

# Dissolved and particulate carbon and nitrogen data from seawater collected during CCGS John P. Tully cruises in the northeast Pacific Ocean from Vancouver Island to Station P from 2018 to 2020

**Website:** <https://www.bco-dmo.org/dataset/865893>

**Data Type:** Cruise Results

**Version:** 1

**Version Date:** 2021-12-07

## Project

» [Constraining Upper-Ocean Carbon Export with Biogeochemical Profiling Floats](#) (EXPORTS BGC Floats)

Contributors	Affiliation	Role
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<a href="#">Johannessen, Sophia</a>	Fisheries and Oceans Canada, Pacific Region (DFO MPO)	International Collaborator
<a href="#">Long, Jacqueline S.</a>	Monterey Bay Aquarium Research Institute (MBARI)	Contact, Technician
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## Abstract

This dataset includes observations of dissolved and particulate carbon and nitrogen from seawater samples collected during CCGS John P. Tully cruises from 2018 to 2020 in the northeast Pacific Ocean from Vancouver Island to Station P. Associated parameters such as dissolved inorganic carbon (DIC), total alkalinity (TA), and pH were also measured.

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## Coverage

**Spatial Extent:** N:50.613 E:-139.6662 S:49.63567 W:-145.0008

**Temporal Extent:** 2018-09-21 - 2020-02-16

## Methods & Sampling

Sampling was conducted aboard the CCGS John P. Tully during five cruises (2018-2020) in the northeast Pacific

from Vancouver Island to Station P (50°N, 145°W).

Fisheries and Oceans Canada (DFO) Cruise numbers: 2018-40, 2019-001, 2019-006, 2019-008, 2020-001

### **Particulate Nitrogen and Carbon**

**Cruise 2018-040:** Prior to use, Whatman 25 mm GF/C filters (~1.2 µm pore size) were placed in aluminum foil packets and baked at 450°C for 4.5 hours and allowed to cool overnight, sealed, and stored in a zip-lock bags in plastic Tupperware containers previously cleaned with a dilute solution of RBS-35 (Thermo Scientific) in deionized water. Filters were not pre-weighed for this cruise. Particulate concentration was determined using the amount of water filtered.

**Cruises 2019-001, 2019-006, 2019-008, and 2020-001:** Whatman 25 mm GF/F filters (~0.7 µm pore size) were used for all other cruises. Prior to use, GF/F filters were baked at 450°C for 4 hours and allowed to cool in the muffle furnace overnight. Further cooling took place in a desiccator. Once cooled to air temperature, filters were weighed on a Sartorius LE225B balance and then stored in individual PALL plastic 47mm filter holders until use.

### **All Cruises:**

For all cruises, all water bottles and silicone tubing used for sampling were initially cleaned in a dilute Extran solution and thoroughly rinsed with Type 1 deionized water. Water samples were collected from Niskin bottles directly into 330 mL to 1L HDPE bottles, through silicon tubing or, at times, directly from the Niskin. Sample bottles were rinsed three times with aliquots from the Niskin and then filled. Volumes varied depending on availability of bottles. Samples were filtered immediately. People doing the sampling wore either vinyl or nitrile gloves. Sample bottles/tubing were reused through the cruise and well-rinsed with sample water between Niskins/casts.

Pre-combusted filters were placed onto a filtration manifold and samples were filtered under vacuum at 5 mm Hg or less. For total particulate carbon, 0.2 µm filtered seawater was used as a final rinse down the sides of the filtration cups. For particulate organic carbon, acidified seawater (10% HCl) was used as a final rinse to purge off the carbonate.

Cleaned forceps were used to remove filters from the manifold and returned to their original containers. After sampling, the filters were oven dried at 30°C. Filters were then stored at -80°C until returned to the lab where they were dried at 30°C for 24 hours. Samples were cooled in a dessicator. They were then sent to Stanford University for further chemical analysis. Samples that arrived at Stanford were placed into plastic petri dishes.

