Water column data collected during Dataflow cruises in the lower York River Estuary, VA during intense summer algal blooms in 2020-21

Website: https://www.bco-dmo.org/dataset/854194
Data Type: Cruise Results
Version: 2
Version Date: 2025-09-03

Project
» Alteration of carbon fluxes by intense phytoplankton blooms in a microtidal estuary (LYRE)

Contributors	Affiliation	Role
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Abstract
This dataset includes continuous data collected during Dataflow cruises with associated grab samples in the lower York River Estuary, VA during intense summer algal blooms in 2020 and 2021.

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Coverage

Location: York River Estuary
Spatial Extent: **N**:37.268 **E**:-76.38636 **S**:37.22389 **W**:-76.54505
Temporal Extent: 2020-08-11 - 2021-09-07

Methods & Sampling

Data were collected on several single-day cruises on small privateers out of the Virginia Institute of Marine Science, Gloucester Point, VA.

High-resolution sampling via Dataflow was performed along the lower York River estuary during two successive summers, 2020-21, before, during, and after intense blooms of *Margalefidinium polykrikoides* and *Alexandrium monilatum* for determinations of pCO2, temperature, salinity, pH, turbidity, chlorophyll-a, and dissolved oxygen (DO). High-resolution sampling was performed with a Dataflow system (Madden & Day, 1992) modified as

described in Crosswell et al. (2017). The pCO2-Dataflow system is instrumented with a pCO2 analyzer, a multi-parameter datasonde (YSI 6600V2), Garmin global positioning system (GPS MAP 546S), and data acquisition system. The system continuously samples surface water (approximately every 30 meters (m) at an average speed of 20 knots) from a stern-mounted water intake located 0.5 m below the water surface with a pump, which delivers water in parallel to (1) a showerhead equilibrator and (2) a flow-through cell attached to the YSI which is configured to measure water temperature, salinity, pH, turbidity, chlorophyll-a fluorescence, and DO. pCO2 in the equilibration chamber is determined by recirculating a carrier gas at a flow of approximately 1.5 liters per minute (L/min) through the equilibrator chamber and a nondispersive infrared absorbance detection analyzer (LI-COR LI-840).

Concurrent with Dataflow sampling, grab sampling was performed at five stations within bloom patches (as determined by levels of chlorophyll-a) and at five stations outside of bloom patches for determinations of dissolved inorganic carbon (DIC), dissolved organic carbon (DOC), total dissolved nitrogen (TDN), nitrate (NO3), nitrite (NO2), ammonium (NH4), dissolved inorganic phosphorus (DIP), active chlorophyll-a (via extraction), and cell abundance of *M. polykrikoides* and *A. monilatum*. DIC samples were filtered through 0.2-micrometer (um) polycarbonate filters into 8-milliliter (mL) hungate tubes and refrigerated underwater until analysis on an Apollo SciTech AS-C3 analyzer coupled to a LI-COR LI-7000 infrared gas analyzer. DOC samples were filtered through 0.45 um polyethersulfone filters and frozen prior to analysis on a Shimadzu TOC-VCSN combustion analyzer. Nutrient samples were also filtered through 0.45 um polyethersulfone filters and frozen prior to analysis on a Lachat QuikChem 8000 automated ion analyzer (Lachat Instruments, Milwaukee, WI, USA); detection limits for NO3−, NH4+, and PO43- are 0.20, 0.36, and 0.16 micromolar (uM), respectively. Chlorophyll-a samples for extraction were filtered through 0.7 um glass fiber filters which were frozen prior to analysis following Arar and Collins (1997, EPA Method 445.0). Samples were extracted in the dark for 24 hours in 8 mL of a 45:45:10 dimethyl sulfoxide : acetone: distilled water solution with 1% diethylamine (Shoaf & Lium, 1976), and read on a 10 AU Turner Designs fluorometer before and after acidification to compute active chlorophyll-a.

