Research Experiences for Teachers

Can Tributary Water Quality Data be Used as Proxies for The Mainstem: A Case Study in The Chesapeake Bay

Austin Gee[1], Jill Arriola[2], Maria Herrmann[2], Raymond Najjar[2]

1- Milton Hershey School, Hershey PA 2- Department of Meteorology and Atmospheric Science, The Pennsylvania State University, University Park, PA

Introduction

Historically, nighttime water quality data for mainstem bodies of water, such as the Chesapeake Bay, have been absent from the record because scientists collect bulk water samples during the day, in good weather and in warmer seasons. In addition, placing buoys in the mainstem and using a research vessel are cost prohibitive in most cases. This means important information could be missing because we do not have nighttime data. This challenge does not exist for some nearshore tributaries as there are water quality stations continuously taking measurements at those locations. It is hypothesized that the data collected in these tributaries can serve as proxies for the nighttime conditions in certain mainstem locations.

Research Questions

1. Can Taskinas Creek, in the Chesapeake Bay Virginia National Estuarine Research Reserve System (NERRS), be used as a proxy for any sections of the mainstem of the Chesapeake Bay?

2. How do the diel (day/night) cycles of Partial Pressure of CO_2 (pCO_2) and Dissolved Oxygen (DO) change over the course of a year?

3. How did the tides affect the pCO_2 of Taskinas Creek?

Methods

Data from Taskinas Creek, for 2008, was requested and downloaded from the NERRS's Centralized Data Management Office (CDMO) website. The data included temperature, pH, DO, water depth and salinity. Alkalinity values were calculated from the salinity. The pCO_2 values were calculated from the pH and the alkalinity. The open-source coding language R was used to process the data. Taskinas Creek was chosen because it is centrally located along the York river, a major tributary of the Chesapeake Bay. The year 2008 was chosen because it contained nearly a complete data set that was typical for the tributary (close to average).

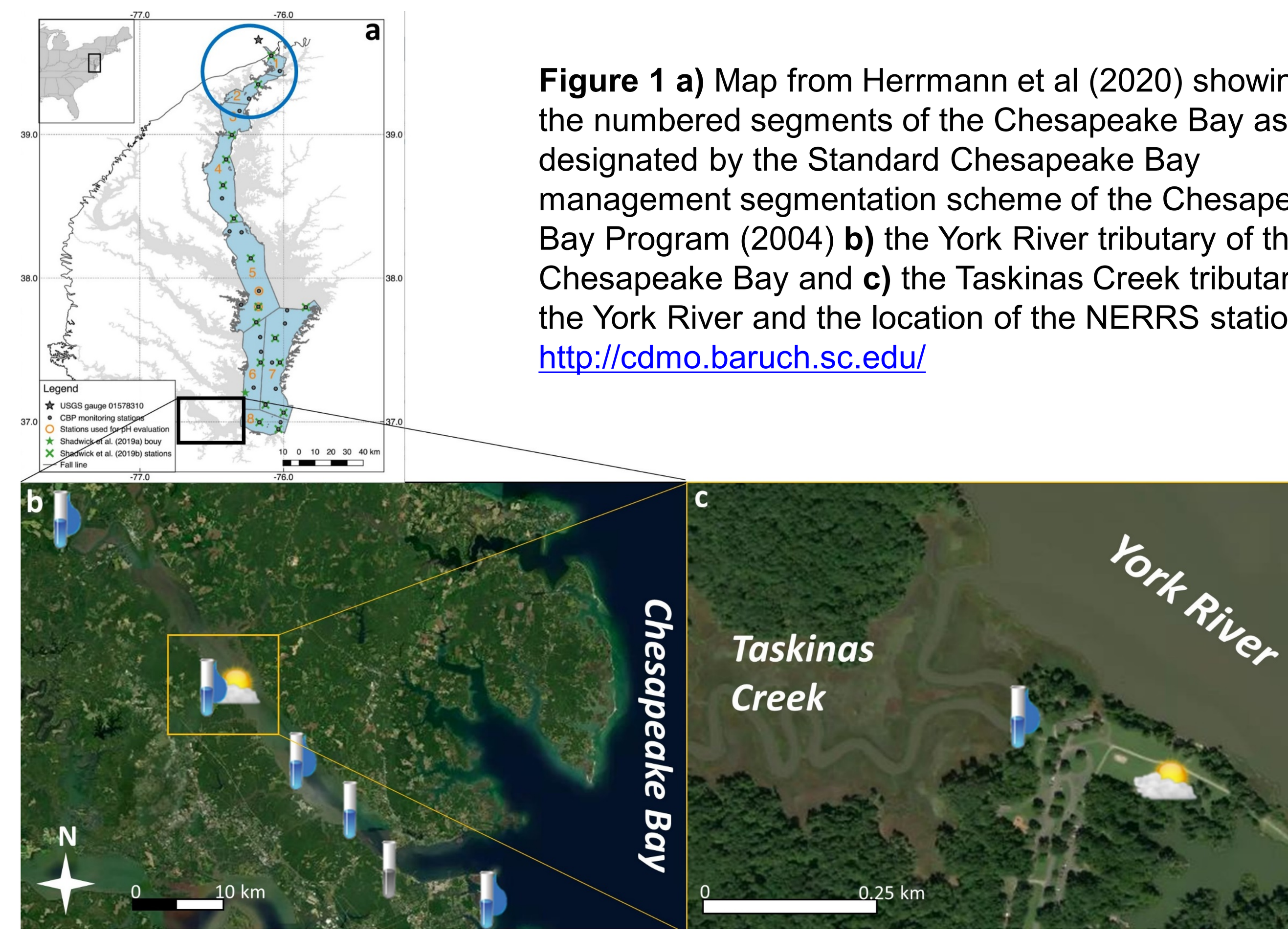

Figure 1 a) Map from Herrmann et al (2020) showing the numbered segments of the Chesapeake Bay as designated by the Standard Chesapeake Bay management segmentation scheme of the Chesapeake Bay Program (2004) **b)** the York River tributary of the Chesapeake Bay and **c)** the Taskinas Creek tributary of the York River and the location of the NERRS station. http://cdmo.baruch.sc.edu/

Results

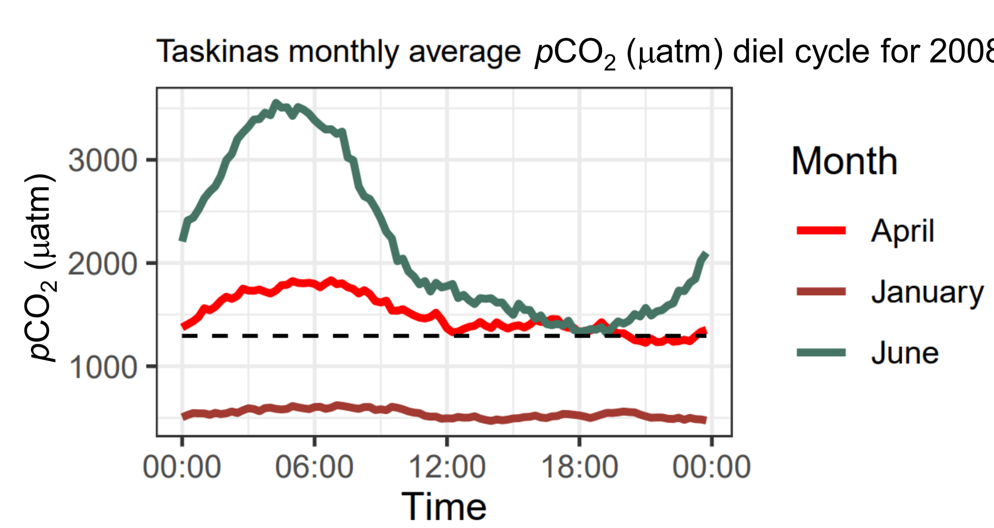

Figure 2 pCO_2 means (µatm) for each time of day for January, April and June of 2008. The mean for the year is also plotted. Strong diel cycles can be seen in warmer months and almost no diel cycle is observed in colder months.

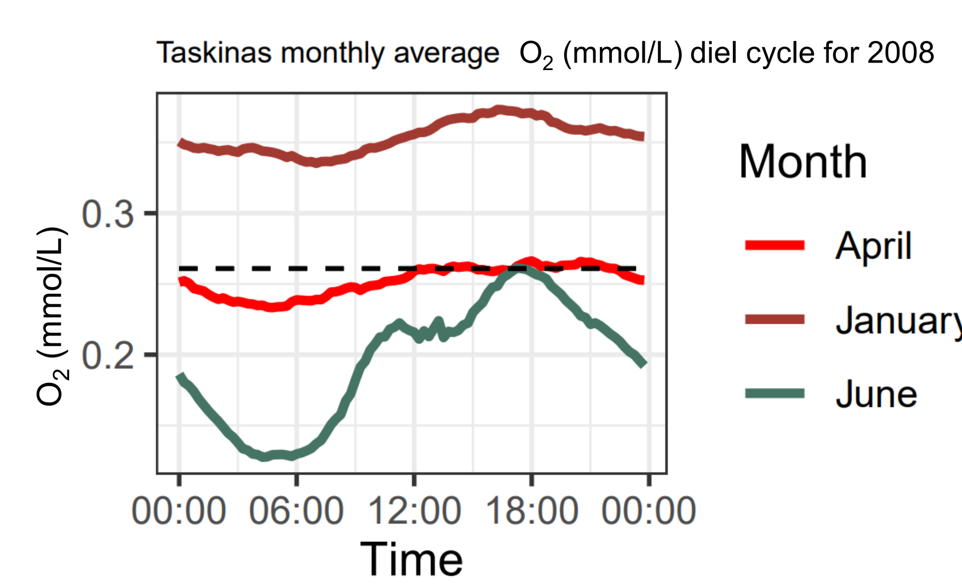

Figure 3 DO means (mmol/L) for each time of day for January, April and June of 2008. The mean for the year is also plotted. Like pCO_2 but inversely, strong diel cycles can be seen in warmer months.

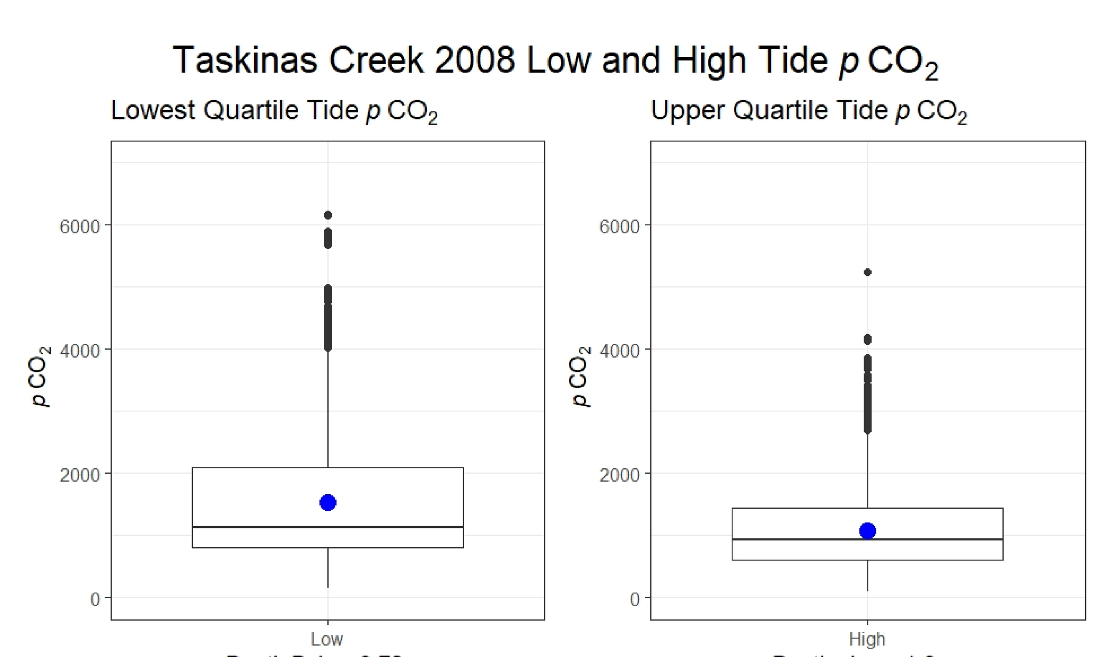

Figure 4 pCO_2 (µatm) measurements during low tides on the left, and high tides on the right. Blue dots are the means. pCO_2 tends to be lower during high tides at this site.

Discussion

- Taskinas Creek showed the high seasonal variability in the diel cycles of pCO_2 (Fig.2) and DO (Fig.3) that was also observed in segments 1 and 2 of the Chesapeake Bay by Herrmann et. al. 2020 (See blue circle in Fig1 a).

- Taskinas Creek showed lower mean pCO_2 values during high tide (1,077 µatm) compared to low tide (1,538 µatm). See Fig.4. This supports the hypothesis that nearshore stations can serve as proxies for the mainstem as they experience similar conditions. High tides bring more water from the mainstem into the tributary and because the mainstem is more autotrophic, there is less CO_2 and the measured pCO_2 values in the tributary decrease.

- In 2008 Taskinas Creek had a comparable average pCO_2 (1,294 µatm) to those of Segments 1 (803 µatm) and 2 especially (1,139 µatm) of the Chesapeake, as calculated by Herrmann et. al (2020). Because of this, along with the above trends, it seems that Taskinas Creek can serve as a proxy for the upper main-stem of the Chesapeake.

- If water quality measurements in the mainstem are taken during the mid to late afternoon, there is potential to miss the highest values of pCO_2 which occur just before sunrise and therefore to underestimate the outgassing that occurs and the contributions of estuaries to the CO_2 levels in the atmosphere.

Future Research

- Future research should expand this work to additional NERRS stations and additional years.

- Careful analysis should be done to match additional nearshore tributary monitoring stations with mainstem segments in the Chesapeake in addition to completing similar research in other estuaries.

Acknowledgements

I would like to thank Kathy Hill, Matthew Johnson, Tiffany Lewis, Jennifer Jackson, Kyle Simon and Katie Nolan at the Center for Science and the Schools for their valuable professional development throughout my Research Experience for Teachers.

References

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The RET for Teachers is funded by the National Science Foundation Grant 1924559.