

# Cross-polarized photon yield, beam attenuation coefficient, scattering, and fluorescence data derived from optical particle sensors interfaced to a CTD deployed during McLane pump casts on the GP17-OCE R/V Roger Revelle (RR2214) cruise Dec 2022 - Jan 2023

**Website:** <https://www.bco-dmo.org/dataset/956099>

**Data Type:** Cruise Results

**Version:** 1

**Version Date:** 2025-03-13

## Project

- » [US GEOTRACES GP17 Section: South Pacific and Southern Ocean \(GP17-OCE\)](#) (GP17-OCE)
- » [Autonomous Ocean Carbon Observer Development and Calibration](#) (OCO Development)

## Program

- » [U.S. GEOTRACES](#) (U.S. GEOTRACES)

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## Abstract

This dataset was derived from optical particle sensors interfaced to a logging CTD and deployed during McLane Pump casts of the as part of the GEOTRACES GP17-OCE Expedition from the south Pacific gyre to Southern Ocean (R/V Roger Revelle RR2214). Data files are provided containing data for the 0-500 meter depth interval and also for the full water column. Files include measures of particle birefringence photon yield (units of parts per million per meter) and particle beam attenuation coefficient (units of per meter), scattering (units of mFTU), and chlorophyll estimated from fluorescence readings. Note McLane CTD scatting profiles are available only at GP17-OCE stations 1, 3, 6, 8, 12, and 14. The two PIC sensors (PIC010, and PIC011) used in this study have been extensively documented (Bishop et al. 2022). Briefly, the sensors are built on a digital WETLabs C-star 25cm pathlength 6000-meter rated transmissometer. A 660-nanometer laser replaced the transmissometer's LED light source. High crossing efficiency polarizers were externally mounted to both source and receiver windows; the source polarizer is aligned with the plane of polarization of the laser and the receiver polarizer is crossed to minimize transmission of the direct beam. As light from the primary beam encounters birefringent particles, its plane of polarization is rotated and the sensor receives a signal. Details of methodology are included in Bishop et al., 2022 (doi: 10.3389/frsen.2022.837938).

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## Coverage

**Spatial Extent:** N:-19.9998 E:-146.4009 S:-52.3119 W:-152.0002

**Temporal Extent:** 2022-12-04 - 2022-12-24

## Methods & Sampling

Methods and Sampling information are described by Bishop, et al. (2022) as well as in supplemental information accompanying this dataset. In this dataset, a logging CTD was deployed during McLane pump casts. Profile data had three segments: down cast, while pumps were operating, and up cast. During deep and intermediate water sampling, the battery-powered CTD stopped recording before the up cast. Data during pump operation are not included in this data submission. The CTD and sensors were lost near 55S, 145W due to extreme ship roll at GP17 Station 16. Please consult the text file: 10\_processing\_notes.txt.

## Data Processing Description

The data processing methodology is as described in Li, et al. (2025) and in Bishop, et al. (2022). Processing code logic was finalized in August 2024.

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Processing logic:

# CST1450 Processing

# cst1450c=(cst1450-cst1450z)/cst1450r - cum1450dr - cst1450t\*0.3

# tr=cst1450c/CST1450\_NetVref

# cp1450\_sd=-4\*ln((CST1450\_NetVref-cst1450\_sd)/CST1450\_NetVref)

# cp1450=-4\*ln(tr)

#

# PIC011 processing

# prc=-PIC011\_PRcoefft\*press ! pressure correction

# drc=PIC011\_driftMULT\*cum1450dr ! drift correction

# tmc=pic011t\*PIC011t\_Mult ! thermal shock correction

#

# pic011zc=pic011-PIC011\_z

# pic011cc=(pic011zc-PIC011\_NETcross\*tr)/pic011r

# adjpic=drc+tmc

# pic011p=(pic011-adjpic)/tr^0.5+prc

# pic011Biref=pic011p\*PIC011\_BIREF

# pic011Biref\_sd=picuse\_sd\*644.4

#

# Fluorometer Processing

# chl\_flwl=(flwlv-Flwl\_z)\*Flwl\_Mult

# chl\_flwl\_sd=(0.02^2+(Flwl\_Mult\*flwlv\_sd)^2)^0.5

# chl\_flwl\_n=flwlv\_n

#

# Turbidity Processing

# mFTU=(seapoint-seapoint\_Z)\*5000

# mFTU\_sd=seapoint\_sd\*5000

# mFTU\_n=seapoint\_n

#

## Problem Description

1) Scattering and Fluorescence-based Chlorophyll data.

