

CRUISE REPORT

USCGC Icebreaker *Healy* (WAGB-20)

**U.S. Law of the Sea cruise to map and sample the US Arctic
Ocean margin**

CRUISE HEALY 1202

August 25 to September 27, 2012

Barrow, AK to Dutch Harbor, AK

Larry A. Mayer

Center for Coastal and Ocean Mapping/Joint Hydrographic Center
University of New Hampshire
Durham, NH 03824

Andrew A. Armstrong

National Oceanic and Atmospheric Administration
Joint Hydrographic Center
University of New Hampshire
Durham, NH 03824



September 28, 2012

Table of Contents

Introduction and Background	3
HEALY 1202 Cruise Overview	19
Scientific Party	25
HLY1202 Technical Report.....	26
Chief Scientist Log	42
HEALY CTD Log.....	95
XCTD Log	100
XBT Log	101
APPENDIX A: Gravity Report.....	103
APPENDIX B: National Ice Center Report.....	106
APPENDIX C: Historical Ice Terminology Study	114
APPENDIX D: GeoCamera Report.....	117
APPENDIX E: Ocean Acidification Report	126
APPENDIX F: Marine Mammal Observations	140
APPENDIX G: Description of Data Formats	145
APPENDIX H: Multibeam Data Processing Pipeline	151

INTRODUCTION and BACKGROUND

HEALY 1202 is the ninth in a series of HEALY cruises dedicated to mapping and sampling regions of the Arctic north of Alaska that may qualify as "extended continental shelf" under Article 76 of the Convention on the Law of the Sea (UNCLOS). Five of these cruises (HEALY-0302, HEALY-0405, HEALY-0703, HEALY-0805, and HEALY-1202) were single-ship operations led by scientists from the University of New Hampshire that focused on the collection of multibeam echo-sounder bathymetric, and shallow, high-resolution chirp subbottom profiler data (and some sample collection). In 2008 there was a second HEALY cruise (HEALY-0806), led by scientists from the U.S. Geological Survey that worked together with the Canadian icebreaker *Louis S. St. Laurent (LSSL)* to collect multi-channel seismic and multibeam echo-sounder data in the ice-covered regions. The success of the 2008 two ship operation led to a second two-ship operation, HEALY-0905, in 2009, a third in 2010 (HEALY-1002) and a fourth, HEALY-1102, in 2011.

Under Article 76 of UNCLOS, coastal states may, under certain circumstances gain sovereign rights over the resources of the seafloor and subsurface of "submerged extensions of their continental margin" beyond the recognized 200 nautical mile limit of their Exclusive Economic Zone. The United States has not yet acceded to the UNCLOS. However, increasing recognition that implementation of Article 76 could confer sovereign rights to large and potentially resource-rich areas of the seabed and subsurface beyond its current 200 nautical mile (nmi) limit has renewed interest in the potential for accession to the treaty and in the collection of the data necessary to establish sovereign rights to the resources of the seafloor and the subsurface beyond 200 nm (referred to as the 'extended continental shelf' or ECS).

The Convention on the Law of the Sea defines the conditions under which a coastal state may extend its continental shelf over regions beyond the 200 nmi EEZ (UN, 1982). These conditions involve the definition of a juridical or legal "continental shelf" that differs significantly from standard morphological descriptions of continental margins. A key element of this definition is the demonstration that the extended area is a "natural prolongation" of the nation's landmass. There are no explicit guidelines for demonstration of "natural prolongation" of a state's land territory. The determination must be based on a general knowledge and interpretation of the bathymetry, geology, and nature of the seafloor in a region.

Once a natural prolongation is demonstrated, a coastal state may extend their "continental shelf" beyond the 200 nmi limit based on either of two formulae. The distance formula allows an extension of the shelf to a line that is 60 nmi beyond the "foot of the continental slope" (defined to be the point of maximum change in gradient at its base). This line is known as the Hedberg Line. The sediment thickness formula allows the extension of the shelf to a point where the sediment thickness is 1 percent of the distance back to the foot of the slope. This line is known as the Gardiner Line. Whichever formula line is most advantageous to the coastal state may be used and they can be combined for the most advantageous extension. There are limits to the extension (limit lines) – the ECS

HLY1202 Cruise Report

shall not extend beyond 100 nmi from the 2500 m isobath or not beyond 350 nmi from the territorial baseline (the officially defined shoreline). Again these limit lines can be mixed in whatever way is most advantageous to the coastal state. Thus the definition of the extended continental shelf under UNCLOS Article 76 is based on a combination of bathymetric data (defining the 2500 m contour and the foot of the slope) and geophysical data (defining the thickness of sediment). When a nation accedes to the Law of the Sea Treaty, it has ten years to submit all data and evidence supporting its submission to the Commission on the Limits of the Continental Shelf (CLCS) who evaluate the veracity of the submission and offer recommendations on it.

The largest potential for an extended continental shelf beyond the current 200 nmi limit of the U.S. EEZ is found in the area of the Chukchi Borderland, a tightly clustered group of generally high-standing, N-S-trending bathymetric elevations that form a natural prolongation from the Chukchi Shelf north of Alaska.

The Chukchi Borderland juts out between eastern Siberia and western Alaska into the deep Amerasia Basin north of the Chukchi Sea. The borderland occupies a rectangular area about 600 by 700 km, or some 4 percent of the Arctic Ocean. This area encompasses three, approximately north-south-trending segmented topographic highs: the Northwind Ridge, the Chukchi Cap and Rise, and the western (Arlis, Sargo, and T3) plateaus (which are located beyond -- westward of -- an agreed maritime boundary line with Russia). The plateau-like crests of the Chukchi Borderland rise, in some cases, as much as 3,400 m above their surroundings and they are relatively shallow (depths between 246 and 1,000 m). The ridges have steep flanks, which in some places exhibit remarkable linearity over hundreds of kilometers, especially along the east side of the Northwind Ridge. Between these ridges lie the Northwind, Chukchi, and Mendeleev “abyssal plains”. These lie at depths between 2,100 and 3,850 m

In 2003, Congress (through NOAA) funded the University of New Hampshire’s Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC) to explore the feasibility of using a multibeam sonar-equipped ice breaker to collect the data needed to make a submission for an extended continental shelf in ice-covered regions of the Arctic. This was in recognition of the fact that a submission for an ECS under Article 76 must be substantiated by high-quality bathymetric and geophysical data, and that the existing bathymetric database in the Arctic was, in many areas, inadequate for these purposes. The test proved successful and since 2003 scientists from the UNH CCOM/JHC have used the USCGC *Healy* (WAGB-20), originally equipped with a SeaBeam 2112 (12 kHz, 121 beam) swath mapping system and now equipped with a Kongsberg EM122 (12 kHz, 288 beam) multibeam echosounder, to map the bathymetry of the Arctic in support of ECS studies. The *HEALY* also operates a Knudsen 320B shallow penetration chirp subbottom profiler adding additional pertinent information.

The multibeam echo-sounder and chirp subbottom data provided by the *Healy* systems provides the morphological data required to establish the “foot of the slope” (needed for the determination of the the Hedberg Line, the Gardiner Line and the 2500 m contour). The seismic system on the Louis S. St. Laurent during past cruises have provided

HLY1202 Cruise Report

sediment thickness information required for establishing the Gardiner Line (once the foot of the slope is determined).

Previous Cruises: (Detailed cruise reports from each of these cruises can be found at <http://www.ccom.unh.edu> or USGS websites).

HEALY 0302 Overview:

A 10 day, 3000 km long exploratory mission (HEALY-0302, September 1-11, 2003) from Barrow, Alaska, to the Chukchi Borderland demonstrated the viability of using the multibeam echo-sounder in ice-covered waters to follow specific bathymetric targets. The 2003 cruise began at the US-Russian boundary line at 78°-30'N 168°-25'W and followed the 2500 m contour around to 78°-35'N 159°-07'W (Figure 1-1). The cruise collected ~3000 km of high-resolution multibeam echo-sounder data and made several significant discoveries that include:

- substantially changing the mapped position and complexity of the 2500-m isobath (a critical component of a Law of the Sea submission for an ECS),
- found further evidence for pervasive ice and current erosion in deep water (flutes and scours),
- finding evidence for gas-related features (pock-marks), and
- discovering a previously unmapped seamount that rises more than 3000 m above the surrounding seafloor. This NE-SW trending feature, some 18 km wide and 40 km long with a slightly concave and northward tilted crest, has been officially named Healy Seamount.

The full cruise report for HEALY-0302 can be found at www.ccom.unh.edu

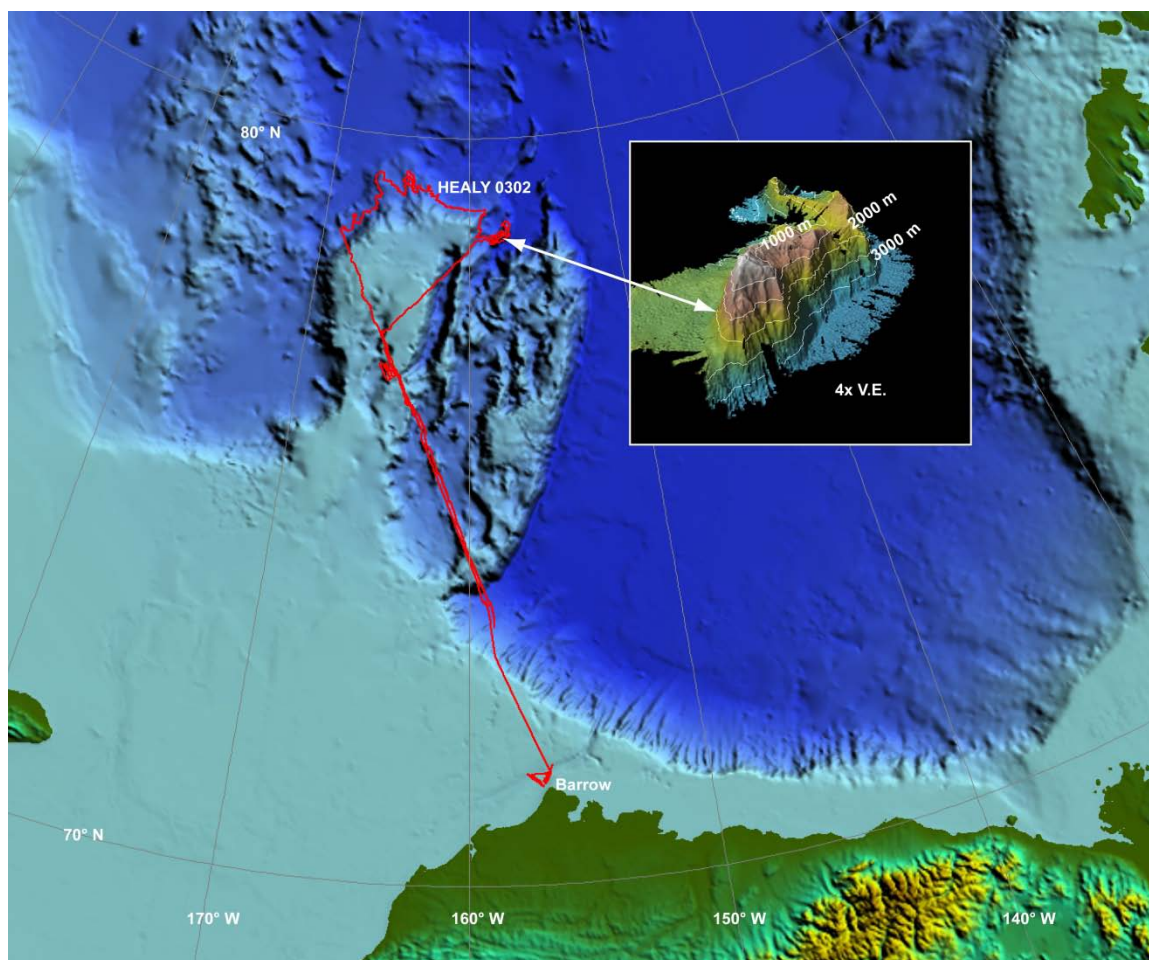


Figure 1-1. Track of HEALY-0302 September 2003.

HEALY-0405 Overview:

In 2004 a second, 20-day cruise, HEALY-0405 was conducted from October 6 to October 26, 2004, originating in Nome and ending in Barrow, Alaska. The cruise covered approximately 6700 km in 20 days and completed most of the mapping of the 2500-m isobath (begun on HEALY-0302) as well as a detailed survey of the “foot of the slope” over a segment of the continental margin east of Barrow, AK. The total area surveyed during HE-0405 was approximately 20,000 sq. km (5830 sq. nmi). The cruise transited northward from Nome over the Northwind Ridge until it intersected the 2500-m isobath at approximately 77° 10'N, 154° W, the point where the 350 nmi cutoff limit from the coast of northern Alaska intersects the 2500-m isobath on the eastern flank of the Northwind Ridge. Ice was first encountered ice at about 76° and by 77°N the ice was very heavy (9/10 to 10/10) with many ridges and very few leads. Progress was slow and we often had to backup and ram but, nonetheless, we managed to continue mapping the 2500-m isobath up the Northwind Ridge until approximately 78° 45'N. During this time, we covered approximately 100 nmi in 4 days. Data was difficult to collect in these conditions but we were able to continuously map the 2500-m isobath to its furthest north

HLY1202 Cruise Report

point. About 5000 sq. km (1458 sq. nmi) of seafloor was mapped during the transect to the north and back.

At 78° 45'N, the *HEALY* had great difficulty breaking through the ridges (one ridge took more than 8 hours to break through) and the decision was made to move south to the relatively ice-free waters of the continental slope east of Barrow. This area was chosen so that we could define the foot of the slope in the central portion of the northern Alaskan margin. The foot of the slope can be used in this region as a starting point for determination of the “Gardiner Line” – one of the formula lines used for making an ECS submission under UNCLOS Article 76. The survey of the foot of the slope area began on October 18 and continued until October 24. During this time, complete overlapping multibeam-sonar data was collected over a region of approximately 15,435 sq. km (4500 sq. nmi), that ranges in water depth from 800 m to 3800 m. The survey not only delineated the foot of the slope, but it also revealed a complex margin with drift deposits, suggesting contour currents, that are cut by numerous canyons. The full cruise report for HEALY-0405 can be found at www.ccom.unh.edu

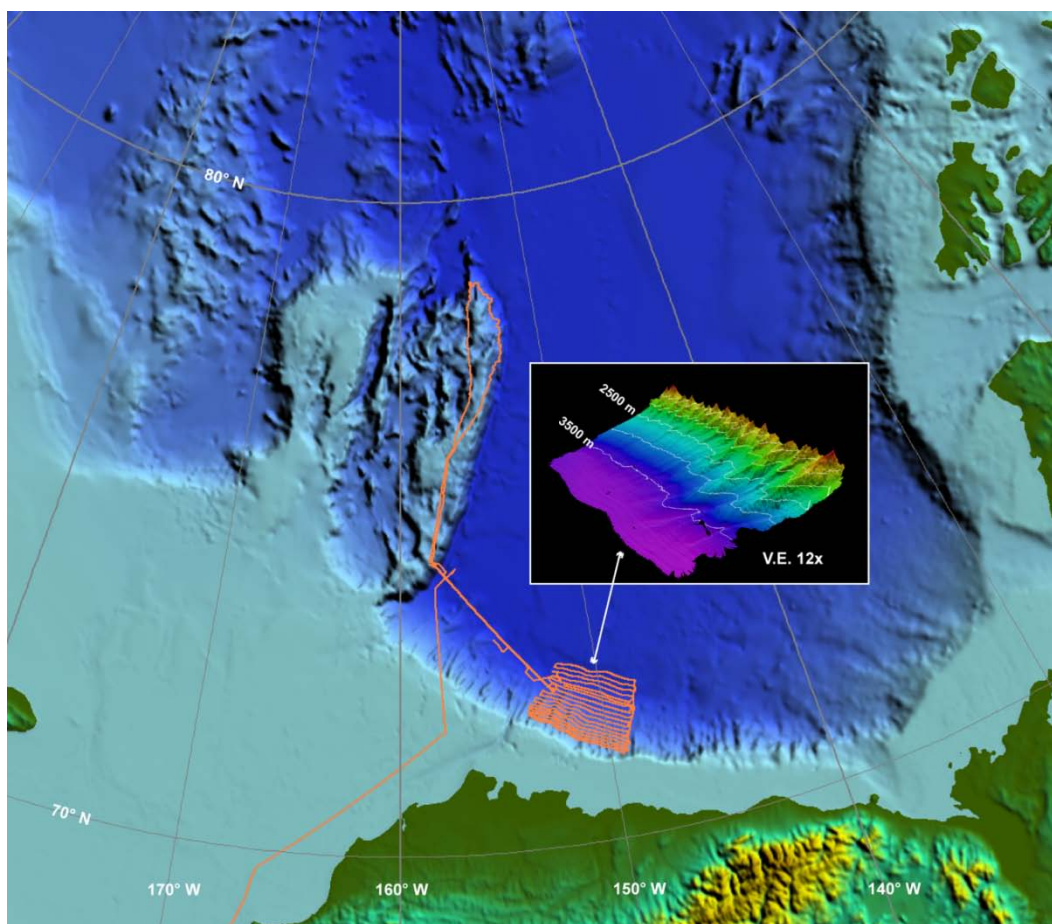


Figure 1-2. Cruise track for HEALY-0405

HEALY-0703 Overview:

HEALY-0703 was conducted from August 17 to September 15, 2007, with both embarkation and disembarkation via helicopter transfer from Barrow, Alaska. The cruise track covered approximately 10,000 km (5400 nm) in 30 days (Figure 1-3). The primary objectives of the cruise were: 1- to complete the mapping of the 2500 m isobath that began on HEALY 0302 and HEALY 0405; 2- to begin to define the “Foot of the Slope” around the northern and eastern edges of Chukchi Cap; and; 3- to further map an area of pockmarks originally discovered on HEALY-0302. Secondary objectives included the recovery and re-deployment of two High-Frequency Acoustic Recording Packages (HARP’s), autonomous recording packages designed to record ambient noise levels at the ice margin for periods up to one year, and: the deployment of up to four ice buoys and continuous ice-observation by representatives of the National Ice Center. All objectives were achieved, far beyond expectations.

Using a nominal swath width of approximately 7 km, the total area surveyed during HE-0703 was approximately 70,000 sq. km (20,400 sq nm). The cruise departed Barrow at approximately 1800L on 17 September and steamed northward approximately 50 miles and successfully recovered the first of two HARP buoys. The second was recovered 25 miles further to the northwest. Details of this recovery as well as a description of the purpose and capabilities of the buoys can be found in the HARP Buoy Report later in the cruise report. We next conducted a patch test and a deep CTD cast at the steep southeastern edge of the Chukchi Cap. We first encountered ice at approximately 76N. It was large pieces of thick, multi-year ice but, broken up enough to allow relatively easy passage at 3- 6 knots (though we did have to back and ram occasionally). We continued northwest to the intersection of the 2500 m isobath and the U.S./Russian maritime boundary line where we then began an exploratory, zig-zag pattern to better define the foot of the slope. No definitive foot of the slope was apparent until a long excursion to the north revealed a clear transition between the slope and flat-lying abyssal plain sediments at approximately 81 15N. We made several more north – south transits and consistently found this same slope/plain transition occurring on the northern end of the cap above 81N. We continued to run a zig-zag pattern in the north-east quadrant of the cap and also found and developed several prominent topographic highs, one which shoaled above 2500 m and may allow the re-definition of the 2500 m isobath.

A well-developed foot of the slope was traced down and then back up the eastern side of Northwind Ridge, revealing a very sharp and clear slope/abyssal plain transition with the abyssal plain sediments consistently occurring at a depth of approximately 3820 m. Following this transition to the north allowed us to define a continuous foot of the slope around the northern most extreme of Chukchi Cap to the northern most point of our survey (82 17N); at this point, the slope/plain transition appears to continue to the north and east. Returning south, we mapped a seamount that rose from abyssal plain depths (3820m) to less than 2200 m at approximately 80 47N and 171 50W and then proceeded to transit southwest to carry out a detailed survey of a region in which pockmarks were discovered on a previous leg. We left the ice at about 77N but ran into occasional large packs of flows until about 75 N.

