

<b>Dataset Expocode</b>	<b>316420230620</b>
<b>Primary Contact</b>	<b>Name:</b> Battisti, Roman <b>Organization:</b> NOAA/PMEL <b>Address:</b> <b>Phone:</b> <b>Email:</b> roman.battisti@noaa.gov
<b>Investigator</b>	<b>Name:</b> Dr. Adrienne Sutton <b>Organization:</b> NOAA/PMEL <b>Address:</b> 7600 Sand Point Wy NE Seattle, WA 98195 <b>Phone:</b> (206) 526-6879 <b>Email:</b> adrienne.sutton@noaa.gov
<b>Investigator</b>	<b>Name:</b> Dr. Robert A. Weller <b>Organization:</b> Woods Hole Oceanographic Institution <b>Address:</b> 266 Woods Hole Rd. MS#29 Woods Hole, MA 02543-1050 <b>Phone:</b> <b>Email:</b>
<b>Investigator</b>	<b>Name:</b> Dr. Albert J. Pleuddemann <b>Organization:</b> Woods Hole Oceanographic Institution <b>Address:</b> 266 Woods Hole Rd. MS#29 Woods Hole, MA 02543-1050 <b>Phone:</b> <b>Email:</b>
<b>Dataset</b>	<b>Funding Info:</b> NOAA <b>Initial Submission (yyyymmdd):</b> 12/26/2024 <b>Revised Submission (yyyymmdd):</b>
<b>Campaign/Cruise</b>	<b>Expocode:</b> 316420230620 <b>Campaign/Cruise Name:</b> <b>Campaign/Cruise Info:</b> <b>Platform Type:</b> <b>CO2 Instrument Type:</b> <b>Survey Type:</b> Moored Buoy <b>Vessel Name:</b> <b>Vessel Owner:</b> <b>Vessel Code:</b>
<b>Coverage</b>	<b>Start Date (yyyymmdd):</b> 20230620 <b>End Date (yyyymmdd):</b> 20240606 <b>Westernmost Longitude:</b> 157.936 W <b>Easternmost Longitude:</b> 157.864 W <b>Northernmost Latitude:</b> 22.798 N <b>Southernmost Latitude:</b> 22.736 N
<b>Variable</b>	<b>Name:</b> Date Time <b>Unit:</b> <b>Description:</b> Date and Time (UTC)
<b>Variable</b>	<b>Name:</b> xCO2 SW (wet) <b>Unit:</b> <b>Description:</b> (umol/mol) Mole fraction of CO2 in air in equilibrium with the seawater at sea surface temperature and measured humidity.
<b>Variable</b>	<b>Name:</b> CO2 SW QF <b>Unit:</b>

**Description:** Flag for xCO<sub>2</sub> sw (wet)

**Variable**

**Name:** H<sub>2</sub>O SW

**Unit:**

**Description:** (mmol/mol) Mole fraction of H<sub>2</sub>O in air from equilibrator.

**Variable**

**Name:** xCO<sub>2</sub> Air (wet)

**Unit:**

**Description:** (umol/mol) Mole fraction of CO<sub>2</sub> in air from airblock, 4 feet above the sea surface at measured humidity.

**Variable**

**Name:** CO<sub>2</sub> Air QF

**Unit:**

**Description:** Quality Flag for xCO<sub>2</sub> Air (wet)

**Variable**

**Name:** H<sub>2</sub>O Air

**Unit:**

**Description:** (mmol/mol) Mole fraction of H<sub>2</sub>O in air from airblock, 4 feet above the sea surface.

**Variable**

**Name:** Licor Atm Pressure

**Unit:**

**Description:** (hPa) The air intake is approximately 1 m above the sea surface. For equilibration-based systems deployed on autonomous surface platforms, the air-sea equilibration also occurs at the sea surface, so Atmospheric Pressure reported here is equivalent to Equilibrator Pressure (P<sub>eq</sub>).

**Variable**

**Name:** Licor Temp

**Unit:**

**Description:** (C) Temperature of the Infrared Licor 820 in degrees Celsius.

**Variable**

**Name:** MAPCO<sub>2</sub> %O<sub>2</sub>

**Unit:**

**Description:** The percent oxygen of the surface seawater divided by the percent oxygen of the atmosphere at 4 feet above the sea surface. Disclaimer: The oxygen measurement is made in the equilibrated air. We have found that the oxygen does not come to complete equilibrium so any rapid changes in oxygen do not get properly captured using this system. Therefore, we tend to use the oxygen data only as a qualitative sense of the biology. It is not a quantitative measure.

