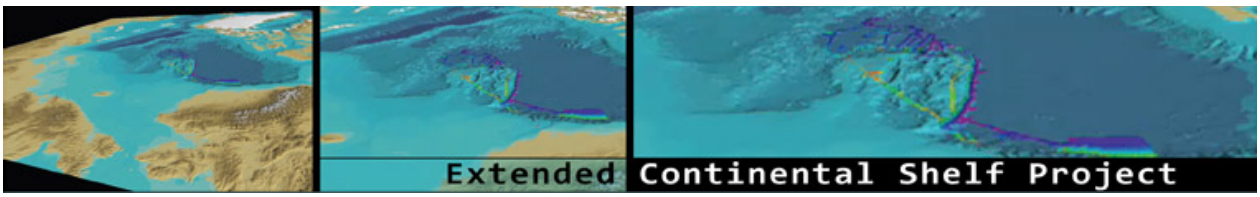
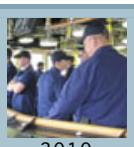


Arctic Seafloor Mapping Project Web Site - arcticseafloormapping.gov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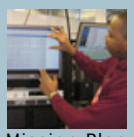
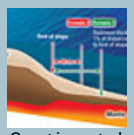

Mission Plan


Law of the Sea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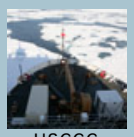
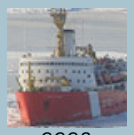

USCGC *Healy*


CCGS *Louis S. St-Laurent*


Healy's Science Team


Teachers

Deep CTD Cast, Part 3
What Do We Do with All This Water?
Ocean Acidification in the Arctic

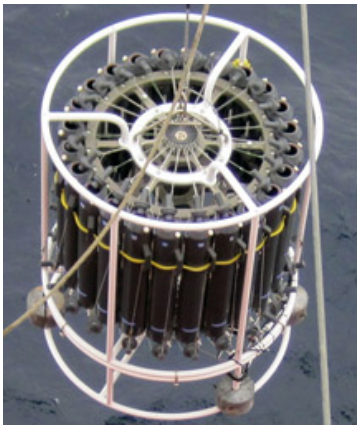
August 25, 2010

By Helen Gibbons, Web Coordinator, ECS Project

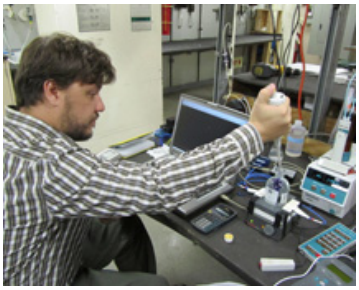
Date: August 25, 2010
Time: 1500 hours Pacific Daylight Time
Latitude: 81°49.16'N
Longitude: 135°20.50'W
Air temperature: 1.1°C (34°F)
Sea temperature: -1.7°C (29°F)
Wind speed and direction: 16 knots from the south-southwest
Ship's speed over the ground: 6.3 knots
Water depth: 3,703 m

On August 21, we lowered a rosette of water-sampling bottles to 3,750-m water depth, nearly to the floor of Canada Basin in the Beaufort Sea. When we winched it back up, it contained 288 liters (about 75 gallons) of seawater, more than enough to keep the ocean acidification team aboard *Healy* busy for several hours.

USGS scientist Chris DuFore, University of South Florida (USF) research associate Xuewu (Sherwood) Liu, and USF graduate student Mark Patsavas are collecting and analyzing water samples throughout the cruise to study the carbon dioxide (CO_2) system in the Arctic Ocean, with a particular emphasis on ocean acidification.

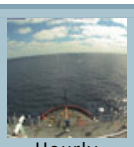


The rosette we use for deep casts carries 24 12-liter Niskin bottles. The bottles have caps at both ends and are sent down open. As the rosette ascends, an operator sends signals down the winch wire (an armored electrical cable) to close the bottles at selected depths, thus collecting water samples from throughout the water column. The rosette also carries a CTD, a dissolved oxygen sensor, a fluorometer, and an altimeter. Oceanographers use the term "CTD" to describe an instrument that measures conductivity (used to calculate salinity), temperature, and depth, thus CTD. (Photo from CTD cast on August 9, 2010.) Click image for larger view. Credit: Helen Gibbons, USGS/ECS Project.

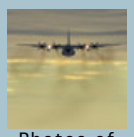


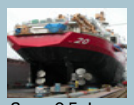
USGS geochemist Chris DuFore measures the alkalinity of a seawater sample. Click image

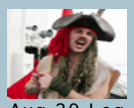
The concentration of CO_2 in the atmosphere has been steadily increasing, primarily due to the combustion of fossil fuels. Simultaneously, the waters of the oceans are removing some of this excess CO_2 through natural geochemical processes. As a result, the chemistry of the ocean is changing, causing a decrease in the pH of surface waters. This "ocean


Hourly Photos from *Healy's* Aloft Conn


USCG Logs


Photos of the Day

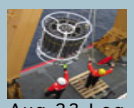

Sep 05 Log


Aug 29 Log


Aug 28 Log


Aug 25 Log


Aug 24 Log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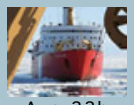

Aug 22b Log

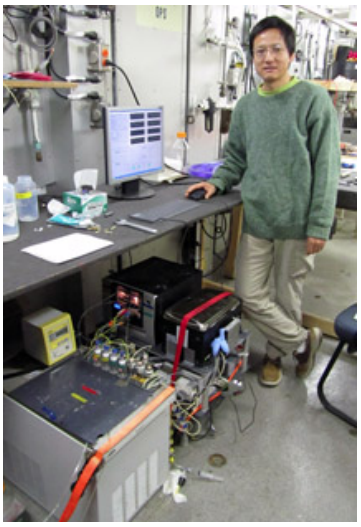
for larger view. **Credit:** Helen Gibbons, USGS/ECS Project.

acidification" reduces the availability of carbonate ions (CO_3^{2-}), which are important for building the shells and skeletons of calcifying marine organisms.

To study the CO_2 system in the Arctic Ocean, Chris, Sherwood, and Mark are collecting and analyzing seawater throughout the mission, both while *Healy* is underway and while on station. Their aim is to document the carbonate chemistry of the Arctic waters and, among other things, to determine the waters' saturation state with respect to calcium carbonate.

For underway measurements, they are using a specially designed instrument called a Multiparameter Inorganic Carbon Analyzer (MICA) developed at the University of South Florida, which continually measures partial pressure of CO_2 (pCO_2), pH, and total dissolved inorganic carbon in seawater. The MICA analyzes seawater from a flow-through system built into *Healy* that takes in seawater and circulates it through the lab before discharging it back into the ocean. Additional sensors built into *Healy's* flow-through system measure temperature, conductivity, dissolved oxygen concentration, blue-green algae cell count, and chlorophyll concentration. Additionally, a LICOR gas analyzer, located at the bow of the ship, is collecting air samples to measure pCO_2 in the atmosphere. This will allow researchers to compare CO_2 levels in the water and the air to determine the storage capacity of the Arctic Ocean for atmospheric CO_2.

Every 2 hours, the scientists collect discrete seawater samples from the flow-through system and use two bench-top spectrometers to measure pH and carbonate ion (CO_3^{2-}) concentrations while onboard, using methods developed in the USF laboratory of Dr. Robert Byrne. Each of these measurements provides important information to characterize the entire seawater carbon dioxide system. Knowing the CO_3^{2-} concentration of seawater provides immediate information relevant to the saturation state with respect to aragonite and calcite, the predominant minerals that compose the shells and skeletons of calcifying organisms.

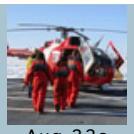


Sherwood Liu checks on the Multiparameter Inorganic Carbon Analyzer, or MICA (the assembly of boxes, tubes, and wires on the floor). The MICA continuously measures partial pressure of CO_2 (pCO_2), pH, and total dissolved inorganic carbon of the seawater sampled from the onboard flow-through system. Click image for larger view. **Credit:** Helen Gibbons, USGS/ECS Project.

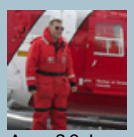
Mark Patsavas uses a benchtop spectrometer to measure carbonate ion (CO_3^{2-}) concentration in a seawater sample from *Healy's* flow-through system. Click image for larger view. **Credit:** Helen Gibbons, USGS/ECS Project.

Occasionally the ship stops to deploy the rosette, giving the geochemists the opportunity to collect seawater samples throughout the water column. Commonly it takes Chris, Sherwood, and Mark 3 to 4 hours to take subsamples from the Niskin bottles for a range of analyses. The subsampling went much faster on August 21, when they had the help of the two teachers aboard *Healy*, PolarTREC teacher Bill Schmoker and NOAA Teacher at Sea Caroline Singler. Here's a photo account of the subsampling process:

The data collected aboard *Healy* combined with the data from onshore analyses of samples shipped to St. Petersburg will provide comprehensive integrated information on the chemistry of Arctic waters. This study is the first of its kind to be conducted during the U.S.-Canada joint mapping missions.


Aug 22a Log


Aug 21 Log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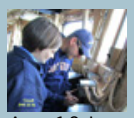
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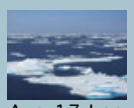
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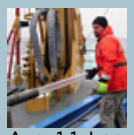
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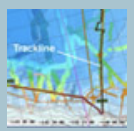
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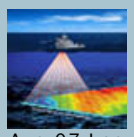
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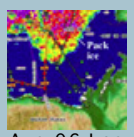
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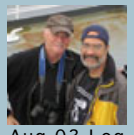
Aug 04 Log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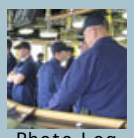
Photo Log

Several subsamples of water were collected from each Niskin bottle. First, Chris collected water for studies of isotopes (atoms of the same element but with a different number of neutrons, which gives them different atomic weights). These samples will be refrigerated and shipped to the USGS laboratory in St. Petersburg, Florida, for analysis. Click image for larger view. **Credit:** Helen Gibbons, USGS/ECS Project.

Sherwood collected subsamples of water for measurement of total dissolved inorganic carbon. These samples will be refrigerated and sent back to the USGS lab in St. Petersburg for analysis. Click image for larger view. **Credit:** Helen Gibbons, USGS/ECS Project.

Next, Mark collected two subsamples from each bottle. He will use the benchtop spectrometers onboard *Healy* to measure the pH of one sample and the CO_3^{2-} concentration of the other. Click image for larger view. **Credit:** Helen Gibbons, USGS/ECS Project.

NOAA Teacher at Sea Caroline Singler collected subsamples for measuring total alkalinity onboard *Healy*. Click image for larger view. **Credit:** Helen Gibbons, USGS/ECS Project.

PolarTREC teacher Bill Schmoker collected water from each of the Niskin bottles and transferred it to small bottles that will be frozen and shipped to the St. Petersburg lab. These samples will be analyzed for nutrients, such as nitrogen and phosphorus. Click image for larger view. **Credit:** Helen Gibbons, USGS/ECS Project.

Chris collected the last set of subsamples, which will be frozen and sent to St. Petersburg for analysis of total organic carbon. Click image for larger view. **Credit:** Helen Gibbons, USGS/ECS Project.

Happy water samplers (left to right): Chris, Bill, Mark, Caroline, and Sherwood. The geochemists were particularly pleased to have the teachers' help, which reduced subsampling time by a couple of hours. Click image for larger view. **Credit:** Helen Gibbons, USGS/ECS Project.