

Raw absorbance and R measurements of CRMs

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Project

» [Improving Accuracy and Precision of Marine Inorganic Carbon Measurements](#) (Inorganic Carbon Measurements)

Contributors	Affiliation	Role
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Abstract

The temperature dependence of spectrophotometric pH measurements was determined and compared to values calculated from total alkalinity and dissolved inorganic carbon using different combinations of the required dissociation constants. Spectrophotometric measurements were made on two batches of CRMS (179 and 189) between -1.7 and 40 °C. This dataset contains the raw absorbance measurements.

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Dataset Description

Raw absorbance and R measurements of CRMs.

Acquisition Description

The temperature dependence of spectrophotometric pH measurements was determined and compared to values calculated from total alkalinity and dissolved inorganic carbon using different combinations of the required dissociation constants. Spectrophotometric measurements were made on two batches of CRMS (179 and 189) between -1.7 and 40 °C.

A custom designed spectrophotometric pH system was used similar to the system described in Carter et al. (2013). It consists of an Agilent 8454 UV-Vis spectrophotometer with a Kloehn v6 syringe pump to rinse, fill, and add the indicator dye to a 10 cm quartz microvolume spectrophotometer cell. A batch of ~2 millimolar Purified meta-cresol purple indicator dye (provided by Robert H. Byrne, University of South Florida) prepared in ~0.7 molar NaCl was used. The pH on the total scale was calculated using the equations of Liu et al. (2011). The dye perturbation was accounted for by making 20 measurements at each temperature with varying amounts of dye and extrapolating to zero dye added. Both the final pH values and the raw absorbances are available from BCO-DMO. Further details of the methods can be found in Woosley (2020).

Related Publications

Carter, B. R., Radich, J. A., Doyle, H. L., & Dickson, A. G. (2013). An automated system for spectrophotometric seawater pH measurements. *Limnology and Oceanography: Methods*, 11(1), 16–27. doi:[10.4319/lom.2013.11.16](https://doi.org/10.4319/lom.2013.11.16)

Methods

Liu, X., Patsavas, M. C., & Byrne, R. H. (2011). Purification and Characterization of meta-Cresol Purple for Spectrophotometric Seawater pH Measurements. *Environmental Science & Technology*, 45(11), 4862–4868. doi:[10.1021/es200665d](https://doi.org/10.1021/es200665d)

Methods

Woosley (submitted). Evaluation of the temperature dependence of dissociation constants for the marine carbon system using pH and Certified Reference Materials. *Mar. Chem.*

Results

Parameters

Parameter	Description	Units
Batch	CRM batch number	unitless
Bottle	CRM bottle number	unitless
Calculation_Temp	Temperature for calculating pH	degrees Celsius
Measured_Temp	Temperature of sample	degrees Celsius
A434	Absorbance at 434 nm	AU
A578	Absorbance at 578 nm	AU
A730	Absorbance at 730 nm	AU
Aiso	Absorbance at isosbestic point	AU
R	Absorbance ratio	unitless

Instruments

Dataset-specific Instrument Name	Agilent 8454 UV-Vis Spectrophotometer
Generic Instrument Name	Spectrophotometer
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

Project Information

Improving Accuracy and Precision of Marine Inorganic Carbon Measurements (Inorganic Carbon Measurements)

Coverage: Lab studies

NSF Award Abstract: The oceans absorb about one third of the CO₂ humans release into the atmosphere from the burning of fossil fuels and other activities. While ocean uptake of CO₂ slows its rate of increase in the atmosphere, it comes with costs for the oceans and the organisms that live there. Once in seawater, CO₂ reacts with water to produce bicarbonate and hydrogen ions. The increase in hydrogen ions lowers the pH in a process called ocean acidification. Not all areas of the ocean are affected equally. The solubility of CO₂ is greater in the cold waters of the Arctic making them more prone to ocean acidification. However, due to the low temperatures and low salinities in the Arctic, the uncertainties in pH values are much larger there than for the other oceans. This project evaluates pH at low temperatures and salinities, and develops best practice recommendations to improve the ability to compare measurements among laboratory groups and studies and reduce overall uncertainty in the measurements. The project provides training for an undergraduate student and promotes awareness of ocean acidification through public outreach. Having highly accurate and precise measurements are important for monitoring changes to pH and CO₂ uptake through time and the effects on marine life. In order to improve pH measurements for polar waters, several different experiments will be conducted. The temperature dependence of pH will be determined from 30°C to near freezing for low salinity waters. The results will be compared to current chemical models to quantify offsets and biases. Recommendations will be made for the best physical chemical model to use for low temperature and salinity seawater. Moreover, pH is measured spectrophotometrically using an indicator dye. Preparation and calibration of the indicator is important to standardize studies across space and time and ensure comparability. Indicator quality is essential for detecting ocean acidification, but its stability is currently unknown. If the dye degrades after production, biases or artifacts in pH measurements may result as the dye ages. Experiments will be undertaken using batches of dyes from weeks to over 10 years old to resolve its degradation characteristics. The experiments will establish how long a batch of dye remains valid once it is prepared without biasing the measurements. This is particularly important for long term studies such as extended research expeditions and autonomous systems where a batch of dye may be used over a year. Together, by both investigating the validity of chemical models for seawater pH at low temperature and salinity and examining the stability of the pH indicator dye, methodological uncertainties can be reduced to permit better monitoring of changes in global ocean pH. This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1923312