

Dataset Expocode	316420190613
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Dataset	Funding Info: NOAA Initial Submission (yyyymmdd): 01/06/2022 Revised Submission (yyyymmdd):
Campaign/Cruise	Expocode: 316420190613 Campaign/Cruise Name: Campaign/Cruise Info: Platform Type: CO2 Instrument Type: Survey Type: Moored Buoy Vessel Name: Vessel Owner: Vessel Code: Papa
Coverage	Start Date (yyyymmdd): 20190613 End Date (yyyymmdd): 20200524 Westernmost Longitude: 144.835 W Easternmost Longitude: 144.835 W Northernmost Latitude: 50.128 N Southernmost Latitude: 50.128 N
Variable	Name: Date Time Unit: Description: Date and Time (UTC)
Variable	Name: xCO2 SW (wet) Unit: Description: (umol/mol) Mole fraction of CO2 in air in equilibrium with the seawater at sea surface temperature and measured humidity.
Variable	Name: CO2 SW QF Unit:

Description: Flag for xCO₂ sw (wet)

Variable

Name: H₂O SW

Unit:

Description: (mmol/mol) Mole fraction of H₂O in air from equilibrator.

Variable

Name: xCO₂ Air (wet)

Unit:

Description: umol/mol) Mole fraction of CO₂ in air from airblock, 4 feet above the sea surface at measured humidity.

Variable

Name: CO₂ Air QF

Unit:

Description: Quality Flag for xCO₂ Air (wet)

Variable

Name: H₂O Air

Unit:

Description: (mmol/mol) Mole fraction of H₂O in air from airblock, 4 feet above the sea surface.

Variable

Name: Licor Atm Pressure

Unit:

Description: (hPa) Atmospheric pressure at the airblock, 4 feet above the sea surface.

Variable

Name: Licor Temp

Unit:

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

Variable

Name: MAPCO₂ %O₂

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.

Variable

Name: Salinity

Unit:

Description: (PSU) Sea Surface Salinity.

Variable

Name: xCO₂ SW (dry)

Unit:

Description: (umol/mol) Mole fraction of CO₂ in air in equilibrium with the seawater at sea surface temperature (dry air).

Variable

Name: xCO₂ Air (dry)

Unit:

Description: (umol/mol) Mole fraction of CO₂ in air at the airblock, 4 feet above the sea surface (dry air).

Variable

Name: fCO₂ SW (sat)

Unit:

Description: (uatm) Fugacity of CO₂ 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: fCO₂ Air (sat)

Unit:

Description: (uatm) Fugacity of CO₂ in air at the airblock, 4 feet above the sea surface (100% humidity).

Variable

Name: dfCO₂

Unit:

Description: Difference of the fugacity of the CO₂ in seawater and the fugacity of the CO₂ in air (fCO₂ SW - fCO₂ Air).

Variable

Name: pCO₂ SW (wet)

Unit:

Description: (uatm) Partial Pressure of CO₂ in air in equilibrium with the seawater at sea surface temperature (100% humidity)

Variable

Name: pCO₂ Air (wet)

Unit:

Description: (uatm) Partial Pressure of CO₂ in air at the airblock, 4 feet above the sea surface (100% humidity).

Variable

Name: dpCO₂

Unit:

Description: Difference of the partial pressure of CO₂ in seawater and air (pCO₂ SW - pCO₂ 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 fCO₂ and pCO₂ calculations (within the degree of accuracy of the CO₂ 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 fCO₂ and pCO₂ calculations (within the degree of accuracy of the CO₂ measurement). Contact us if you would like the CTD post-calibration information.

**Atmospheric
Pressure**

Location: 1m height

Normalized to Sea Level:

Manufacturer: LICOR

Model: LICOR 820

Accuracy: 2 hPa (hPa if units not given)

Precision: 1 hPa (hPa if units not given)

Calibration: Compared annually with Paros 765 Pressure Standard

Comments:

Atmospheric CO₂

Measured/Frequency: yes, 3hr cycle

Intake Location: unused

Drying Method: unused

Atmospheric CO₂ Accuracy: 1 uatm

Atmospheric CO₂ Precision: 0.6 uatm

**Aqueous CO₂
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:

Drying Method:

**Aqueous CO₂
Sensor Details**

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, 419.64 umol/mol, from ESRL. ESRL standards are traceable to WMO scale. All standard values were obtained from the most current WMO/GAW scale at the time of the start of the deployment. 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 CO₂ 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: Xylem/Aanderaa
Model: 4175
Accuracy:
Precision:
Calibration: ~ Annually by Aanderaa, 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 xCO₂ 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 As part of the QC process, each data set is compared with the Marine Boundary Layer (MBL) data from GlobalView-CO₂. o As part of the QC process, xCO₂ air measurements are compared to the following data sets when available: previous MAPCO₂ deployment if overlap on recovery/deployment, following MAPCO₂ deployment if overlap on recovery/deployment, and Marine Boundary Layer (MBL) xCO₂ air data from GlobalView-CO₂. The available comparison data sets are in good agreement with the MAPCO₂ air data and no adjustment was made. 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/. o MBL Data were last downloaded from ESRL on 01/05/2022 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 +0.200 applied. Averaged wet xCO₂ measurements are post-calibrated using a simple linear regression between original averaged measurements and span coefficients, a method similar to the post-cal established by the underway pCO₂ community as described here: Feely, R.A., R. Wanninkhof, H.B. Milburn, C.E. Cosca, M. Stapp, and P.P. Murphy, A new automated underway system for making high precision pCO₂ measurements onboard research ships, *Analytica Chim. Acta*, 377, 185-191, 1998. o Post calculation correlation between Licor temperature and coefficient is: $\text{Licor coef} = -0.001056 * \text{Temp} + 0.7423$ $r^2 = 0.95$ o During the QC process, the community-established calibration bias of 2 for the WET Labs ECO-series fluorometer was applied to these in situ fluorometric chlorophyll values. See: Roesler, C. , and others. 2017. Recommendations for obtaining unbiased chlorophyll estimates from in situ chlorophyll fluorometers: A global analysis of WET Labs ECO sensors. *Limnol. Oceanogr.: Methods* 15: 572-585. doi:10.1002/lom3.10185. o Only nighttime measurements of chlorophyll (defined as 21:00 to 03:00 local time) are published, given the lack of validation data for correcting daytime quenching. All daytime measurements are flagged as missing (QF = 5). WetLabs ECO FLNTUS failed on deployment. Aanderaa Optode data submitted separately by Emerson et al. at the University of Washington. 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., S. Maenner, S. Musielewicz, R. Battisti, R. Bott, and J. Osborne. 2019. High-resolution ocean and atmosphere pCO₂ time-series measurements from mooring Papa_145W_50N.

Other References for this Dataset:

None