

# Atmospheric & gaseous mercury from aerosol samples collected using high volume and low volume sampling systems on Leg 1 (Seattle, WA to Hilo, HI) of the US GEOTRACES PMT cruise (GP15, RR1814) on R/V Roger Revelle from Sept-Oct 2018

**Website:** <https://www.bco-dmo.org/dataset/833482>

**Data Type:** Cruise Results

**Version:** 1

**Version Date:** 2020-12-14

## Project

» [US GEOTRACES Pacific Meridional Transect](#) (U.S. GEOTRACES PMT)

» [US GEOTRACES Pacific Meridional Transect: Determination of the air-sea exchange of inorganic and methylated mercury in the anthropogenically-impacted and remote Pacific Ocean](#) (PMT Mercury air-sea exchange)

## Program

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

Contributors	Affiliation	Role
<a href="#">Mason, Robert</a>	University of Connecticut (UConn)	Principal Investigator
<a href="#">Rauch, Shannon</a>	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

## Abstract

Aerosol samples were collected using high volume and low volume sampling systems on Leg 1 (Seattle, WA to Hilo, HI) of the US GEOTRACES Pacific Meridional Transect (PMT) cruise (GP15, RR1814) on R/V Roger Revelle from Sept-Oct 2018. This dataset reports atmospheric mercury associated with aerosols collected using these sampling systems. The Tekran low volume sampling system was also used to measure total gaseous elemental mercury and gaseous ionic ("reactive") mercury, which are also reported in this dataset.

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## Coverage

**Spatial Extent:** N:56.055 E:-122.431 S:19.676 W:-156.958

**Temporal Extent:** 2018-09-18 - 2018-10-22

## Acquisition Description

This dataset reports atmospheric mercury associated with aerosols collected using a high volume sampling system and from a low volume sampling system (a Tekran speciation unit). The Tekran low volume sampling system was also used to measure total gaseous elemental mercury and gaseous ionic ("reactive") mercury, which are also reported in this dataset.

### **High Volume Sampling:**

Atmospheric mercury associated with aerosols collected using a high volume sampling system. The samplers were deployed and monitored by the GEOTRACES atmospheric group (operated by Bill Landing/Cliff Buck). The sampling duration was based on the volume of air filtered, which was not consistent as the sample system was sectorized, based on wind direction and speed, so that air was only sampled under conditions where there was no potential for contamination from the ship's stack and other potential sources. Filter samples were provided post-cruise for analysis. Samples are identified by an event ID and a sample ID. Samples were digested prior to analysis for total Hg using standard techniques as detailed in various publications (Mason et al., 2017; DiMento et al., 2019).

Total atmospheric Hg from the high volume sampler is reported in units of picograms per cubic meter ( $\text{pg}/\text{m}^3$ ).

Detection limit = 0.02

Spike recovery (%) =  $99.6 \pm 6.3$

### **Low Volume Sampling:**

Atmospheric mercury associated with aerosols collected using a low volume sampling system (using a Tekran speciation unit). The Tekran sampler was deployed continuously but after the cruise data was removed that was compromised due to potential contamination by the ship, based on the high volume collection sampling times, and also when the sampling was compromised while the ship was on station. As the instrument blanks itself after every measurement, this post-cruise analysis was possible. As these samples were collected continuously with 1 hour sampling resolution, there are no identifying GEOTRACES ID's associated with them. The automated instrument collects a sample for a pre-determined period and then the collected particulate material is heated to high temperature to release the Hg as elemental Hg, which is detected and quantified by a Tekran 2537X analyzer. The analyzer is calibrated by an in situ calibration (permeation) system and via external spike injections. Reported concentrations are daily average values and their standard deviation.

Total atmospheric Hg from the low volume Tekran sampler is reported in units of picograms per cubic meter ( $\text{pg}/\text{m}^3$ ).

Detection limit = <6

Spike recovery (%) = 95-107

### **Total Gaseous Elemental Mercury:**

Total gaseous elemental mercury concentration in the atmosphere, measured using the Tekran speciation with 5-minute resolution. This is an automated sampling system. The Tekran sampler was deployed continuously but after the cruise data was removed that was compromised due to potential contamination by the ship, based on the high volume collection sampling times, and also when the sampling was compromised while the ship was on station. As the instrument blanks itself after every measurement this post-cruise analysis was possible. There are no identifying GEOTRACES IDs' associated with these samples. Reported concentrations are daily average values and their standard deviation. The method of analysis is detailed in Mason et al. (2017) and DiMento et al. (2019). Parameter is named based on the format developed by the GEOTRACES committee as: Hg\_G\_0\_CONC\_LOWVOL, with the designation of G for a gaseous sample. In the scientific literature, the measurements are reported with the following acronyms: TGM, TGHg, GEM.

