

Benthic fluxes collected in August 2018 and July 2019 in northern Gulf of Mexico shelf on R/V Pelican

Website: <https://www.bco-dmo.org/dataset/944947>

Data Type: Cruise Results

Version: 1

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Project

» [Collaborative Research: Sediment Geochemical Control on Ocean Acidification and Carbon Budget in a River Dominated Shelf System](#) (Sed Control on OA)

Contributors	Affiliation	Role
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Abstract

This dataset provides benthic fluxes of nutrients, dissolved inorganic carbon (DIC), and total alkalinity (TALK) as well as estimates of total oxygen and diffusive oxygen utilization in northern Gulf of Mexico shelf region.

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Coverage

Location: northern Gulf of Mexico - Louisiana Shelf

Spatial Extent: N:29.02 E:-90.1 S:28.14 W:-90.83

Temporal Extent: 2018-08-14 - 2019-07-20

Methods & Sampling

Benthic fluxes were measured along the northern Gulf of Mexico shelf during cruises aboard the R/V Pelican in August 2018 and July 2019. Sediment cores, incubation experiments, and in-situ measurements from a custom made benthic lander all provided data on benthic fluxes of nutrients, dissolved inorganic carbon (DIC), and total alkalinity (TALK) as well as estimates of total oxygen and diffusive oxygen utilization.

Intact sediment cores were collected in triplicate from ____ (** how many stations? ** five stations each year?) each station using an Ocean Instruments MC800 multi-corer and utilized for benthic flux measurements through whole core incubation technique (** reference? **). Temperature-controlled recirculating water baths adjusted to the bottom water temperature were used for all incubation experiments. Filtered bottom water was used to gradually fill up the core tube with minimum disturbance to the sediment-water interface. The overlying water column height was adjusted to 25 cm from the sediment surface to ensure similar water column volume among all cores using custom PVC core caps. Care was taken to avoid any visible air bubbles or headspace. The custom designed lids are fitted with two O-rings for gas-tight incubations, and include one tube

attachment for the corresponding water reservoir, one tube attachment for sample extraction, and two tube attachments that connect to each other in a peristaltic pump, allowing continuous flow and circulation in the core for the entire duration of the incubation. Sediment cores were fully submerged into the temperature-controlled water bath, and reservoir tanks along with the incubation water bath were covered with an opaque shroud to ensure no primary production.

A custom benthic lander system was deployed with minimum sediment disturbance at each of the stations to carry out in situ flux measurements for total oxygen utilization (TOU). The lander system was equipped with chambers that each seal a sediment surface area of 840 square centimeters and a volume of approximately 16 liters. Each chamber included a magnetically coupled stirrer that mixed the water within the chamber uniformly in about 20 minutes at 12-16 rpm and produced a 300-400 μm diffusive boundary layer. Leakage was calculated from the loss of a CsBr tracer from samples taken from each chamber every 4 hours. Three of the benthic chambers were fitted with Seaguard dissolved oxygen (DO) optode sensors that directly measured DO every 15 minutes for the duration of the 22 hour deployment.

Sediment oxygen penetration depth (OPD) was measured with a Unisense in situ 130 microprofiler system, which was equipped with two oxygen sensors (250 μm) and a resistivity sensor. The position of the sediment-water interface (SWI) was determined relative to the in situ oxygen profiles using a modified version of the technique of Sweerts 133 et al. (** ? what is this reference?**) (Revsbech 1989; Sweerts et al. 1989; Rabouille et al. 2003). Diffusive oxygen utilization (DOU) was calculated with Cai and Sayles's adaptation of Fick's law of diffusion using the oxygen gradient in coastal sediments.

Measurement details:

- DIC was measured with an Apollo SciTech DIC multisample analyzer (AS-C6L) with a laser-based CO₂ detector. Certified reference material from batch 180 provided by Dr. Andrew Dickinson was used for calibration for DIC and TA measurements.
- TA was measured with an Apollo SciTech Total Alkalinity titrator (AS-ALK2). Certified reference material from batch 180 provided by Dr. Andrew Dickinson was used for calibration for DIC and TA measurements.
- NO₂+NO₃ was measured using EPA method 353.4
- NH₄ was measured using EPA method 350.1
- PO₄ was measured using EPA method 365.1
- SiO₄ was measured using the method described in Strickland and Parsons (1968).
- Dissolved nutrient analysis was carried out using a Seal Analytical Auto Analyzer.
- Oxygen penetration depth (OPD) was measured in situ with a Unisense microprofiler and utilized to calculate DOU.
- TOU was measured using custom benthic lander system.

