Underway pCO2 from GO System 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/3287
Version: 28 Dec 2009
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Project
» Southern Ocean Gas Exchange Experiment (SO_GasEx)

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

Contributors	Affiliation	Role
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Dataset Description

SO-GasEx Underway pCO2 data from the General Oceanics System
xCO2 in surface water and atmosphere
In situ fugacity of CO2 in air and surface water and delta fCO2

Methods & Sampling

See: SO-GasEx cruise report, Section 5.4.3 pgs 21-23

Method:
The system was built by General Oceanics (GO) and is described in Pierrot, et al. (2009)

The three standard gases come from CMDL in Boulder and are directly traceable to the WMO scale.

Sampling Cycle:

The system runs on an cycle during which 3 standard gases, 5 air samples from the bow tower and 50 surface water samples (from the equilibrator head space) are analyzed on the following schedule:

1. Zero and span of Licor
2. Three standard gases
3. Five air samples
4. Fifty equilibrator headspace gas samples
5. Repeat steps 2 - 4 nine more times
6. Restart from step 1

Standards:
SN CA06745, 289.06 ppm;
SN CA05398, 370.90 ppm;
SN CA06352, 411.42 ppm.

Units:
All xCO2 values are reported in parts per million (ppm) and fCO2 values are reported in microatmospheres (uatm) assuming 100 % humidity at the equilibrator temperature.

Notes:
1. Beginning with this cruise, a new pCO2 analytical system was installed aboard the Brown, built by General Oceanics (GO). The file format has changed slightly and air values are now included in the file. QC flags now apply to the fCO2 value for Equ measurements and to the xCO2 value for Atm measurements. Most measurements with a flag of 4 (bad) are no longer included in the data file. While the fCO2 value of Equ measurements flagged 3 are questionable, the xCO2 values should be considered good (2). For details about the system see the master readme file.

2. Any values outside the range of the standards (289.06, 370.90, & 411.42 ppm) should be considered approximate (within 5 ppm). While individual data points above 411 or below 289 may not be accurate, the general trends should be indicative of the seawater chemistry.

3.Salinity readings from the ship's TSG were bad. Readings from the Seabird Micro TSG in the Hydro Lab sink were used instead. This was connected to the old pCO2 analytical system which was running concurrently with the new system and thus was recorded at lower frequency than either the data from the ship's computer system (SCS) or the new GO system (1 every 4 - 4-1/2 minutes vs. 1 per minute for SCS and ~ 1 every 2-1/2 minutes for the GO system). The Micro TSG data were first merged into the data from the ship's computer system (SCS) with a 4-minute offset to account for the time it took seawater to travel from the bow intake to the Hydro Lab. This left numerous gaps in the SCS data file which contains 1-minute averages. Missing values in the Micro TSG data were interpolated. The Micro TSG data was then merged into the GO system data.

4. The uncontaminated seawater system (UCS) was shut down twice while tracers were being injected as part of the Southern Ocean Gas Exchange Experiment. The first shutdown occurred from 3/7 at 23:49 to 3/8 at 21:27. The second was from 03:58 to 15:18 on 3/21. Good and questionable (flags 2 & 3) air values during these periods have been retained in the data file.

5. The system was shut down at various times. The longest of these was from 23:51 on 4/4 to 14:30 on 4/5. Other shut downs were for 1:06 on 3/8 at 01:27, for 0:15 on 3/8 at 21:12, for 1:04 on 3/19 at 19:47, for 0:37 on 4/5 at 20:46, and for 6 minutes (0:06) on 4/8 at 16:32.

6. There are 2 short gaps in the SCS data file on 3/31 from 23:24 to 23:36 and from 23:40 to 23:57. From 23:24 to 23:57 there is no SST data. Equ samples in this period have been retained and flagged as 4 because the

xCO2 values appear to be good although no fCO2 computations were done.

7. The GPS feed to the GO system failed on 4/5 at 20:48 and remained off until 4/8 at 16:38. Times of measurements during this period were derived from the PC time, which started 1 minute 49 seconds faster than GPS and was 3 minutes 52 seconds fast when the GPS came back on. A linear interpolation was done and 1:49 to 3:52 was added to PC time to produce a new GPS time. Latitudes and longitudes during this period were merged from the SCS data.

8. There were roughly 200 individual dropouts in equilibrator temperature that were interpolated. About 95% of these were flagged as 2 (good) after examining the fCO2 values. The rest were flagged as 3 (questionable). The subflag field gives the reason for flagging points as questionable.

9. Offset between the ship's intake and the system in the Hydro Lab was problematic. Normally, there is an approximate 3-4 minute delay between water arriving at the intake and water arriving in the Hydro Lab. At the beginning of the cruise this held true but by the end, the temperature values in the Hydro Lab were actually leading the values for SST from the ship's intake. Consequently, no offset was applied when merging data from the SCS.

