CTD and bottle data: TOM and nutrients from R/V Melville cruise MV1310 in the North Pacific Gulf of Alaska; 48N to 59N and 129W to 153W in 2013 (North Pacific RDOC project)

Website: https://www.bco-dmo.org/dataset/527121
Data Type: Cruise Results
Version:
Version Date: 2016-11-28

Project
» Characterizing a refractory DOC sink in the deep northern North Pacific (North Pacific RDOC)
» Quantifying the Photochemical Reactivity of Deep Ocean Water (DORC PhotoChem)

Program
» United States Surface Ocean Lower Atmosphere Study (U.S. SOLAS)

Contributors	Affiliation	Role
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Table of Contents

Dataset Description

Dataset includes TOC, TDN, nutrients ($NO2^-$, $NO3^-$, NH4+, P, Si), CTD oxygen, temperature and salinity.

Related Files and References:

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.

Hansell, D.A. 2005. Dissolved organic carbon reference material program. *EOS* 86(35): 318.

UNESCO (1994). Protocols for the joint global ocean flux study (JGOFS) core measurements. Vol. 29.

Langdon C (2010) Determination of dissolved oxygen in seawater by Winkler titration using the amperometric technique. In: Hood EM, Sabine CL, Sloyan BM (eds) The GO-SHIP Repeat Hydrography Manual: A Collection of Expert Reports and Guidelines. IOCCP Report Number 14, ICPO Publication Series Number 134. http://www.go-ship.org/HydroMan.html

Methods & Sampling

Sampling and Analytical Methodology:

A single SBE9*plus* CTD (S/N 831) was used for all casts and was deployed with all sensors and pumps as recommended by SBE. In situ salinity and dissolved oxygen check samples were collected to calibrate conductivity and dissolved oxygen sensors (see MV1310 Preliminary Cruise Report).

The primary conductivity and temperature sensors failed on the up-casts of stations 19, 21-27 and on the down-cast of stations 28 and 29. The secondary sensors were chosen for consistent reporting.

In addition to the 0.0073 second temperature and conductivity standard alignment factor an offset of 0.08 seconds was applied for each station and sensor configuration.

CTD Pressure: Paroscientific Digiquartz pressure transducer (S/N 831-99677) last calibrated in November 2012 at the SIO/STS Calibration Facility. Residual pressure offsets indicated that an offset of -0.84350 dbar be applied to pressure sensor calibration.

CTD Temperature: A SBE35RT Digital Reversing Thermometer sensor was not used, therefore only standard laboratory calibrations were used for T1 and T2 sensors. The secondary sensors were chosen for consistency. An offset observed in cast 12/3 was adjusted based on data from adjacent casts at the same station. Sensors used: The SBE3plus secondary (T2/03-2309) was swapped for (T2/03-4307) after cast 12/1. The SBE3plus secondary (T2/03-4307) was swapped for (T2/03-2309) after station/cast 12/3. The SBE3plus secondary (T2/03-2309) was swapped for (T2/03-2322) after cast 28/1.

The 95% confidence limits for the MV1310 data mean low-gradient differences are +- 0.00137C for T1-T2 .The 95% confidence limit for deep temperature residuals (where pressure > 1800 dbars) is +- 0.00105C for T1-T2 .

CTD Conductivity: Pre-cruise calibration coefficients were applied to convert raw frequencies to conductivity. Secondary sensors were compared to conductivity calculated from check sample salinities using CTD pressure and temperature. Sensors used: The SBE4C secondary (C2/04-2819) was swapped for (C2/04-2765) after cast 28/1. The 95% confidence limits are ± 0.00445 relative to bottle salinities for all salinities, where T1-T2 is within +- 0.01C; and +- 0.000781 relative to bottle salinities for deep salinities, where pressure is more than 1800 decibars. Within the context of having only a small number of salinity check samples, when questionable check samples were ignored, the final CTD salinities (and temperatures) appear to meet a reasonable standard, though less reliable than the reference cruises (P16N (2009) and P17N (2001)).

