Underway shipboard flow-through data collected from continuously flowing uncontaminated seawater on several R/V Gulf Challenger cruises in Casco Bay, Gulf of Maine from 2008-2012

Website: https://www.bco-dmo.org/dataset/550607
Version: 25 Feb 2015
Version Date: 2015-02-25

Project
» River and sediment-modulated stress in planktonic and early settlement Mya arenaria (OA stress in Mya arenaria)

Contributors	Affiliation	Role
Green, Mark	St. Joseph's College	Principal Investigator
Salisbury, Joseph	University of New Hampshire (UNH)	Co-Principal Investigator
Shellito, Shawn	University of New Hampshire (UNH)	Contact
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

Dataset Description

A collection of underway shipboard flow-through data from 2008–2012 in Casco Bay collected from continuously flowing uncontaminated seawater aboard the R/V Gulf Challenger from an intake depth of 1 meter.

Methods & Sampling

The following fields have been QC'ed by the UNH Coastal Ocean Observing Center:
year
day_of_year
secDay
lat
lon
speed
Water_temp
Salinity
xCO2_w
fCO2_w
xCO2_a
fCO2_a

The following fields came at least partly from National Buoy Data Center data, and cannot be verified:

pressure_atm
air_temp

A shipboard flow-through system was used to continuously measure physical and chemical properties of surface water. Seawater temperature and salinity were measured using a Sea-Bird SBE 45 thermosalinograph, pumped at 1.5 L/min. Tests using a handheld temperature and salinity sensor (YSI 85, YSI Instruments Yellow Springs OH), aboard the R/V Gulf Challenger indicate temperature differences are less than 0.01 degree Celsius between equilibrator outflow and intake sea surface water. Therefore, no temperature correction is applied to data taken aboard the RV Gulf Challenger. A temperature offset was observed between the sea surface temperature measured by the continuous-flow SBE-45 and that measured at the water surface by a SBE-37 thermosalinograph deployed as part of a profiling package. For each estuary survey, the average temperature offset between the continuous-flow and profiler sea-surface temperature was removed, to bring the continuous-flow temperature into agreement with in-situ sea surface temperature. The SBE-45 thermosalinograph sensor received annual manufacturer calibrations, but was not calibrated in the field against discrete measurements.

Flow to the shipboard flow-through system was also pumped to an equilibrator, similar to that described by Wanninkhof and Thoning (1993), but consisting of three Plexiglas chambers instead of a single chamber. Equilibrated air was drawn out of the third chamber, while ambient air was drawn into the first chamber and passed through the second and third chambers, equilibrating with the pumped water supply at each step. Equilibrated air was drawn at 100 mL/min through tubing containing a Nafion selectively permeable membrane (Perma Pure, Toms River NJ) with a counter-flowing stream of dry nitrogen, which dried the sample gas stream of water vapor. Due to the short run of tubing between the water source for both the continuous-flow system and the gas equilibrator, no water temperature difference was observed between that measured by the continuous-flow SBE-45 and the outflow from the equilibrator (measured with a handheld meter- YSI Yellow Springs, Ohio- manufacturer accuracy +/- 0.2 degrees C). Temperature from the continuous-flow SBE-45 was used in sea-surface temperature corrections during the calculation of pCO2. After drying, the sample was pumped to a non-dispersive infrared gas analyzer (Li-cor, LI-6262 or LI-840), which measured the molar fraction of carbon dioxide (xCO2) of the sample stream. The Li-cor was calibrated several times each survey with pure nitrogen (0 ppm CO2 molar fraction) and one span tank. Over the study period we employed a succession of span tanks containing a gas mixture with CO2 molar fraction between 819 and 851 ppm (Scott-Marin, Riverside, CA). Corrections of the data for water vapor pressure and sea surface temperature and conversion from xCO2 to the partial pressure of carbon dioxide (pCO2) were carried out according to standard methods (Dickson et al. 2007). Atmospheric pCO2 was periodically measured as well while the ship was underway. Ambient air was drawn from the ship's bow through a length of tubing and pumped into the non-dispersive infrared gas analyzer described above. The estimated uncertainty of pCO2 measurements is +/- 3 uatm. All pCO2 data have been banked with the Carbon Dioxide Information Analysis Center (http://cdiac.ornl.gov/oceans/Coastal/unh_ts.html).

CO2 Analyzer: Licor 6262 or Licor 840 infrared (IR) analyzer (Li-cor Biosciences Inc, Lincoln NE).

Drying method: Nafion selectively permeable membrane drying loop (Perma Pure, Toms River NJ) with counter-flowing nitrogen stream.

