

The effect of seasonal and short-term destratification events on the detection of phytoplankton on the Scotian Shelf

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Summary

- There are distinct spring and summer peaks in the in-situ proxy measurements for chlorophyll-a and particulate organic carbon (conflicting with the spring and autumn peaks seen in concurrent satellite imagery).
- Despite hurricanes causing a deepening of the mixed layer, these storms may only prompt a limited biological response on the Scotian Shelf.
- The apparent phytoplankton blooms seen at the surface in the fall and after the passing of hurricanes are simply due to an observation bias, not net growth.

Methods

- Gliders made cross-shelf transects from 2011 to 2019 measuring hydrographic and bio-optical parameters (Fig. 1).
- We assess the biological response to autumnal and hurricane-driven destratification, as well as compare in-situ, glider bio-optical measurements with satellite imagery.

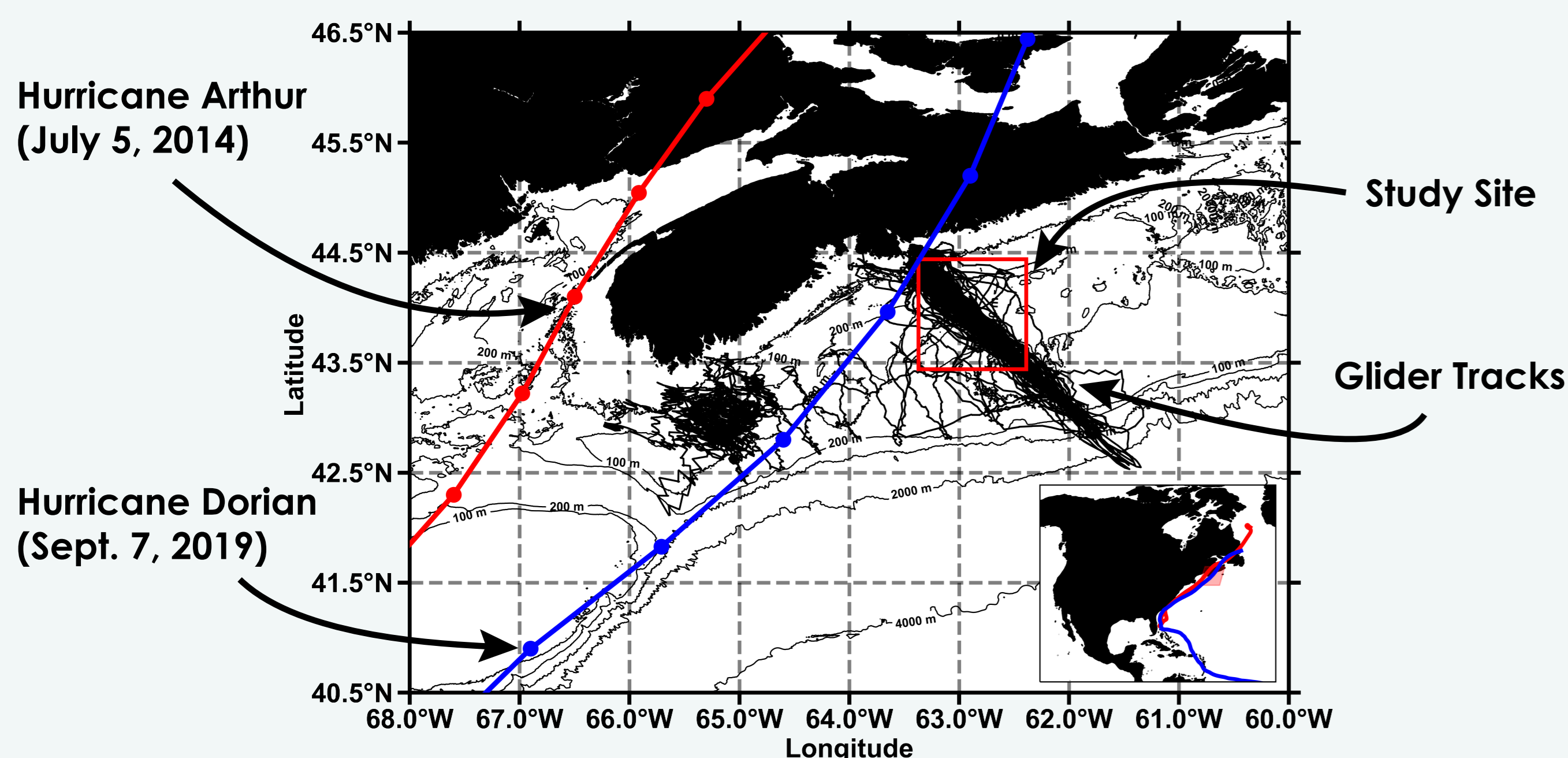


Fig 1. Map of the study site (red box), the gliders' paths (black lines), and the hurricane tracks (red and blue lines); data from Landsea and Franklin, 2013).