CTD Dissolved Oxygen: SBE43 dissolved oxygen sensor (DO/43-0275) was calibrated to dissolved oxygen bottle samples taken at bottle stops. At the end of the cruise, standard and blank values for bottle oxygen data were smoothed, and the bottle oxygen values were recalculated (changes were less than 0.01 ml/l for most stations). Standard deviations were 3.142 umol/kg for all oxygens and 1.365 umol/kg for deep oxygens. CTD dissolved oxygen ml/l data are converted to umol/kg units.

Salinity (in situ): To calibrate conductivity CTD sensors, salinity was determined at the Marine Chemistry Laboratory at the University of Washington's School of Oceanography. Water was collected from Niskin bottles directly into acid leached, 500 mL HDPE bottles and stored at room temperature until analysis at shore-based laboratories. Samples were collected at the surface and/or mixed layer of the CTD profile and at least three samples evenly spaced below the high gradient region with one sample at the bottom of the cast. Analyses were run on Guildline models 8400B and 8410 Portasal - Calibration is with IAPSO Standard Seawater. Limit of Detection: 0.002PSU.

Dissolved Oxygen (in situ): To calibrate oxygen CTD sensors, dissolved oxygen was sampled and measured onboard by Winkler titration using the amperometric technique (Langdon 2010). At least six oxygen samples were sampled on full depth stations from the surface, bottom and major min/max inflection points with-in the profile. There were insufficient bottle oxygen samples of usable quality available from this cruise to provide reasonable assurance of values of dissolved oxygen at a given level from a given profile. Because the final data do match the shape of P17N data, there is, however somewhat more confidence in the shape and gradients revealed in the final CTD oxygen probe data.

TOC and TDN: TOC and TDN concentrations were determined in the Hansell lab at the University of Miami. Water was collected from Niskin bottles directly (unfiltered) into acid leached, 60-mL polycarbonate bottles and stored frozen at –20°C in volatile organic-free freezers until analysis at shore-based laboratories. TOC was measured by high temperature combustion (HTC) using a Shimadzu TOC-L with auto injection (CV of 1.5-2.5%), following the method described in Dickson et al. (2007). TOC was combusted to CO2 upon injection and the resulting gas stream scrubbed of water vapor and halides and the magnitude of CO_2 detected with a non-dispersive infrared detector. TDN was determined by HTC where TDN was converted to nitric oxide (NO) gas, which then reacted with ozone producing an excited chemiluminescence NO_2 species. The fluorescence signal was then detected with a Shimadzu TNM-1 chemiluminescence detector. TON is calculated as the difference between TDN concentrations and dissolved, combined inorganic (nutrient) nitrogen. Four point standard curves using KHP for C and KNO_3 for N were run daily to calibrate the response of the high temperature combustion systems. Both measurements were quality controlled using consensus reference materials (CRMs) distributed to the international community (Hansell, 2005). The CRMs were analyzed at regular intervals during each analytical day. Low C (and N) reference water was employed to determine system blanks.

Nutrients: Nutrient concentrations were determined in the Marine Chemistry Laboratory at the University of Washington School of Oceanography. Water was collected from Niskin bottles directly into acid leached 60-mL HDPE bottles and stored at –20C in volatile organic-free freezers or at 4°C refrigerators (silicate only) until analysis at shore-based laboratories. Analyses and calibration follow the protocols of the WOCE Hydrographic Program using a Technicon AAII system (UNESCO 1994).

Detection Limits:
Phosphate: 0.03µM, 0.0009mg/L
Silicate: 0.59µM, 0.0166mg/L
Nitrate: 0.15µM, 0.0021mg/L
Nitrite: 0.02µM, 0.0003mg/L
Ammonium: 0.12µM, 0.0017mg/L

Data Processing Description

Data Processing:
Bottle Data Processing: CTD data were processed by Alejandro D. Quintero and Courtney M. Schatzman at the Oceanographic Data Facility (ODF) at Scripps Institution of Oceanography (SIO). ODF performs systematic standard processes on all hydrographic data sets. The 0.5-second time series data were checked for consistency, clean sensor response and calibration shifts. Shipboard CTDO data were processed using SIO/ODF CTD processing software v.5.6. The raw CTDO data and bottle trips acquired by SBE SeaSave on the Windows XP workstation were copied onto the Linux database and web server system. Pre-cruise calibration data were applied to CTD Pressure, Temperature and Conductivity sensor data, then the data were processed to a 0.5-second time series. A 1-decibar downcast pressure series was created from the time series; CTDO data from down-casts were matched along isopycnals to up-cast trips and extracted, then fit to bottle oxygen data at trips.

These results included a quality code associated with each measured value and followed the coding scheme developed for the World Ocean Circulation Experiment (WOCE) Hydrographic Programme (WHP) manual Tables 4.8 and 4.9 (http://cchdo.ucsd.edu/woce_flags.html)

BOTTLE QUALITY FLAGS:
1 = BOTTLE INFO UNAVAILABLE
2= NO PROBLEMS NOTED
4= DID NOT TRIP CORRECTLY
5= NOT REPORTED
9= SAMPLES NOT DRAWN FROM THIS BOTTLE

WATER SAMPLE QUALITY FLAGS:
1 = SAMPLE FOR THIS MEASUREMENT WAS DRAWN FROM WATER BOTTLE BUT ANALYSIS NOT RECEIVED
2= ACCEPTABLE MEASUREMENT
3= QUESTIONABLE MEASUREMENT
4= BAD MEASUREMENT
5= NOT REPORTED
9= SAMPLES NOT DRAWN FROM THIS BOTTLE

BCO-DMO Processing Notes

* New version of data 28 Nov 2016 is an updated revision of previous data version 24 Nov 2014. This version of data contains revised TOC concentrations.
* TOC Rounded to 4 decimal places
* Value "-999" which corresponds to an instrument error in which no data was given replaced with 'nd' for no

data
* Parameter names edited to conform to BCO-DMO naming convention found at Choosing Parameter Name
* Blank values replaced with no data value 'nd'
* Date/Time format converted to ISO Date format "ISO_DateTime_UTC"
* Added a conventional header with dataset name, PI name, version date

[table of contents | back to top]

Data Files

File
CTD_Bottle.csv(Comma Separated Values (.csv), 222.01 KB) MD5:fe1d3dd60c89bbbe71b668d4bef362a1 Primary data file for dataset ID 527121

[table of contents | back to top]

Parameters

Parameter	Description	Units
STNNBR	Station number	dimensionless
CASTNO	Cast number per station	dimensionless
BTLNBR	Niskin Bottle sampled	dimensionless
BTLNBR_QF	Niskin Bottle sampled Quality Flag ("QF" ARE REFERENCED IN ODV)	dimensionless
BTLNBR_FLAG_W	Niskin Bottle sampled data quality flag (FLAGS ACCORDING TO WOCE MANUAL TABLES 4.8 AND 4.9)	dimensionless
DATE	Date of cast (GMT)	yyyymmdd
TIME	Time of cast (GMT)	hhmm
DEPTH	Bottom depth; REPORTED DEPTH IS CTD_DEPTH + DISTANCE_ABOVE_BOTTOM AT MAX PRESSURE	METERS
LATITUDE	Latitude (South is negative)	decimal degrees
LONGITUDE	Longitude (West is negative)	decimal degrees
CTDPRS	Water pressure at measurement depth; depth reported as pressure; positive number increasing with water depth	DBAR
CTDTMP	Water temperature at measurement depth; ITS-90	degrees Celsius
CTDSAL	Salinity calculated from CTD sensors (conductivity and temperature) at measurement depth; PSS-78	PSU
CTDSAL_QF	Salinity calculated from CTD sensors (conductivity and temperature) at measurement depth; PSS-78 ("QF" ARE REFERENCED IN ODV)	dimensionless
CTDSAL_FLAG_W	Salinity calculated from CTD sensors (conductivity and temperature) at measurement depth data quality flag (FLAGS ACCORDING TO WOCE MANUAL TABLES 4.8 AND 4.9)	dimensionless
CTDOXY	CTD dissolved oxygen at measurement depth	UMOL/KG
CTDOXY_QF	CTD dissolved oxygen at measurement depth Quality Flag ("QF" ARE REFERENCED IN ODV)	dimensionless