Data Processing Description

Diffusive oxygen utilization (DOU) was calculated with Cai and Sayles's adaptation of Fick's law of diffusion using the oxygen gradient in coastal sediments.

(** need more information here on how this was done and what the gradient was **)

BCO-DMO Processing Description

- Converted date format from m/d/yy to yyyy-mm-dd (ISO Date 8601 format)
- Modified parameter (column) names to conform with BCO-DMO naming conventions. The only allowed characters are A-Z,a-z,0-9, and underscores. No spaces, hyphens, commas,

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Related Publications

Strickland, J.D.H and Parsons, T.R. (1968) A Practical Handbook of Seawater Analysis. Fisheries Research Board of Canada Bulletin 167, 71-75 [as seen in The Quarterly Review of Biology (1969) 44(3), 327-327.

doi:[10.1086/406210](https://doi.org/10.1086/406210)]

Methods

U.S. EPA. (1993). Method 350.1. Revision 2.0, Determination of Ammonia Nitrogen by Semi-Automated Colorimetry. U.S. Environmental Protection Agency, Cincinnati, OH, EPA/601/R-93/007

<https://www.epa.gov/esam/epa-method-3501-determination-ammonia-nitrogen-semi-automated-colorimetry>

Methods

U.S. EPA. (1993). Method 365.1. Revision 2.0, Determination of Phosphorus by Semi-Automated Colorimetry. U.S. Environmental Protection Agency, Cincinnati, OH. https://www.epa.gov/sites/default/files/2015-08/documents/method_365-1_1993.pdf

https://www.epa.gov/sites/default/files/2015-08/documents/method_365-1_1993.pdf

Methods

Zhang, J-Z, Ortner, P. B., and Fischer, C.J. (1997). Method 353.4, Revision 2.0, Determination of Nitrate and Nitrite in Estuarine and Coastal Waters by Gas Segmented Continuous Flow Colorimetric Analysis. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-15/012.

https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NERL&dirEntryId=309421

Methods

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Parameters

Parameter	Description	Units
Latitude	latitude	decimal degrees
Longitude	longitude	decimal degrees
ISO_Date_UTC	start date of incubation	unitless
O2_flux	sediment oxygen flux	millimoles per square meter per day (mmol/m ² /day)
DIC_flux	sediment dissolved inorganic carbon (DIC) flux	millimoles per square meter per day (mmol/m ² /day)
TA_flux	sediment total alkalinity flux	millimoles per square meter per day (mmol/m ² /day)
NO2_plus_NO3	sediment nitrite plus nitrate (NO ₂ + NO ₃) flux	millimoles per square meter per day (mmol/m ² /day)
NH4_flux	sediment ammonium (NH ₄) flux	millimoles per square meter per day (mmol/m ² /day)
PO4_flux	sediment phosphate (PO ₄) flux	millimoles per square meter per day (mmol/m ² /day)
SiO4_flux	sediment silicate (SiO ₄) flux	millimoles per square meter per day (mmol/m ² /day)
POC_percent	average percent organic carbon of the top 10 centimeters of sediment	percent (%)
OPD	oxygen penetration depth into the sediment	millimeters (mm)
TOU	total oxygen utilization	millimoles per square meter per day (mmol/m ² /day)
DOU	diffusive oxygen utilization	millimoles per square meter per day (mmol/m ² /day)

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Instruments

Dataset-specific Instrument Name	Apollo SciTech Total Alkalinity titrator (AS-ALK2)
Generic Instrument Name	Apollo SciTech AS-ALK2 total alkalinity titrator
Dataset-specific Description	Total Alkalinity (TA) was measured with an Apollo SciTech Total Alkalinity titrator (AS-ALK2).
Generic Instrument Description	An automated acid-base titrator for use in aquatic carbon dioxide parameter analysis. The titrator provides standardisation and sample analysis, using the Gran titration procedure for alkalinity determination of seawater and brackish waters. It is designed for both shipboard and land based laboratory use. The precision of the instrument is 0.1 percent or higher, and sample volumes may range from 10-25 ml. Titration takes approximately 8 minutes per sample, and the repeatability is within plus or minus 1-2 micromoles per kg.

