Seawater Inorganic Carbon Data (DIC) from the R/V Thomas G. Thompson TN303 cruise in the Eastern Tropical Pacific from October to December 2013 (U.S. GETORACES EPZT project)

Website: https://www.bco-dmo.org/dataset/699295
Data Type: Cruise Results
Version: 03 May 2017
Version Date: 2017-05-03

Project
» U.S. GEOTRACES East Pacific Zonal Transect (GP16) (U.S. GEOTRACES EPZT)
» Collaborative Research: Seawater Inorganic and Organic Carbon Measurements for the US GEOTRACES Eastern Pacific Zonal Transect (EPZT Carbon)

Program
» U.S. GEOTRACES (U.S. GEOTRACES)

Contributors	Affiliation	Role
Bates, Nicholas	Bermuda Institute of Ocean Sciences (BIOS)	Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

Coverage

Spatial Extent: **N**:-10.224 **E**:-77.3761 **S**:-16.0006 **W**:-152.0006
Temporal Extent: 2013-10-29 - 2013-12-18

Dataset Description

Dissolved inorganic carbon (DIC) from samples collected on the 2013 US GEOTRACES EPZT cruise, TN303.

Methods & Sampling

Sampling:
Seawater samples for carbonate chemistry were collected for the entire water column at all of the GEOTRACES CTD-hydrocast stations. Samples for DIC awere drawn from the Niskin samplers into the clean 500 ml size Pyrex glass reagent bottles, using established gas sampling protocols (Bates et al, 1996; Dickson et al., 2007). A headspace of <1% of the bottle volume was left to allow for water expansion and all samples were poisoned with 100 ul of saturated HgCl solution to prevent biological alteration. Bottles were sealed with ground-glass stoppers and Apiezon vacuum grease. Rubber bands were placed around the lip of the bottle and stopper to provide positive closure. Samples were returned to the Bermuda Institute of Ocean Sciences (BIOS) for analysis. Similar sampling protocols were established at BIOS for sampling at the BATS (Bates et al., 1996a,b; Bates, 2001). Samples were typically analyzed within three months of collection.

Analytical Procedures:
DIC was measured by a gas extraction/coulometric technique (see Bates et al., 1996a,b for details), using a SOMMA (Single-Operator Multi-Metabolic Analyzer) to control the pipetting and extraction of seawater samples and a UIC CO2 coulometer detector. DIC samples were analyzed using a VINDTA 3C (Marianda Com). Both analytical systems use identical chemical approaches for the measurement of DIC in seawater, with the VINDTA 3C providing an updated instrument for use over the last decade (Bates et al., 2012). The precision of DIC analyses of this system is typically better than 0.025% (~0.4 umoles/kg) based on duplicate and triplicate analyses of >4000 seawater samples analyzed at BIOS from 1992 to present. Seawater certified reference materials (CRM's; prepared by A.G. Dickson, Scripps Institution of Oceanography) were analyzed to ensure that the accuracy of DIC was within 0.03% (~0.5 umoles/kg).

Data Processing Description

BCO-DMO Processing:
- changed "DIC #" to "DIC_NUM", otherwise retained submitted parameter names (submitted names were already formatted in accordance with GEOTRACES conventions);
- formatted time to HHMM;
- removed leading spaces from EXPOCODE and BTLNBR columns;
- corrected EXPOCODE (was incorrect due to original file containing scientific notation);
- joined to BCO-DMO EPZT master file; added GEOTRC_INSTR, ISO_DATETIME_UTC_START_EVENT, and BTL_ISO_DATETIME_UTC columns;
- removed PI-provided date and time for consistency with other GEOTRACES datasets;
- added cruise_id column.

Additional GEOTRACES Processing:
As was done for the GEOTRACES-NAT data, BCO-DMO added standard US GEOTRACES information, such as the US GEOTRACES event number, to each submitted dataset lacking this information. To accomplish this, BCO-DMO compiled a 'master' dataset composed of the following parameters:

cruise_id, EXPOCODE,SECT_ID, STNNBR, CASTNO, GEOTRC_EVENTNO, GEOTRC_SAMPNO, GEOTRC_INSTR, SAMPNO, GF_NO, BTLNBR, BTLNBR_FLAG_W, DATE_START_EVENT, TIME_START_EVENT, ISO_DATETIME_UTC_START_EVENT, EVENT_LAT, EVENT_LON, DEPTH_MIN, DEPTH_MAX, BTL_DATE, BTL_TIME, BTL_ISO_DATETIME_UTC, BTL_LAT, BTL_LON, ODF_CTDPRS, SMDEPTH, FMDEPTH, BTMDEPTH, CTDPRS, CTDDEPTH.

