Distance-weighted data flow averages interpolated over 24-hours for the York River estuary in 2018 and 2019

Website: https://www.bco-dmo.org/dataset/809808
Data Type: Other Field Results
Version: 1
Version Date: 2020-04-24

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

Contributors	Affiliation	Role
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Abstract
Dataflow data collected seasonally during dawn, dusk, and 2nd dawn cruises down the York River estuary. Data distance-weighted for each of 5 boxes, and interpolated over 24-hours.

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Coverage

Spatial Extent: **N**:37.5217 **E**:-76.3685 **S**:37.265 **W**:-76.8037
Temporal Extent: 2018-02-06 - 2019-10-15

Methods & Sampling

High resolution sampling surveys in the York River estuary (YRE): performed in 2018 during Feb, March, June, August, and October and in 2019 during Feb, April, July, and October at dawn, dusk, and the following dawn along a zig-zag cruise track, covering approximately equal areas of shoal and channel, a total distance of 30 km, using a DataFlow system modified from Madden and Day (1992). All sampling is performed during spring tides, the period following de-stratification in the YRE when the system is well-mixed (Haas 1977). This high resolution sampling plan enables us to capture day-time primary production (dawn to dusk) and night-time respiration (dusk to dawn) while sampling water masses exposed to the same tidal stage. The DataFlow system captures continuous measurements of water quality parameters and allows grab sampling (at five channel and five shoal stations) for DIC and other parameters shown in different spread sheets and used for multiple regression analyses. The pCO_2-DataFlow system is instrumented with a pCO_2 analyzer, a multi-parameter datasonde (YSI 6600V2), Wet Labs CDOM sensor, Garmin global positioning system (GPS MAP 546S), and data acquisition system. The system continuously samples surface water (approximately every 30 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 shower-head equilibrator and (2) a flow-through cell attached to the YSI which is configured to measure water temperature, salinity, chl-*a* fluorescence, DO, pH, and turbidity. pCO_2 in the equilibration chamber is determined by recirculating a carrier gas at a flow of approximately 1.5 L min^{-1} through the equilibrator chamber and a nondispersive infrared absorbance detection analyzer (LI-COR, LI-840). The mole fraction of CO_2 (xCO_2) is corrected for headspace pressure and temperature to determine surface-water pCO_2 with an attainable accuracy of ±4 µatm over the functional range of 100 to 5,000 ppmv (Crosswell et al. 2012). All measurements are taken at 2-second intervals, and the lag time between DataFlow and LI-COR data is measured and corrected for each sampling run. At the beginning, during, and end of each survey, ambient atmospheric air and two CO_2 gas standards (Praxair Inc.) are measured for calibration and verification of the absorbance detection analyzer.

Calculation of Air-Water CO2 and O2 Fluxes: Data in these spreadsheets are used to calculate CO2, O2 fluxes and metabolic parameters as described below. Air-water CO2 and O2 exchanges are driven by the differences between the gas concentrations in the surface water and the atmosphere (ΔpCO2, ΔpO2) scaled by the gas solubility, and the rate of exchange is set by the gas-transfer velocity (k, cm h-1). Input data include: K0, the solubility coefficient (K0(CO2): Weiss 1974; K0(O2): Benson and Krause 1984); k600 the gas exchange coefficient; ΔpCO2 and ΔpO2 and ScSST is the Schmidt number at ambient sea-surface temperature and salinity (Wanninkhof 1992). The gas solubility and Schmidt numbers for CO2 and O2 are determined based on temperature and salinity. The transfer velocity k is parameterized as a function of wind speed normalized to 10 m above the water surface (u10). We calculate air-water CO2 fluxes using the Jiang et al. (2008) parameterization, which provides a conservative estimate of k and has been widely used in reviews of estuarine CO2 fluxes (Crosswell et al 2014).

Spatial and Diel Interpolation of Dawn-Dusk Data for Calculation of Daily CO2 and O2 Fluxes: Data from each dawn–dusk survey is spatially averaged by calculating distance-weighted means of ΔpCO2 and delta pO2 (difference water and atmospheric concentrations), water temperature, salinity and other parameters within a series of five boxes of the YRE. Data are used to calculate CO2 and O2 fluxes, and metabolic parameters as described below.

Open Water measurements of metabolism (based on diel variations of DO): NEM gross primary production (GPP), and respiration (R) are determined from changes in DO concentrations in Dataflow samples collected at dawn, dusk, and the following dawn using the open water method (Kemp and Boynton 1980). ΔDO (dawn to dusk; dusk to dawn), corrected for air/sea exchanges of O2 are used to calculate NEM, GPP, and R. To scale metabolic measurements to regional estimates, the surface areas and water volumes of the YRE were determined for each spatial element using ArcGIS 10 and bathymetric data. Daily average hourly O2 fluxes (mmol DO m-2 d-1) for each box are multiplied by their respective spatial element areas and scaled to annual O2 fluxes. Daily fluxes for each spatial element are summed to provide seasonal and annual totals (moles O2 per m2 per y).

