Total dissolved gaseous mercury in surface waters and in the atmosphere collected aboard the R/V Kilo Moana in the tropical Pacific Ocean from October 2011.

Website: https://www.bco-dmo.org/dataset/763650
Data Type: Cruise Results
Version: 0
Version Date: 2019-03-27

Project
» Collaborative Research: Interwoven biogeochemical cycles and biological transformations of mercury and selenium in the upper ocean (Mercury and Selenium)

Contributors	Affiliation	Role
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Table of Contents

Coverage

Spatial Extent: **N**:19.662 **E**:-154.211 **S**:-15.124 **W**:-174.5
Temporal Extent: 2011-10-02 - 2011-10-24

Dataset Description

The data include measurements of total dissolved gaseous mercury in surface waters and in the atmosphere, both primarily elemental Hg (Hg(0)), in the tropical Pacific Ocean in 2011.

The samples were collected on a separately funded cruise (Metzyme cruise) and details are available at: www.bco-dmo.org/deployment/59053

Data from the CTD deployed can be found at: www.bco-dmo.org/dataset/716469

Data on the nutrient concentrations for each sample depth can be found at: www.bco-dmo.org/dataset/646115

Data on the selenium concentrations for each sample depth can be found at: www.bco-dmo.org/dataset/74939

Methods & Sampling

Surface water samples were obtained using water collected at 5-10 m depth from the ship's underway

sampling system. The water is continuously sparged with low Hg0 air in a water-gas separation device (gas equilibrator) with a reverse flow configuration where the water is added to an inner chamber at the top and air at the bottom of the chamber. The water then flows through an outer jacket of the device to maintain the water temperature in the inner chamber at that of the incoming sweater. The device is based on the equilibrator described in detail in Andersson et al. (2008). For the best performance the water flow should be high relative to that of the air, and in this study the air flow was maintained around 1.5 L min-1, somewhat higher than that required by the Tekran 2537B instrument that was used for Hg detection (1 L min-1). The water flow was somewhat variable but typically was 6-10 times that of the air. The incoming air is passed through spargers that create small gas bubbles to enhance equilibration and this is also enhanced by the mixing induced by the incoming water. Based on the relative flow rates, the response time of the instrument to changes in water concentration is <5 min (Andersson et al., 2008) so changes between a set of measurements could reflect changes in the water on the same timescale. Depending on the ship's speed, this represents a spatial sampling resolution of 1-2 km for a 5 minute sample. Based on our experience, measurements while the ship is stationary are often higher and more variable, and so these measurements are not considered reliable and are not included in the database. The air is dried using a Teflon filter and a soda lime trap prior to the passing to the detector – a Tekran 2537B mercury analyzer.
The detection of Hg as elemental Hg in the air after sparging relied on another Tekran 2537B instrument with a sampling resolution of 5 min. As described above, the instrument is calibrated in two ways. Air is sampled continuously as there are two sampling gold traps lines within the instrument and while one sample is being analyzed, the other is being trapped, with the timing controlled by the instrument's software. Air was sampled from the outside at a location sufficiently above the water level to prevent entrainment of water, and in a position to prevent contamination for the ships' exhaust while underway. The air is dried using a Teflon filter and a soda lime trap prior to the detector.

Data Processing Description

QA/QC:
Both measurements relied on the use of a Tekran air measurement instrument, which has a built-in calibration unit (Hg0 permeation tube) for calibration, which was done daily. External injections of Hg0 were also used to check the accuracy of the permeation device. The instruments had a detection limit of <0.2 ng m-3 for air sampling and <2 fM for water sampling during the cruise (water concentration calculated from the measured value in the equilibrated air). The detection limit for the equilibrator is evaluated based on the sparging of water without water flow. As the DGHg is removed by sparging and not replenished without flow, long-term sparging results in values that reflect the background blank and the variability in this value is used to estimate the detection limit. For the air sampling, the instrument periodically flushes the system with Hg-free air and makes blank measurements. Again, these values and their variability can be used to determine the detection limit for air sampling. Prior studies have compared concentrations measured using the continuous sampler to those with manual methods and verified consistency over a range of seawater temperatures (Andersson et al., 2008; Soerensen et al., 2014). Performance of the continuous sampler was also verified in the laboratory prior to the cruise by injection and recovery of external standards. Data presented in the table represent the average hourly value for each set of measurements, which were made at 5 minute resolution. Typical variability was 3% and 10% for 1 hr of observations in air and water, respectively; n = 12 for 5-min samples (per hour).