This added information will facilitate subsequent analysis and inter comparison of the datasets.

Bottle parameters in the master file were taken from the GT-C_Bottle and ODF_Bottle datasets. Non-bottle parameters, including those from GeoFish tows, Aerosol sampling, and McLane Pumps, were taken from the TN303 Event Log (version 30 Oct 2014). Where applicable, pump information was taken from the PUMP_Nuts_Sals dataset.

A standardized BCO-DMO method (called "join") was then used to merge the missing parameters to each US GEOTRACES dataset, most often by matching on sample_GEOTRC or on some unique combination of other parameters.

If the master parameters were included in the original data file and the values did not differ from the master file, the original data columns were retained and the names of the parameters were changed from the PI-submitted names to the standardized master names. If there were differences between the PI-supplied parameter values and those in the master file, both columns were retained. If the original data submission included all of the master parameters, no additional columns were added, but parameter names were modified to match the naming conventions of the master file.

See the dataset parameters documentation for a description of which parameters were supplied by the PI and which were added via the join method.

[table of contents | back to top]

Data Files

File
DIC_joined.csv (Comma Separated Values (.csv), 125.90 KB) MD5:752f41fb75602adc53e06e49907cdea5 Primary data file for dataset ID 699295

[table of contents | back to top]

Related Publications

Bates, N. R. (2001). Interannual variability of oceanic CO2 and biogeochemical properties in the Western North Atlantic subtropical gyre. Deep Sea Research Part II: Topical Studies in Oceanography, 48(8-9), 1507–1528. doi:10.1016/s0967-0645(00)00151-x https://doi.org/10.1016/S0967-0645(00)00151-X
Methods

Bates, N. R., Best, M. H. P., Neely, K., Garley, R., Dickson, A. G., & Johnson, R. J. (2012). Detecting anthropogenic carbon dioxide uptake and ocean acidification in the North Atlantic Ocean. Biogeosciences, 9(7), 2509–2522. doi:10.5194/bg-9-2509-2012
Methods

Bates, N. R., Michaels, A. F., & Knap, A. H. (1996). Seasonal and interannual variability of oceanic carbon dioxide species at the U.S. JGOFS Bermuda Atlantic Time-series Study (BATS) site. Deep Sea Research Part II: Topical Studies in Oceanography, 43(2-3), 347–383. doi:10.1016/0967-0645(95)00093-3
Methods

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO2 measurements. PICES Special Publication 3, 191 pp. ISBN: 1-897176-07-4. URL: https://www.nodc.noaa.gov/ocads/oceans/Handbook_2007.html https://hdl.handle.net/11329/249
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
cruise_id	Cruise identification	unitless
SECT_ID	Cruise section identifier; EPZT = GEOTRACES East Pacific Zonal Transect	unitless
EXPOCODE	Cruise EXPO code.	unitless
STNNBR	Station number	unitless
GEOTRC_EVENTNO	GEOTRACES event number	unitless
CASTNO	Cast number	unitless
LATITUDE	Latitude; positive = North	decimal degrees
LONGITUDE	Longitude; negative = West	decimal degrees
ISO_DATETIME_UTC_START_EVENT	Date and time, formatted to the ISO 8601 standard, at the start of the sampling event, according to the event log. Format: YYYY-MM-DDTHH:MM:SS[.xx]Z. Added from BCO-DMO EPZT master data file.	unitless
BTMDEPTH	Bottom depth	meters
GEOTRC_INSTR	Sampling instrument; added from BCO-DMO EPZT master data file	unitless
GEOTRC_SAMPNO	Unique GEOTRACES sample number	unitless
DIC_NUM	DIC sample number	unitless
SAMPNO	Sequential sample number within the cast (usually corresponds to bottle number).	unitless
BTLNBR	Bottle number; typically 1-24.	unitless
BTLNBR_FLAG_W	Bottle number quality flag; follows WOCE conventions. 2 = no problems noted; 3 = leaking; 4 = did not trip correctly; 9 = samples not drawn from this bottle	unitless
CTDPRS	CTD pressure	decibars
CTDDEPTH	CTD bottle firing depth	meters

