pH, temperature, salinity, and oxygen data from SeapHOx sensors deployed at three sites in the Florida Keys in June 2018

Website: https://www.bco-dmo.org/dataset/821091
Data Type: Other Field Results
Version: 1
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Project
» Carbon Cycling in Carbonate-Dominated Benthic Ecosystems: Eddy Covariance Hydrogen Ion and Oxygen Fluxes (ECHOES Benthic Ecosystems)

Contributors	Affiliation	Role
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Abstract
An eddy covariance system, known as ECHOES, was deployed at three sites offshore of Key Largo, Florida during June 2018. The ECHOES systems logged the three-dimensional velocity, depth, O2 optode, pH sensor, and triaxial Inertial Measurement Unit. A separate frame at each site contained a photosynthetically active radiation (PAR) sensor and a Seabird SeapHOx, measuring salinity, temperature, depth, O2, and pH. This dataset contains pH, temperature, salinity, and oxygen data recorded by the SeapHOx sensor.

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Coverage

Spatial Extent: **N**:25.120328 **E**:-80.300504 **S**:25.11732 **W**:-80.303069
Temporal Extent: 2018-06-24 - 2018-06-29

Dataset Description

An eddy covariance system, known as ECHOES, was deployed at three sites offshore of Key Largo, Florida during June 2018. The ECHOES systems logged the three-dimensional velocity, depth, O2 optode, pH sensor, and triaxial Inertial Measurement Unit. A separate frame at each site contained a photosynthetically active radiation (PAR) sensor and a Seabird SeapHOx, measuring salinity, temperature, depth, O_2, and pH. This dataset contains pH, temperature, salinity, and oxygen data recorded by the SeapHOx sensor.

Methods & Sampling

Background

The basis for the eddy covariance (EC) technique is that turbulent mixing, caused by the interaction of current velocity with the benthic, atmospheric, sea-ice, or cline interfaces, is the dominant vertical transport process in boundary layers. Therefore, vertical fluxes across the ecosystem interfaces can be derived from high-resolution measurements of the vertical velocity and a solute concentration.

Field Sites
The field sites were located ~7 km offshore of Key Largo, Florida, USA at the southern tip of Florida in the Florida Keys. The sites were located on or adjacent to Little Grecian Rocks Reef with a site on the reef crest (25.119016°N, -80.300504°W) at 2.9 m mean depth, in a seagrass bed located ~225 m to the northwest of the reef site (25.120328°N, -80.302222°W) at 4.8 m mean depth, and in a sandy site located ~300 m to the southwest of the reef site (25.117320°N, -80.303069°W) at 6.3 m mean depth. The reef site is described in substantial detail (3-dimensional and species analyses) in Hopkinson et al. (2020), where the EC instrument can be seen near the center of the image analyses (in Figure 6 of Hopkinson et al. 2020) during its deployment in this study. This reef site is substantially degraded with its benthic surface and primary production dominated by octocorals, algae and rubble (Hopkinson et al. 2020). The seagrass site was dominated by dense Thalassia testudinum (turtlegrass) with a canopy height of 0.2 m underlain by carbonate sands. The sandy site was composed of carbonate sands with microalgal mats and migrating bedforms 0.1 m in height. Research was conducted from June 24 to June 29 in 2018 with the seagrass deployment beginning on the 24th and the sand and reef deployment beginning on the 25th of June, 2018.

Instrumentation
The EC systems used here, known as Eddy Covariance Hydrogen Ion and Oxygen Exchange System (ECHOES, Long et al. 2015) consisted of an Acoustic Doppler Velocimeter (ADV, Nortek) that was coupled to a FirestingO_2 Mini fiber-optic O_2 meter with a fast-response (~ 0.3 s) 430 µm diameter optode (Pyroscience) (Long et al. 2015, Long and Nicholson 2018, Long et al. 2019) and a fast-response (~0.6 s) Honeywell Durafet III pH sensor with a preamp Cap Adapter and a custom isolation amplifier (based on Texas Instruments ISO124P). The ECHOES systems logged the three-dimensional velocity, depth, O_2 optode, pH sensor, and triaxial Inertial Measurement Unit (IMU, MicroStrain model 3DM-GX3) at a frequency of 32 Hz continuously.

A separate frame at each site contained an Odyssey (Dataflow Systems, New Zealand) photosynthetically active radiation (PAR) sensor and a Seabird SeapHOx (measuring salinity, temperature, depth, O_2, and pH). The SeapHOx was factory calibrated and the Odyssey PAR sensors were calibrated to a HR-4 spectroradiometer system (HOBI Labs HydroRAD-4) using the methods of Long et al. (2012).

Refer to the Supplemental File "ECHOES_methods_FL2018.pdf" for more details on methdology.

Data Processing Description

BCO-DMO Processing:
- concatenated data from the three different sites into one dataset;
- renamed fields;
- added latitude and longitude columns;
- added date/time field in ISO8601 format.

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Data Files

File
Fl_seaphox.csv (Comma Separated Values (.csv), 12.11 MB) MD5:6691221eda59243520c402d292363a92 Primary data file for dataset ID 821091

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Supplemental Files

File
ECHOES FL 2018 Methods filename: ECHOES_methods_FL2018.pdf (Portable Document Format (.pdf), 615.40 KB) MD5:32e714361f0a5aee33baae62748d4333 Study site and methods description for Florida Keys 2018 datasets from the project "Carbon Cycling in Carbonate-Dominated Benthic Ecosystems: Eddy Covariance Hydrogen Ion and Oxygen Fluxes".

