

Dataset Expocode	33RR20160602
Primary Contact	Name: Sullivan, Kevin Organization: NOAA/AOML CIMAS Address: 4301 Rickenbacker Causeway, Miami, FI 33149 Phone: (305) 361-4382 Email: kevin.sullivan@noaa.gov
Investigator	Name: Wanninkhof, Rik Organization: NOAA/Atlantic Oceanographic & Meteorological Laboratory Address: 4301 Rickenbacker Causeway, Miami FI, 33149 Phone: 305-361-4379 Email: Rik.Wanninkhof@noaa.gov
Investigator	Name: Pierrot, Denis Organization: NOAA/Atlantic Oceanographic & Meteorological Laboratory Address: 4301 Rickenbacker Causeway, Miami FI, 33149 Phone: 305-361-4441 Email: Denis.Pierrot@noaa.gov
Dataset	Funding Info: NOAA Climate Program Office Initial Submission (yyyymmdd): 20161215 Revised Submission (yyyymmdd): 20161215
Campaign/Cruise	Expocode: 33RR20160602 Campaign/Cruise Name: RR1607 Campaign/Cruise Info: AOML_SOOP_CO2; FLEAT2 Platform Type: CO2 Instrument Type: Equilibrator-IR or CRDS or GC Survey Type: Research Cruise Vessel Name: Roger Revelle Vessel Owner: U.S. Navy; operated by Scripps Institute of Oceanography Vessel Code: 33RR
Coverage	Start Date (yyyymmdd): 20160602 End Date (yyyymmdd): 20160623 Westernmost Longitude: 134.0 E Easternmost Longitude: 134.8 E Northernmost Latitude: 8.8 N Southernmost Latitude: 6.9 N Port of Call: Malakal Harbor, Palau
Variable	Name: xCO2_EQU_ppm Unit: ppm Description: Mole fraction of CO2 in the equilibrator headspace (dry) at equilibrator temperature (ppm)
Variable	Name: xCO2_ATM_ppm Unit: ppm Description: Mole fraction of CO2 measured in dry outside air (ppm)
Variable	Name: xCO2_ATM_interpolated_ppm Unit: ppm Description: Mole fraction of CO2 in outside air associated with each water analysis. These values are interpolated between the bracketing averaged good xCO2_ATM analyses (ppm)
Variable	Name: PRES_EQU_hPa

Unit: hPa
Description: Barometric pressure in the equilibrator headspace (hPa)

Variable **Name:** PRES_ATM@SSP_hPa
Unit: hPa
Description: Barometric pressure measured outside, corrected to sea level (hPa)

Variable **Name:** TEMP_EQU_C
Unit: Degree C
Description: Water temperature in equilibrator (°C)

Variable **Name:** SST_C
Unit: Degree C
Description: Sea surface temperature (°C)

Variable **Name:** SAL_permil
Unit: ppt
Description: Sea surface salinity on Practical Salinity Scale (o/oo)

Variable **Name:** fCO2_SW@SST_uatm
Unit: µatm
Description: Fugacity of CO2 in sea water at SST and 100% humidity (µatm)

Variable **Name:** fCO2_ATM_interpolated_uatm
Unit: µatm
Description: Fugacity of CO2 in air corresponding to the interpolated xCO2 at SST and 100% humidity (µatm)

Variable **Name:** dfCO2_uatm
Unit: µatm
Description: Sea water fCO2 minus interpolated air fCO2 (µatm)

Variable **Name:** WOCE_QC_FLAG
Unit: None
Description: Quality control flag for fCO2 values (2=good, 3=questionable)

Variable **Name:** QC_SUBFLAG
Unit: None
Description: Quality control subflag for fCO2 values, provides explanation when QC flag=3

Sea Surface Temperature **Location:** Hydro Lab
Manufacturer: Seabird
Model: 45
Accuracy: 0.002 (°C if units not given)
Precision: 0.0002 (°C if units not given)
Calibration: Factory calibration
Comments: Manufacturer's Typical Stability is taken as Precision; Maintained by ship. A regression fit between the average temperatures measured in the Hydro Lab and the CTD surface temperatures during a prior GO-SHIP cruise was done to estimate SST. See additional comments below.

Sea Surface Salinity **Location:** In Hydro Lab, near CO2 system
Manufacturer: Seabird
Model: SBE 45
Accuracy: ± 0.005 o/oo
Precision: 0.0002 o/oo
Calibration: Factory calibration

Comments: Manufacturer's Resolution is taken as Precision; Maintained by ship.

**Atmospheric
Pressure**

Location: On MET mast, ~17 m above the sea surface water

Normalized to Sea Level: yes

Manufacturer: RMYoung

Model: 61302V

Accuracy: ± 0.3 hPa (hPa if units not given)

Precision: 0.01 hPa (hPa if units not given)

Calibration: Factory calibration

Comments: Manufacturer's Resolution is taken as Precision; Maintained by ship.

Atmospheric CO2

Measured/Frequency: Yes, 5 readings in a group every ~4.5 hours

Intake Location: Bow mast, ~14 meters above sea surface

Drying Method: Gas stream passes through a thermoelectric condenser (~5 °C) and then through a Perma Pure (Nafion) dryer before reaching the analyzer (90% dry).