At Stanford University, filters from all cruises were loaded into a Costech Analytical Technologies Zero Blank carousel attached to a Carlo Erba NA1500 Series 2 elemental analyzer (EA) at the Stanford University Stable Isotope Laboratory Facility. The EA was configured with a 10 ml oxygen loop, a combustion oxidation reactor set at 1080°C, reduction reactor at 650°C, magnesium perchlorate column to remove water, the chromatography column set to 60°C, and the thermal conductivity detector set at 190°C. The UHP grade helium flow rate was 65 ml per minute and the UHP oxygen used to enhance combustion was 20 ml per minute.

All standards were loaded into 5×9 mm tin capsules (Costech Analytical Technologies). An empty 5×9 mm tin was analyzed with each run sequence for blank correction. All GF/C and GF/F filters were loaded into 9×10 mm tin capsules and one pre-combusted GF/C or GF/F filter was loaded into a 9×10 mm tin capsule for blank correction. Each 31-drop run sequence was composed of 2 conditioners, 1 5×9 mm tin blank, 1 9×10 mm filter blank, 2 acetanilide standards, 7 unknown filters, 1 acetanilide standard, 7 unknown filters, 1 acetanilide standard, 7 unknown filters, 2 acetanilide standards.

Though instrument precision is relatively high ( $\pm 1 \mu\text{g N}$ , and  $\pm 2 \mu\text{g C}$ ), overall uncertainty is strongly tied to the sampling procedure, with errors anticipated to range from 10% to 25%.

### **Dissolved Inorganic Carbon, Total Alkalinity, and pH**

Samples were collected following standard protocols (Dickson et al., 2007) into 500 mL borosilicate glass bottles and preserved with 200 µL saturated mercuric chloride for later analysis. Samples were shipped to and analyzed at the Monterey Bay Aquarium Research Institute (MBARI). Three parameters (DIC, TA, and pH) were measured from each 500 mL sample bottle. All samples were run in triplicate, and the results were averaged. DIC and TA instrument performance was monitored by measuring Certified Reference Material (CRM; provided by Andrew Dickson at SIO) approximately hourly.

## Data Processing Description

### Particulate Nitrogen and Carbon

Analyses were conducted using a Costech Analytical Technologies Zero Blank carousel attached to a Carlo Erba NA1500 Series 2 elemental analyzer (EA). The instrument precision was estimated from Acetanilide standards (189 measurements over 24 unique sampling dates) as the standard deviation of weight percent measurements for both carbon and nitrogen multiplied by the mean total weight.

The data obtained from the Carlo Erba NA1500 Series 2 elemental analyzer were calibrated using Acetanilide standard composed of 10.36 Wt. % N and 71.09 Wt. % C.

K-factor (KF) method was used to correct all unknown data using 6 acetanilide standards using the following equations.

Where:  $KF = (\text{mass mg} * 10.36) / (\text{Area N} - \text{Area N blank})$   
 $KF = (\text{mass mg} * 70.09) / (\text{Area C} - \text{Area C blank})$

Sample C and N concentrations were calculated as follows:

Where:  $\mu\text{g/L N} = \{(\text{Average KF} * (\text{Area N} - \text{Area N blank})) / \text{Volume Filtered (L)}\} * (1000 \mu\text{g} / 1 \text{ mg})$   
 $\mu\text{g/L C} = \{(\text{Average KF} * (\text{Area C} - \text{Area C blank})) / \text{Volume Filtered (L)}\}$