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Related Publications

Hopkinson, B. M., King, A. C., Owen, D. P., Johnson-Roberson, M., Long, M. H., & Bhandarkar, S. M. (2020). Automated classification of three-dimensional reconstructions of coral reefs using convolutional neural networks. PLOS ONE, 15(3), e0230671. doi:10.1371/journal.pone.0230671
Methods

Long, M. H., & Nicholson, D. P. (2017). Surface gas exchange determined from an aquatic eddy covariance floating platform. Limnology and Oceanography: Methods, 16(3), 145–159. doi:10.1002/lom3.10233
Methods

Long, M. H., Charette, M. A., Martin, W. R., & McCorkle, D. C. (2015). Oxygen metabolism and pH in coastal ecosystems: Eddy Covariance Hydrogen ion and Oxygen Exchange System (ECHOES). Limnology and Oceanography: Methods, 13(8), 438–450. doi:10.1002/lom3.10038
Methods

Long, M. H., Koopmans, D., Berg, P., Rysgaard, S., Glud, R. N., & Søgaard, D. H. (2012). Oxygen exchange and ice melt measured at the ice-water interface by eddy correlation. Biogeosciences, 9(6), 1957–1967. doi:10.5194/bg-9-1957-2012
Methods

Long, M. H., Rheuban, J. E., McCorkle, D. C., Burdige, D. J., & Zimmerman, R. C. (2019). Closing the oxygen mass balance in shallow coastal ecosystems. Limnology and Oceanography, 64(6), 2694–2708. doi:10.1002/lno.11248
Methods

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Parameters

Parameter	Description	Units
site	Site description	unitless
lat	Site latitude	decimal degrees North
lon	Site longitude	decimal degrees East
Time_SeapHOx	Date and time (local); format: MM/DD/YY hh:mm	unitless
ISO_DateTime_Local	Date and time (local) formatted to ISO8601 standard: YYYY-MM-DDThh:mm	unitless
pH_SeapHOx	pH measured by SeapHOx	pH units
Temperature_SeapHOx	Temperature measured by SeapHOx	degrees Celsius
Salinity_SeapHOx	Salinity measured by SeapHOx	unitless
Oxygen_SeapHOx	Oxygen measured by SeapHOx	milliliters per liter (mL L-1)

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Instruments

Dataset-specific Instrument Name	HR-4 spectroradiometer system (HOBI Labs HydroRAD-4)
Generic Instrument Name	Radiometer
Generic Instrument Description	Radiometer is a generic term for a range of instruments used to measure electromagnetic radiation (radiance and irradiance) in the atmosphere or the water column. For example, this instrument category includes free-fall spectral radiometer (SPMR/SMSR System, Satlantic, Inc), profiling or deck cosine PAR units (PUV-500 and 510, Biospherical Instruments, Inc). This is a generic term used when specific type, make and model were not specified.

Dataset-specific Instrument Name	Seabird SeapHOx
Generic Instrument Name	SeapHOx/SeaFET
Generic Instrument Description	The SeapHOx and SeaFET are autonomous sensors originally designed and developed by the Todd Martz Lab at Scripps Institution of Oceanography. The SeaFET was designed to measure pH and temperature. The SeapHOx, designed later, combined the SeaFET with additional integrated sensors for dissolved oxygen and conductivity. Refer to Martz et al. 2010 (doi:10.4319/lom.2010.8.172). The SeapHOx package is now produced by Sea-Bird Scientific and allows for integrated data collection of pH, temperature, salinity, and oxygen. Refer to Sea-Bird for specific model information.

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Project Information

Carbon Cycling in Carbonate-Dominated Benthic Ecosystems: Eddy Covariance Hydrogen Ion and Oxygen Fluxes (ECHOES Benthic Ecosystems)

Website: https://www2.whoi.edu/staff/mlong/projects/project-4/

Coverage: Bermuda

NSF Award Abstract:

Chemical and biological processes that occur in and on the seafloor can create chemical exchange of elements with seawater and make significant contributions to carbon and nutrient cycling in shallow coastal systems. However, these processes are exceedingly difficult to measure directly in the ocean, with no satisfactory methods currently available to quantify their full impact. The researchers undertaking this project have developed a unique, field instrument referred to as the Eddy Covariance H+ and O2 Exchange System (ECHOES). These novel measurements of hydrogen ion (H+) and oxygen (O2) exchange between the seafloor and the overlying seawater will allow unique, direct evaluation of the important linked biological and chemical reactions. Data from ECHOES will transform understanding of the potentially critical contribution of seafloor processes to the resilience of coastal ecosystems experiencing rapid changes in seawater chemistry. Results from this project will provide critical data for improved models of the consequences of coastal acidification. Additionally, this project will fund an early career scientist and the mentorship of undergraduate students in ocean science research through the Woods Hole Oceanographic Institute's Summer Student Fellowship Program.

Laboratory experiments have successfully examined the benthic response of individual organisms and chemical reactions to stress related to changing seawater chemistry but the integrated response of intact ecosystems has been very difficult to quantify due to unsatisfactory methods for in situ measurements of the required suite of biogeochemical fluxes. This deployment of ECHOES at a variety of carbonate-dominated seafloor sites in Bermuda is a pioneering effort to simultaneously measure net community production (NCP) and net community calcification (NCC). The study will focus on traditionally difficult-to-study systems including complex reefs, vertical seagrass canopies, and bare permeable sediments, evaluating diel variability, patchiness, and the impact of upstream fluxes on downstream ecosystems. Important biogeochemical parameters (e.g. pH, CO2, O2, alkalinity, etc.) in these productive shallow environments can experience daily fluctuations over a greater dynamic range than 100-year model projections for the open ocean due to increasing atmospheric CO2. Therefore, the novel field data generated by this research will help define the potentially critical and heretofore ill-defined role for shallow, productive carbonate sediments in predictive models of ecosystem response to ocean acidification.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1657727

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