Results of sediment core experiments from R/V Terrapin, R/V Hugh R. Sharp multiple cruises in the Chesapeake Bay, 2010-2011 (LiDZ project)

Website: https://www.bco-dmo.org/dataset/518468
Data Type: Cruise Results
Version: almost final
Version Date: 2014-07-09

Project
» Life in the Dead Zone: Microbial respiration, production, diversity and gene expression in seasonally anoxic estuarine waters (LiDZ)

Contributors	Affiliation	Role
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Coverage

Spatial Extent: **N**:38.9866 **E**:-76.1715 **S**:37.7784 **W**:-76.4947
Temporal Extent: 2011-04-18 - 2011-08-30

Dataset Description

Sediment core data with accompanying environmental measurements from the middle region of the Chesapeake Bay, in seasonally anoxic bottom waters, collected in spring and summer of 2010-2011.

Core samples and sensor-based measurements were made during sixteen research cruises in 2010-2012: two 1-week cruises aboard the UNOLS vessel R/V Hugh R. Sharp, and fourteen 1-day cruises aboard the R/V Terrapin, which is a 25' Parker outboard motorboat with davit for deploying a CTD package.

Methods & Sampling

Sediment cores were collected with an acrylic/PVC Soutar-design box corer to determine sediment-water fluxes.
The sediment was sub-cored using two 7×30 cm (inner diameter × height) acrylic cylinders to a depth of ~15 cm.
Sediment and water column blank cores were preincubated in a temperature-controlled walk-in chamber or incubator at bottom water temperatures (±1 °C) for 6 h for oxic conditions and overnight for anoxic conditions to allow any initial core disturbance artifacts to dissipate. Each core was equipped with a

Teflon magnetic stir bar rotating at 20 rpm to mix overlying water without resuspension. Overlying water was collected four times during 4-6 hour incubations (oxic) or 24 h incubations (anoxic): gas and solute samples were collected in triplicate 6 ml Exetainer vials and 20 ml syringes, respectively. During each subsampling, <5 % water volume in each core was replaced with collected bottom water through a second port so that no bubbles formed within the tubes. Sediment-water fluxes were calculated using linear regressions of gas or solute concentrations and the slopes of blank cores were used to account for water column processes.

Data Processing Description

Because sediment processing proceeded along with water column processing, see

SAMPLE ANALYSES

References:

Lane, L., Rhoades, S., Thomas, C., Van Heukelem, L. 2000. Standard Operating Procedures. Horn Point Laboratory Technical Report No. TA-264-00.

Brewer, P. G. and D. W. Spencer. 1971. Colorimetric Determination of Manganese in Anoxic Waters. Limnology And Oceanography 16:107-110.

Parsons, T. R., Y. Maita, and C. M. Lalli. 1984. A manual of chemical and biological methods for seawater analysis. Pergamon Press, Oxford.

Arar, E. J., Collins, G. B., 1997. In Vitro Determination of chlorophyll a and pheophytin a in marine and freshwater algae by fluorescence. Method 445.0. U.S. Environmental Protection Agency.

DMO notes:

Format or vocabulary adjustments to metadata primarily involved controlling the vocabulary and adding UNOLS names for the cruises.
Date changed to date_local
Time -> time_local
Cruise -> cruise [Inserted cruise_new to give column for UNOLS name]
Lowercase Cast, Depth

Changed modifier from cruise name to cast and called new column cast_new (e.g. LDZ8_NO3 to LDZ8 and Channel_NO3).
Abbreviated Latitude, Longiture, Conductivity, Temperature, Salinity, Fluorescence
Decoded Oxygen1 -> O2_conc and Oxygen2 -> O2_rate

In keeping with BCO-DMO best practices, ISODateTime has been added as a formatted time column. At this time it is local time.