Dataset-specific Instrument Name	Apollo SciTech DIC multisample analyzer (AS-C6L) with a laser-based CO2 detector.
Generic Instrument Name	Apollo SciTech AS-C6L Dissolved Inorganic Carbon (DIC) analyzer
Dataset-specific Description	Dissolved inorganic carbon (DIC) was measured with an Apollo SciTech DIC multisample analyzer (AS-C6L) with a laser-based CO2 detector.
Generic Instrument Description	An instrument designed for the analysis of dissolved inorganic carbon in samples from various aquatic environments. It comprises of a laser-based CO2 detector (LI-7815), a digital syringe pump, a mass flow controller, CO2 stripping reactor, an electronic cooling system and a computer communication assembly (RS-485, USB). The AS-C6L supersedes the earlier AS-C3 model, which used non-dispersive infra-red CO2 detection (LI-7000, discontinued). The AS-C6L improves on the AS-C3 by incorporating a multi-sampler of one set of standards plus 8 samples, and uses improved Apollo SciTech software. The AS-C6L is suitable for use in either shipboard or land-based laboratories. It maintains a precision of +/-0.1 % for seawater (or +/-2 umol/kg), enables sample volumes ranging from 0.5 - 3.5 ml per analysis, and an analytical rate of approximately 3 minutes.

Dataset-specific Instrument Name	custom benthic lander system
Generic Instrument Name	benthic lander
Dataset-specific Description	A custom benthic lander system was deployed at each of the stations to carry out in situ flux measurements for total oxygen utilization (TOU).
Generic Instrument Description	A benthic lander is an autonomous research platform used in marine research to take measurements directly on the seafloor. Benthic landers are carrier systems to which different measuring and sampling devices can be attached. They transport these devices to the seafloor and back up again. Autonomous means that the lander is not connected to the ship via a cable. It can thus work independently on the seafloor for a long period of time.

Dataset-specific Instrument Name	Temperature-controlled recirculating water bath
Generic Instrument Name	circulating water bath
Dataset-specific Description	Temperature-controlled recirculating water baths adjusted to the bottom water temperature were used for all incubation experiments.
Generic Instrument Description	A device designed to regulate the temperature of a vessel by bathing it in water held at the desired temperature. [Definition Source: NCI]

Dataset-specific Instrument Name	Seal Analytical Auto Analyzer
Generic Instrument Name	Nutrient Autoanalyzer
Dataset-specific Description	Dissolved nutrient analysis was carried out using a Seal Analytical Auto Analyzer.
Generic Instrument Description	Nutrient Autoanalyzer is a generic term used when specific type, make and model were not specified. In general, a Nutrient Autoanalyzer is an automated flow-thru system for doing nutrient analysis (nitrate, ammonium, orthophosphate, and silicate) on seawater samples.

Dataset-specific Instrument Name	Ocean Instruments MC800 multi-corer
Generic Instrument Name	Ocean Instruments MC-800 Multi corer
Dataset-specific Description	Intact sediment cores were collected in triplicate from each station using an Ocean Instruments MC800 multi-corer and utilized for benthic flux measurements through whole core incubation technique.
Generic Instrument Description	A multi-corer with a series of cores attached to one deployment frame. This model carries eight sample tubes. This is the largest corer in the MC series and is used primarily at deep ocean depths. It is designed to recover undisturbed surface sediments and are therefore well-suited to study benthic processes. This device can be used to study local fauna variations, geochemistry, and is ideal for sediment/water interface studies. The multi-corer is disposed on a research vessel and is lowered into the water body by a cable. When the multi-corer touches the sediment the units ballast weight pushes the assembled cores into the substrate. Each of the tubes contains a unique sediment core. The multi-corer uses a unique hydrostatic damping system that slows the penetration rate down to approximately 1 cm/s. It has a specially designed flow-through sample tube to reduce corer 'bow wake' effect, a double door sealing feature, double guide slides, special slow-down cylinder for smooth corer penetration, adjustable penetration limit stops, and pre-trip safety pin. The overall sample tube length is 70 cm, with an effective penetration of greater than 45 cm. The tube diameter is 10 cm.

