Time-series of nutrient measurements following addition of Prochlorococcus derived POM to seawater samples collected at Station ALOHA on R/V Kilo Moana cruise KM1110 in the North Pacific Subtropical Gyre in 2011

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Project
» Taxon-Specific Variability of Organic Matter Production and Remineralization Potential (Taxon-Specific Organic P-C-N Production)

Contributors	Affiliation	Role
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Dataset Description

Time-series of nutrient measurements following addition of *Prochlorococcus* derived POM to seawater collected at Station ALOHA. Data published in Figure 1 in Burkhardt et al. (2014).

Related Publications and References:
Burkhardt, B., K. S. Watkins-Brandt, D. Defforey, A. Paytan and A. E. White. 2014. Remineralization of phytoplankton-derived organic matter by natural populations of heterotrophic bacteria. *Marine Chemistry* 162. doi: 10.1016/j.marchem.2014.03.007

See Related Datasets:
Controls
Killed Controls
Trichodesmium
Diatoms
OR POM
Tricho NMR
Diatom NMR

Methods & Sampling

All analytical and sampling methodologies are described in Burkhardt et al. (2014). However, summary of most relevant methods are included here:

To explore the relationship between POM source and remineralization rates and stoichiometry, the investigators conducted a suite of on-deck incubation experiments in the North Pacific Subtropical Gyre (NPSG) in March of 2011 near Station ALOHA. 20-L aliquots of seawater were collected from the 75-m depth horizon at Station ALOHA. Immediately after collection, seawater was stored in the dark in an incubator continually flushed with surface seawater for ~72 hours. Dried POM material (cultured Trichodesmium IMS 101, “TRICHO”, Prochlorococcus MED4, “PRO”, T. weissflogii, “DIATOM” and the natural POM from the Oregon coast, “OR-POM”) was added to the carboys with aged Station ALOHA seawater. Each treatment was prepared in duplicate except for the OR-POM. Concentrations of ammonium (NH4) and SRP were obtained every 5 min for roughly the first half hour following POM addition to capture any solubilization trends. This initial phase was followed by discrete sampling every 3 hours. Nutrient samples were run at OSU, NMR samples were run at the University of California, Santa Cruz.

Nutrients were analyzed using flow-through colorimetric methods on a Technicon Auto Analyzer II. SRP was analyzed using the phosphomolybdic acid reduction; ammonium (NH4) was measured by the indophenol blue method (Gordon et al., 1993); and nitrate + nitrite (N+N) was analyzed using the cadmium reduction method of Armstrong et al. (1967). Detection limits were 55 nmol L-1 for SRP, 22 nmol L-1 for NH4, and 8 nmol L-1 for N+N. Total dissolved P and N (TDP and TDN, respectively) were determined by the alkaline persulfate oxidation method (Valderrama, 1981) using a 1:10 oxidant to sample ratio. Dissolved organic P (DOP) and N (DON) were calculated as the difference of TDP and SRP and TDN less the sum of NH4+ + NO3- + NO2-, respectively.

Particulate C, N, and P content of each POM type was determined by collecting a subsample of the biomass onto combusted GFF filters, wrapping in foil, flash freezing, and storing at -80 degrees C. The filters were then thawed and dried at 60 degrees C overnight, folded into tin and silver boats, and run on a Carlo-Erba C/N Analyzer for particulate C (PC) and N (PN) content (Sharp (1974). For particulate P (PP) analyses samples were thawed and combusted at 450 degrees C for 4.5 hours, then extracted with 0.15 M HCl for 1 hour at 60 degrees C. PP was then analyzed as SRP in a 1.0 cm cell at 880 nm following Strickland and Parsons (1972).

