# Diurnal Gross Oxygen Production (GOP) from NOAA Ship Ronald H. Brown cruise RB-08-02 in the Southwest Atlantic sector of the Southern Ocean near South Georgia Island in 2008 (SO_GasEx project)

**Website**: https://www.bco-dmo.org/dataset/4057
**Version**: 14 October 2013
**Version Date**: 2013-10-14

**Project**
» Southern Ocean Gas Exchange Experiment (SO_GasEx)

**Programs**
» Ocean Carbon and Biogeochemistry (OCB)
» United States Surface Ocean Lower Atmosphere Study (U.S. SOLAS)



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## Dataset Description

**Dataset Description:**
Final Gross Oxygen Production derived from Diurnal O2/Ar changes as measured by underway mass spectrometry

**Operation Description:**
Continuous analysis of oxygen/argon ratios by equilibrator inlet mass spectrometry (EIMS).

### Methods & Sampling

**Overall Sampling Strategy:**
Plan was to collect mass spectrometry continuously from the underway seawater system, except for tracer injection and brief service intervals.  Calibration was to be performed vs. discrete samples from the surface on every CTD cast and from the underway system at other times to create a calibration point ever 6-12 hours.

**Continuous Sample Collection:**

Flow of seawater to the EIMS and optode was controlled by a small ball valve to about 3-5 L/min. Seawater flowed through a coarse filter and into a 1L plastic graduated cylinder. A flow of 100mL/min was withdrawn from the graduated cylinder through a fine sock-shaped filter using a small pump. The rest of the seawater flow exited through holes in the side of the graduated cylinder into a bucket the cylinder was immersed in. This bucket drained from its halfway point to a sink draining directly into the sea. The smaller flow was pumped through a small Liquicel equilibrator cartridge and then through a flow meter and finally discharged to the bucket. The equilibrator cartridge was immersed in the bucket to provide temperature stabilization. A capillary picked off gas from the equilibrator cartrige and sent it through a valco switching valve to the quadrupole mass spectrometer for analysis. The switching valve allowed for direct sampling of lab air by a second capillary of similar length. Seven thermistors measured water and air temperatures.

**Data Processing Description**

**Analytical method:**
Quadrupole mass spectrometer is Michael Bender's second instrument, a Pfeiffer Vacuum Prisma. Ion currents measured at masses 18, 28, 29, 32, 40, 44, 45, 64 as well as pressure within mass spectrometer. Inlet capillary switched from equilibrator to air for 10 minutes of every 2 hours for calibration. Quadrupole housing made from PVC pipe with heater and fan controlled at 50oC. Temperature within housing and of electronics unit continuously monitored. Small pump is a Micropump GA-V21.J8FTC. Flowmeter is a McMillan 101 Flo-Sen. Equilibrator cartridge is Membrana LiquiCel MicroModule G569 with flow-through water but only one air-side inlet/outlet. Optode was borrowed from Mike DeGrandpre's group and is model 4175 with analog converter. Ship's electronic's technician made a cable for it which is read by both an RS232 and by the Omega AtoD converter. Tenma EX354D dual power supply 280W suppling 8-8.5V to run the small pump and 12.3V to power the optode. Omega OMB-DAQ-56 AtoD converter being used to read seven thermistors, small pump flow rate, and optode analog signals. Flowmeter calibration applied is 100.39*signal - 5.64. All tubing in air upstream of equilibrator cartridge was insulated with gasketing material to slow warming of water. Capillary is 0.05mm fused silica tubing, catalog 602038 Grace Davison Discovery Science. Capillary length from valco valve to mass spec about 1.15m, capillary lengths from equilibrator cartridge to valco valve and from air to valco valve about 0.85m and closely matched. Air capillary tucked into cable tie or bungee cord holding mass spec housing together. Valco valve is 6 port Cheminert C5 HPLC stream connector valve with microelectric actuator. Used FS1.3-5 ferrules at beginning of cruise and switched to FS1.4-5 ferrules on March 15.

