

Contact Person:

Name: Castle, Robert
Organization: NOAA/Atlantic Oceanographic & Meteorological Laboratory
Address: 4301 Rickenbacker Causeway, Miami, FL 33149
Phone: 305-361-4418
Email: Robert.Castle@noaa.gov

Investigator(s):

Name: Wanninkhof, Rik
Organization: NOAA/Atlantic Oceanographic & Meteorological Laboratory
Address: 4301 Rickenbacker Causeway, Miami Fl, 33149
Phone: 305-361-4379
Email: Rik.Wanninkhof@noaa.gov

Name: Pierrot, Denis
Organization: NOAA/Atlantic Oceanographic & Meteorological Laboratory
Address: 4301 Rickenbacker Causeway, Miami Fl, 33149
Phone: 305-361-4441
Email: Denis.Pierrot@noaa.gov

Dataset Information:

Funding_Info: NOAA Climate Program Office
Initial_Submission: 20160131
Revised_Submission:

Cruise Information:

Experiment Name: RB1406
Experiment Type: Research Cruise
Platform Type: Ship
Co2 Instrument Type: Equilibrator-IR
Cruise ID: 33RO20141105
Cruise Info: TAO 155W, AOML_SOOP_CO2
Geographical Region:
Westernmost Longitude: 167.7
Easternmost Longitude: -156.3
Northernmost Latitude: 21.2
Southernmost Latitude: -8.4
Cruise Dates (YYYYMMDD)
Start_Date: 20141105
End_Date: 20141124
Ports of Call:
Honolulu, HI
Kwajalein, RMI
Vessel Name: R/V Ronald H. Brown
Vessel ID: 33RO

Vessel Owner: NOAA

Variables Information:

Variable Name: xCO2_EQU_ppm

Description of Variable: Mole fraction of CO2 in the equilibrator headspace (dry) at equilibrator temperature (ppm)

Unit of Variable: ppm

Variable Name: xCO2_ATM_ppm

Description of Variable: Mole fraction of CO2 measured in dry outside air (ppm)

Unit of Variable: ppm

Variable Name: xCO2_ATM_interpolated_ppm

Description of Variable: 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)

Unit of Variable: ppm

Variable Name: PRES_EQU_hPa

Description of Variable: Barometric pressure in the equilibrator headspace (hPa)

Unit of Variable: hPa

Variable Name: PRES_ATM@SSP_hPa

Description of Variable: Barometric pressure measured outside, corrected to sea level (hPa)

Unit of Variable: hPa

Variable Name: TEMP_EQU_C

Description of Variable: Water temperature in equilibrator (°C)

Unit of Variable: Degree C

Variable Name: SST_C

Description of Variable: Sea surface temperature (°C)

Unit of Variable: Degree C

Variable Name: SAL_permil

Description of Variable: Sea surface salinity on Practical Salinity Scale (o/oo)

Unit of Variable: ppt

Variable Name: fCO2_SW@SST_uatm

Description of Variable: Fugacity of CO2 in sea water at SST and 100% humidity (μatm)

Unit of Variable: μatm

Variable Name: fCO2_ATM_interpolated_uatm

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

Unit of Variable: μatm

Variable Name: dfCO2_uatm

Description of Variable: Sea water fCO2 minus interpolated air fCO2 (μatm)

Unit of Variable: μatm

Variable Name: WOCE_QC_FLAG

Description of Variable: Quality control flag for fCO2 values (2=good, 3=questionable)

Unit of Variable: None

Variable Name: QC_SUBFLAG

Description of Variable: Quality control subflag for fCO₂ values, provides explanation when QC flag=3

Unit of Variable: None

Method Description:

Equilibrator Design:

Depth of Seawater Intake: 5 meters

Location of Seawater Intake: Bow

Equilibrator Type: Spray head above dynamic pool, with thermal jacket

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

Water Flow Rate: 1.5 - 2.0 L/min

Headspace Gas Flow Rate: 70 - 150 ml/min

Vented: Yes

Drying Method for CO₂ in Water:

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

Additional Information: Primary equilibrator is vented through a secondary equilibrator.