Results: Seasonality

- Depth-integrated measures of chlorophyll-a fluorescence (F_{Chla}) and particulate backscattering (b_{bp}) showed annual peaks in the spring and in the summer for most years (Fig. 3; c.f. Craig et al., 2015).
- The summer peaks were not apparent in the corresponding MODIS satellite imagery, although an autumn bloom was.
- This discrepancy exists because the subsurface layer of phytoplankton is too deep to be detected by satellites in the summer, and is only 'revealed' once destratification occurs in the fall (Fig. 2; c.f. Perry et al., 2008).

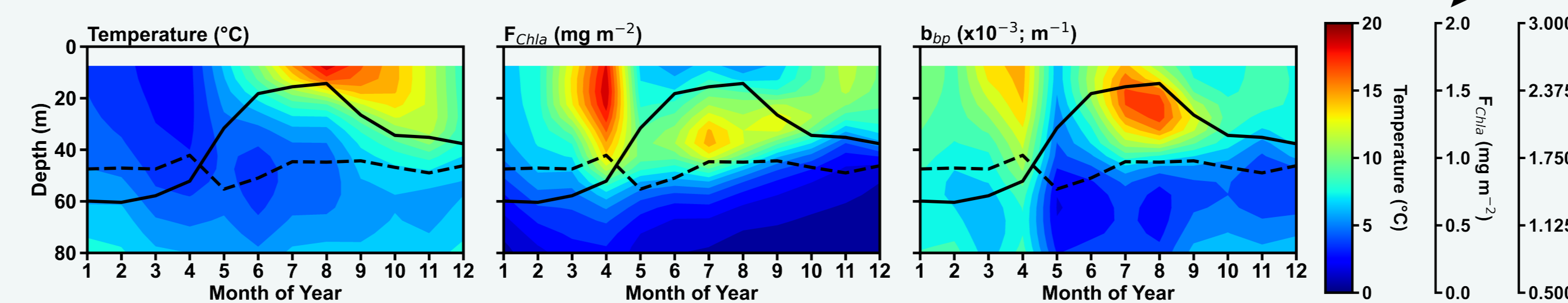


Fig 2. Depth-time plots of the study site. The mixed layer depth (solid line) and euphotic depth (dashed line) are shown.

