Biogeochemistry Data from R/V Atlantic Explorer X0606, X0705, AE0810 in the Western Sargasso Sea roughly 38-20N and 66-43W from 2006-2008 (ATP3 project)

Website: https://www.bco-dmo.org/dataset/3354
Version: 06 December 2011
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Project
» DOP Utilization in the Sargasso Sea: Quantifying Taxon-specific Rates of Hydrolysis and Uptake (ATP3)

Contributors	Affiliation	Role
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Dataset Description

DOP Utilization (ATP3, DOP) Biogeochemistry Data
Biogeochemical data collected on transect cruises studying
Dissolved Organic Phosphorus throughout the western Sargasso Sea.
Data are from several cruises over the span 2006 to 2008.

Note the cruise identifiers for the Atlantic Explorer were originally formatted as XYY## (e.g. X0806 was the 6th cruise in 2008). The data files include cruise IDs of this type. The vessel operator changed the cruise ID syntax several years after the cruise and the official cruise ID syntax was changed to AEYY##. For example, AE0810 should be the same cruise as X0810. One exception for this dataset is that X0804 is cruise ID AE0810.

Related files and references:
Detailed information on analyses:

Lomas, M.W., Burke, A., Lomas, D.A., Bell, D.W., Shen, C., Ammerman, J.W., Dyhrman, S.T. 2010. Sargasso Sea phosphorus biogeochemistry: An important role for dissolved organic phosphorus (DOP). Biogeosciences 7: 695-710.

Other published work:

Michelou, V.K., Lomas, M.W., Kirchman, D.L. Phosphate and ATP uptake by cyanobacteria and heterotrophic bacteria in the Sargasso Sea. Limnology and Oceanography, in press.

McLaughlin, K., Sohm, J.A., Cutter, G.A., Lomas, M.W., Paytan, A. 2010. Phosphate cycling in the Sargasso Sea: Investigation using the oxygen isotopic composition of phosphate, enzyme labeled fluorescence, and turnover times.

Journal of Geophysical Research - Biogeosciences, in press.

Longnecker, K., Lomas, M.W., and Van Mooy, B.A.S. 2010. Characterizing the abundance and diversity of heterotrophic bacterial cells assimilating phosphate in the sub-tropical North Atlantic Ocean. Environmental Microbiology, in press.

Orchard, E.D., Ammerman, J.W., Lomas, M.W., Dyhrman, S.T. 2010. Dissolved inorganic and organic phosphorus
uptake in Trichodesmium and the microbial community: The importance of phosphorus ester in the Sargasso Sea.
Limnology and Oceanography, 55:1390-1399.

Casey, J., Lomas, M.W., Michelou, V., Orchard, E.D., Dyhrman, S.T., Ammerman, J.W., and Sylvan, J. 2009. Phytoplankton taxon-specific orthophosphate (Pi) and ATP uptake in the northwestern Atlantic subtropical gyre.
Aquatic Microbial Ecology, 58:31-44.

Van Mooy, B.A.S., Fredricks, H.F., Pedler, B.F., Dyhrman, S.T., Karl, D.M., Koblizek, M., Lomas, M.W., Moore, L.R., Moutin, T., Rappé, M.S., and Webb, E.A. 2009. Phytoplankton in the oligotrophic ocean use non-phosphorus lipids in response to phosphorus scarcity. Nature Geosciences, doi:10.1038/nature07659.

Methods & Sampling

Sampling and Analytical Methodology:
Detailed methods for all data collected as part of this study can be found in the publications arising from this study (references given below). This contains information on analytical machines and certified standards where applicable.

Sample QA/QC procedures followed those of the Bermuda Atlantic Time-series Study (BATS). At the point of collection, any leaking niskin bottles were noted on the master cast sheets and samples were taken from a different niskin fired at the same depth as the leaking bottle. No data are reported for leaking Niskin bottles. During sample analysis standard curves and/or certified standards were carefully examined to ensure that they were consistent with expectations and accurate. If nothing was found, then we examined other data from that niskin to see if other samples are in question. If no obvious error or problem was found, the data were considered OK and in the range of environmental data that this study hoped to observe.

Sample accuracy and precision:
Sample accuracy was assessed by using certified standards, for those measurements where standards are available (dissolved oxygen, nutrients, salinity). Certified standards were run with each analytical run and compared to long term control charts for respective analyses. Samples were not run until certified standards were shown to be accurate for that analytical run. Sample precision was determined by analyzing replicate samples (not replicate analyses on the same sample) and therefore is higher than analytical precision due to the inclusion of sampling error. At the concentrations observed during this study, sample precision was <5% for stock measurements and <10% for rate measurements. Some analyses, namely dissolved

oxygen and salinity, were much better and often had a sample precisions <1%. These precision

estimates are consistent with the long term QA/QC seen with the BATS program.

The provided data files are complete matrices and therefore not every sample (columns) will be taken from every Niskin fired (rows). Data that were either not collected, or were associated with leaking Niskins, or were found to be in error for other reasons are denoted by "nd" in the spreadsheets.

Data Processing Description

Data Processing:
Most of the data given in this dataset are not derived variables and are calculated using reasonably standard equations as given in the appropriate reference above. The one exception is CTD data. Raw CTD data were processed using SBE-Data Processing software using configuration and calibration files provided by the Shipboard Science technician. Sensors were calibrated every 6 months. Manual determinations of dissolved oxygen, salinity and HPLC Chlorophyll a, once passing the above QA/QC steps, were taken as correct. CTD sensor data was regressed against the appropriate manual variable. In all cases, regression statistics were very strong and linear. CTD data were corrected to manual measurements using the regression data and it is this corrected data that is given in the associated data files.

Only nutrient analyses were close to analytical method detection limits (MDL). MDLs were estimated as 3x the standard deviation of the lowest standard used for the analysis and are ~30nM for nitrate and phosphate using a standard autoanalyzer. We used the MAGIC co-precipitation method for phosphate which lowered our MDL to ~1.5nM. Samples below the MDL are reported as calculated for the reason that they are somewhere between the MDL and a true zero; we consider listing them as either to be incorrect.

BCO-DMO Edits
- Parameter names modified to conform to BCO-DMO convention
- **Note:** Parameter names starting with 33P_xxx changed to P33_xxx for use within system
- date reformatted to YYYYMMDD
- time reformatted to HHMM
- lat/lon padded to 7 decimal places
- added CruiseId column and combined all BGC data into one dataset
- X0606 station 7 year corrected from 2007 to 2006

- "-9.99" changed to "nd" (no data) for X0804

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Data Files

File
Biogeochemistry.csv (Comma Separated Values (.csv), 554.51 KB) MD5:18880eea041a440982d1b068cc18a8d7 Primary data file for dataset ID 3354

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Parameters

Parameter	Description	Units
CruiseId	Cruise Id	text
Station	Station Id	integer
Cast	CTD drop number	integer
date	date of operation (GMT)	YYYYMMDD
time	time of operation (GMT)	HHMM

lon	Longitude position West is negative	decimal degrees
lat	Latitude position South is negative	decimal degrees
Niskin	Niskin bottle number	integer
Depth	target bottle fire depth	meters
CTD_bottlefire_depth	CTD sensor value when bottle fired; depth	meters
CTD_bottlefire_Temp	CTD sensor value when bottle fired; Temp	oC
CTD_bottlefire_Salinity	CTD sensor value when bottle fired; Salinity	dimensionless
CTD_bottlefire_density	CTD sensor value when bottle fired; density	kg/m3
CTD_bottlefire_Fluorometer	CTD sensor value when bottle fired; Fluorometer	rfu
CTD_bottlefire_DO	CTD sensor value when bottle fired; Dissolved Oxygen	umol/kg
NO3	autoanalyzer nitrate concentration	microM
NO2	autoanalyzer nitrite concentration	microM
PO4	autoanalyzer phosphate concentration	microM
SiOH4	autoanalyzer silicate concentration	microM
TDP	manual total dissolved phosphorus concentration	nM
SRP	manual phosphate (MAGIC method) concentration	nM
DOP	manual dissolved organic phosphorus concentration by subtraction	nM
POP	manual particulate organic phosphorus concentration	nmolP/L
POC	elemental analyzer particulate organic carbon concentration	micromol C/L