Total gaseous elemental mercury from the Tekran system is reported in units of nanograms per cubic meter ( $\text{ng}/\text{m}^3$ )

Detection limit = 0.02

Spike recovery (%) = 95-107

### **Gaseous Reactive Mercury:**

Gaseous ionic (so-called "reactive") mercury concentration in the atmosphere, measured using the Tekran speciation with 1-hour resolution. This is an automated sampling system. The gaseous ionic fraction is removed by the Tekran instrument using a potassium chloride-coated denuder which collects an integrated sample. After heating the denuder, the Hg is released as elemental Hg and quantified using a Tekran 2537X instrument, which is calibrated as detailed above. Analytical details can be found in He and Mason (2021). The Tekran sampler was deployed continuously but after the cruise data was removed that was compromised due to potential contamination by the ship, based on the high volume collection sampling times, and also when the sampling was compromised while the ship was on station. As the instrument blanks itself after every measurement this post-cruise analysis was possible. There are no identifying GEOTRACES ID's associated with these samples. Reported concentrations are daily average values and their standard deviation. Parameter is named based on the format developed by the GEOTRACES committee as: Hg\_G\_R\_CONC\_LOWVOL. In the scientific literature, the measurements are reported with the following acronyms: RGM, RGHg, GOM.

Gaseous reactive mercury from the Tekran system is reported in units of picograms per cubic meter ( $\text{pg}/\text{m}^3$ ).

Detection limit = <6

Spike recovery (%) = 95-107

## Processing Description

### BCO-DMO Processing:

- added date-time fields in ISO8601 format;
- applied GEOTRACES D0oR barcoded names;
- renamed fields to conform with BCO-DMO naming conventions.

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## Related Publications

DiMento, B. P., Mason, R. P., Brooks, S., & Moore, C. (2019). The impact of sea ice on the air-sea exchange of mercury in the Arctic Ocean. *Deep Sea Research Part I: Oceanographic Research Papers*, 144, 28–38.

doi:[10.1016/j.dsr.2018.12.001](https://doi.org/10.1016/j.dsr.2018.12.001)

*Methods*

He, Y., Mason, R.P. 2021. Comparison of reactive gaseous mercury measured by KCl-coated denuders and cation exchange membranes during the Pacific GEOTRACES GP15 expedition. *Atmospheric Environment* 244: Art # 117973.

*Methods*

Mason, R. P., Hammerschmidt, C. R., Lamborg, C. H., Bowman, K. L., Swarr, G. J., & Shelley, R. U. (2017). The air-sea exchange of mercury in the low latitude Pacific and Atlantic Oceans. *Deep Sea Research Part I: Oceanographic Research Papers*, 122, 17–28. doi:[10.1016/j.dsr.2017.01.015](https://doi.org/10.1016/j.dsr.2017.01.015)

*Methods*

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## Related Datasets

### IsContinuedBy

Mason, R. (2020) **Atmospheric & gaseous mercury from aerosol samples collected using high volume and low volume sampling systems on Leg 2 (Hilo, HI to Papeete, French Polynesia) of the US GEOTRACES PMT cruise (GP15, RR1815) on R/V Roger Revelle from Oct-Nov 2018**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2020-12-14 <http://lod.bco-dmo.org/id/dataset/833539> [[view at BCO-DMO](#)]