Molecular characterization of PP compounds was performed using subsamples of each POM type with 31P nuclear magnetic resonance (NMR) spectral analysis as per Cade-Menun et al. (2005). Samples were freeze-dried, extracted with a 25-mL solution of 0.25M NaOH 0.05M Na2EDTA for 4h, and then centrifuged. 1-mL aliquots of the supernatant and digested residue samples were analyzed for P concentrations via inductively coupled plasma optical emission spectroscopy (ICP-OES) to determine the extracted P and fraction that was not extracted. The remaining supernatant was analyzed for 31P-NMR spectroscopy on a 600 MHz Varian Unity INOVA spectrometer equipped with a 10mm broadband probe at 20 degrees C and a 90 degrees pulse. Compounds were identified by their chemical shifts (ppm) relative to an external orthophosphoric acid standard. After standardizing the orthophosphate peak in all samples to 6 ppm, peak assignments were based on Tebby and Glonek (1991) Cade-Menun and Preston (1996) and Turner et al. (2003b,c). Peak areas were calculated by integration of spectra processed with a 5 Hz line broadening, using NUTS software (Acorn NMR Inc.) as described in Paytan et al., (2003). Finally, the relative contribution of surface-adsorbed P was assessed for remaining TRICHO and DIATOM POM samples via the oxalate rinse method described in Fu et al. (2005); not enough material remained from PRO and OR-POM for similar analyses.

Data Processing Description

All data processing is described in Burkhardt et al. (2014). In general, data processing for nutrients involved conversion of raw absorbance data to nutrient concentrations using standard curves.

BCO-DMO processing:
- Re-formatted date and time fields; added ISO_DateTime_Local.
- Replaced blanks (missing data) and 'NaN' with 'nd' to indicate 'no data'.
- Modified parameter names to conform with BCO-DMO naming conventions.

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Data Files

File
pro.csv(Comma Separated Values (.csv), 5.06 KB) MD5:caf9e02a77ba087ee0d65245383bf977 Primary data file for dataset ID 557179

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Parameters

Parameter	Description	Units
replicate	Replicate identifier.	A or B
taxon	Taxon name.	text
exp_type	Experiment type/location. (lab = measured in the lab post-cruise; sea = measured at sea)	text
run_time_hrs	Experiment run-time.	hours
date	Month, day, and year (local time zone).	mm/dd/yyyy
time_local	Time, in hours and minutes (local time zone); 24-hour clock. Recorded during lab measurements.	HH:MM
run_id	Run identification number.	alphanumeric
PO4	Phosphate.	micromoles per liter (umol L-1)
NO3_NO2	Nitrate + nitrite.	micromoles per liter (umol L-1)
silicate	Silicate.	micromoles per liter (umol L-1)
NO2	Nitrite.	micromoles per liter (umol L-1)
NH4	Ammonium.	micromoles per liter (umol L-1)
ISO_DateTime_Local	Date and time (local time zone) formatted to the ISO 8601 standard.	YYYY-mm-ddTHH:MM:SS.xx

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Instruments

Dataset-specific Instrument Name	Carlo-Erba C/N Analyzer
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	A Carlo-Erba C/N Analyzer was used to determine particulate C (PC) and N (PN) content.
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	inductively coupled plasma optical emission spectroscopy (ICP-OES)
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Samples were analyzed for P concentrations via inductively coupled plasma optical emission spectroscopy (ICP-OES).
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	nuclear magnetic resonance (NMR)
Generic Instrument Name	Nuclear Magnetic Resonance Spectrometers
Dataset-specific Description	Molecular characterization of PP compounds was performed using subsamples of each POM type with 31P nuclear magnetic resonance (NMR) spectral analysis.
Generic Instrument Description	Instruments that identify and quantify magnetically active chemical entities by subjecting a sample to orthogonal magnetic and electrical fields.

Dataset-specific Instrument Name	Technicon Auto Analyzer II
Generic Instrument Name	Technicon AutoAnalyzer II
Dataset-specific Description	Nutrients were analyzed using flow-through colorimetric methods on a Technicon Auto Analyzer II.
Generic Instrument Description	A rapid flow analyzer that may be used to measure nutrient concentrations in seawater. It is a continuous segmented flow instrument consisting of a sampler, peristaltic pump, analytical cartridge, heating bath, and colorimeter. See more information about this instrument from the manufacturer.

