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| Dataset Expocode | BMBE20120913 |
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| Investigator | Name: Pierrot, Denis Organization: NOAA/Atlantic Oceanographic & Meteorological Laboratory Address: 4301 Rickenbacker Causeway Phone: 305-361-4441 Email: Denis.Pierrot@noaa.gov |
| Dataset | Funding Info: NOAA Climate Program Office; NOAA Ocean Acidification Program Initial Submission (yyyymmdd): 20160713 Revised Submission (yyyymmdd): 20160713 |
| Campaign/Cruise | Expocode: BMBE20120913 Campaign/Cruise Name: BarX20120913 Campaign/Cruise Info: AOML_SOOP_CO2 Platform Type: CO2 Instrument Type: Equilibrator-IR or CRDS or GC Survey Type: SOOP Line Vessel Name: Barcelona Express Vessel Owner: Anglo Eastern Ship Management Vessel Code: BMBE |
| Coverage | Start Date (yyyymmdd): 20120913 End Date (yyyymmdd): 20121004 Westernmost Longitude: 92.9 W Easternmost Longitude: 23.4 W Northernmost Latitude: 33.6 N Southernmost Latitude: 21.0 N Port of Call: Cagliari, Italy Port of Call: Leghorn, Italy Port of Call: Genoa, Italy Port of Call: Barcelona, Spain Port of Call: Valencia, Spain Port of Call: Port Everglades, FL, USA Port of Call: Veracruz, Mexico Port of Call: Altamira, Mexico Port of Call: Houston, TX, USA Port of Call: New Orleans, LA, USA |
| Variable | Name: xCO2_EQU_ppm Unit: ppm Description: Mole fraction of CO2 in the equilibrator headspace (dry) at equilibrator temperature (ppm) |

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| 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 in situ temperature 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 ship's engine room at a side port off the piping carrying cooling water for the engines. Between the sea chest and the side port there is ~5 meters of pipe (~0.25 diameter). During the transit, the seawater warms an estimated 0.2-0.5 deg C. The reported SST is the value measured at the side port. Manufacturer: Seabird 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.

Sea Surface Salinity **Location:** In the ship's engine room next to 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.

Atmospheric Pressure **Location:** On deck above bridge at ~20 m above sea surface.
Normalized to Sea Level: yes
Manufacturer: Druck
Model: RPT350
Accuracy: ± 0.08 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.

Atmospheric CO2 **Measured/Frequency:** Yes, 5 readings in a group every ~4.5 hours
Intake Location: On mast above the bridge at ~20 meters 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).
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 (~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: 840A
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 ~4.5 hours using ESRL standards that are directly traceable to the WMO scale. Ultra-High

Purity air (0.0 ppm CO₂) and the high standard (when both present) are used to zero and span the LI-COR analyzer.

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, used every ~5.0 hours.

Std 3: CA03910, 372.81 ppm, owned by ESRL, used every ~5.0 hours.

Std 4: CC71588, 531.98 ppm, owned by ESRL, used every ~5.0 hours.

Comparison to Other CO₂ Analyses:

Comments: Instrument is located below a walkway in the engine room.

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: 1521

Accuracy: 0.025 (°C if units not given)

Precision: 0.001 (°C if units not given)

Calibration: Factory calibration

Comments: Manufacturer's Resolution is taken as Precision.

**Equilibrator
Pressure Sensor**

Location: Inside LICOR connected to ambient air. The differential pressure reading from A Setra 239, which is attached to the equilibrator headspace, is added to the pressure reading from the LICOR analyzer.

Manufacturer: Licor

Model: 840-P

Accuracy: 15 (hPa if units not given)

Precision: 1 (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 atmospheric pressure was estimated from the LICOR pressure using the offset between the 2 determined at the beginning of the BarX20120703 cruise (LICOR P - atm P = 0.229 +/- 0.212 mbar). The ATM xCO₂ shows high variability in the middle of the Atlantic but nothing indicates that these measurements are contaminated. They were left as is. Original Data Location: http://www.aoml.noaa.gov/ocd/ocdweb/barcelona/barcelona_introduction.html

Citation for this Dataset:

Other References for this Dataset: