Influence of temperature on organic matter consumption and nutrient regeneration by microbial respiration in the Gulf of Maine

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Introduction

- The Gulf of Maine is warming 99% faster than the global ocean since the onset of anomalous temperatures in 2012, due to the Gulf Stream moving north and cutting off cool waters from the Labrador Current into the basin [2,3].
- Warming temperatures lead to a faster growth rate of microbes [1] and can increase the rate of respiration due to activation energy being lowered.
- How do increasing temperatures impact respiration of organic matter (OM) in the Gulf of Maine?
- H_1: Higher temperatures correlate to faster respiration of OM by microbes, limiting the amount of nutrients and energy making it to benthic organisms.
- H_2: Higher temperatures correlate to an overall larger amount of OM respired in any environment compared to lower temperature environments.
- As OM is consumed, NO_3^- and PO_4^{3-} are produced:

$$OM + O_2 \leftrightarrow CO_2 + NO_3^- + PO_4^{3-} + H_2O$$

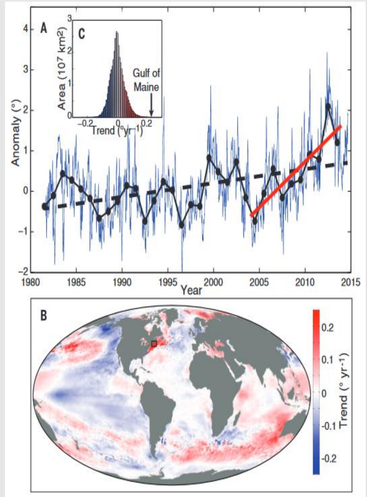


Figure 1: Obtained from Pershing et al., 2015. Temperature trends in the surface ocean from the Gulf of Maine and global oceans.

Methods

- Sampling at 1m depth at 43°01'35.3" N 70°34'48.2" W in the Gulf of Maine (Figure 2).
- Bulk seawater filtered into dissolved organic matter (DOM) and particulate organic matter (POM) treatment. Incubated at 14°C and 19°C (Figure 3).
- Treatment bottles kept in dark room on roller tables to inhibit photosynthesis and reduce particle settlement
- Time point sampling
  - T= 0, 2, 4, 6, 8 days
- Phosphorus by Spectrophotometry
- Nitrate by Chemiluminescence

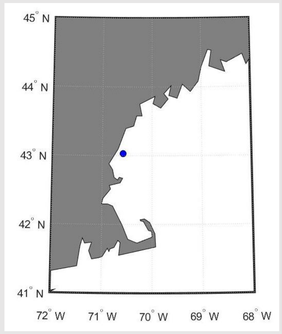


Figure 2: Location of October sampling.

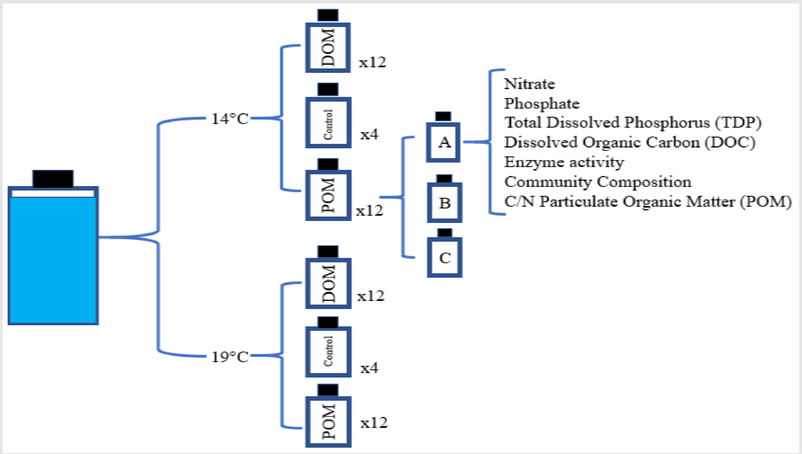
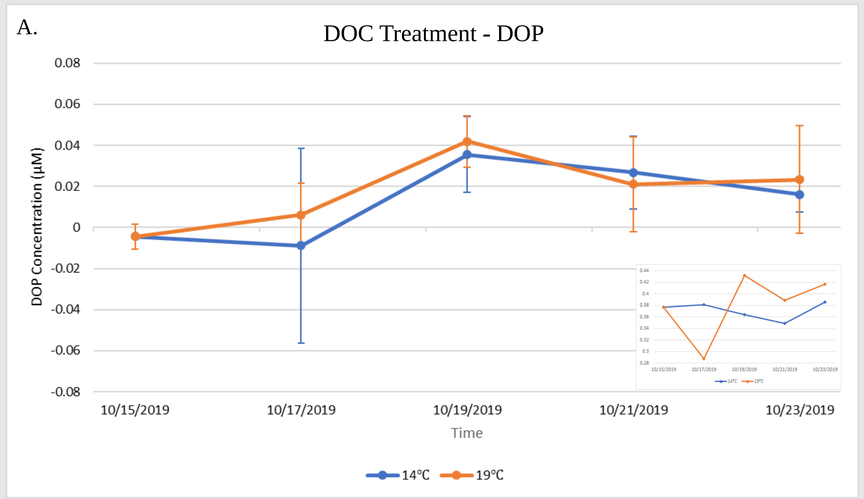
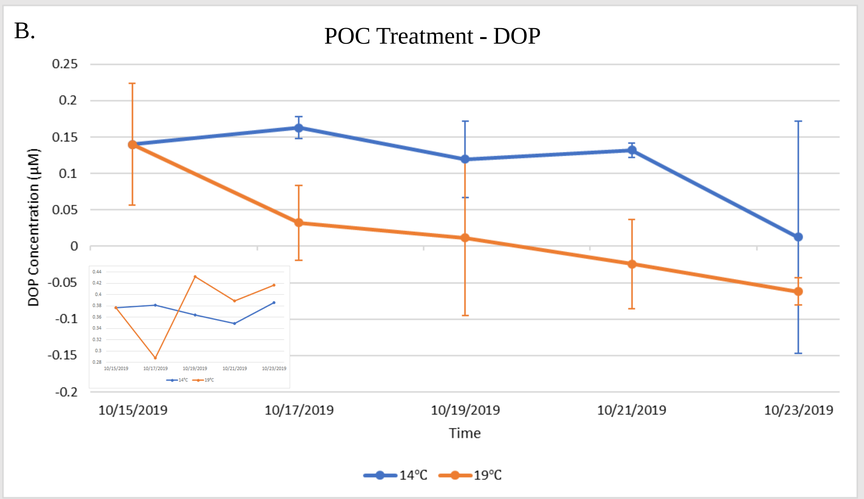
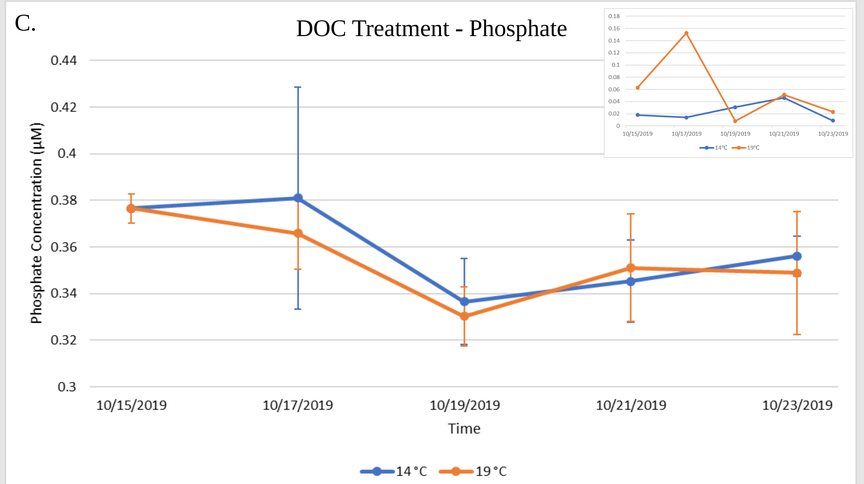


