

## NOAA PMEL UWPCO<sub>2</sub> – 2012 Coastal Cruises

Partial pressure of carbon dioxide (pCO<sub>2</sub>), temperature, salinity and other variables collected from surface underway observations using shower head equilibrator, carbon dioxide gas detector, and other instruments from NOAA Ship Bell M. Shimada in the surface waters of the North American West from 2012-02-20 to 2012-09-16 (NODC Accession 0115714)

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### ABSTRACT:

NODC Accession 0115714 includes underway measurements of partial pressure (or fugacity) of carbon dioxide, sea surface temperature, salinity, barometric pressure and other parameters collected in 2012 on board the NOAA Ship Bell Shimada in the surface waters of the North American West Coast. Cruise names and Expocodes: SH1201 (332220120220), SH1202\_L1 (332220120327), SH1204\_L2 (332220120717), SH1206 (332220120905). This effort was conducted in support of the coastal monitoring and research objectives of the NOAA Ocean Acidification Program (OAP).

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### TEMPORAL COVERAGE:

START DATE: 2/20/2012      END DATE: 9/16/2012

### SPATIAL COVERAGE:

NORTH BOUND: 49.027

WEST BOUND: -126.12      EAST BOUND: -117.77

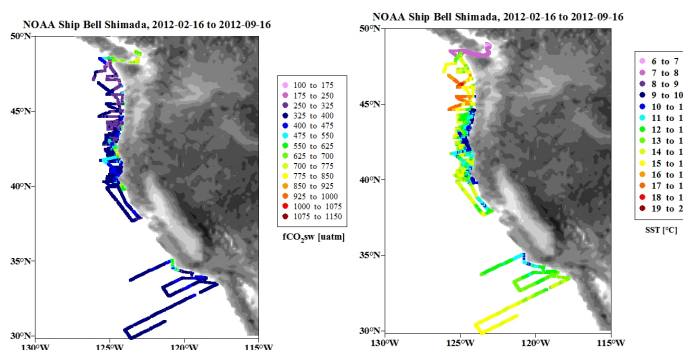
SOUTH BOUND: 29.822

### GEOGRAPHIC NAMES:

North Pacific Ocean

### PLATFORMS:

Bell Shimada (Call Sign: WTED);



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## *pCO<sub>2</sub> (fCO<sub>2</sub>) autonomous*

<b>Abbreviation:</b>	fCO <sub>2</sub> W@SST
<b>Unit:</b>	μatm
<b>Observation type:</b>	Surface underway
<b>In-situ / Manipulation / Response variable:</b>	In-situ observation
<b>Measured or calculated:</b>	Measured
<b>Sampling instrument:</b>	Seawater pump
<b>Location of seawater intake:</b>	Bow
<b>Analyzing instrument:</b>	General Oceanics 8050. PMEL system ID: GO8
<b>Detailed sampling and analyzing information:</b>	The sampling and analyzing methods of the Neill/General Oceanics Underway pCO <sub>2</sub> systems are described in detail in: Pierrot, D.; Neill, C.; Sullivan, K.; Castle, R.; Wanninkhof, R.; Luger, H.; Johannessen, T.; Olsen, A.; Feely, R.A.; and Cosca, C.E. (2009). Recommendations for autonomous underway pCO <sub>2</sub> measuring systems and data-reduction routines. <i>Deep-Sea Res., II</i> , v. 56, pp. 512-522.
<b>Equilibrator type:</b>	Shower head
<b>Equilibrator volume:</b>	about 0.5 L
<b>Is the equilibrator vented or not:</b>	Vented
<b>Water flow rate:</b>	3 L/min
<b>Gas flow rate:</b>	~ 0.8 L/m
<b>How was temperature inside the equilibrator measured:</b>	Hart Scientific model 1521 digital thermometer, serial number A8B280, with an NIST traceable model 5610 thermistor probe, serial number A8C0309. Accurate to ± 0.01°C
<b>How was pressure inside the equilibrator measured:</b>	Setra 239 differential pressure transducer, accurate to plus minus 0.15 hPa. The equilibrator was passively vented to a secondary equilibrator, and the Licor sample output was vented to the laboratory when CO <sub>2</sub> measurements were made, thus equilibrator headspace pressure was assumed to be laboratory pressure. Pressure in the laboratory was measured with a GE Druck barometer, with an accuracy of ± 0.01 %.
<b>Drying method for gas:</b>	From Pierrot, et al.: Sample air is dried in a condenser that is cooled to 4-5°C by a Peltier thermoelectric device. This partially dried air flushes a chamber that is vented and remains at ambient pressure. The dried air inside the chamber is used as the counter flow in the Nafion tubing. A vacuum pump pulls the dried air from the chamber first through a fixed restrictor and then through the Nafion tubes, thus creating an absolute pressure and corresponding partial pressure gradient for water vapor across the membrane. When atmospheric air is measured, some of the partially dried air (80-100 ml/min) is pushed through a Nafion tube, the analyzer and out a vent instead of flushing the chamber. The headspace gas, when being measured, is circulated in a closed loop through the analyzer at a rate similar to that of the atmospheric air (80-100 ml/min). It is dried first in the condenser, then in a Nafion tube prior to entering the analyzer and being returned to the

equilibrator. Typically, the water mole fraction ( $x_{H_2O}$ ) in the dried gas is about 2 parts per thousand (ppt), which corresponds to a dew point temperature of about  $-20^{\circ}\text{C}$ . The liquid water condensed out of the sample air streams is removed by peristaltic pumps into the vent equilibrator at intervals determined by the user.