CTDTMP	CTD temperature	degrees Celsius
CTDSAL	CTD salinity (PSS-78). CTDSAL is the calculated corrected value of salinity derived from the conductivity sensors on the CTD unit at the time of the bottle trip. CTDSAL is compared with SALNTY which is the PSS-78 value measured from the actual samples drawn from the niskin bottles themselves. Reporting both is meant, among other things, as a of show the goodness of fit, source of quality coding and offer alternative for measurements/calculations if one of those values is missing or lacking a good quality code.	unitless
CTDSAL_FLAG_W	CTDSAL quality flag; follows WOCE conventions. 2 = good; 3 = questionable; 4 = bad; 9 = missing data.	unitless
SALNTY	Salinity; the PSS-78 value measured from the actual samples drawn from the niskin bottles themselves	unitless
SALNTY_FLAG_W	SALNTY quality flag; follows WOCE conventions. 2 = good; 3 = questionable; 4 = bad; 9 = missing data.	unitless
SALTREF	SELFTREF is salinity reference in TEOS-10 (http://www.teos-10.org/) and defined as absolute salinity units (G/KG) published in 2010. That compared with the classic salinity measurement in practical salinity units (PSS-78).	grams per kilogram (g/kg)
SALTREF_FLAG_W	SALTREF quality flag; follows WOCE conventions. 2 = good; 3 = questionable; 4 = bad; 9 = missing data.	unitless
DIC	Dissolved inorganic carbon	micromoles per kilogram (umoles/kg)
DIC_flag	DIC quality flag; follows WOCE conventions. 2 = good; 3 = questionable; 4 = bad; 9 = missing data.	unitless
BTL_ISO_DATETIME_UTC	Date and time, formatted to the ISO 8601 standard, at the time of bottle firing. Format: YYYY-MM-DDTHH:MM:SS[.xx]Z. Added from BCO-DMO EPZT master data file.	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	SOMMA (Single-Operator Multi-Metabolic Analyzer)
Generic Instrument Name	CO2 Analyzer
Dataset-specific Description	DIC was measured by a gas extraction/coulometric technique (see Bates et al., 1996a,b for details), using a SOMMA (Single-Operator Multi-Metabolic Analyzer) to control the pipetting and extraction of seawater samples and a UIC CO2 coulometer detector.
Generic Instrument Description	Measures atmospheric carbon dioxide (CO2) concentration.

Dataset-specific Instrument Name	UIC CO2 coulometer detector
Generic Instrument Name	CO2 Coulometer
Dataset-specific Description	DIC was measured by a gas extraction/coulometric technique (see Bates et al., 1996a,b for details), using a SOMMA (Single-Operator Multi-Metabolic Analyzer) to control the pipetting and extraction of seawater samples and a UIC CO2 coulometer detector.
Generic Instrument Description	A CO2 coulometer semi-automatically controls the sample handling and extraction of CO2 from seawater samples. Samples are acidified and the CO2 gas is bubbled into a titration cell where CO2 is converted to hydroxyethylcarbonic acid which is then automatically titrated with a coulometrically-generated base to a colorimetric endpoint.

Dataset-specific Instrument Name	VINDTA 3C
Generic Instrument Name	MARIANDA VINDTA 3C total inorganic carbon and titration alkalinity analyser
Dataset-specific Description	DIC samples were analyzed using a VINDTA 3C (Marianda Com).
Generic Instrument Description	The Versatile INstrument for the Determination of Total inorganic carbon and titration Alkalinity (VINDTA) 3C is a laboratory alkalinity titration system combined with an extraction unit for coulometric titration, which simultaneously determines the alkalinity and dissolved inorganic carbon content of a sample. The sample transport is performed with peristaltic pumps and acid is added to the sample using a membrane pump. No pressurizing system is required and only one gas supply (nitrogen or dry and CO2-free air) is necessary. The system uses a Metrohm Titrino 719S, an ORION-Ross pH electrode and a Metrohm reference electrode. The burette, the pipette and the analysis cell have a water jacket around them. Precision is typically +/- 1 umol/kg for TA and/or DIC in open ocean water.

Dataset-specific Instrument Name	Niskin samplers
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Seawater samples for carbonate chemistry were collected for the entire water column at all of the GEOTRACES CTD-hydrocast stations. Samples for DIC awere drawn from the Niskin samplers into the clean 500 ml size Pyrex glass reagent bottles.
Generic Instrument Description	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.

