Simulated Floats in ROMS to Guide BGC-Argo Sampling Strategies

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Introduction

- BGC-Argo floats measure depth-resolved biogeochemical parameters in the upper 2000 meters of the ocean.
- There currently are >700 active BGC-Argo floats across the globe (see fig. 1 and fig. 2).

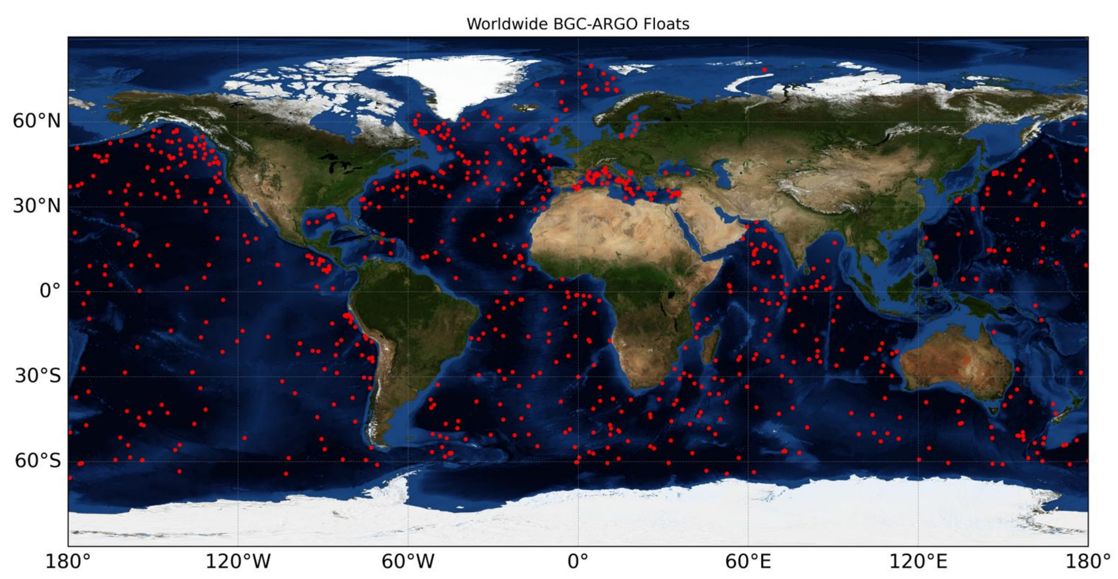

Figure 1. Map showing active BGC-Argo floats that have surfaced in the last 10 days.