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Data Files

File
sediment_cores.csv (Comma Separated Values (.csv), 6.29 KB) MD5:db86b9e2f36cccf683f3d50ecf63dfeb Primary data file for dataset ID 518468

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Parameters

Parameter	Description	Units

cruise	Internal cruise number	text
cruise_new	UNOLS cruise identifier	text
cast	where in the bay strata the core was collected	text
cast_new	location in the bay geography where the core was collected plus Nitrate	text
date_local	Date	Eastern Daylight Time
time_local	HH:MM	24-hour clock
depth	Sampling depth	meters
lat	Latitude	decimal degrees
lon	Longitude	decimal degrees
cond	Conductivity: Measured with a SBE 25 on the R/V Terrapin and SBE 911plus on R/V Hugh R. Sharp; Sea-Bird Electronics	microsiemens per centimeter
temp	Temperature: Measured with a SBE 25 on the R/V Terrapin and SBE 911plus on R/V Hugh R. Sharp; Sea-Bird Electronics	degrees celsius
sal	Salinity: Measured with a SBE 25 on the R/V Terrapin and SBE 911plus on R/V Hugh R. Sharp; Sea-Bird Electronics	salinity
O2_conc	oxygen concentration: Measured with a SBE 25 on the R/V Terrapin and SBE 911plus on R/V Hugh R. Sharp; Sea-Bird Electronics	milligrams per liter
O2_sat	oxygen saturation: Measured with a SBE 25 on the R/V Terrapin and SBE 911plus on R/V Hugh R. Sharp; Sea-Bird Electronics	percent saturation
fluor	Fluorescence: Measured with a WETStar sensor; WET Labs	milligrams per cubic meter
N2_flux	Nitrogen flux; micromoles per meter square hour; Sediment-water flux is calculated using a linear regression of concentrations and the slope of blank core is used to account for water column processes	umol N2-N/m2/h
O2_flux	Oxygen flux; micromoles per meter square hour; Measured with membrane inlet mass spectrometer	umol/m2/h
DIC_flux	Dissolved inorganic carbon flux; micromoles per meter square hour; Measured with an infrared CO2 detector	umol/m2/h
NOx_flux	Nitrite + Nitrate flux; micromoles per meter square hour; Measured colorimetrically (Brewer and Spencer 1971; Parsons et al. 1984)	umol/m2/h
NH4_flux	Ammonium flux; micromoles per meter square hour; Measured colorimetrically (Brewer and Spencer 1971; Parsons et al. 1984)	umol/m2/h
SRP_flux	Soluble reactive phosphorous flux; micromoles per meter square hour; Measured colorimetrically (Brewer and Spencer 1971; Parsons et al. 1984)	umol/m2/h
H2S_flux	Total dissolved sulfide (DS = [S2-] + [HS-] + [H2S]) flux; micromoles per meter square hour; Measured colorimetrically (Brewer and Spencer 1971; Parsons et al. 1984)	umol/m2/h
H2Spw01	Total dissolved sulfide (DS = [S2-] + [HS-] + [H2S]); micromolar; Total dissolved sulfide concentration in pore water. Number following pw (pore water) indicates sampling depth in sediment (e.g: 01: centimeter from 0 to 1 cm)	uM
H2Spw12	Total dissolved sulfide (DS = [S2-] + [HS-] + [H2S]); micromolar; Total dissolved sulfide concentration in pore water. Number following pw (pore water) indicates sampling depth in sediment (e.g: 12: centimeter from 1 to 2 cm)	uM

H2Spw24	Total dissolved sulfide (DS = [S2-] + [HS-] + [H2S]); micromolar; Total dissolved sulfide concentration in pore water. Number following pw (pore water) indicates sampling depth in sediment (e.g: 24: centimeter from 2 to 4 cm)	uM
H2Spw46	Total dissolved sulfide (DS = [S2-] + [HS-] + [H2S]); micromolar; Total dissolved sulfide concentration in pore water. Number following pw (pore water) indicates sampling depth in sediment (e.g: 46: centimeter from 4 to 6 cm)	uM
H2Spw68	Total dissolved sulfide (DS = [S2-] + [HS-] + [H2S]); micromolar; Total dissolved sulfide concentration in pore water. Number following pw (pore water) indicates sampling depth in sediment (e.g: 68: centimeter from 6 to 8 cm)	uM
H2Spw810	Total dissolved sulfide (DS = [S2-] + [HS-] + [H2S]); micromolar; Total dissolved sulfide concentration in pore water. Number following pw (pore water) indicates sampling depth in sediment (e.g: 810: centimeter from 8 to 10 cm)	uM
ISO_DateTime_Local	ISO8601-compliant date/time standard	YYYY-mm-ddTHH:MM:SS.ss