**Calculations:**
O2/Ar ion currents during each 10-min air standard sampling were averaged together and then interpolated to each water sample time. O2/Ar sat was calculated as the ratio of the ion current for the equilibrator divided by that for the air standard (minus one, and times 100). Data was then binned on one-minute intervals. O2/Ar saturations were corrected for observed offsets from the discrete samples based on an average offset derived for each equilibrator. The minimum and maximum O2/Ar sat was calculated for each day as the average of the continuous O2/Ar sat measurements within the patch, as determined by the underway SF6 measurements, in 3 h windows centered on dawn and dusk. Gross O2 production was calculated from the daytime change in O2/Ar sat minus the average of the nighttime change for the previous and subsequent nights, multiplied by the equilibrium O2 concentration, density, and mixed layer depth. For more details see Hamme, R. C., et al. (2012), Dissolved O2/Ar and other methods reveal rapid changes in productivity during a Lagrangian experiment in the Southern Ocean, J. Geophys. Res., 117, C00F12, doi:10.1029/2011JC007046.

**BCO-DMO Processing Notes**
Original file: "Hamme2012_diurnalGOP.csv" contributed by Roberta Hamme
Metadata file: "Metadata_report_DiurnalGOP_Final.xls" contributed by Roberta Hamme
- year, month, date combined into a single date field formatted as YYYYMMDD
- hour, minute combined into a single time field formatted as HHMM
- Parameter names edited to conform to BCO-DMO parameter naming conventions

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## Data Files

| File |
| --- |
| **DiurnalGOP.csv** (Comma Separated Values (.csv), 680 bytes)<br>MD5:358cbdfed6df9ead1c1afd9e3a95f1e6<br>Primary data file for dataset ID 4057 |

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## Parameters

| Parameter | Description | Units |
| --- | --- | --- |
| date | date (UTC) | yyyymmdd |
| time | time (UTC) | hhmm |
| latitude | mean latitude over calculation period; negative denotes South | dec degs |
| longitude | mean longitude over calculation period; negative denotes West | dec degs |
| temp | mean temperature over calculation period (measured by ship TS near intake; compares well with rosette CTD) | degs C |
| sal | mean underway salinity over calculation period from data by David Drapeau measured on a nearby SBE45 but corrected for observed CTD/underway offsets; except used salinity measurement from pCO2 system when Drapeau data was unavailable | PSS-78 |
| Diurnal_O2_GOP | gross oxygen production determined by diurnal O2/Ar changes | mmol O2 /m2/d |
| mixed_layer_depth | mixed layer depth from nearest CTD cast | m |

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## Instruments

| | |
|---|---|
| **Dataset-specific Instrument Name** | Equilibrator Inlet Mass Spectrometer |
| **Generic Instrument Name** | Equilibrator Inlet Mass Spectrometer |
| **Dataset-specific Description** | Continuous analysis of oxygen/argon ratios by equilibrator inlet mass spectrometry (EIMS) Liquicel equilibrator cartridge - Equilibrator cartridge is Membrana LiquiCel MicroModule G569 with flow-through water but only one air-side inlet/outlet. |
| **Generic Instrument Description** | Cassar N, Barnett BA, Bender ML, Kaiser J, Hamme RC, Tilbrook B., Continuous high-frequency dissolved O2/Ar measurements by equilibrator inlet mass spectrometry. Anal Chem. 2009 Mar 1;81(5):1855-64. doi: 10.1021/ac802300u. Source: Department of Geosciences, Princeton University, Princeton, New Jersey 08544, USA. ncassar@princeton.edu Abstract The oxygen (O(2)) concentration in the surface ocean is influenced by biological and physical processes. With concurrent measurements of argon (Ar), which has similar solubility properties as oxygen, we can remove the physical contribution to O(2) supersaturation and determine the biological oxygen supersaturation. Biological O(2) supersaturation in the surface ocean reflects the net metabolic balance between photosynthesis and respiration, i.e., the net community productivity (NCP). We present a new method for continuous shipboard measurements of O(2)/Ar by equilibrator inlet mass spectrometry (EIMS). From these measurements and an appropriate gas exchange parametrization, NCP can be estimated at high spatial and temporal resolution. In the EIMS configuration, seawater from the ship's continuous intake flows through a cartridge enclosing a gas-permeable microporous membrane contactor. Gases in the headspace of the cartridge equilibrate with dissolved gases in the flowing seawater. A fused-silica capillary continuously samples headspace gases, and the O(2)/Ar ratio is measured by mass spectrometry. The ion current measurements on the mass spectrometer reflect the partial pressures of dissolved gases in the water flowing through the equilibrator. Calibration of the O(2)/Ar ion current ratio (32/40) is performed automatically every 2 h by sampling ambient air through a second capillary. A conceptual model demonstrates that the ratio of gases reaching the mass spectrometer is dependent on several parameters, such as the differences in molecular diffusivities and solubilities of the gases. Laboratory experiments and field observations performed by EIMS are discussed. We also present preliminary evidence that other gas measurements, such as N(2)/Ar and pCO(2) measurements, may potentially be performed with EIMS. Finally, we compare the characteristics of the EIMS with the previously described membrane inlet mass spectrometry (MIMS) approach. PMID: 19193192 [PubMed - indexed for MEDLINE] |

