Concentration of atmospheric aerosol total mercury (Hg) from R/V Knorr cruises KN199-04 and KN204-01 (GA03) in the Subtropical northern Atlantic Ocean from 2010-2011 (U.S. GEOTRACES NAT project)

Website: https://www.bco-dmo.org/dataset/3854
Data Type: Cruise Results
Version: 1
Version Date: 2012-12-31

Project
» U.S. GEOTRACES North Atlantic Transect (GA03) (U.S. GEOTRACES NAT)

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

Contributors	Affiliation	Role
Hammerschmidt, Chad	Wright State University	Co-Principal Investigator
Lamborg, Carl	Woods Hole Oceanographic Institution (WHOI)	Co-Principal Investigator
Swarr, Gretchen	Woods Hole Oceanographic Institution (WHOI)	Contact
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset includes concentrations of atmospheric aerosol total mercury (Hg) from R/V Knorr cruises KN199-04 and KN204-01 (GA03) in the Subtropical northern Atlantic Ocean from 2010-2011 (U.S. GEOTRACES NAT project).

Table of Contents

Coverage

Spatial Extent: **N**:39.699 **E**:-9.66 **S**:17.337 **W**:-69.798
Temporal Extent: 2010-10-15 - 2011-12-09

Dataset Description

This dataset includes concentrations of atmospheric aerosol total mercury across the North Atlantic Zonal Transect.

Methods & Sampling

In general, the cruise path was contained from 15 to 40 N and 19 to 70 W. Aerosols were collected by Tisch high-volume aerosol sampler mounted on the 03 deck of the R/V Knorr, forward of the main stack. Sampling was sector-controlled to collect air only arriving at the ship from over the bow, to avoid sampling stack gases and debris associated with science activities on the back deck.

Samples were frozen and transported to Woods Hole Oceanographic Institution (Woods Hole, MA) where they were analyzed within 3 months of collection. The filter swaths that were provided were digested in acid-cleaned polypropylene containers with 5 mL of 2N HNO3, heated to 60 degrees C and sonicated. Following digestion, 1 mL of BrCl was added directly to the digestate (Lamborg et al., 1995, Morton et al., in press).

Total mercury analysis:
- Fitzgerald & Gill, 1979, Bloom & Fitzgerald, 1988, Bloom, 1989.
- Tekran Model 2500 CVAFS Mercury Detector
- Detection limit: 50 fmoles
- Procedural duplicates: 3 ± 2 percent r.s.d. (n=24)
- Results are presented in filter- and reagent-blank corrected form.

Data Processing Description

Quality Flags:
2 = ok
3 = questionable
4 = bad analysis
5 = sample lost
6 = mean of replicates
9 = sample was not collected for Hg analysis

'< DL' indicates that a sample was below the method detection limit Sampling metadata (location, flow rates, sampling duration, etc) are courtesy of Rachel Shelley and Bill Landing (FSU).

BCO-DMO made the following edits:
- Replaced 'not available' with 'nd' to indicate 'no data'.
- Separated each original date-time field to month, day, year, and time fields.
- Added the cruise_id column.

Additional GEOTRACES Processing:
After the data were submitted to the International Data Management Office, BODC, the office noticed that important identifying information was missing in many datasets. With the agreement of BODC and the US GEOTRACES lead PIs, 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: station_GEOTRC, cast_GEOTRC (bottle and pump data only), event_GEOTRC, sample_GEOTRC, sample_bottle_GEOTRC (bottle data only), bottle_GEOTRC (bottle data only), depth_GEOTRC_CTD (bottle data only), depth_GEOTRC_CTD_rounded (bottle data only), BTL_ISO_DateTime_UTC (bottle data only), and GeoFish_id (GeoFish data only). 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_GT10, GT-C_Bottle_GT11, ODF_Bottle_GT10, and ODF_Bottle_GT11 datasets. Non-bottle parameters, including those from GeoFish tows, Aerosol sampling, and McLane Pumps, were taken from the Event_Log_GT10 and Event_Log_GT11 datasets. McLane pump cast numbers missing in event logs were taken from the Particulate Th-234 dataset submitted by Ken Buesseler.

