

Dataset Expocode	MLCE20230424
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Dataset	Funding Info: NOAA Climate Program Office; NOAA Ocean Acidification Program Initial Submission (yyyymmdd): 20230606 Revised Submission (yyyymmdd): 20230606
Campaign/Cruise	Expocode: MLCE20230424 Campaign/Cruise Name: EQNX_20230424 Campaign/Cruise Info: AOML_SOOP_CO2 Platform Type: CO2 Instrument Type: Equilibrator-IR or CRDS or GC Survey Type: SOOP Line Vessel Name: M/V Equinox Vessel Owner: Royal Caribbean International Vessel Code: MLCE
Coverage	Start Date (yyyymmdd): 20230424 End Date (yyyymmdd): 20230504 Westernmost Longitude: 80.1 W Easternmost Longitude: 59.6 W Northernmost Latitude: 26.2 N Southernmost Latitude: 13.1 N Port of Call: Fort Lauderdale, FL Port of Call: St. Johns, Antigua Port of Call: Castries, St. Lucia Port of Call: Bridgetown, Barbados Port of Call: Fort de France, Martinique Port of Call: Basseterre, St. Kitts and Nevi
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:** In Bow Thruster room, about 1m after the intake which is directly through the ship's hull, before the SW pump.
Manufacturer: Seabird, Inc.
Model: SBE 38
Accuracy: 0.001 (°C if units not given)
Precision: 0.0003 (°C if units not given)
Calibration: Factory calibration
Comments: Manufacturer's Resolution is taken as Precision; Maintained by University of Miami's MTG group.

Sea Surface Salinity **Location:** Next to the pCO₂ 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 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: ± 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: ± 0.5 μatm in fCO2_ATM
Atmospheric CO2 Precision: ± 0.01 μatm 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: ± 2 μatm in fCO2_SW
Aqueous CO2 Precision: ± 0.01 μatm 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, 280.24 ppm, owned by ESRL, used every ~5.0 hours.
Std 2: CA05979, 382.05 ppm, owned by AOML, used every ~5.0 hours.
Std 3: CA05998, 419.51 ppm, owned by AOML, used every ~5.0 hours.
Std 4: CB08988, 455.80 ppm, owned by ESRL, used every ~5.0 hours.
Std 5: LL100000, 0.00 ppm, owned by AOML, used every ~24.0 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 operated fine during this cruise. Communication with the SBE38 SST sensor was frequently lost. The missing SST values were estimated by subtracting 0.03 degrees from the equilibrator temperatures. The average difference between the equilibrator and SBE38 temperatures was 0.032 (+/-0.005) degree Celsius. Original Data Location: 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: