BioChemical results from the CO2 Aggregation Experiment from UCSB Marine Science Institute Passow Lab from 2009 to 2010 (OA - Ocean Acidification and Aggregation project)

Website: https://www.bco-dmo.org/dataset/3945
Version: 07 May 2013
Version Date: 2013-05-07

Project
» Will Ocean Acidification Diminish Particle Aggregation and Mineral Scavenging, Thus Weakening the Biological Pump? (OA - Ocean Acidification and Aggregation)

Programs
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
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Dataset Description

Series 2: CO2 Aggregation Experiment - BioChemical

Reference: Passow, U., Rocha, C.L.D.L., Fairfield, C., Schmidt, K., 2014. Aggregation as a function of pCO2 and mineral particles. Limnology and Oceanography 59 (2), 532-547.

Methods & Sampling

See: Series 2: CO2 Aggregation Experiment - Methods

BCO-DMO Note:
Instruments listed apply to all phases of the Series 2 data.
Not just the experiment(s) represented in the individual dataset.

Data Processing Description

See: Series 2: CO2 Aggregation Experiment - Methods

BCO-DMO Note:
Instruments listed apply to all phases of the Series 2 data.
Not just the experiment(s) represented in the individual dataset.

BCO-DMO Processing Notes
Original file: "CO2 Aggregation ExperimentUtaApril2011-4.xlsx" contributed by Uta Passow
Sheet: "Biochemical"
- Approx Lat/Lon of Passow Lab appended to enable data discovery in MapServer
- Blank lines removed
- "Identifier" column added
- "nd" (no data) inserted into blank cells
- Parameter names edited to conform to BCO-DMO parameter naming conventions

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Data Files

File
Series2_CO2AggExp_BioChem.csv (Comma Separated Values (.csv), 9.11 KB) MD5:363d751d864e8f5ddac42316241a3d89 Primary data file for dataset ID 3945

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Parameters

Parameter	Description	Units
Lab_Id	Lab Id - Lab identifier where experiments were conducted	text
Lat	Approximate Latitude Position of Lab; South is negative	decimal degrees
Lon	Approximate Longitude Position of Lab; West is negative	decimal degrees
Identifier	Experiment Phase Identifier	text
Tank	Tank Identifier (#)	dimensionless
pCO2	CO2 conditions	text
clay	Volume of concentrated suspension of clay (illite) additions	ug/L
Tank_Vol	Tank Volume	L

avgDW_g_per_l	Avg DW in g/L	g/L
stdDW_g_per_l	SDev DW in g/L	g/L
avgDW_mg_per_tank	Avg DW in mg/tank	mg/tank
stdDW_mg_per_tank	SDev DW in mg/tank	mg/tank
Dw_equals_PIM_plus_POM_mg_per_tank	Dw=PIM+POM in mg/tank	mg/tank
avgPIM_g_per_l	Avg PIM in g/L	g/L
stdPIM_g_per_l	SDev PIM in g/L	g/L
avgPIM_mg_per_tank	Avg PIM in mg/tank	mg/tank
stdPIM_mg_per_tank	SDev PIM in mg/tank	mg/tank
avgPOM_mg_per_tank	Avg POM in mg/tank	mg/tank
stdPOM_mg_per_tank	SDev POM in mg/tank	mg/tank
avgPOC_ug_per_l	Avg POC in ug/L	ug/L
stdPOC_ug_per_l	SDev POC in ug/L	ug/L
avgPOC_mg_per_tank	Avg POC in mg/tank	mg/tank
stdPOC_mg_per_tank	SDev POC in mg/tank	mg/tank
avgPON_ug_per_l	Avg PON in ug/L	ug/L
stdPON_ug_per_l	SDev PON in ug/L	ug/L
avgPON_mg_per_tank	Avg PON in mg/tank	mg/tank
stdPON_mg_per_tank	SDev PON in mg/tank	mg/tank_mg

avgTEP_ug_GX_per_l	Avg TEP in ug GX/L	ug GX/ L
stdTEP_ug_GX_per_l	SDev TEP in ug GX/L	ug GX/ L
avgTEP_mg_GX_per_tank	Avg TEP in mg GX/Tank	mgGX/tank
stdTEP_mg_GX_per_tank	SDev TEP in mg GX/Tank	mgGX/tank
avgDOC_uM	Avg DOC_uM	uM
stdDOC_uM	SDev DOC_uM	uM
avgDOC_mg_per_tank	Avg DOC in mg/tank	mg/tank
stdDOC_mg_per_tank	SDev DOC in mg/tank	mg/tank

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Instruments

Dataset-specific Instrument Name	AggrCam
Generic Instrument Name	Aggregate Camera
Dataset-specific Description	The settled aggregates were then photographed for image analysis of their size and total number.
Generic Instrument Description	A type of underwater camera system used for photographing aggregates in tanks or other containers.

