Dissolved organic matter (DOM) and base-extracted particulate organic matter (BEPOM) collected from a plankton senescence experiment from water samples offshore of North Carolina

Website: https://www.bco-dmo.org/dataset/773802
Data Type: experimental
Version: 1
Version Date: 2019-08-01

Project
» Collaborative Research: Planktonic Sources of Chromophoric Dissolved Organic Matter in Seawater (PlankDOM)

Contributors	Affiliation	Role
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Abstract
A mixed assemblage of natural phytoplankton community collected from waters offshore of North Carolina were used to create planktonic dissolved organic matter (DOM) and particulate organic matter (POM). The latter was extracted with 0.1 M NaOH to create base-extracted POM (BEPOM). Methods are reported in Kinsey et al. (2018) and Osburn et al. (2019). The medium used was: Natural Assemblage 2x filtered North Atlantic Surface water with f/2 nutrients; Whole water experiment - unfiltered North Atlantic Surface water with f/20 nutrients Irradiance ~70-100 umol photon m-2 s-1 (cool white bulbs); on roller table; diel cycle, 19 °C

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Coverage

Spatial Extent: **Lat**:34.65 **Lon**:-69.63
Temporal Extent: 2016-11-15 - 2017-01-16

Dataset Description

A mixed assemblage of natural phytoplankton community collected from waters offshore of North Carolina were used to create planktonic dissolved organic matter (DOM) and particulate organic matter (POM). The latter was extracted with 0.1 M NaOH to create base-extracted POM (BEPOM). Methods are reported in Kinsey et al. (2018) and Osburn et al. (2019).
The medium used was: Natural Assemblage 2x filtered North Atlantic Surface water with f/2 nutrients; Whole water experiment - unfiltered North Atlantic Surface water with f/20 nutrients Irradiance ~70-100 umol photon m-2 s-1 (cool white bulbs); on roller table; diel cycle, 19 °C

Controls: 0.2 um Filtered Sargasso seawater amended with f/2 nutrients; NASW (or WW) unfiltered Sargasso Seawater amended with f/20 nutrients; NASW: Sargasso seawater amended with plankton tow sample and f/2 nutrients. All samples were in 1.9 L bottles with minimal headspace.

Methods & Sampling

Inoculated bottles and seawater controls (medium without cells) were grown on a Wheaton roller apparatus rotating at ~1 rpm (Kinsey et al. 2018; Osburn et al. 2019) and maintained at 19 °C with a 12:12 light:dark cycle at ~90 µEs m−2 s−1 under cool-white fluorescent light in a growth incubator (Percival Scientific, Iowa). The algal assemblages reached stationary phase within ~20 days with cell densities at approximately 30,000 cells mL−1 with an average specific growth rate of 0.5. Changes in cell densities (mL−1) were based on microscopical cell counts (Olympus BX53) to monitor algal growth after preservation with acid Lugol's solution (5%) and settling varied volumes depending on growth phase. The remaining bottles were placed in the dark for 60 days of degradation to simulate transport of POM from surface waters to the mesopelagic ocean.

Sample aliquots were gently vacuum filtered through pre-combusted (450 °C, minimum 6 h) GF/F filters to collect particles for base extraction. The filtrate was collected in polycarbonate bottles for optical measurements and in pre-combusted borosilicate vials for DOC analysis. POM collected on GF/F filters was base-extracted with 0.1 M sodium hydroxide (NaOH) as described in Kinsey et al. (2018). DOC and base-extracted particulate organic carbon (from BEPOM solutions) were prepared and analyzed using an OI Analytical 1030D TOC analyzer as described in Kinsey et al. (2018). Limit of detection of this measurement was 0.11 mg C L-1; precision on standards (including the Hansell Deep Sea Reference material) was ± 0.04 mg C L−1.

Sodium borohydride (NaBH4) was used to reduce carbonyl groups (aldehydes, ketones) to their corresponding alcohols (Schendorf et al., 2016). CDOM and BEPOM samples from stationary and degradation stages were treated with 25-mass excess of NaBH4 (i.e., 15 mol borohydride per mole C per sample), using a basified 1M NaBH4 stock solution, and sparged with ultra-high purity argon gas for 24 h. Following reduction, samples were neutralized to their original pH and analyzed for absorbance and fluorescence as described below. For comparison, 2 mg C L−1 and 4 mg C L−1 samples of both SRFA (Lot 1R101F) and PLFA (Lot 1R109F) were prepared in MilliQ water. Optical measurements were taken before and after NaBH4 reduction for all samples.