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
Aerosol_Hg_GT10-11_joined.csv (Comma Separated Values (.csv), 6.71 KB) MD5:8704de36d72866d109e219fad634e0e3 Primary data file for dataset ID 3854

[table of contents | back to top]

Related Publications

Bloom, N. (1989). Determination of Picogram Levels of Methylmercury by Aqueous Phase Ethylation, Followed by Cryogenic Gas Chromatography with Cold Vapour Atomic Fluorescence Detection. Canadian Journal of Fisheries and Aquatic Sciences, 46(7), 1131–1140. doi:10.1139/f89-147
Methods

Bloom, N., & Fitzgerald, W. F. (1988). Determination of volatile mercury species at the picogram level by low-temperature gas chromatography with cold-vapour atomic fluorescence detection. Analytica Chimica Acta, 208, 151–161. doi:10.1016/s0003-2670(00)80743-6 https://doi.org/10.1016/S0003-2670(00)80743-6
Methods

Fitzgerald, W. F., & Gill, G. A. (1979). Subnanogram determination of mercury by two-stage gold amalgamation and gas phase detection applied to atmospheric analysis. Analytical Chemistry, 51(11), 1714–1720. doi:10.1021/ac50047a030
Methods

Lamborg, C. H., Fitzgerald, W. F., Vandal, G. M., & Rolfhus, K. R. (1995). Atmospheric mercury in northern Wisconsin: Sources and species. Water, Air, & Soil Pollution, 80(1-4), 189–198. doi:10.1007/bf01189667 https://doi.org/10.1007/BF01189667
Methods

Morton, P. L., Landing, W. M., Hsu, S.-C., Milne, A., Aguilar-Islas, A. M., Baker, A. R., … Zamora, L. M. (2013). Methods for the sampling and analysis of marine aerosols: results from the 2008 GEOTRACES aerosol intercalibration experiment. Limnology and Oceanography: Methods, 11(2), 62–78. doi:10.4319/lom.2013.11.62
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
cruise_id	Official cruise identifier e.g. KN199-04 = R/V Knorr cruise number 199-04.	text
sample_GEOTRC	Unique identifying number for US GEOTRACES samples; ranges from 5033 to 6078 for KN199-04 and from 6112 to 8148 for KN204-01. PI-supplied values were identical to those in the intermediate US GEOTRACES master file. Originally submitted as 'GEOTRACES #', this parameter name has been changed to conform to BCO-DMO's GEOTRACES naming conventions.	unitless

year_start	4-digit year (GMT) at start of sampling event.	YYYY
month_start	2-digit month of year (GMT) at start of sampling event.	mm (01 to 12)
day_start	2-digit day of month (GMT) at start of sampling event.	dd (01 to 31)
time_start	Time (GMT) in HHMM format at start of sampling event; 24-hour clock.	HHMM
lat_start	Latitude at start of sampling event. North = Positive.	decimal degrees
lon_start	Longitude at start of sampling event. West = Negative.	decimal degrees
year_end	4-digit year (GMT) at end of sampling event.	YYYY
month_end	2-digit month of year (GMT) at end of sampling event.	mm (01 to 12)
day_end	2-digit day of month (GMT) at end of sampling event.	dd (01 to 31)
time_end	Time (GMT) in HHMM format at end of sampling event; 24-hour clock.	HHMM
lat_end	Latitude at end of sampling event. North = Positive.	decimal degrees
lon_end	Longitude at end of sampling event. West = Negative.	decimal degrees
run_time	Total run time in hours.	hours
flow_rate	Flow rate in cubic meters per minute.	m^3/min
vol_tot	Total volume sampled in cubic meters.	m^3
Hg_tot	Total mercury.	pg/m^3
Hg_tot_rsd	Relative standard deviation (RSD) of Hg_tot.	%
Hg_tot_sd	Standard deviation of Hg_tot.	pg/m^3