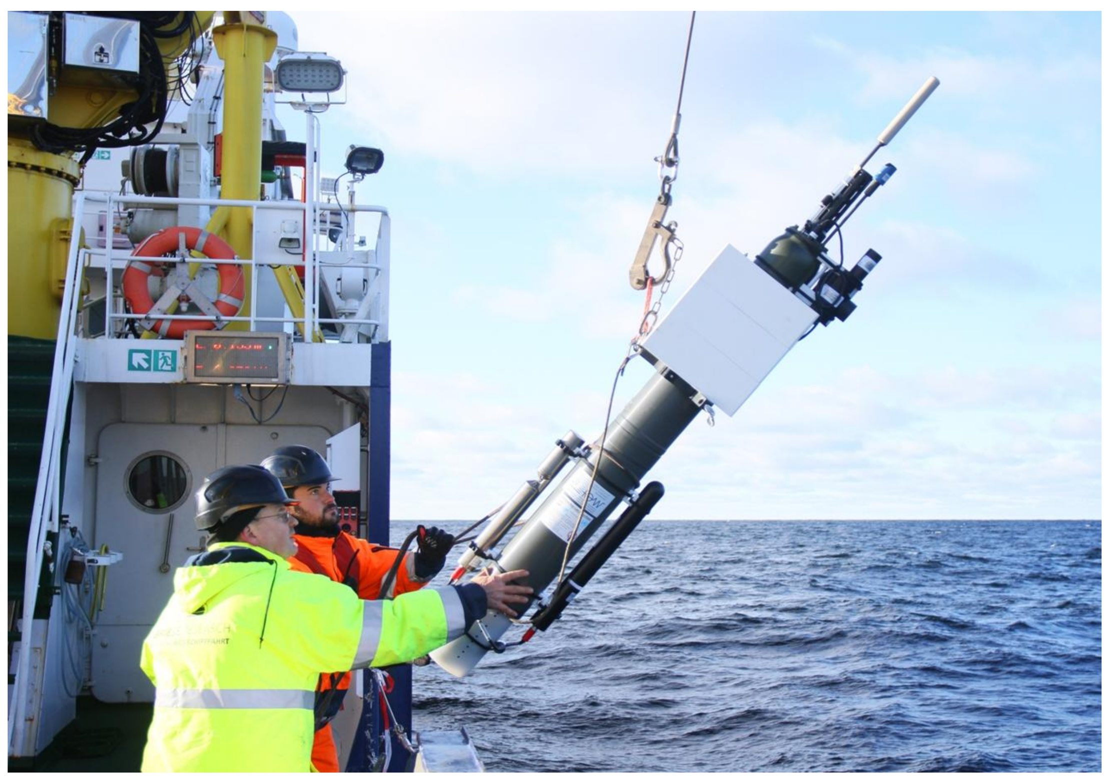

Figure 2. Deployment of a BGC-Argo float.

Background on Methods

- Fast-profiling (every 3 hours) floats have been used to estimate production from the daily cycle of dissolved oxygen in the Gulf of Mexico (Gordon et al., 2020).
- Due to low productivity in the Gulf of Mexico the biological signal in dissolved oxygen concentration was masked by physical variability.
- Global production has been estimated using daily cycle of oxygen from floats (Johnson and Bif, 2021).
- This method assumes that gross oxygen production is equal to community respiration (see fig. 3).

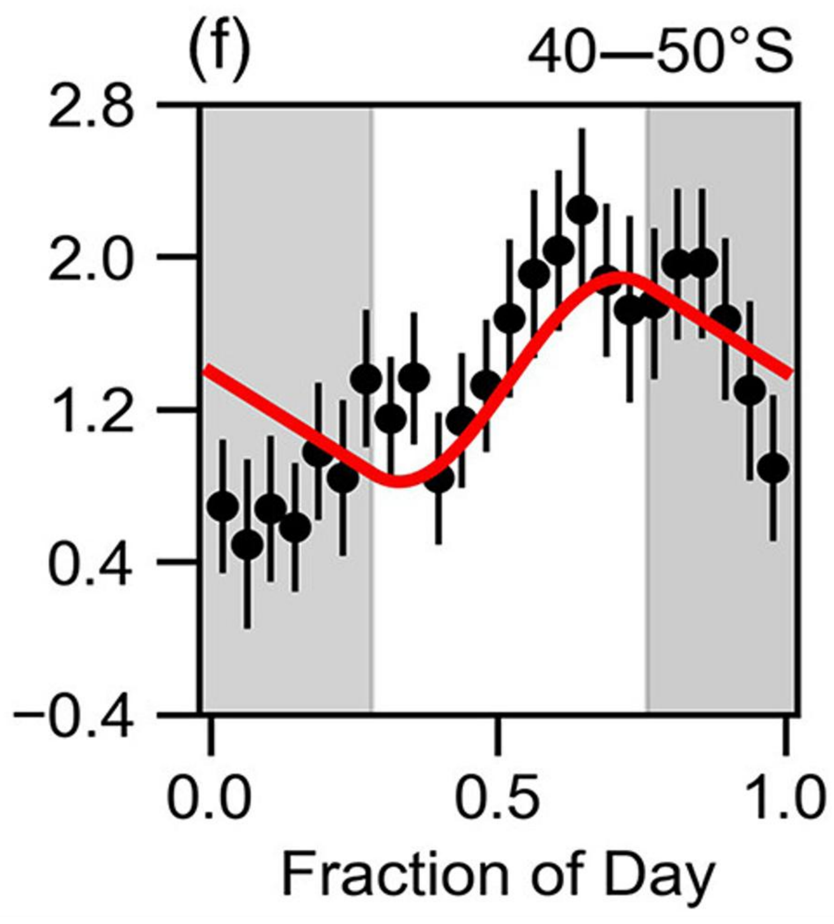

Figure 3. Yearly average of the daily cycle of dissolved oxygen between 40-50° S measured with BGC-Argo floats (Stoer and Fennel 2022).

Objective

- Develop methods for estimating production and respiration from Argo measurements.
- Use virtual Argo floats in the model to determine the best sampling strategy for obtaining primary production and respiration.
- Determine the minimum number of floats in an area required to resolve a daily oxygen cycle.
- Estimate production and respiration without assuming gross oxygen production equals community respiration.
- Determine the latitude bin size that is necessary for accurate estimates of production.