Cell concentrations of *M. polykrikoides* (Marg) and *A. monilatum* (Alex) by qPCR were measured as described in Wolney et al. (2020). Briefly, 100 mL water samples were collected, and 25-100 mL were filtered onto 3 um Isopore membrane filters (Millipore Corp., Darmstadt, Germany), with the volume filtered for DNA extraction dependent on Dataflow-measured chlorophyll-a concentrations. Disposable filtration units were used to prevent cross contamination between samples. DNA was extracted from the filters using the Qiamp Fast Stool Mini Kit (QIAGEN Corp., Germantown, MD, USA) using the modified protocol as described in Wolney et al. (2020). DNA was amplified targeting Marg and Alex DNA using TaqMan qPCR assays designed in the Reece laboratory with York River Marg and Alex sequences included for assay design (Vandersea et al., 2017; Wolney et al., 2020). The cell concentrations of Marg and Alex cultures were determined by microscopy using a Sedgwick-Rafter counting cell chamber and DNA was extracted from a known number of cells. This material was used as positive control material and to generate standard curves by serially diluting the DNA to achieve a range of cell number equivalents.

Data represent means and standard errors (SE) at the five bloom and five non-bloom stations on each cruise. Dataflow values represent means and SE of all readings while sampling at each site; grab sample values represent the means and SE of three replicate samples.

Data Processing Description

Data represent means and standard errors (SE) at the five bloom and five non-bloom stations on each cruise. Dataflow values represent means and SE of all readings while sampling at each site; grab sample values represent the means and SE of three replicate samples.

BCO-DMO Processing Description

Version History:

Version 1:
Date: 2021-06-22
Dataset contained only 2020 data.
BCO-DMO Processing:
- changed date format to YYYY-MM-DD;

- renamed fields.

Version 2:
Date: 2025-04-01
Dataset contains 2020-2021 data, including corrections/additions to the 2020 data.
BCO-DMO Processing:
- Imported original file "water_column_2020_2021.xlsx" into the BCO-DMO system.
- Marked "n.d." as a missing data value (missing data are empty/blank in the final CSV file).
- Converted Date column to YYYY-MM-DD format.
- Saved final file as "854194_v2_water_column.csv".

Problem Description

pCO2 data are missing for the August 11, 2020 cruise due to instrument failure.

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Related Publications

Arar, E. J. & Collins, G. B. (1997). In vitro determination of chlorophyll a and phaeophtin a in marine and freshwater phytoplankton by fluorescence – USEPA Method 445.0. Revision 1.2. In: USEPA methods for determination of chemical substances in marine and estuarine environmental samples. Cincinnati, OH. URL: https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NERL&dirEntryId=309417
Methods

Crosswell, J. R., Anderson, I. C., Stanhope, J. W., Van Dam, B., Brush, M. J., Ensign, S., … Paerl, H. W. (2017). Carbon budget of a shallow, lagoonal estuary: Transformations and source-sink dynamics along the river-estuary-ocean continuum. Limnology and Oceanography, 62(S1), S29–S45. doi:10.1002/lno.10631
Methods

Madden, C. J., & Day, J. W. (1992). An Instrument System for High-Speed Mapping of Chlorophyll a and Physico-Chemical Variables in Surface Waters. Estuaries, 15(3), 421. doi:10.2307/1352789
Methods

Shoaf, W. T., & Lium, B. W. (1976). Improved extraction of chlorophyll a and b from algae using dimethyl sulfoxide. Limnology and Oceanography, 21(6), 926–928. Portico. https://doi.org/10.4319/lo.1976.21.6.0926
Methods

Vandersea, M. W., Kibler, S. R., Van Sant, S. B., Tester, P. A., Sullivan, K., Eckert, G., Cammarata, C., Reece, K., Scott, G., Place, A., Holderied, K., Hondolero, D., & Litaker, R. W. (2017). qPCR assays for Alexandrium fundyense and A. ostenfeldii (Dinophyceae) identified from Alaskan waters and a review of species-specific Alexandrium molecular assays. Phycologia, 56(3), 303–320. https://doi.org/10.2216/16-41.1
Methods

