

TEP and CSP particle concentrations from incubations collected from Station ALOHA and 31°N at 5m and 125m in the North Pacific in June 2021 on the R/V Kilo Moana cruise KM2108

Website: <https://www.bco-dmo.org/dataset/1010763>

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Project

» [Collaborative Research: Transparent exopolymer and phytoplankton vertical migration as sources for preformed nitrate anomalies in the subtropical N. Pacific Ocean](#) (TEP and phytoplankton migration)

Contributors	Affiliation	Role
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Abstract

This data includes transparent exopolymer particle (TEP) and Coomassie stainable particle (CSP) concentrations during incubation experiments at 5m and 125m collected from Station ALOHA and 31N during a 12-day June 2021 cruise aboard the R/V Kilo Moana (KM2108) that visited Station ALOHA to 31 N nominally along 158 W in the subtropical North Pacific. Particle concentrations are measured spectrophotometrically using Alcian blue (TEP) and Coomassie blue (CSP) dyes and reported in the semi-quantitative concentration units of xanthan gum equivalents $\mu\text{g} / \text{L}$ (TEP) and bovine albumen equivalents $\mu\text{g} / \text{L}$ (CSP). We also included nitrate, phosphate, dissolved organic phosphorus, dissolved organic nitrogen, and total organic carbon concentrations in μM units. In addition, INT in $\text{nM O}_2/\text{hr}$ units, Glucosidase in nM C/hr units, and cells. These analyses are a contribution to the project, "Collaborative Research: Transparent exopolymer and phytoplankton vertical migration as sources for preformed nitrate anomalies in the subtropical N. Pacific Ocean" funded by the Chemical and Biological Oceanography Programs at NSF.

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Coverage

Location: Station ALOHA 22.75 N, 158 W to 31 N, 156 W in the subtropical North Pacific Ocean

Spatial Extent: N:31 E:-156 S:22.45 W:-158

Temporal Extent: 2021-06-05 - 2021-06-15

Methods & Sampling

Seawater samples were collected from 22°45'N (S(5m), S(125m)) and 31°N (N(5m), N(125m)) in June 2021 at 5m and at 125m. At each station and depth, approximately 100 liters of seawater were collected and the following treatments were conducted in triplicate by placing 10L of initial volume into acid-cleaned and rinsed 10 L HDPE amber carboys (Justrite ®): (1) Whole water (W), 100% seawater; (2) Filtrate (F), 0.2 μm -filtered water; and (3) Mixed (M), 80% filtrate and 20% whole water.

For the F and M treatments, gravity filtration was used through an in-line Pall Acropak 1000 (0.8/0.2 µm) filter attached directly to the 50 L carboy spigot with silicone tubing. The incubation carboys were then stored in the dark within two deckboard environmental chambers maintained at the *in-situ* temperatures by use of recirculating surface or chilled (closed loop) seawater. The experiments were performed over a period of 80-100 hours, experiments S(5m), S(125m), and N(125m) were sampled at 4 discrete time points, and experiment N(5m) at 3 time points, after the incubation initiation, spaced at ~1-1.5 day intervals.

TEP and CSP particles were collected onto 0.4 µm polycarbonate filters from 1 liter each of incubation subsample filtrate collected for nutrient analysis. Filtration was achieved using a peristaltic pump and silicone tubing through a 25 mm polycarbonate filter holder. Filters containing particles were immediately stained with Alcian blue (TEP) or Coomassie blue (CSP) dyes and stored frozen at -20 degC until analysis on shore back at the University of New Hampshire. TEP and CSP concentrations were determined spectrophotometrically following the protocols of Bittar et al., (2018) for TEP and Cisternas-Novoa et al.,(2015) for CSP with minor modifications, and standardized with xanthan gum and bovine albumen, respectively.

Incubation samples collected from TEP/CSP filtering were put into 40 mL glass EPA vials with silicone septa tops and frozen at -20degC until analysis on shore back at the University of New Hampshire. Phosphate concentrations were measured using Shimadzu UV-1800 Dual Beam UV-Vis Spectrophotometer, and Nitrate concentrations were measured using Thermo Scientific 42iQ NO-NO₂-NO_x Analyzer. Total organic carbon was measured Shimadzu TOC-V CSH with TNM-1 and ASI-V Autosampler. All were measured at the University of New Hampshire. Dissolved organic phosphorus and dissolved organic nitrogen were computed after subtracting the relevant inorganic nutrient concentrations from the measured total dissolved phosphorus (TDP) and total dissolved nitrogen concentrations (TDN).

For INT, at each incubation time point, incubation water was subsampled and analyzed following the García-Martín et al., (2019) method. The INT reagent was added to the sample and placed in the incubation tank for 1.5 hours, and then placed in a -20°C freezer for later laboratory analysis. Once samples were at the UNH laboratory, samples were then added to acrylic 1 cm pathlength cuvettes and run on a Shimadzu UV-Vis spectrophotometer to measure the absorbance at 485 nm.

For cells, at each time point, samples were fixed with 0.01% glutaraldehyde and stored in a -80 °C freezer until they were measured at the UNH laboratory using a flow cytometer (Miltenyi BiotecMACSQuant VYB) with SYBR green as a DNA stain (Gasol & Del Giorgio, 2000). For measuring α-glucosidases, the incubated water was subsampled and 25 µL of 1mM MUF-a-D-glucopyranoside solution was added and shaken. During a 24-hours-period the fluorescence readings were performed at an excitation of 365-395 nm and emission of 440-470 nm using a handheld Turner® TBS-380 mini UV fluorometer. The fluorescence readings were calibrated using the MUF standard solution which was prepared within the range 10 – 250 µM MUF, with the slope and time duration of the 4-point glucosidase incubation at each time used to convert to nM C hr⁻¹ rates.

Problem Description

There was no INT data for experiment N(5m).

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Related Publications

Bittar, T. B., Passow, U., Hamaraty, L., Bidle, K. D., & Harvey, E. L. (2018). An updated method for the calibration of transparent exopolymer particle measurements. *Limnology and Oceanography: Methods*, 16(10), 621–628. doi:[10.1002/lom3.10268](https://doi.org/10.1002/lom3.10268)
Methods

Cisternas-Novoa, C., Lee, C., & Engel, A. (2015). Transparent exopolymer particles (TEP) and Coomassie stainable particles (CSP): Differences between their origin and vertical distributions in the ocean. *Marine Chemistry*, 175, 56–71. <https://doi.org/10.1016/j.marchem.2015.03.009>
Methods

García-Martín, E. E., Aranguren-Gassis, M., Karl, D. M., Martínez-García, S., Robinson, C., Serret, P., & Teira, E. (2019). Validation of the in vivo Iodo-Nitro-Tetrazolium (INT) Salt Reduction Method as a Proxy for Plankton Respiration. *Frontiers in Marine Science*, 6. <https://doi.org/10.3389/fmars.2019.00220>
Methods

Letscher, R. T., & Curran, K. (2025). TEP and CSP particle concentrations from samples collected from Station ALOHA to 31°N in the North Pacific in June 2021 on the R/V Kilo Moana cruise KM2108 (Version 1) [Dataset]. Biological and Chemical Oceanography Data Management Office (BCO-DMO). <https://doi.org/10.26008/1912/BCO-DMO.968636.1> <https://doi.org/10.26008/1912/bco-dmo.968636.1>
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Deployments

KM2108

Website	https://www.bco-dmo.org/deployment/968661
Platform	R/V Kilo Moana
Start Date	2021-06-05
End Date	2021-06-16
Description	A 12-day June 2021 cruise aboard the R/V Kilo Moana (KM-2108) that visited Station ALOHA to 31 N nominally along 158 W in the subtropical North Pacific. Cruise information provided by Chief Scientist Robert Letscher as it was not yet available at R2R.

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Project Information

Collaborative Research: Transparent exopolymer and phytoplankton vertical migration as sources for preformed nitrate anomalies in the subtropical N. Pacific Ocean (TEP and phytoplankton migration)

Coverage: North Pacific Gyre, Hawaii Ocean Time-Series

NSF Award Abstract:

The ocean is usually layered, with light and oxygen in the warmer surface and nutrients at the cooler depths. Biological and physical processes determine this distribution. Marine algae grow in the well-lit upper layers but need nutrients to grow. However, in the subtropics, the ocean's largest biome, the relationship between oxygen and nitrate (a key nutrient required for photosynthesis) is different from expected. Two processes could explain this. Nutrients could be transported upward by migrating giant single-celled algae (phytoplankton). Another explanation is that the production of an organic material called transparent exopolymer (TEP) takes up carbon without using nutrients or exporting carbon to depth, as would occur in photosynthesis. While both processes could be occurring, the relative contribution of migrating phytoplankton versus TEP would tell us whether the observed oxygen pattern in the upper ocean results from photosynthesis. This problem relates to the general question of where and how nutrients reach the well-lit surface waters to enable photosynthesis. These hypotheses are tested at the Hawaii Ocean Time-Series using in-situ camera systems to image and quantify the giant phytoplankton and direct water samples to measure the vertical distribution of TEP. The data are entered into numerical models to calculate the nitrate to oxygen relationships and add information about the carbon cycle. In addition to training of undergraduate students and a postdoctoral fellow, the cruises provide an opportunity to prepare a cadre of communication fellows who will develop materials and media, including videos, to translate this highly complex scientific concepts for the general public. The social media campaign #SaveOur70 provides a valuable venue to reach and engage with the public.

Quantifying nutrient transport, utilization, and its relationship to carbon drawdown in the subtropical gyres is fundamental to our understanding of the carbon cycle. Geochemical distributions from the well-characterized time-series sites near Hawaii and Bermuda have long-served to identify previously unknown links between subsurface nitrate fields, summertime dissolved inorganic carbon (DIC) drawdown, and net community production in the absence of known nutrient sources. Two recently suggested processes rise to prominence to explain anomalies in subtropical distributions of dissolved carbon, oxygen, and nitrate in the upper ocean: 1) nutrient transport by giant phytoplankton that vertically migrate, and 2) cycling of low N organic matter between the mixed layer and the upper nutricline as transparent exopolymer particles (TEP) or gel-like organic material (GLOM). While linked at a fundamental level (phytoplankton are TEP producers), the outcome of the two processes are distinct. Vertical migration of phytoplankton is an active transport of nitrate, acquired in the nutricline, to the surface. There is an implication of subsequent reduction, photosynthetic carbon fixation and eventual export. TEP/GLOM cycling results in apparent DIC drawdown but there is no net export out of the surface layer and no requirement for additional nutrient sources in the mixed layer. This project collects the data to quantify the contribution of these two processes to the observed anomalies in nitrate to oxygen distribution at the time-series station at Hawaii (HOT). This is accomplished by enumerating the vertically migrating, aflagellate flora (VMF), implementing a 1-D model on vertical migration, and coupling these results with a 1-D model of the contribution of N-poor carbon cycling patterns in the upper water column derived from TEP and carbohydrate measurements. The combined VMF and TEP/GLOM 1-D models are used to model the dissolved oxygen, carbon, and nitrate budgets at HOT allowing for attribution of both hypothesized processes to the observed preformed nitrate distribution, its formation rate, and summertime inorganic carbon drawdown.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1923687

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