A High-Resolution View of Carbon System Parameters in the Canada Basin, Arctic Ocean

Robbins, L.L.[1], Yates, K.K.[1], Byrne, R.[2], Liu, Xuewu[2], Dufore, C.[1], Patsavas, M.[2], Hansen, M.[1]

[1]U.S. Geological Survey, 600 4th Street South, St. Petersburg, FL 33701 USA
[2]University of South Florida, College of Marine Science, 140 7th Avenue South, St. Petersburg, FL 33701 USA

Background

The Arctic Ocean covers an area of 14 x 10^6 km^2 and has a fairly constant temperature of 0ºC. Its cold waters absorb carbon dioxide more rapidly than warmer seawater; and increasing temperature (~Δ16ºC over the past 150 yrs) has increased melting of Arctic ice. Over the last three decades, retreat of summertime sea ice cover has exposed shelf waters to the atmosphere, allowing additional absorption of atmospheric CO_2. In August FY2010, high-resolution data sets of seawater chemistry were collected during a 5-week U.S. - Canadian Extended Continental Shelf Arctic Mission (Law of the Sea) Cruise on the USCGC Healy in the Canada Basin (Fig 1). This unique baseline dataset allows us to test a number of critical hypotheses associated with ocean acidification (Fig 2).

Healy Trackline - August/September 2010

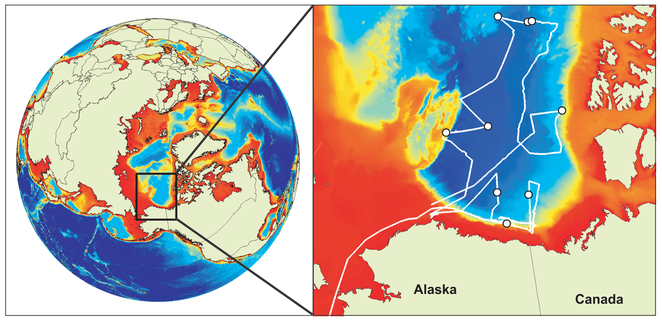


Figure 1: August-September 2010 Healy Cruise Trackline with CTD/Niskin Sample Locations in the Canada Basin.

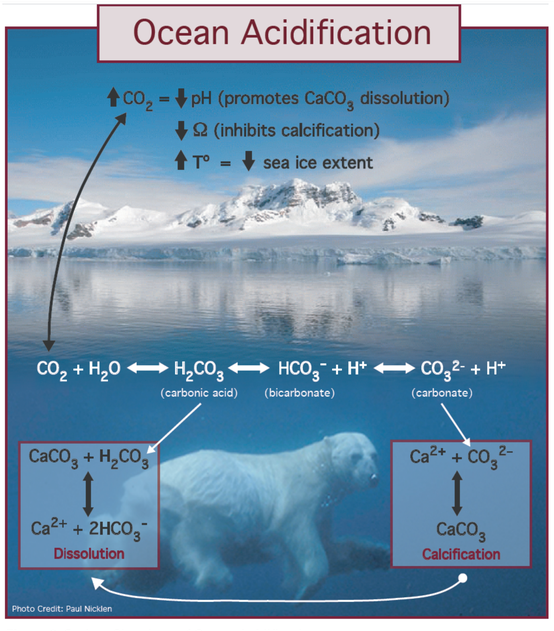
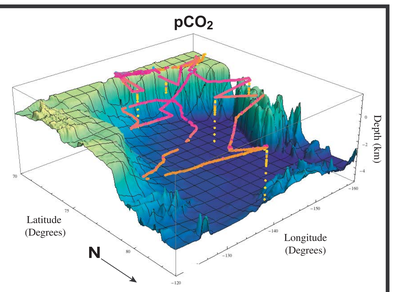
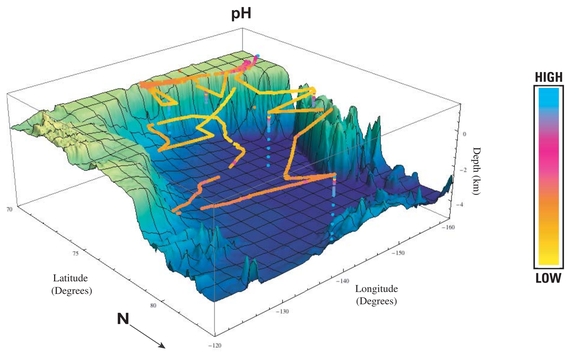