The Model

- An implementation of ROMS for the northwest North Atlantic and Labrador Sea (see domain in fig. 4) that is described in detail in Ohashi et al. [2024].
- This model includes a sea-ice model (CICE) and a biogeochemical module (see fig. 5).
- Boundary conditions are set using the daily Copernicus global 1/12° oceanic and sea ice reanalysis throughout the simulation duration.

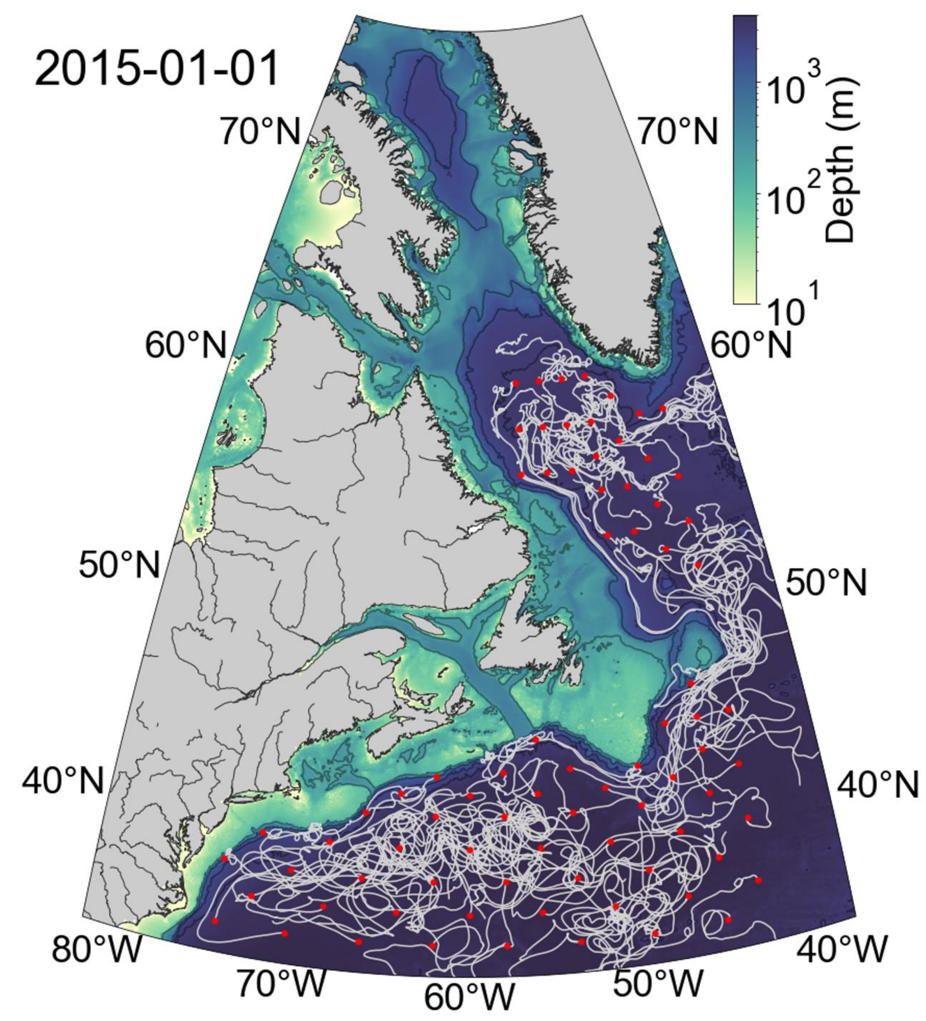

Figure 4. Model domain and bathymetry with deployment locations and trajectories of simulated floats.

