Beam attenuation coefficient, scattering, and fluorescence data derived from optical particle sensors deployed during casts of the ODF rosette on the GEOTRACES GP17-OCE cruise aboard R/V Roger Revelle (RR2214) from December 2022 to January 2023

Website: https://www.bco-dmo.org/dataset/949808
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)

Contributors	Affiliation	Role
Bishop, James K.B.	University of California-Berkeley (UC Berkeley)	Principal Investigator
Twining, Benjamin	Bigelow Laboratory for Ocean Sciences	Scientist
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Abstract
This dataset contains recalculated and filtered transmissometer beam attenuation coefficient values for the ODF CTD from the GEOTRACES GP17-OCE cruise aboard R/V Roger Revelle (RR2214) from December 2022 to January 2023. Data files are provided containing the average of all optical data profiles at each station for 0-500 meters (m) depth (depth intervals of 5-meters) as well as for the full depth of the water column (6000 meters). Note scattering sensor data are only available in the ODF CTD data from GP17-OCE stations 18 onward.

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Coverage

Spatial Extent: **N**:-19.9998 **E**:-75.0972 **S**:-67.0002 **W**:-152.0002
Temporal Extent: 2022-12-04 - 2023-01-24

Methods & Sampling

Calculated Beam Attenuation coefficient from despiked 10-second averaged data sets. The resulting data are further averaged over 5-meter intervals.

Data Processing Description

The data from Transmissometer 1874 was recalculated using

dt=temp-t391 ; calculated difference between water temperature and instrument temperature

cst1874c=(cst1874-0.0024)/cst1874r ; cst1874r is a temperature response function derived from WETLabs thermal cycling tests. ; 0.0024 is the blocked beam voltage on the CTD

cst1874cc=cst1874c+dt/1300 ; corrects for hysteresis in the thermoclone

cst1874tr=cst1874cc/(cst1874_NETVrefUSE) ; transmission ratio ; cst1874_NETVrefUSE is the zero corrected reading the transmissometer would have in particle free seawater.

cp1874=-4*ln(cst1874tr) ; calculation of beam attenuation coefficient

the data from Fluorometer Voltages was offset and multiplied to agree with Seapoint Fluorometer data on the GTC CTD. Relative units.

The following GEOTRACES parameter names have been registered in DOoR:

CTDBEAMCP_T_VALUE_SENSOR::kpdsqt

Problem Description

See files "9_GP17_ODF_bad_seapoint.csv" and "10_GP17_ODF__cpbad.csv".