Hg_tot_q_flag	Quality flag for Hg_tot.	unitless
filter	Filter type.	text
station_GEOTRC	GEOTRACES station number; ranges from 1 through 12 for KN199-04 and 1 through 24 for KN204-01. Stations 7 and 9 were skipped on KN204-01. Some GeoFish stations are denoted as X_to_Y indicating the tow occurred between stations X and Y. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	unitless
event_GEOTRC	Unique identifying number for US GEOTRACES sampling events; ranges from 2001 to 2225 for KN199-04 events and from 3001 to 3282 for KN204-01 events. Values were added from the intermediate US GEOTRACES master file (see Processing Description).	unitless
ISO_DateTime_UTC_start	Date and time (UTC) variable recorded at the start of sampling time in ISO compliant format. Values were added from the intermediate US GEOTRACES master file (see Processing Description). This standard is based on ISO 8601:2004(E) and takes on the following form: 2009-08-30T14:05:00[.xx]Z (UTC time)	YYYY-MM-DDTHH:MM:SS[.xx][+/-TZ]
ISO_DateTime_UTC_end	Date and time (UTC) variable recorded at the end of sampling time in ISO compliant format. Values were added from the intermediate US GEOTRACES master file (see Processing Description). This standard is based on ISO 8601:2004(E) and takes on the following form: 2009-08-30T14:05:00[.xx]Z (UTC time)	YYYY-MM-DDTHH:MM:SS[.xx][+/-TZ]

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Aerosol Sampler
Generic Instrument Name	Aerosol Sampler
Dataset-specific Description	Aerosols were collected by Tisch high-volume aerosol samplers.
Generic Instrument Description	A device that collects a sample of aerosol (dry particles or liquid droplets) from the atmosphere.

Dataset-specific Instrument Name	Cold Vapor Atomic Fluorescence Spectrophotometer
Generic Instrument Name	Cold Vapor Atomic Fluorescence Spectrophotometer
Dataset-specific Description	A Tekran Model 2500 CVAFS Mercury Detector was used. See the manufacturer's product fact sheet (PDF; opens in new window/tab).
Generic Instrument Description	A Cold Vapor Atomic Fluorescent Spectrophotometer (CVAFS) is an instrument used for quantitative determination of volatile heavy metals, such as mercury. CVAFS make use of the characteristic of mercury that allows vapor measurement at room temperature. Mercury atoms in an inert carrier gas are excited by a collimated UV light source at a particular wavelength. As the atoms return to their non-excited state they re-radiate their absorbed energy at the same wavelength. The fluorescence may be detected using a photomultiplier tube or UV photodiode.

[table of contents | back to top]

Deployments

KN199-04

Website	https://www.bco-dmo.org/deployment/58066
Platform	R/V Knorr
Report	http://bcodata.whoi.edu/US_GEOTRACES/AtlanticSection/Cruise_Report_for_Knorr_199_Final_v3.pdf
Start Date	2010-10-15
End Date	2010-11-04
Description	This cruise constitutes the first survey section as part of the U.S. participation in an international program named GEOTRACES. Funding: NSF OCE award 0926423 Science Objectives: To obtain state of the art trace metal and isotope measurements on a suite of samples taken on a mid-latitude zonal transect of the North Atlantic. In particular, sampling targeted the oxygen minimum zone extending off the west African coast near Mauritania, the TAG hydrothermal field, and the western boundary current system along Line W. For additional information, please refer to the GEOTRACES program Web site (https://www.geotraces.org/) for overall program objectives and a summary of properties measured. Science Activities include seawater sampling via GoFLO and Niskin carousels, in situ pumping (and filtration), CTDO2 and transmissometer sensors, underway pumped sampling of surface waters, and collection of aerosols and rain. Hydrography, CTD and nutrient measurements were supported by the Ocean Data Facility (J. Swift) at Scripps Institution of Oceanography and funded through NSF Facilities. They provided an additional CTD rosette system along with nephelometer and LADCP. A trace metal clean Go-Flo Rosette and winch were provided by the group at Old Dominion University (G. Cutter) along with a towed underway pumping system. Additional cruise information is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/KN199-04 Other Relevant Links: List of cruise participants: [PDF] Cruise track: JPEG image (from Woods Hole Oceanographic Institution, vessel operator) ADCP data are available from the Currents ADCP group at the University of Hawaii: KN199-04 ADCP