### Dissolved Inorganic Carbon (DIC)

DIC was analyzed using a custom automated system in which a Kloehe V6 syringe pump (5 mL syringe) handles fluid control, delivering 1.75 mL of sample to a custom designed CO<sub>2</sub> stripping chamber. 200  $\mu\text{L}$  of 5% phosphoric acid (H<sub>3</sub>PO<sub>4</sub>) is subsequently added to the CO<sub>2</sub> stripping chamber for acidification of the sample. CO<sub>2</sub>-free gas is then bubbled through the acidified sample and the evolved CO<sub>2</sub>(g) is delivered to a LiCOR 7000 Nondispersive Infrared gas analyzer for measurement. Carrier gas flow rate is controlled using a mass flow controller. The DIC concentration of the sample is proportional to the integral of the LiCOR CO<sub>2</sub>(g) sample peak. The LiCOR 7000 is calibrated annually using WMO traceable standard gases containing known CO<sub>2</sub> mole fractions. The average accuracy of the instrument relative to CRMs is better than than 1  $\mu\text{mol kg}^{-1}$ .

Sampling precision ( $\sigma_s$ ) was estimated by analyzing sets of replicate samples drawn from the same Niskin bottle during rosette casts. The average standard deviation between replicate sets was found to be  $\pm 1.5 \mu\text{mol kg}^{-1}$  ( $n = 8$ ). Analytical precision ( $\sigma_i$ ) was estimated as the standard deviation of CRM samples, post calibration factor implementation, analyzed intermittently with the cruise samples over the course of a few days. The analytical precision was found to be  $\pm 0.7 \mu\text{mol kg}^{-1}$  ( $n = 23$ ). The overall measurement precision of 1.6  $\mu\text{mol kg}^{-1}$  was estimated by combining the sampling precision and analytical precision [ $(\sigma_s^2 + \sigma_i^2)^{0.5}$ ], which is the square root of the sum of the squares.

### Total Alkalinity (TA)

Total Alkalinity was analyzed using a Metrohm 855 automated titrator following standard open cell alkalinity titration procedures. The titrant was comprised of 0.1 M hydrochloric acid (HCl) in a 0.7 M sodium chloride (NaCl) background solution. The titration temperature was held constant at  $20.0 \pm 0.2^\circ\text{C}$  throughout the titration. The temperature of the sample was measured immediately upon delivery to the jacketed cell for later sample mass determination using density and volume. The average accuracy of the instrument relative to Certified Reference Material (CRM) is better than 1  $\mu\text{mol kg}^{-1}$ .

Sampling precision ( $\sigma_s$ ) was estimated by analyzing sets of replicate samples drawn from the same Niskin bottle during rosette casts. The average standard deviation between replicate sets was found to be  $\pm 1.5 \mu\text{mol kg}^{-1}$  ( $n = 8$ ). Analytical precision ( $\sigma_i$ ) was estimated as the standard deviation of CRM samples, post calibration factor implementation, analyzed intermittently with the cruise samples over the course of a few days. The analytical precision was found to be  $\pm 1.4 \mu\text{mol kg}^{-1}$  ( $n = 13$ ). The overall measurement precision of 2.1  $\mu\text{mol kg}^{-1}$  was estimated by combining the sampling precision and analytical precision [ $(\sigma_s^2 + \sigma_i^2)^{0.5}$ ], which is the square root of the sum of the squares.

### pH

pH was analyzed using an Agilent 8453 spectrometer in an automated system designed after the one described in *Carter et al.*, (2013). The temperature of the sample was held constant at  $20^\circ\text{C}$  using a 10-cm jacketed cell, and every sample was immersed in a  $20^\circ\text{C}$  water bath for at least 25 minutes before analysis. An indicator dye (purified m-cresol purple from Sunburst Sensors - lab batch 6) solution (2 mM) was used to

assess sample pH. The sample pH perturbation caused by dye addition was quantified by adding both the normal amount and twice the amount of dye to seawater solutions of ~pH 7.4, 7.8, and 8.1. The pH perturbation caused by dye addition to the sample was quantified by adding both the normal amount and twice the amount of dye to a subset of seawater samples. The average precision of the instrument is  $\pm 0.004$ .