Atmospheric CO2 Accuracy: ± 0.5 μ atm in fCO2_ATM

Atmospheric CO2 Precision: ± 0.01 μ atm in fCO2_ATM

**Aqueous CO2
Equilibrator Design**

System Manufacturer:

Intake Depth: 5 meters

Intake Location: Bow, or engine room sea chest (mid-ship)

Equilibration Type: Spray head above dynamic pool, no thermal jacket

Equilibrator Volume (L): 0.95 L (0.4 L water, 0.55 L headspace)

Headspace Gas Flow Rate (ml/min): 70 - 150 ml/min

Equilibrator Water Flow Rate (L/min): 1.3 - 2.5 L/min

Equilibrator Vented: Yes

Equilibration Comments: Primary equilibrator is vented through a secondary equilibrator. Depending on weather conditions, the inlet of the scientific seawater system was switched between the bow and engine room.

Drying Method: Gas stream passes through a thermoelectric condenser (~5 °C) and then through a Perma Pure (Nafion) dryer before reaching the analyzer (90% dry).

**Aqueous CO2
Sensor Details**

Measurement Method: IR

Method details: details of CO2 sensing (not required)

Manufacturer: LI-COR

Model: 6262

Measured CO2 Values: xco2(dry)

Measurement Frequency: Every 140 seconds, except during calibration

Aqueous CO2 Accuracy: ± 2 μ atm in fCO2_SW

Aqueous CO2 Precision: ± 0.01 μ atm in fCO2_SW

Sensor Calibrations:

Calibration of Calibration Gases: The analyzer is calibrated every 4.5 hours with field standards that in turn were calibrated with primary standards that are directly traceable to the WMO scale. The zero gas is ultra-high purity air.

Number Non-Zero Gas Standards: 4

Calibration Gases:

Std 1: JA02280, 233.46 ppm, owned by AOML, used every ~4.5 hours.

Std 2: JA02264, 326.18 ppm, owned by AOML, used every ~4.5 hours.

Std 3: JA02285, 406.06 ppm, owned by AOML, used every ~4.5 hours.

Std 4: JA02646, 463.00 ppm, owned by AOML, used every ~4.5 hours.

Std 5: 0.00 ppm, owned by AOML, used every ~23.5 hours.

Comparison to Other CO2 Analyses:

Comments:

Method Reference:

Pierrot, D., C. Neil, K. Sullivan, R. Castle, R. Wanninkhof, H. Lueger, T. Johannessen, A. Olsen, R. A. Feely, and C. E. Cosca (2009), Recommendations for autonomous underway pCO₂ measuring systems and data reduction routines, Deep-Sea Res II, 56, 512-522.

Equilibrator Temperature Sensor

Location: Inserted into equilibrator ~5 cm below water level

Manufacturer: Hart

Model: 1523

Accuracy: 0.015 (°C if units not given)

Precision: 0.001 (°C if units not given)

Calibration: Factory calibration

Comments: Resolution is taken as Precision.

Equilibrator Pressure Sensor

Location: Attached to equilibrator headspace. The differential pressure reading from Setra 239, which is attached to the equilibrator headspace, is added to the pressure reading from the LICOR analyzer, which is measured by an external Setra 270 connected to the exit of the analyzer.

Manufacturer: Setra

Model: 270

Accuracy: 0.15 (hPa if units not given)

Precision: 0.015 (hPa if units not given)

Calibration: Factory calibration

Comments: Manufacturer's Resolution is taken as Precision.

Additional Information

Suggested QC flag from Data Provider: NA

Additional Comments: The analytical system performed fine during this cruise. Values for the ship's sensors were taken from the MET files logged by the ship. The HydroLabTSG Temp, oxygen Temp, and equilibrator Temp all tracked each other nicely. The average difference between the HydroLabTSG Temp and Equ Temp is 0.004 (+/-0.027) degC, n=11441 for RR1607 and RR1608. For the 712 analyses during RR1607 without Equ Temp, the values were estimated by subtracting 0.004 degC from the HydroLabTSG temperatures. During a prior cruise (RR1604, I09N) the temperature data from the CTD casts and shipboard sensors were used to estimate SSTemperature. A regression fit between the average temperature measured in the Hydro Lab (HLT, average of equilibrator and TSG temperatures) and the CTD temperature (average over top 8 db) was done for all 117 casts. After eliminating eleven outlying data, the resulting second degree polynomial equation was used to estimate the SST. $SST(\text{estimated}) = 0.001424 \cdot HLT^2 + 0.950053 \cdot HLT + 0.048227$; standard deviation of the differences between the CTD temperatures and the SST(estimated) was +/- 0.061 degree Celcius. The temperatures measured during this cruise fall within the range covered by the regression equation. The same temperature sensors in the hydro lab were used on both cruises. Starting at 17:25 on 17 June (YrDay 169.73), the condensor was not being chilled (increased from ~5 to ~24 degC). Even though this behavior is not optimal, the analytical results seem unaffected. The condensor restarted chilling at 01:30 on 21 June (YrDay 173.06). The main valves on standard cylinders were not opened at the start of the cruise. Two sets of standard analyses were completed before the pressures in the regulators reached ambient. After ~4.5 days, the main valves on the standard cylinders were opened. The standard responses before and after this interval were very close and the ATM analyses remained remarkable constant across this interval. Even though the analyzer was not calibrated every ~4

hrs as usual, the response of the analyzer appeared to have been optimally stable over the ~4.5 days. Original Data Location: http://www.aoml.noaa.gov/ocd/ocdweb/revelle/revelle_2016.html

Citation for this Dataset:

Other References for this Dataset: