

<b>Dataset Expocode</b>	<b>BHAF20241213</b>
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<b>Dataset</b>	<b>Funding Info:</b> NOAA Climate Program Office; NOAA Ocean Acidification Program <b>Initial Submission (yyyymmdd):</b> 20250203 <b>Revised Submission (yyyymmdd):</b> 20250203
<b>Campaign/Cruise</b>	<b>Expocode:</b> BHAF20241213 <b>Campaign/Cruise Name:</b> ALoS_20241213 <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> Allure of the Seas <b>Vessel Owner:</b> Royal Caribbean International <b>Vessel Code:</b> BHAF
<b>Coverage</b>	<b>Start Date (yyyymmdd):</b> 20241215 <b>End Date (yyyymmdd):</b> 20250104 <b>Westernmost Longitude:</b> 80.2 W <b>Easternmost Longitude:</b> 77.3 W <b>Northernmost Latitude:</b> 26.6 N <b>Southernmost Latitude:</b> 24.9 N <b>Port of Call:</b> Miami, FL
<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 <b>Description:</b> 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)
<b>Variable</b>	<b>Name:</b> 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:** Near 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:** none  
**Normalized to Sea Level:**  
**Manufacturer:** none  
**Model:** none  
**Accuracy:** (hPa if units not given)  
**Precision:** (hPa if units not given)  
**Calibration:**  
**Comments:**

**Atmospheric CO2**

**Measured/Frequency:** No  
**Intake Location:** none  
**Drying Method:** none  
**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: CA04890, 282.59 ppm, owned by ESRL-X2007, used every  $\sim 4.5$  hours.  
Std 2: CA05386, 357.61 ppm, owned by ESRL-X2007, used every  $\sim 4.5$  hours.  
Std 3: CA04523, 401.55 ppm, owned by ESRL-X2007, used every  $\sim 4.5$  hours.  
Std 4: CB11260, 503.43 ppm, owned by ESRL-X2007, used every  $\sim 4.5$  hours.  
Std 5: LL100000, 0.00 ppm, owned by AOML, used every  $\sim 24.0$  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 pCO<sub>2</sub> measuring systems and data reduction routines, Deep-Sea Res II, 56, 512-522.

**Equilibrator**

**Location:** Inserted into equilibrator ~5 cm below water level

**Temperature Sensor**

**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**

**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.

**Pressure Sensor**

**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:** Data for 2025 01 17 to 01 31 have been processed together for convenience. They represent several short 4 day cruises. The equ temp sensor was not turned on until Jan 10, 2025. That temperature record was replaced by the SBE45 internal temperature. The SBE45 is located in the same space as the pCO<sub>2</sub> system and receives the same water. On a later cruise, the equ temp sensor was working, it was determined that the SBE45 and the equ temp are equal  $\pm$  0.002 °C. The seawater flow was interrupted regularly due to issues with the valve controls, which resulted in data loss. That data was flagged 4. The time offset between SST and EQU t was kept at 1.55 min. As determined in the previous cruise. The Delta T was good. On year day 7 and 8 (Jan 7 and 8, 2025), no equ gas flow. The equ pump wires got damaged and the pump was not working anymore. It got fixed on the 10th. A couple times, (12/16 and 12/19), the equ T had to be estimated from the SST using the offset determined from the same day. It seems the SBE45 (which is used as proxy for equ T on these cruises) started drifting. The system exhibits High pCO<sub>2</sub> values upon port departure, which seems suspicious. The water flow rate is at about 1L/min, which might not be enough to achieve good equilibration in a timely manner. The first half hour after port departure will be flagged 4. In view of this, these data set should be flagged 3 and not receive a flag above C in SOCAT. Original Data Location: [http://www.aoml.noaa.gov/ocd/ocdweb/allure/allure\\_introduction.html](http://www.aoml.noaa.gov/ocd/ocdweb/allure/allure_introduction.html)

**Citation for this Dataset:**

**Other References for this Dataset:**