Figure 3: DOM and POM incubation experiment set up and measurements taken from each triplicate.

Results







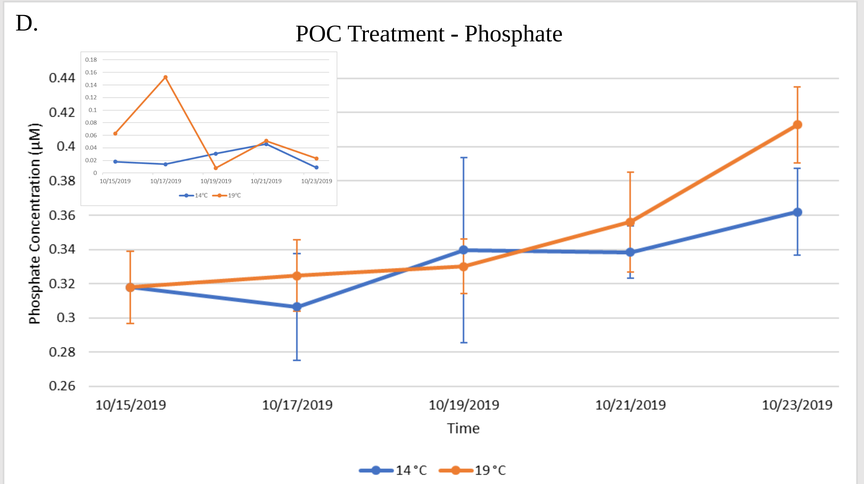


Figure 4: DOP concentrations calculated from phosphate subtracted from TDP concentration at 14°C and 19°C in DOC treatment (A), and POC treatment (B). Phosphate concentrations at 14°C and 19°C in DOC treatment (C) and POC treatment (D). Inset plots is the Control treatment at 14°C and 19°C. Error bars represent the standard deviation within each triplicate. Collective standard deviation for DOP is 0.104 and phosphate is 0.0322.

Discussion and Future Work

- As respiration continues, PO_4^{3-} concentrations should increase at a more rapid rate over time with higher concentrations in the higher temperature incubation.
- Overall, there is a higher production of PO_4^{3-} in higher temperature but not necessarily at a faster rate.
- Consumption of DOP occurred in the POM treatment with a production of PO_4^{3-}.
- No detected changes in the DOP pool in DOM treatment due to being at the limit of detection.
- POM is larger in size and thought to be more important in the recycling loop in the euphotic zone compared to DOM, which may have other factors controlling its degradation besides temperature.
- Increased remineralization of POM in the water column with increasing ocean temperatures will reduce the amount of energy sinking to the benthos, potentially reducing the overall productivity of benthic ecosystems.

- Complete NO_3^-, DON, and retest TDP samples collected from October 2019 once labs open.
  - Compile DOC concentrations, enzyme activity, DNA community composition, and C/N composite data.
  - Compare with NO_3^-, DON, PO_4^{3-}, and DOP trends.
- Collect, run, and analyze samples from another bloom, at same location and same methods.
- Timeline will alter due to COVID – 19 pandemic.
- Outcomes: Apply to all oceans and global model to improve climate models and predictions.

Acknowledgments

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References

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