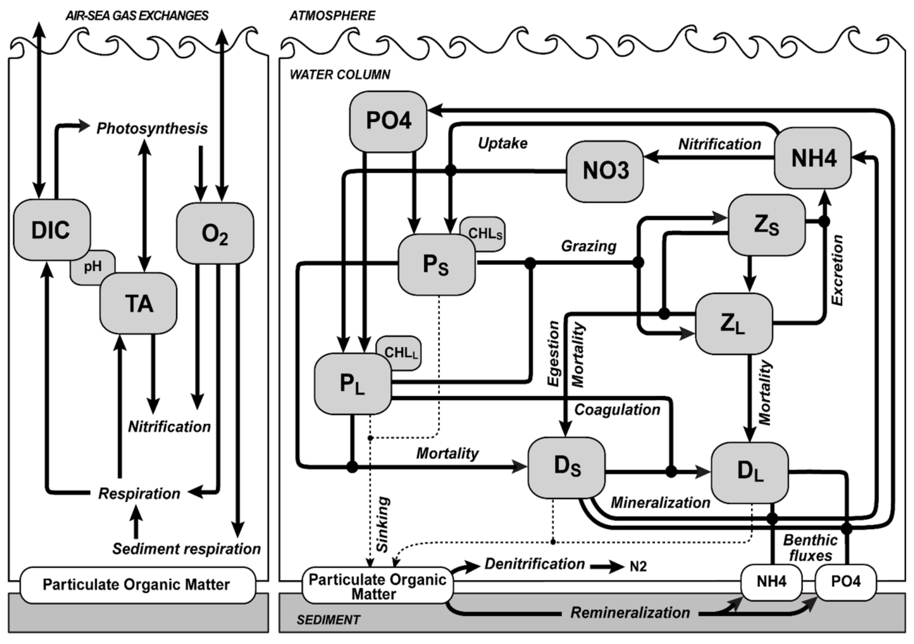

Figure 5. Schematic showing the BGC module.

BGC-Argo vs Simulation Floats

- Our group and collaborators have recently deployed 19 Argo floats in the model region and will be deploying 14 more shortly.

