Data describing O2, pH, temperature, and salinity in a light chamber (ECHOES project)

Website: https://www.bco-dmo.org/dataset/563439
Data Type: experimental
Version: 2015-07-29

Project
» Development of a Novel High-Resolution O2/H+ Eddy Correlation Technique to Study Carbon Cycling in the Coastal Ocean (ECHOES)

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Dataset Description

This dataset includes O2, pH, temperature, and salinity data from a data sonde located within a clear benthic chamber.

Related Reference:

Long MH, Charette MA, Martin WR, McCorkle DC. (2015) Oxygen metabolism and pH in coastal ecosystems: Eddy Covariance Hydrogen ion and Oxygen Exchange System (ECHOES). Limnology and Oceanography: Methods. DOI: 10.1002/lom3.10038

Related Datasets:

Datasonde in water column
Eddy covariance proton and oxygen flux data

Methods & Sampling

Two cylindrical plexiglass chambers (one clear and one dark) measuring 0.31 m tall and 0.20 m in diameter, as described by Rao and Charette (2012), were installed to a depth of 0.15 m into the sediments. Each chamber had a stirring motor and battery pack, with the stir rates set at the maximum of 44 revolutions min-1 to approximate natural advection and its impact on advective porewater flow. Each chamber was fitted with a data sonde (600XLM; YSI, USA) that monitored the pH, O2, temperature and salinity within each chamber.

Sampling ports on the chambers were used to collect samples for DIC and TA at the same time the water

column was sampled. A 40 mL sample was withdrawn every ~ 2 h with one 20 mL portion poisoned with mercuric chloride for TA analysis and the other portion sealed and kept on ice for DIC analysis. Due to the lower sample volumes from the chambers, the DIC samples were analyzed within 24 h on a AS-C3 DIC Analyzer (Apollo SciTech, USA) and TA was analyzed with a small volume alkalinity titrator (808 Titrando; Metrohm, CH).

Data Processing Description

MATLAB code was developed to calculate the EC fluxes. Several data treatment procedures were tested; most of them were adapted from commonly used calculation procedures for terrestrial eddy covariance measurements (e.g. Baldocchi et al. 2003). The flux was determined over periods of 0.25 h. Data were averaged to 8Hz for flux calculations due to the ~ 10 Hz sample output refresh rate of the O2 optode meter. The fluctuating components of the vertical velocity, O2 and H+ (Eq. 1), were determined by Reynolds decomposition with the means determined by a running average window of 5 minutes, which was identified to be the optimal time period for maintaining a constant flux signal while removing non-turbulent fluctuations (McGinnis et al. 2008).

Inherent in the high-frequency ADV velocity data were anomalous spikes that contaminated the EC signal. These velocity data spikes were replaced with interpolated data using existing MATLAB de-spiking procedures described by Goring and Nikora (2002) that resulted in the interpolation of <1 % of the vertical velocities used to calculate the flux. The ECHOES H+ and O2 signals were compared to the water column data sonde measurements to verify that the sensors had not malfunctioned by confirming that the real-time correlation between sensors and data sonde matched that of the overall correlation (i.e. the calibration curves). All signals were then examined manually to remove any further data spikes that were due to malfunction, fouling, or debris contacting the sensors. A GoPro camera (HERO2, GoPro, USA) on the ECHOES frame helped identify fouling of the sensors. Due to the difficulty of accurately leveling the instrument in the field, and the resulting potential to bias the vertical velocity measurements, a planar rotation was used based on the methods described by Lorke et al. (2013) that uses an average rotation angle for the different current directions.

The benthic chamber fluxes were calculated from the change in O2, H+, DIC and TA concentrations in the chambers through time, using the known volume and sediment surface area of the chamber. Corrections for the removal of water for DIC and TA samples were included to account for the influx of ambient water, utilizing the measured water column conditions.