Absorbance and fluorescence was measured from 200 to 800 nm on a Horiba Aqualog fluorescence spectrophotometer in 1 cm quartz cells (Starna Cells, Inc.). MilliQ water or a neutralized NaOH solution was used as a blank for initial DOM and BEPOM optical measurements, respectively. MilliQ water treated with NaBH4 was used as a blank following NaBH4 reduction. After blank subtraction, absorbance values (Aλ) were then converted to Napierian absorption coefficients (aλ) (Green and Blough, 1994).

Data Processing Description

Excel used for spreadsheets; Matlab (v 2016 to 2018) is used to process absorbance and fluorescence results and data and to conduct statistical testing using in-house scripts. SigmaPlot is used for data visualization.

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions

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Data Files

File
plankDOM_na1.csv (Comma Separated Values (.csv), 7.63 KB) MD5:cd1be4b199a13cc9c52b5b8e6c43e520 Primary data file for dataset ID 773802

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Related Publications

Green, S. A., & Blough, N. V. (1994). Optical absorption and fluorescence properties of chromophoric dissolved organic matter in natural waters. Limnology and Oceanography, 39(8), 1903–1916. doi:10.4319/lo.1994.39.8.1903
Methods

Kinsey, J. D., Corradino, G., Ziervogel, K., Schnetzer, A., & Osburn, C. L. (2018). Formation of Chromophoric Dissolved Organic Matter by Bacterial Degradation of Phytoplankton-Derived Aggregates. Frontiers in Marine Science, 4. doi:10.3389/fmars.2017.00430. Table 3.
Methods

Osburn, C. L., Kinsey, J. D., Bianchi, T. S., & Shields, M. R. (2019). Formation of planktonic chromophoric dissolved organic matter in the ocean. Marine Chemistry, 209, 1–13. doi:10.1016/j.marchem.2018.11.010
Results

Shields, M. R., Bianchi, T. S., Osburn, C. L., Kinsey, J. D., Ziervogel, K., Schnetzer, A., & Corradino, G. (2019). Linking chromophoric organic matter transformation with biomarker indices in a marine phytoplankton growth and degradation experiment. Marine Chemistry, 214, 103665. doi:10.1016/j.marchem.2019.103665
Methods

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Parameters

Parameter	Description	Units
sample_id	Sample ID	unitless
sample_date	Date sample measured	unitless
days	Days of incubation in day-month-year	unitless
growth	Time point of experiment	unitless
label_time_rep	Extra sample information	unitless
bottle_nr	Incubation bottle number	unitless
raw_invivo_flu	Raw in vivo fluorescence	arbitrary
bact_abund	Bacteria Abundance	cells per mL
doc	dissolved organic carbon	micromoles per Liter (umol/L)
dom_b	DOM fluorescence peak B	quinine sulfate units
dom_t	DOM fluorescence peak T	quinine sulfate units
dom_a	DOM fluorescence peak A	quinine sulfate units
dom_c	DOM fluorescence peak C	quinine sulfate units
dom_m	DOM fluorescence peak M	quinine sulfate units
dom_n	DOM fluorescence peak N	quinine sulfate units
dom_bix	Biological index	unitless
dom_hix	Humificaiton index	unitless
dom_a254	DOM absorption coefficient at 254 nm	inverse meters
dom_a300	DOM absorption coefficient at 300 nm	inverse meters
dom_a320	DOM absorption coefficient at 320 nm	inverse meters
dom_slope	Slope of DOM absorption from 300 to 650 nm	inverse micrometer