CTDOXY_FLAG_W	CTD dissolved oxygen at measurement depth data quality flag (FLAGS ACCORDING TO WOCE MANUAL TABLES 4.8 AND 4.9)	dimensionless
TOC	Total Organic Carbon	UMOL/KG
TOC_QF	Total Organic Carbon Quality Flag ("QF" ARE REFERENCED IN ODV)	dimensionless
TOC_FLAG_W	Total Organic Carbon data quality flag (FLAGS ACCORDING TO WOCE MANUAL TABLES 4.8 AND 4.9)	dimensionless
TDN	Total Dissolved Nitrogen	UMOL/KG
TDN_QF	Total Organic Nitrogen Quality Flag ("QF" ARE REFERENCED IN ODV)	dimensionless
TDN_FLAG_W	Total Organic Nitrogen data quality flag (FLAGS ACCORDING TO WOCE MANUAL TABLES 4.8 AND 4.9)	dimensionless
PHSPHT	PO4; Phosphate	UMOL/L
PHSPHT_QF	PO4; Phosphate Quality Flag ("QF" ARE REFERENCED IN ODV)	dimensionless
PHSPHT_FLAG_W	PO4; Phosphate data quality flag (FLAGS ACCORDING TO WOCE MANUAL TABLES 4.8 AND 4.9)	dimensionless
SILCAT	Silicate; Silicic Acid; Si; Si(OH)4	UMOL/L
SILCAT_QF	Silicate; Silicic Acid; Si; Si(OH)4 Quality Flag ("QF" ARE REFERENCED IN ODV)	dimensionless
SILCAT_FLAG_W	Silicate; Silicic Acid; Si; Si(OH)4 data quality flag (FLAGS ACCORDING TO WOCE MANUAL TABLES 4.8 AND 4.9)	dimensionless
NITRAT	Nitrate; NO3-	UMOL/L
NITRAT_QF	Nitrate; NO3- Quality Flag ("QF" ARE REFERENCED IN ODV)	dimensionless
NITRAT_FLAG_W	Nitrate; NO3- data quality flag (FLAGS ACCORDING TO WOCE MANUAL TABLES 4.8 AND 4.9)	dimensionless
NITRIT	Nitrite; NO2-	UMOL/L
NITRIT_QF	Nitrite; NO2- Quality Flag ("QF" ARE REFERENCED IN ODV)	dimensionless
NITRIT_FLAG_W	Nitrite; NO2- data quality flag (FLAGS ACCORDING TO WOCE MANUAL TABLES 4.8 AND 4.9)	dimensionless
AMMONIA	Ammonium; NH4+	UMOL/L
AMMONIA_QF	Ammonium; NH4+ Quality Flag ("QF" ARE REFERENCED IN ODV)	dimensionless
AMMONIA_FLAG_W	Ammonium; NH4+ data quality flag (FLAGS ACCORDING TO WOCE MANUAL TABLES 4.8 AND 4.9)	dimensionless
ISO_DateTime_UTC	Date/time (UTC) in ISO format YYYY-mm-ddTHH:MM:SS[.xx]Z	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	CTD SBE 911plus
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	A single SBE9plus CTD (S/N 831) was used for all casts and was deployed with all sensors and pumps as recommended by SBE. In situ salinity and dissolved oxygen check samples were collected to calibrate conductivity and dissolved oxygen sensors (see MV1310 Preliminary Cruise Report).
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Guildline 8410A Portasal
Generic Instrument Name	Guildline 8410A Portasal
Dataset-specific Description	Analyses were run on Guildline models 8400B and 8410 Portasal - Calibration is with IAPSO Standard Seawater. Limit of Detection: 0.002PSU.
Generic Instrument Description	Portasal Salinometer 8410A Guildline 8410A Portasal is a truly portable, high precision instrument from the world leader in salinometers. The Portasal will deliver salinity calculations on-board ship with laboratory level accuracy. It measures accurate conductivity ratios and displays calculated salinity directly as well as measured parameters. http://www.osil.co.uk/Products/Ignore/tabid/56/agentType/View/PropertyID...