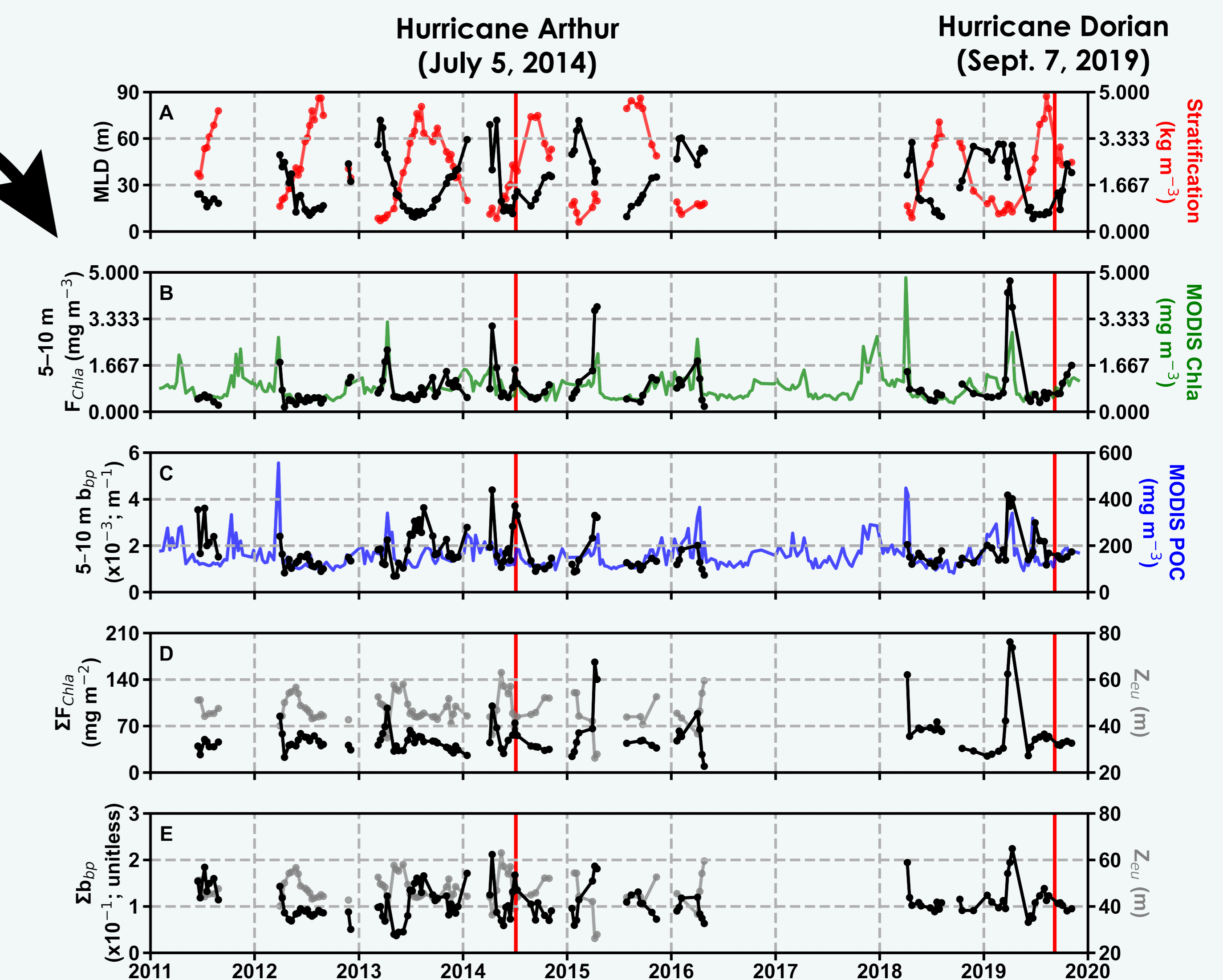


Fig 3. A time series of water column characteristics over the Emerald Basin study site.

Results: Hurricane Impacts

- Despite anomalously deeper mixed layers driven by hurricane-strength winds, ΣF_{Chla} and Σb_{bp} followed similar climatological trends as non-hurricane years (Fig. 3, Fig. 4).
- The storms had little to no impact on ΣF_{Chla} and Σb_{bp} in the water column.

