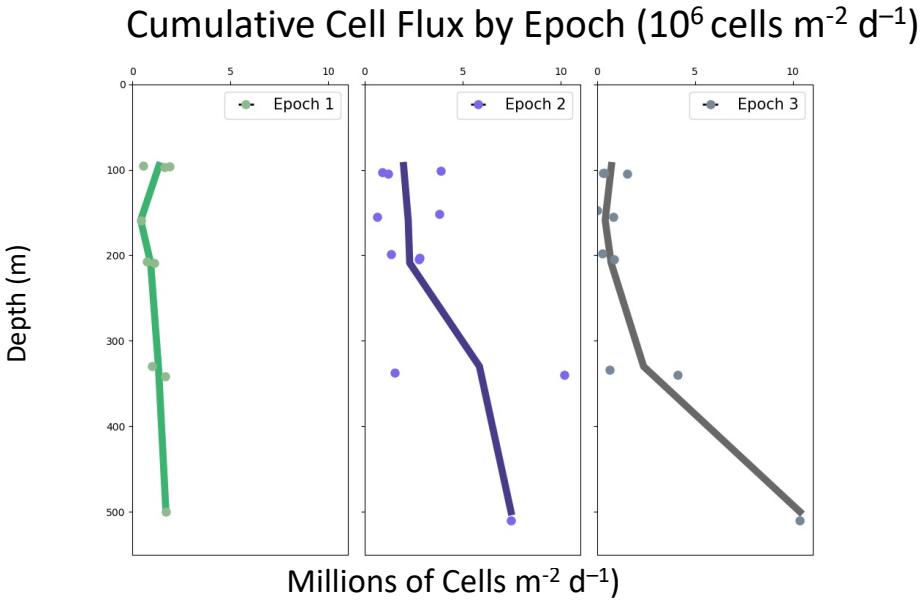
3rd) compare counting uncertainty to trap-to-trap variability (replicate depths). Determine how to show larger source of error.

2) Visualize depth profiles of different cell Taxa
3) Propagate counting uncertainties by addition

2)Visualization of estimated Carbon Flux Data:

1) Simulate Biovolumes for cells and calculate Carbon: Cell ratio for every taxon in traps.

2) Visualize depth profiles of estimated POC flux for cells in traps.
3) Visualize distinct Phytoplankton and Rhizaria POC depth profiles



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