Dataset-specific Instrument Name	Niskin bottle
Generic Instrument Name	Niskin bottle
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.

Dataset-specific Instrument Name	Pressure Sensor
Generic Instrument Name	Pressure Sensor
Dataset-specific Description	CTD Pressure: Paroscientific Digiquartz pressure transducer (S/N 831-99677)
Generic Instrument Description	A pressure sensor is a device used to measure absolute, differential, or gauge pressures. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	SBE-43 DO
Generic Instrument Name	Sea-Bird SBE 43 Dissolved Oxygen Sensor
Dataset-specific Description	CTD Dissolved Oxygen: SBE43 dissolved oxygen sensor (DO/43-0275)
Generic Instrument Description	The Sea-Bird SBE 43 dissolved oxygen sensor is a redesign of the Clark polarographic membrane type of dissolved oxygen sensors. more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Shimadzu TOC-L
Generic Instrument Name	Shimadzu TOC-L Analyzer
Dataset-specific Description	TOC was measured by high temperature combustion (HTC) using a Shimadzu TOC-L with auto injection (CV of 1.5-2.5%)
Generic Instrument Description	A Shimadzu TOC-L Analyzer measures DOC by high temperature combustion method. Developed by Shimadzu, the 680 degree C combustion catalytic oxidation method is now used worldwide. One of its most important features is the capacity to efficiently oxidize hard-to-decompose organic compounds, including insoluble and macromolecular organic compounds. The 680 degree C combustion catalytic oxidation method has been adopted for the TOC-L series. http://www.shimadzu.com/an/toc/lab/toc-l2.html

[table of contents | back to top]

Deployments

MV1310

Website	https://www.bco-dmo.org/deployment/526876
Platform	R/V Melville
Report	http://dmoserv3.whoi.edu/data_docs/NorthPacific_RDOC/MV1310_Preliminary_Report_2.pdf
Start Date	2013-08-04
End Date	2013-08-23
Description	Original data are available from the NSF R2R data catalog

[table of contents | back to top]

Project Information

Characterizing a refractory DOC sink in the deep northern North Pacific (North Pacific RDOC)

Website: http://yyy.rsmas.miami.edu/groups/biogeochem/

Coverage: North Pacific, Gulf of Alaska: 48ºN to 59ºN and 129ºW to 153ºW

Extracted from the NSF award abstract:

Refractory dissolved organic carbon (RDOC) in the ocean has long been recognized as highly resistant to removal. It has a mean lifetime in the ocean of thousands of years, so it is generally thought of as a recalcitrant pool that is transported mostly conservatively with the thermohaline circulation. But unlike RDOC in the present-day ocean, this vast reservoir has been implicated by paleoceanographic research as a relatively rapid-turnover carbon source/sink involved in past climate changes. Accordingly, the RDOC reservoir in ancient oceans must at times have been much larger than today, and that large reservoir must have been rapidly mobilized to release its carbon to the atmosphere. There is a clear need to understand how RDOC source and sink processes operate in the modern ocean in order to understand its potential role in past or future oceans.