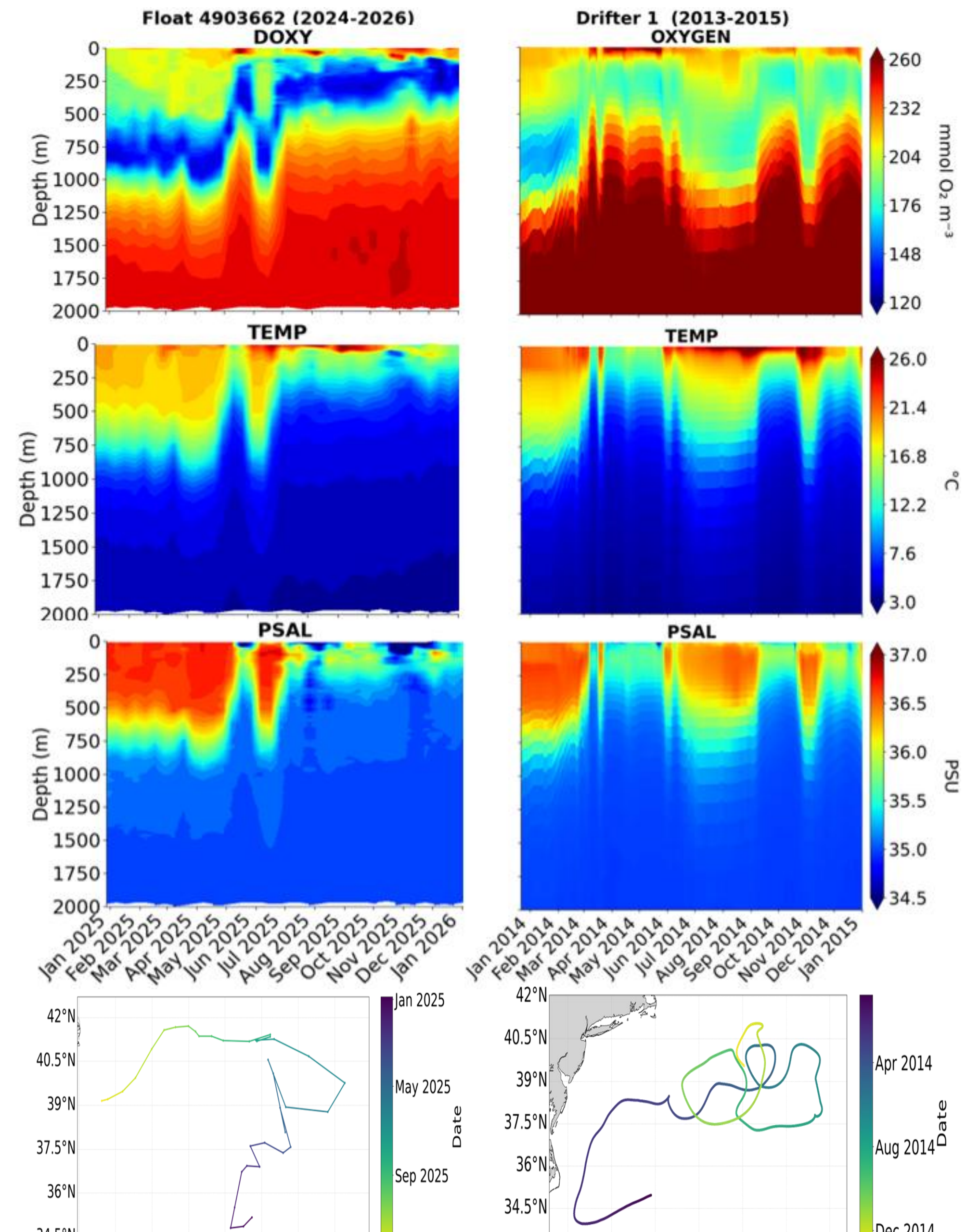

Figure 6. Oxygen (1st row), temperature (2nd row), and salinity (3rd row) measured by a BGC-Argo float (left) and a simulated model-float (right) and their trajectories (4th row).

Methods

- Model floats were deployed as Lagrangian particles at 1000 meters depth.
- Simulated floats take a complete profile of the water column every 1 hour; to mimic the real-life floats we will subsample this data set (see fig. 7 and fig. 8).
- To resolve the daily oxygen cycle, we will use 2 different methods:
  - ❖ Single-float high-temporal resolution (between 1-3 hours).
  - ❖ Multiple floats in close proximity that sample every 5 days and 2 hours, or 10 days and 2 hours binned together to resolve a daily cycle.

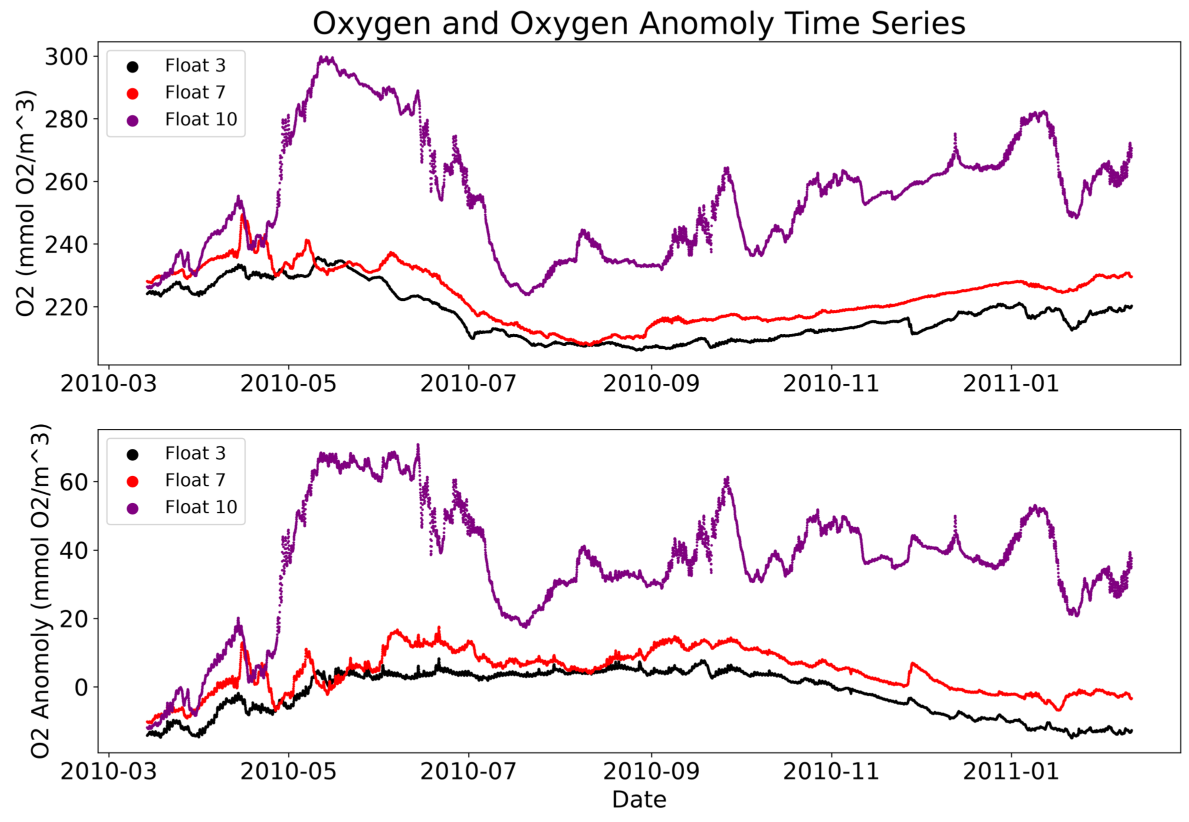

Figure 7. Comparison of oxygen concentration and oxygen anomaly throughout the year from 3 representative model floats chosen as examples.

