

<b>Dataset Expocode</b>	<b>MLCE20190323</b>
<b>Primary Contact</b>	<b>Name:</b> Sullivan, Kevin <b>Organization:</b> NOAA/AOML CIMAS <b>Address:</b> 4301 Rickenbacker Causeway, Miami, FI 33149 <b>Phone:</b> (305) 361-4382 <b>Email:</b> kevin.sullivan@noaa.gov
<b>Investigator</b>	<b>Name:</b> Wanninkhof, Rik <b>Organization:</b> NOAA/Atlantic Oceanographic & Meteorological Laboratory <b>Address:</b> 4301 Rickenbacker Causeway, Miami FI, 33149 <b>Phone:</b> 305-361-4379 <b>Email:</b> Rik.Wanninkhof@noaa.gov
<b>Investigator</b>	<b>Name:</b> Pierrot, Denis <b>Organization:</b> NOAA/Atlantic Oceanographic & Meteorological Laboratory <b>Address:</b> 4301 Rickenbacker Causeway, Miami FI, 33149 <b>Phone:</b> 305-361-4441 <b>Email:</b> Denis.Pierrot@noaa.gov
<b>Dataset</b>	<b>Funding Info:</b> NOAA Climate Program Office; NOAA Ocean Acidification Program <b>Initial Submission (yyyymmdd):</b> 20190411 <b>Revised Submission (yyyymmdd):</b> 20190808
<b>Campaign/Cruise</b>	<b>Expocode:</b> MLCE20190323 <b>Campaign/Cruise Name:</b> EQNX_20190323 <b>Campaign/Cruise Info:</b> AOML_SOOP_CO2 <b>Platform Type:</b> <b>CO2 Instrument Type:</b> Equilibrator-IR or CRDS or GC <b>Survey Type:</b> SOOP Line <b>Vessel Name:</b> M/V Equinox <b>Vessel Owner:</b> Royal Caribbean International <b>Vessel Code:</b> MLCE
<b>Coverage</b>	<b>Start Date (yyyymmdd):</b> 20190323 <b>End Date (yyyymmdd):</b> 20190330 <b>Westernmost Longitude:</b> 87.7 W <b>Easternmost Longitude:</b> 80 W <b>Northernmost Latitude:</b> 25.8 N <b>Southernmost Latitude:</b> 18.7 N <b>Port of Call:</b> Miami, FL <b>Port of Call:</b> Key West,FL <b>Port of Call:</b> George Town, Grand Cayman <b>Port of Call:</b> Costa Maya, Mexico <b>Port of Call:</b> Cozumel, Mexico
<b>Variable</b>	<b>Name:</b> xCO2_EQU_ppm <b>Unit:</b> ppm <b>Description:</b> Mole fraction of CO2 in the equilibrator headspace (dry) at equilibrator temperature (ppm)
<b>Variable</b>	<b>Name:</b> xCO2_ATM_ppm <b>Unit:</b> ppm <b>Description:</b> Mole fraction of CO2 measured in dry outside air (ppm)
<b>Variable</b>	<b>Name:</b> xCO2_ATM_interpolated_ppm <b>Unit:</b> ppm

**Description:** Mole fraction of CO<sub>2</sub> in outside air associated with each water analysis. These values are interpolated between the bracketing averaged good xCO<sub>2</sub>\_ATM analyses (ppm)

<b>Variable</b>	<b>Name:</b> PRES_EQU_hPa <b>Unit:</b> hPa <b>Description:</b> Barometric pressure in the equilibrator headspace (hPa)
<b>Variable</b>	<b>Name:</b> PRES_ATM@SSP_hPa <b>Unit:</b> hPa <b>Description:</b> Barometric pressure measured outside, corrected to sea level (hPa)
<b>Variable</b>	<b>Name:</b> TEMP_EQU_C <b>Unit:</b> Degree C <b>Description:</b> Water temperature in equilibrator (°C)
<b>Variable</b>	<b>Name:</b> SST_C <b>Unit:</b> Degree C <b>Description:</b> Sea surface temperature (°C)
<b>Variable</b>	<b>Name:</b> SAL_permil <b>Unit:</b> ppt <b>Description:</b> Sea surface salinity on Practical Salinity Scale (o/oo)
<b>Variable</b>	<b>Name:</b> fCO <sub>2</sub> _SW@SST_uatm <b>Unit:</b> µatm <b>Description:</b> Fugacity of CO <sub>2</sub> in sea water at SST and 100% humidity (µatm)
<b>Variable</b>	<b>Name:</b> fCO <sub>2</sub> _ATM_interpolated_uatm <b>Unit:</b> µatm <b>Description:</b> Fugacity of CO <sub>2</sub> in air corresponding to the interpolated xCO <sub>2</sub> at SST and 100% humidity (µatm)
<b>Variable</b>	<b>Name:</b> dfCO <sub>2</sub> _uatm <b>Unit:</b> µatm <b>Description:</b> Sea water fCO <sub>2</sub> minus interpolated air fCO <sub>2</sub> (µatm)
<b>Variable</b>	<b>Name:</b> WOCE_QC_FLAG <b>Unit:</b> None <b>Description:</b> Quality control flag for fCO <sub>2</sub> values (2=good, 3=questionable)
<b>Variable</b>	<b>Name:</b> QC_SUBFLAG <b>Unit:</b> None <b>Description:</b> Quality control subflag for fCO <sub>2</sub> values, provides explanation when QC flag=3
<b>Sea Surface Temperature</b>	<b>Location:</b> In Bow Thruster room, about 1m after the intake which is directly through the ship's hull, before the SW pump. <b>Manufacturer:</b> Seabird, Inc. <b>Model:</b> SBE 38 <b>Accuracy:</b> 0.001 (°C if units not given) <b>Precision:</b> 0.0003 (°C if units not given) <b>Calibration:</b> Factory calibration <b>Comments:</b> Manufacturer's Resolution is taken as Precision; Maintained by University of Miami's MTG group.
<b>Sea Surface Salinity</b>	<b>Location:</b> Next to the pCO <sub>2</sub> System. <b>Manufacturer:</b> Seabird <b>Model:</b> SBE 45

**Accuracy:**  $\pm 0.005$  o/oo  
**Precision:** 0.0002 o/oo  
**Calibration:** Factory calibration  
**Comments:** Manufacturer's Resolution is taken as Precision; Maintained by University of Miami's MTG group.

**Atmospheric Pressure**

**Location:** At the base of the radar mast, 48 meter above sea level.  
**Normalized to Sea Level:** no  
**Manufacturer:** RM Young  
**Model:** 61202V  
**Accuracy:**  $\pm 0.3$  hPa (hPa if units not given)  
**Precision:** 0.1 hPa (hPa if units not given)  
**Calibration:** Factory Calibration  
**Comments:** Manufacturer's Resolution is taken as Precision; Maintained by University of Miami's MTG group.

**Atmospheric CO2**

**Measured/Frequency:** Yes, 5 readings in a group every 5 hours.  
**Intake Location:** At forward-most, grated opening in the starboard hull on the mooring deck, which is 12 meters above sea level.  
**Drying Method:** Gas stream passes through a thermoelectric condenser ( $\sim 5^\circ\text{C}$ ) and then through a Perma Pure (Nafion) dryer before reaching the analyzer (90% dry).  
**Atmospheric CO2 Accuracy:**  $\pm 0.5$   $\mu\text{atm}$  in fCO2\_ATM  
**Atmospheric CO2 Precision:**  $\pm 0.01$   $\mu\text{atm}$  in fCO2\_ATM

**Aqueous CO2 Equilibrator Design**

**System Manufacturer:**  
**Intake Depth:** 5 meters  
**Intake Location:** Bow  
**Equilibration Type:** Spray head above dynamic pool, with 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):** 1.5 - 2.0 L/min  
**Equilibrator Vented:** Yes  
**Equilibration Comments:** Primary equilibrator is vented through a secondary equilibrator.  
**Drying Method:** Gas stream passes through a thermoelectric condenser ( $\sim 5^\circ\text{C}$ ) 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:**  $\pm 2$   $\mu\text{atm}$  in fCO2\_SW  
**Aqueous CO2 Precision:**  $\pm 0.01$   $\mu\text{atm}$  in fCO2\_SW  
**Sensor Calibrations:**  
**Calibration of Calibration Gases:** The analyzer is calibrated every 5 hours with field standards that in turn were calibrated with primary standards that are directly traceable to the WMO X2007 scale. The zero gas is ultra-high purity air.  
**Number Non-Zero Gas Standards:** 4  
**Calibration Gases:**

Std 1: CA05585, 280.18 ppm, owned by ESRL, used every ~5.0 hours. Std 2: CA06368, 328.12 ppm, owned by ESRL, was not used. Std 3: CA05979, 381.89 ppm, owned by AOML, used every ~5.0 hours. Std 4: CB08988, 455.60 ppm, owned by ESRL, used every ~5.0 hours. Std 5: LL100000, 0.00 ppm, owned by AOML, used every ~24.5 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 pCO<sub>2</sub> 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 operated well during this cruise. Sea water flow was variable for one day. Serial logging of SST, TSG, and Barometric pressure sensors was intermittent, but gaps in data were filled with data saved by another system. Some missing sensor data was interpolated from surrounding good values. The most recent submission corrects a processing error and accounts for the barometer height. Original Data Location: [http://www.aoml.noaa.gov/ocd/ocdweb/equinox/equinox\\_introduction.html](http://www.aoml.noaa.gov/ocd/ocdweb/equinox/equinox_introduction.html) Full unprocessed data files from analytical instrument including flow information plus meteorological and TSG data at time of sampling can be obtained upon request.

**Citation for this Dataset:**

**Other References for this Dataset:**