HLY1202 Cruise Report

Throughout this period (17 Aug to approximately 5 September) ice conditions were variable but for the most part very light considering the latitudes we were at allowing survey speeds to average about 6 knots. Ice flows large enough to support deployment NIC ice buoys were difficult to find but three flows were found and three buoys deployed. A fourth buoy was deployed in open water at the far western extreme of our survey. Details of the ice buoy deployments and ice observations can be found in the NIC trip-report included in this document.

On HEALY-0302, several large and well-defined pockmarks (probably related to gas extrusion) were discovered in a shallow region of the Chukchi Cap at approximately 76 30N and 163 50W. NOAA's Office of Ocean Exploration asked us to further expand this survey and generate a better map of the distribution of these pockmarks. Our plan called for a survey of two areas, one where the pockmarks were already discovered and one slightly to the north and the east of the pockmark area where there is more of a depth transition and thus we might better understand the relationship of depth to pockmark formation. Our survey of the second (not previously surveyed) region revealed no pockmarks but did show a remarkable series of closely spaced, NW-SE oriented, parallel grooves in depths of approximately 400 to 500 m. Given the remarkably parallel nature of these features, they appear to be related to ice-sheet flow rather than individual icebergs scours. Even more intriguingly, south of these grooves, as the water depths get a bit deeper, there appear to be a series of large, dune-like features that appear erosional in origin in the high-resolution subbottom profiles. We speculate that these may be related to flow under an ice-shelf that is not grounded but with near the seafloor.

When we reached the pockmark area, just a few miles south of the scoured region, the winds and seas greatly increased (50 knot winds, 15 foot seas) creating less than optimal mapping conditions but the size and stability of the HEALY allowed us to continue. An approximately 40 km x 14 km area was mapped revealing numerous pockmarks of various sizes, but typically about 300-400 m in diameter and 30 – 50 m deep. Simultaneous collection of subbottom profiles revealed an apparent relationship to subsurface faulting but the nature of this relationship will need further study. Most remarkable was a circle of pockmarks (approximately 20 of them) forming a ring that is approximately 4 km in diameter.

Upon completion of the pockmark survey, the HEALY transited south to re-deploy the two HARP buoys that were recovered at the beginning of the leg. These buoys were successfully re-deployed approximately 90 and 75 miles off Barrow, to be recovered next year. The HEALY arrived off Barrow at 0700L on the 15th of Sept with transfer of the science party by helo commencing at approximately 0900L. The full cruise report for HEALY-0703 can be found at www.ccom.unh.edu

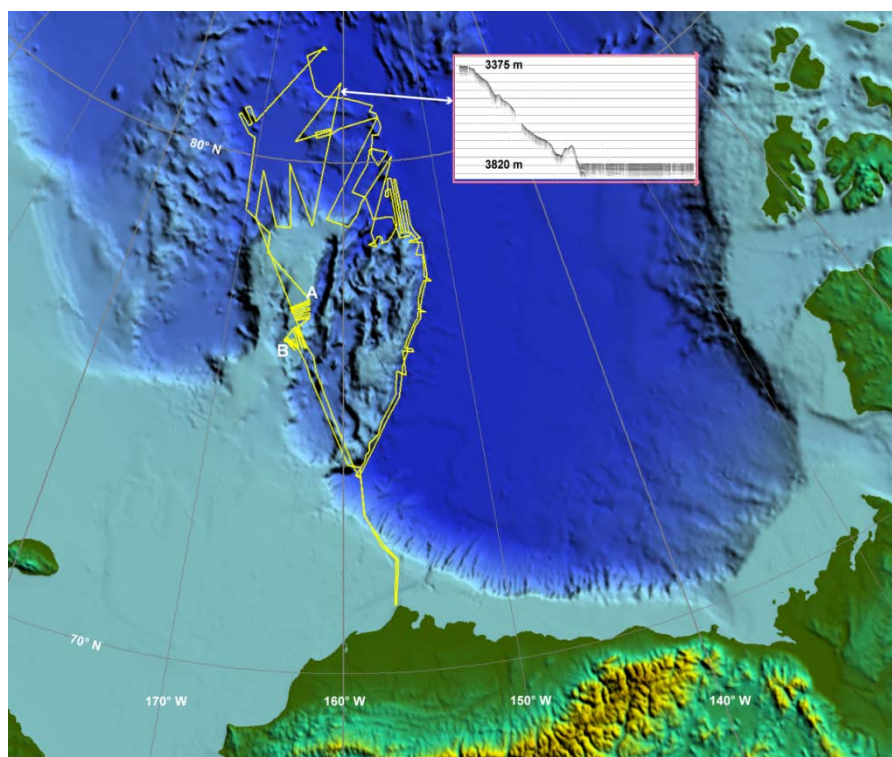


Figure 1-3. Ship-track for HEALY 0703

HEALY-0805 Overview:

HEALY 08-05 was the fourth in a series of cruises designed to map the seafloor on the northern Chukchi Cap in order to explore this poorly known region and better understand its morphology and its potential for an extended continental shelf under UNCLOS. The multibeam echo sounder on board the HEALY was the primary tool, supplemented by the Knudsen subbottom profiler and deep sea dredging operations. The primary targets for the mapping were the delineation of the 2500 m depth contour and the “foot” of the continental slope – the area where the continental margin transitions into the deep sea floor. In addition to its usefulness for Law of the Sea, the seafloor mapping data we collect is also valuable for better understanding seafloor processes, fisheries habitat, and as input into climate and circulation models that will help us predict future conditions in the Arctic. Three ancillary programs also took place during HEALY-0805: 1- the recovery of High-Frequency Acoustic Recording Packages (HARP’s) that are designed to make long-term measurements of ambient noise in the Arctic and that had been deployed on HEALY-0703; 2- the deployment of several different types of ice-monitoring buoys by personnel from the National Ice Center (NIC), and; 3- the daily observation by a specialist from the Fish and Wildlife Service of both bird and marine mammal sightings. Summary reports of each of these activities are presented at below.

HEALY 08-05 departed Barrow on 14 Sept and commenced operations with both mapping and the successful recovery of two HARP hydrophones that had been deployed

HLY1202 Cruise Report

on HEALY 07-03. From the HARP sites we steamed north to pick up mapping of the region thought to represent the base of the slope in the vicinity of 82° N and 162°W. Surveying continued east following the morphologic expression of the base of the slope until approximately 150°W where the character of the morphological expression of the base of the slope changed and we switched to a reconnaissance mode of surveying. This mode of survey continued until we reached the easternmost extent of our survey at approximately 139°W. From this point we traveled westward mapping several regions that we suspected shoaled above 2500 m (they did) and then began dredging operations (on 30 August). A total of 3114 linear nautical miles were surveyed (5767 km) on HLY08-05 covering an area of approximately 34,600 sq. km (assuming an average swath width of 6 km).

A total of seven dredges were taken on HEALY-0805, four on the southern portions of the Alpha/Mendeleev Ridge complex, two on ridges north of the Chukchi Borderland and one in the northwestern Northwind Ridge area. The first dredge site on the southern Alpha/Mendeleev Ridge complex yielded samples from what appeared to be an outcrop of layered sedimentary rock that appeared on shipboard examination to be non-marine in origin. The second dredge from the same vicinity contained over 200 pounds of mud and ice rafted debris. The third dredge, from another feature on the southern Alpha/Mendeleev Ridge Complex, also brought back only mud and IRD. The fourth dredge, from the same general vicinity as the third, was predominantly mud and IRD however there were interesting iron concretions and manganese crusts along with one sample of a possible altered ash deposit. The fifth dredge, from the northern extend of the Chukchi Borderland, recovered over 1000 pounds of mud with about 10 pounds of IRD of various rock types. The sixth dredge from a very steep (about 60 degree) slope on the northern Chukchi Borderland was mud free and contained over 200 pounds of what appear to be basalts. Finally, the seventh dredge from the western wall of Northwind Ridge had very little mud but over 700 pounds of rock that probably represented both outcrop and angular talus from the foot of the steep slope from which it was dredged. Samples from this dredge represented a range of rock types including sedimentary, metamorphic, and possibly basaltic. The full cruise report for HEALY-0805 can be found at www.ccom.unh.edu.

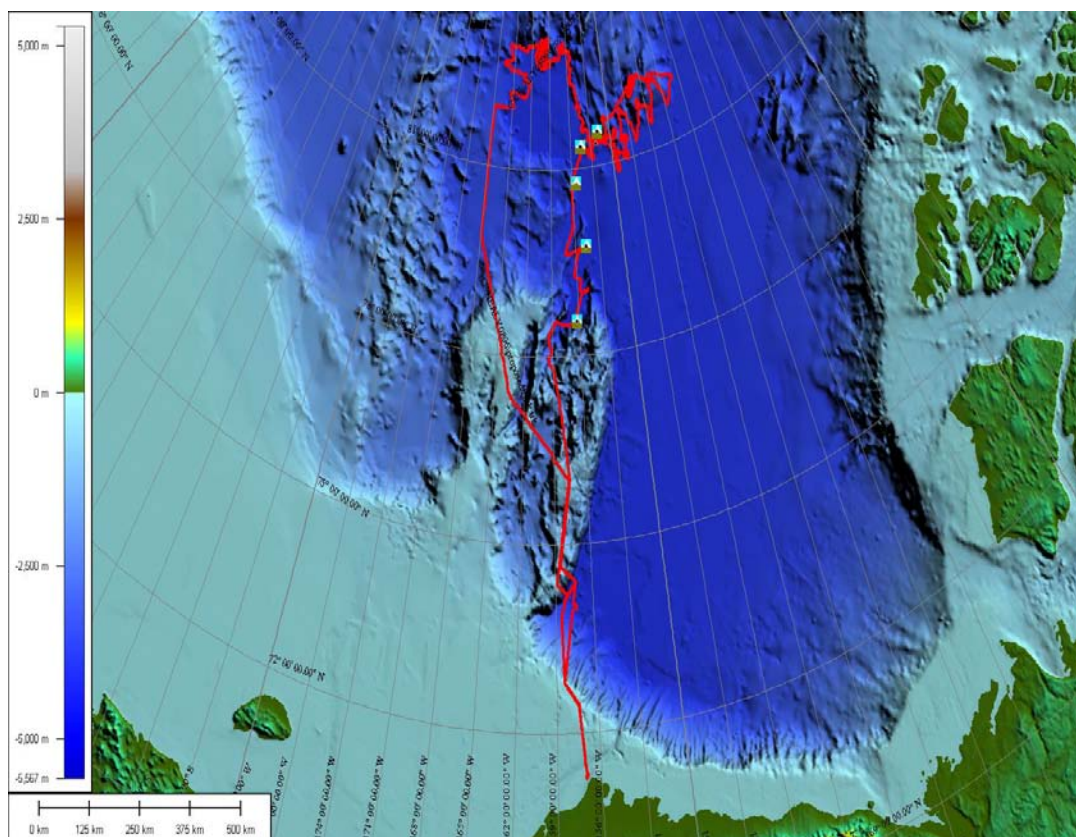


Figure 1-4. Healy 08-05 – Ship Track 14 Aug –5 Sept. 2008 – Dredge sites indicated by small blue icons. Dredges are numbered sequentially (1–7) from north to south, Dredge Sites 1 and 2 are at the same location and represented by a single icon; 3 and 4 are at the same location and represented by a single icon.

HEALY-0806:

HEALY-0806 was part of a two-ship operation led by scientists from the U.S. Geological Survey and the Geological Survey of Canada (operating a seismic system on the Canadian icebreaker Louis S. St. Laurent). For details of these operations please see: Childs et al, 2009.

HEALY-0905

With the success of the two-ship operation in 2008, a second joint Canadian/U.S. operation HEALY-0905 was conducted in 2009. The primary objective was to take advantage of the presence of two very capable icebreakers to collect seismic data in support of delineating the extended continental shelf for both Canada and the United States in regions where a single vessel would have difficulty due to ice-cover. A secondary objective of the joint program was to take advantage of the two vessels to collect high-resolution multibeam echo-sounder data in regions where it would be difficult to collect data with one vessel. In addition to the collection of seismic and bathymetric data, each vessel also carried out ancillary projects including meteorological,

oceanographic and ice studies; the *Healy* was also equipped to sample the seafloor with dredges.

The *Louis S. St. Laurent (LSSL)* and the *Healy* rendezvoused on 11 August and conducted a seismic source calibration experiment to document the source levels and source signatures of the *LSSL*'s airgun array. After concluding the seismic source calibrations (on 12 August), the *LSSL* deployed its hydrophone streamer, the *Healy* took the lead and the vessels stayed together in the ice until 7 September. By the 7th of September the ice had diminished to the point that the vessels were able to separate, the *LSSL* continuing to collect seismic data and the *Healy* collecting multibeam bathymetry and sampling the seafloor with dredges. Over the course of the expedition, the *LSSL* collected more than 4000 km of high-quality multichannel seismic reflection, refraction and gravity data (Figure 1-5) and the *Healy* collected 9585 km (5175 nmi) of multibeam bathymetry, sub-bottom profiler and gravity data (Figure 1-6). Assuming an average swath width of 6.9 km the total area mapped was 66, 135 sq. km (19,280 sq. nmi). The multibeam bathymetry collected during these transects revealed a remarkably flat abyssal plain with an average depth of around 3850m and changes in depth of less than 20 m over hundreds of kms. On several occasions the mapping priorities changed and the bathymetric surveys were conducted over targets of interest. Amongst these targets of interest were the mapping of the foot of the slope in an area on the southern side of the Alpha-Mendelev ridge complex (at approximately 81 30 N, 143 45W) and the examination of several topographic features that were implied on earlier bathymetric compilations. One such feature which appeared as a single 100 m contour (above the abyssal plain) on a Russian chart, turned out to be an 1100 m high, 26 km long, 7.5 km wide seamount.

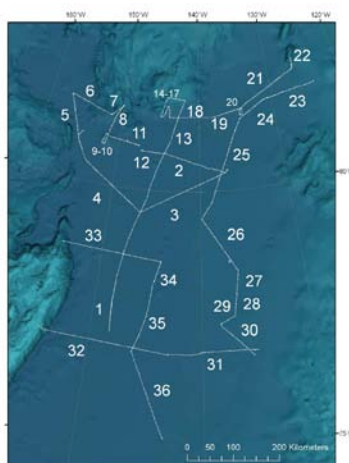


Figure 1-5. Seismic data collected by *LSSL* during joint HLY0905.

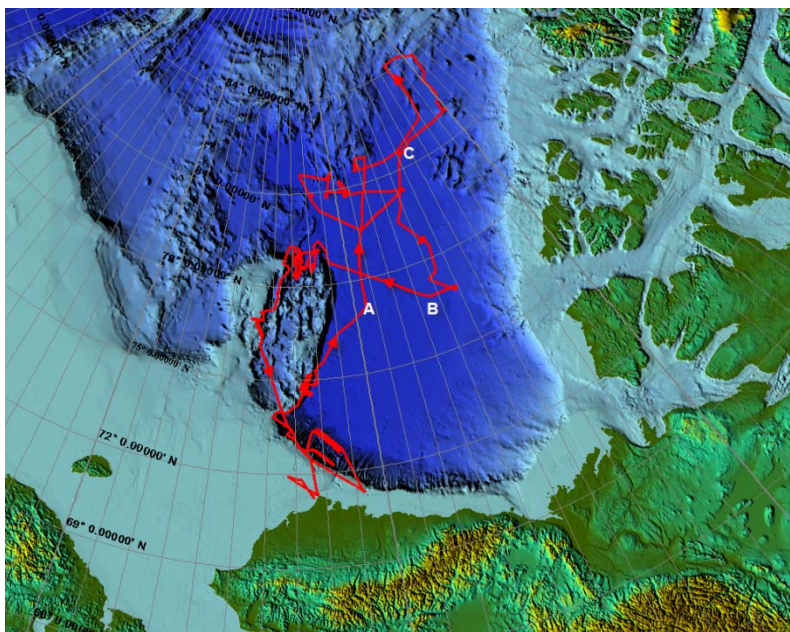


Figure 1-6. HLY-0905 track line. Point A is rendezvous point for LSSL and HEALY on 11 August. Point B is where the two vessels separated on 7 Sept. 2009. Point C is newly mapped seamount.

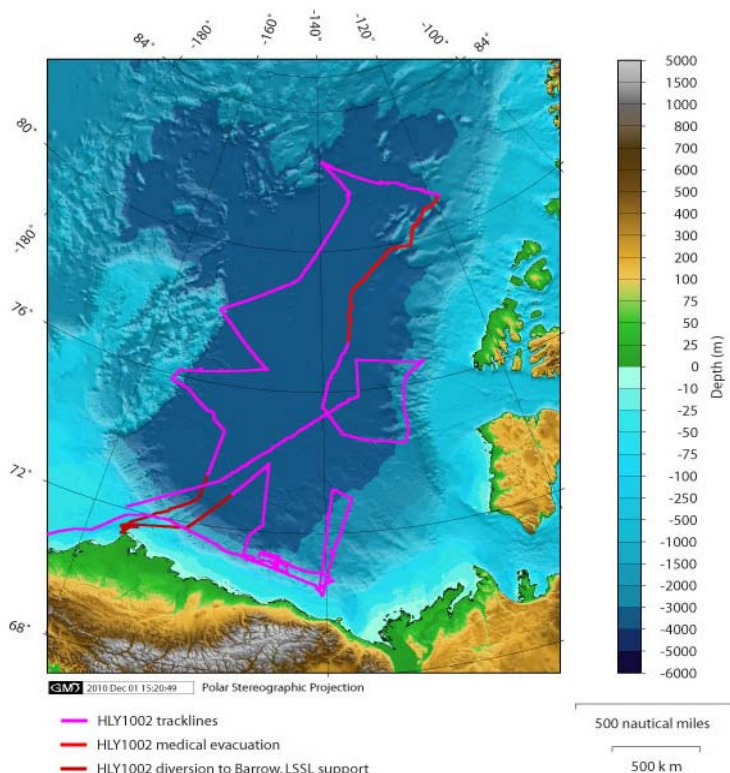
On 7 September, the ice conditions had evolved to the point where the *LSSL* could continue to collect seismic data without the *Healy* breaking ice in her lead. At this point the *Healy* left the *LSSL* and started to map independently. The *Healy* transited to the northern end of Chukchi Cap and proceeded to survey and occupy 5 dredge stations located on relatively steep slopes amenable to recovery *in situ* material with a dredge. More than 800 kg (1520 lbs) of rock material was recovered from these dredge sites with much ice rafted debris but also many samples that appear to be representative of the outcrop. The majority of the material recovered appeared to represent several types of basalts. There was also a large amount of manganese crust, and in the Chukchi region, numerous metamorphic rocks. These samples will be sent to the appropriate labs for full description and analyses.

Four ancillary programs also took place during HLY-0905: 1- the recovery of High-Frequency Acoustic Recording Packages (HARP's) that are designed to make long-term measurements of ambient noise in the Arctic and that had been deployed on HLY-0805; 2- ice observations and the deployment of several different types of ice-monitoring buoys by personnel from the National Ice Center (NIC); 3- the launch and recovery of a SeaEagle glider by representatives of the U.S. Navy supplemented by XBT measurements and meteorological observations, and; 4- the daily observation by a NOAA marine mammal observer of both bird and marine mammal sightings. The full cruise report for HEALY-0905 can be found at www.ccom.unh.edu; details of the *LSSL* leg can be found in Mosher et al. 2010.

HEALY-1002

HEALY-1002 was the third two-ship joint Canadian/U.S. operation, and the second led by scientists from the U.S. Geological Survey and the Geological Survey of Canada (operating a seismic system on the Canadian icebreaker *Louis S. St. Laurent*). For details of these operations please see:

Edwards et al, 2010



HEALY-1102

HEALY-1102 was the fourth in a series of two-ship, joint Canadian/U.S. ECS mapping programs involving the *Healy* and the Canadian icebreaker *Louis S. St. Laurent (LSSL)*. The primary objective was to take advantage of the presence of two very capable icebreakers to collect seismic data (from *LSSL*) in support of delineating the extended continental shelf for both Canada and the United States in regions where a single vessel would have difficulty due to ice. A secondary objective of the joint program was to take advantage of the two vessels to collect high-resolution multibeam echo-sounder data (from *Healy*) in regions where it would be difficult to collect data with one vessel. Each vessel also carried out ancillary projects including meteorological, oceanographic, wildlife and ice studies; the *LSSL* carried a large Autonomous Underwater Vehicle

(AUV) to test the feasibility of using AUV's deployed from icebreakers in ice-covered Arctic waters for seafloor mapping, and the *Healy* was equipped to sample the seafloor with dredges should the opportunity arise. Researchers on the *Healy* also hoped to explore the feasibility of using a small autonomous airplane (UAV) to map ice and wildlife around the vessel, but were denied permission by the USCG and thus the program was moved to the *LSSL*. This report focuses on the activities of the *Healy* with a summary of each of the ancillary programs presented in the Appendices; for details of the *LSSL* cruise, please see Mosher et al 2011.

While waiting to rendezvous with the *LSSL*, the *Healy* proceeded to a region approximately 200 nm WNW of Barrow to continue mapping the margin off the north slope of Alaska in order to delineate the foot of the slope. Survey work in this area was completed on 21 August when it was necessary to depart in order to meet the *LSSL* at the rendezvous point; a total of approximately 25,000 km² (7500 nm²) of multibeam sonar data collected in this area

Proceeding from the rendezvous point, the *Healy* took the lead and a remarkable, almost continuous, 750nm seismic line was collected across the top of Chukchi Cap, west of Nautilus Basin, over Alpha-Mendeleev Ridge, across Makarov Basin and partially up the Lomonosov Ridge. Multibeam sonar data was also collected continuously along the 750 nm line (Figure 1-8). Ice conditions on the Lomonosov Ridge were such that it was impossible to collect seismic data so at this point the *LSSL* and the *Healy* changed positions and the *LSSL* began to lead the *Healy* to optimize multibeam sonar data collection. During collection of multibeam sonar data on the Lomonosov Ridge, the *Healy* reached its furthest north point -- **88° 27.4626' N 159° 22.05' E**.

Moving south from the Lomonosov Ridge multibeam sonar surveying focused on mapping the foot of the slope in the area of Marvin Spur (Figure 1-8). Heavy multiyear ice made mapping difficult but with *LSSL* in lead, useful data were collected. On 3 September, the *LSSL* separated from the *Healy* to deploy an AUV equipped with multibeam and single beam sonars (see Mosher et al., 2011 for discussion of AUV operations) while the *Healy* continued collecting multibeam sonar data on its own until 6 September.

Upon completion of AUV operations, the vessels joined up together and proceeded with the *LSSL* in the lead, optimizing multibeam sonar data collection while mapping the foot of the slope around the eastern side of the Makarov Basin (Figure 1-8). Ice conditions were heavy with thick multiyear ice common and much backing and ramming required. Nonetheless the two-vessel combination allowed useable bathymetric and high-resolution subbottom data to be acquired. The survey of the foot of the slope around Makarov Basin was followed by a long transit to the southeast across Alpha/Mendeleev Ridge and into Stefansson Basin (Figure 1-8). The transit continued until the 12th of September when the vessels reached of Sever Spur, a prime target for Canadian ECS mapping. The *LSSL* deployed seismic gear at the approaches to Sever Spur and was able to collect seismic data for 18 hours before ice conditions required recovery of the seismic system. The vessels swapped positions again and proceeded to the east until approximately 80°

9°N, 119° 10'W when ice conditions prevented both vessels from progressing further east. At this point the survey was turned southwest to once again examine the transition from Sever Spur into the Stefansson Basin (Figure 1-8). At the western edge of this line the seismic gear was deployed again and seismic data collected for another 11 hours. At about 1800Z on the 16th of September the *LSSL* separated from the *Healy* to launch its AUV (see Mosher et al. 2011) while the *Healy* continued to map Sever Spur on its own. The vessels rejoined on 19 September and began a transit into Canada Basin hoping to again collect seismic data. During the deployment of the seismic gear the *LSSL* noted a strange noise coming from one of their shafts. Investigation by small ROV revealed that the main propeller had moved on the shaft and was loose. Operations ceased while the *LSSL* waited for guidance from Canadian Coast Guard Headquarters. The *LSSL* received word to proceed directly to the Northwest Passage and requested that the *Healy* accompany her for some of the way through the ice. This brought to a close the joint science operations of the program. Despite this slightly premature ending to the joint program, all of the objectives originally outlined were more than met.

On 21 September, the two vessels began a transit towards the entrance to the NW Passage, with the *Healy* in the lead to ease passage of the *LSSL* through the ice. The *Healy* continued to collect multibeam sonar data during the transit over the Canada Basin. The vessels stayed together until mid-day on the 22nd when ice conditions lessened to the point that the *LSSL* was comfortable transiting on her own. At this point the *Healy* and *LSSL* exchanged salutes and separated with the *LSSL* heading for the NW Passage and the *Healy* heading towards Dutch Harbor.

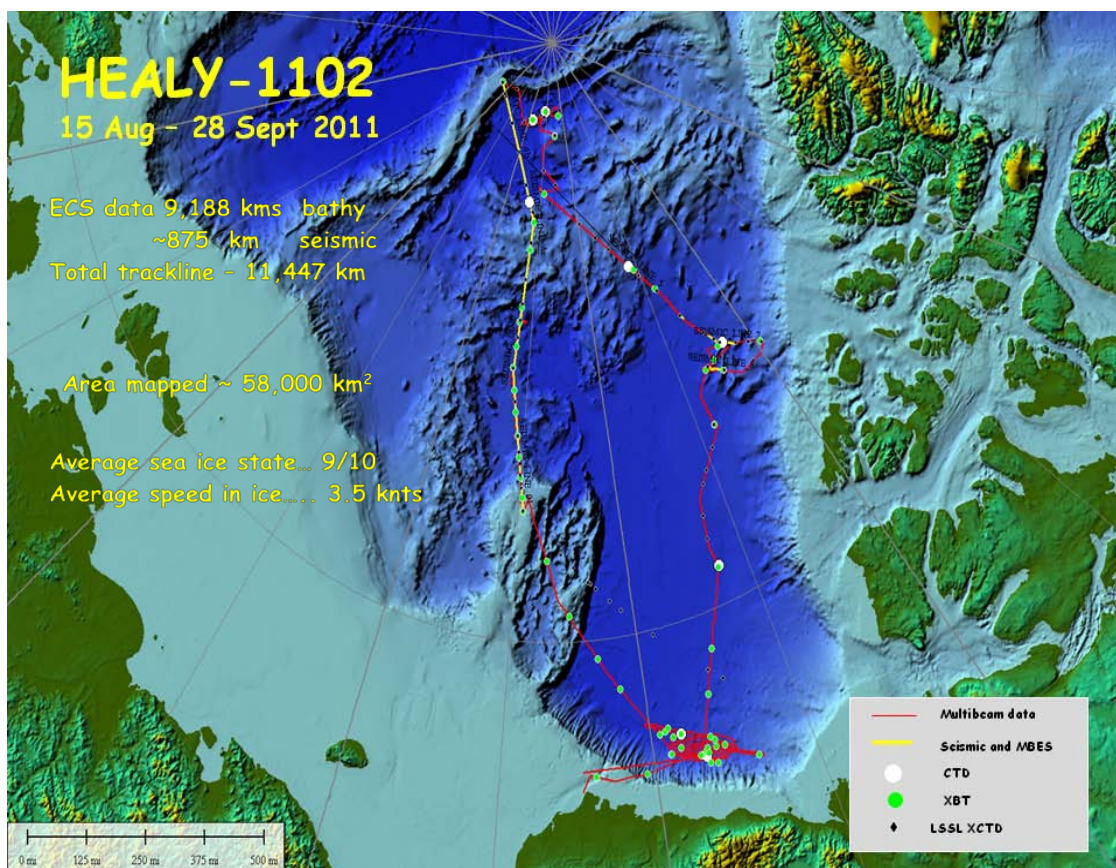


Figure 1-8. Trackline for HEALY-1102. Cross-hatched lines represent seismic data collection lines. Multibeam sonar data collected on all lines.

The *Healy* averaged over 16 knots transiting to Dutch Harbor, arriving at 0900L on 28 Sept. and bringing HEALY-1102 to an official end. Total track covered on HEALY-1102 was 11,447 km (6181 nm) with 9188 km (4,961 nm) of multibeam sonar data and 875 km (472 nm) of seismic data collected in support of ECS purposes. These data were collected in average ice conditions of 9/10's ice cover and at an average speed of 3.5 knots in the ice. ECS multibeam data collection covered an area of approximately 58,000 km² (16,960 nm²) adding approximately 20% to the U.S. Arctic multibeam sonar data holdings.

HEALY 1202 OVERVIEW

HEALY-1202 was the first single-ship ECS mapping program since 2008. The primary objective of this leg was to collect high-resolution multibeam sonar data in the region north of Chukchi Cap leading into Nautilus Basin in order to unambiguously locate the position of the "foot of the slope" as defined by Article 76 and to better understand the morphology of the northward extension of Chukchi Cap into Nautilus Basin. Secondary objectives included the collection of high-resolution chirp subbottom profiles to help in the determination of the location of the foot of the slope, the collection of dredge samples to better understand the geologic nature of Chukchi Cap and its northern extension, and the collection of underway gravity data. Ancillary projects were also carried out including, oceanographic, wildlife and ice studies.

The scientific party of the HLY1202 began embarkation by helicopter from Barrow AK, onto *Healy* on 25 August as scheduled, but complications with the unexpected on load of ship's stores delayed departure until approximately 1500L on the 26th of August. Enroute to the Chukchi Cap, the *Healy* deployed two "EARS" acoustic buoys on behalf of DARPA/Lockheed Martin at locations approximately 122 and 152 nm north of Barrow in water depths of 3126 and 3751 m respectively (Figure 2-1). Upon completion of the buoy deployments, the *Healy* continued on into the Canada Basin to the base of the Northwind Ridge for the performance of a patch test to calibrate the offsets entered into the multibeam sonar. Before the patch test was conducted a deep (3850 m) CTD cast was made including water sampling for the USGS ocean acidification program (see Appendix E). An XBT and XCTD were also deployed at the same site to inter-calibrate these sensors. The patch test was completed and indicated no modifications were necessary to the configuration of the sonar.

The *Healy* then transited over Chukchi Cap to begin a series of surveys designed to ambiguously locate the foot of the slope on the western edge of Nautilus Basin. First indication of any ice (a few bergy bits) was seen at approximately 76d 40'N. By 79dN larger chunks of ice were being seen but still no indication of the ice pack. On the 29th of August the *Healy* reached the transition into the Nautilus Basin at approximately 81d 12'N with clear foot of the slope at approximately 3800m depth apparent in both the multibeam bathymetry and the chirp subbottom profiler (see Chief Scientist's Daily Log for images and details). Large streams of broken ice impacted the quality of the multibeam sonar records but there was still no indication of a solid ice pack.

Between the 29th of August and the 6th of Sept, the *Healy* continued to make a series of crossings in and out of Nautilus Basin, documenting the location of the foot of the slope in the transition from the Nautilus Basin to the Alpha/Mendelev Ridge complex (Figure 2-1). During this time, ice conditions worsened with the *Healy* eventually encountering 7/10 - 10/10 ice conditions for brief periods of time (see Chief Scientist's Daily Log for details of foot of slope crossings and ice conditions). On 4 Sept 2012, the furthest point north of this expedition was reached at approximately 83d 32'N , 162d 36'W. At this

HLY1202 Cruise Report

location a CTD station was occupied with water and ice sampling for the ocean acidification project. On 5 Sept. an AXIB ice buoy was deployed by crane on a large flow and more ice samples taken (Figure 2-1).

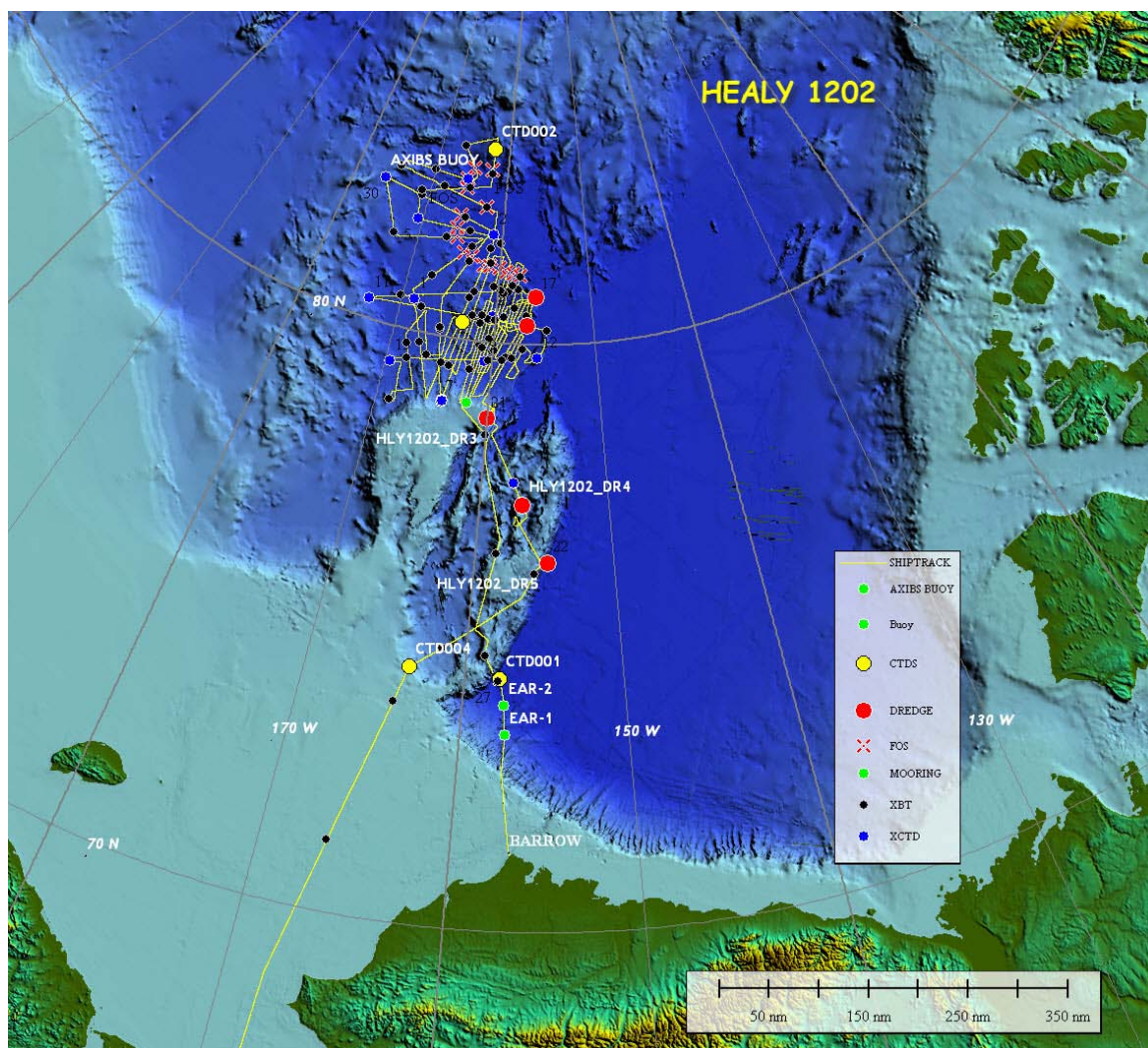


Figure 2-1 - HEALY 1202 Shiptrack, XBT, XCTD, CTD, buoy, and dredge locations.

With numerous foot of slope crossings around the periphery of Nautilus Basin, the mapping effort then focused on the northern extension of the Chukchi Cap that transitions into Nautilus Basin. Our objectives here were to collect as complete mapping as possible to better understand the morphology of this area and to identify potential dredge sites that would enable to sample bedrock in this region. Between the 6th of Sept and the 17th of September detailed mapping of the this area was conducted. This mapping consisted of a series of N-S oriented lines interspersed with several longer, E-W lines (Figure 2-1). During this time the *Healy* encountered variable ice conditions but mostly open water. Towards the end of this period, new ice was forming causing serious problems for the

EM122. The new soft ice seems to scrape by and stick to the transducers causing very high noise levels and difficulty detecting the bottom.

The initial surveys of the northern extension of Chukchi Cap indicated that the greatest possibility of finding suitable dredging sites (our criterion is a slope greater than 30 degrees) was in the eastern (Northwind) portion where steeper topography is present. We thus concentrated our survey work in this area but even here found very few potential dredge sites (Figure 2-1). We did identify an isolated site (with only marginally appropriate slopes) on the western end of the survey area near the U.S./Russian maritime boundary and, on 13 Sept. proposed a dredge there but very strong winds (25-35 knots) from the north created a situation (relative to the orientation of the feature) that precluded dredging (see Chief Scientist's Log for details). Surveying continued to the east filling in gaps and looking for potential dredge sites.

In the course this surveying we mapped a spectacular submarine channel that drains from west to east over a distance of at least 160 km with an average gradient of about 0.18 degrees. The channel does not significantly meander but is complex with numerous small tributaries and several bifurcations. The maximum depth of the channel is approximately 80 m (Figure 2-2).

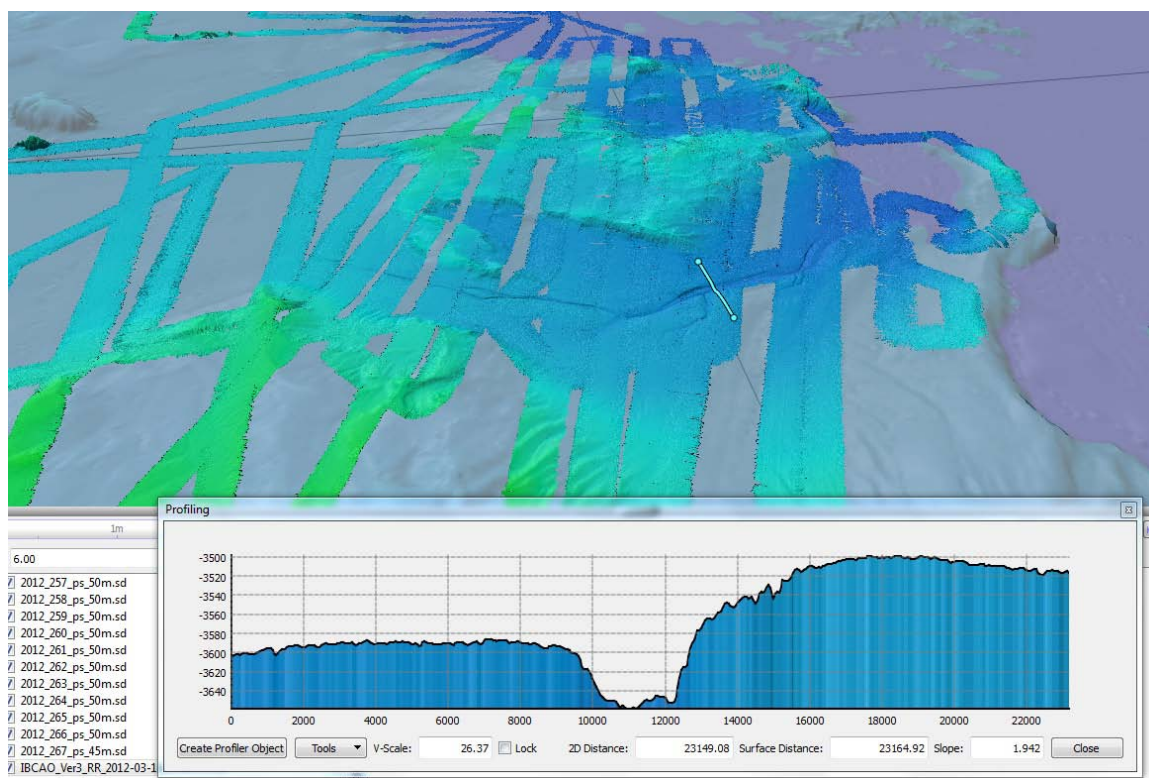


Figure 2-2. Submarine channel north of Chukchi Cap - overall length is approximately 160 km. Cross-section shown in figure is 23 km long.

At the conclusion of the survey work, no dredge sites could be identified with slopes greater than 30 degrees in the middle of the northern extension of Chukchi Cap. Instead,

HLY1202 Cruise Report

two dredge sites (DR-1 and DR-2) were selected on the northeast rim of the northern extension of the Cap.

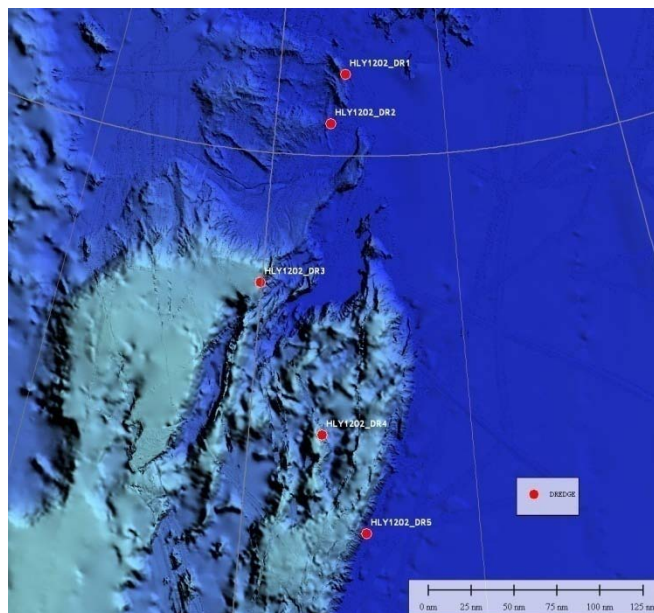


Figure 2-3 - Healy 1202 dredge sites

The final three dredge sites (DR-3, DR-4 and DR-5) are located on the northern tip of Chukchi Cap (just west of Healy Seamount), in the middle of Northwind Ridge and on the eastern flank of Northwind Ridge respectively. A brief description of the dredge sites and the results are presented below. More detail on the dredge sites can be found in the Chief Scientist's Log.

Dredge site 1 (DR1): 9/16/12 (0441-0830 GMT)

Start- 80° 48.826'N, 155° 54.256'W

Target: >50° slope on southern edge of Nautilus Basin between 3750-3650m water depth. Ice cover was at least 9/10 so ship drove the entire line to recon and break ice along dredge track. Dredge site was a small promontory trending N-S at a high angle to wind direction and ice drift.

Several 6500 lbs tension pulls on wire out between 3700-3650m suggest outcrop target was hit with the dredge. Total weight of dredge haul was around 300 lbs of mostly mud (about 99% of weight). Outcrop rock (<1% haul) was very soft fine-grained ochre colored sedimentary rock (possibly volcanoclastics similar to those collected from HLY0805-DR1 ??).

Dredge site 2 (DR2): 9/18/12 (0350-0830 GMT)

Start- 80° 19.023' N, 156° 45.057' W

Target: >30° slope along an inlet of the southern edge of Nautilus Basin at a depth of 3720m water depth. Wind from NE at 20knots, ice was drifting to SE making it difficult for the ship to hold position. Dredging was further complicated by problems with the wire out counter that was not calibrated correctly making it impossible to know how

HLY1202 Cruise Report

much wire was out. Great care was taken when pulling in wire to check for kinks or damage to wire.

Many 8000-10000 lb tension pulls on wire out between about 3700-3600m water depth suggest dredge hit solid outcrop. Total weight of haul was only about 120 lbs of which 99% was mud. Rock included ice rafted debris (IRD) and Mn pavements, with few angular outcrop rocks of very highly altered basalt.

Dredge site 3 (DR3) 9/21/12 (1310-1620 GMT)

Start- 78° 42.215' N, 160° 02.990' W

Target: >40° slopes on far NE corner of Chukchi Plateau just west of Healy Seamount. MCS seismic line from HLY0503 (Hopper and Coakley) across this structure show it to be a large offset normal fault scarp. Target depth was between -1749-920m with steepest slopes at -1140m. >9000 lbs pulls (near limit of weak link) and being stuck with 1135m wire out, suggest that outcrop was sampled between about 1350-1250m, then between -1200-1150m. Total dredge haul weight was about 250lbs. 60% mud, 25% IRD and tallus, 5% Mn crusts and 10% outcrop rocks. Also in this dredge were carbonate pavements common around methane seeps, and coral fragments. Outcrop samples were metasedimentary.

Dredge site 4 (DR4) 9/22/12 (0500—0700 GMT)

Start- 77° 13.895' N, 156° 42.352' W

Target: >40° slopes near top of normal fault block imaged by MCS lines (Hopper and Coakley, 2005) west of Northwind Ridge between 780-600m water depth. Winds due W and very calm seas with some fog. Many >9000lb tension pulls on wire suggest outcrop was sampled between about 730-650m water depth.

Total dredge weight was about 150lbs, 50% mud, 25% outcrop rock, 12.5% IRD and tallus, 12.5% Mn pavements. Outcrop rocks were covered with thick Mn pavements seen in every dredge haul we've taken and carbonate pavements that have been described around methane seeps. Outcrop rocks were metasedimentary (schists and possible slates).

Dredge site 5 (DR5) 9/22/12 (1710-2108 GMT)

76° 15.8079' N, 154° 46.3878' W

Target: >40° slope of small salient fault block along the Northwind Escarpment. Target depth between -3600-3400m. Many >9000lb tension pulls on wire suggest outcrop was sampled between 3700-3500m water depth.

Total weight of dredge haul was around 700lbs 90% of which was rock with very little mud. 70% was outcrop, 10% Mn crusts and 10% IRD/tallus. Outcrop samples were metasedimentary, (schists, possible phyllites).

HLY1202 Cruise Report

Upon completing the last dredge site, the "IceGoat Buoy" was deployed for the U.S. Naval Academy and the *Healy* departed for Dutch Harbor (23 Sept), arriving in Dutch Harbor on 27 Sept. Total track covered on HEALY 1202 was 11,965 km (6461 nm) with 10,030 km (5,416 nm) of multibeam sonar data collected in support of ECS purposes. These data were collected in average ice conditions of 6/10's ice cover and at an average speed of 7 knots in the ice. ECS multibeam data collection covered an area of approximately 68,600 km² (20,000 nm²) adding approximately 25% to the U.S. Arctic multibeam sonar data holdings.

In addition to the primary ECS mapping mission of HEALY-1202, five ancillary programs were accommodated on a non-interference basis. These programs included:

- 1- Gravity measurements made by Dr. Bernard Coakley Univ of Alaska Fairbanks. See Appendix A.
- 2- Ice observations, analyses and reporting along with the deployment of one UpTempO buoy, 1 AXIB seasonal buoys, 1 Argo profiler, 1 USNA "IceGoat" ice buoy and 5 SVP TechOcean and METOCEAN buoys as part of the U.S. International Arctic Ice Buoy Program. The ice program on HEALY-1202 was under the supervision Pablo Clemente-Colon, National Ice Center. See Appendix B.
- 3- A comparative study of historical modern vs historical ice terminology by Matthew Ayre of the University of Sunderland. See Appendix C.
- 4- Deployment and development of a geo-referenced ice camera for ice and other studies – Roland Arsenault – Center for Coastal and Ocean Mapping – Univ. of N.H. See Appendix D.
- 5- Ocean Acidification measurements under the supervision of Lisa Robbins, U.S. Geological Survey. These measurements sampling of water bottles from included 4 CTD stations, 625 discrete underway samples for pH, 614 discrete underway samples for alkalinity and 4000 continuous measurements of pH , pCO₂, and TCO₂. See Appendix E.
- 6- Marine Mammal Observations by Mabel Smith, of the Umiak Inupiat Corporation. During the 31 days of the ECS science program, 3 unidentified seals and 5 polar bears were seen. No whales were observed. See Appendix F.

Scientific Party

<i>Last Name</i>	<i>First Name</i>	<i>Institution</i>	<i>Position</i>
Mayer	Larry	University of New Hampshire	Chief Scientist
Armstrong (CAPT. ret)	Andrew	NOAA	Co-Chief Scientist
Calder	Brian	University of New Hampshire	Scientist
Arsenault	Roland	University of New Hampshire	Scientist
Englert	Chris	University of New Hampshire	Grad Student
Flinders	Ashston	University of New Hampshire	Grad Student
Jerram	Kevin	University of New Hampshire	Grad Student
Masetti	Giussepe	University of New Hampshire	Grad Student
McKenna	Lindsay	University of New Hampshire	Grad Student
Rice	Glen	University of New Hampshire	Grad Student
Sowers	Derek	University of New Hampshire	Grad Student
Coakley	Bernard	University of Alasaka, Fairbanks	Scientist
Farrell	John	U.S. Arctic Research Comm	Scientist
Moore	Barbara	State Dept.	Scientist
Chayes	Dale	Lamont Doherty Earth Observatory	Chief of Everything
Roberts	Steve	LDEO/UCAR	Shipboard Data Acquisition
Freismuth	Thomas	USN (LT)	Scientist NIC
McLearen	Chad	USN (E-6)	Forecaster FWC
Patria	Nick	USN (LGJG)	Scientist
Morris	Giuseppe	NAVO	Scientist
Prince	Monica	NAVO	Scientist
Knorr	Paul	USGS	Scientist
Onac	Bogdan	Univ. of South Florida	Scientist
Wynn	Jonathan	Univ. of South Florida	Scientist
Robbins	Lisa	USGS	Scientist
Brumley	Kelley	Stamford University	Grad Student
Clemente-Colon	Pablo	National Ice Center	Scientist
Zib	Behnjamin	National Ice Center	Scientist
Ayer	Matt	Univ of Sunderland	Scientist
Smith	Mabel	CH2MHILL	Community Participant and MMO
Lim	Elliot	NGDC	Scientist
McQuinn	Elliot	NGDC	Scientist
McMullen	Kate	USGS	Sample Curator
Reyes	Joshua	MATE Program	Scientist



HLY1202 Technical Report

Dale N. Chayes

dale@ldeo.columbia.edu

Steve Roberts

sroberts@ucar.edu

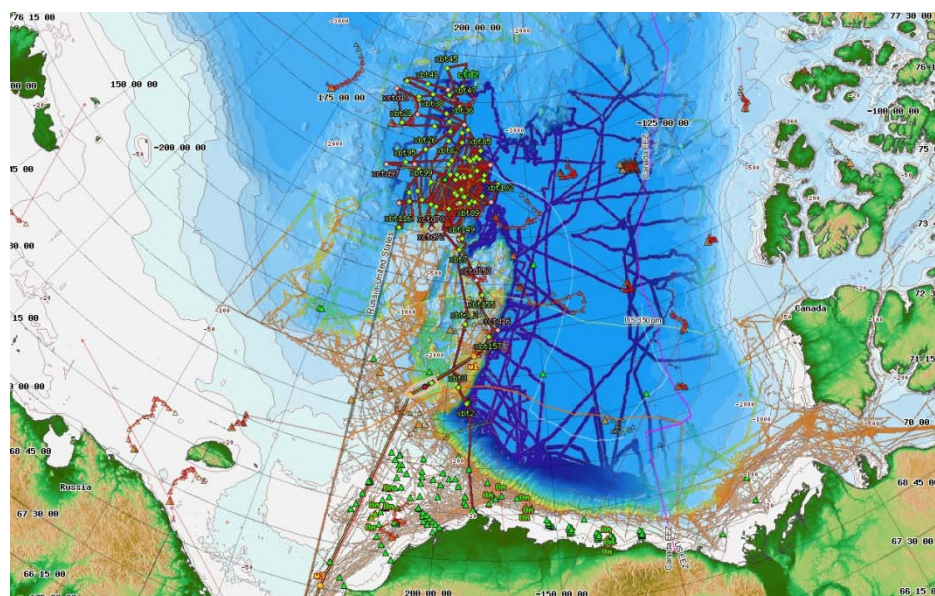
With input from Donny Graham (ESU) and others

Version Date: September 26, 2012

Instrument Lab

Lamont-Doherty Earth Observatory of Columbia University

Palisades, NY 10964 US



Introduction

This report documents the technical performance and status of science and science related systems during HLY1202 from Barrow, AK to Dutch Harbor, AK. HLY1202 was a single ship cruise on the US Coast Guard icebreaker Healy in support of the US Extended Continental Shelf mapping program. There were various ancillary programs collecting data about sea ice and ocean chemistry.

Dr. Larry Mayer of the University of New Hampshire Center for Coastal and Ocean Mapping was the chief scientist on the Healy. The primary mapping tools for the ECS cruise were the Kongsberg EM122 multibeam mapping sonar, Knudsen 320B/R sub-bottom profiler and dual BGM3 marine gravity meters. Five successful rock dredges and 4 CTDs were taken.

Table of Major events during HLY1102

Date	Event
2011-08-25 & 26	Helicopter transfers at Barrow, AK
2012-09-27	Arrive Dutch Harbor

Mapserver

The Healy's real-time Geographic Information System (GIS) was extensively used during this leg for planning and execution of this cruise.

Terascan

During this cruise we routinely monitored and processed directly received imagery from NOAA AVHRR satellites and from Navy DMSP RTD satellites. GeoTIFF (georeferenced TIFF) images were generated and provided to the Mapserver.

UPS:

The UPS supporting the Terascan system failed during the Seattle in-port period well before this cruise. During this cruise, the ship's ETs replaced the batteries but that did not fix the UPS so they plugged the Terascan into the UPS that is intended to support the Helm Display system for the Multibeam.

Receiver Performance (for NOAA satellites)

During the transit from Seattle both NOAA AVHRR and DMSP quality was extremely poor and data was unusable. However DMSP improved once we were north in the Chukchi. But NOAA AVHRR remained poor. Based on prior groom reports the issue could be due to a damaged LNA feed on the antenna. Steve had the ships ET replace the suspect feed with a spare. AVHRR quality improved significantly after this. But performance has been slowly degrading over time, particularly as we head back south. So it is not entirely clear if the feed is the source of this problem.

DMSP Encryption

Most of this cruise operated in an area where the US Air Force transitions the DMSP satellites to/from encrypted/unencrypted mode which lowers usability of this imagery because the existing system can only collect data in one mode during a satellite pass so when the satellite changes encryption mode data is lost after that change.

Science Internet Connectivity

Science Internet connectivity on this leg was provided by three systems: leased commercial VSAT, Iridium Reachback, and Iridium Openport.

Iridium Reachback

The Healy's science Reachback low bandwidth Iridium network connection was used extensively during this leg, primarily to carry email traffic to/from the Internet via is' shore-side paired unit. Total email file size was originally set to 200kbytes but increased to 400kbytes when it became apparent that the system could handle the extra bandwidth. There were a few, not unexpected, issues with the system that required occasional reboots of one end or the other, each of which resulted in temporary email backups. On the whole, the system worked as expected, and perhaps somewhat more reliably than on other similar legs in previous seasons.

Iridium OpenPort

The OpenPort is an Iridium-based "high speed" (up to 128 kbits per second) link that was only used when we were beyond the footprint of the VSAT system, and then primarily for downloading satellite ice images from shore for tactical use during the cruise.

While this system is much faster at file downloads than the Reachback, it is expensive and billed by the amount of data transferred (not by time or at a fixed annual cost) costly and therefore must be managed appropriately. The system was provisioned with a fixed price limit of 250 megabytes per month. Usage beyond that is billed at \$7 per megabyte afterwards. Because of the ice images that were necessary and available, we probably exceeded the 250 megabyte threshold by about 750 megabytes.

Unlike Reachback, this system is not a bridge to a fixed shore site, it is an external connection to the public Internet and is managed by our firewall like the VSAT. this allows for a seamless failover transition from VSAT (when in range) to Openport for situations like the laptop that was used by the ice team guys.

VSAT:

The KU band, high bandwidth satellite started losing connectivity around 80° 30'N. Elog entries suggest that reliable coverage is usually lost at 79 N. Donny and Frank spent a fair amount of time troubleshooting with our satellite support group to squeeze every bit of Internet that we could even at the higher latitudes. This required many hands-on reconfigurations of our ACU (antenna control unit). These configurations would allow bursts of connectivity that ranged from minutes to sometimes hours before losing connection. Each time a manual entry would need to be made for us to lock on to and connect to again. It also seems, that the Antenna Control Unit needs to be adjusted by our support contractors.

EM122:

SIS Version

SIS was updated to Version 3.9.0 prior to this leg. This version supports the “hokey-pokey” mode which allows the operator to telnet into the TRU (PU) and force the sonar to sweep the beams fore and aft for a +/- 10° degree range. This proved useful during the few periods when we were in moderately heavy ice.

Real-time data access

To provide near real-time access to the *raw.all* files logged by SIS, we exported the SIS “data” file system from the SIS PC to *emgate* from which we can automatically transfer it using *rsync* to our archive where it is used for processing and archiving.

This also allows access to the sound speed profiles (.asvp files) used by SIS from *emgate*.

Generating sound speed profiles for SIS

We used Steve’s profile2asvp extensively during the cruise to construct sound speed profiles from XBTs, XCTDs, and CTD data. For XBT's the nearest XCTD's or CTD's salinity profile was used to correct the XBT sound speed profile.

Dale wrote a simple (python/matplotlib) application (plot_asvps.py) to facilitate plotting and comparing various “.asvp” files. An example plot is shown below.

We obtained a copy of Jonathan Beaudoin’s (UNH/CCOM) latest SVP Editor and installed it on emgate (one of our real-time servers.) We were eventually able to get the GUI that allowed you to generate svp profiles working. But were unable to get it to “talk” (communicate over the network) to the EM122 in order for it to push these profiles to the EM122. This still needs to be debugged.

SIS gridding

Under some circumstances, *hdds.exe* exited occasionally this year but not nearly as often as it did last year.

