

**Investigators:** Wiley Evans (Hakai Institute), Katie Pocock (Hakai Institute), Shawn Hateley (Hakai Institute), and Jessy Barrette (Hakai Institute)

**Title:** Surface seawater and marine boundary layer CO<sub>2</sub> observations made from the Kwakshua Channel (KC) Buoy on the central coast of British Columbia

**Abstract:** Kwakshua Channel, located near Fitz Hugh Sound on the central coast of British Columbia, has been a site for moored, high-resolution measurements of surface seawater and marine boundary layer CO<sub>2</sub> content since May 2018. Measurements of in situ temperature, salinity, seawater and atmospheric CO<sub>2</sub> partial pressure are made using a Battelle Seaology (MApCO<sub>2</sub>) System. The effort to collect these data are part of the Hakai Institute's directive to advance the understanding of carbon cycling in northeast Pacific coastal settings with specific emphasis on ocean acidification. This data contribution consists of measurements from May 1, 2018 to October 25, 2020.

**Cite as:** Evans, W., K. Pocock, S. Hateley, and J. Barrette (2021). Surface seawater and marine boundary layer CO<sub>2</sub> observations made from the Kwakshua Channel (KC) Buoy on the central coast of British Columbia. Version 2.0. Hakai Institute. Dataset. [access date].

**Type of Study:** Measurements of surface ocean and marine boundary layer CO<sub>2</sub> from a surface buoy

**Temporal Coverage:** May 1, 2018 to October 25, 2020

**Spatial Coverage:** Surface ocean and marine boundary layer CO<sub>2</sub> measurements from the mouth of Kwakshua Channel; Fitz Hugh Sound; central British Columbia coast; 51.6507°N, 127.9697°W

**Geographic Names:** Kwakshua Channel; Fitz Hugh Sound; central British Columbia coast; Gulf of Alaska; North Pacific Ocean

**Expocode:** 187F20180501

**Platforms:** KC Buoy

**Version:** 2.0

**Submission Date:** January 15, 2021

**Change log:**

Version 2.0 of this dataset includes the original version 1.0 data plus new measurements up to October 25, 2020. Sampling frequencies varied over this dataset. Details on sampling frequency, data processing segments, and flagging windows for quality control are described below.

*Sampling frequencies:*

May 1st - Aug 4th 2018: 30 minutes  
Aug 5th 2018 - Jan 23rd 2019: 1 hour  
Jan 24th 2019 - Jan 2020: 3 hours  
Apr 2020 - Oct 2020: 1 hour

*Data processing segments:*

May 2018  
June - Aug 2018  
Aug 2018 - Jan 2019  
Jan 2019 - Jan 2020  
Apr 2020 - Oct 2020

*Flagging windows:*

May - Aug 2018: 6 points on either side of measurement (same measurements get flagged as with 3 points)  
Aug 2018 - Jan 2019: 3 points on either side of measurement  
Jan 2019 - Jan 2020: 3 points on either side of measurement  
Jan 2020 - Jan 2019: 3 points on either side of measurement

*Dataset Metadata note:*

As part of the QC process, a trend analysis is performed on the CO<sub>2</sub> measurements in which an average xCO<sub>2</sub> and standard deviation is computed over a set time window around each value (i.e. number of points on each side of the measurement). These values are then compared to the measured xCO<sub>2</sub> to determine whether the measurement should be flagged. Due to the variable nearshore environment of the deployment location, the flagging range used in the QC of this record was decreased from the default of 48 points on each side of the measurement (with a 3-hour sample frequency) to 3 points on each side of the measurement.

**Filename:** KC\_BUOY\_May2018\_Oct2020.csv

**Data dictionary / header information:**

- (1) Mooring Name: Name/description of mooring
- (2) Latitude: Mooring latitude in decimal degrees
- (3) Longitude: Mooring longitude in decimal degrees
- (4) Date: UTC date (mm/dd/yyyy)
- (5) Time: UTS time (hh:mm)
- (6) xCO<sub>2</sub> SW (wet): (umol/mol) Mole fraction of CO<sub>2</sub> in air in equilibrium with the seawater at sea surface temperature and measured humidity
- (7) CO<sub>2</sub> SW QF: Flag for xCO<sub>2</sub> sw (wet)
- (8) H<sub>2</sub>O SW: (mmol/mol) Mole fraction of H<sub>2</sub>O in air from equilibrator
- (9) xCO<sub>2</sub> Air (wet): (umol/mol) Mole fraction of CO<sub>2</sub> in air from airblock, 4 feet above the sea surface at measured humidity.
- (10) CO<sub>2</sub> Air QF: Quality Flag for xCO<sub>2</sub> Air (wet)
- (11) H<sub>2</sub>O Air: (mmol/mol) Mole fraction of H<sub>2</sub>O in air from airblock, 4 feet above the sea surface.