Scattering - there are no issues with Seapoint turbidity sensor data.

Fluorescence Chl - WETLabs FLNTU sensor data are scaled to be consistent with similar data derived from sensors on the GTC and ODF CTDs. Data are not calibrated.

At depths below 300 m, any Fluorescence-based Chl data are not believable.

## 2) PIC sensor data:

During cast 9 at station 1 (s01d), the salinity and temperature sensors were blocked.

Since temperature data are used for PIC sensor data reduction, all of the temp, sal, theta, and sigth data from the cast were replaced using averaged profile data from GP17 ODF CTD at the same station.

The best profiles are from station 14s and 14d and 3s. The deep cast data at stations 3 and 12 indicate a systematic maximum in intermediate waters.

For this cruise, the Birefringence data for pic011 are secondary to those for pic010 on the GTC rosette.

## 3) Transmissometer-based transmittance and beam attenuation coefficient data:

Transmissometer CST1450DR was connected to the CTD using a faulty cable and results were contaminated by dropouts. The quality of upper 500m data is best.

Cast s03m had 60% of readings that were bad - on most casts deeper than 500m. For GP17, beam attenuation coefficient data from CST1874 on the ODF rosette is of highest quality.

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cast_id	tr_flag	trdrops	reads,%bad	trdrops500	reads500,%bad500
s01s	1,	121,	596, 20,	54,	287, 19
s01d	2,	470,	1140, 41,	2,	173, 1
s03s	1,	158,	557, 28,	103,	271, 38
s03d	4,	28,	87, 32,	28,	87, 32
s03m	2,	425,	711, 60,	33,	149, 29
s06s	1,	172,	664, 26,	68,	233, 39
s08s	1,	53,	378, 14,	6,	124, 5
s12s	1,	92,	688, 13,	63,	244, 31
s12d	2,	128,	1267, 10,	2,	167, 2
s14s	1,	0,	737, 0,	0,	318, 0
s14d	1,	30,	1051, 3,	1,	211, 0

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## Supplemental Files

File	
<b>01_GP17_MCL_CTD_Cast_Parameters_submit.csv</b>  Metadata file for dataset ID 956099, version 1. This file contains the parameter (column) definitions for file "02_GP17_MCL_CTD_Cast_Data_Values_submit.csv". Includes dates, times, latitude, longitude, etc. and cast-specific parameters used in the Optical Sensor data reduction. Also included are euphotic zone depth.	(Comma Separated Values (.csv), 2.34 KB) MD5:205a3920ce1c7c1dccb111e6e6ea6dad
<b>02_GP17_MCL_CTD_Cast_Data_Values_submit.csv</b>  Data file for dataset ID 956099, version 1. This file contains the CTD data used in the Optical Sensor data reduction. Also included is track distance and euphotic zone depth.	(Comma Separated Values (.csv), 3.23 KB) MD5:664f5eb1ca9f8336fce431ca46a7ce5d
<b>03_GP17_MCL_CTD_Profile_Average_Parameters_Submit.csv</b>  Metadata file for dataset ID 956099, version 1. This file contains the parameter (column) definitions for files "04_GP17_MCL_CTD_Profile_Average_0500m_data.csv" and "05_GP17_MCL_CTD_Profile_Average_6000m_data.csv".	(Comma Separated Values (.csv), 1.49 KB) MD5:50d5afbfcfc6526f18652593b3efba3c
<b>04_GP17_MCL_CTD_Profile_Average_0500m_data.csv</b>  Data file for dataset ID 956099, version 1. This file contains the profile data for hydrographic and optical data (mean and standard deviation) over all CTD casts at each GP17-OCE station. Data are averaged over 5-meter (m) intervals and profiles extend from ~5 m to 500 m. Stations 1, 3, 6, 8, 12, and 14.	(Comma Separated Values (.csv), 132.45 KB) MD5:de5d42eb95907c13f9deeb22de1722c7
<b>05_GP17_MCL_CTD_Profile_Average_6000m_data.csv</b>  Data file for dataset ID 956099, version 1. This file contains the profile data for hydrographic and optical data (mean and standard deviation) over all CTD casts at each GP17-OCE station. Data are averaged over 10-meter (m) intervals and profiles extend from ~5 m to 6000 m. Stations 1, 3, 6, 8, 12, and 14.	(Comma Separated Values (.csv), 346.55 KB) MD5:28f062e33215cce35520bf866d2412f6
<b>06_GP17_MCL_CTD_Profile_ByCast_Parameters_Submit.csv</b>  Metadata file for dataset ID 956099, version 1. This file contains the parameter (column) definitions for files "07_GP17_MCL_CTD_Profile_ByCast_0500m_data.csv" and "08_GP17_MCL_CTD_Profile_ByCast_6000m_data.csv".	(Comma Separated Values (.csv), 2.51 KB) MD5:55beb50bc0359e622f0f0637c3e85bad9
<b>07_GP17_MCL_CTD_Profile_ByCast_0500m_data.csv</b>  Data file for dataset ID 956099, version 1. This file contains the profile data for hydrographic and optical data (mean and standard deviation) for specific CTD casts (up and down profiles are distinct) at each GP17-OCE station. Data are averaged over 5-meter (m) intervals and profiles extend from ~5 m to 500 m. Stations 1, 3, 6, 8, 12, and 14. Also included in the "ByCast" data files are the standard deviations and number of points averaged initially over 10 second intervals from 4 Hz CTD data.	(Comma Separated Values (.csv), 313.67 KB) MD5:baedcf58631510f08c6347baa89207a0
<b>08_GP17_MCL_CTD_Profile_ByCast_6000m_data.csv</b>  Data file for dataset ID 956099, version 1. This file contains the profile data for hydrographic and optical data (mean and standard deviation) for specific CTD casts (up and down profiles are distinct) at each GP17-OCE station. Data are averaged over 10-meter (m) intervals and profiles extend from ~5 m to near bottom (deepest bottom depth was 5000m). Stations 1, 3, 6, 8, 12, and 14. Also included in the "ByCast" data files are the standard deviations and number of points averaged initially over 10 second intervals from 4 Hz CTD data.	(Comma Separated Values (.csv), 681.21 KB) MD5:f361b67213c6fd6d99b9fda7cb0f4938
<b>09_GP17_MCL_cpbad.csv</b>  Data file for dataset ID 956099, version 1. As noted in issues, there was a high number of data dropouts in transmissometer data. This file is from second pass filtering of the bad data.	(Comma Separated Values (.csv), 12.60 KB) MD5:7aa7cf860d8a2a58103665d3cce47817
<b>10_GP17_MCL_processingnotes.txt</b>  Supplemental file for dataset ID 956099, version 1. This file contains processing notes summarizing methods and data issues.	(Plain Text, 4.58 KB) MD5:586ac785f3c6a9497f55f927297206d7

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## Related Publications

Bishop, J. K. B., Amaral, V. J., Lam, P. J., Wood, T. J., Lee, J.-M., Laubach, A., Barnard, A., Derr, A., & Orrico, C. (2022). Transmitted Cross-Polarized Light Detection of Particulate Inorganic Carbon Concentrations and Fluxes in the Ocean Water Column: Ships to ARGO Floats. *Frontiers in Remote Sensing*, 3. <https://doi.org/10.3389/frsen.2022.837938>  
*Methods*

Li, Y., Bishop, J. K. B., Lam, P. J., & Ohnemus, D. (2025). Analysis of Satellite and in-situ Optical Proxies for PIC and POC during GEOTRACES GP15 and GP17-OCE Transects from the Subarctic North Pacific to the Southern Ocean. <https://doi.org/10.22541/essoar.172988067.75831081/v2>  
*Results*

