Spatial surveys of carbonate chemistry in Heron Reef, Great Barrier Reef, Australia

Website: https://www.bco-dmo.org/dataset/839261
Data Type: Other Field Results
Version: 1
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Project
» CAREER: Biogeochemical Modification of Seawater CO2 Chemistry in Near-Shore Environments: Effect of Ocean Acidification (Nearshore CO2)

Contributors	Affiliation	Role
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Abstract
Seawater samples and environmental measurements were collected across the Heron Island coral reef during three reef-scale surveys in the morning and evening in October of 2015. Seawater samples were analyzed for dissolved inorganic carbon chemistry parameters. The study was designed to characterize the natural spatio-temporal variability of carbonate chemistry and environmental parameters across the entire coral reef system. The spatial surveys were complemented with autonomous sensors making high frequency measurements at three locations.

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Coverage

Spatial Extent: **N**:-23.4369 **E**:151.9925 **S**:-23.4691 **W**:151.9067
Temporal Extent: 2015-10-12 - 2015-10-14

Methods & Sampling

General study design:
Seawater samples and environmental measurements were collected across the Heron Island coral reef during three reef-scale surveys in the morning and evening in October of 2015. Seawater samples were analyzed for dissolved inorganic carbon chemistry parameters. The study was designed to characterize the natural spatio-temporal variability of carbonate chemistry and environmental parameters across the entire coral reef system. The spatial surveys were complemented with autonomous sensors making high frequency measurements at three locations.

Methods description:

Seawater samples for carbonate chemistry analysis were collected from 0.5 m depth using a bucket and line at 28 stations inside the Heron reef lagoon and 1 station outside of the reef. Seawater samples were collected in 250 ml Pyrex Corning glass bottle and immediately poisoned with 100 µL $HgCL_2$ following standard protocols (Dickson et al., 2007). Seawater temperature, salinity, and dissolved oxygen were also measured at each sampling location using a handheld YSI multiprobe. Each survey took approximately 2 hours to complete.

Analytical Methods:
All seawater samples were transported to the Scripps Coastal and Open Ocean Biogeochemistry lab and analyzed for TA via an open-cell potentiometric acid titration system developed at Scripps Institution of Oceanography (SIO) by A. Dickson (Dickson et al. 2007) and DIC via an automated infra-red inorganic carbon analyzer (AIRICA, Marianda Inc).

Quality Control:
Samples for seawater carbon chemistry analysis were collected and analyzed following standard protocol (Dickson et al., 2007). The handheld YSI multiprobe was calibrated prior to each survey with and accuracy of ±0.2°C for temperature and 1% for salinity. The accuracy and precision for DIC and TA samples were - 0.86 ± 1.78 and 1.37 ± 2.79, respectively and were evaluated using CRMs provided by the laboratory of A. Dickson at SIO. CRMs were analyzed every 5 samples for DIC and every 10 for TA.

Data Processing Description

Data Processing:
Measured TA, DIC, temperature and salinity were input into CO2SYS for MATLAB (version 2.1) in order to calculate pCO2, pH, and Ar.

BCO-DMO Processing:
-added UTC date/time field in ISO8601 format;
- converted latitude values from positive to negative.

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Data Files

File
heron_reef.csv (Comma Separated Values (.csv), 9.82 KB) MD5:b9fb12dc18ab2ff16129f95cf5f0f1a3 Primary data file for dataset ID 839261

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Related Publications

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to Best Practices for Ocean CO2 Measurements. PICES Special Publication 3, 191 pp https://isbnsearch.org/isbn/1-897176-07-4
Methods

Kekuewa, S. A. H., Courtney, T. A., Cyronak, T., Kindeberg, T., Eyre, B. D., Stoltenberg, L., & Andersson, A. J. (2021). Temporal and Spatial Variabilities of Chemical and Physical Parameters on the Heron Island Coral Reef Platform. Aquatic Geochemistry, 27(4), 241–268. https://doi.org/10.1007/s10498-021-09400-7
Results

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Parameters

Parameter	Description	Units
Sample	Sample number for reference	unitless
Time	Date of the survey in local time (AEST); format: mm/dd/yyyy HH:mm	unitless
ISO_DateTime_UTC	Date and time of the survey in UTC; format: YYYY-MM-DDThh:mmZ	unitless
Station	Station number for reference	unitless
Survey_Number	Survey number for reference	unitless
Lat	Latitude of survey station	degrees North
Long	Longitude of survey station	degrees East
T	Temperature of seawater	degrees Celsius
S	Salinity of seawater	PSU
DO_mg	Dissolved oxygen of seawater	milligrams per liter (mg/L)
DO	Dissolved oxygen of seawater	micromoles per kilogram (umol/kg)
DIC	Dissolved inorganic carbon of seawater	micromoles per kilogram (umol/kg)
TA	Total alkalinity of seawater	micromoles per kilogram (umol/kg)
pCO2	pCO2 of seawater	microatmospheres (uatm)
Ar	Aragonite saturation state of seawater	unitless
pH	pH of seawater	unitless