- (12) Licor Atm Pressure: (hPa) Atmospheric pressure at the airblock, 4 feet above the sea surface.
- (13) Licor Temp: (C) Temperature of the Infrared Licor 820 in degrees Celsius.
- (14) MAPCO<sub>2</sub> %O<sub>2</sub>: 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 and does not come to complete equilibrium therefore this measurement is qualitative and for diagnostic use only.
- (15) SST: (C) Sea Surface Temperature.
- (16) Salinity: Sea Surface Salinity on the practical scale.
- (17) xCO<sub>2</sub> SW (dry): (umol/mol) Mole fraction of CO<sub>2</sub> in air in equilibrium with the seawater at sea surface temperature (dry air).
- (18) xCO<sub>2</sub> Air (dry): (umol/mol) Mole fraction of CO<sub>2</sub> in air at the airblock, 4 feet above the sea surface (dry air).
- (19) fCO<sub>2</sub> SW (sat): (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.
- (20) fCO<sub>2</sub> Air (sat): (uatm) Fugacity of CO<sub>2</sub> in air at the airblock, 4 feet above the sea surface (100% humidity)
- (21) dfCO<sub>2</sub>: 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).
- (22) pCO<sub>2</sub> SW (sat): (uatm) Partial Pressure of CO<sub>2</sub> in air in equilibrium with the seawater at sea surface temperature (100% humidity)
- (23) pCO<sub>2</sub> Air (sat): (uatm) Partial Pressure of CO<sub>2</sub> in air at the airblock, 4 feet above the sea surface (100% humidity).
- (24) dpCO<sub>2</sub>: Difference of the partial pressure of CO<sub>2</sub> in seawater and air (pCO<sub>2</sub> SW - pCO<sub>2</sub> Air).

**Researcher Contact:** Please direct questions regarding these data to Wiley Evans (wiley.evans@hakai.org).

**Researcher institution:** Hakai Institute

**Core Variables:**

*Seawater partial pressure of carbon dioxide at sea surface temperature*

**Abbreviation:** pCO<sub>2</sub> SW (sat)

**Unit:** μatm

**Observation type:** Measurements from moored buoy with MApCO<sub>2</sub> system

**In-situ/Manipulation/Response variable:** In situ observation

**Measured or calculated:** Calculated from measured CO<sub>2</sub> mole fractions (xCO<sub>2</sub>) and ambient atmospheric pressure.

**Sampling instrument:** MApCO<sub>2</sub> equilibrator

**Analyzing instrument:** Battelle Seaology (MApCO<sub>2</sub>) System with LI-COR LI-820

**Detailed sampling and analyzing information:** All measurements are at sea surface temperature and atmospheric pressure. 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 Hz and then averaged. 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 Hz and then averaged. 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. Sampling occurs every 30 minutes. The infrared detector is calibrated at the beginning of every sampling period using a zero and span gas. To calculate the dry measurements, the water mole fraction in the Licor detector is measured using a relative humidity sensor located immediately downstream of the detector.

**Replicate information:** N/A

**Standardization description:** Measurements calibrated using onboard zero and span gas with a known concentration. Span gases used to generate this dataset were 907 ppm from May 1 2018 to July 9 2018 (Praxair, Inc.), 514.47 ppm (ESRL) from August 4 2018 to January 24 2019, 901 ppm from January 24 2019 to January 11 2020 (Praxair, Inc.), and 900 ppm from April 8 2020 to present of 907 ppm (Praxair, Inc.).

**Standardization frequency:** Every measurement

**CRM manufacturer:** Praxair, Inc. and ESRL

**Poison name:** N/A

**Poison volume:** N/A

**Poison correction:** N/A

**Uncertainty:** 2 ppm for calibrated xCO<sub>2</sub>; ~2 μatm for pCO<sub>2</sub>

**Quality flag convention:** No quality flag applied

**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, H.J., and Kozyr, A. (2014). A high-frequency atmospheric and seawater pCO<sub>2</sub> data set from 14 open-ocean sites using a moored autonomous system. *Earth System Science Data* 6, 353-366.

**Researcher name:** Wiley Evans

**Researcher institution:** Hakai Institute

*Atmospheric partial pressure of carbon dioxide*

**Abbreviation:** ATM pCO<sub>2</sub> wet

**Unit:** μatm

**Observation type:** Measurements from air intake on M/V Columbia foredeck

**In-situ/Manipulation/Response variable:** In situ observation

**Measured or calculated:** Calculated from measured CO<sub>2</sub> mole fractions (xCO<sub>2</sub>) and ambient atmospheric pressure.

**Sampling instrument:** Air intake

**Analyzing instrument:** Battelle Seaology (MApCO<sub>2</sub>) with LI-COR LI-820

**Detailed sampling and analyzing information:** All measurements are at sea surface temperature and atmospheric pressure. 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 Hz and then averaged.

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 Hz and then averaged. 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. Sampling occurs every 30 minutes. The infrared detector is calibrated at the beginning of every sampling period using a zero and span gas. To calculate the dry measurements, the water mole fraction in the Licor detector is measured using a relative humidity sensor located immediately downstream of the detector.

**Replicate information:** N/A

**Standardization description:** Measurements calibrated using onboard zero and span gas with a known concentration. Span gases used to generate this dataset were 907 ppm from May 1 2018 to July 9 2018 (Praxair, Inc.), 514.47 ppm (ESRL) from August 4 2018 to January 24 2019, 901 ppm from January 24 2019 to January 11 2020 (Praxair, Inc.), and 900 ppm from April 8 2020 to present of 907 ppm (Praxair, Inc.).

**Standardization frequency:** Every measurement

**CRM manufacturer:** Praxair, Inc. and ESRL

**Poison name:** N/A

**Poison volume:** N/A

**Poison correction:** N/A

**Uncertainty:** 2 ppm for calibrated xCO<sub>2</sub>; ~2 µatm for pCO<sub>2</sub>

**Quality flag convention:** No quality flag applied

**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, H.J., and Kozyr, A. (2014). A high-frequency atmospheric and seawater pCO<sub>2</sub> data set from 14 open-ocean sites using a moored autonomous system. *Earth System Science Data* 6, 353-366.

**Researcher name:** Wiley Evans

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*Sea surface temperature*

**Abbreviation:** Intake T

**Unit:** °C, ITS-90 scale

**Observation type:** Measurements from surface buoy (1 m depth)

**In-situ/Manipulation/Response variable:** In situ observation

**Measured or calculated:** Measured

**Sampling instrument:** N/A

**Analyzing instrument:** SBE16plusV2

**Detailed sampling and analyzing information:** Data captured using a Campbell Scientific data logger onboard the surface buoy

**Replicate information:** N/A

**Standardization description:** N/A

**Standardization frequency:** N/A

**CRM manufacturer:** N/A

**Poison name:** N/A

**Poison volume:** N/A

**Poison correction:** N/A  
**Uncertainty:** 0.005°C  
**Quality flag convention:** No quality flag applied  
**Method reference:**  
**Researcher name:** Wiley Evans  
**Researcher institution:** Hakai Institute

*Seawater Salinity*

**Abbreviation:** TSG Salinity  
**Unit:** 1978 Practical Salinity Scale  
**Observation type:** Measurements from surface buoy (1 m depth)  
**In-situ/Manipulation/Response variable:** In situ observation  
**Measured or calculated:** Calculated from conductivity and temperature measurements  
**Sampling instrument:** N/A  
**Analyzing instrument:** SBE16plusV2  
**Detailed sampling and analyzing information:** Data captured using a Campbell Scientific data logger onboard the surface buoy  
**Replicate information:** N/A  
**Standardization description:** N/A  
**Standardization frequency:** N/A  
**CRM manufacturer:** N/A  
**Poison name:** N/A  
**Poison volume:** N/A  
**Poison correction:** N/A  
**Uncertainty:** 0.0005 S/m  
**Quality flag convention:** No quality flag applied  
**Method reference:**  
**Researcher name:** Wiley Evans  
**Researcher institution:** Hakai Institute