dom_S275_295	Slope of DOM absorption from 275 to 295 nm	inverse nanometer
dom_S350_400	Slope of DOM absorption from 350 to 400 nm	inverse nanometer
dom_SR	Ratio of S275-295 to S350-400	unitless
BEPOC	base-extracted POC concentration	micromoles per Liter (umol/L)
bepom_b	BEPOM fluorescence peak B	quinine sulfate units
bepom_t	BEPOM fluorescence peak T	quinine sulfate units
bepom_a	BEPOM fluorescence peak A	quinine sulfate units
bepom_c	BEPOM fluorescence peak C	quinine sulfate units
bepom_m	BEPOM fluorescence peak M	quinine sulfate units
bepom_n	BEPOM fluorescence peak N	quinine sulfate units
bepom_bix	Biological index	unitless
bepom_hix	Humificaiton index	unitless
bepom_a254	BEPOM absorption coefficient at 254 nm	inverse meters
bepom_a300	BEPOM absorption coefficient at 300 nm	inverse meters
bepom_a320	BEPOM absorption coefficient at 320 nm	inverse meters
bepom_slope	Slope of BEPOM absorption from 300 to 650 nm	inverse micrometer
bepom_S275_295	Slope of BEPOM absorption from 275 to 295 nm	inverse nanometer
bepom_S350_400	Slope of BEPOM absorption from 350 to 400 nm	inverse nanometer
bepom_SR	Ratio of S275-295 to S350-400	unitless

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Instruments

Dataset-specific Instrument Name	Horiba Aqualog Fluorescence Spectrometer
Generic Instrument Name	Spectrometer
Dataset-specific Description	Horiba Aqualog Fluorescence Spectrometer, absorbance and fluorescence. Calibrated with quinine sulfate solution after normalization to instrument’s water Raman peak. Fluorescence corrected for water blank, inner filtering effects.
Generic Instrument Description	A spectrometer is an optical instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.

Dataset-specific Instrument Name	OI Analytical Aurora 1030 W Total Organic Carbon (TOC) Analyzer
Generic Instrument Name	Total Organic Carbon Analyzer
Dataset-specific Description	OI Analytical Aurora 1030 W Total Organic Carbon (TOC) Analyzer: DOC & DIC. Calibrated with stock solutions of sodium bicarbonate (DIC) and caffeine (DOC). A certified reference material (CRM) for DIC is analyzed regularly as a check standard.
Generic Instrument Description	A unit that accurately determines the carbon concentrations of organic compounds typically by detecting and measuring its combustion product (CO2). See description document at: http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/bs116.pdf

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Project Information

Collaborative Research: Planktonic Sources of Chromophoric Dissolved Organic Matter in Seawater (PlankDOM)

Coverage: Northern Atlantic Ocean, 34.65 N, 69.63 W

NSF abstract:

Chromophoric dissolved organic matter (CDOM) is a small but important fraction of the marine carbon pool that interacts with solar radiation and thus affects many photochemical and biological processes in the ocean. Despite its importance, the chemical basis for the formation of oceanic CDOM remains unclear. CDOM may be formed from two possible sources: 1) heterotrophic bacterial transformations of primary productivity (plankton-derived), or 2) terrestrially-derived. This project will examine the role of phytoplankton as a source of CDOM in the ocean by utilizing a powerful, new technique to measure particulate organic matter absorbance and fluorescence, discrete chemical measurements of probable precursors to planktonic CDOM, and enzymatic assays. Results of this research will provide new insights into the origin and production of planktonic CDOM and its transformation by heterotrophic bacteria. This research on CDOM will be shared broadly through a module at a North Carolina Aquarium, and streaming live feeds of shipboard activities to elementary school classrooms.

Terrestrial and oceanic dissolved organic matter (DOM) differ in their chemical composition. Laboratory and open-ocean observations suggest that bacterial transformation of phytoplankton DOM produces humic-like CDOM signals that are visually similar to those in terrestrial CDOM. However, prior studies of oceanic CDOM using absorbance and fluorescence fit an electronic interaction (EI) model of intramolecular charge transfer (CT) reactions between donor and acceptor molecules common to partially-oxidized terrestrial molecules found in humic substances. This project will test the hypothesis that phytoplankton and bacteria provide a source of donors and acceptors that are microbially-transformed and linked, enabling CT contacts between them and creating oceanic CDOM. To address this, researchers will systematically study phytoplankton growth, including marine snow formation. A new technique for measuring base-extracted POM (BEPOM) absorbance and fluorescence will be used to incorporate planktonic CDOM results into the EI model, and supplemented with measurements of its probable chemical precursors. These experiments will improve understanding of how the production of CDOM in the ocean is linked to the optics and chemistry of planktonic CDOM formation. Determining the time course and extent of phytoplankton POM and DOM transformation by heterotrophic bacteria during the same phytoplankton growth experiments will provide an in-depth understanding as to how bacterial transformation of marine snow-associated planktonic organic matter drives CDOM production throughout the ocean.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1547976
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NSF Division of Ocean Sciences (NSF OCE)	OCE-1459294

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