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## Parameters

Parameter	Description	Units
Station_ID	Station number	unitless
Start_Date_UTC	Date (UTC) at start of sample collection; format: DD/MM/YYYY	unitless
Start_Time_UTC	Time (UTC) at start of sample collection; format: hh:mm	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) at start of sample collection; formatted to ISO8601 standard: YYYY-MM-DDThh:mmZ	unitless
End_Date_UTC	Date (UTC) at end of sample collection; format: DD/MM/YYYY	unitless
End_Time_UTC	Time (UTC) at end of sample collection; format: hh:mm	unitless
End_ISO_DateTime_UTC	Date and time (UTC) at end of sample collection; formatted to ISO8601 standard: YYYY-MM-DDThh:mmZ	unitless
Start_Latitude	Latitude at start of sample collection	degrees North
Start_Longitude	Longitude at start of sample collection	degrees East
End_Latitude	Latitude at end of sample collection	degrees North
End_Longitude	Longitude at end of sample collection	degrees East
Event_ID	Event number	unitless
Sample_ID	GEOTRACES sample number	unitless
Sample_Depth	Sample depth	meters (m)
Hg_A_T_CONC_LOWVOL_3s9lkr	Atmospheric mercury associated with aerosols collected using a low volume sampling system (using a Tekran speciation unit)	picograms per cubic meter (pg m-3)
SD1_Hg_A_T_CONC_LOWVOL_3s9lkr	One standard deviation of Hg_A_T_CONC_LOWVOL_3s9lkr	picograms per cubic meter (pg m-3)
Flag_Hg_A_T_CONC_LOWVOL_3s9lkr	Quality flag for Hg_A_T_CONC_LOWVOL_3s9lkr	unitless
Hg_A_T_CONC_HIVOL_eqkbt2	Atmospheric mercury associated with aerosols collected using a high volume sampling system	picograms per cubic meter (pg m-3)
SD1_Hg_A_T_CONC_HIVOL_eqkbt2	One standard deviation of Hg_A_T_CONC_HIVOL_eqkbt2	picograms per cubic meter (pg m-3)
Flag_Hg_A_T_CONC_HIVOL_eqkbt2	Quality flag for Hg_A_T_CONC_HIVOL_eqkbt2	unitless
Hg_G_0_CONC_LOWVOL	Total gaseous elemental mercury concentration in the atmosphere, measured using the Tekran speciation with 5 minute resolution	nanograms per cubic meter (ng m-3)
SD1_Hg_G_0_CONC_LOWVOL	One standard deviation of Hg_G_0_CONC_LOWVOL	nanograms per cubic meter (ng m-3)
Flag_Hg_G_0_CONC_LOWVOL	Quality flag for Hg_G_0_CONC_LOWVOL	unitless
Hg_G_R_CONC_LOWVOL	Gaseous ionic (so-called "reactive") mercury concentration in the atmosphere, measured using the Tekran speciation with 1 hour resolution	picograms per cubic meter (pg m-3)
SD1_Hg_G_R_CONC_LOWVOL	One standard deviation of Hg_G_R_CONC_LOWVOL	picograms per cubic meter (pg m-3)
Flag_Hg_G_R_CONC_LOWVOL	Quality flag for Hg_G_R_CONC_LOWVOL	unitless

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## Instruments

<b>Dataset-specific Instrument Name</b>	Tisch Environmental, model 5170V-BL
<b>Generic Instrument Name</b>	Aerosol Sampler
<b>Generic Instrument Description</b>	A device that collects a sample of aerosol (dry particles or liquid droplets) from the atmosphere.

<b>Dataset-specific Instrument Name</b>	Tekran air speciation unit
<b>Generic Instrument Name</b>	Atmospheric Gas Analyzer
<b>Generic Instrument Description</b>	In-situ instruments that can determine the proportion of one or more gaseous components of the atmosphere.

<b>Dataset-specific Instrument Name</b>	Tekran 2537X analyzer
<b>Generic Instrument Name</b>	Tekran 2537X Automated Ambient Air Analyzer
<b>Generic Instrument Description</b>	The Tekran 2537X performs continuous long-term, unattended analysis of gaseous elemental mercury. More information from the manufacturer: <a href="https://www.tekran.com/products/ambient-air/tekran-model-2537-cvafs-auto...">https://www.tekran.com/products/ambient-air/tekran-model-2537-cvafs-auto...</a>

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## Deployments

### RR1814

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/776913">https://www.bco-dmo.org/deployment/776913</a>
<b>Platform</b>	R/V Roger Revelle
<b>Report</b>	<a href="https://datadocs.bco-dmo.org/docs/geotraces/GEOTRACES_PMT/casciotti/data_docs/GP15_Cruise_Report_with_ODF_Report.pdf">https://datadocs.bco-dmo.org/docs/geotraces/GEOTRACES_PMT/casciotti/data_docs/GP15_Cruise_Report_with_ODF_Report.pdf</a>
<b>Start Date</b>	2018-09-18
<b>End Date</b>	2018-10-21

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## Project Information

### US GEOTRACES Pacific Meridional Transect (U.S. GEOTRACES PMT)

**Website:** [http://www.usgeotraces.org/USGEOTRACES\\_website/html/pacific-alaska.html](http://www.usgeotraces.org/USGEOTRACES_website/html/pacific-alaska.html)

**Coverage:** Pacific Meridional Transect along 152W (GP15)

A 60-day research cruise took place in 2018 along a transect from Alaska to Tahiti at 152° W. A description of the project titled "*Collaborative Research: Management and implementation of the US GEOTRACES Pacific Meridional Transect*", funded by NSF, is below. Further project information is available on the [US GEOTRACES website](#) and on the [cruise blog](#). A detailed [cruise report is also available](#) as a PDF.