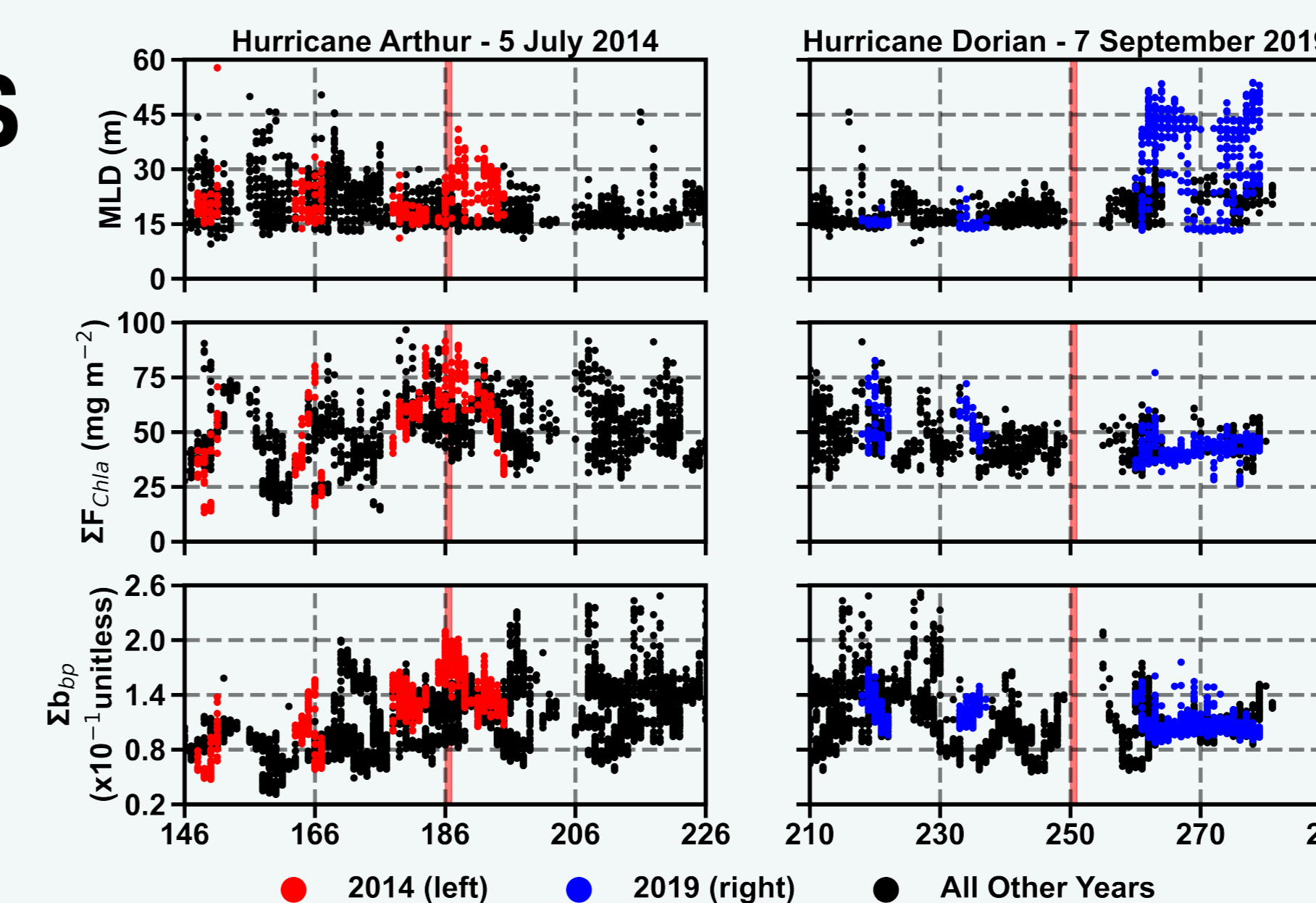


Fig 4. A time series of water column characteristics within 40 days of the storm events (shown in red).

References and Data

- Craig, S. E., Thomas, H., Jones, C. T., Li, W. K., Greenan, B. J., Shadwick, E. H., & Burt, W. J. (2015). The effect of seasonality in phytoplankton community composition on CO₂ uptake on the Scotian Shelf. *Journal of Marine Systems*, 147, 52-60.
- Landsea, C. W., & Franklin, J. L. (2013). Atlantic hurricane database uncertainty and presentation of a new database format. *Monthly Weather Review*, 141(10), 3576-3592.
- NASA Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group. Moderate-resolution Imaging Spectroradiometer (MODIS) Aqua Chlorophyll Data; 2018 Reprocessing. NASA OB.DAAC, Greenbelt, MD, USA. doi: data/10.5067/AQUA/MODIS/L3M/CHL/2018. Accessed on 03/04/2021
- Painter, S. C., Finlay, M., Hemsley, V. S., & Martin, A. P. (2016). Seasonality, phytoplankton succession and the biogeochemical impacts of an autumn storm in the northeast Atlantic Ocean. *Progress in Oceanography*, 142, 72-104.
- Perry, M. J., Sackmann, B. S., Eriksen, C. C., & Lee, C. M. (2008). Seaglider observations of blooms and subsurface chlorophyll maxima off the Washington coast. *Limnology and Oceanography*, 53(5, part 2), 2169-2179.

The Coastal Environmental Observation Technology and Research (CEOTR) group collected the glider data used in this study from 2011 to 2016. The data is available on their website at <http://ceotr.ocean.dal.ca/gliders/>.

The glider research group at the Department of Fisheries and Oceans (DFO) collected the data used in this study starting in 2018. As of March 2021, they are still making regular cross-shelf transects. The data is available from Clark Richards (clark.richards@dfo-mpo.gc.ca).