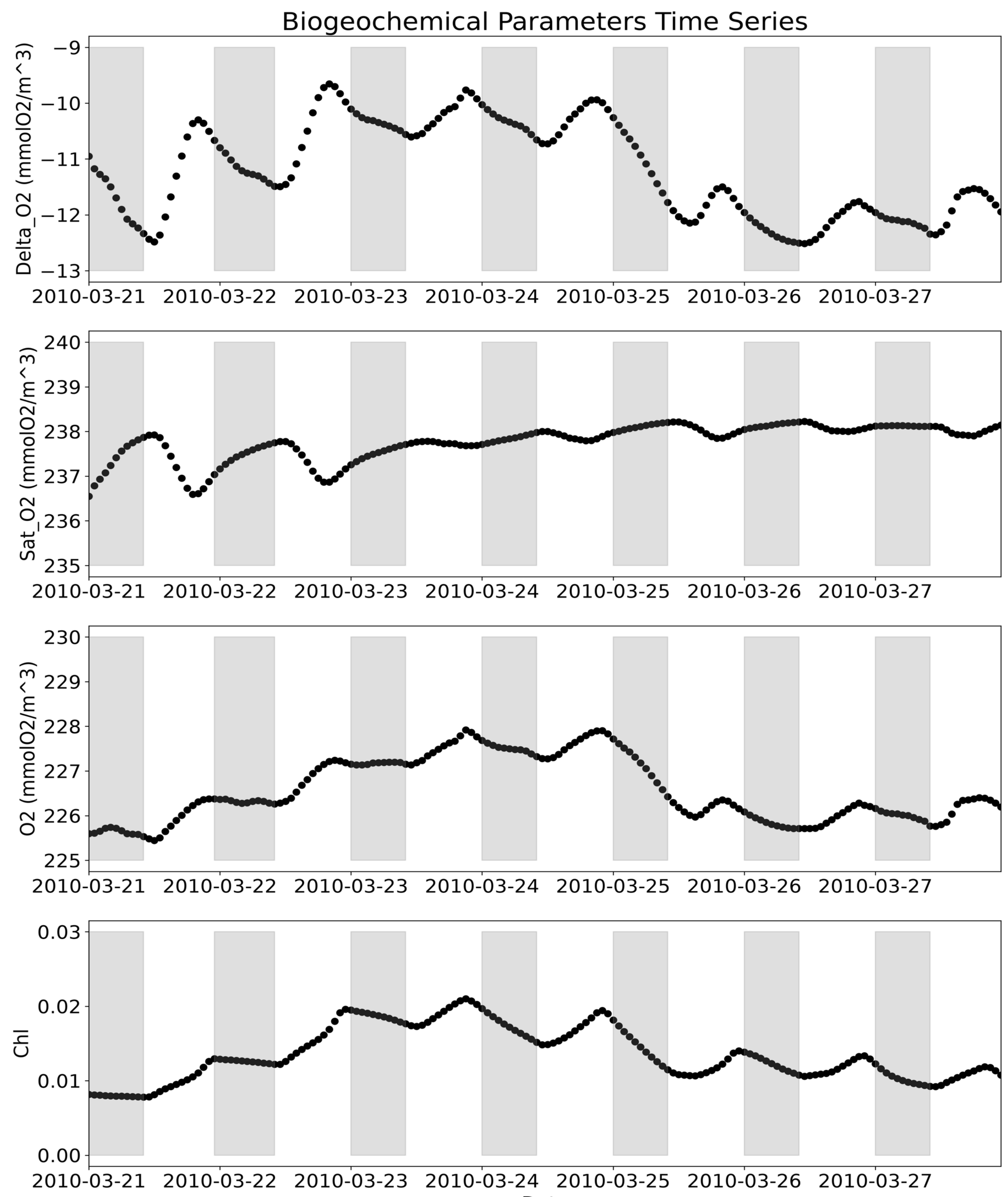

Figure 8. 1 week of oxygen anomaly, 100% oxygen saturation, dissolved oxygen concentration, and chlorophyll concentration, gray bars represent nighttime. This is a zoomed in plot of float 3 in Figure 7.

References

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