

**Contact Person:**

Name: Sullivan, Kevin  
Organization: AOML/NOAA  
Address: 4301 Rickenbacker Causeway  
Phone: 305-361-4382  
Email: Kevin.Sullivan@noaa.gov

**Investigator(s):**

Name: Millero, Frank  
Organization: RSMAS/University of Miami  
Address: 4600 Rickenbacker Causeway, Miami Fl, 33149  
Phone: 305-421-4707  
Email: FMillero@rsmas.miami.edu

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

**Dataset Information:**

Funding\_Info: NOAA Climate Program Office; NOAA Ocean Acidification Program  
Initial\_Submission: 20160130  
Revised\_Submission: 20160130

**Cruise Information:**

Experiment Name: WS1118  
Experiment Type: Research Cruise  
Platform Type: Ship  
Co2 Instrument Type: Equilibrator-IR or CRDS or GC

Cruise ID: 33WA20111211  
Cruise Info: South FL Hydro Survey; SOOP\_CO2  
Geographical Region:

Westernmost Longitude: -83.1  
Easternmost Longitude: -80  
Northernmost Latitude: 26.0  
Southernmost Latitude: 24.2

**Cruise Dates (YYYYMMDD)**

Start\_Date: 20111211  
End\_Date: 20111216

Ports of Call:  
Miami, FL

Vessel Name: F.G. Walton Smith  
Vessel ID: 33WA  
Vessel Owner: University of Miami

## 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 (hectopascals)

Unit of Variable: hPa

Variable Name: PRES\_ATM@SSP\_hPa

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

Unit of Variable: hPa

Variable Name: TEMP\_EQU\_C

Description of Variable: Water temperature in equilibrator (degrees Celsius)

Unit of Variable: Degree C

Variable Name: SST\_C

Description of Variable: Sea surface temperature (degrees Celsius)

Unit of Variable: Degree C

Variable Name: SAL\_permil

Description of Variable: Sea surface salinity on Practical Salinity Scale (permil)

Unit of Variable: ppt

Variable Name: fCO2\_SW@SST\_uatm

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

Unit of Variable:  $\mu$ atm

Variable Name: fCO2\_ATM\_interpolated\_uatm

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

Unit of Variable:  $\mu$ atm

Variable Name: dfCO2\_uatm

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

Unit of Variable:  $\mu$ atm

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: 1.5 meters

Location of Seawater Intake: Bow

Equilibrator Type: Sprayhead 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 CO<sub>2</sub> 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

### CO<sub>2</sub> in Marine Air:

Measurement: Yes, 5 readings in a group every 4 hours

Location and Height: Mast above the bridge, ~13 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).

### CO<sub>2</sub> Sensor:

Measurement Method: Infrared absorption of dry sample gas

Manufacturer: LI-COR

Model: 6262

Frequency: Every 140 seconds, except during calibration

Resolution Water: 0.01 microatmosphere

Uncertainty Water: ± 1 microatmospheres

Resolution Air: 0.01 ppm

Uncertainty Air: ± 0.2 ppm

Manufacturer of Calibration Gas:

Airgas, Inc. - Std 1: 202.52 ppm / Std 2: 391.28 ppm / Std 3: 628.67 ppm / Std 4: 1479.07 ppm

Number of Non Zero Gas Standards: 4

### CO<sub>2</sub> Sensor Calibration:

The analyzer is calibrated every 4 hours with field standards that in turn were calibrated with primary standards that are directly traceable to the WMO scale.

### 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 pCO<sub>2</sub> measuring systems and data reduction routines, Deep-Sea Res II, 56, 512-522.

### Details Co<sub>2</sub> Sensing:

details of CO<sub>2</sub> sensing (not required)

### Measured Co<sub>2</sub> Params:

xco<sub>2</sub>(dry)

### Sea Surface Temperature:

Location: After sea water pump  
Manufacturer: Seabird  
Model: SBE-38  
Accuracy Degrees Celsius: 0.001  
Precision Degrees Celsius: 0.00025  
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: 1523  
Accuracy Degrees Celsius: 0.015  
Precision Degrees Celsius: 0.001  
Calibration: Factory calibration  
Comments: Manufacturer's Resolution is taken as Precision.

Equilibrator Pressure:

Location: Attached to equilibrator headspace  
Manufacturer: Setra  
Model: 239  
Accuracy hPa: 0.052  
Precision hPa: 0.01  
Calibration: Factory calibration  
Comments:  
Differential pressure reading from Setra-239 attached to the equilibrator headspace was added to the pressure reading of the analyzer to yield the equilibrator pressure. Manufacturer's Resolution is taken as Precision.

Atmospheric Pressure:

Location: On mast above the bridge at ~13 m above the sea surface water  
Manufacturer: R.M. Young  
Model: 61302  
Accuracy:  $\pm 0.3$  hPa  
Precision: 0.1 hPa  
Calibration: Factory calibration  
Normalized: yes  
Comments: Manufacturer's Resolution is taken as Precision; Maintained by ship.

Sea Surface Salinity:

Location: In dry lab  
Manufacturer: Seabird  
Model: SBE 45  
Accuracy:  $\pm 0.005$  permil  
Precision: 0.0002 permil  
Calibration: Factory calibration  
Comments: Manufacturer's Resolution is taken as Precision; Maintained by ship.

**Additional Information:**

No data was available from the ship's sensors for the last 20 minutes of pCO<sub>2</sub> data. A salinity of 35 psu was assigned for this interval. The missing SST values were estimated by subtracting 1.0 from the equilibrator temperatures. For 2600 analyses with complete data records, the average difference between the equilibrator and SBE38 temperatures was 1.00 (+/-0.11) degree Celsius. The LICOR pressure transducer operated poorly,

and the atmospheric pressure recorded by the ship had a resolution of 1 mbar. The atmospheric and LICOR pressures were estimated from the average of barometer readings on five buoys in the Florida Bay region.

**Preliminary Quality Control:**

NA

**Form Type:**

underway