**Variable**

**Name:** SST

**Unit:**

**Description:** (C) Sea Surface Temperature. For equilibration-based systems deployed on autonomous surface platforms, the air-sea equilibration occurs at the sea surface, so SST reported here is equivalent to Equilibrator Temperature (T<sub>eq</sub>). This means that there is no warming between in situ SST and T<sub>eq</sub> as on ship-based equilibrator-based pCO<sub>2</sub> systems.

**Variable**

**Name:** Salinity

**Unit:**

**Description:** (PSU) Sea Surface Salinity.

**Variable**

**Name:** xCO<sub>2</sub> SW (dry)

**Unit:**

**Description:** (umol/mol) Mole fraction of CO<sub>2</sub> in air in equilibrium with the seawater at sea surface temperature (dry air).

**Variable**

**Name:** xCO<sub>2</sub> Air (dry)

**Unit:**  
**Description:** (umol/mol) Mole fraction of CO<sub>2</sub> in air at the airblock, 4 feet above the sea surface (dry air).

**Variable**

**Name:** fCO<sub>2</sub> SW (sat)  
**Unit:**  
**Description:** (uatm) Fugacity of CO<sub>2</sub> in air in equilibrium with the seawater at sea surface temperature (100% humidity). Since the measurements are taken at the sea surface, warming calculations are not necessary.

**Variable**

**Name:** fCO<sub>2</sub> Air (sat)  
**Unit:**  
**Description:** (uatm) Fugacity of CO<sub>2</sub> in air at the airblock, 4 feet above the sea surface (100% humidity).

**Variable**

**Name:** dfCO<sub>2</sub>  
**Unit:**  
**Description:** Difference of the fugacity of the CO<sub>2</sub> in seawater and the fugacity of the CO<sub>2</sub> in air (fCO<sub>2</sub> SW - fCO<sub>2</sub> Air).

**Variable**

**Name:** pCO<sub>2</sub> SW (wet)  
**Unit:**  
**Description:** (uatm) Partial Pressure of CO<sub>2</sub> in air in equilibrium with the seawater at sea surface temperature (100% humidity)

**Variable**

**Name:** pCO<sub>2</sub> Air (wet)  
**Unit:**  
**Description:** (uatm) Partial Pressure of CO<sub>2</sub> in air at the airblock, 4 feet above the sea surface (100% humidity).

**Variable**

**Name:** dpCO<sub>2</sub>  
**Unit:**  
**Description:** Difference of the partial pressure of CO<sub>2</sub> in seawater and air (pCO<sub>2</sub> SW - pCO<sub>2</sub> Air)

**Variable**

**Name:** pH SW  
**Unit:**  
**Description:** pH of Seawater (total scale)

**Variable**

**Name:** pH QF  
**Unit:**  
**Description:** Quality Flag for pH

**Variable**

**Name:** CHL  
**Unit:**  
**Description:** Total Chlorophyll (ug/l)

**Variable**

**Name:** CHL QF  
**Unit:**  
**Description:** Quality Flag for CHL

**Variable**

**Name:** NTU  
**Unit:**  
**Description:** Nephelometric Turbidity Unit(NTU Units)

**Variable**

**Name:** NTU QF  
**Unit:**  
**Description:** Quality Flag for NTU

**Variable**

**Name:** DOXY

**Unit:**  
**Description:** Salinity-Compensated dissolved oxygen(umol/kg)

**Variable**

**Name:** DOXY QF  
**Unit:**  
**Description:** Quality Flag for DOXY

**Sea Surface  
Temperature**

**Location:** 1m  
**Manufacturer:** SeaBird  
**Model:** SBE 16  
**Accuracy:** < 0.01 (°C if units not given)  
**Precision:** (°C if units not given)  
**Calibration:** ~ Annually by SeaBird  
**Comments:** Temperature data are internally recorded and collected during the equilibration period. Data are not post-calibrated. Annual drift for this deployment was minimal and does not impact the fCO<sub>2</sub> and pCO<sub>2</sub> calculations (within the degree of accuracy of the CO<sub>2</sub> measurement). Contact us if you would like the CTD post-calibration information.

**Sea Surface Salinity**

**Location:** 1m  
**Manufacturer:** SeaBird  
**Model:** SBE 16  
**Accuracy:** < 0.05  
**Precision:**  
**Calibration:** ~ Annually by SeaBird  
**Comments:** Conductivity data are internally recorded and collected during the equilibration period. Data are not post-calibrated. Annual drift for this deployment was minimal and does not impact the fCO<sub>2</sub> and pCO<sub>2</sub> calculations (within the degree of accuracy of the CO<sub>2</sub> measurement). Contact us if you would like the CTD post-calibration information.

**Atmospheric  
Pressure**

**Location:**  
**Normalized to Sea Level:**  
**Manufacturer:**  
**Model:**  
**Accuracy:** (hPa if units not given)  
**Precision:** (hPa if units not given)  
**Calibration:**  
**Comments:**

**Atmospheric CO<sub>2</sub>**

**Measured/Frequency:** yes, 3hr cycle  
**Intake Location:** unused  
**Drying Method:** unused  
**Atmospheric CO<sub>2</sub> Accuracy:** 1 uatm  
**Atmospheric CO<sub>2</sub> Precision:** 0.6 uatm

**Aqueous CO<sub>2</sub>  
Equilibrator Design**

**System Manufacturer:**  
**Intake Depth:** 14cm - 20cm  
**Intake Location:**  
**Equilibration Type:** Bubble Equilibrator  
**Equilibrator Volume (L):** N/A  
**Headspace Gas Flow Rate (ml/min):** ~600 cc/min  
**Equilibrator Water Flow Rate (L/min):** N/A  
**Equilibrator Vented:** Yes  
**Equilibration Comments:**

## Aqueous CO2 Sensor Details

### Drying Method:

**Measurement Method:** Absolute, non-dispersive infrared (NDIR) gas analyzer

### Method details:

**Manufacturer:** Licor

**Model:** LI-820

### Measured CO2 Values:

**Measurement Frequency:** 3hr cycle

**Aqueous CO2 Accuracy:** 2 uatm

**Aqueous CO2 Precision:** 0.7 uatm

### Sensor Calibrations:

**Calibration of Calibration Gases:** At the beginning of each sample, the instrument self-calibrates using a zero and high standard. The zero standard is generated by cycling a small amount of air through a soda lime chamber. The high standard is from a cylinder of calibrated standard reference gas, 606.0 umol/mol, from ESRL. ESRL standards are traceable to WMO x93 scale with a stated reproducibility of 0.06 micromole/mole. For more information on estimates of accuracy and precision of the MAPCO2 system, see Sutton et al. 2014 (reference below).

### Number Non-Zero Gas Standards:

### Calibration Gases:

NOAA Earth System Research & Laboratory (ESRL)

### Comparison to Other CO2 Analyses:

### Comments:

### Method Reference:

Sutton, A.J., Sabine, C.L., Maenner-Jones, S., Lawrence-Slavas, N., Meinig, C., Feely, R.A., Mathis, J.T., Musielewicz, S., Bott, R., McLain, P.D., Fought, J., Kozyr, A., 2014b. A high-frequency atmospheric and seawater pCO2 data set from 14 open ocean sites using a moored autonomous system. Earth Sys. Sci. Data, 6, doi: 10.5194/essd-6-353-2014, 353-366.

## Equilibrator Temperature Sensor

### Location:

### Manufacturer:

### Model:

**Accuracy:** (°C if units not given)

**Precision:** (°C if units not given)

### Calibration:

### Comments:

## Equilibrator Pressure Sensor

### Location:

### Manufacturer:

### Model:

**Accuracy:** (hPa if units not given)

**Precision:** (hPa if units not given)

### Calibration:

### Comments:

## Other Sensor

### Description:

**Manufacturer:** Maxtec Oxygen Sensor

**Model:** Max-250

**Accuracy:** 2.0% Full Scale over operating temperature range. 1.0% Full Scale @ constant temperature and pressure

### Precision:

**Calibration:** Factory calibrated before purchase. Recalibrated to sea level atmospheric air every 7 days

**Comments:**

**Other Sensor**

**Description:**

**Manufacturer:** Sensirion Humidity Sensor

**Model:** SHT71

**Accuracy:** > 0.01%

**Precision:**

**Calibration:** Factory calibrated before purchase.

**Comments:**

**Other Sensor**

**Description:**

**Manufacturer:** Sunburst Sensors, LLC

**Model:** SAMI2 pH

**Accuracy:**

**Precision:**

**Calibration:** ~ Annually by Sunburst Sensors

**Comments:** pH data are collected and internally recorded during the CO<sub>2</sub> equilibration period. Data are salinity compensated with salinity collected by the Seabird SBE16, using the program Sunburst Sensors QC\_PH. Spaulding, R., 2015. Salinity Measurement and SAMI-pH Accuracy. Tech Notes, 1. Sensor resolution and uncertainty were provided by the manufacturer.