In this project, a researcher at the Rosenstiel School of Marine and Atmospheric Science of the University of Miami hopes to fill knowledge gaps in the RDOC-climate connection. Inasmuch as mapping of its global distribution was accomplished only within the past few years, few solid facts about processes controlling the RDOC pool have been established. One particularly important RDOC sink is in the northern North Pacific. The PI believes that RDOC carried in bottom waters from the Southern Ocean to the far north is conserved, but once in the vicinity of Pacific Deep Water formation there is a rather abrupt loss of carbon. His immediate goal in this project is to characterize the RDOC sink in the North Pacific, an objective that is one part of the larger goal of understanding the role of ocean RDOC in global climate.

Quantifying the Photochemical Reactivity of Deep Ocean Water (DORC PhotoChem)

Coverage: Sub-Arctic Pacific, Gulf of Alaska, Line P

NSF award abstract:
Because 70% of marine dissolved organic carbon (DOC) is found in the deep ocean, it is important to determine its sources and sinks to understand its role in the global carbon cycle. Unfortunately, the sinks for DOC at depth remain largely unknown; however, limited data has suggested that photochemistry may influence the removal of deep refractory DOC. A scientist from the University of Georgia will use field and laboratory irradiation experiments to quantify the photochemical rates controlling (1) direct loss of DOC and photoproduction of carbon monoxide, a significant product resulting from DOC oxidation, (2) common optical tracers of organic carbon such as colored dissolved organic matter and fluorescent dissolved organic matter fading; and (3) two reactive oxygen species (hydrogen peroxide and superoxide) that reflect the role of oxygen in DOC photochemistry. The study will focus on the north Pacific, where the lowest deep ocean DOC concentrations are found which most likely reflect the presence of an aged and refractory carbon pool. Layered in the top 1000m above this deep DOC is a concentration gradient that will allow comparison of waters with different DOC concentrations, ages and apparent refractivity. Results from the study will be used to quantitatively reevaluate this basic question that now constrains global DOC models: Does photochemistry have a significant role in the removal of the massive amount of refractory DOC that is pooled in the deep sea?

In terms of the broader impacts, based on established links with K-12 teachers, the scientist and his students plan visits to local schools to present their science, as well as have a website entitled "ask the oceanographer" and maintain a live blog during their cruise. Results from this study will be included into class materials dealing with the carbon cycle. One graduate and three undergraduate students would be supported and trained as part of this project. It is anticipated that undergraduate students from historically underrepresented groups would be recruited via the University of Georgia's Summer Undergraduate Research Program.

[table of contents | back to top]

Program Information

United States Surface Ocean Lower Atmosphere Study (U.S. SOLAS)

Website: http://www.us-solas.org/

Coverage: Global

The Surface Ocean Lower Atmosphere Study (SOLAS) program is designed to enable researchers from different disciplines to interact and investigate the multitude of processes and interactions between the coupled ocean and atmosphere.

Oceanographers and atmospheric scientists are working together to improve understanding of the fate, transport, and feedbacks of climate relevant compounds, and also weather and hazards that are affected by processes at the surface ocean.

Oceanographers and atmospheric scientists are working together to improve understanding of the fate, transport, and feedbacks of climate relevant compounds.

Physical, chemical, and biological research near the ocean-atmosphere interface must be performed in synergy to extend our current knowledge to adequately understand and forecast changes on short and long time frames and over local and global spatial scales.

The findings obtained from SOLAS are used to improve knowledge at process scale that will lead to better quantification of fluxes of climate relevant compounds such as CO2, sulfur and nitrogen compounds, hydrocarbons and halocarbons, as well as dust, energy and momentum. This activity facilitates a fundamental understanding to assist the societal needs for climate change, environmental health, weather prediction, and national security.

The US SOLAS program is a component of the International SOLAS program where collaborations are forged with investigators around the world to examine SOLAS issues ubiquitous to the world's oceans and atmosphere.

Â» International SOLAS Web site

Science Implementation Strategy Reports

US-SOLAS (4 MB PDF file)
Other SOLAS reports are available for download from the US SOLAS Web site

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1153930

[table of contents | back to top]