PON	elemental analyzer particulate organic nitrogen concentration	micromol N/L
F_Chla	extracted chlorophyll concentration	ng/L
F_Phaeoph	extracted phaeopigment concentration	ng/L
Prochloro	Prochlorococcus abundance	cells/ml
Synecho	Synechococcus abundance	cells/ml
P_euks	Pico-eukaryote abundance	cells/ml
N_euks	Nano-eukaryote abundance	cells/ml
APA_whole	manual alkaline phosphatase activity	nmol/L/h
P33_PO4_uptake	radiotracer phosphate uptake **Note:** Original parameter names was 33P_PO4_uptake. Changed to P33 for use within BCO-DMO system.	nmol/L/h
P33_PO4_turnover_time	radiotracer phosphate turnover time **Note:** Original parameter names was 33P_PO4_turnover_time. Changed to P33 for use within BCO-DMO system.	/hr
P33_PO4_turnover_rate	radiotracer phosphate turnover rate **Note:** Original parameter names was 33P_PO4_turnover_rate. Changed to P33 for use within BCO-DMO system.	percent/h
P33_ATP_uptake	radiotracer Adenosinetriphosphate (ATP) uptake **Note:** Original parameter names was 33P_ATP_uptake. Changed to P33 for use within BCO-DMO system.	nmol/L/h
P33_ATP_turnover_time	radiotracer Adenosinetriphosphate (ATP) turnover time **Note:** Original parameter names was 33P_ATP_turnover_time. Changed to P33 for use within BCO-DMO system.	/hr

P33_ATP_turnover_rate	radiotracer Adenosinetriphosphate (ATP) turnover rate **Note:** Original parameter names was 33P_ATP_turnover_rate. Changed to P33 for use within BCO-DMO system.	percent/h

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Instruments

Dataset-specific Instrument Name	CTD Sea-Bird 911
Generic Instrument Name	CTD Sea-Bird 911
Dataset-specific Description	1.0 CTD 1.1 Seabird Electronics SBE 9/11+ Max Depth is 6800m for all CTD sensors except Chelsea Fluorometer, Wetlabs Transmissometer and Altimeter which are all 6000m. Aluminum frame holds 24 12 liter water samplers. 1.2 Sensors include Seabird SBE 9/11+, Dual pumped Temperature, conductivity and Dissolved Oxygen. Chelsea Aquatracka III Flourometer, Wetlabs SeaStar 25cm/660nm Transmissometer, Benthos PSA9000 Altimeter. All data logged with Seabird Software. 1.3 Water Samplers - 24x12 liter Ocean Test Equipment (OTE) Niskin Water samplers and 4x10 liter OTE Go-Flo's.
Generic Instrument Description	The Sea-Bird SBE 911 is a type of CTD instrument package. The SBE 911 includes the SBE 9 Underwater Unit and the SBE 11 Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 and SBE 11 is called a SBE 911. The SBE 9 uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 and SBE 4). The SBE 9 CTD can be configured with auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). More information from Sea-Bird Electronics.

Dataset-specific Instrument Name	Niskin Bottle
Generic Instrument Name	Niskin bottle
Dataset-specific Description	3.0 Water Samplers 3.1 36x12 liter Ocean Test Equipment Niskin sampling bottles; 8x12 liter Go Flo bottles with 1000 meters Spectra Line
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

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Deployments

X0606

Website	https://www.bco-dmo.org/deployment/58060
Platform	R/V Atlantic Explorer
Start Date	2006-05-19
End Date	2006-05-27
Description	One in a series of transect cruises to study the biological and biogeochemical aspects of the marine phosphorus cycle.

X0705

Website	https://www.bco-dmo.org/deployment/58061
Platform	R/V Atlantic Explorer
Start Date	2007-06-02
End Date	2007-06-14
Description	One in a series of transect cruises to study the biological and biogeochemical aspects of the marine phosphorus cycle.