BCO-DMO Processing:

- added conventional header with dataset name, PI name, version date, reference information
- renamed parameters to BCO-DMO standard
- reformatted date
- added depth in meters column

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Data Files

File
datasonde_light.csv (Comma Separated Values (.csv), 68.77 KB) MD5:7b9b75caab7d078603b6f9d0767bc632 Primary data file for dataset ID 563439

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Parameters

Parameter	Description	Units
date	local date	yyyy-mm-dd
time	local time	hh:mm:ss
temp	temperature	degrees Celsius
SpCond	specific conductance	mS/cm
cond	conductivity	uS/cm
sal	salinity	ppt
DOsat	dissolved oxygen saturation	%
DO	dissolved oxygen	mg/L
DO_umol	dissolved oxygen	micromolar
depth_ft	depth in feet	feet
depth	depth in meters	meters
pH	pH	unitless

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Instruments

Dataset-specific Instrument Name	ADV
Generic Instrument Name	Acoustic Doppler Velocimeter
Dataset-specific Description	Acoustic Doppler Velocimeter
Generic Instrument Description	ADV is the acronym for acoustic doppler velocimeter. The ADV is a remote-sensing, three-dimensional velocity sensor. Its operation is based on the Doppler shift effect. The sensor can be deployed either as a moored instrument or attached to a still structure near the seabed. Reference: G. Voulgaris and J. H. Trowbridge, 1998. Evaluation of the Acoustic Doppler Velocimeter (ADV) for Turbulence Measurements. J. Atmos. Oceanic Technol., 15, 272–289. doi: http://dx.doi.org/10.1175/1520-0426(1998)0152.0.CO;2

Dataset-specific Instrument Name	Oxygen Optode
Generic Instrument Name	Optode
Dataset-specific Description	FirestingO2-Mini fiber-optic O2 meter with a fluorescence-based fast-response (< 0.3 s) 430 um tip diameter optode (Pyroscience, GE)
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	ISFET
Generic Instrument Name	pH Sensor
Dataset-specific Description	Fast-response (< 0.6 s) H1 Ion-Selective Field Effect Transistor (ISFET) and controller (Microsens, CH)
Generic Instrument Description	An instrument that measures the hydrogen ion activity in solutions. The overall concentration of hydrogen ions is inversely related to its pH. The pH scale ranges from 0 to 14 and indicates whether acidic (more H+) or basic (less H+).

Dataset-specific Instrument Name	multi-sensor data sonde
Generic Instrument Name	Water Quality Multiprobe
Dataset-specific Description	Multi-sensor data sonde (MS5; Hydrolab)
Generic Instrument Description	An instrument which measures multiple water quality parameters based on the sensor configuration.

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Deployments

Waquoit_Long

Website	https://www.bco-dmo.org/deployment/563651
Platform	WHOI
Start Date	2014-06-25
Description	Measurements of the exchange of oxygen and hydrogen ions across the sediment-water interface.

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Project Information

Development of a Novel High-Resolution O2/H+ Eddy Correlation Technique to Study Carbon Cycling in the Coastal Ocean (ECHOES)

Coverage: Waquoit Bay, Massachusetts, USA

An aquatic eddy covariance (EC) system was developed to measure the exchange of oxygen (O_2) and hydrogen ions (H^+) across the sediment-water interface. The system employs O_2 optodes and a newly developed micro-flow cell H^+ ion selective field effect transistor; these sensors displayed sufficient precision and rapid enough response times to measure concentration changes associated with turbulent exchange. Discrete samples of total alkalinity and dissolved inorganic carbon (DIC) were used to determine the background carbonate chemistry of the water column and relate the O_2 and H^+ fluxes to benthic processes. The ECHOES system was deployed in a eutrophic estuary (Waquoit Bay, Massachusetts, USA), and revealed that the benthos was a sink for acidity during the day and a source of acidity during the night, with H^+ and O_2

fluxes of ± 0.0001 and ± 10 mmol m^{-2} h^{-1}, respectively. H^+ and O_2 fluxes were also determined using benthic flux chambers, for comparison with the EC rates. Chamber fluxes determined in 0.25 h intervals co-varied with EC fluxes but were ~4 times lower in magnitude. This difference was likely due to suppressed porewater advection in the chambers and changes in the chemistry of the enclosed chamber overlying water. The individual H^+ and O_2 fluxes were highly correlated in each data set (EC and chambers), and both methods yielded H^+ fluxes that could not be explained by O_2 metabolism alone. The ECHOES system provides a new tool for determining the influence of benthic biogeochemical cycling on coastal ocean acidification and carbon cycling.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1361514

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