Dataset-specific Instrument Name	CHN Elemental Analyzer - CEC 44OHA by Control Equipment Corp
Generic Instrument Name	CHN Elemental Analyzer
Dataset-specific Description	The filters for POC and PON were fumed to remove inorganic carbon and analyzed at the Analytical Laboratory of the Marine Science Institute at UCSB using an elemental analyzer (CEC 44OHA by Control Equipment Corp).
Generic Instrument Description	A CHN Elemental Analyzer is used for the determination of carbon, hydrogen, and nitrogen content in organic and other types of materials, including solids, liquids, volatile, and viscous samples.

Dataset-specific Instrument Name	Conductivity Meter - 3100 Yellow Springs Instruments
Generic Instrument Name	Conductivity Meter
Dataset-specific Description	Salinity was determined from TA samples using a conductivity instrument (3100 Yellow Springs Instruments)
Generic Instrument Description	Conductivity Meter - An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. Commonly used in hydroponics, aquaculture and freshwater systems to monitor the amount of nutrients, salts or impurities in the water.

Dataset-specific Instrument Name	Flow Injection Analyzer - QuickCem 8000, Lachat Instruments
Generic Instrument Name	Flow Injection Analyzer
Dataset-specific Description	Concentrations of NO3+NO2, PO4 and Si(OH)4 in the initial phytoplankton-detritus mixture were measured by simultaneous flow injection analysis (QuickCem 8000, Lachat Instruments) in the Analytical Laboratory of the Marine Science Institute at UCSB from pre-filtered frozen samples.
Generic Instrument Description	An instrument that performs flow injection analysis. Flow injection analysis (FIA) is an approach to chemical analysis that is accomplished by injecting a plug of sample into a flowing carrier stream. FIA is an automated method in which a sample is injected into a continuous flow of a carrier solution that mixes with other continuously flowing solutions before reaching a detector. Precision is dramatically increased when FIA is used instead of manual injections and as a result very specific FIA systems have been developed for a wide array of analytical techniques.

Dataset-specific Instrument Name	in-situ incubator
Generic Instrument Name	In-situ incubator
Generic Instrument Description	A device on a ship or in the laboratory that holds water samples under controlled conditions of temperature and possibly illumination.

Dataset-specific Instrument Name	Dissecting Microscope
Generic Instrument Name	Microscope - Optical
Dataset-specific Description	The length and width of each aggregate were measured to the nearest mm under a dissecting scope.
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

Dataset-specific Instrument Name	Nutrient Autoanalyzer - TRAACS CS800 autoanalyzer
Generic Instrument Name	Nutrient Autoanalyzer
Dataset-specific Description	DIC was measured colorimetrically in duplicate with a TRAACS CS800 autoanalyzer (Seal, Mequon, USA) with a precision of ± 5 µmol kg-1. CRM (Batch No. 54) supplied by A. Dickson was used as a calibration (see for methodological details).
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	Roller Tank
Generic Instrument Name	Roller Tank
Dataset-specific Description	Roller tanks experiments: 14 cylindrical five-liter roller tanks/ treatments rotating at 1 rpm encompassing three acidification scenarios and 5 concentrations of the clay illite incubated at 14oC in continuous darkness for 44 to 48 hours. Solid body rotation was established within three hours.
Generic Instrument Description	Rolling tanks, which keep particles in suspension, thus simulating aggregate formation in situ. Marine snow experiments are conducted in roller tanks, which turn continuously, keeping marine snow in suspension. It is important for marine snow not to touch surfaces. The rolling tanks, which keep particles in suspension, thus simulate aggregate formation in situ. Marine snow formation due to different types of oil was tested. Some treatments are easily identifiable as containing oil by their color (middle). UCSB, CA 2012.

Dataset-specific Instrument Name	Shimadzu TOC-V
Generic Instrument Name	Shimadzu TOC-V Analyzer
Dataset-specific Description	The filtered samples were immediately frozen at -20°C and later analyzed via high temperature combustion on a modified Shimadzu TOC-V analyzers in the Carlson lab at UCSB.
Generic Instrument Description	A Shimadzu TOC-V Analyzer measures DOC by high temperature combustion method.

Dataset-specific Instrument Name	Genesys 10SVIS Spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	The samples for pHT were collected bubble free in 20-ml scintillation vials and measured within 1-2 hours of sampling with a spectrophotometer (Genesys 10SVIS) equipped with a single cell Peltier (SPG1A, both Thermo Scientific) using the indicator dye m-cresol purple (Sigma-Aldrich) at a constant temperature of 25oC.
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

Dataset-specific Instrument Name	Automatic titrator - TitroLine alpha plus (Schott Instruments, Mainz, Germany)
Generic Instrument Name	Titrator
Dataset-specific Description	TA was calculated from linear Gran plots (Gran 1952) after duplicate potentiometric titration (Brewer et al. 1986) using a TitroLine alpha plus (Schott Instruments, Mainz, Germany). Average precision was ± 5 µmol kg-1. Certified Reference Materials (CRMs, Batch No. 54) supplied by A. Dickson (Scripps Institution of Oceanography, USA) was used as a control.
Generic Instrument Description	Titrators are instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

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Deployments

lab_UCSB_MSI_Passow

Website	https://www.bco-dmo.org/deployment/58780
Platform	UCSB MSI Passow
Report	http://www.msi.ucsb.edu/people/research-scientists/uta-passow
Start Date	2009-09-01
End Date	2016-01-22
Description	Results form a series of controlled laboratory experiments investigating the effect of altered carbonate system chemistry on the abiotic formation of TEP

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Project Information

Will Ocean Acidification Diminish Particle Aggregation and Mineral Scavenging, Thus Weakening the Biological Pump? (OA - Ocean Acidification and Aggregation)

Website: http://www.msi.ucsb.edu/people/research-scientists/uta-passow

Coverage: Passow Lab, Marine Science Institute, University of California Santa Barbara

Will Ocean Acidification Diminish Particle Aggregation and Mineral Scavenging, Thus Weakening the Biological Pump?

This award is funded under the American Recovery and Reinvestment Act of 2009 (Public Law 111-5).

The pH of the ocean is predicted to decrease by 0.2-0.5 pH units in the next 50 to100 years as a result of increasing atmospheric CO2. To date almost all the research on impending ocean acidification has focused on the impacts to calcifying organisms and the carbonate system. However, ocean acidification will also affect other significant marine processes that are pH dependent.

In this project, researchers at the University of California at Santa Barbara will investigate the impact of ocean acidification on the organic carbon or 'soft tissue' biological pump. They predict that a decline in oceanic pH will result in an increase in the protonation of negatively charged substances, especially of Transparent Exopolymer Particles (TEP), the gel-like particles that provide the matrix of aggregates and bind particles together. A decreased polarity of these highly surface-active particles may reduce their "stickiness" resulting in decreased aggregation of organic-rich particles and a decreased ability of aggregates to scavenge and retain heavy ballast minerals. A reduction in aggregation will lower the fraction of POC enclosed in fast-sinking aggregates. Decreased scavenging of minerals by aggregates will result in reduced sinking velocities and consequently a decline in the fraction of material escaping degradation in the water column. Both processes ultimately reduce carbon flux to depth. The resulting weakening of the biological pump will alter pelagic ecology and potentially produce a positive feed-back pathway that further increases atmospheric CO2 concentrations.

The research team will experimentally investigate TEP-production, aggregation rates and aggregate characteristics, mineral scavenging and sinking velocity as a function of ocean acidification, because these parameters are susceptible to pH and central in determining sedimentation rate of organic carbon. They will determine potential changes in the abiotic formation of TEP or in the release rate of TEP or TEP-precursors by phytoplankton that have been adapted to increased CO2 regimes for multiple generations, up to 1000 doublings. Additionally, they will experimentally test potential changes in the aggregation rate of adapted phytoplankton and natural particles, and measure impacts on scavenging rates of ballast minerals by aggregates. Effects of various acidification levels on aggregate characteristics, including size, composition, density, and sinking velocity will also be determined. These results are expected to provide parameterization for a predictive model that will be used to investigate the impact of changing ballasting or aggregation on carbon flux.

Broader impact: Climate and environmental change are a global challenge to society. We need to know if possible positive feed back mechanisms to the biological pump will further increase atmospheric CO2 in order to prepare for and hopefully manage future climate changes.

These data are also available at Pangea

RELATED FILES:
Passow U (2012) The Abiotic Formation of Tep under Ocean Acidification Scenarios. Marine Chemistry 128-129:72-80

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH
Bathmann U, Passow U. "Global Erwaermung. Kohlenstoffpumpen im Ozean steuern das Klima.," *Biologie in unserer Zeit 5*, v.5, 2010.

Benner I, Passow U. "Utilization of organic nutrients by coccolithophores," *Marine Ecology Progress Series*, v.404, 2010, p. 21.

Feng Y, Hare C, Leblanc K, Rose J, Zhang Y, DiTullio G, Lee P, Wilhelm S, Rowe J, Sun J, Nemcek N, Gueguen C, Passow U, Benner I, Brown C, Hutchins D. "Effects of increased pCO2 and temperature on the North Atlantic spring bloom. I. The phytoplankton community and biogeochemical response," *Marine Ecology Progress Series*, v.388, 2009, p. 13.