*Description from NSF award abstract:*

GEOTRACES is a global effort in the field of Chemical Oceanography in which the United States plays a major role. The goal of the GEOTRACES program is to understand the distributions of many elements and their isotopes in the ocean. Until quite recently, these elements could not be measured at a global scale. Understanding the distributions of these elements and isotopes will increase the understanding of processes that shape their distributions and also the processes that depend on these elements. For example, many "trace elements" (elements that are present in very low amounts) are also important for life, and their presence or absence can play a vital role in the population of marine ecosystems. This project will launch the next major U.S. GEOTRACES expedition in the Pacific Ocean between Alaska and Tahiti. The award made here would support all of the major infrastructure for this expedition, including the research vessel, the sampling equipment, and some of the core oceanographic measurements. This project will also support the personnel needed to lead the expedition and collect the samples.

This project would support the essential sampling operations and infrastructure for the U.S. GEOTRACES Pacific Meridional Transect along 152° W to support a large variety of individual science projects on trace element and isotope (TEI) biogeochemistry that will follow. Thus, the major objectives of this management proposal are: (1) plan and coordinate a 60 day research cruise in 2018; (2) obtain representative samples for a wide variety of TEIs using a conventional CTD/rosette, GEOTRACES Trace Element Sampling Systems, and in situ pumps; (3) acquire conventional CTD hydrographic data along with discrete samples for salinity, dissolved oxygen, algal pigments, 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 data to the GEOTRACES Data Assembly Centre (via the US BCO-DMO data center); and (6) coordinate all cruise communications between investigators, including preparation of a hydrographic report/publication. This project would also provide baseline measurements of TEIs in the Clarion-Clipperton fracture zone (~7.5°N-17°N, ~155°W-115°W) where large-scale deep sea mining is planned. Environmental impact assessments are underway in partnership with the mining industry, but the effect of mining activities on TEIs in the water column is one that could be uniquely assessed by the GEOTRACES community. In support of efforts to communicate the science to a wide audience the investigators will recruit an early career freelance science journalist with interests in marine science and oceanography to participate on the cruise and do public outreach, photography and/or videography, and social media from the ship, as well as to submit articles about the research to national media. The project would also support several graduate students.

**US GEOTRACES Pacific Meridional Transect: Determination of the air-sea exchange of inorganic and methylated mercury in the anthropogenically-impacted and remote Pacific Ocean (PMT Mercury air-sea exchange)**

**Website:** <http://mason.mercury.uconn.edu/research-projects-2/>

**Coverage:** Pacific Ocean Alaska (Aleutian Islands to Tahiti along 150 W, 55 N to 20 S)

*NSF Award Abstract:*

Human activity has greatly increased the amount of mercury (Hg) in the environment, and particularly in the surface ocean. Most of the Hg enters the ocean from the atmosphere as a gas, on particles, or in precipitation. Complex physical and chemical processes at the interface between the ocean and atmosphere control the amount of Hg that is retained and therefore that can ultimately accumulate in seafood. Methylmercury (MeHg) is a chemical form of Hg that is commonly retained in organisms and impacts the health and development of humans and wildlife. This research will assess concentrations of Hg together with its "methyl" forms in the atmosphere and surface ocean at sea from Alaska to Tahiti. The spatial extent of the cruise will allow comparison of the air-sea exchange and concentrations of mercury in both the North Pacific where human emissions are large and in remote regions with minimal human impact. The researchers will use established techniques and develop new methods to examine the fate and transport of mercury within the surface ocean. These findings will contribute key Hg data to the GEOTRACES program and thus enhance its overall impact as part of an extensive marine trace element study. Findings will have potential to inform public policy and global environmental treaties related to Hg, thus providing data to evaluate human risk from Hg in present and future climate scenarios. Educational impact will include

support for a graduate student and their dissertation using the field data, as well as several undergraduates that will gain high level, hands-on research experience.

The research will take advantage of recent analytical advances that enable high resolution determination of the concentrations and forms of inorganic Hg in the surface ocean and atmosphere. The analytical approach will also be expanded to include measurements of methylated Hg compounds, including MeHg and dimethylmercury. These measurements, and ancillary data collected during the GEOTRACES Pacific Meridional Transect cruise, will allow assessment of both atmospheric input and in situ oceanic loss for the dominant forms of inorganic and methylated Hg. Exchange will also be evaluated in the context of the suite of environmental variables collected by collaborators during the cruise. The resulting data will help assess the long-term impact of anthropogenic inputs of Hg to the atmosphere and ocean, and the factors that influence the loss of Hg from the ocean by gas evasion. The studies will build on previous results obtained as part of the GEOTRACES program and other NSF-funded studies, adding novel measurements and building an enhanced understanding of the sources and sinks of Hg to the open ocean.

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## Program Information

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

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

**Coverage:** Global

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

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

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

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

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

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

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1736659</a>

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