| | |
|---|---|
| **Dataset-specific Instrument Name** | McMillan 101 Flo-Sen |
| **Generic Instrument Name** | Flow Meter |
| **Dataset-specific Description** | Flowmeter is a McMillan 101 Flo-Sen |
| **Generic Instrument Description** | General term for a sensor that quantifies the rate at which fluids (e.g. water or air) pass through sensor packages, instruments, or sampling devices. A flow meter may be mechanical, optical, electromagnetic, etc. |

| | |
|---|---|
| **Dataset-specific Instrument Name** | Quadrupole mass spectrometer - A Pfeiffer Vacuum Prisma |
| **Generic Instrument Name** | Mass Spectrometer |
| **Dataset-specific Description** | Quadrupole mass spectrometer is Michael Bender's second instrument, a Pfeiffer Vacuum Prisma. |
| **Generic Instrument Description** | General term for instruments used to measure the mass-to-charge ratio of ions; generally used to find the composition of a sample by generating a mass spectrum representing the masses of sample components. |

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|---|---|
| **Dataset-specific Instrument Name** | Optode |
| **Generic Instrument Name** | Optode |
| **Dataset-specific Description** | Optode was borrowed from Mike DeGrandpre's group and is model 4175 with analog converter |
| **Generic Instrument Description** | An optode or optrode is an optical sensor device that optically measures a specific substance usually with the aid of a chemical transducer. |

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|---|---|
| **Dataset-specific Instrument Name** | Micropump GA-V21.J8FTC |
| **Generic Instrument Name** | Pump |
| **Dataset-specific Description** | Small pump is a Micropump GA-V21.J8FTC |
| **Generic Instrument Description** | A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps |

| | |
|---|---|
| **Dataset-specific Instrument Name** | Pump - surface underway ship intake |
| **Generic Instrument Name** | Pump - Surface Underway Ship Intake |
| **Dataset-specific Description** | Plan was to collect mass spectrometry continuously from the underway seawater system, except for tracer injection and brief service intervals. |
| **Generic Instrument Description** | The 'Pump-underway ship intake' system indicates that samples are from the ship's clean water intake pump. This is essentially a surface water sample from a source of uncontaminated near-surface (commonly 3 to 7 m) seawater that can be pumped continuously to shipboard laboratories on research vessels. There is typically a temperature sensor near the intake (known as the hull temperature) to provide measurements that are as close as possible to the ambient water temperature. The flow from the supply is typically directed through continuously logged sensors such as a thermosalinograph and a fluorometer. Water samples are often collected from the underway supply that may also be referred to as the non-toxic supply. Ideally the data contributor has specified the depth in the ship's hull at which the pump is mounted. |

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|---|---|
| **Dataset-specific Instrument Name** | Thermistor |
| **Generic Instrument Name** | Thermistor |
| **Dataset-specific Description** | Seven thermistors measured water and air temperatures. |
| **Generic Instrument Description** | A thermistor is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors. The word is a portmanteau of thermal and resistor. Thermistors are widely used as inrush current limiters, temperature sensors, self-resetting overcurrent protectors, and self-regulating heating elements. Thermistors differ from resistance temperature detectors (RTD) in that the material used in a thermistor is generally a ceramic or polymer, while RTDs use pure metals. The temperature response is also different; RTDs are useful over larger temperature ranges, while thermistors typically achieve a higher precision within a limited temperature range, typically 90C to 130C. |

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## Deployments

**RB-08-02**

| | |
|---|---|
| **Website** | https://www.bco-dmo.org/deployment/57846 |
| **Platform** | NOAA Ship Ronald H. Brown |
| **Report** | http://bcodata.whoi.edu/SO-GasEx/SO_GasEx_Cruise_Report.pdf |
| **Start Date** | 2008-02-29 |
| **End Date** | 2008-04-12 |
| **Description** | The Southern Ocean GasEx experiment was conducted aboard the NOAA ship Ronald H. Brown with 31 scientists representing 22 institutions, companies and government labs. The cruise departed Punta Arenas, Chile on 29 February, 2008 and transited approximately 5 days to the nominal study region at 50°S, 40°W in the Atlantic sector of the Southern Ocean. The scientific work concentrated on quantifying gas transfer velocities using deliberately injected tracers, measuring CO2 and DMS fluxes directly in the marine air boundary layer, and elucidating the physical, chemical, and biological processes controlling air-sea fluxes with measurements in the upper-ocean and marine air. The oceanic studies used a Lagrangian approach to study the evolution of chemical and biological properties over the course of the experiment using shipboard and autonomous drifting instruments. The first tracer patch was created and studied for approximately 6 days before the ship was diverted from the study site, 350 miles to the south, to wait near South Georgia Island for calmer seas. After more than 4 days away, we returned to the study area and managed to find some remnants of the tracer patch. After collecting one final set of water column samples and recovering the two drifting buoys deployed with the patch, we relocated to the northwest, closer to the area where the first patch was started. A second tracer patch was created and studied for approximately 15 days before we had to break off the experiment and transit to Montevideo, Uruguay for the completion of the cruise. |

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## Project Information

**Southern Ocean Gas Exchange Experiment (SO_GasEx)**

**Website**: http://so-gasex.org/

**Coverage**: Southwest Atlantic sector of the Southern Ocean (nominally at 50°S, 40°W, near South Georgia Island)

The Southern Ocean Gas Exchange Experiment (SO-GasEx; also known as GasEx III) took place in the Southwest Atlantic sector of the Southern Ocean (nominally at 50°S, 40°W, near South Georgia Island) in austral fall of 2008 (February 29-April 12, 2008) on the NOAA ship *Ronald H. Brown*. SO-GasEX is funded by NOAA, NSF and NASA.

The research objectives for Southern Ocean GasEx are to answer the following questions:

- What are the gas transfer velocities at high winds?
- What is the effect of fetch on the gas transfer?
- How do other non-direct wind effects influence gas transfer?
- How do changing pCO2 and DMS levels affect the air-sea CO2 and DMS flux, respectively in the same locale?
- Are there better predictors of gas exchange in the Southern Ocean other than wind?
- What is the near surface horizontal and vertical variability in turbulence, pCO2, and other relevant biochemical and physical parameters?
- How do biological processes influence pCO2 and gas exchange?
- Do the different disparate estimates of fluxes agree, and if not why?
- With the results from Southern Ocean GasEx, can we reconcile the current discrepancy between model based CO2 flux estimates and observation based estimates?

## Related files

SO-GasEx cruise report
SO-GasEx Science Plan
SO-GasEx Implementation Plan

The SO-GasEx cruise report and Science and Implementation plans, may also be available at the SO-GasEx science Web page.

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## Program Information

**Ocean Carbon and Biogeochemistry (OCB)**

**Website**: http://us-ocb.org/

**Coverage**: Global

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF.

The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems.

The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO2 and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two.

The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen conditions in the coastal and open oceans.

**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

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## Funding

| Funding Source | Award |
| --- | --- |
| National Oceanic and Atmospheric Administration (NOAA) | unknown SO_GasEx NOAA |
| National Aeronautics & Space Administration (NASA) | unknown SO_GasEx NASA |
| National Science Foundation (NSF) | unknown SO_GasEx NSF |


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