

# Carbon export from San Dieguito Lagoon from samples for seawater carbonate biogeochemistry between April 2014 and January 2015

**Website:** <https://www.bco-dmo.org/dataset/765108>

**Data Type:** Other Field Results

**Version:** 1

**Version Date:** 2019-04-17

## Project

» [CAREER: Biogeochemical Modification of Seawater CO<sub>2</sub> Chemistry in Near-Shore Environments: Effect of Ocean Acidification](#) (Nearshore CO<sub>2</sub>)

Contributors	Affiliation	Role
<a href="#">Andersson, Andreas</a>	University of California-San Diego (UCSD-SIO)	Principal Investigator
<a href="#">Rauch, Shannon</a>	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

## Abstract

General study design: In this study, samples for seawater carbonate biogeochemistry were collected in the San Dieguito Lagoon (SDL) over the course of a year, both at the mouth of the lagoon during ebb tide and at stations spatially distributed across the lagoon at high tide. The study was designed to assess the lateral carbon flux from SDL to the coastal ocean, and how this changed under different environmental conditions.

---

## Table of Contents

- [Coverage](#)
- [Dataset Description](#)
  - [Acquisition Description](#)
  - [Processing Description](#)
- [Related Publications](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Funding](#)

---

## Coverage

**Spatial Extent:** N:33.063419 E:-117.118508 S:32.968031 W:-117.266867

**Temporal Extent:** 2014-04-30 - 2015-01-24

---

## Dataset Description

General study design:

In this study, samples for seawater carbonate biogeochemistry were collected in the San Dieguito Lagoon (SDL) over the course of a year, both at the mouth of the lagoon during ebb tide and at stations spatially distributed across the lagoon at high tide. The study was designed to assess the lateral carbon flux from SDL to the coastal ocean, and how this changed under different environmental conditions.

## Acquisition Description

### Methods description:

Between April 2014 and January 2015, discrete samples for total alkalinity (TA), dissolved inorganic carbon (DIC), total organic carbon (TOC), and nutrients (nitrate, nitrite, ammonium, phosphate, and silicate) were collected hourly from high tide to low tide at the mouth of SDL, both during the day and during the night. Samples for TA, DIC, and nutrients were also collected at ten different sites across the SDL during the day at high tide. For all samples collected, surface temperature, salinity, and dissolved oxygen were measured with handheld YSI multiprobe while discrete seawater samples were collected by hand at the surface following standard protocols.

### Analytical Methods:

Surface seawater samples were collected by hand at ~0.25 m depth using 250 ml Pyrex glass bottles and immediately fixed with 100  $\mu$ L HgCl<sub>2</sub> as per standard protocols (Dickson et al. 2007). A handheld YSI multiprobe Pro2030 was calibrated and used to measure temperature, salinity, and dissolved oxygen saturation at the time of sampling. 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). Nutrient samples were filtered through a 0.45  $\mu$ m filter into acid-leached HDPE-containers, and kept frozen until analysis. They were analyzed at Oceanographic Data Facility at SIO (<http://odf.ucsd.edu>) using a Seal Analytical continuous-flow AutoAnalyzer. TOC samples were collected in combusted glass-vial and acidified with trace-metal grade HCl. They were analyzed in the Aluwihare lab at SIO according to Pedler et al. (2014) by combusting an unfiltered sample and measuring CO<sub>2</sub> gas concentration using a non-dispersive infrared detector.

### Quality Control:

Standard protocols were followed for sampling and analysis of seawater all parameters. The YSI multiprobe was calibrated prior to each sampling with an accuracy of  $\pm 0.2^\circ\text{C}$  for temperature,  $\pm 0.3\text{ g kg}^{-1}$  for salinity, and  $\pm 2\%$  for DO. The mean accuracy (TA  $\pm 1\ \mu\text{mol kg}^{-1}$ , DIC  $\pm 1\ \mu\text{mol kg}^{-1}$ ) and precision (TA  $\pm 2\ \mu\text{mol kg}^{-1}$ , DIC  $\pm 2\ \mu\text{mol kg}^{-1}$ ) of TA and DIC measurements were evaluated using certified reference materials (CRM) provided by the laboratory of A. Dickson at SIO and analyzed every 5 samples for DIC and ~10 samples for TA. The uncertainty of the nutrient measurements were reported as nitrate  $\pm 0.05\ \mu\text{M}$ , nitrite  $\pm 0.05\ \mu\text{M}$ , ammonium  $\pm 0.03\ \mu\text{M}$ , silicate  $\pm 2\text{-}4\ \mu\text{M}$ , and phosphate  $\pm 0.004\ \mu\text{M}$  by ODF. The TOC method was reported with an uncertainty of  $\pm 5\%$ .

## Processing Description

BCO-DMO Processing:

- replaced "%" with "\_pcnt" in column header;
- replaced "nan" with "nd" (for "no data");
- formatted dates to dd/mm/yyyy;
- formatted times to HH:MM;
- created ISO\_DateTime\_Local column from date and time fields provided.

[ [table of contents](#) | [back to top](#) ]

---

## Related Publications

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO<sub>2</sub> measurements. PICES Special Publication 3, 191 pp. ISBN: 1-897176-07-4. Handle: <http://hdl.handle.net/11329/249>. URL:

[https://www.nodc.noaa.gov/ocads/oceans/Handbook\\_2007.html](https://www.nodc.noaa.gov/ocads/oceans/Handbook_2007.html)

Paulsen, M.-L., Andersson, A. J., Aluwihare, L., Cyronak, T., D'Angelo, S., Davidson, C., ... Schroeter, S. (2017). Temporal Changes in Seawater Carbonate Chemistry and Carbon Export from a Southern California Estuary. *Estuaries and Coasts*, 41(4), 1050–1068.

doi:[10.1007/s12237-017-0345-8](https://doi.org/10.1007/s12237-017-0345-8)

[ [table of contents](#) | [back to top](#) ]

---

## Parameters

Parameter	Description	Units
Lat	Latitude of survey station	decimal degrees
Lon	Longitude of survey station	decimal degrees
Date	Date of the survey in DD/MM/YYYY	unitless
Time	Time of survey in local time (GMT -8); 24-hour; format: HH:MM	unitless
Temp	Temperature of survey station	degrees Celsius
Sal	Salinity of survey station	n/a
DO_pcmt	Dissolved oxygen saturation (%)	unitless (percentage)
DIC	Dissolved inorganic carbon of seawater	micromoles per kilogram (umol/kg)
TA	Total alkalinity of seawater	micromoles per kilogram (umol/kg)
TOC	Dissolved organic carbon of seawater	micromoles per kilogram (umol/kg)
PO4	Dissolved phosphate of seawater	micromoles per kilogram (umol/kg)
Si	Dissolved silicate of seawater	micromoles per kilogram (umol/kg)
NO2	Dissolved nitrite of seawater	micromoles per kilogram (umol/kg)
NO3	Dissolved nitrate of seawater	micromoles per kilogram (umol/kg)
NH4	Dissolved ammonium of seawater	micromoles per kilogram (umol/kg)
ISO_DateTime_Local	Date and time of survey formatted to ISO8601 standard: yyyy-mm-ddThh:mm:ss	unitless

[ [table of contents](#) | [back to top](#) ]

---

## Instruments

<b>Dataset-specific Instrument Name</b>	Shimadzu 500 V-CSN/TNM-1 TOC analysis system
<b>Generic Instrument Name</b>	Shimadzu TOC-V Analyzer
<b>Dataset-specific Description</b>	TOC samples were collected in 40 mL precombusted borosilicate vials after these were prerinced with the sample, followed by acidification to ~pH 2 using 12M trace metal-grade HCl, and capped with acid-washed teflon-lined septa. TOC concentrations were quantified by combusting the unfiltered samples and measuring the CO <sub>2</sub> released using a non-dispersive infrared detector. The instrument precision was checked using low carbon deep seawater TOC samples.
<b>Generic Instrument Description</b>	A Shimadzu TOC-V Analyzer measures DOC by high temperature combustion method.

<b>Dataset-specific Instrument Name</b>	Water Quality Multiprobe
<b>Generic Instrument Name</b>	Water Quality Multiprobe
<b>Dataset-specific Description</b>	YSI Handheld Multiparameter Instrument was used to measure in situ temperature (accuracy $\pm 0.15^\circ\text{C}$ ), salinity (accuracy $\pm 1\%$ ), and DO% (accuracy $\pm 2\%$ ).
<b>Generic Instrument Description</b>	An instrument which measures multiple water quality parameters based on the sensor configuration.