Equilibrator type: Three-chamber fast-rate equilibrator similar to that of Wanninkhof and Thoning (1993, reference below), flow rate 1.5 L/min.

CO2 calibration standards: Two-point calibration using ultrapure nitrogen and a mixture of CO2 in nitrogen, ranging from 832.3 to 856.1 ppm. Mixtures of CO2 in nitrogen, analyzed to within +/- 1%, were obtained from Scott-Marrin Inc (Riverside, CA). These standards are then adjusted based on comparison to a series of standards ranging from 378-515 ppmv obtained from NOAA/ESRL (http://www.esrl.noaa.gov/).

CO2 data calculation: Corrections of the data for water vapor pressure and sea surface temperature and conversion from pCO2 to the fugacity of carbon dioxide (fCO2) were carried out according to the DOE handbook (1994).

CO2 data quality: all data, excepting those from 20040721, have been verified to an accuracy of +/- 2 mmol/mol or uatm.

References:
Dickson, A.G., Sabine, C.L. and J.R. Christian (Eds.). 2007. Guide to best practices for Ocean CO2 Measurements. PICES Special Publication 3, 191 pp. http://cdiac.ornl.gov/oceans/Handbook_2007.html

DOE (2007) *Guide to Best Practices for Ocean CO2 Measurements,* A.G. Dickson, C.L. Sabine and J.R. Christian,

eds. PICES Special Publication, 191 pp.

Sea-bird Electronics. 2013. SBE 43 Dissolved Oxygen Sensor- Background Information, Deployment Recommendations, and Cleaning and Storage. (http://www.seabird.com/application_notes/AN64.htm). Accessed 13 September 2013.

Wanninkhof, R. and K. Thoning. 1993. Measurement of fugacity of CO2 in surface water using continuous and discrete sampling methods. *Marine Chemistry* 44: 189-204. doi:10.1016/0304-4203(93)90202-Y

Data Processing Description

See the headers from original data files for processing dates and temperature offsets.

BCO-DMO processing:
- Replaced '-9999' with 'nd' to indicate 'no data'.
- Modified parameter names to conform with BCO-DMO naming conventions.
- Calculated an added 'time' (in hours and minutes) using the original secDay data provided.

[table of contents | back to top]

Data Files

File
cruise_underway.csv (Comma Separated Values (.csv), 2.34 MB) MD5:506b0819a5746e2568550e4f0bf1cd16 Primary data file for dataset ID 550607

[table of contents | back to top]

Parameters

Parameter	Description	Units
date	Date of the cruise (UTC).	YYYYmmdd
month	2-digit month of the cruise.	mm (01 to 12)
day	2-digit day of month.	dd (01 to 31)
year	Year the measurements were taken.	YYYY
day_of_year	Sequential day of year measurements were taken.	unitless
time	Time of day in HHMM.mmmm format where HH=2-digit hour (24-hour clock), MM=2-digit minutes, and mmmm=fraction of a minute. (UTC)	HHMM.mmmm
secDay	Sequential seconds of day of measurement (e.g. 60,000 secDay=16:40:00).	seconds
lat	Latitude in decimal degrees (negative values are in the Southern Hemisphere).	decimal degrees
lon	Longitude in decimal degrees (negative values are in the Western Hemisphere).	decimal degrees
heading	Ship's heading.	degrees
speed	Ship speed in meters per second.	meters per second (m/s)
temp	Sea surface temperature measured by a SBE-45 thermosalinograph, in degrees Celsius.	degrees Celsius (C)
sal	Sea surface salinity measured by a SBE-45 thermosalinograph, on the Practical Salinity Scale.	PSU
pressure_atm	Barometric pressure from either ship’s barometer, nearby buoy barometer, or standard atmospheric pressure (1013.25 hPa), in hectopascals. (Values came at least partly from National Buoy Data Center data, and cannot be verified.)	hectopascals (hPa)
xCO2_w	Mole fraction of CO2 (dry) in equilibrator headspace at equilibrator temperature, in parts per million.	parts per million (ppm)
fCO2_w	Fugacity of CO2 in seawater, in microatmospheres.	microatmospheres (uatm)
xCO2_a	Mole fraction of CO2 (dry) in air, in parts per million.	parts per million (ppm)
fCO2_a	Fugacity of CO2 in air, in microatmospheres.	microatmospheres (uatm)
air_temp	Air temperature in degrees Celsius. (Values came at least partly from National Buoy Data Center data, and cannot be verified.)	degrees Celsius (C)
ISO_DateTime_UTC	Date and time formatted to ISO 8601 standard. This standard is based on ISO 8601:2004(E) and takes on any of the following form: YYYY-mm-ddTHH:MM:SS[.xx]Z (UTC time), where the T indicates the start of the time string and the trailing Z indicates UTC.	YYYY-mm-ddTHH:MM:SS[.xx]Z