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Instruments

Dataset-specific Instrument Name	Open-cell potentiometric acid titrator
Generic Instrument Name	Automatic titrator
Dataset-specific Description	The open-cell potentiometric acid titration system was developed by the laboratory of A.G. Dickson. Briefly, a known amount of seawater is added to an open cell temperature controlled beaker. Hydrochloric acid (0.1 N) is added using a Methrom Dosimat to a pH of 3.5-4.0. Following equilibration, small increments of hydrochloric acid are then added to the seawater until pH equals ~ 3.0. The titration is monitored by a glass electrode and the total alkalinity of the sample is calculated using a non-linear least-squares method following Dickson et al. (2007).
Generic Instrument Description	Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

Dataset-specific Instrument Name	AIRICA (Marianda)
Generic Instrument Name	Inorganic Carbon Analyzer
Dataset-specific Description	The Automated Infra Red Inorganic Carbon Analyzer (AIRICA) utilizes infrared detection of CO2 gas purged from an acidified seawater sample. A pump extracts the seawater sample, acidifies the sample with phosphoric acid, and analyzes the gas released with an infrared light analyzer (LICOR). The CO2 signal is integrated for four individual peaks for each sample and the three closest integrated peaks are averaged for a single given sample.
Generic Instrument Description	Instruments measuring carbonate in sediments and inorganic carbon (including DIC) in the water column.

Dataset-specific Instrument Name	YSI Professional Plus handheld multi-parameter instrument (YSI 6600 V2)
Generic Instrument Name	Water Quality Multiprobe
Dataset-specific Description	The instrument was used to measure in situ temperature (±0.2°C), salinity (± 1%), and DO (both mg/L and %; ± 2%).
Generic Instrument Description	An instrument which measures multiple water quality parameters based on the sensor configuration.

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Deployments

Andersson_Heron_Island_2015-10

Website	https://www.bco-dmo.org/deployment/839292
Platform	Small Boat
Start Date	2015-10-12
End Date	2015-10-13
Description	Seawater samples and environmental measurements were collected across the Heron Island coral reef during three reef-scale surveys in the morning and evening in October of 2015.

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Project Information

CAREER: Biogeochemical Modification of Seawater CO2 Chemistry in Near-Shore Environments: Effect of Ocean Acidification (Nearshore CO2)

Coverage: San Diego, California; Bermuda; Oahu, Hawaii

NSF Award Abstract:
Because of well-known chemical principles, changes in the CO2 chemistry of seawater in the open ocean as a result of rising atmospheric CO2 can be predicted very accurately. On the other hand, in near-shore environments, these projections are much more difficult because the CO2 chemistry is largely modified by biogeochemical processes operating on timescales of hours to months. To make predictions on how near-shore seawater CO2 chemistry will change in response to ocean acidification (OA), it is critical to consider the relative influence of net ecosystem production (NEP) and net ecosystem calcification (NEC), and how these processes might change in response to this major perturbation. Understanding how future OA will alter near-shore seawater CO2 chemistry and variability was identified as a major critical knowledge gap at the recent IPCC WG II/WG I workshop on impacts of ocean acidification on marine biology and ecosystems in January of 2011, and also at the International Ocean Acidification Network workshop in Seattle in June of 2012.

With funding from this CAREER award, a researcher at the Scripps Institute of Oceanography and his students will study how biogeochemical processes and the relative contributions from NEP and NEC modify seawater CO2 chemistry in near-shore environments influenced by different benthic communities under well-characterized environmental and physical conditions, and how these processes might change in response to OA. The team will investigate a limited number of contrasting habitats in subtropical (reef crest, back/patch reef, lagoon, seagrass bed, algal mat) and temperate (kelp bed, inter- and sub-tidal, marsh) environments during summer and winter, employing a method that evaluates the function and performance of the carbon cycle of a system using a stoichiometric vector approach based on changes in total dissolved inorganic carbon (DIC) and total alkalinity (TA). These field studies will be complemented by controlled mesocosm experiments with contrasting and mixed benthic communities under different OA scenarios.

The project has two educational components: (1) developing a research-driven OA and biogeochemistry course based on inquiry-, experience-, and collaborative-based learning; and (2) working with the Ocean Discovery Institute (ODI) to engage individuals from a local underrepresented minority community in science through educational activities focused on OA, and also providing a moderate number of internships for high school and college students to engage in this research project.

Broader Impacts: This project will directly support one PhD student, one junior research technician, and two high school and college interns from underrepresented minorities (URM) each summer of the project. It will contribute to the education of 80 undergraduate and graduate students participating in the research based ocean acidification/biogeochemistry course offered four times throughout the duration of the project at SIO/UCSD. Education and curricular material on the topics of OA, including hands-on laboratories, classroom and field-based activities will be developed through the collaboration with the ODI and brought to hundreds of URM students and their teachers in the City Heights area, a community with the highest poverty and ethnic diversity in the San Diego region. This collaboration will enable URM students to directly engage in a rapidly evolving field of research that has high relevance at both the local and global scales. To ensure broad dissemination of this project and the topic of OA, the research team will work with the Google Ocean team to incorporate information and educational material in the Google Ocean Explorer.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1255042

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