Sampling precision ( $\sigma_s$ ) was estimated by analyzing sets of replicate samples drawn from the same Niskin bottle during rosette casts. The average standard deviation between replicate sets was found to be  $\pm 0.0031$  ( $n = 9$ ). Instrument precision ( $\sigma_i$ ) is estimated to be  $\pm 0.004$ . The overall measurement precision of 0.005 was estimated by combining the sampling precision and instrument precision  $[(\sigma_s^2 + \sigma_i^2)^{0.5}]$ , which is the square root of the sum of the squares.

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### BCO-DMO Processing:

- Imported data from source file "LineP\_QCd\_bottle\_data.xlsx" into the BCO-DMO data system.
- Data file imported using missing data identifiers "NaN". The missing data identifier "NaN" in the original source file will be displayed as appropriate based on the type of file you download from the BCO-DMO data system. For example, missing data will be shown as blank (null) values in the csv files. In MATLAB .mat files it will be displayed as NaN. When viewing data at BCO-DMO the missing value will be shown as "nd" meaning "no data."
- Adjusted dates to be four digit years, and padded time column with leading zeros. Then converted separate date and time to single datetime column with ISO8601 format.
- Added column for vessel/ship
- Added conventional header with dataset name, PI name, version date.
- Modified parameter (column) names to conform with BCO-DMO naming conventions. (The only allowed characters are A-Z,a-z,0-9, and underscores. No spaces, hyphens, commas, parentheses, or Greek letters).

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## Data Files

File
<b>discrete.csv</b> (Comma Separated Values (.csv), 45.11 KB) MD5:df9927f77bb60bd879b7630103e53d506
Primary data file for dataset ID 865893

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## Related Publications

Carter, B. R., Radich, J. A., Doyle, H. L., & Dickson, A. G. (2013). An automated system for spectrophotometric seawater pH measurements. *Limnology and Oceanography: Methods*, 11(1), 16–27.

doi:[10.4319/lom.2013.11.16](https://doi.org/10.4319/lom.2013.11.16)

*Methods*

Dickson, A. G., Afghan, J. D., & Anderson, G. C. (2003). Reference materials for oceanic CO<sub>2</sub> analysis: a method for the certification of total alkalinity. *Marine Chemistry*, 80(2), 185–197.

[https://doi.org/10.1016/S0304-4203\(02\)00133-0](https://doi.org/10.1016/S0304-4203(02)00133-0)

*Methods*

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to Best Practices for Ocean CO<sub>2</sub> Measurements. PICES Special Publication 3, 191 pp <https://isbnsearch.org/isbn/1-897176-07-4>

*Methods*

## Related Datasets

### IsRelatedTo

Fassbender, A. J., Long, J. S., Takeshita, Y. (2021) **Underway pH of seawater sampled during CCGS John P. Tully cruises in the northeast Pacific Ocean from Vancouver Island to Station P from 2019 to 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-12-13 doi:10.26008/1912/bco-dmo.866582.1 [[view at BCO-DMO](#)]

Johannessen, S., Fassbender, A. J., Long, J. S., Wright, C. (2021) **DOC and TOC of seawater collected during CCGS John P. Tully cruises in the northeast Pacific Ocean from Vancouver Island to Station P from 2018 to 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-12-06 doi:10.26008/1912/bco-dmo.865829.1 [[view at BCO-DMO](#)]