Data Processing Description

BCO-DMO Processing:
- formatted date/time to YYYY-MM-DDThh:mm;
- moved the box numbers from a row to a column.

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Data Files

File
interpolated_data.csv (Comma Separated Values (.csv), 87.74 KB) MD5:e44bd6c7631c2f3ce8042b73cc9efeab Primary data file for dataset ID 809808

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Related Publications

Benson, B. B., & Krause, D. (1984). The concentration and isotopic fractionation of oxygen dissolved in freshwater and seawater in equilibrium with the atmosphere1. Limnology and Oceanography, 29(3), 620–632. doi:10.4319/lo.1984.29.3.0620
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
General

Crosswell, J. R., Wetz, M. S., Hales, B., & Paerl, H. W. (2012). Air-water CO2fluxes in the microtidal Neuse River Estuary, North Carolina. Journal of Geophysical Research: Oceans, 117(C8), n/a–n/a. doi:10.1029/2012jc007925 https://doi.org/10.1029/2012JC007925
Methods

Crosswell, J. R., Wetz, M. S., Hales, B., & Paerl, H. W. (2014). Extensive CO2 emissions from shallow coastal waters during passage of Hurricane Irene (August 2011) over the Mid-Atlantic Coast of the U.S.A. Limnology and Oceanography, 59(5), 1651–1665. doi:10.4319/lo.2014.59.5.1651
Methods

Haas, L. W. (1977). The effect of the spring-neap tidal cycle on the vertical salinity structure of the James, York and Rappahannock Rivers, Virginia, U.S.A. Estuarine and Coastal Marine Science, 5(4), 485–496. doi:10.1016/0302-3524(77)90096-2
Methods

Jiang, L.-Q., Cai, W.-J., & Wang, Y. (2008). A comparative study of carbon dioxide degassing in river- and marine-dominated estuaries. Limnology and Oceanography, 53(6), 2603–2615. doi:10.4319/lo.2008.53.6.2603
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

Wanninkhof, R. (1992). Relationship between wind speed and gas exchange over the ocean. Journal of Geophysical Research, 97(C5), 7373. doi:10.1029/92jc00188 https://doi.org/10.1029/92JC00188
Methods

Weiss, R. F. (1974). Carbon dioxide in water and seawater: the solubility of a non-ideal gas. Marine Chemistry, 2(3), 203–215. doi:10.1016/0304-4203(74)90015-2
Methods

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Parameters

Parameter	Description	Units
ISO_DateTime_Local	Date and time (local) formatted to ISO8601 standard; format: YYYY-MM-DDThh:mm	unitless
box	Box into which the estuary has been subdivided. 1.00 is at the mouth; 5.00 at the head. All data were collected continuously during cruises along the entire estuary. Data within a single box were distance weighted, representing a distance weighted average for the box.	unitless
pCO2_1	Delta partial pressure CO2 in water and atmosphere	micro atmospheres (uatm)
Temp	Water temperature	degrees Celsius
Salinity	Salinity	unitless
DO_1	Dissolved oxygen	percent saturation
DO_2	Dissolved oxygen	milligrams per liter (mg/L)
DO_3	Dissolved oxygen	mg/L at saturation
pH	pH	unitless
Turbidity	Turbidity	units relative to standard
Chlorophyll_a	in situ chlorophyll a	micrograms per liter (ug/L)
DIC	Dissolved inorganic carbon	milligrams per liter (mg/L)

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Instruments

Dataset-specific Instrument Name	Wet Labs CDOM sensor
Generic Instrument Name	Fluorometer
Dataset-specific Description	Wet Labs FLCD-SB CDOM sensor
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	Garmin global positioning system (GPS MAP 546S)
Generic Instrument Name	Global Positioning System Receiver
Dataset-specific Description	The pCO_2-DataFlow system is instrumented with a pCO_2 analyzer, a multi-parameter datasonde (YSI 6600V2), Wet Labs CDOM sensor, 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	pCO2 analyzer
Generic Instrument Name	pCO2 Sensor
Dataset-specific Description	The pCO_2-DataFlow system is instrumented with a pCO_2 analyzer, a multi-parameter datasonde (YSI 6600V2), Wet Labs CDOM sensor, Garmin global positioning system (GPS MAP 546S), and data acquisition system.
Generic Instrument Description	A sensor that measures the partial pressure of CO2 in water (pCO2)

Dataset-specific Instrument Name	YSI 6600V2
Generic Instrument Name	YSI Sonde 6-Series
Dataset-specific Description	The pCO_2-DataFlow system is instrumented with a pCO_2 analyzer, a multi-parameter datasonde (YSI 6600V2), Wet Labs CDOM sensor, 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:

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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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