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Li-cor LI-6262
Generic Instrument Name	LI-COR LI-6262 Gas Analyzer
Dataset-specific Description	After drying, the sample was pumped to a non-dispersive infrared gas analyzer (Li-cor, LI-6262 or LI-840), which measured the molar fraction of carbon dioxide (xCO2) of the sample stream.
Generic Instrument Description	The LI-6262 CO2/H2O Gas Analyzer measures CO2 flux in the environment. It was manufactured by LI-COR Biosciences Inc. (licor.com) from 1990 through 2005 and serial Numbers for this model have the prefix of IRG3-XXXX. The LI-6262 is a differential, non-dispersive, infrared (NDIR) gas analyzer. The CO2 and H2O measurements are based on the difference in absorption of infrared (IR) radiation passing through two gas sampling cells. The reference cell is used for a gas of known CO2 or H2O concentration, and the sample cell is used for a gas of unknown concentration. Infrared radiation is transmitted through both cell paths, and the output of the analyzer is proportional to the difference in absorption between the two (LI-6262 CO2/H2O Analyzer Operating and Service Manual, Publication Number 9003-59, March, 1996, pg 18).

Dataset-specific Instrument Name	LI-COR LI-840
Generic Instrument Name	LI-COR LI-840 NDIR Gas Analyzer
Dataset-specific Description	After drying, the sample was pumped to a non-dispersive infrared gas analyzer (Li-cor, LI-6262 or LI-840), which measured the molar fraction of carbon dioxide (xCO2) of the sample stream.
Generic Instrument Description	The LI-COR LI-840 is specifically designed for continuous monitoring of CO2 and H2O over a wide range of environmental conditions. The LI-840 is an absolute, non-dispersive, infrared (NDIR) gas analyzer based on a single, interchangeable optical path, and a dual wavelength infrared detection system.

Dataset-specific Instrument Name	Sea-bird SBE-45 thermosalinograph
Generic Instrument Name	Sea-Bird SBE 45 MicroTSG Thermosalinograph
Dataset-specific Description	Temperature and salinity were determined by a Sea-bird SBE-45 thermosalinograph (Sea-bird electronics, Bellevue, WA).
Generic Instrument Description	A small externally powered, high-accuracy instrument, designed for shipboard determination of sea surface (pumped-water) conductivity and temperature. It is constructed of plastic and titanium to ensure long life with minimum maintenance. It may optionally be interfaced to an external SBE 38 hull temperature sensor. Sea Bird SBE 45 MicroTSG (Thermosalinograph)

Dataset-specific Instrument Name	SBE-37 thermosalinograph
Generic Instrument Name	Thermosalinograph
Dataset-specific Description	A temperature offset was observed between the sea surface temperature measured by the continuous-flow SBE-45 and that measured at the water surface by a SBE-37 thermosalinograph deployed as part of a profiling package.
Generic Instrument Description	A thermosalinograph (TSG) is used to obtain a continuous record of sea surface temperature and salinity. On many research vessels the TSG is integrated into the ship's underway seawater sampling system and reported with the underway or alongtrack data.

[table of contents | back to top]

Deployments

GC011608CB

Website	https://www.bco-dmo.org/deployment/552371
Platform	R/V Gulf Challenger
Start Date	2008-01-16
End Date	2008-01-16
Description	One-day cruise in Casco Bay on the R/V Gulf Challenger for the project, "River and sediment-modulated stress in planktonic and early settlement Mya arenaria".

GC041608CB

Website	https://www.bco-dmo.org/deployment/552439
Platform	R/V Gulf Challenger
Start Date	2008-04-16
End Date	2008-04-16
Description	One-day cruise in Casco Bay on the R/V Gulf Challenger for the project, "River and sediment-modulated stress in planktonic and early settlement Mya arenaria".

GC051508CB

Website	https://www.bco-dmo.org/deployment/552502
Platform	R/V Gulf Challenger
Start Date	2008-05-15
End Date	2008-05-15
Description	One-day cruise in Casco Bay on the R/V Gulf Challenger for the project, "River and sediment-modulated stress in planktonic and early settlement Mya arenaria".

GC061008CB

Website	https://www.bco-dmo.org/deployment/552560
Platform	R/V Gulf Challenger
Start Date	2008-06-10
End Date	2008-06-10
Description	One-day cruise in Casco Bay on the R/V Gulf Challenger for the project, "River and sediment-modulated stress in planktonic and early settlement Mya arenaria".