## Parameters

Parameter	Description	Units
ISO_DateTime.UTC	Date and time in ISO8601 standard format (YYYY-MM-DDThh:mm:ssZ)	unitless
Vessel	Vessel	unitless
Cruise_ID	Cruise	unitless
Event_Number	Event number	unitless
Station	Station number	unitless
Niskin	Niskin bottle number	unitless
Latitude	Latitude of sample collection	decimal degrees
Longitude	Longitude of sample collection	decimal degrees
Depth	Depth of sample collection	meters (m)
PON_GFF	Particulate Organic Nitrogen sampled using GF/F filter. Instrument precision $\pm 1 \mu\text{g N}$ . Reference standard is acetanilide from Costech Analytical	micrograms per liter (ug N/L)
POC_GFF	Particulate Organic Carbon sampled using GF/F filter. Instrument precision $\pm 2 \mu\text{g C}$ . Reference standard is acetanilide from Costech Analytical	micrograms per liter (ug C/L)
QF_GFF_PO	Quality flag for particulate organics on GF/F filter where 2=acceptable; 3=questionable; 4=bad; 5=not reported; 6=mean of replicates; 9=not sampled	unitless
Comments_GFF_PO	Comments for particulate organic samples on GF/F filters	unitless
PON_GFC	Particulate Organic Nitrogen sampled using GF/C filter. Instrument precision $\pm 1 \mu\text{g N}$ . Reference standard is acetanilide from Costech Analytical	micrograms per liter (ug N/L)
POC_GFC	Particulate Organic Carbon sampled using GF/C filter. Instrument precision $\pm 2 \mu\text{g C}$ . Reference standard is acetanilide from Costech Analytical	micrograms per liter (ug C/L)
QF_GFC_PO	Quality flag for particulate organics on GF/C filter where 2=acceptable; 3=questionable; 4=bad; 5=not reported; 6=mean of replicates; 9=not sampled	unitless
Comments_GFC_PO	Comments for particulate organic samples on GF/C filters	unitless

TPN_GFF	Total Particulate Nitrogen sampled using GF/F filter. Instrument precision $\pm 1 \mu\text{g N}$ . Reference standard is acetanilide from Costech Analytical	micrograms per liter (ug N/L)
TPC_GFF	Total Particulate Carbon sampled using GF/F filter. Instrument precision $\pm 2 \mu\text{g C}$ . Reference standard is acetanilide from Costech Analytical	micrograms per liter (ug C/L)
QF_GFF_TP	Quality flag for total particulates on GF/F filter where 2=acceptable; 3=questionable; 4=bad; 5=not reported; 6=mean of replicates; 9=not sampled	unitless
Comments_GFF_TP	Comments for total particulate samples on GF/F filter	unitless
TPN_GFC	Total Particulate Nitrogen sampled using GF/C filter. Instrument precision $\pm 1 \mu\text{g N}$ . Reference standard is acetanilide from Costech Analytical	micrograms per liter (ug N/L)
TPC_GFC	Total Particulate Carbon sampled using GF/C filter. Instrument precision $\pm 2 \mu\text{g C}$ . Reference standard is acetanilide from Costech Analytical	micrograms per liter (ug C/L)
QF_GFC_TP	Quality flag for total particulates on GF/C filter	unitless
Comments_GFC_TP	Comments for total particulate samples on GF/C filter	unitless
DIC	Dissolved Inorganic Carbon where measurement precision is $\pm 1.6 \mu\text{mol per kg}$ . Certified Reference Material provided by Andrew Dickson at SIO.	micromoles per kilogram (umols/kg)
DIC_flag	Quality flag for DIC where 2=acceptable; 3=questionable; 4=bad; 5=not reported; 6=mean of replicates; 9=not sampled	unitless
TA	Total Alkalinity where measurement precision is $\pm 2.1 \mu\text{mol per kg}$ . Certified Reference Material provided by Andrew Dickson at SIO	micromoles per kilogram (umols/kg)
TA_flag	Quality flag for Total Alkalinity where 2=acceptable; 3=questionable; 4=bad; 5=not reported; 6=mean of replicates; 9=not sampled	unitless
R	Ratio of spectrophotometric absorbance at 578 nm versus 434 nm. Instrument wavelength accuracy is $\pm 0.5 \text{ nm}$	unitless
pH_20_deg	Total scale pH measured at 20 degrees Celsius. Measurement precision is $\pm 0.005$	unitless
pH_in_situ	Total scale pH converted to in situ temperature from 20 degrees Celsius measurement	unitless
pH_flag	Quality flag for pH where 2=acceptable; 3=questionable; 4=bad; 5=not reported; 6=mean of replicates; 9=not sampled	unitless