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- added ISO Date format generated from date and time values

[table of contents | back to top]

Related Publications

Andersson, M. E., Gårdfeldt, K., & Wängberg, I. (2008). A description of an automatic continuous equilibrium system for the measurement of dissolved gaseous mercury. Analytical and Bioanalytical Chemistry, 391(6), 2277–2282. doi:10.1007/s00216-008-2127-4
Methods

Gosnell, K. J., & Mason, R. P. (2015). Mercury and methylmercury incidence and bioaccumulation in plankton from the central Pacific Ocean. Marine Chemistry, 177, 772–780. doi:10.1016/j.marchem.2015.07.005
General

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 I 122: 17-28. 10.1016/j.dsr.2017.01.015
General

Munson, K. M., Lamborg, C. H., Swarr, G. J., & Saito, M. A. (2015). Mercury species concentrations and fluxes in the Central Tropical Pacific Ocean. Global Biogeochemical Cycles, 29(5), 656–676. doi:10.1002/2015gb005120 https://doi.org/10.1002/2015GB005120
General

Soerensen, A. L., Mason, R. P., Balcom, P. H., & Sunderland, E. M. (2013). Drivers of Surface Ocean Mercury Concentrations and Air–Sea Exchange in the West Atlantic Ocean. Environmental Science & Technology, 47(14), 7757–7765. doi:10.1021/es401354q
General

Soerensen, A. L., Mason, R. P., Balcom, P. H., Jacob, D. J., Zhang, Y., Kuss, J., & Sunderland, E. M. (2014). Elemental Mercury Concentrations and Fluxes in the Tropical Atmosphere and Ocean. Environmental Science & Technology, 48(19), 11312–11319. doi:10.1021/es503109p
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
Date	Date given in Greenwich Mean Time	unitless
Hour	Date and hour given in Greenwich Mean Time	unitless
Julian_day	Julian day given in Greenwich Mean Time	unitless
Latitude	latitude (negative values for the southern hemisphere)	decimal degrees
Longitude	longitude degrees west	decimal degrees
Air_TGHg	atmospheric gaseous mercury	nanograms per meter cubed (ng/m3)
Water_DGHg	total dissolved gaseous mercury	picoMole (pM)
Sea_Temp	surface water temperature from the ship’s underway sampling system	degrees Celsius
Windspeed	wind speed from the ship’s data	meters per second (m/s)
Salinity	salinity from the ship’s underway sampling system	unitless
Fluorescence	fluorescence (unitless) from the ship’s underway sampling system	unitless
ISO_Date_Time_GMT	Date and time provided in ISO 8601 format	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Tekran 2537B mercury analyzer
Generic Instrument Name	Atmospheric Gas Analyzer
Dataset-specific Description	Two Tekran 2537B air analysis instruments
Generic Instrument Description	In-situ instruments that can determine the proportion of one or more gaseous components of the atmosphere.

[table of contents | back to top]

Deployments

KM1128

Website	https://www.bco-dmo.org/deployment/59053
Platform	R/V Kilo Moana
Start Date	2011-10-01
End Date	2011-10-25
Description	This is a MetZyme project cruise. The original cruise data are available from the NSF R2R data catalog.

[table of contents | back to top]

Project Information

Collaborative Research: Interwoven biogeochemical cycles and biological transformations of mercury and selenium in the upper ocean (Mercury and Selenium)

Coverage: Tropical North and South Pacific and equatorial region; cruise track from Hawaii to Tahiti

NSF Award Abstract:
Researchers from the University of Connecticut, Woods Hole Oceanographic Institution, and Harvard University plan to address three questions related to the global biogeochemical mercury (Hg) and selenium (Se) cycles, namely (1) what are the abiotic and biotic mechanisms for formation of methylated Hg and Se compounds in the upper ocean?; (2) what is the role of photochemical reactions in air-sea exchange of Hg and Se?; and (3) how are the biogeochemical cycles of Hg and Se related? To attain their goal, the scientists will participate in a cruise of opportunity to the Tropical North Pacific, as well as carry out laboratory culture and controlled incubation experiments. Samples collected during the cruise will be used to determine the speciation of Hg and Se, as well as obtain measurements of photochemical status (i.e., UV, ozone, light levels, chemical (i.e., natural organic matter, redox metals), and biological (i.e., chlorophyll a, phytoplankton composition,proteomics, estimates of carbon mineralization) properties. The laboratory culture and controlled incubation experiments will be used to determine the specific pathways for Hg and Se compound formation and degradation, especially the role of photochemical transformations, as well as assess the importance of Se as a binding ligand for Hg in the marine environment. Lastly, the researchers will continue to develop the oceanic sub-model of the GEOS-Chem global biochemical Hg model to include the cycling of Se and will use the model to ascertain the importance of various processes of conversion and evasion in the global cycles of these two elements.

As regards broader impacts, this study has societal benefits because it would improve our understanding on how mercury enters seafood which impacts human health. Results from the research would be included in curriculum material. One graduate student from the University of Connecticut, one postdoc from Harvard University, and one graduate student from Woods Hole Oceanographic Institution would be supported and

trained as part of the project.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1130711

[table of contents | back to top]