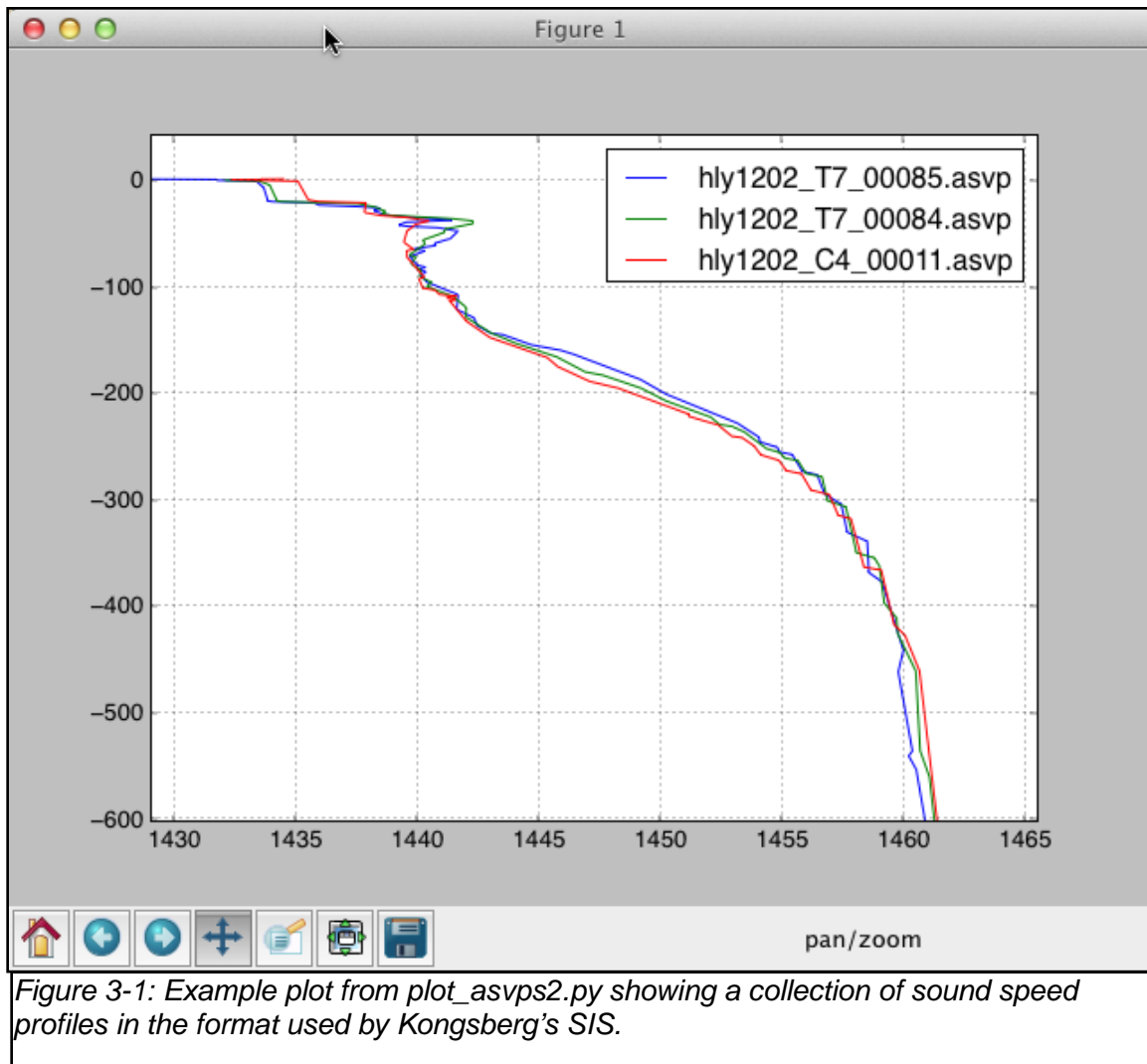
Helm display:

The Helm display was utilized on the bridge. This system was generally stable stable but there were a few instances where it crashed .

Built In Self Tests:

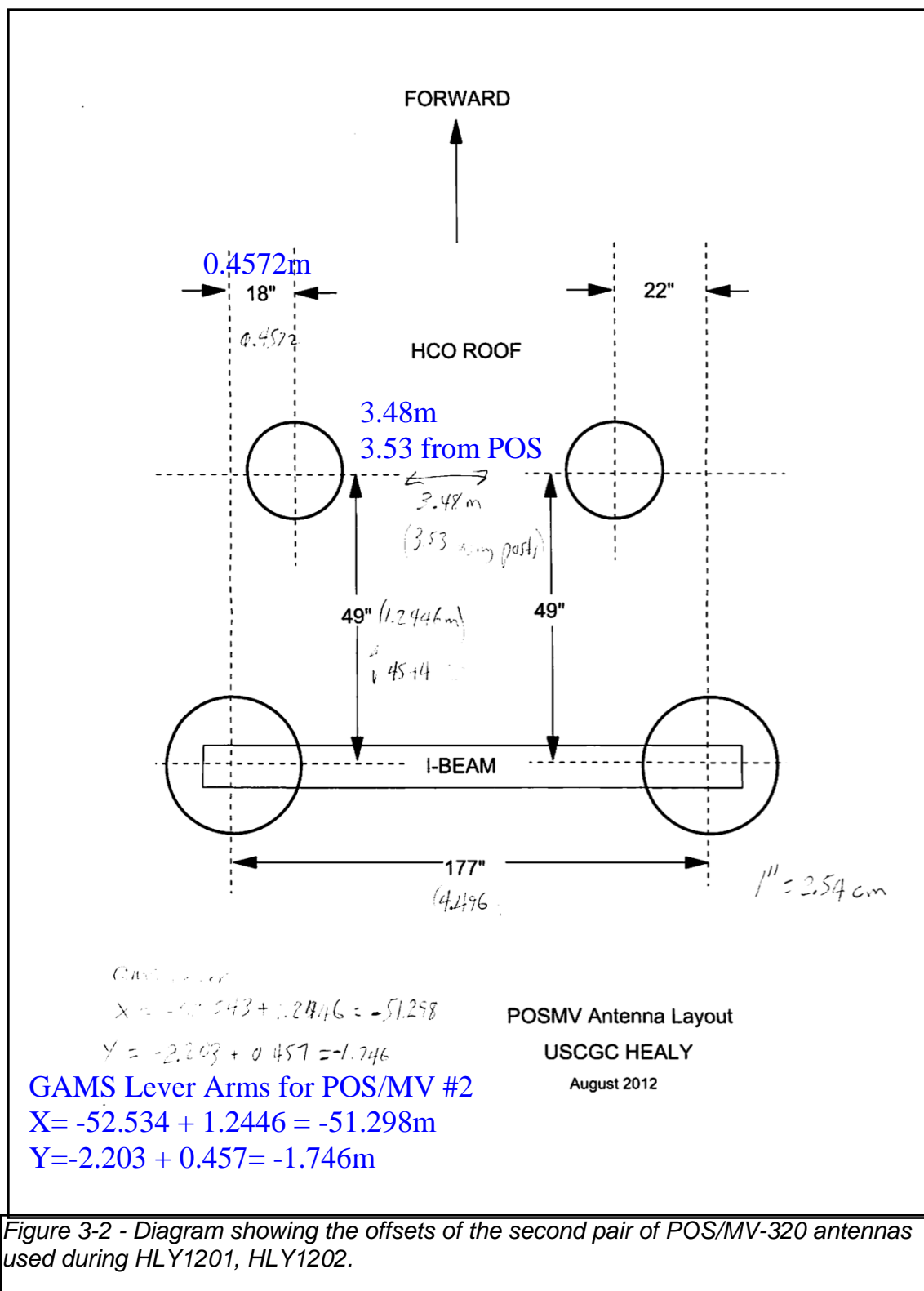
We collected and logged BIST (GUI and TRU) tests when opportunities presented themselves during the cruise.

HLY1202 Cruise Report



GUI TX BIS tests “fail” due to cold seawater. Further examination using the TRU BIS Tests shows more detail.

Missing PU data warnings



When pinging at high data rates (e.g. 2.5 Hz) we noticed periodic instances when SIS displayed errors stating the 1PPS (one pulse per second) data was not arriving. Inspection of the signals

HLY1202 Cruise Report

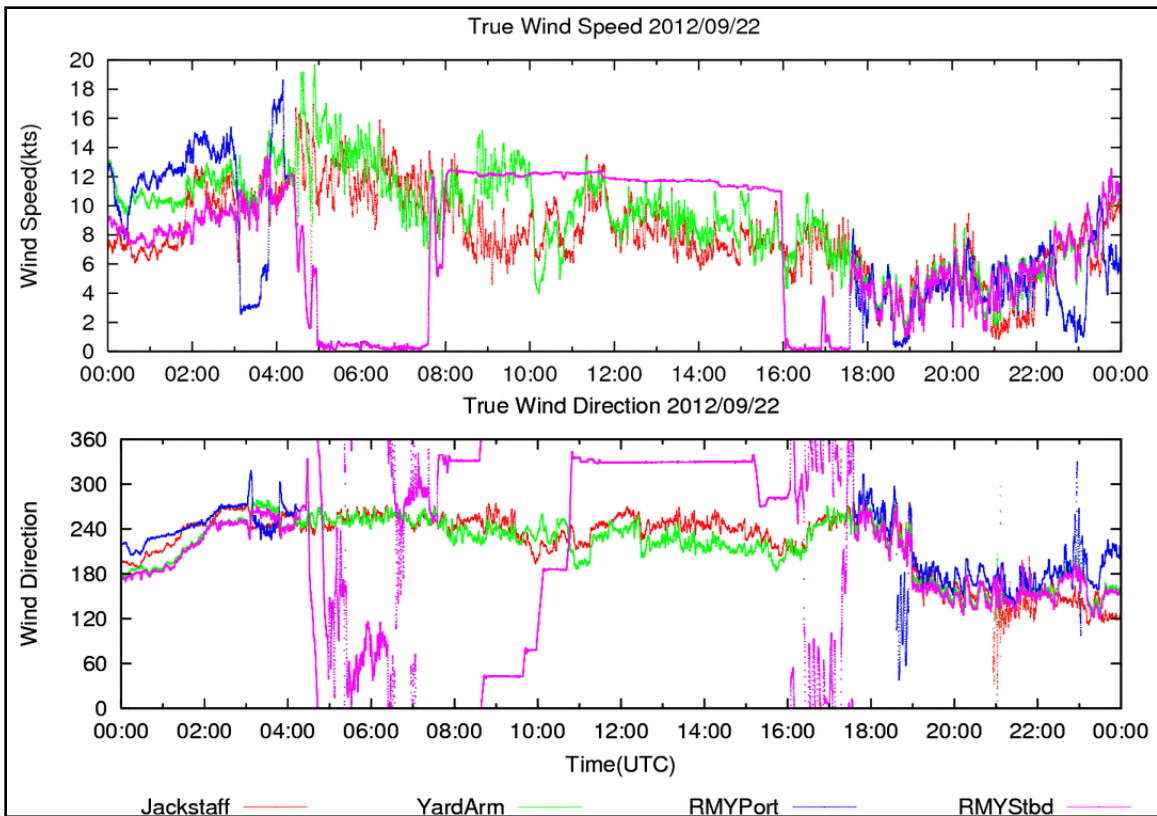


Figure 3-3 - Plot of wind speed and direction data showing the RM Young mechanical wind birds freezing up around 0500 and coming free again around 1900Z.

indicated that it was and there was no degraded performance in the data. This suggests that the PU was not able to keep up with the input data.

The 1PPS input is in two parts: a once per second TTL signal, and the accompanying UDP datagram from the POS/MV which contains the actual time info. It is possible that the TRU (PU) is sporadically having trouble with the input datagrams

Watchstanders:

As is always the case for cruises where there is a full-time underway watch like this one, a substantial amount of time is spent training and trying to educate watchstanders and in reminding them when things go wrong.

Watch Standers Workstation

The video quality on the monitor for the ship's CCTV system on the Watch Standers Workstation was so poor during this leg that it was turned off.

Knudsen 320 sub-bottom profiler

During the Healy shakedown cruise in June the Knudsen software was downgraded to 1.64. This broke the heave correction from the POS/MV that we have been using for several years. We

HLY1202 Cruise Report

upgraded the software back to 1.82 which was the version we had been using prior to the down-grade. Heave correction has been working since then.

After the re-upgrade, the system in general appears to be working well. No significant issues were observed with the Knudsen.

POS/MV-320s:

POS/MV #1 was used as the primary source during this cruise and there were no unusual issues.

GPS Antenna splitters

Prior to this cruise, the antenna splitters were removed and the two POS/MVs were configured to use separate antennas.

The offset values for the second pair of antennas are shown in the figure below.

This seems to have dramatically reduced the number of instances when the error estimates for the #2 POS/MV “blew up” (became much larger than “normal”) compared to last season. This suggests that there is an issue with some combination of the cabling, the new antennas, and the splitters.

CTD System

Four CTD casts were taken on this cruise. The primary goal of these casts was to collect data for accurate sound speed profiles in support of the EM122 multibeam data for ECS mapping purposes. They were also sampled for the USGS Ocean Acidification ancillary program.

There were no significant issues with the CTD system.

Wind Birds

The RM Young mechanical wind birds iced up intermittently during this cruise. One example was on September 22 as shown in the figure below.

LDS/SIO MetACQ

The Lamont Data System was the primary real-time data logging system for this cruise. Real-time data from the SIO MetACQ system was logged by LDS. The data from the SIO MetACQ system is also being logged separately. The NOAA SCS system was removed during the last Seattle in port period and was not operating during this cruise.

LDS Acquisition management

We started new cruise during flight ops at Barrow. Data acquisition for HLY1202 ended on our transit south at about 71°N latitude and transitioned the data collection to the transit leg HLY12TC.

During the cruise we monitored data quality and the data loggers.

HLY1202 Cruise Report

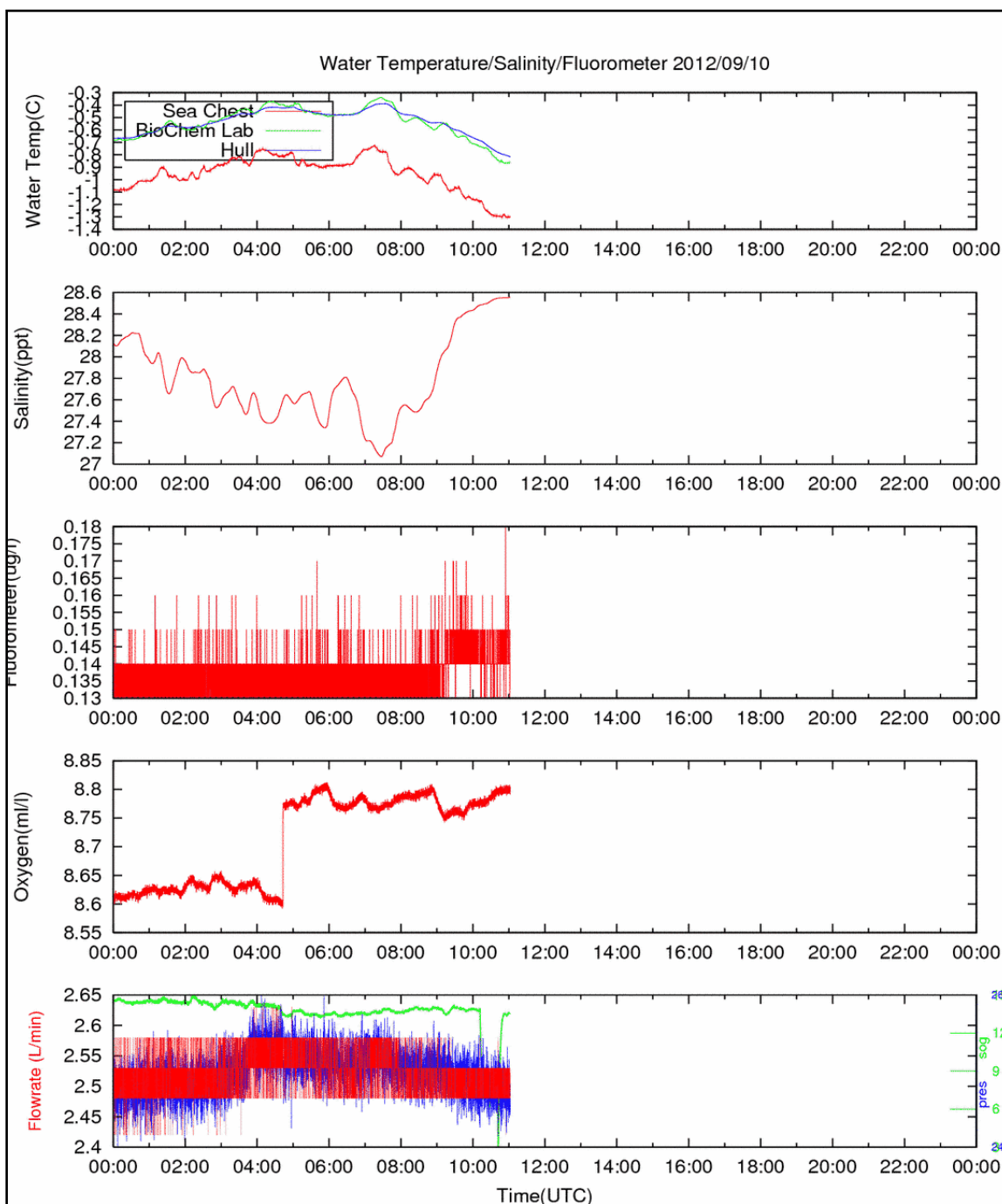


Figure 3-4 - Plot of flow through sensor data showing the “tear” (offset) in Dissolved Oxygen from the SBE43 DO sensor at about 0445Z on 2012-09-10. This tear is typical of a failure of the sensor.

There were no issues with LDS.