KN204-01

Website	https://www.bco-dmo.org/deployment/58786
Platform	R/V Knorr
Report	http://bcodata.whoi.edu/US_GEOTRACES/AtlanticSection/STS_Prelim_GT11_Doc.pdf
Start Date	2011-11-06
End Date	2011-12-11
Description	The US GEOTRACES North Atlantic cruise aboard the R/V Knorr completed the section between Lisbon and Woods Hole that began in October 2010 but was rescheduled for November-December 2011. The R/V Knorr made a brief stop in Bermuda to exchange samples and personnel before continuing across the basin. Scientists disembarked in Praia, Cape Verde, on 11 December. The cruise was identified as KN204-01A (first part before Bermuda) and KN204-01B (after the Bermuda stop). However, the official deployment name for this cruise is KN204-01 and includes both part A and B. Science activities included: ODF 30 liter rosette CTD casts, ODU Trace metal rosette CTD casts, McLane particulate pump casts, underway sampling with towed fish and sampling from the shipboard "uncontaminated" flow-through system. Full depth stations are shown in the accompanying figure (see below). Additional stations to sample for selected trace metals to a depth of 1000 m are not shown. Standard stations are shown in red (as are the ports) and "super" stations, with extra casts to provide large-volume samples for selected parameters, are shown in green. Station spacing is concentrated along the western margin to evaluate the transport of trace elements and isotopes by western boundary currents. Stations across the gyre will allow scientists to examine trace element supply by Saharan dust, while also contrasting trace element and isotope distributions in the oligotrophic gyre with conditions near biologically productive ocean margins, both in the west, to be sampled now, and within the eastern boundary upwelling system off Mauritania, sampled last year. Funding: The cruise was funded by NSF OCE awards 0926204, 0926433 and 0926659. Additional cruise information is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/KN204-01 Other Relevant Links: ADCP data are available from the Currents ADCP group at the University of Hawaii at the links below: KN204-01A (part 1 of 2011 cruise; Woods Hole, MA to Bermuda) KN204-01B (part 2 of 2011 cruise; Bermuda to Cape Verde)

[table of contents | back to top]

Project Information

U.S. GEOTRACES North Atlantic Transect (GA03) (U.S. GEOTRACES NAT)

Website: https://www.geotraces.org/

Coverage: Subtropical western and eastern North Atlantic Ocean (GA03)

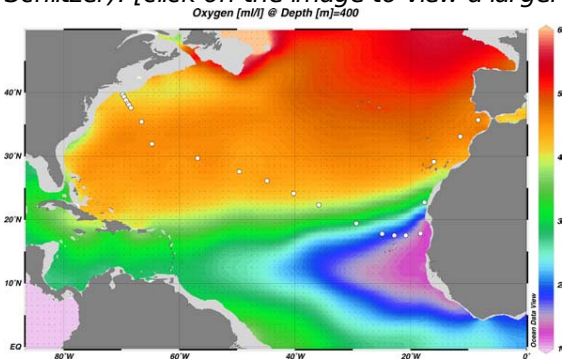
Much of this text appeared in an article published in OCB News, October 2008, by the OCB Project Office.

The first U.S. GEOTRACES Atlantic Section will be specifically centered around a sampling cruise to be carried out in the North Atlantic in 2010. Ed Boyle (MIT) and Bill Jenkins (WHOI) organized a three-day planning workshop that was held September 22-24, 2008 at the Woods Hole Oceanographic Institution. The main goal of the workshop, sponsored by the National Science Foundation and the U.S. GEOTRACES Scientific Steering Committee, was to design the implementation plan for the first U.S. GEOTRACES Atlantic Section. The primary cruise design motivation was to improve knowledge of the sources, sinks and internal cycling of Trace Elements and their Isotopes (TEIs) by studying their distributions along a section in the North Atlantic (Figure 1). The North Atlantic has the full suite of processes that affect TEIs, including strong meridional advection, boundary scavenging and source effects, aeolian deposition, and the salty Mediterranean Outflow. The North Atlantic is particularly important as it lies at the "origin" of the global Meridional Overturning Circulation.