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## Parameters

*Parameters for this dataset have not yet been identified*

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## Instruments

<b>Dataset-specific Instrument Name</b>	SBE 19+ logging CTD
<b>Generic Instrument Name</b>	CTD Sea-Bird
<b>Generic Instrument Description</b>	A Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics. This instrument designation is used when specific make and model are not known or when a more specific term is not available in the BCO-DMO vocabulary. Refer to the dataset-specific metadata for more information about the specific CTD used. More information from: <a href="http://www.seabird.com/">http://www.seabird.com/</a>

<b>Dataset-specific Instrument Name</b>	Birefringence Sensor PIC011
<b>Generic Instrument Name</b>	PIC Sensor
<b>Generic Instrument Description</b>	Description from Bishop et al. (2022) (doi: 10.3389/frsen.2022.837938) PIC Sensor Concept: The sensor concept has been described by Guay and Bishop (2002) (doi: 10.1016/s0967-0637(01)00049-8) and Bishop (2009) (doi: 10.5670/oceanog.2009.48). The first profiling sensor was a modified version of an analog WETLabs C-Star 25 cm pathlength transmissometer. A 660-nm laser replaced the LED source, and a cell with high crossing efficiency polarizers (630–700 nm, Polarcor, Corning) was inserted into the water path length of the instrument. At the source end, the polarizer is aligned with the plane of polarization of the laser; on the receiver end, the polarizer is crossed, thus minimizing the detection of the primary beam. The sensor thus detects the photon yield resulting from the interaction of polarized laser light with birefringent particles in the beam. The first full water column profiles of the first sensor (PIC001) took place in 2003 in the North Atlantic (Bishop, 2009). This sensor was stabilized in 2006 by replacing the cell with body-mounted polarizers. Over many iterations of the basic design and multiple sea trials, it was demonstrated in 2013 that multiple PIC sensors yielded identical results and exceeded the performance of PIC001.

<b>Dataset-specific Instrument Name</b>	Seapoint scattering sensor (gain setting 10)
<b>Generic Instrument Name</b>	Seapoint Turbidity Meter
<b>Generic Instrument Description</b>	The Seapoint Turbidity Meter detects light scattered by particles suspended in water, generating an output voltage proportional to turbidity or suspended solids.

<b>Dataset-specific Instrument Name</b>	SeaBird (formerly WETLabs) Transmissometer CST1450
<b>Generic Instrument Name</b>	WET Labs {Sea-Bird WETLabs} C-Star transmissometer
<b>Dataset-specific Description</b>	The transmissometer used was a SeaBird transmissometer operating at 650 nm. They used to be made by WETLabs Inc., Philomath, OR. The complete ID is CST1450DR (meaning it was 6000 m rated and operating at a red wavelength of 650 nm). See: <a href="https://www.seabird.com/c-star-transmissometer/product?id=60762467717">https://www.seabird.com/c-star-transmissometer/product?id=60762467717</a>
<b>Generic Instrument Description</b>	The C-Star transmissometer has a novel monolithic housing with a highly integrated opto-electronic design to provide a low cost, compact solution for underwater measurements of beam transmittance. The C-Star is capable of free space measurements or flow-through sampling when used with a pump and optical flow tubes. The sensor can be used in profiling, moored, or underway applications. Available with a 6000 m depth rating. More information on Sea-Bird website: <a href="https://www.seabird.com/c-star-transmissometer/product?id=60762467717">https://www.seabird.com/c-star-transmissometer/product?id=60762467717</a>

<b>Dataset-specific Instrument Name</b>	WETLabs FLNTU sensor
<b>Generic Instrument Name</b>	WetLabs FLNTU
<b>Generic Instrument Description</b>	The WetLabs ECO FLNTU is a dual-wavelength, single-angle sensor for simultaneously determining both chlorophyll fluorescence and turbidity. It detects light scattered by particles suspended in water, generating an output voltage proportional to turbidity or suspended solids. Scaling factors are used to convert the voltage readings to values representing chlorophyll concentration and turbidity expressed in Nephelometric Turbidity Units (NTUs).