<b>Dataset-specific Instrument Name</b>	Open-cell potentiometric acid titration system
<b>Generic Instrument Name</b>	Automatic titrator
<b>Dataset-specific Description</b>	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 is added using a Methrom Dosimat to a pH of 3.5-4.0 and allowed to stabilize to remove CO <sub>2</sub> gas formed by the addition of acid. Small aliquots of hydrochloric acid are then added to pH of $\sim 3.0$ . 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).
<b>Generic Instrument Description</b>	Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

<b>Dataset-specific Instrument Name</b>	Automated Infra Red Inorganic Carbon Analyzer (AIRICA)
<b>Generic Instrument Name</b>	Inorganic Carbon Analyzers
<b>Dataset-specific Description</b>	<p>The Automated Infra Red Inorganic Carbon Analyzer (AIRICA) utilizes infrared detection of CO<sub>2</sub> gas purged from an acidified seawater sample. A high-precision syringe pump extracts the seawater sample, acidifies the sample with phosphoric acid, and analyzes the gas released with an infrared light analyzer (LICOR). The CO<sub>2</sub> signal is integrated for each sample to quantify the total inorganic carbon for a given aliquot of seawater analyzed. Three aliquots and peak integrations are performed for each seawater sample and averaged to determine the dissolved inorganic carbon for each sample. Precision was typically <math>\pm 1-2 \mu\text{mol/kg}</math> for TA. Please see <a href="http://marianda.com/index.php?site=products&amp;subsite=airica">http://marianda.com/index.php?site=products&amp;subsite=airica</a> for a complete instrument description.</p>
<b>Generic Instrument Description</b>	Instruments measuring carbonate in sediments and inorganic carbon in the water column.



<b>Dataset-specific Instrument Name</b>	SEAL AutoAnalyzer 3 four-channel segmented flow analyzer
<b>Generic Instrument Name</b>	Seal Analytical AutoAnalyser 3HR
<b>Dataset-specific Description</b>	<p>Nutrient samples were taken according to best practices and were filtered using a 0.4 µm filter and immediately frozen until analysis. Samples were analyzed using US Environmental Protection Agency methods for ammonium (method G-171-96, detection limit 0.034 µmol/L), nitrite+nitrate (method G-172-96, detection limit 0.010 µmol/L), silicate (method G-177-96, detection limit 0.016 µmol/L), and phosphate (method G-297-03, detection limit 0.025 µmol/L). Please see <a href="http://seal-analytical.com/Products/AA3SFAAnalyzer/tabid/59/Default.aspx">http://seal-analytical.com/Products/AA3SFAAnalyzer/tabid/59/Default.aspx</a> for a complete instrument description.</p>
<b>Generic Instrument Description</b>	<p>A fully automated Segmented Flow Analysis (SFA) system, ideal for water and seawater analysis. It comprises a modular system which integrates an autosampler, peristaltic pump, chemistry manifold and detector. The sample and reagents are pumped continuously through the chemistry manifold, and air bubbles are introduced at regular intervals forming reaction segments which are mixed using glass coils. The AA3 uses segmented flow analysis principles to reduce inter-sample dispersion, and can analyse up to 100 samples per hour using stable LED light sources.</p>

## Deployments

### San\_Dieguito\_Lagoon\_2014-15

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/765182">https://www.bco-dmo.org/deployment/765182</a>
<b>Platform</b>	San Dieguito Lagoon
<b>Start Date</b>	2014-04-30
<b>End Date</b>	2015-01-24
<b>Description</b>	In this study, samples for seawater carbonate biogeochemistry were collected in the San Dieguito Lagoon (SDL) over the course of a year, both at the mouth of the lagoon during ebb tide and at stations spatially distributed across the lagoon at high tide.

## Project Information

### **CAREER: Biogeochemical Modification of Seawater CO<sub>2</sub> Chemistry in Near-Shore Environments: Effect of Ocean Acidification (Nearshore CO<sub>2</sub>)**

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

NSF abstract: Because of well-known chemical principles, changes in the CO<sub>2</sub> chemistry of seawater in the open ocean as a result of rising atmospheric CO<sub>2</sub> can be predicted very accurately. On the other hand, in near-shore environments, these projections are much more difficult because the CO<sub>2</sub> chemistry is largely modified by biogeochemical processes operating on timescales of hours to months. To make predictions on how near-shore seawater CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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.

[ [table of contents](#) | [back to top](#) ]

---

## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1255042</a>

[ [table of contents](#) | [back to top](#) ]