AE0810

Website	https://www.bco-dmo.org/deployment/58062
Platform	R/V Atlantic Explorer
Start Date	2008-05-03
End Date	2008-05-25
Description	One in a series of transect cruises to study the biological and biogeochemical aspects of the marine phosphorus cycle. Note the cruise identifiers for the Atlantic Explorer were originally formatted as XYY## (e.g. X0806 was the 6th cruise in 2008). The data files include cruise IDs of this type. The vessel operator changed the cruise ID syntax several years after the cruise and the official cruise ID syntax was changed to AEYY##. For example, AE0810 should be the same cruise as X0810. One exception for this dataset is that X0804 is cruise ID AE0810 (unclear how the cruise numbering scheme got so confused). Database validation showed that AE0804 was not the correct cruiseid based on information at R2R. The cruiseid was then updated to reflect the corrected information (the May 2008 cruise was AE0810. Additional Information from R2R Site

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Project Information

DOP Utilization in the Sargasso Sea: Quantifying Taxon-specific Rates of Hydrolysis and Uptake (ATP3)

Website: http://www.bios.edu/Labs/pel/Research%20Pages/Research_DOP.html

Coverage: Western Sargasso Sea roughly 38-20oN and 66-43oW.
Water depths always exceeded 4200m.

Photosynthetic uptake of CO2 by oceanic phytoplankton and the export of the resulting organic carbon to the deep sea comprise a 'biological pump' capable of extracting globally significant amounts of CO2 from the atmosphere. Mounting evidence suggests that primary production in two of the larger subtropical ocean gyres, the Western Tropical/Subtropical Atlantic and the North Pacific Subtropical Gyre (NPSG), may be

controlled by the availability of inorganic phosphorus. This conclusion is based on vanishingly low inorganic phosphorus (SRP) concentrations, sub-nanomolar in some locales, ratios of inorganic nutrient availability that greatly exceed the canonical Redfield Ratio, and high rates of dissolved organic phosphorus (DOP) hydrolysis.

Indeed, data collected in the Sargasso Sea shows a 30% decline in DOP inventories during summer stratification. Moreover, several studies have documented significant taxonomic variability in the ability to hydrolyze and to assimilate phosphorus from organic sources We hypothesize that despite rapid turnover times, chronically low and seasonally invariant SRP concentrations at BATS cannot support measured rates of primary production without utilization of additional P from the DOP pool. Moreover, we hypothesize that inherent physiological differences among microbial taxa represents a significant source of temporal and spatial variability in DOP utilization rates that is yet neither understood nor constrained.

Our specific research objectives are:
1. To quantify temporal and spatial variability in DOP hydrolysis in the Sargasso Sea with measures of whole-community and taxon-specific alkaline phosphatase
2. To quantify temporal and spatial variability in taxon-specific SRP and DOP uptake rates by combining flow cytometry and radioisotope methodologies.
3. To quantify whole-community total P uptake rates through BAP (biologically available phosphorus) assays, as well as SRP and model compound DOP uptake and regeneration rates.
4. To identify factors regulating rates of DOP hydrolysis and assimilation using experimental nutrient manipulations, and to evaluate the role of DOP in supporting primary production in the Sargasso Sea.

To successfully meet our objectives, we propose to employ three cruise sampling strategies: CORE, PROCESS, and CRUISES OF OPPORTUNITY. The CORE cruises and CRUISES OF OPPORTUNITY will be conducted in conjunction with the BATS biogeochemical time-series program. The PROCESS cruises are principal-use cruises that are designed to allow a more intensive study on the mechanisms of and controls on DOP hydrolysis and utilization in the Sargasso Sea.

An understanding of ocean ecosystem function is important on a broad scale. This project will provide information critical for successful modeling efforts constrain predictions of the strength of the oceanic biological pump, as well as provide information of interest to students, teachers and the general public. If in fact DOP supports a significant, and previously unquantified, fraction of the annual primary production in the Sargasso Sea, then diversity in biological metabolic processes in the central oceans plays a greater role in the global carbon cycle - including regulation of atmospheric CO2 - than we recognize at present. The overall goal of the student teaching/training programs at BBSR, WHOI and Rutgers is to expose students to oceanographic research, its global significance, and its impact on their daily lives. As such, we will incorporate data on DOP cycling in the Sargasso Sea into a problem-based learning module for courses taught by the PIs and submit our curriculum to the appropriate digital repository (e.g. www.dlese.org). The PIs have a strong commitment to direct mentoring, and they will also sponsor a minimum of three undergraduate researchers each year in their laboratories, and support the research and training of MIT/WHOI Joint Program and Rutgers University graduate students.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0453023

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