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Deployments

KM1110

Website	https://www.bco-dmo.org/deployment/59056
Platform	R/V Kilo Moana
Report	http://dmoserv3.bco-dmo.org/jg/serv/BCO-DMO/DIAZOTROPHS_CO2/726342.html1%7Bdir=dmoserv3.whoi.edu/jg/dir/BCO-DMO/DIAZOTROPHS_CO2/,info=dmoserv3.bco-dmo.org/jg/info/BCO-DMO/DIAZOTROPHS_CO2/CO2_experimental%7D?cruise_id_eq_km1110
Start Date	2011-03-12
End Date	2011-03-23

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Project Information

Taxon-Specific Variability of Organic Matter Production and Remineralization Potential (Taxon-Specific Organic P-C-N Production)

Description from NSF award abstract:
The marine phosphorus (P) cycle is characterized by tight coupling between the uptake and decomposition of dissolved inorganic P (DIP) and dissolved organic P (DOP). DIP is incorporated into a broad range of cellular compounds integral for energy storage, genetic material and cell structure. Cell death and autolysis, exudation, viral lysis and grazing all lead to the release of DOP into the environment where it can be depolymerized, hydrolyzed, reassimilated, removed by absorption onto sinking particles or accumulate in the surrounding environment. In this manner, the form and composition of P in the marine environment is largely controlled by the metabolic activity of microorganisms and is intimately linked to the cycling of carbon (C) and nitrogen (N) as particulate organic P (POP) and DOP is bound to C and N in multiple forms, including esters, phospholipids and phosphonates. Thus, a consideration of marine P cycling is most relevant when P transformations are viewed as part of the nutrient and energy flow in the oceanic water column. At the ecosystem scale, the balance of productivity and respiration in the open ocean is regulated by the availability of potentially limiting nutrients such as C, N and P. Therefore, understanding the coupling of C, N, and P cycles is central to the determination of the long-term controls of the magnitude and variability of primary production and particle export. Nonetheless, a paucity of simultaneous measures of dissolved organic carbon (DOC), dissolved organic nitrogen (DON) and DOP and a relative lack of information on production and decomposition processes have hindered progress in understanding the coupled dynamics of these pools. Recent studies of dissolved organic matter (DOM) dynamics show large departures from Redfield trajectories driven by alterations in phytoplankton species composition, the stoichiometry and chemical composition of organic matter production, differential lability of organic compounds and preferential remineralization of N and P by heterotrophic bacteria. Furthermore, there is mounting evidence of the potential liberation of greenhouse gases occurring via DOP hydrolysis.

In this research, the investigators will characterize the composition, lability and remineralization stoichiometry of organic P-C-N produced by ecologically significant photosynthetic genera. They will conduct a series of in situ and laboratory-based bio-assays where particulate (POM) and DOM isolated from *Prochlorococcus* and phosphonate-containing strains of *Trichodesmium* are added to natural microbial populations and incubated in the laboratory and at sea. Hypothesis driven experiments will address the following objectives:

(1) Determine the elemental (P-C-N) stoichiometry and biomolecular alterations (31P-nuclear magnetic resonance) occurring in response to exogenous additions of *Trichodesmium* and *Prochlorococcus* POM and DOM to natural populations of heterotrophic bacteria, estimate the labile and semi-labile fraction of organic material generated by ecologically significant genera and measure potential aerobic production of select greenhouse gases (methane and ethane).

(2) Initiate decomposition experiments in the NPSG at opposing phases of the seasonal cycle (summer/winter) in order to capture varying microbial assemblages having different initial metabolic status and community structure.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0962362
NSF Division of Ocean Sciences (NSF OCE)	OCE-0961555

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