10. The ship's fluorometer was turned off during this cruise to reduce the drain on the UCS because many groups were drawing water from it and one of them had their own multi-spectral fluorometer. Therefore no fluorometer data is included in the data file.

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Data Processing Description

See: SO-GasEx cruise report, Section 5.4.3 pgs 21-23

BCO-DMO Processing Notes
- Generated from original file RB0802GO.csv

BCO-DMO Edits
- parameter names modified to conform to BCO-DMO convention
- date reformatted to YYYYMMDD
- time reformatted to HHMMSS
- decimal places padded as appropriate
- '-9' (No data flag in original) changed to 'nd'
- blank cells filled with 'nd' (no data)

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Data Files

File
uw_pCO2_GO.csv (Comma Separated Values (.csv), 3.65 MB) MD5:8ea1b7b85253c5ea8390f8b7b7f023d2 Primary data file for dataset ID 3287

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Parameters

Parameter	Description	Units
Group_Ship	AOML_BROWN for all Ron Brown data	text
Cruise_ID	RBYYNNGO where YY is the 2 digit year and NN is the cruise number for that year	text
JD_GMT	Decimal year day	ddd.xxx
date	Date (UTC)	YYYYMMDD
time	Time (UTC)	HHMMSS
lon	longitude (West is negative)	decimal degrees
lat	latitude (South is negative)	decimal degrees
xCO2_EQU	Mole fraction of CO2 in the equilibrator at equilibrator temperature	ppm
xCO2_ATM	Mole fraction of CO2 in air	ppm
xCO2_ATM_interpolated	Bracketing average air values interpolated to time of current Equ measurement	ppm
PRES_EQU	Barometric pressure in the equilibrator	hectopascals
PRES_ATM_SSP	Barometric pressure from ship's barometer corrected to sea level	hectopascals
TEMP_EQU	Equilibrator water temperature	degrees celsius
SST	Sea surface temperature	degrees celsius
SAL	Salinity from ship's TSG or Micro TSG in the Hydro Lab	practical salinity units
fCO2_SW_SST	Fugacity of CO2 in sea water	microatmospheres
fCO2_ATM_interpolated	Fugacity of CO2 in air interpolated to time of Equ measurement	microatmospheres
dfCO2	Fugacity of CO2 in sea water - fugacity of CO2 in air	microatmospheres
WOCE_QC_FLAG	Quality control flag for Equ fCO2 values and Atm xCO2 values (2 = good; 3 = questionable; 4 = bad)	integer
QC_SUBFLAG	Subflag text string for values flagged as 3	text
WATER_FLOW	Water flow through the equilibrator	liters per minute
GAS_FLOW_IR	Gas flow through the Licor sample cell	milliliters per minute
SHIP_SPEED	Ship's speed from the ship's computer system	knots
SHIP_HEADING_TRUE	Ship's heading from the ship's computer system in degrees (0 =North; 90 = East; etc)	degrees
AIR_TEMP	Outside air temperature	degrees celsius
WIND_DIR_TRUE	Absolute (true) wind direction in degrees	degrees
WIND_SPEED_TRUE	Absolute (true) wind speed	meters per second
WIND_SPEED_REL	Wind speed relative to the ship	meters per second
WIND_DIR_REL	Wind direction relative to the ship	degrees

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Instruments

Dataset-specific Instrument Name	Licor 6262 analyser
Generic Instrument Name	LI-COR LI-6262 Gas Analyzer
Generic Instrument Description	The LI-6262 CO2/H2O Gas Analyzer measures CO2 flux in the environment. It was manufactured by LI-COR Biosciences Inc. (licor.com) from 1990 through 2005 and serial Numbers for this model have the prefix of IRG3-XXXX. The LI-6262 is a differential, non-dispersive, infrared (NDIR) gas analyzer. The CO2 and H2O measurements are based on the difference in absorption of infrared (IR) radiation passing through two gas sampling cells. The reference cell is used for a gas of known CO2 or H2O concentration, and the sample cell is used for a gas of unknown concentration. Infrared radiation is transmitted through both cell paths, and the output of the analyzer is proportional to the difference in absorption between the two (LI-6262 CO2/H2O Analyzer Operating and Service Manual, Publication Number 9003-59, March, 1996, pg 18).

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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. **Methods & Sampling** Method: Infrared absorption of dried gas using Licor 6262. Equilibrator volume ~2 L. Air intake on bow mast at ~8 meters. The system makes 3 standard gas measurements, 5 ambient air, and 55 equilibrator headspace measurements every 2.6 hours. Standard gases are from NOAA/ESRL in Boulder and are directly traceable to the WMO scale. Concentrations are 289.06, 370.90, and 411.42 ppm. The system records the Licor millivolt and um/mol, H2O millivolt and mm/mol, cell temperature and pressure, equilibrator temperature, and gas and water flows. In addition, a deck box containing a GPS and Druck barometer is connected to the system which also records these values.

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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.

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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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