<b>Gas detector manufacturer:</b>	Licor 7000
<b>Gas detector model:</b>	IRG4-0233
<b>Gas detector resolution:</b>	0.2 $\mu\text{atm}$
<b>Gas detector uncertainty:</b>	0.3 $\mu\text{atm}$ for equilibrator measurements, 0.2 $\mu\text{atm}$ for atmospheric measurements
<b>Standardization technique:</b>	The system runs a full cycle in approximately 10 hours. The cycle starts with 4 standard gases, then measures three rounds of 6 atmospheric samples followed by 60 surface water samples. Each new gas is flushed through the Licor Analyzer for 3 minutes prior to a stop-flow measurement.
<b>Standardization frequency:</b>	Every 10 hours
<b>Standard gas manufacturer:</b>	Standard gases are supplied by NOAA's Earth System Research Laboratory, Global Monitoring Division, in Boulder, CO, and are directly traceable to the WMO scale.
<b>Standard gas concentration:</b>	LL85884, 301.13 ppm; LL83547, 450.34 ppm; LL83516, 552.68 ppm; LL83514, 654.98 ppm
<b>Standard gas uncertainty:</b>	0.01 ppm
<b>Water vapor correction method:</b>	Details of the data reduction are described in Pierrot, et.al. (2009).
<b>Temperature correction method:</b>	Details of the data reduction are described in Pierrot, et.al. (2009).
<b>At what temperature was pCO<sub>2</sub> reported:</b>	In situ sea surface temperature
<b>Uncertainty:</b>	$\pm 0.01^{\circ}\text{C}$
<b>Quality flag convention:</b>	WOCE quality control flags are used: 2 = good value, 3 = questionable value, 4 = bad value
<b>Method reference:</b>	Pierrot, D.; Neill, C.; Sullivan, K.; Castle, R.; Wanninkhof, R.; Luger, H.; Johannessen, T.; Olsen, A.; Feely, R.A.; and Cosca, C.E. (2009). Recommendations for autonomous underway pCO <sub>2</sub> measuring systems and data-reduction routines. Deep-Sea Res., II, v. 56, pp. 512-522.
<b>Researcher name:</b>	Catherine E. Cosca
<b>Researcher institution:</b>	Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration

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### *Sea Surface Temperature*

<b>Abbreviation:</b>	SST(TSG)_C
<b>Unit</b>	Degree Celcius
<b>Observation type:</b>	Surface Underway
<b>In-situ / Manipulation /Response variable:</b>	In-situ observation

**Measured or calculated:** Measured

**Sampling instrument:** Seabird 3 remote probe, mounted in the sea chest approximately 5m below the sea surface, maintained by the NOAA Ship Bell Shimada.

**Uncertainty:** 0.0025°C

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### *Salinity*

**Abbreviation:** SAL(TSG)\_PERMIL

**Observation type:** Surface Underway

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

**Measured or calculated:** Measured

**Sampling instrument:** Seabird 21, mounted in the sea chest approximately 5m below the sea surface, maintained by the NOAA Ship Bell Shimada.

**Uncertainty:** 0.005 PSU

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#### **PUBLICATIONS DESCRIBING THIS DATA SET:**

Pierrot, D.; Neill, C.; Sullivan, K.; Castle, R.; Wanninkhof, R.; Luger, H.; Johannessen, T.; Olsen, A.; Feely, R.A.; and Cosca, C.E. (2009). Recommendations for autonomous underway pCO<sub>2</sub> measuring systems and data-reduction routines. *Deep-Sea Res., II*, v. 56, pp. 512-522.

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 pCO<sub>2</sub> measurements onboard research ships, *Analytica Chim. Acta*, 377, 185-191, 1998.

Wanninkhof and Thoning, Measurement of fugacity of Carbon Dioxide in surface water and air using continuous sampling methods, *Marine Chemistry*, 44, 189-205, 1993.

#### **ADDITIONAL INFORMATION:**

Project website: <http://www.pmel.noaa.gov/co2/story/North+American+West+Coast+uwpCO2>

#### **FUNDING AGENCY:**

NOAA's Ocean Acidification Program

*PROJECT TITLE:* West Coast Ocean Acidification Monitoring Network: Volunteer Observing Ships

*PROJECT ID:* OAPFY12.03.PMEL.002

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