Wolny, J. L., Tomlinson, M. C., Schollaert Uz, S., Egerton, T. A., McKay, J. R., Meredith, A., Reece, K. S., Scott, G. P., & Stumpf, R. P. (2020). Current and Future Remote Sensing of Harmful Algal Blooms in the Chesapeake Bay to Support the Shellfish Industry. Frontiers in Marine Science, 7. https://doi.org/10.3389/fmars.2020.00337
Methods

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Parameters

Parameter	Description	Units
Date	Date when the sampling took place	unitless

Station	Sampling location (station number) starting at the estuary mouth and moving up-estuary. Locations varied among intensive cruises.	unitless
Type	Type of station; "bloom" stations were inside of intense bloom patches; "non-bloom" stations were outside of bloom patches.	unitless
Lat	Latitude of sample location	decimal degrees North
Long	Longitude of sample location	decimal degrees East
pCO2	Partial pressure of CO2 in water from Dataflow	microatmospheres
pCO2_SE	Standard error of pCO2	microatmospheres
Temp	Water temperature from Dataflow	degrees Celsius (°C)
Temp_SE	Standard error of water temperature	degrees Celsius (°C)
Sal	Salinity from Dataflow	unitless
Sal_SE	Standard error of salinity	unitless
pH	pH from Dataflow	unitless
pH_SE	Standard error of pH	unitless
Turb	Turbidity from Dataflow	NTU
Turb_SE	Standard error of turbidity	NTU
ChlaYSI	In situ chlorophyll a from Dataflow	micrograms per liter (ug/L)
ChlaYSI_SE	Standard error of in situ chlorophyll a	micrograms per liter (ug/L)
DOsat	Dissolved oxygen percent saturation from Dataflow	percent (%)
DOsat_SE	Standard error of dissolved oxygen percent saturation	percent (%)

DOmgl	Dissolved oxygen concentration from Dataflow	milligrams per liter (mg/L)
DOmgl_SE	Standard error of dissolved oxygen concentration	milligrams per liter (mg/L)
DIC	Dissolved inorganic carbon	milligrams per liter (mg/L)
DIC_SE	Standard error of DIC	milligrams per liter (mg/L)
DOC	Dissolved organic carbon	micromolar
DOC_SE	Standard error of DOC	micromolar
TDN	Total dissolved nitrogen	micromolar
TDN_SE	Standard error of TDN	micromolar
NO3	Nitrate	micromolar
NO3_SE	Standard error of NO3	micromolar
NO2	Nitrite	micromolar
NO2_SE	Standard error of NO2	micromolar
NH4	Ammonium	micromolar
NH4_SE	Standard error of NH4	micromolar
DIP	Dissolved inorganic phosphate	micromolar
DIP_SE	Standard error of DIP	micromolar
ChlaEXTR	Active chlorophyll-a from extracted samples	micrograms per liter (ug/L)
ChlaEXTR_SE	Standard error of active chlorophyll-a from extracted samples	micrograms per liter (ug/L)
Marge	*Margalefidinium polykrikoides* abundance based on qPCR	cells per milliliter (cells/mL)

Marg_SE	Standard error of *M. polykrikoides* abundance	cells per milliliter (cells/mL)
Alex	*Alexandrium monilatum* abundance based on qPCR	cells per milliliter (cells/mL)
Alex_SE	Standard error of *A. monilatum* abundance	cells per milliliter (cells/mL)

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Instruments

Dataset-specific Instrument Name	Apollo SciTech AS-C3 analyzer
Generic Instrument Name	Apollo SciTech AS-C3 Dissolved Inorganic Carbon (DIC) analyzer
Dataset-specific Description	DIC samples were analyzed using an Apollo SciTech AS-C3 analyzer coupled to a LI-COR LI-7000 infrared gas analyzer.
Generic Instrument Description	A Dissolved Inorganic Carbon (DIC) analyzer, for use in aquatic carbon dioxide parameter analysis of coastal waters, sediment pore-waters, and time-series incubation samples. The analyzer consists of a solid state infrared CO2 detector, a mass-flow controller, and a digital pump for transferring accurate amounts of reagent and sample. The analyzer uses an electronic cooling system to keep the reactor temperature below 3 degrees Celsius, and a Nafion dry tube to reduce the water vapour and keep the analyzer drift-free and maintenance-free for longer. The analyzer can handle sample volumes from 0.1 - 1.5 milliliters, however the best results are obtained from sample volumes between 0.5 - 1 milliliters. It takes approximately 3 minutes per analysis, and measurement precision is plus or minus 2 micromoles per kilogram or higher for surface seawater. It is designed for both land based and shipboard laboratory use.

Dataset-specific Instrument Name	Applied BiosystemsTM QuantStudio TM 6 Flex Real-time PCR System
Generic Instrument Name	Applied Biosystems Real-Time PCR System (ThermoFisher)
Dataset-specific Description	Used to quantify the abundance of Margalefidinium polykrikoides and Alexandrium monilatum
Generic Instrument Description	Encompasses various models of real-time PCR systems manufactured by Applied Biosystems, including the ABI-9300, ABI-7500, and QuantStudio.

Dataset-specific Instrument Name	Applied BiosystemsTM 7500 Fast Real-time PCR System
Generic Instrument Name	Applied Biosystems Real-Time PCR System (ThermoFisher)
Dataset-specific Description	Used to quantify the abundance of Margalefidinium polykrikoides and Alexandrium monilatum
Generic Instrument Description	Encompasses various models of real-time PCR systems manufactured by Applied Biosystems, including the ABI-9300, ABI-7500, and QuantStudio.

Dataset-specific Instrument Name	Lachat QuikChem 8000 automated ion analyzer
Generic Instrument Name	Flow Injection Analyzer
Dataset-specific Description	Nutrients were analyzed using a Lachat QuikChem 8000 automated ion analyzer (Lachat Instruments, Milwaukee, WI, USA).
Generic Instrument Description	An instrument that performs flow injection analysis. Flow injection analysis (FIA) is an approach to chemical analysis that is accomplished by injecting a plug of sample into a flowing carrier stream. FIA is an automated method in which a sample is injected into a continuous flow of a carrier solution that mixes with other continuously flowing solutions before reaching a detector. Precision is dramatically increased when FIA is used instead of manual injections and as a result very specific FIA systems have been developed for a wide array of analytical techniques.

Dataset-specific Instrument Name	Garmin global positioning system (GPS MAP 546S)
Generic Instrument Name	Global Positioning System Receiver
Dataset-specific Description	The pCO2-Dataflow system is instrumented with a pCO2 analyzer (LI-COR LI-840), a multi-parameter datasonde (YSI 6600V2), Garmin global positioning system (GPS MAP 546S), and data acquisition system.
Generic Instrument Description	The Global Positioning System (GPS) is a U.S. space-based radionavigation system that provides reliable positioning, navigation, and timing services to civilian users on a continuous worldwide basis. The U.S. Air Force develops, maintains, and operates the space and control segments of the NAVSTAR GPS transmitter system. Ships use a variety of receivers (e.g. Trimble and Ashtech) to interpret the GPS signal and determine accurate latitude and longitude.