Dataset-specific Instrument Name	Seaguard dissolved oxygen (DO) optode sensors
Generic Instrument Name	Optode
Dataset-specific Description	Seaguard dissolved oxygen (DO) optode sensors were used to directly measure DO every 15 minutes for the duration of the deployment
Generic Instrument Description	An optode or optrode is an optical sensor device that optically measures a specific substance usually with the aid of a chemical transducer.

Dataset-specific Instrument Name	Unisense microprofiler
Generic Instrument Name	Unisense oxygen microsensor
Dataset-specific Description	Oxygen penetration depth (OPD) was measured in situ with a Unisense microprofiler and utilized to calculate diffusive oxygen utilization.
Generic Instrument Description	The Unisense oxygen microsensor is a miniaturized Clark-type dissolved oxygen instrument, including glass micro-sensors with minute tips (diameters ranging from 1 to 800 um). A gold sensing cathode is polarized against an internal reference and, driven by external partial pressure, oxygen from the environment penetrates through the sensor tip membrane and is reduced at the sensing cathode surface. A picoammeter converts the resulting reduction current to a signal. The sensor also includes a polarized guard cathode, which scavenges oxygen in the electrolyte, thus minimizing zero-current and pre-polarization time. See more on the manufacturer's website: https://www.unisense.com/

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Deployments

PE20-03

Website	https://www.bco-dmo.org/deployment/831673
Platform	R/V Pelican
Start Date	2019-07-15
End Date	2019-07-22

PE19-07

Website	https://www.bco-dmo.org/deployment/945019
Platform	R/V Pelican
Start Date	2018-08-14
End Date	2018-08-22

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Project Information

Collaborative Research: Sediment Geochemical Control on Ocean Acidification and Carbon Budget in a River Dominated Shelf System (Sed Control on OA)

Coverage: Louisiana shelf, northern Gulf of Mexico shelf

NSF Award Abstract:

In many coastal regions fertilizer washed down rivers leads to high production of algae. Consumption of organic material produced by the algae in deeper waters or in sediments consumes oxygen, leading to low-oxygen "dead zones" in many places like the northern Gulf of Mexico. This process of nutrient input, algal

growth, and loss of oxygen is called eutrophication. Consumption of the organic matter also releases dissolved carbon dioxide into the water, and contributes directly and indirectly to ocean acidification. In order to understand and predict this impact on acidification, it is important to understand how much of the organic matter degradation occurs in the water column versus in the sediments, how variable it is between seasons and years, and how it is affected by processes such as storms that disturb the bottom sediments. In this project, investigators from three institutions along with their graduate and undergraduate students will conduct a combination of field observations and computer modeling to address these questions in the northern Gulf of Mexico. They will share their results with the public through local outreach activities, and with secondary school students in Louisiana through partnerships and curriculum development with local teachers.

The proposed research will use a combined observational and numerical modeling approach to better understand the role of shelf sediment in driving bottom water dissolved inorganic carbon (DIC) and pH dynamics and acidification at seasonal scales. Past and current studies have not addressed this mechanism. This current lack of knowledge makes it difficult to construct a comprehensive carbon budget for this region. The proposed research will (i) quantify the role of benthic fluxes in DIC production leading to acidification in the bottom water; (ii) determine the importance of the seasonally changing benthic DIC flux in acidifying the bottom water; and (iii) explore the importance of episodic resuspension events in modulating benthic fluxes of DIC. Seasonal sampling will be carried out in Louisiana shelf using state of the art benthic lander platform to record in situ sediment and bottom water oxygen consumption rates, organic matter remineralization rates, sediment oxygen penetration depths, benthic fluxes of DIC and accompanying pH drop. Bottom current velocities and turbidity will also be recorded in conjunction with sediment porewater and water column sampling. Complementing these detailed near-bed and seabed observations, we will utilize a recently developed coupled hydrodynamics, sediment transport and biogeochemistry model (HydroBioSed) to scale up observed estimates of benthic fluxes to an annual scale.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

Related Project note:

There are overlapping cruises with the project "nGOMx acidification" <https://www.bco-dmo.org/project/751332>. Thus, while all benthic data can be found under this project "Sed Control on OA", some water column data can be found under the "nGOMx acidification" project.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756788

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