It is well understood that many trace metals play important roles in biogeochemical processes and the carbon cycle, yet very little is known about their large-scale distributions and the regional scale processes that affect them. Recent advances in sampling and analytical techniques, along with advances in our understanding of their

roles in enzymatic and catalytic processes in the open ocean provide a natural opportunity to make substantial advances in our understanding of these important elements. Moreover, we are motivated by the prospect of global change and the need to understand the present and future workings of the ocean's biogeochemistry. The GEOTRACES strategy is to measure a broad suite of TEIs to constrain the critical biogeochemical processes that influence their distributions. In addition to these "exotic" substances, more traditional properties, including macronutrients (at micromolar and nanomolar levels), CTD, bio-optical parameters, and carbon system characteristics will be measured. The cruise starts at Line W, a repeat hydrographic section southeast of Cape Cod, extends to Bermuda and subsequently through the North Atlantic oligotrophic subtropical gyre, then transects into the African coast in the northern limb of the coastal upwelling region. From there, the cruise goes northward into the Mediterranean outflow. The station locations shown on the map are for the "fulldepth TEI" stations, and constitute approximately half of the stations to be ultimately occupied.

Figure 1. The proposed 2010 Atlantic GEOTRACES cruise track plotted on dissolved oxygen at 400 m depth. Data from the World Ocean Atlas (Levitus et al., 2005) were plotted using Ocean Data View (courtesy Reiner Schlitzer). [click on the image to view a larger version]

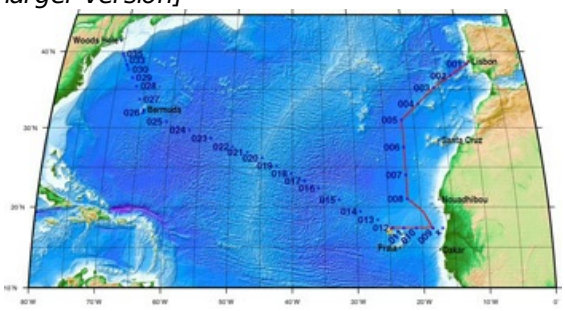


Hydrography, CTD and nutrient measurements will be supported by the Ocean Data Facility (J. Swift) at Scripps Institution of Oceanography and funded through NSF Facilities. They will be providing an additional CTD rosette system along with nephelometer and LADCP. A trace metal clean Go-Flo Rosette and winch will be provided by the group at Old Dominion University (G. Cutter) along with a towed underway pumping system.

The North Atlantic Transect cruise began in 2010 with KN199 leg 4 (station sampling) and leg 5 (underway sampling only) (Figure 2).

KN199-04 Cruise Report (PDF)

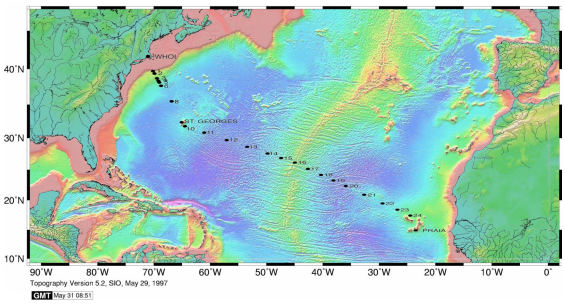
Figure 2. The red line shows the cruise track for the first leg of the US Geotraces North Atlantic Transect on the R/V Knorr in October 2010. The rest of the stations (beginning with 13) will be completed in October-December 2011 on the R/V Knorr (courtesy of Bill Jenkins, Chief Scientist, GNAT first leg). [click on the image to view a larger version]



The section completion effort resumed again in November 2011 with KN204-01A,B (Figure 3).

KN204-01A,B Cruise Report (PDF)

Figure 3. Station locations occupied on the US Geotraces North Atlantic Transect on the R/V Knorr in November 2011. [click on the image to view a larger version]



Data from the North Atlantic Transect cruises are available under the Datasets heading below, and consensus values for the SAFe and North Atlantic GEOTRACES Reference Seawater Samples are available from the GEOTRACES Program Office: Standards and Reference Materials

ADCP data are available from the Currents ADCP group at the University of Hawaii at the links below:
KN199-04 (leg 1 of 2010 cruise; Lisbon to Cape Verde)
KN199-05 (leg 2 of 2010 cruise; Cape Verde to Charleston, NC)
KN204-01A (part 1 of 2011 cruise; Woods Hole, MA to Bermuda)
KN204-01B (part 2 of 2011 cruise; Bermuda to Cape Verde)

[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-0927274
NSF Division of Ocean Sciences (NSF OCE)	OCE-1132515
NSF Division of Ocean Sciences (NSF OCE)	OCE-0928191
NSF Division of Ocean Sciences (NSF OCE)	OCE-1132480

[table of contents | back to top]