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## Instruments

<b>Dataset-specific Instrument Name</b>	Metrohm 855 automated titrator
<b>Generic Instrument Name</b>	Automatic titrator
<b>Dataset-specific Description</b>	The average accuracy of the Metrohm 855 automated titrator relative to Certified Reference Materials is better than $1 \mu\text{mol per kilogram}$ .
<b>Generic Instrument Description</b>	Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

<b>Dataset-specific Instrument Name</b>	Carlo Erba NA1500 Series 2 elemental analyzer
<b>Generic Instrument Name</b>	Carlo-Erba NA-1500 Elemental Analyzer
<b>Dataset-specific Description</b>	Particulate nitrogen and carbon were measured using a Costech Analytical Technologies Zero Blank carousel attached to a Carlo Erba NA1500 Series 2 elemental analyzer
<b>Generic Instrument Description</b>	A laboratory instrument that simultaneously determines total nitrogen and total carbon from a wide range of organic and inorganic sediment samples. The sample is completely and instantaneously oxidised by flash combustion, which converts all organic and inorganic substances into combustion products. The resulting combustion gases pass through a reduction furnace and are swept into the chromatographic column by the carrier gas which is helium. The gases are separated in the column and detected by the thermal conductivity detector which gives an output signal proportional to the concentration of the individual components of the mixture. The instrument was originally manufactured by Carlo-Erba, which has since been replaced by Thermo Scientific (part of Thermo Fisher Scientific). This model is no longer in production.

<b>Dataset-specific Instrument Name</b>	LiCOR 7000 Nondispersive Infrared gas analyzer
<b>Generic Instrument Name</b>	LI-COR LI-7000 Gas Analyzer
<b>Dataset-specific Description</b>	The evolved CO <sub>2</sub> gas is delivered to a LiCOR 7000 Nondispersive Infrared gas analyzer for measurement. The LiCOR 7000 is calibrated annually using WMO traceable standard gases containing known CO <sub>2</sub> mole fractions. The average accuracy of the instrument relative to CRMs is better than 1 µmol per kilogram.
<b>Generic Instrument Description</b>	The LI-7000 CO <sub>2</sub> /H <sub>2</sub> O Gas Analyzer is a high performance, dual cell, differential gas analyzer. It was designed to expand on the capabilities of the LI-6262 CO <sub>2</sub> / H <sub>2</sub> O Gas Analyzer. A dichroic beam splitter at the end of the optical path provides radiation to two separate detectors, one filtered to detect radiation absorption of CO <sub>2</sub> and the other to detect absorption by H <sub>2</sub> O. The two separate detectors measure infrared absorption by CO <sub>2</sub> and H <sub>2</sub> O in the same gas stream. The LI-7000 CO <sub>2</sub> / H <sub>2</sub> O Gas Analyzer is a differential analyzer, in which a known concentration (which can be zero) gas is put in the reference cell, and an unknown gas is put in the sample cell.

<b>Dataset-specific Instrument Name</b>	Niskin bottle
<b>Generic Instrument Name</b>	Niskin bottle
<b>Dataset-specific Description</b>	Seawater samples for dissolved and total organic carbon were collected from 10 L Niskin bottles
<b>Generic Instrument Description</b>	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.

<b>Dataset-specific Instrument Name</b>	Kloehn V6 syringe pump
<b>Generic Instrument Name</b>	Pump
<b>Dataset-specific Description</b>	A custom analysis system for DIC was used in which a Kloehn V6 syringe pump (5 mL syringe) handles fluid control.
<b>Generic Instrument Description</b>	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

<b>Dataset-specific Instrument Name</b>	Sartorius LE225B balance
<b>Generic Instrument Name</b>	scale
<b>Dataset-specific Description</b>	Filters were weighed on a Sartorius LE225B balance
<b>Generic Instrument Description</b>	An instrument used to measure weight or mass.