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Supplemental Files

File	
1_GP17_ODF_CTD_Cast_Parameters_submit.csv	(Comma Separated Values (.csv), 1.70 KB) MD5:dd303e073142c58529dbd317df8a248b
Metadata file for dataset ID 949808, version 1. This file contains the parameter (column) definitions for file "2_GP17_ODF_CTD_Cast_Data_Values_submit.csv".	
2_GP17_ODF_CTD_Cast_Data_Values_submit.csv	(Comma Separated Values (.csv), 13.33 KB) MD5:f508452bf66a23339aa620135eb68428
Data file for dataset ID 949808, version 1. This file contains the CTD optics data used in data processing, including mixed layer depths.	
3_GP17_ODF_CTD_Average_Profile_0500_submit.csv	(Comma Separated Values (.csv), 735.41 KB) MD5:82598ef8f7c2c3b4e114af663b1afe1e
Data file for dataset ID 949808, version 1. This file contains the 500-meter data averaged over all casts at each station.	
4_GP17_ODF_CTD_Average_Profile_6000_submit.csv	(Comma Separated Values (.csv), 2.38 MB) MD5:c35749e96d396ff599eb6794806c0e1e
Data file for dataset ID 949808, version 1. This file contains the 6000-meter data averaged over all casts at each station.	
5_GP17_ODF_CTD_Average_Profile_Parameters.csv	(Comma Separated Values (.csv), 1.61 KB) MD5:2aeae0833f75bd95b6029d1e050dedeb
Metadata file for dataset ID 949808, version 1. This file contains parameter (column) definitions for files "3_GP17_ODF_CTD_Average_Profile_0500_submit.csv" and "4_GP17_ODF_CTD_Average_Profile_6000_submit.csv".	
6_GP17_ODF_CTD_ByCast_Profiles_0500_submit.csv	(Comma Separated Values (.csv), 2.57 MB) MD5:d019b51b1a5b4ee1bf64394b79f8b4bf
Data file for dataset ID 949808, version 1. This file contains the 500-meter data for each cast and each cast direction at all stations.	
7_GP17_ODF_CTD_ByCast_Profiles_6000_submit.csv	(Comma Separated Values (.csv), 7.79 MB) MD5:54872b212b4f34c7751929ad11682b74
Data file for dataset ID 949808, version 1. This file contains the 6000-meter data for each cast and each cast direction at all stations.	
8_GP17_ODF_CTD_ByCast_Profile_Parameters.csv	(Comma Separated Values (.csv), 2.11 KB) MD5:4b98a6687e032bced5d572393d12415b
Metadata file for dataset ID 949808, version 1. This file contains parameter (column) definitions for files "6_GP17_ODF_CTD_ByCast_Profiles_0500_submit.csv" and "7_GP17_ODF_CTD_ByCast_Profiles_6000_submit.csv".	
9_GP17_ODF_bad_seapoint.csv	(Comma Separated Values (.csv), 21.26 KB) MD5:e9b51afde747dae76af2e382c9bfedc2
Data file for dataset ID 949808, version 1. This file is a summary of Seapoint turbidity sensor data that were excluded in the files above. The bad data likely arose due to electrical tape fluttering near the sensor. There was no turbidity sensor on the ODF CTD for stations 1 through 16. All fields at these stations are replaced with -9999's.	
GP17_ODF__cpbad.csv filename: 10_GP17_ODF__cpbad.csv	(Comma Separated Values (.csv), 8.14 KB) MD5:82375e5844a11da52b876908e5157b1a
Data file for dataset ID 949808, version 1. This file is summary of beam attenuation coefficient data that were excluded in the files above. The bad data likely arose due to fouling of the sensor during profiling.	

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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

Dataset-specific Instrument Name	Seapoint scattering sensor (gain setting 10)
Generic Instrument Name	Turbidity Meter
Generic Instrument Description	A turbidity meter measures the clarity of a water sample. A beam of light is shown through a water sample. The turbidity, or its converse clarity, is read on a numerical scale. Turbidity determined by this technique is referred to as the nephelometric method from the root meaning "cloudiness". This word is used to form the name of the unit of turbidity, the NTU (Nephelometric Turbidity Unit). The meter reading cannot be used to compare the turbidity of different water samples unless the instrument is calibrated. Description from: http://www.gvsu.edu/wri/education/instructor-s-manual-turbidity-10.htm (One example is the Orion AQ4500 Turbidimeter)

Dataset-specific Instrument Name	SeaBird (formerly WETLabs) Transmissometer CST1874
Generic Instrument Name	WET Labs {Sea-Bird WETLabs} C-Star transmissometer
Dataset-specific Description	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 CST1874DR (meaning it was 6000 m rated and operating at a red wavelength of 650 nm). See: https://www.seabird.com/c-star-transmissometer/product?id=60762467717
Generic Instrument Description	The C-Star transmissometer has a novel monolithic housing with a highly intgrated 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: https://www.seabird.com/c-star-transmissometer/product?id=60762467717

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Deployments

RR2214

Website	https://www.bco-dmo.org/deployment/905754
Platform	R/V Roger Revelle
Report	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/rogerrevelle_rr2214.pdf
Start Date	2022-12-01
End Date	2023-01-25
Description	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: https://www.rvdata.us/search/cruise/RR2214 CCHDO: https://cchdo.ucsd.edu/cruise/33RR20221201 More information can also be found at: https://usgeotraces.ldeo.columbia.edu/content/gp17-oce

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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 that fuel the OCBP 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 OCBP 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 -- attenuance and cross-polarized photon yield. Bourne et al. (2019; Biogeosciences, 16, 1249-1264; doi:10.5194/bg-16-1249-2019) show that attenuance 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 attenuance 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
NSF Division of Ocean Sciences (NSF OCE)	OCE-1657781
NSF Division of Ocean Sciences (NSF OCE)	OCE-2023315
NSF Division of Ocean Sciences (NSF OCE)	OCE-1736601
NSF Division of Ocean Sciences (NSF OCE)	OCE-2123942

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