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## Deployments

RR2214

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/905754">https://www.bco-dmo.org/deployment/905754</a>
<b>Platform</b>	R/V Roger Revelle
<b>Report</b>	<a href="https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/rogerrevelle_rr2214.pdf">https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/rogerrevelle_rr2214.pdf</a>
<b>Start Date</b>	2022-12-01
<b>End Date</b>	2023-01-25
<b>Description</b>	<p>The U.S. GEOTRACES GP17-OCE expedition departed Papeete, Tahiti (French Polynesia) on December 1st, 2022 and arrived in Punta Arenas, Chile on January 25th, 2023. The cruise took place in the South Pacific and Southern Oceans aboard the R/V Roger Revelle with a team of 34 scientists led by Ben Twining (Chief Scientist), Jessica Fitzsimmons, and Greg Cutter (Co-Chief Scientists). GP17 was planned as a two-leg expedition, with its first leg (GP17-OCE) as a southward extension of the 2018 GP15 Alaska-Tahiti expedition and a second leg (GP17-ANT; December 2023-January 2024) into coastal and shelf waters of Antarctica's Amundsen Sea. The GP17-OCE section encompassed three major transects: (1) a southbound pseudo-meridional section (~152-135 degrees West) from 20 degrees South to 67 degrees South; (2) an eastbound zonal transect from 135 degrees West to 100 degrees West; (3) and a northbound section returning to Chile (100-75 degrees West). Additional cruise information is available from the following sources: R2R: <a href="https://www.rvdata.us/search/cruise/RR2214">https://www.rvdata.us/search/cruise/RR2214</a> CCHDO: <a href="https://cchdo.ucsd.edu/cruise/33RR20221201">https://cchdo.ucsd.edu/cruise/33RR20221201</a> More information can also be found at: <a href="https://usgeotraces.ldeo.columbia.edu/content/gp17-oce">https://usgeotraces.ldeo.columbia.edu/content/gp17-oce</a></p>

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## Project Information

### US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE) (GP17-OCE)

**Website:** <http://www.geotraces.org/>

**Coverage:** Papeete, Tahiti to Punta Arenas, Chile

The U.S. GEOTRACES GP17-OCE expedition departed Papeete, Tahiti (French Polynesia) on December 1st, 2022 and arrived in Punta Arenas, Chile on January 25th, 2023. The cruise took place in the South Pacific and Southern Oceans aboard the R/V Roger Revelle (cruise ID RR2214) with a team of 34 scientists lead by Ben Twining (Chief Scientist), Jessica Fitzsimmons and Greg Cutter (Co-Chief Scientists). GP17 was planned as a two-leg expedition, with its first leg (GP17-OCE) as a southward extension of the 2018 GP15 Alaska-Tahiti expedition and a second leg (GP17-ANT; December 2023-January 2024) into coastal and shelf waters of Antarctica's Amundsen Sea.

The South Pacific and Southern Oceans sampled by GP17-OCE play critical roles in global water mass circulation and associated global transfer of heat, carbon, and nutrients. Specific oceanographic regions of interest for GP17-OCE included: the most oligotrophic gyre in the global ocean, the Antarctic Circumpolar Current (ACC) frontal region, the previously unexplored Pacific- Antarctic Ridge, the Pacific Deep Water (PDW) flow along the continental slope of South America, and the continental margin inputs potentially emanating from South America.

Further information is available on the [US GEOTRACES website](#) and in the [cruise report](#) (PDF).

*NSF Project Title:* Collaborative Research: Management and Implementation of US GEOTRACES GP17 Section: South Pacific and Southern Ocean (GP17-OCE)

#### *NSF Award Abstract:*

This award will support the management and implementation of a research expedition from Tahiti to Chile that will enable sampling for a broad suite of trace elements and isotopes (TEI) across oceanographic regions of importance to global nutrient and carbon cycling as part of the U.S. GEOTRACES program. GEOTRACES is a global effort in the field of Chemical Oceanography, the goal of which is to understand the distributions of trace elements and their isotopes in the ocean. Determining the distributions of these elements and isotopes will

increase understanding of processes that shape their distributions, such as ocean currents and material fluxes, and also the processes that depend on these elements, such as the growth of phytoplankton and the support of ocean ecosystems. The proposed cruise will cross the South Pacific Gyre, the Antarctic Circumpolar Current, iron-limited Antarctic waters, and the Chilean margin. In combination with a proposed companion GEOTRACES expedition on a research icebreaker (GP17-ANT) that will be joined by two overlapping stations, the team of investigators will create an ocean section from the ocean's most nutrient-poor waters to its highly-productive Antarctic polar region - a region that plays an outsized role in modulating the global carbon cycle. The expedition will support and provide management infrastructure for additional participating science projects focused on measuring specific external fluxes and internal cycling of TEIs along this section.

The South Pacific Gyre and Pacific sector of the Southern Ocean play critical roles in global water mass circulation and associated global transfer of heat, carbon, and nutrients, but they are chronically understudied for TEIs due to their remote locale. These are regions of strong, dynamic fronts where sub-surface water masses upwell and subduct, and biological and chemical processes in these zones determine nutrient stoichiometries and tracer concentrations in waters exported to lower latitudes. The Pacific sector represents an end member of extremely low external TEI surface fluxes and thus an important region to constrain inputs from the rapidly-changing Antarctic continent. Compared to other ocean basins, TEI cycling in these regions is thought to be dominated by internal cycling processes such as biological uptake, regeneration, and scavenging, and these are poorly represented in global ocean models. The cruise will enable funded investigators to address research questions such as: 1) what are relative rates of external TEI fluxes to this region, including dust, sediment, hydrothermal, and cryospheric fluxes? 2) What are the (micro) nutrient regimes that support productivity, and what impacts do biomass accumulation, export, and regeneration have on TEI cycling and stoichiometries of exported material? 3) What are TEI and nutrient stoichiometries of subducting water masses, and how do scavenging and regeneration impact these during transport northward? This management project has several objectives: 1) plan and coordinate a 55-day research cruise in 2021-2022; 2) use both conventional and trace-metal 'clean' sampling systems to obtain TEI samples, as well as facilitate sampling for atmospheric aerosols and large volume particles and radionuclides; 3) acquire hydrographic data and samples for salinity, dissolved oxygen, algal pigments, and macro-nutrients; and deliver these data to relevant repositories; 4) ensure that proper QA/QC protocols, as well as GEOTRACES intercalibration protocols, are followed and reported; 5) prepare the final cruise report to be posted with data; 6) coordinate between all funded cruise investigators, as well as with leaders of proposed GP17-ANT cruise; and 7) conduct broader impact efforts that will engage the public in oceanographic research using immersive technology. The motivations for and at-sea challenges of this work will be communicated to the general public through creation of immersive 360/Virtual Reality experiences, via a collaboration with the Texas A&M University Visualization LIVE Lab. Through Virtual Reality, users will experience firsthand what life and TEI data collection at sea entail. Virtual reality/digital games and 360° experiences will be distributed through GEOTRACES outreach websites, through PI engagement with local schools, libraries, STEM summer camps, and adult service organizations, and through a collaboration with the National Academy of Sciences.

## **Autonomous Ocean Carbon Observer Development and Calibration (OCO Development)**

**Coverage:** Pacific Ocean

### ***NSF Award Abstract***

The very fast and dynamic ocean biological carbon pump (OBCP) plays a fundamental role in the global carbon cycle and in setting concentrations of atmospheric carbon dioxide. Photosynthetic organisms that fuel the OBCP live and die on a week to week basis, and the resulting sinking (or export) of organic and inorganic carbon particles from the surface layer and consumption losses of these particles in deeper waters are similarly variable. Simply stated, the OBCP is poorly understood due to dependence on short-term, and seasonally and spatially limited ship observations; thus model estimates of its strength and future trajectory are highly uncertain. To address this gap, the investigators will engineer and sea-test two robotic Lagrangian Ocean Carbon Observer (OCO) floats capable of 8 month to multi-year missions, yet able to resolve flux processes on hourly to daily time scales and relay data in real time via satellite telemetry while operating anywhere in the ocean. The development of the OCO enables the identification of specific pathways and controls on the vertical transfer of particulate organic and inorganic carbon (POC and PIC) from the surface ocean to subsurface waters. The project logically follows on from the investigator's development and successful deployment of robotic Lagrangian Carbon Explorer (CE) and Carbon Flux Explorer (CFE) floats, which measure optically POC and PIC concentration and flux variability to depths of 1000 m. A unique capability of the CFE is that it is able to measure the sinking flux of carbon carried by different sizes and classes of



particles. The project will merge CFE and CE capabilities to create the OCO. The team will contribute to the development of a STEM workforce by engaging UC Berkeley undergraduates and one graduate student in all phases (development, laboratory, seagoing, and interpretive) of the project and in the class room.

Specifically, CFEs and two new Ocean Carbon Observers (OCOs) that simultaneously measure both particle flux and concentration profiles will be constructed and test-deployed at sea in January 2023. During the times that these autonomous instruments drift at target depths within the upper kilometer (interrupted by transit to the surface for location and real time bidirectional telemetry), they will autonomously quantify the inherent optical properties and size distributions of sinking material captured. Bishop et al. (2016; Biogeosciences 13, 3019-3129, doi:10.5194/bg-13-3109) describe CFE capabilities and methodology for rendering raw OSR imagery to rigorously defined inherent optical measures of particle loading -- attenuation and cross-polarized photon yield. Bourne et al. (2019; Biogeosciences, 16, 1249-1264; doi:10.5194/bg-16-1249-2019) show that attenuation is strongly correlated ( $r^2 > 0.86$ ) with POC and PN sampled at 150 m by sampler-equipped CFEs "(CFE-Cal floats)" over a broad range of particle flux and particle size distributions. Planned further deployment of the CFE-Cal floats to sample sinking material to depths of at least 500 m will enable validation of our calibration of the attenuation proxy and to enable a first calibration of the PIC optical flux proxy. Bourne et al. (2021; Biogeosciences, 18, 3053-3086, doi:10.5194/bg-18-3053-2021) demonstrate the unique capability of CFEs to resolve and quantify the vertical flux carried by different particle size classes in the mesopelagic; furthermore, they describe prototype algorithms that will lead to flux size-distribution analysis in real time on the CFEs. The project will enable fully autonomous long-term deployments of CFE and OCO systems in the global ocean. The involvement a commercial float vendor (MRV Systems) and sensor manufacturer (Seabird Scientific) may lead to a commercialization pathway for the OCO.

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## Program Information

### U.S. GEOTRACES (U.S. GEOTRACES)

**Website:** <http://www.geotraces.org/>

**Coverage:** Global

**GEOTRACES** is a [SCOR](#) sponsored program; and funding for program infrastructure development is provided by the [U.S. National Science Foundation](#).

GEOTRACES gained momentum following a special symposium, S02: Biogeochemical cycling of trace elements and isotopes in the ocean and applications to constrain contemporary marine processes (GEOSECS II), at a 2003 Goldschmidt meeting convened in Japan. The GEOSECS II acronym referred to the Geochemical Ocean Section Studies To determine full water column distributions of selected trace elements and isotopes, including their concentration, chemical speciation, and physical form, along a sufficient number of sections in each ocean basin to establish the principal relationships between these distributions and with more traditional hydrographic parameters;

- \* To evaluate the sources, sinks, and internal cycling of these species and thereby characterize more completely the physical, chemical and biological processes regulating their distributions, and the sensitivity of these processes to global change; and

- \* To understand the processes that control the concentrations of geochemical species used for proxies of the past environment, both in the water column and in the substrates that reflect the water column.

GEOTRACES will be global in scope, consisting of ocean sections complemented by regional process studies. Sections and process studies will combine fieldwork, laboratory experiments and modelling. Beyond realizing the scientific objectives identified above, a natural outcome of this work will be to build a community of marine scientists who understand the processes regulating trace element cycles sufficiently well to exploit this knowledge reliably in future interdisciplinary studies.

Expand "Projects" below for information about and data resulting from individual US GEOTRACES research

projects.

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1657781</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-2023315</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1736601</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-2123942</a>

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