CO₂ in Marine Air:

Measurement: Yes, 5 readings in a group every 3.5 hours

Location and Height: Bow tower ~10 m above the 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).

CO₂ Sensor:

Measurement Method: IR

Manufacturer: LI-COR

Model: 6262

Frequency: Every 140 seconds, except during calibration

Resolution Water: ± 0.01 µatm in fCO₂_SW

Uncertainty Water: ± 2 µatm in fCO₂_SW

Resolution Air: ± 0.01 µatm in fCO₂_ATM

Uncertainty Air: ± 0.5 µatm in fCO₂_ATM

Manufacturer of Calibration Gas:

Std 1: CA04957, 282.55 ppm, owned by ESRL, used every ~3.5 hours. Std 2: CC105863, 380.22 ppm, owned by ESRL, used every ~3.5 hours. Std 3: CB09696, 453.04 ppm, owned by ESRL, used every ~3.5 hours. Std 4: CB09032, 539.38 ppm, owned by ESRL, used every ~3.5 hours. Std 5: 0.00 ppm, owned by AOML, used every ~20.0 hours.

Number of Non Zero Gas Standards: 4

CO₂ Sensor Calibration:

The analyzer is calibrated every 3.5 hours using field standards that were calibrated with primary standards that are directly traceable to the WMO scale. Ultra-High Purity air (0.0 ppm CO₂) and the high standard are used to zero and span the LI-COR analyzer.

Other Comments:

Instrument is located in an air-conditioned laboratory.

Method References:

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.

Details Co2 Sensing:

details of CO2 sensing (not required)

Measured Co2 Params:

xco2(dry)

Sea Surface Temperature:

Location: Bow thruster room, before sea water pump, ~5 m below water line.

Manufacturer: Seabird

Model: SBE-21

Accuracy Degrees Celsius: 0.01

Precision Degrees Celsius: 0.001

Calibration: Factory calibration

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

Equilibrator Temperature:

Location: Inserted into equilibrator ~5 cm below water level

Manufacturer: Hart

Model: 1521

Accuracy Degrees Celsius: 0.025

Precision Degrees Celsius: 0.01

Calibration: Factory calibration

Comments: Resolution is taken as Precision.

Equilibrator Pressure:

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

Manufacturer: Setra

Model: 270

Accuracy hPa: 0.15

Precision hPa: 0.015

Calibration: Factory calibration

Comments:

Manufacturer's Resolution is taken as Precision.

Atmospheric Pressure:

Location: On bulkhead exterior on the port side of the radio room aft of the bridge at ~14 m above the sea surface.

Manufacturer: Vaisala

Model: PTB330

Accuracy: ± 0.2 hPa

Precision: ± 0.08 hPa

Calibration: Factory calibration

Normalized: yes

Comments: Manufacturer's resolution is taken as precision. Maintained by ship.

Sea Surface Salinity:

Location: Attached to underway system at sea water input.

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

Additional Information:

(1.) It was determined that there was a 2.68 minute offset between the SST data record from the SBE-21 in the bow and the Hart 1521 temperature sensor in the equilibrator. The SST data were interpolated using this offset to determine the SST at the time of the equilibrator measurement. (2.) A total of 7548 measurements were taken with 7533 flagged as good, 7 flagged as questionable, and 8 flagged as bad. All measurements flagged as 4 (bad) have been removed from the final data file. (3.) There was a 2 hour dropout of SST readings on 11/16 at 0612. New values were determined using a relation between equilibrator temperature and SST. The equation used was $SST = 0.968 * EqT + 0.7895$, $n = 145$, $r^2 = 0.9633$. (4.) The system was shut down twice for EEZ issues. The first was from 11/5 at 0433 to 11/7 at 0130 and the second was from 11/10 at 0332 to 11/14 at 0106. Despite this the ship was recording data when they crossed the international date line at the equator.

Location: http://www.aoml.noaa.gov/ocd/ocdweb/brown/brown_introduction.html

Preliminary Quality Control:

NA

Form Type:

underway