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Instruments

Dataset-specific Instrument Name	Box Corer
Generic Instrument Name	Box Corer
Dataset-specific Description	Acrylic/PVC Soutar-design box corer. (Andy Soutar, Scripps)
Generic Instrument Description	General description of a box corer: A box corer is a marine geological tool that recovers undisturbed soft surface sediments. It is designed for minimum disturbance of the sediment surface by bow wave effects. Traditionally, it consists of a weighted stem fitted to a square sampling box. The corer is lowered vertically until it impacts with the seabed. At this point the instrument is triggered by a trip as the main coring stem passes through its frame. While pulling the corer out of the sediment a spade swings underneath the sample to prevent loss. When hauled back on board, the spade is under the box. (definition from the SeaVox Device Catalog) Box corers are one of the simplest and most commonly used types of sediment corers. The stainless steel sampling box can contain a surface sediment block as large as 50cm x 50cm x 75cm with negligible disturbance. Once the sediment is recovered onboard, the sediment box can be detached from the frame and taken to a laboratory for subsampling and further analysis. The core sample size is controlled by the speed at which the corer is lowered into the ocean bottom. When the bottom is firm, a higher speed is required to obtain a complete sample. A depth pinger or other depth indicator is generally used to determine when the box is completely filled with sediment. Once the core box is filled with sediment, the sample is secured by moving the spade-closing lever arm to lower the cutting edge of the spade into the sediment, until the spade completely covers the bottom of the sediment box. (definition from Woods Hole Oceanographic Institution).

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Deployments

LDZ1

Website	https://www.bco-dmo.org/deployment/515278
Platform	R/V Terrapin
Start Date	2010-05-17
End Date	2010-05-17
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package.

LDZ2

Website	https://www.bco-dmo.org/deployment/515281
Platform	R/V Terrapin
Start Date	2010-06-07
End Date	2010-06-07
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package.

LDZ3

Website	https://www.bco-dmo.org/deployment/515284
Platform	R/V Terrapin
Start Date	2010-06-16
End Date	2010-06-16
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package.

HRS100709BC

Website	https://www.bco-dmo.org/deployment/514970
Platform	R/V Hugh R. Sharp
Start Date	2010-07-09
End Date	2010-07-16

LDZ5

Website	https://www.bco-dmo.org/deployment/515323
Platform	R/V Terrapin
Start Date	2010-08-05
End Date	2010-08-05
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package. The deployment synonym (in the same place and time) called "*_filt" is labeled a deployment although it was really a different treatment of the samples -- filtered or unfiltered.

LDZ6

Website	https://www.bco-dmo.org/deployment/515326
Platform	R/V Terrapin
Start Date	2010-08-31
End Date	2010-08-31
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package. The deployment synonym (in the same place and time) called "*_filt" is labeled a deployment although it was really a different treatment of the samples -- filtered or unfiltered. [DMO- I have removed this synonym. Not necessary.]

LDZ7

Website	https://www.bco-dmo.org/deployment/515329
Platform	R/V Terrapin
Start Date	2010-10-18
End Date	2010-10-18
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package. **Methods & Sampling** http://dmoserv3.bco-dmo.org/jg/serv/BCO-DMO/LiDZ/sediment_cores.html0%7B...

LDZ8

Website	https://www.bco-dmo.org/deployment/515332
Platform	R/V Terrapin
Start Date	2011-04-18
End Date	2011-04-18
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package.

LDZ9

Website	https://www.bco-dmo.org/deployment/515334
Platform	R/V Terrapin
Start Date	2011-05-24
End Date	2011-05-24
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package.

LDZ10

Website	https://www.bco-dmo.org/deployment/515337
Platform	R/V Terrapin
Start Date	2011-06-14
End Date	2011-06-14
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package.

HRS110705BC

Website	https://www.bco-dmo.org/deployment/515146
Platform	R/V Hugh R. Sharp
Start Date	2011-07-05
End Date	2011-07-13

LDZ12

Website	https://www.bco-dmo.org/deployment/515340
Platform	R/V Terrapin
Start Date	2011-08-08
End Date	2011-08-08
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package.

LDZ13

Website	https://www.bco-dmo.org/deployment/515343
Platform	R/V Terrapin
Start Date	2011-08-30
End Date	2011-08-30
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package.

LDZ14

Website	https://www.bco-dmo.org/deployment/515346
Platform	R/V Terrapin
Start Date	2011-09-21
End Date	2011-09-21
Description	One of 14 one-day cruises on a 25' Parker outboard motorboat with a davit for deploying a CTD package.

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Project Information

Life in the Dead Zone: Microbial respiration, production, diversity and gene expression in seasonally anoxic estuarine waters (LiDZ)

Coverage: Chesapeake Bay

Every summer in many estuaries and coastal margins, eutrophication-elevated phytoplankton production drives rapid bacterial respiration creating hypoxic and anoxic bottom waters. These so-called “dead zones” exclude fish, kill benthic organisms, and eliminate habitat. Despite their popular name, anoxic/hypoxic zones are not really dead, but rather are populated with living and very active microbial communities. In fact, bacterial production in anoxic waters can exceed that in overlying oxic waters due, in part, to reduced grazing and increased cell size and abundance. Once oxygen is depleted, microbial respiration undergoes a succession of redox reactions with decreasing energy yield as terminal electron acceptors are depleted (e.g., O2, NO3-, Mn(IV), Fe(III), and SO42-). This combination of high production and reduced growth efficiency creates a condition in which respiration may be very high, making anoxic zones significant sinks for organic matter and key sites for nutrient cycling.

Previous research documented respiratory succession in Chesapeake Bay bottom waters based on redox chemistry measurements. Heterotrophic bacterial production was very high at some stages of this succession, suggesting elevated respiration. Also, the phylogenetic composition of bacterioplankton communities in anoxic waters was similar to oxic surface waters for nearly half the summer, only changing after the appearance of H2S. This suggests that typical aerobic estuarine bacteria are able to shift to anaerobic metabolisms and continue to dominate.

Most of what is known about microbial respiration and community composition in anoxic water comes from studies of permanently anoxic systems like the Black Sea and Cariaco Basin. By comparison, very little is known about what is a much more common and more dynamic marine environment – seasonally anoxic estuarine waters. This proposal describes a 3-year integrated study to advance the quantitative and mechanistic understanding of biogeochemical cycling in one of the largest seasonal estuarine anoxic zones in the USA. It hypothesize that:

• Dominant sub-pycnocline respiratory processes undergo a succession from aerobic respiration to nitrate respiration and metal reduction to sulfate reduction.
• Bacterial growth efficiency decreases with this respiratory succession, but bacterial production remains high, resulting in very high carbon respiration rates.
• Bacterial community composition changes little during respiratory succession until sulfate respiration dominates (i.e., the sulfide threshold), but gene expression closely tracks changes in redox conditions in order to support the most energetic respiratory processes.

These hypotheses will be addressed by quantifying carbon respiration rates using several techniques including delta CO2; quantifying bacterial production, biomass and growth efficiency; and characterizing succession in the composition and respiratory gene expression patterns of microbial communities in water column and sediments during each stage of respiratory succession. This project will integrate biogeochemical, biological, and genomic data to explain how biogeochemistry influences, and is influenced by, microbial respiration, production, diversity, and gene expression.

The proposed research will provide (1) reliable measurements of production and respiration in anoxic/hypoxic waters, (2) techniques applicable to other ecosystems, and (3) ecological insight for predicting future changes with ongoing restoration efforts in anoxia-impacted estuaries. These measurements will be useful for calibrating biogeochemical models and for estimating carbon budgets. This research will train two graduate students and one postdoctoral scientist in several state-of-the-art geochemical and molecular biology techniques. Applications will be submitted to the NSF Research Experiences for Teachers program to engage two teachers to work on this project and to participate in the seven-week Environmental Science Education Partnership (ESEP) Teacher Research Fellowship Program (www.esep.umces.edu) at UMCES Horn Point Laboratory. New discoveries will be incorporated into graduate-level courses entitled Aquatic Microbial Ecology, Biological Oceanography, and Environmental Geochemistry. Nucleic acid sequences will be deposited in online repositories including GenBank.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0961920

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