HLY1202 Cruise Report

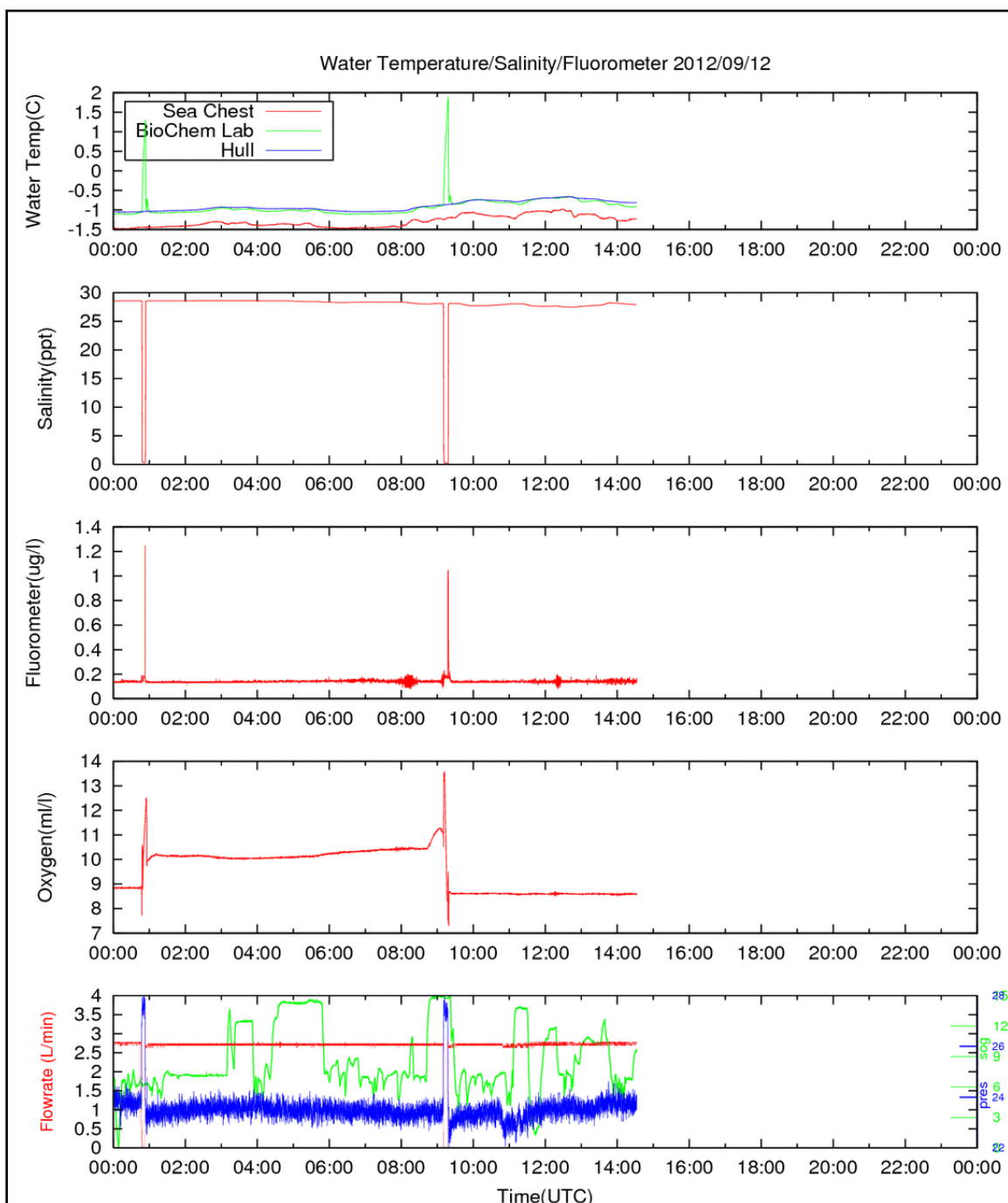
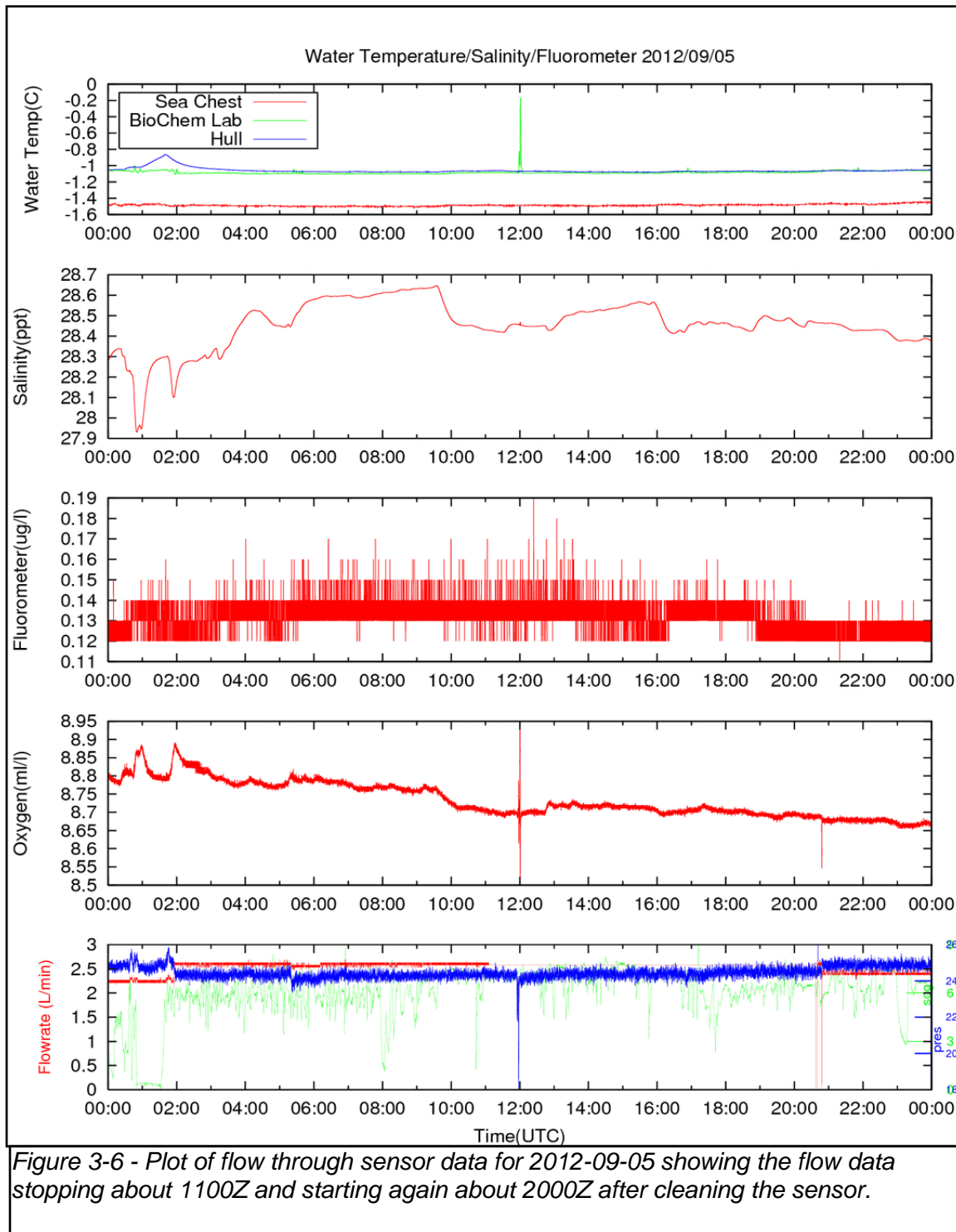


Figure 3-5 - Plot of flow through sensor data showing the offset in Dissolved Oxygen from the SBE43 DO sensor at about 0100Z on 2012-09-12 when the spare sensor was installed and then about 0115 when the second spare with correct performance and calibration data was installed.

SIO MetACQ was restarted several times to accommodate debugging of automatic data transfer for SAMOS, and to add real-time UDP datagrams for the winch wire data. We started the cruise using **HLY12C?** as the configuration file and ended the cruise using **HLY12?**

HLY1202 Cruise Report

Data Distribution



Steve generated the end of cruise data distribution for the chief scientist and for transfer to R2R.

Steve generated 1 minute averaged underway data file. This was requested by several members of the science party. Identified some issues that needed fixing when the code was updated to use this years sensor additions and changes.

pCO₂ System

The system to measure the partial pressure of Carbon Dioxide in seawater and the atmosphere (pCO₂) developed by Taro Takahashi of Lamont-Doherty with funding from NOAA was temporarily installed by Tim Newberger after the 2010 shakedown and continues to operate in it's temporary configuration during this cruise.

The system worked reliably during this cruise, requiring periodic monitoring and one gas bottle change.

Science Sea Water System (SSW)

When working in heavy ice the system is still prone to interruption and/or reduction of flow.

The strategy for reducing the impact of ice chips, is enabling more water to be diverted overboard, reducing the amount of water available for science use. However due to the record low sea ice extent during this cruise we encountered very little ice that effected the system. So was able to leave system in a configuration that allowed high water flow to the sensors.

Flow through sensors

The Healy's flow through sensors for this leg included a SeaBird TSG (SBE45), Dissolved Oxygen sensor (SBE43), a remote temperature sensor (SBE3) and a Turner Flurometer. A water flow meter was also logged.

The SBE43 Dissolved Oxygen sensor in the flowthrough system exhibited a significant offset on 2012-09-10. We replaced the sensor with a second spare and updated the calibration data in the SIO MetAcq system. The new sensor showed a value much too high to be realistic. Removed and replaced with a third spare and updated the calibration data in the SIO MetAcq system. Values then looked reasonable after that.

Because of the relatively light sea-ice conditions, there were few instances of ice blockage and flow reduction.

Flow Meter

The flow meter in the SSW system failed about 1100Z on 2012-09-05. We loosened the cover to the flow meter and allowed flowing water to flush the pick-up and the sensor started working again about 2000Z on the 5th as shown in the figure above.

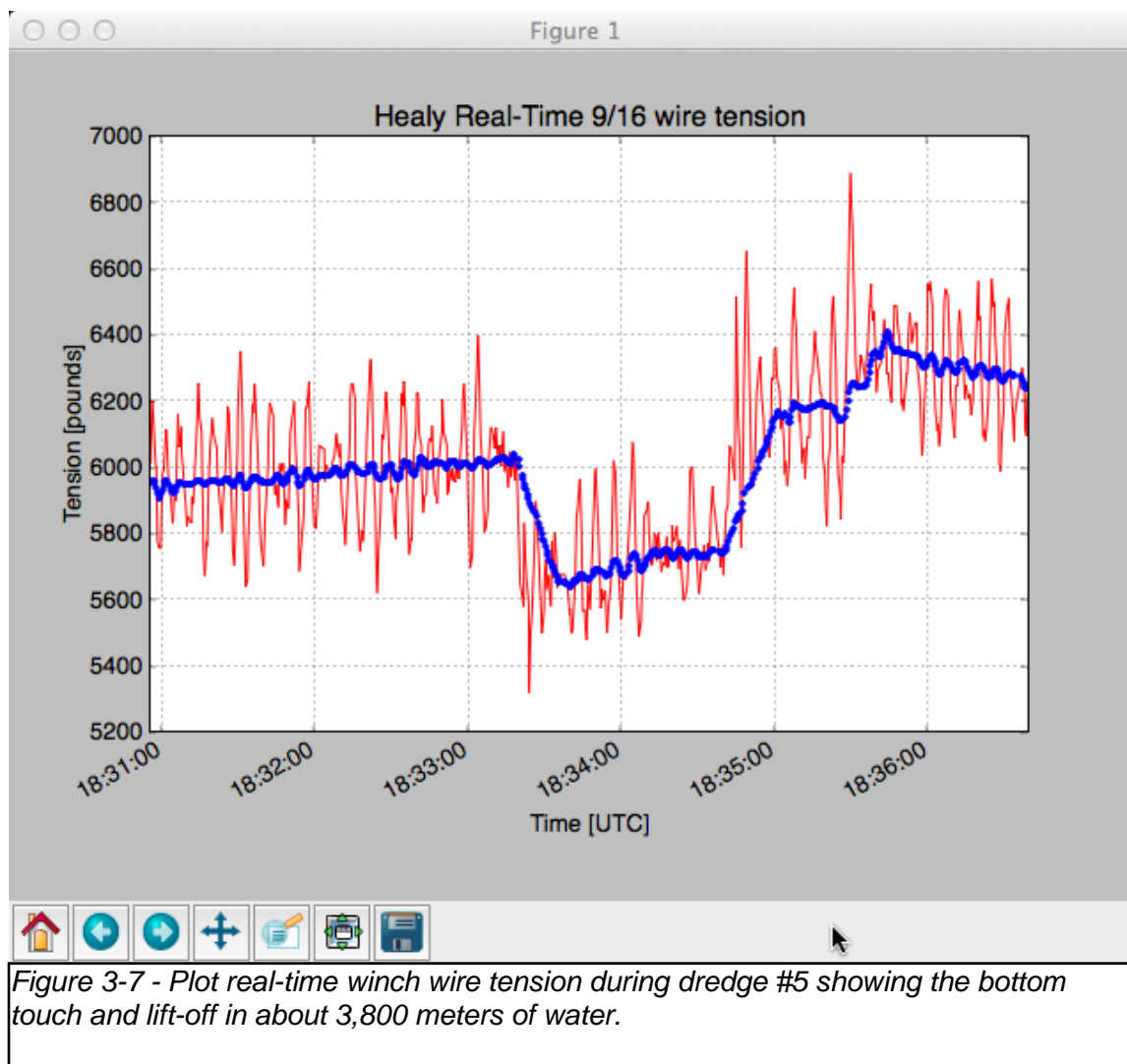
ADCPs

The OS75 and OS150 CTDs ran under control of UHDAS during this cruise. Data quality was monitored remotely by Jules Hummon. A large fraction of this cruise was out of VSAT range with severely limited remote access.

Prior to the start of the 2012 field season, the ADCPs were relocated to a more permanent location on the starboard side of MICA.

Expendable Probes (XBTs and XCTDs)

Approximately 90 expendable probes dropped. Most of the probes were XBTs but a significant number of XCTDs were provided by the science party. The Sippican software for the XBTs and XCTDs has been a constant headache. The software frequently locks up requiring a reboot of computer. The automated sequencing seems to be unreliable which caused the software to overwrite a previous XBT in one instance.



Gravity Meters

The two BGM-3 marine gravity meters worked well during this cruise.

Science AIS receiver

The science AIS receiver worked normally during this leg but there were only one short-term target except in the vicinity of Barrow and while transiting south.

Aloftconn, Aftconn and Main Lab web cameras

The web cameras worked well during this cruise. There was more than normal interest in the Aloftcon camera in part due to the GeoCamera that was brought by the science party. This year's version of GeoCam used two fixed cameras in Aloftcon - pointed to port and to starboard along with data from the existing Aloftcon camera.

Winch wire data monitoring system

The old winch wire monitoring system was replaced just prior to departure from Seattle with four LCI-90s from MTNW. The system was incompletely documented and the calibration data for the 9/16" wire was not configured properly. On our first attempt to dredge, the wire speed and wire-out counter was clearly off by a factor of 3 to 4. Tension seemed reasonable. We recovered the dredge, put on a 700-pound weight and did some investigation and testing.

There was only one entry in Elog that indicated only that changes were being made. No cal data, drawings, or details were available on board. Lacking any useful documentation other than the LCI-90 manual which I had a PDF of on my computer, EO (LCDR Tom Lowry) and Steve Roberts and I investigated the arrangement in the Winch Room.

All of the wiring from the load cells and wire counter (Hall effect) switches go to a single LCI-90 - the left most unit in the left hand cabinet. This using is the Master, and all of the rest (three in the Winch Room and the two active ones in AftCon are simply slaves that display data. Each slave (and the Master) can be set to display data from any of the four winches.

LCI-90 Winch Number	Wire Diameter	Wire Type
1	0.322"	CTD
2	3/8"	grab, non-conductor
3	0.680"	Double armored, coaxial
4	9/16"	3x19 trawl/core wire

We calculated a new wire counter calibration value based on the label on the meter wheel in the Winch room.

Then we started dredge #1. Prior to actually dredging, we calculated a new pulses per meter coefficient. We hit bottom about 5% shallow.

We then measured the root diameter of the sheave with a piece of monofilament to be 3.788 meters and recalculated the metering coefficient. On the subsequent dredge we hit bottom very

HLY1202 Cruise Report

with the wire out measurement very close (less than 1/2 of one percent) of the corrected water depth.

The current Pulses Per Meter (PPM) coefficient for the 9/16" wire is 2.087.

The LCI-90 display head for the 9/16" wire froze several times at each dredge station. This seems like a fundamental flaw that should be fixed.

The UNOLS Research Vessel Safety Standard Appendix A implies that the winch wire system should be able to capture AND DISPLAY short duration high tension events. This capability does not seem to be available in this version of the LCI-90. A "max" display value over the whole station in addition to a "recent peak" value would seem to meet the apparent intent of Appendix A. It does not appear that the display on the LCI-90 updates at 20Hz.

Real-time Winch Wire data

No real-time winch wire data was available on the science network. We worked with Scott Hiller ashore who provided an updated configuration file for the SIO MetACQ system. The update provided UDP datagrams at a 2Hz update rate over the network.

The two Hertz rate is much too slow to allow operating under the high tension regions of the UNOLS Research Vessel Safety Standards Appendix A.

Dale wrote a real-time application in Python using the matplotlib package to graph the winch wire tension in real-time to facilitate dredging. An example plot is shown in the figure above.

Revision History of this document

This section captures revisions to this document.

Comments, corrections, additions, etc. should be sent to Dale Chayes

<dale@ldeo.columbia.edu>

Date	Author	Comment
2012-09-23	Dale Chayes	Started, from HLY1102 cruise report
2012-09-25	Dale Chayes	Add to Winch wire data discussion
2012-09-26	Dale Chayes	Many updates with input from Steve Roberts and Donny Graham

HLY1202 Cruise Report

Date	Author	Comment
2012-09-27	Dale Chayes	Minor edits

CHIEF SCIENTIST LOG

HEALY 1202

26 August – 27 September 2012

Barrow – Dutch Harbor

NOTE: LOG WILL BE KEPT IN GMT WITH REFERENCE OCCASSIONALLY TO ALAKSA DST TIME (ADST = GMT – 8)

25 AUGUST 2012: JD 238

1600Z: (0800L) Science team gathered at the SAR hanger in Barrow for embarkation process. Prediction of fog led to change two plans – if foggy first flight at noon – if not start at 0800L. First helo flight did not take place till 1230L despite clear weather all morning. Additionally the ship had 9 large palettes of food stores that needed to vertically lifted to ship. Ops ran from 1230L till 2130L when fog set in. Andy and Kevin Jerram and 4700 lbs of cargo left on shore.

26 AUGUST 2012: JD 239

1800Z: (1000L) Helo ops continued until final loading at 1400L (2200Z) – underway at about 2300Z. Plan is to head for deployment sites of EARS buoys for DARPA – deploy first buoy and then deploy second buoy. From there we will go to patch test site do deep CTD with water bottles, XBT, XCTD.

27 AUGUST 2012: JD 240

0000Z: Underway toward EARS buoy deployment site.

0723Z: Slowed to 2 knts for deployment of EARS Buoy A2- Serial Number 08016.

0755Z

Site: HLY1202 EARS 1

Buoy: EARS A2 08016

Latitude: 73° 19.214' N

Longitude: 157° 21.299' W

Water Depth: 3126 m

Depth of Water column occupied: bottom to 19m above bottom

Date of deployment: 2012-08-26

Date of removal: anticipated October 2013

Navigation system: DGPS

Sounding sensor: Kongsberg EM122

0756Z Coming up to speed – enroute to next buoy deployment station approximately 28 nm north.

1005Z Slowing to launch second EARS buoy.

HLY1202 Cruise Report

1020Z EARS Buoy A1 – Serial Number 09003

Site: HLY1202 EARS 2

Buoy: EARS A1 09003

POC:

Latitude: 73° 48.733' N

Longitude: 157° 29.209 W

Water Depth: 3751m

Depth of Water column occupied: bottom to 19m above bottom

Date of deployment: 2012-08-26

Date of removal: anticipated October 2013

Navigation System: DGPS

Sounding Sensor: Kongsberg EM122

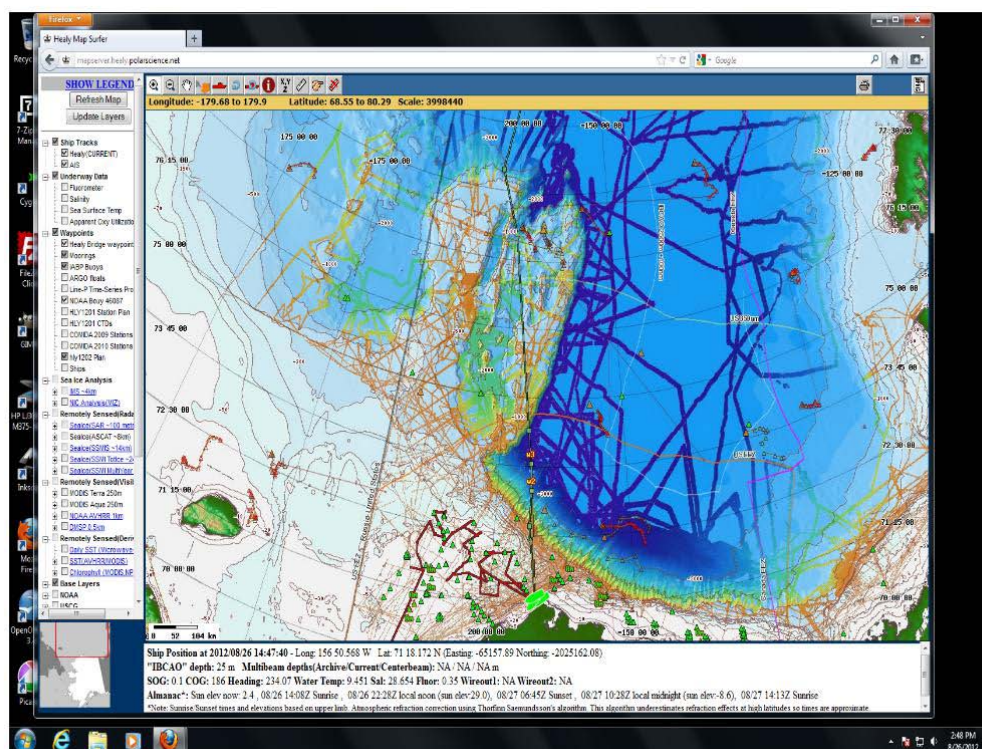


Figure 4-1 - Overview of track leaving Barrow

HLY1202 Cruise Report

1028Z Getting underway to CTD site.

Patch test Plan (Fig 4-2) – go to point A – do deep CTD (3850 m water depth – 150 m above bottom). Do pitch test first (A-B) – up hill then down, then do roll test (A-C).