GC071008CB

Website	https://www.bco-dmo.org/deployment/552624
Platform	R/V Gulf Challenger
Start Date	2008-07-10
End Date	2008-07-10
Description	One-day cruise in Casco Bay on the R/V Gulf Challenger for the project, "River and sediment-modulated stress in planktonic and early settlement Mya arenaria".

GC061611CB

Website	https://www.bco-dmo.org/deployment/552689
Platform	R/V Gulf Challenger
Start Date	2011-06-16
End Date	2011-06-16
Description	One-day cruise in Casco Bay on the R/V Gulf Challenger for the project, "River and sediment-modulated stress in planktonic and early settlement Mya arenaria".

GC020712CB

Website	https://www.bco-dmo.org/deployment/552739
Platform	R/V Gulf Challenger
Start Date	2012-02-07
End Date	2012-02-07
Description	One-day cruise in Casco Bay on the R/V Gulf Challenger for the project, "River and sediment-modulated stress in planktonic and early settlement Mya arenaria".

GC091312CB

Website	https://www.bco-dmo.org/deployment/552804
Platform	R/V Gulf Challenger
Start Date	2012-09-13
End Date	2012-09-13
Description	One-day cruise in Casco Bay on the R/V Gulf Challenger for the project, "River and sediment-modulated stress in planktonic and early settlement Mya arenaria".

[table of contents | back to top]

Project Information

River and sediment-modulated stress in planktonic and early settlement Mya arenaria (OA stress in Mya arenaria)

Coverage: Gulf of Maine: Kennebec River, Casco Bay

Extracted from the NSF award abstract:

Estuaries are productive, complex and have great economic value by virtue of their fisheries, ecosystem services and recreation potential. They are typically less buffered to acid than open oceans due to the combined effects of acid production during heterotrophy and acidic inputs from both land and atmosphere. Within estuaries, it is important to understand how varying acid burdens impact living resources, particularly those that provide ecosystem services and/or generate income as fisheries. The bivalve Mya arenaria, the focal species of this proposed research, is one such resource that sustains a valuable coastal fishery while providing service via its filtration capacity. Because Mya shells are constructed from a relatively soluble form of calcium carbonate (aragonite), and the clams often inhabit eutrophic waters, they may be particularly vulnerable as pH declines. Planktonic larvae and benthic juveniles are critical life stages -- even small reductions in theier abundances could substantially decrease adult populations.

This proposed research addresses four distinct hypotheses concerning the roles of riverine and sediment interactions on the viability of larval and juvenile Mya. Research activities include the following.

1. Fieldwork will evaluate the spatial and seasonal changes in aragonite saturation state within the Kennebec River Estuary and Casco Bay. Seasonal sampling will be coupled with high-frequency sampling during the annual Mya spawn to observe and document the effect of lowered aragonite saturation state on the health status of larval Mya.

2. Using larval Mya, laboratory experiments will mimic the aragonite saturation state observed in Casco Bay during the high-frequency cruises. Metamorphic change (veligers, pediveligers, and metamorphosed juveniles), growth rate, and survivorship of Mya will be evaluated as a function of aragonite saturation state.

3. Spatially intensive daily cohort monitoring of the intertidal mud flats in Falmouth, Maine, will establish the link between changes in abundance of settling juveniles and aragonite saturation state during the period of Mya set. Cohort monitoring of settling Mya will be examined in reference to sediment pH and aragonite saturation state in nearby deposits to ascertain if sediment saturation state is a primary settlement cue for transitioning larvae.

4. A diagnostic model will be developed for the shellfish management community that can be used to detect aragonite saturation state of the water column. The model would run on routine oceanographic measurements (salinity, temperature, oxygen and chlorophyll fluorescence).

The chemical consequences of increasing atmospheric CO2 and resulting hydrolysis of carbonic acid is well understood and resultant ocean acidification has been accurately predicted with the current generation of global circulation models. These predictions have accelerated research into the effects of ocean acidification on marine organisms, particularly those with CaCO3 exoskeletons. Estuarine waters are far less buffered than oceans, are subject to a variety of acid loadings, and are quite possibly acidifying at a faster rate than the open ocean. Yet, these regions have been largely ignored in 'acidification' research. Effects of acidification on calcifying organisms are similar regardless of whether of acid origin -- atmospheric exchange, net heterotrophy, or discharge of acidic river water. Likewise, each of these acid fluxes is being perturbed via anthropogenic activity (e.g. fossil fuel use, deforestation, agriculture). The proposed research will further understanding of the combined and cumulative impacts of varied acid burdens on calcifying organisms in coastal waters.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0961825

[table of contents | back to top]