<b>Dataset-specific Instrument Name</b>	Agilent 8453 spectrometer
<b>Generic Instrument Name</b>	Spectrophotometer
<b>Dataset-specific Description</b>	Agilent 8453 UV-visible Spectroscopy System (aka Agilent 8453 spectrophotometer) has average precision of $\pm 0.004$ .
<b>Generic Instrument Description</b>	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

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## Deployments

### Line-P cruises

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/744516">https://www.bco-dmo.org/deployment/744516</a>
<b>Platform</b>	CCGS John P. Tully
<b>Description</b>	Line P is an oceanic transect of 26 periodically sampled stations running from southern Vancouver Island to "Ocean Station Papa", situated at 50°N 145°W. Ocean (Weather) Station Papa, station P26, was originally operated as an ocean weather station from December of 1949 through 1981. After 1981, the Line-P / Station-P program was then taken over by the Institute of Ocean Sciences from Fisheries and Oceans Canada (DFO). While hydrographic (CTD-based) measurements are made at all of the 26 sites, water chemistry (bottle rosettes) and plankton (bongo) samples are only made at stations P4, P8, P12, P16, P20, and P26. Of those expanded sampling variables sites, all but P8 are featured in this web summary. See: <a href="https://www.st.nmfs.noaa.gov/copepod/time-series/ca-50903/https://www.wa...">https://www.st.nmfs.noaa.gov/copepod/time-series/ca-50903/https://www.wa...</a>

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## Project Information



## Constraining Upper-Ocean Carbon Export with Biogeochemical Profiling Floats (EXPORTS BGC Floats)

**Coverage:** Eastern Subarctic Pacific near Ocean Station Papa (50°N, 145°W)

OCE-1756932 Start Date: 2018-03-01

OCE-2032754 Start Date: 2020-05-28

### NSF abstract:

A goal in chemical oceanography is to advance our understanding of the global carbon cycle, specifically to quantify the transfer of carbon from the surface ocean to depth through the sinking of particles produced by marine organisms. Yet, modern global estimates of this process (commonly called carbon export) differ by over 100%. These estimates are often derived from regional relationships between ocean measurements and satellite observations that are then applied globally. Persistent differences between the satellite and field-based estimates of carbon export have been found throughout the ocean, suggesting that improvements are needed. This project will determine whether profiling floats equipped with chemical sensors can be used to estimate the export of carbon in the ocean. Floats will be deployed at Ocean Station Papa, but the approach is scalable in nature and could be used to validate and improve the satellite algorithms used for global carbon export determinations. The project will support a female, early career scientist and a postdoc, as well as facilitate international collaboration with Canadian scientists. Additionally, the results may assist the National Aeronautics and Space Administration (NASA) EXPORTS campaign as well as other satellite carbon export development efforts.

Modern global estimates of the biological pump differ by over 100% (~5 to >12 Pg C yr<sup>-1</sup>) making it challenging to determine the role of marine biogeochemical (BGC) cycling in modern climate and climate variability. Global carbon export estimates are often derived from regional empirical relationships between field and satellite observations that are then applied globally. Persistent discrepancies between unique satellite algorithms and unique geochemical approaches suggest that accurately quantifying the biological pump remains a fundamental research goal. This project will assess the capability of using BGC profiling floats to estimate the export of distinct biogenic carbon pools (dissolved and particulate organic carbon, and particulate inorganic carbon). By using BGC floats to close multiple upper ocean tracer budgets this project will address two known issues common to other geochemical approaches: assumptions about (1) dissolved organic carbon cycling and (2) the integration depth used for annual carbon export assessments. The method will be tested at Ocean Station Papa, but is scalable in nature and could be used to develop a carbon export database suitable for the validation and training of satellite algorithms required for global carbon export determinations. Results from the floats will be compared to satellite carbon export algorithm estimates over the 5-year float lifetimes. Ten years of existing BGC data from profiling floats and a mooring in the region will also be used to provide further context about interannual variability.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-2032754</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1756932</a>

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