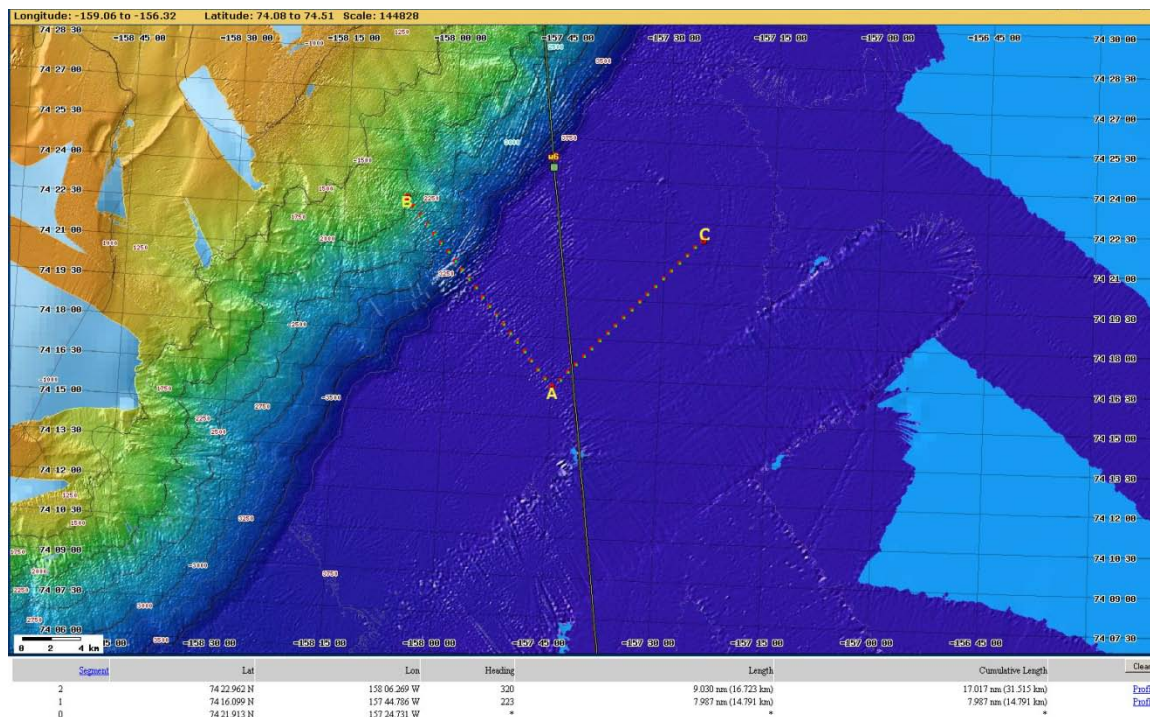


Figure 4-2 CTD Location (A) and Patch Test Plan

1200Z Armstrong on watch

1310Z On Station for CTD.

1320Z CTD in the water. Lat 76-16-03 N, Lon 157-46-20 W.

1420Z Restarted SIS.

1610Z CTD on Deck

1614Z Deployed XBT T-5_00002

1620Z Deployed XCTD-2 C4_00003

1705Z Began Pitch Patch Test line to NW

1714Z Increased speed to 9 kt to reduce ship wallowing.

HLY1202 Cruise Report

1819Z Began Pitch Patch Test line to SE.

1923Z Began Roll Patch Test line to NE

2030Z Began Roll Patch Test line to SW

2000Z Calder on watch

2140Z Completed Roll Patch Test line to SW

2145Z Started Yaw Patch Test line to NW

2242Z Completed Yaw Patch Test line (and patch test). Restarting survey operations and transit north over Northwind Ridge. Patch test showed that no modifications were required to the current configuration of the sonar.

28 August 2012: JD241

0055Z XBT (Deep Blue, Drop 0003, Serial 0088134) launched at 0005Z in 74d 39.254N, 158d 48.52W and installed now; using salinity from CTD 001.

0400Z Mayer on watch – continuing to transit north towards top of Chukchi

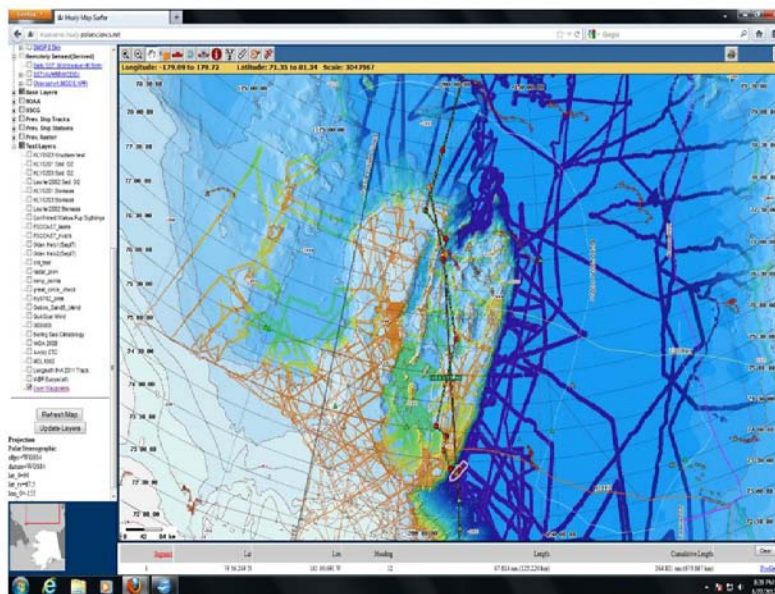


Figure 4-3 Proposed track up Chukchi

HLY1202 Cruise Report

0420Z Bridge notified us that small bergy bits have been seen and that they will maneuver to avoid.

0450Z Slowing to 10 knots due to increased ice presence

0612Z - 0616Z Knudsen showing lots of hyperbolic echos – nothing apparent on real-time MB record though indication in backscatter – ends at big bathymetric step - captured screen on Knudsen.

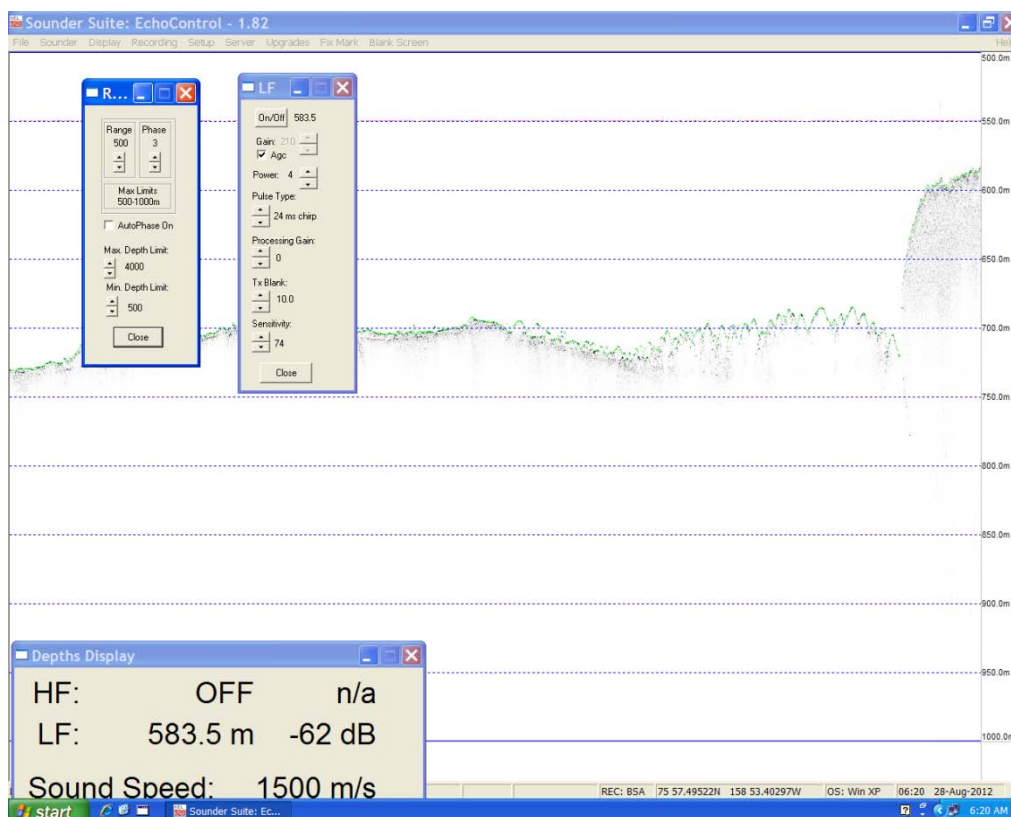


Figure 4-4 - Hyperbolic echos on Chukchi Cap

0810Z XBT (Deep Blue, Drop 0003_2, Serial 000973500) launched at 0800Z in 76d 39.639N, 158d 30.1796W – NB – the file name on did not increment – so this file has been renamed TD_0003_2. Installed using salinity from CTD 01.

0900Z Bridge called to say they were slowing to 5 knots due to ice – there is really no ice to speak of just a few bergy bits – hmmm.

HLY1202 Cruise Report

0915Z Bridge increased speed (without our asking) – back up to 15 knts (though conditions appear to be same).

1600Z Armstrong on watch – continuing transit north-northwestward.

1647Z Reduced speed for XCTD-2, which has a maximum speed of 3.5 kt. XCTD failed—no data passed from probe. Increased speed to 5 kt while ship completes daily check of rescue boats.

1715Z Dropped XBT T5_0007 successfully.

1725Z Boat checks completed, increasing speed to 15 kt.

1800Z Calder on watch – continuing transit north-northwestward.

2115Z During manipulation of the planning module on SIS, there was an apparent loss of data from COM1 that caused many of the real-time indicators to turn red (lack of data). The sonar appeared to continue to ping and collect data during this time, and the problem resolved spontaneously during investigation of the problem in SIS. This appears to have been an issue of display for the most part, rather than an actual data gap.

29 August 2012: JD 242

0005Z XBT launched (Deep Blue, Serial 00888135, Sequence 009) in 79d 53.32N 161d 04.49W. Converted with World Ocean Atlas salinity to give better match to current surface salinity conditions. Speed dropped simultaneously to ~5 kt due to light ice being sighted. Speed recovered to ~7 kt due to increasing presence of noise.

0045Z Larger chunks of ice being spotted, although still small floes of broken up ice in open water (Matt says “streams of heavy loose ice”). Speed of advance variable to accommodate.

0400Z Mayer on watch – preparing to launch an XCTD – this will be one of the UNH XCTD – this is an XCTD3 – which is the high speed XCTD. The CTD software does not have an entry for an XCTD3 so we will use the XCTD1 entry and see what happens.

Software was not compatible with XCTD3 so switching to XCTD2 and slowing to 3 knts.

0430Z XCTD-2 C4_00011 launched (Serial 12078408, Sequence 011) at 80d 27.2827N 160d 20.02734W

We are continuing NNE until we cross our FOS at the 3820 contour – we will then move into Nautilus Basin – we will then turn NW to cross the FoS and follow up A/M Ridge.

HLY1202 Cruise Report

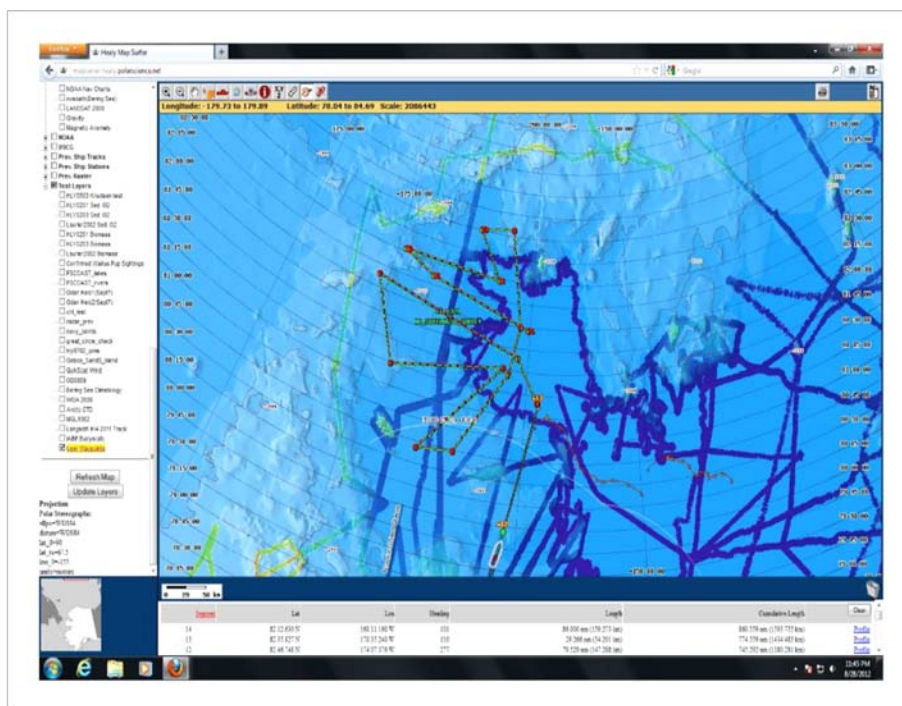


Figure 4-5 Proposed Track for FoS crossings in SW Nautilus Basin

0825Z XBT-T5 launched (Serial # 00349507, Sequence 012) at 80d 54.2622N 159d 42.20996W. Comparison of XBT to XCTD C4 00011 was in near perfect agreement when salinity from XCTD C4 00011 was used. Will leave XCTD C4 00011 as input for sound speed profile.

1118Z Crossing the “FOS” seen in 2007, depth ~3800 m.

1122Z Changing EM-122 to very deep mode.

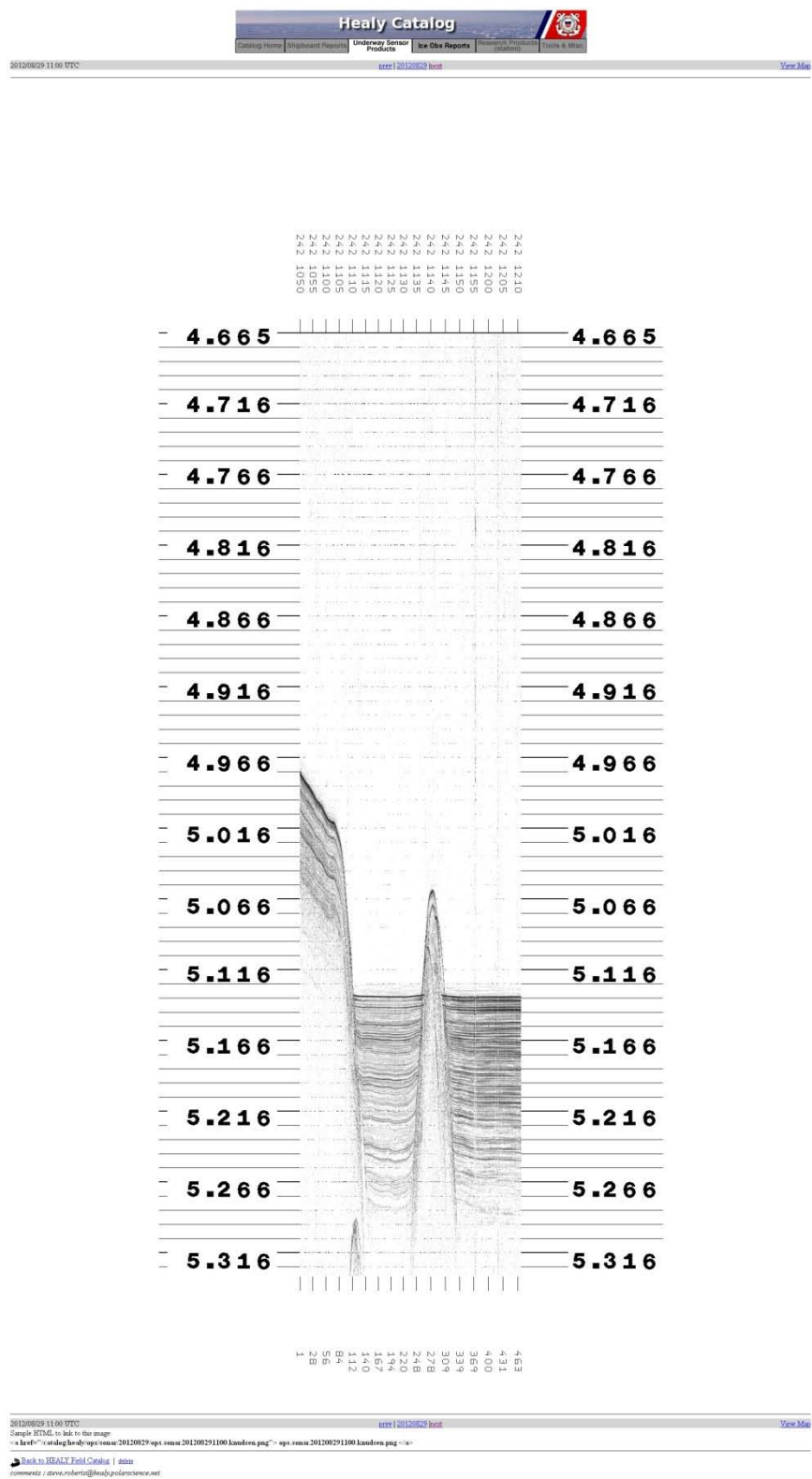


Figure 4-6 Crossing of "FoS" into Nautilus Basin 29 August 2012 1118Z

HLY1202 Cruise Report

1200Z Armstrong on watch

1540Z EM122 is losing bottom track when passing through broken ice at 6 kt. Forcing depth helps, but does not always work.

1620Z Reduced speed from 7 kt to 6 kt and dropped XBT T5_00013 to 1830 m. Profile was essentially identical to 00012, so we did not load a new sound speed profile. Resumed best speed for conditions.

1735Z Discussed speed in ice with bridge, will increase to 7 kt.

1745Z Ship is conducting ice helm training and will be in manual steering. I asked that turn rate and amount be kept to a minimum.

1835Z Altered course to left to begin WNW line onto elevated seafloor west of Nautilus Basin.

2000Z Calder on watch.

2015Z Briefing on the bridge for the OODs for how to drive with vector directions from the science lab.

2355Z XBT launched early since we have a little open water (Deep Blue, Serial Number 00888136, Launch Number 14) in 82d 04.86N 164d 56.08W. Bottom half of the cast appears anomalous, and therefore cast was not applied. Top half of the cast appears to be very close to the previous cast, however.

30 August 2012: JD 243

0030Z Slowed down to attempt to improve bottom lock in large flow of mostly first year ice. Reduction to 5 kt significantly improved bottom, just in time for a sighting of the foot of the slope.

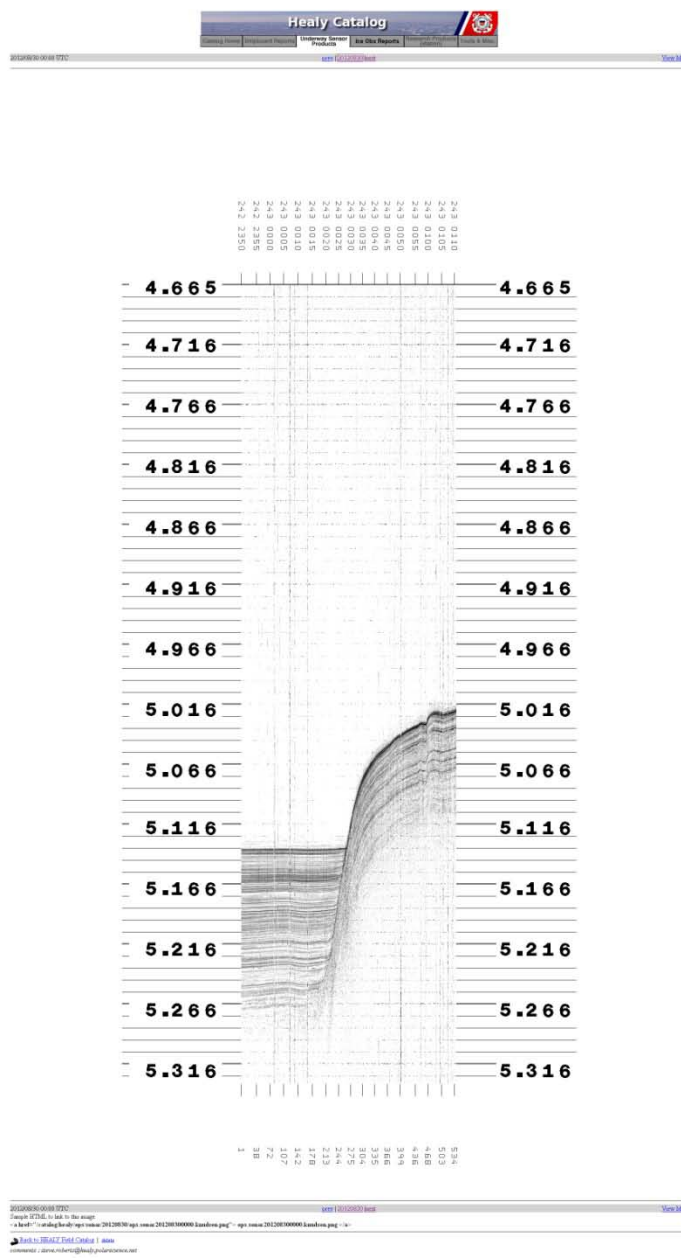


Figure 4-7 FoS coming out of NB onto Mendeleev Ridge

0245Z Confirmation from shore that the XCTD-1 setting in the Sippican software is actually compatible with the XCTD-3s that UNH provisioned for the mission; the problem during the launch yesterday was most likely operator error than a software malfunction.