Figure 2: Carbon Chemistry of Ocean Acidification

Results

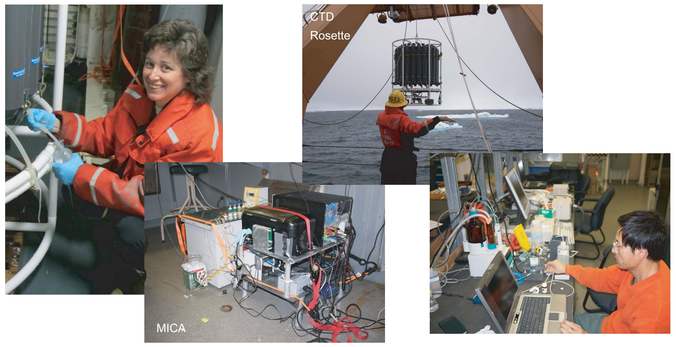
3-D views of pCO_2 fluxes and pH in the Canada Basin are shown here and on the iPad (movie). Data show strong CO_2 draw-down in parts of the northern and southern basin and emission mid-basin. Higher pH areas are associated with >80% ice cover.





Methods

The USGS, in collaboration with researchers at the University of South Florida, used a seawater flow-through Multiparameter Inorganic Carbon Analyzer (MICA) and Niskin casts along the Aug. 2010 Healy cruise trackline (Fig.1). The MICA allowed continuous measurement of over 25,000 samples of pH, total carbon (TCO_2), and pCO_2 (seawater and air). Approx. 300 discrete water samples, taken along the trackline and at 8 CTD stations, were also measured on board and in our St. Petersburg laboratories for pH, alkalinity, CO_3^{-2} and TCO_2 , allowing validation of MICA data. Temperature, salinity, dissolved oxygen, and chlorophyll data were continuously measured. Water samples were taken for nutrient, isotope, and metal analyses in order to supplement our understanding of the Arctic carbonate system (data not shown).



High-Resolution Maps

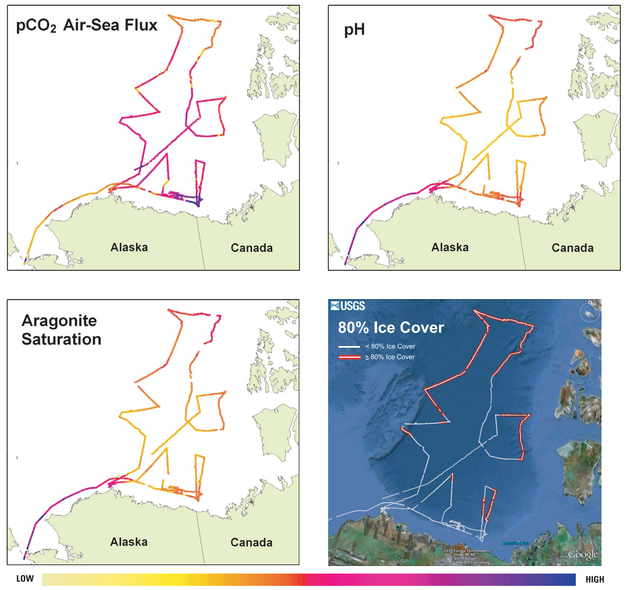
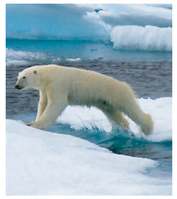


Figure 3: High Resolution Maps of Ocean Acidification Data Collected on the 2010 Healy Cruise

Future Research



The Arctic datasets allow a number of critical questions associated with ocean acidification to be addressed, including:

- How do pCO_2 fluxes compare within the Canada Basin?
- What is the saturation state for different parts of the Basin?
- How does saturation state compare to other regions? And if temperature is not a factor, how is the saturation state of the Arctic Ocean responding to increasing atmospheric CO_2?
- How do the carbon parameters relate to physical and biological properties of sea water, such as temperature, ice cover, and biological activity?
- What is the buffering capacity of sea water (Revelle Factor)?
- What kind of variability does the carbon system demonstrate in the Arctic (near shore vs. offshore)?

A number of these questions are unresolved. Future cruises will allow us to address yearly changes and start tracking any chemical/carbon changes in the Arctic Ocean.

Acknowledgements

We gratefully acknowledge the following persons for their assistance before, during, and after the cruise: Debbie Hutchinson, Jon Childs, Brian Edwards, Bill Schmoker, Caroline Singler, and the Captain and crew of the USCGC Healy.