Dataset-specific Instrument Name	LI-COR LI-7000 infrared gas analyzer
Generic Instrument Name	LI-COR LI-7000 Gas Analyzer
Dataset-specific Description	DIC samples were analyzed using an Apollo SciTech AS-C3 analyzer coupled to a LI-COR LI-7000 infrared gas analyzer.
Generic Instrument Description	The LI-7000 gas analyzer is a differential, single source, non-dispersive, infrared gas analyzer. It has two solid state detectors, one each for CO2 and H2O, filters at 4.255 microns and 2.595 microns respectively. CO2 is measured in the range 0-3000ppm, with an accuracy of 1 percent nominally. H2O is measured in the range 0-60 mmol per mol, with an accuracy of one 1 percent.

Dataset-specific Instrument Name	LI-COR LI-840
Generic Instrument Name	LI-COR LI-840 Gas Analyzer
Dataset-specific Description	The pCO2-Dataflow system is instrumented with a pCO2 analyzer (LI-COR LI-840), a multi-parameter datasonde (YSI 6600V2), Garmin global positioning system (GPS MAP 546S), and data acquisition system
Generic Instrument Description	The LI-COR LI-840 is an absolute, non-dispersive infrared gas analyzer based on a single path, dual wavelength, and thermostatically controlled infrared detection system. It has an operating temperature range of -20 to +40 degrees Celsius. CO2 is measured in the range 0-3,000 ppm with an accuracy of better than 1.5 percent of the reading. H2O is measured in the range 0-80 ppt with an accuracy of better than 1.5 percent of reading.

Dataset-specific Instrument Name	pCO2-Dataflow system
Generic Instrument Name	pCO2-Dataflow system
Dataset-specific Description	The pCO2-Dataflow system is instrumented with a pCO2 analyzer (LI-COR LI-840), a multi-parameter datasonde (YSI 6600V2), Garmin global positioning system (GPS MAP 546S), and data acquisition system. The platform used here includes a separate flow cell with a sensor to measure chromophoric dissolved organic matter, and is further coupled to a pCO2 analyzer as described in Crosswell et al. (2017) (doi: 10.1002/lno.10631).
Generic Instrument Description	Dataflow is a high-resolution sampling platform for underway surface water quality mapping, originally developed by Madden & Day (1992) (doi: 10.2307/1352789). The system consists of a pump that draws water from just below the estuary surface and passes it through a flow cell with a YSI datasonde to measure temperature, salinity, pH, turbidity, chlorophyll-a, and dissolved oxygen.

Dataset-specific Instrument Name	Shimadzu TOC-VCSN combustion analyzer
Generic Instrument Name	Shimadzu TOC-V Analyzer
Dataset-specific Description	DOC was analyzed using a Shimadzu TOC-VCSN combustion analyzer.
Generic Instrument Description	A Shimadzu TOC-V Analyzer measures DOC by high temperature combustion method.

Dataset-specific Instrument Name	10 AU Turner Designs fluorometer
Generic Instrument Name	Turner Designs Fluorometer 10-AU
Dataset-specific Description	Samples were read on a 10 AU Turner Designs fluorometer before and after acidification to compute active chlorophyll-a.
Generic Instrument Description	The Turner Designs 10-AU Field Fluorometer is used to measure Chlorophyll fluorescence. The 10AU Fluorometer can be set up for continuous-flow monitoring or discrete sample analyses. A variety of compounds can be measured using application-specific optical filters available from the manufacturer (read more from Turner Designs, turnerdesigns.com, Sunnyvale, CA, USA).

Dataset-specific Instrument Name	YSI 6600V2
Generic Instrument Name	YSI Sonde 6-Series
Dataset-specific Description	The pCO2-Dataflow system is instrumented with a pCO2 analyzer (LI-COR LI-840), a multi-parameter datasonde (YSI 6600V2), Garmin global positioning system (GPS MAP 546S), and data acquisition system.
Generic Instrument Description	YSI 6-Series water quality sondes and sensors are instruments for environmental monitoring and long-term deployments. YSI datasondes accept multiple water quality sensors (i.e., they are multiparameter sondes). Sondes can measure temperature, conductivity, dissolved oxygen, depth, turbidity, and other water quality parameters. The 6-Series includes several models. More from YSI.

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Project Information

Alteration of carbon fluxes by intense phytoplankton blooms in a microtidal estuary (LYRE)

Coverage: York River Estuary, Virginia

NSF Award Abstract:
Estuaries, coastal water bodies where rivers mix with ocean water, are hotspots for the processing of carbon and nutrients moving from land to the coastal ocean. Within estuaries land-based nutrient inputs can cause intense blooms of single-celled algae called phytoplankton, which can have significant impacts on the ecosystem. As blooms move down-estuary some of the phytoplankton material is buried on the bottom, and some is decomposed, resulting in low oxygen conditions (hypoxia), harmful to marine life, and production of carbon dioxide (CO2), the major greenhouse gas, which can exchange with the atmosphere. The remaining phytoplankton material can be exported to the ocean. The type and amount of carbon exported from the estuary depend both on its biological activity and physical factors such as fresh water discharge, temperature, and light availability. If phytoplankton production is greater than decomposition, the estuary will take up atmospheric CO2 and export phytoplankton carbon to the coastal ocean. On the other hand, if decomposition is greater than production the estuary will be a source of CO2 to the atmosphere and dissolved CO2 to the coastal ocean. The investigators expect that intense phytoplankton blooms will greatly amplify carbon exchanges with the atmosphere, coastal ocean, and bottom sediments. As intense phytoplankton blooms increase in the future due to increased nutrient inputs and temperature, low oxygen events may become more frequent with potential negative impacts on fisheries and increased export of carbon to the coastal ocean and atmosphere. This study will fill critical gaps identified by the Coastal Carbon Synthesis Program in knowledge of how microtidal estuaries transform and export C to the atmosphere, benthos, and coastal ocean. In addition, there will be a strong teaching and training component to this project, with support for graduate and undergraduate students. The graduate student will be partnered with secondary teachers to gain teaching experience and enrich the middle school educational programs. Summer undergraduate interns will be recruited for a summer program from Hampton University, a historically Black college. There will be public outreach through participation in existing programs at VIMS.

Estuaries serve as critical hotspots for the processing of carbon (C) as it transits from land to the coastal ocean. Recent attempts to synthesize what is known about sources and fates of C in estuaries have noted large data gaps; thus, the role of estuaries, especially those that are microtidal, as important sources of carbon dioxide (CO2) to the atmosphere and total organic carbon (TOC) and dissolved inorganic carbon (DIC) to the coastal ocean, or as a C sink in bottom sediments, remains uncertain. Intensive phytoplankton blooms are becoming increasingly frequent in many estuaries and are likely to have important and yet unknown impacts on the C cycle. The trophic status of an estuary will determine in large part the species of C exported to the atmosphere, bottom sediments, and coastal ocean. The overarching objective of this project is to identify the impacts of intense phytoplankton blooms on C speciation, net C fluxes and exchanges in the Lower

York River Estuary (LYRE), a representative mesotrophic, microtidal mid-Atlantic estuary. Metabolic processes are hypothesized to be spatially and temporally dynamic, driving the speciation, abundance, and fates of C in the LYRE. High spatiotemporal resolution sampling in the LYRE will capture rates of C cycling under both baseline conditions throughout most of the year, and during periods when the estuary is perturbed by widespread and intense, but patchy, late summer phytoplankton blooms. The short-term effects of physical drivers (wind, temperature, salinity, fresh water discharge, nutrient and organic carbon loads) and biological drivers (metabolic rates, bacterial and phytoplankton abundances and composition) on C transformations, speciation, and exchanges will be assessed. Expected longer term variations in the C cycle due to anthropogenic and natural disturbances will be predicted through use of modeling. In addition, laboratory manipulations will examine the impacts of specific organisms dominating intensive phytoplankton blooms on benthic metabolism, processing of organic C by the microbial community, and C fluxes to the water column.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1737258

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