[table of contents | back to top]

Deployments

TN303

Website	https://www.bco-dmo.org/deployment/499719
Platform	R/V Thomas G. Thompson
Report	http://dmoserv3.whoi.edu/data_docs/GEOTRACES/EPZT/GT13_EPZT_ODFReport_All.pdf
Start Date	2013-10-25
End Date	2013-12-20
Description	A zonal transect in the eastern tropical South Pacific (ETSP) from Peru to Tahiti as the second cruise of the U.S.GEOTRACES Program. This Pacific section includes a large area characterized by high rates of primary production and particle export in the eastern boundary associated with the Peru Upwelling, a large oxygen minimum zone that is a major global sink for fixed nitrogen, and a large hydrothermal plume arising from the East Pacific Rise. This particular section was selected as a result of open planning workshops in 2007 and 2008, with a final recommendation made by the U.S.GEOTRACES Steering Committee in 2009. It is the first part of a two-stage plan that will include a meridional section of the Pacific from Tahiti to Alaska as a subsequent expedition. Figure 1. The 2013 GEOTRACES EPZT Cruise Track. [click on the image to view a larger version] Additional cruise information is available from the Rolling Deck to Repository (R2R): http://www.rvdata.us/catalog/TN303

[table of contents | back to top]

Project Information

U.S. GEOTRACES East Pacific Zonal Transect (GP16) (U.S. GEOTRACES EPZT)

Website: http://www.geotraces.org/

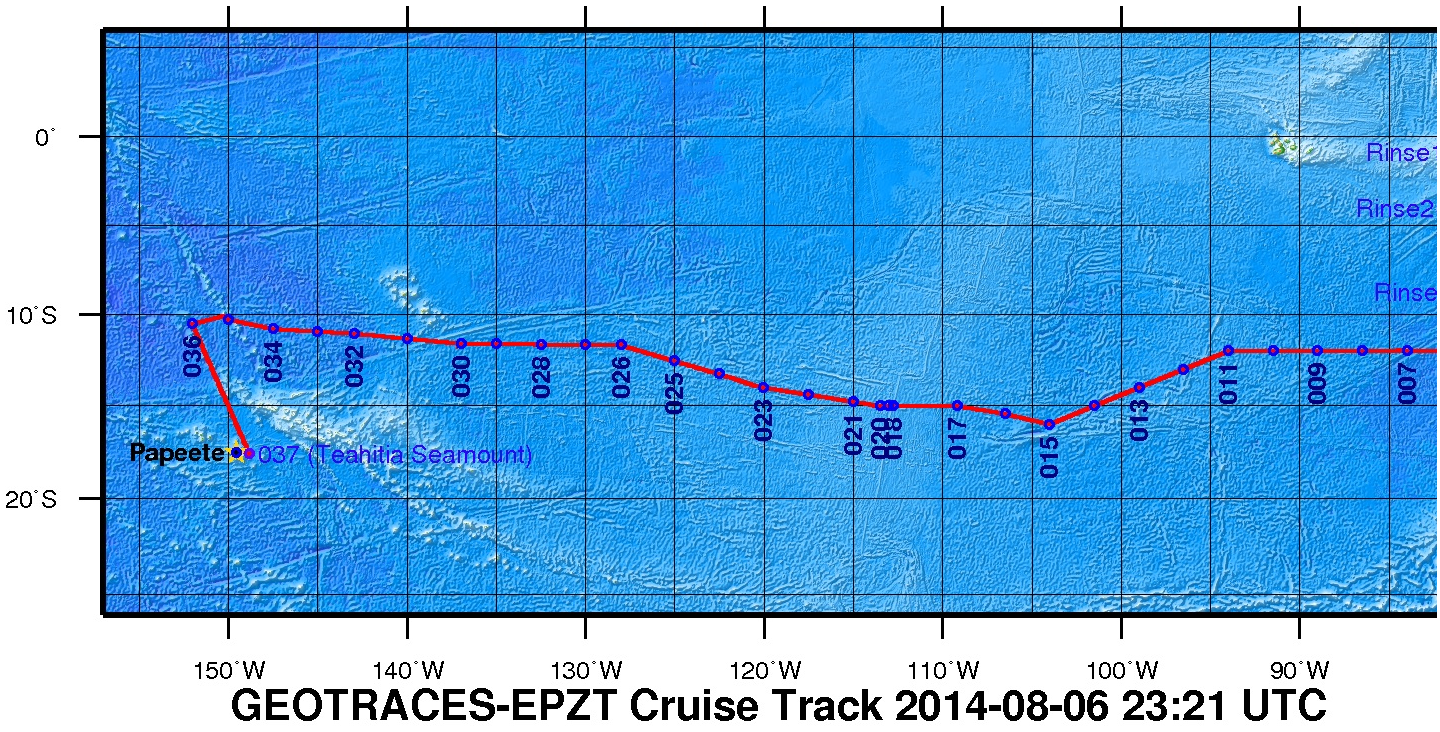
Coverage: Eastern Tropical Pacific - Transect from Peru to Tahiti (GP16)

From the NSF Award Abstract
The mission of the International GEOTRACES Program (https://www.geotraces.org/), of which the U.S. chemical oceanography research community is a founding member, is "to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions" (GEOTRACES Science Plan, 2006). In the United States, ocean chemists are currently in the process of organizing a zonal transect in the eastern tropical South Pacific (ETSP) from Peru to Tahiti as the second cruise of the U.S.GEOTRACES Program. This Pacific section includes a large area characterized by high rates of primary production and particle export in the eastern boundary associated with the Peru Upwelling, a large oxygen minimum zone that is a major global sink for fixed nitrogen, and a large hydrothermal plume arising from the East Pacific Rise. This particular section was selected as a result of open planning workshops in 2007 and 2008, with a final recommendation made by the U.S.GEOTRACES Steering Committee in 2009. It is the first part of a two-stage plan that will include a meridional section of the Pacific from Tahiti to Alaska as a subsequent expedition.

This award provides funding for management of the U.S.GEOTRACES Pacific campaign to a team of scientists from the University of Southern California, Old Dominion University, and the Woods Hole Oceanographic Institution. The three co-leaders will provide mission leadership, essential support services, and management structure for acquiring the trace elements and isotopes samples listed as core parameters in the International GEOTRACES Science Plan, plus hydrographic and nutrient data needed by participating investigators. With this support from NSF, the management team will (1) plan and coordinate the 52-day Pacific research cruise described above; (2) obtain representative samples for a wide variety of trace metals of interest using conventional CTD/rosette and GEOTRACES Sampling Systems; (3) acquire conventional JGOFS/WOCE-quality hydrographic data (CTD, transmissometer, fluorometer, oxygen sensor, etc) along with discrete samples for salinity, dissolved oxygen (to 1 uM detection limits), plant pigments, redox tracers such as ammonium and nitrite, and dissolved nutrients at micro- and nanomolar levels; (4) ensure that proper QA/QC protocols are followed and reported, as well as fulfilling all GEOTRACES Intercalibration protocols; (5) prepare and deliver all hydrographic-type data to the GEOTRACES Data Center (and US data centers); and (6) coordinate cruise communications between all participating investigators, including preparation of a hydrographic report/publication.

Broader Impacts: The project is part of an international collaborative program that has forged strong partnerships in the intercalibration and implementation phases that are unprecedented in chemical oceanography. The science product of these collective missions will enhance our ability to understand how to interpret the chemical composition of the ocean, and interpret how climate change will affect ocean chemistry. Partnerships include contributions to the infrastructure of developing nations with overlapping interests in the study area, in this case Peru. There is a strong educational component to the program, with many Ph.D. students carrying out thesis research within the program.

Figure 1. The 2013 GEOTRACES EPZT Cruise Track. [click on the image to view a larger version]



Collaborative Research: Seawater Inorganic and Organic Carbon Measurements for the US GEOTRACES Eastern Pacific Zonal Transect (EPZT Carbon)

Coverage: Equatorial Pacific

NSF Award Abstract:
Scientists from Bermuda Institute of Ocean Sciences and the University of California, Santa Barbara, plan to collect samples during the 2013 GEOTRACES Eastern Pacific Zonal Transect cruise and analyze them for dissolved inorganic carbon, dissolved organic carbon (DOC), and total alkalinity. The resultant data will be highly precise and accurate to allow calculation of pH and seawater carbonate chemistry (e.g., hydroxide, carbonate ion, saturation sate for calcium carbonate minerals). Given the influence of pH on redox chemistry, speciation, and ligand-particle-trace metal/isotope interactions, the transect from Peru to Tahiti with its range of marine seawater carbonate chemistry will provide an opportunity to test the hypotheses that (1) pH is a critical constraint for controlling distributions of trace elements and their isotopes (TEIs) and their dynamics within the water column, and; (2) DOC interacts with TEIs providing a spectrum of binding ligands that influence trace element solubility, complexation, and speciation. Also, because the cruise track will pass over the East Pacific Rise, the scientists plan to evaluate DOC variability within the hydrothermal plume and determine the partitioning of organic matter between DOC and particulate organic carbon. In collaboration with other GEOTRACES researchers, the data will be used to assess the speciation of iron, copper, cobalt and mercury, as well as determine the removal rate of DOC from the surface ocean with the help of chlorofluorocarbon data obtained by a collaborator from the University of Miami, Rosenstiel School of Marine and Atmospheric Science.

As regards broader impacts, this project would result in a high quality data set that would benefit not only the GEOTRACES community to help them interpret their trace metal and isotope measurements but other scientists involved in organic/inorganic carbon cycle research as well. One graduate student from the University of California, Santa Barbara would be supported and trained as part of this project.

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1233706

[table of contents | back to top]