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| Dataset Expocode | 316420230413 |
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| Dataset | Funding Info: NOAA Initial Submission (yyyymmdd): 12/26/2024 Revised Submission (yyyymmdd): |
| Campaign/Cruise | Expocode: 316420230413 Campaign/Cruise Name: Campaign/Cruise Info: Platform Type: CO2 Instrument Type: Survey Type: Moored Buoy Vessel Name: Vessel Owner: Vessel Code: |
| Coverage | Start Date (yyyymmdd): 20230413 End Date (yyyymmdd): 20240802 Westernmost Longitude: 144.876 W Easternmost Longitude: 144.76 W Northernmost Latitude: 50.161 N Southernmost Latitude: 50.117 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) 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_{eq}).

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. 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_{eq}). This means that there is no warming between in situ SST and T_{eq} as on ship-based equilibrator-based pCO₂ systems.

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

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, 459.8 $\mu\text{mol/mol}$, 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: ($^{\circ}\text{C}$ if units not given)

Precision: ($^{\circ}\text{C}$ 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: 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 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 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 +0.040 applied. o Post calculation and correlation between Licor temperature and span coefficient at cluster center 0 is: Licor coef = -0.000838 * Temp + 0.8600, r² = 0.6024 o Post calculation and correlation between Licor temperature and span coefficient at cluster center 1 is: Licor coef = -0.000618 * Temp + 0.8611, r² = 0.6467 o As part of the QC process, xCO₂ air measurements are compared to the following data sets when available: previous MAPCO₂ deployment at same site if overlap on recovery/deployment, following MAPCO₂ deployment at same site if overlap on recovery/deployment, and Marine Boundary Layer (MBL) xCO₂ air data from GlobalView-CO₂. This MAPCO₂ deployment is offset from the available comparison data sets, and no adjustment 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/. 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 pCO₂ time-series measurements from mooring Papa_145W_50N.

Other References for this Dataset:

None