**Other Sensor**

**Description:**

**Manufacturer:** Wet Labs

**Model:** ECO FLNTUS

**Accuracy:**

**Precision:**

**Calibration:** ~ Annually by Wet Labs, Inc

**Comments:** The community-established calibration bias of 2 for the WET Labs ECO-series fluorometer was applied to these in situ fluorometric chlorophyll values (Roesler et al. 2017). Sensor resolution was provided by the manufacturer. The accuracy of fluorescence-based chlorophyll is unknown.

**Other Sensor**

**Description:**

**Manufacturer:** Wet Labs

**Model:** ECO FLNTUS

**Accuracy:**

**Precision:**

**Calibration:** ~ Annually by Wet Labs, Inc

**Comments:** Sensor resolution and uncertainty were provided by the manufacturer. The accuracy of optical-based turbidity is unknown.

**Other Sensor**

**Description:**

**Manufacturer:** Seabird

**Model:** SBE63

**Accuracy:**

**Precision:**

**Calibration:** ~ Annually by Seabird Electronics, Inc

**Comments:** Sensor resolution and uncertainty were provided by the manufacturer.

**Additional Information**

**Suggested QC flag from Data Provider:**

**Additional Comments:** o All measurements are at sea surface temperature and atmospheric pressure. o During the equilibration cycle, a closed loop of air equilibrates with seawater for 10 minutes. Once the equilibration period is

complete, the pump stops and the system opens to the atmosphere allowing the pressure to equilibrate with atmospheric pressure. Measurements are recorded for 30 seconds at 2 hertz and then averaged. o During the air cycle, fresh air is pumped through the detector for 1 minute. Once the pump stops, the system opens to the atmosphere allowing the pressure to equilibrate with atmospheric pressure. Measurements are recorded for 30 seconds at 2 hertz and then averaged. o The gas streams for both the air cycle and equilibrator cycle are partially dried before entering the detector. The values listed as wet xCO<sub>2</sub> generally have relative humidity levels ranging from 40 to 80 percent. The humidity levels increase over the course of a deployment. o Sampling occurs every 3 hours. The infrared detector is calibrated at the beginning of every sampling period. Averaged data and standard deviations for each measurement are transmitted back daily. o To calculate the dry measurements, the water mole fraction in the Licor detector must be known. A relative humidity sensor is located immediately downstream of the detector. o During the QC process, an adjustment to the Licor pressure is also made based on each sensor's bias to barometric pressure as measured in the lab. This system has Licor pressure bias of -0.050 applied. o Post calculation and correlation between Licor temperature and span coefficient at cluster center 0 is:  $\text{Licor coef} = -0.000982 * \text{Temp} + 0.8059$ ,  $r^2 = 0.9096$  o As part of the QC process, xCO<sub>2</sub> air measurements are compared to the following data sets when available: previous MAPCO<sub>2</sub> deployment at same site if overlap on recovery/deployment, following MAPCO<sub>2</sub> deployment at same site if overlap on recovery/deployment, and Marine Boundary Layer (MBL) xCO<sub>2</sub> air data from GlobalView-CO<sub>2</sub>. This MAPCO<sub>2</sub> deployment is offset from the available comparison data sets, and an adjustment of -2.0 umol mol<sup>-1</sup> was applied to the data set. Dlugokencky, E.J., K.W. Thoning, P.M. Lang, and P.P. Tans (2019), NOAA Greenhouse Gas Reference from Atmospheric Carbon Dioxide Dry Air Mole Fractions from the NOAA ESRL Carbon Cycle Cooperative Global Air Sampling Network. Data Path: [ftp://aftp.cmdl.noaa.gov/data/trace\\_gases/co2/flask/surface/](ftp://aftp.cmdl.noaa.gov/data/trace_gases/co2/flask/surface/). o MBL Data were last downloaded from ESRL on 2024-12-23. o No data = -999 o These data are made freely available to the public and the scientific community in the belief that their wide dissemination will lead to greater understanding and new scientific insights. The availability of these data does not constitute publication of the data. We rely on the ethics and integrity of the user to assure that PMEL receives fair credit for our work. Please send manuscripts using this data to PMEL for review before they are submitted for publication so we can insure that the quality and limitations of the data are accurately represented.

**Citation for this Dataset:**

Sutton, A., C. Sabine, S. Maenner, S. Musielewicz, R. Battisti, S. Dougherty, R. Bott, and J. Osborne. 2023. High-resolution ocean and atmosphere pCO<sub>2</sub> time-series measurements from mooring WHOTS\_158W\_23N.

**Other References for this Dataset:**

None