pCO2 as one of multiple stressors for Thalassiosira weissflogii - Cell Characteristics - dry weight per cell from UCSB MSI Passow Lab from 2009 to 2010 (OA - Ocean Acidification and Aggregation project)

Website: https://www.bco-dmo.org/dataset/540098
Version: 13 November 2014
Version Date: 2014-11-13

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
Passow, Uta	University of California-Santa Barbara (UCSB-MSI)	Principal Investigator, Contact
Laws, Edward	Louisiana State University (LSU-CC&E [formerly SC&E])	Co-Principal Investigator
Gegg, Stephen R.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Dataset Description

The increase in partial pressure of CO2 (pCO2) is causing ocean acidification, which impacts the growth rates and elemental composition of phytoplankton. Here, shifts in growth rates and cell quotas of Thalassiosira weissflogii grown under a variety of different temperatures, irradiances, and pCO2 conditions are discussed. The presented data suggest that acclimatization times of exponentially growing diatoms to environmental perturbations may be weeks to months, rather than days to weeks. The response of acclimatized T. weissflogii to pCO2 depended on irradiance and temperature and was highly interactive, non-linear, and non-uniform. A very significant negative effect of pCO2 was observed under growth conditions that were light-, and temperature-limited; a smaller, but still significant negative response was seen under light-limiting growth conditions, whereas pCO2 did not affect growth rates of T. weissflogii under light-saturated growth conditions. Cell quotas of organic carbon, nitrogen, or chlorophyll a were linked to growth rate. The cell-normalized production of transparent exopolymer particles (TEP) was positively correlated with POC cell quotas, with some minor impact of irradiance and pCO2 on the relationship. This correlation of TEP production with carbon cell quotas is consistent with the hypothesis that extracellular release is an inherent component of cell metabolism. Results suggest that elevated pCO2 functions as an (additional) metabolic stressor for T. weissflogii and that the interaction of different stressors determines growth rates and cell characteristics in a complex, non-linear relationship.

Methods & Sampling

See: Series 5: Acclimatization Data - Methods

Data Processing Description

See: Series 5: Acclimatization Data - Methods

BCO-DMO Processing Notes
Original file: "Acclimat Datafor BCODMO.xlsx" contributed by Uta Passow
Sheet: "Charachteristics"
- Approx Lat/Lon of Passow Lab appended to enable data discovery in MapServer
- Data reorganized to facilitate serving in one set of columns and rows
- New parameter names generated to accomodate data reorganization
- Original data value "Chla: C" converted to Chla_C to allow serving of data
- "nd" (no data) inserted into blank cells
- Parameter names edited to conform to BCO-DMO naming convention found at Choosing Parameter Name

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Data Files

File
Series5_CellCharacteristics.csv (Comma Separated Values (.csv), 997 bytes) MD5:a19cd366b6dffef08f962703b1ba8a4e Primary data file for dataset ID 540098

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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
Data	Cell characteristics data - DW cell-1 (pg cell-1)	text
temperature	Growth temperature	degs celsius
pCO2	pCO2 treatment – ambient: target pH: 8.0 to 8.6; future: target pH: 7.6 to 8.3	text
light	light level - LL (Low Light) = 35umol m-2s-1; HL (High Light) = 65umol m-2s-1	text
Tp1_Repl1	DW cell-1 at Time Point 1; for Replicate 1	pg per cell
Tp1_Repl2	DW cell-1 at Time Point 1; for Replicate 2	pg per cell
Tp1_Repl3	DW cell-1 at Time Point 1; for Replicate 3	pg per cell
Tp1_Repl4	DW cell-1 at Time Point 1; for Replicate 4	pg per cell
Tp2_Repl1	DW cell-1 at Time Point 2; for Replicate 1	pg per cell
Tp2_Repl2	DW cell-1 at Time Point 2; for Replicate 2	pg per cell
Tp2_Repl3	DW cell-1 at Time Point 2; for Replicate 3	pg per cell
Tp2_Repl4	DW cell-1 at Time Point 2; for Replicate 4	pg per cell
Tp3_Repl1	DW cell-1 at Time Point 3; for Replicate 1	pg per cell
Tp3_Repl2	DW cell-1 at Time Point 3; for Replicate 2	pg per cell
Tp3_Repl3	DW cell-1 at Time Point 3; for Replicate 3	pg per cell
Tp3_Repl4	DW cell-1 at Time Point 3; for Replicate 4	pg per cell
Tp4_Repl1	DW cell-1 at Time Point 4; for Replicate 1	pg per cell
Tp4_Repl2	DW cell-1 at Time Point 4; for Replicate 2	pg per cell
Tp4_Repl3	DW cell-1 at Time Point 4; for Replicate 3	pg per cell
Tp4_Repl4	DW cell-1 at Time Point 4; for Replicate 4	pg per cell

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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 CO_2 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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