Gaerdes A, Iversen MH, Grossart H-P, Passow U, Ullrich M. "Diatom associated bacteria are required for aggregation of Thalassiosira weissflogii.," *ISME Journal*, 2010, p. 1.

Leblanc K, Hare CE, Feng Y, Berg GM, DiTullio GR, Neeley A, Benner I, Sprengel C, Beck A, Sanudo-Wilhelmy SA, Passow U, Klinck K, Rowe JM, Wilhelm SW, Brown CW, Hutchins DA. "Distribution of calcifying and silicifying

phytoplankton in relation to environmental and biogeochemical parameters during the late stages of the 2005 North East Atlantic Spring Bloom," *Biogeosciences*, v.6, 2009, p. 2155.

Ploug H, Terbruggen A, Kaufmann A, Wolf-Gladrow D, Passow U. "A novel method to measure particle sinking velocity in vitro, and its comparison to three other in vitro methods.," *Limnolgy and Oceanography Methods*, v.8, 2010, p. 386.

Passow, U., Rocha, C.L.D.L., Fairfield, C., Schmidt, K., 2014. Aggregation as a function of pCO2 and mineral particles. Limnology and Oceanography 59 (2), 532-547.

De La Rocha, C.L., Passow, U., 2014. The biological pump. In: Turekian, K.K., Holland, H.D. (Eds.), Treatise on Geochemistry. Elsevier, Oxford, pp. 93-122.

Boyd, P., Rynearson, T., Armstrong, E., Fu, F., Hayashi, K., Hu, Z., Hutchins, D., Kudela, R., Litchman, E., Mulholland, M., Passow, U., Strzepek, R., Whittaker, K., Yu, E., Thomas, M., 2013. Marine Phytoplankton Temperature versus Growth Responses from Polar to Tropical Waters - Outcome of a Scientific Community-Wide Study. PLoS ONE 8 (5), e63091.

Passow, U., Carlson, C., 2012. The Biological Pump in a High CO2 World. Marine Ecology Progress Series 470, 249-271.

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Program Information

Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Website: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503477

Coverage: global

NSF Climate Research Investment (CRI) activities that were initiated in 2010 are now included under Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES). SEES is a portfolio of activities that highlights NSF's unique role in helping society address the challenge(s) of achieving sustainability. Detailed information about the SEES program is available from NSF (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504707).

In recognition of the need for basic research concerning the nature, extent and impact of ocean acidification on oceanic environments in the past, present and future, the goal of the SEES: OA program is to understand (a) the chemistry and physical chemistry of ocean acidification; (b) how ocean acidification interacts with processes at the organismal level; and (c) how the earth system history informs our understanding of the effects of ocean acidification on the present day and future ocean.

Solicitations issued under this program:
NSF 10-530, FY 2010-FY2011
NSF 12-500, FY 2012
NSF 12-600, FY 2013
NSF 13-586, FY 2014
NSF 13-586 was the final solicitation that will be released for this program.

PI Meetings:
1st U.S. Ocean Acidification PI Meeting(March 22-24, 2011, Woods Hole, MA)
2nd U.S. Ocean Acidification PI Meeting(Sept. 18-20, 2013, Washington, DC)
3rd U.S. Ocean Acidification PI Meeting (June 9-11, 2015, Woods Hole, MA – Tentative)

NSF media releases for the Ocean Acidification Program:

Press Release 10-186 NSF Awards Grants to Study Effects of Ocean Acidification

Discovery Blue Mussels "Hang On" Along Rocky Shores: For How Long?

Discovery nsf.gov - National Science Foundation (NSF) Discoveries - Trouble in Paradise: Ocean Acidification This Way Comes - US National Science Foundation (NSF)

Press Release 12-179 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: Finding New Answers Through National Science Foundation Research Grants - US National Science Foundation (NSF)

Press Release 13-102 World Oceans Month Brings Mixed News for Oysters

Press Release 13-108 nsf.gov - National Science Foundation (NSF) News - Natural Underwater Springs Show How Coral Reefs Respond to Ocean Acidification - US National Science Foundation (NSF)

Press Release 13-148 Ocean acidification: Making new discoveries through National Science Foundation research grants

Press Release 13-148 - Video nsf.gov - News - Video - NSF Ocean Sciences Division Director David Conover answers questions about ocean acidification. - US National Science Foundation (NSF)

Press Release 14-010 nsf.gov - National Science Foundation (NSF) News - Palau's coral reefs surprisingly resistant to ocean acidification - US National Science Foundation (NSF)

Press Release 14-116 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: NSF awards $11.4 million in new grants to study effects on marine ecosystems - US National Science Foundation (NSF)

Ocean Carbon and Biogeochemistry (OCB)

Website: http://us-ocb.org/

Coverage: Global

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF.

The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems.

The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO2 and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two.

The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen conditions in the coastal and open oceans.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0926711

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