0400Z Mayer on watch. Continuing NW up the Mendeleev Ridge. Averaging about 6 knots – reasonable data though dropouts in the ice.

0750Z Noticed that when vessel sped up to 8 knots the swath width increased significantly – hmm...

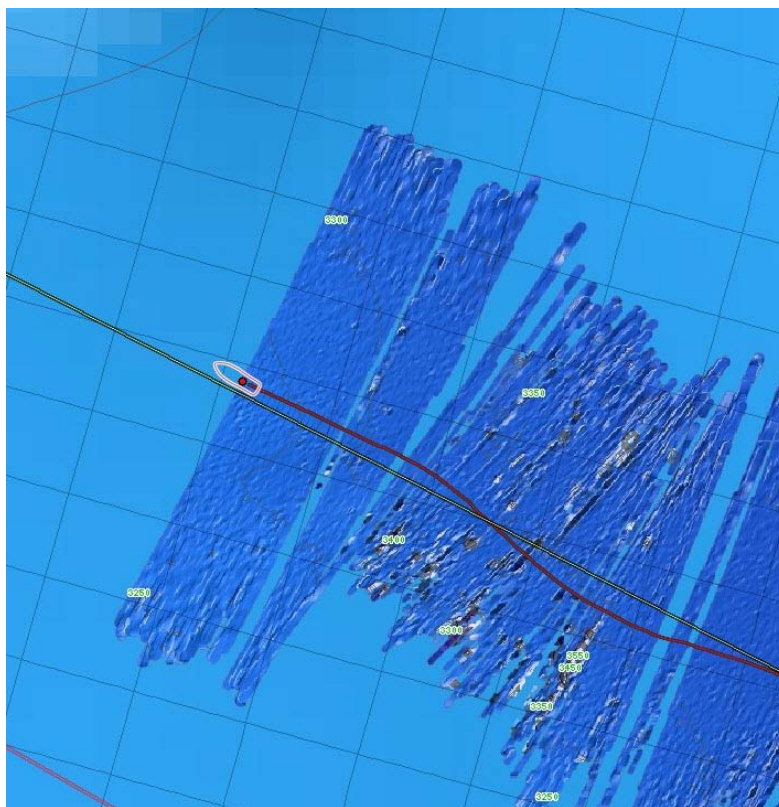


Figure 4-8 6 knots - right - 8 knots left

0800Z XBT launched (T-7, Serial Number 01053458, Launch Number 17) – bad record. We will skip this one and conduct experiment to see effect of increasing speed on quality of MBES record.

0820Z Increasing speed to 8 knots – record has improved but little ice.

0826Z Entering ice at 8 knots – didn't seem to help – will back down to 6-7 knots. Steve pulled out the aloftcon photos and it became clear the changes in record quality were due to ice vs open water.

0908Z Experimenting with fixed angle swath – change to manual mode and fixed angle of 55 deg.

1200Z Armstrong on watch.

2000Z Calder on watch.

2230Z Passing small knoll to port; shoalest depth appears to be in the 2600m range, although the swath only clipped the westward edge. Contours from Map Surfer appear to show that this is isolated, and a 2500m contour is considered unlikely.

31 August 2012: JD 244

HLY1202 Cruise Report

0010Z XBT Launched (Deep Blue, Serial No. 00888139, Launch No. 21) in 81d 32.38°N/172d 51.66W at 2831m. Converted using salinity from most recent XCTD launch and inserted into SIS 0052Z.

0400Z Mayer on watch. Continuing east to WP4 to cross FoS back into NB – will then turn southwest for long run to maritime boundary line and then a line down to Chukchi to start filling in the “the porch.”

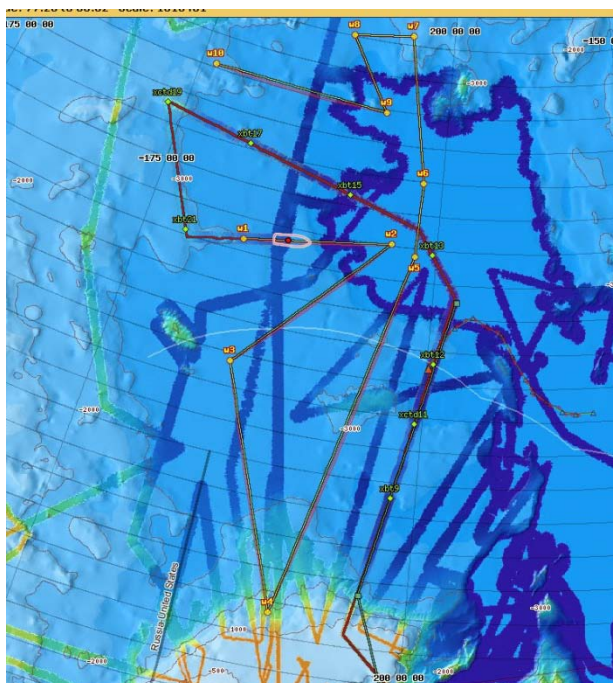


Figure 4-9 Planned tracks for run down western side of porch

0813Z XBT launched (T-7, Serial Number 01053584, Launch Number 23) 81d 40.83398°N/166d 40.85547W. This profile was installed using salinity from XCTD C4)

0845Z Noted that there was a 20d turn made – called bridge – they said they were training in aloftcon – will try to keep straight.

0949Z Crossing the FoS into Nautilus Basin

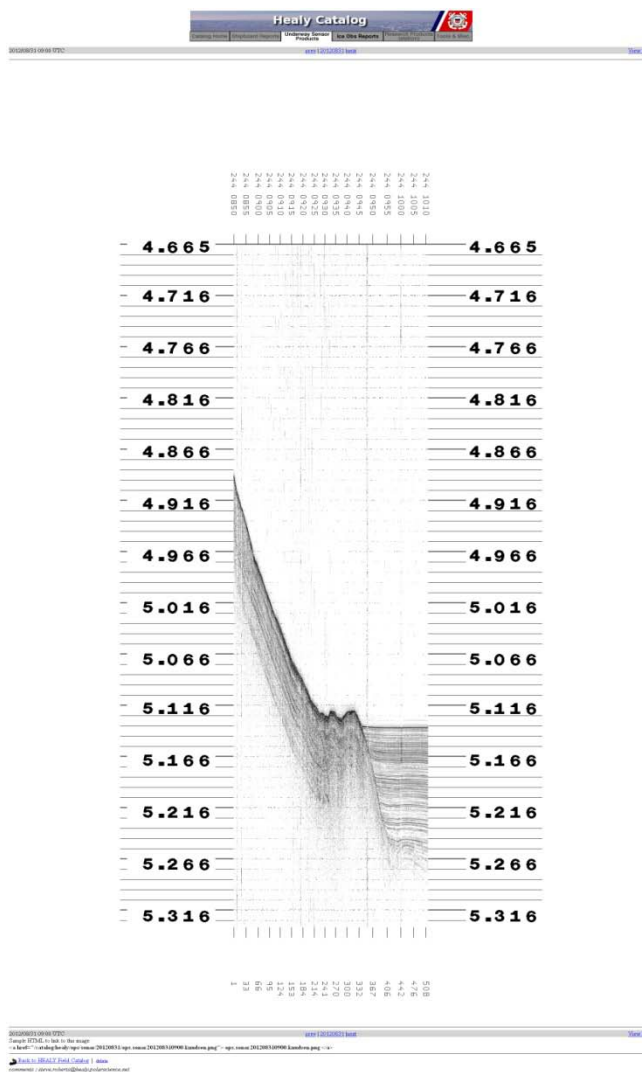


Figure 4-10. FOS crossing into NB 31 Aug 2012

0953Z Swath decreased to 33 deg so we changed mode to VERY DEEP. Equiangle beams

1200Z Armstrong on watch, temperature 27F, snowing

1438Z Changed course to SW for track back across FoS and onto Mendeleev Plain. Ice cover is 6/10-7/10, mostly first year with some multiyear floes. Surface of the ocean is re-freezing.

1642Z Dropped XBT T7_00024. Profile was essentially identical to XBT 23, so did not enter new sound speed profile into SIS.

1820Z Crossed FoS from basin traveling up the slope.

HLY1202 Cruise Report

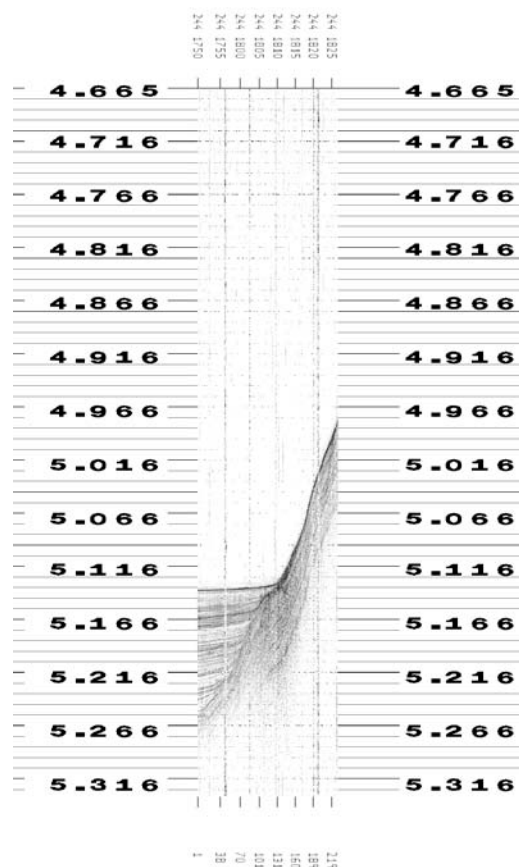


Figure 4-11 Fos Leaving Nautilus Basin onto Mendelev Plain

2000Z Calder on watch.

2015Z Switched EM122 to 'automatic' depth mode, hoping that performance might improve. Found that system switched to 'deep' and stayed there; swath at approximately 54-55 deg. consistently, which is not significantly better (but certainly no worse).

2313Z Switched to high-density equidistant mode on EM122 to see if we can maintain the swath width currently being achieved in equiangular mode.

1 September 2012: JD 245

0005Z XBT launched (Deep Blue, Serial No. 00973845, Launch No. 26) in 80d 59.73°N/167d 21.92°W at 3300m. Converted with XCTD launch 19 salinity, and applied 0040Z.

0040Z Encountered sufficient open water to allow us to speed up to ~9 kts.

0400Z Mayer on watch EM122 is on auto ping mode, in Deep mode, min depth 2500 m, max depth 3500 m, auto 60d 60d, 20,000m, HD Equidistant, actual swath is about 9000m 52d and 54d.

HLY1202 Cruise Report

0405Z Slowing for XCTD –

0414Z XCTD launched XCTD-3 C3_00028 Sequence number 00028 at 80d 31.7832N 168d 41.75781W – looks good – will use this for EM122.

0434Z updated sound speed using XCTD- 00028

0805Z XBT-T7_00030 Sequence 30 @ 79d 49.84033N 167 13.79102W Serial Number 01053460. Looks good – applied to EM122 using XCTD – 00028 salinity.

0828Z Changed max angle to 75d 75d auto as we are about to get shallower

1200Z Armstrong on watch; 28°F, overcast, no ice in sight.

1255Z Reached southern end of line up to Chukchi Plateau; turned to NNE and began line down slope toward Nautilus Basin.

1600Z Dropped XBT T7_00031

1819Z Applied ss profile from 00031 using XCTD 00028 salinity.

2000Z Calder on watch.

2350Z XBT launch (early: open water) (DeepBlue, Serial No. 000888140, Launch No. 31) in 80d 42.85N/162d 59.45W. A confusion on naming at the Sippican terminal means that the launch sequence number was not appropriately incremented, but swapping probe types means that no data was compromised. The converted file name was modified to TD_00031_2 to differentiate from the previous launch (T7_00031).

2 September 2012: JD 246

0225Z Recovered Chief Scientists log after laptop issues; copied to RAID devices in addition to provide a little better safeguard for the current version.

0400Z Mayer on watch – continuing to steam north into Nautilus Basin. EM122 is on auto in DEEP mode, 60d 60d, actual swath 54d 54 d.

0505Z Crossed over into Nautilus Basin – switch to VERY DEEP MODE, manual 55d 55d, equiangular

HLY1202 Cruise Report

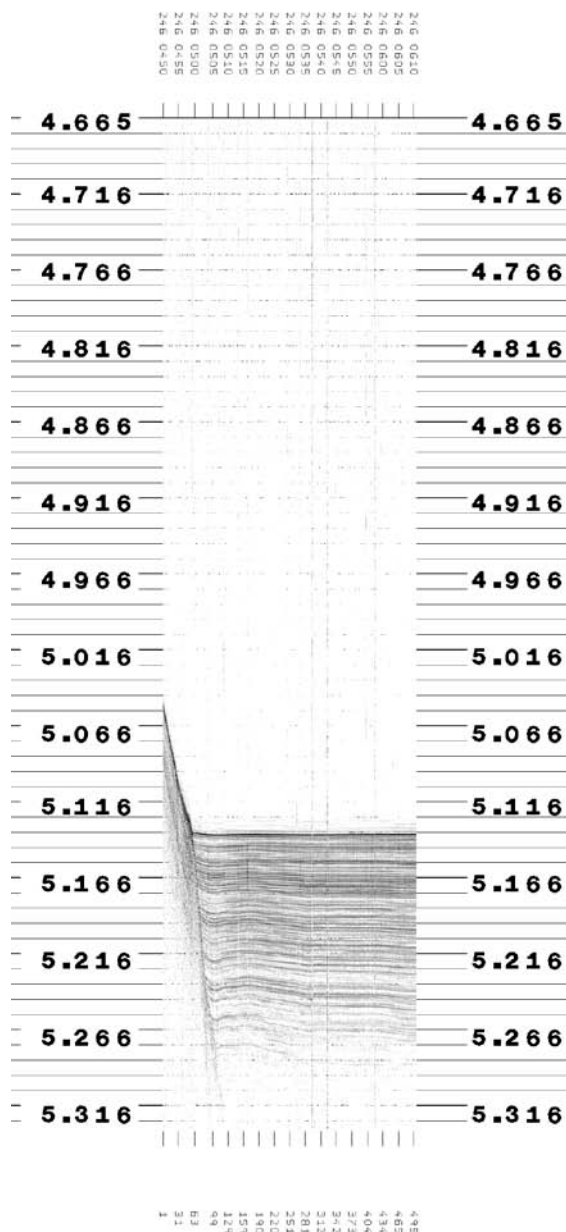


Figure 4-11B. FoS Entering NB 2 Sept 2012

0508Z Changed EM122 to 50d 50d

0510Z Min and max depth changed – 3700 – 3900 m

0800Z XBT T7 T7_00033 Sequence #33 @ 81d 36.67822 161d 16.11523 Serial # 01053456
Looks good – will update sound speed profile with this XBT and salinity from XCTD C4_00011

HLY1202 Cruise Report

1015Z Slowing to take XCTD-2 at request of Jon Wynne. Will stop in open water.

1020Z XCTD-2 C4_00035 Serial # 12078410 at 81d50.31738N 161d 5.04998W
Beautiful fit to last XBT with old salinity – use new XCTD for sound speed profile.

1200Z Armstrong on watch.

1315Z In heavier ice than before; speed has dropped to approximately 3 kt. Losing bottom return.

1345Z Speed has worked up to approximately 6 kt.

1440Z Turned left to run profile to the west. Ice is reducing data quality.

1512Z Changed EM122 run time parameters—filter strength from “weak” to “strong,” range gate from “normal” to “small.” Will evaluate performance effects.

1620Z Widened swath opening to 60° in anticipation of crossing FoS, which is beginning to appear on the Knudsen.

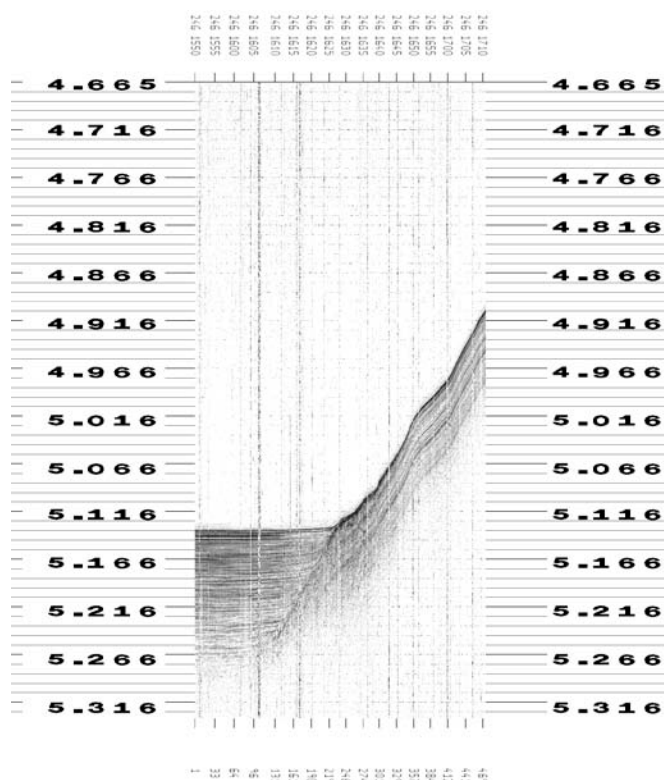


Figure 4-12 Knudsen SBP record crossing FoS out of Nautilus Basin

1630Z Dropped XBT T7_00036 s/n 00973, 605; some unlikely irregularity below 400 m. The derived sound speed profile is otherwise similar to XCTD 00035; we will not enter 00036.

HLY1202 Cruise Report

2000Z Calder on watch.

3 September 2012: JD 247

0005Z XBT launched (T-7, Serial No. 01053585, Launch No. 38) in 82d 32.00'N/168d 19.61'W. Slowed to provide better chance of clean profile in more dense ice coverage.

0058Z Track deviation to avoid a substantial chunk of ice.

0400Z Mayer on watch – steaming WNW up the Mendeleev Ridge – to 2500 m contour – ice thickening – tried switching to deep from very deep mode but bottom tracking was poor – switching back to very deep mode. Now equiangle very deep manual 60 60 - but only receiving 30 30 so will bring angle into 50 50. Bringing max depth to 3500 m from 3800. Still doing 6.4 knots. -1.73 deg – clear

0512Z Shallow feature to the starboard – having them come right a few degrees. Change swath to 60 60

0800Z Slowing to take XBT-T7 -- also polar bear spotted 1 mile to starboard.
XBT T-7 00039 Sequence 39 at 82d 40.36914N 174d 34.71875W – will use with XCTD C4-00019

0830Z Large multiyear flow ahead – will work around to right (N)

1200Z Armstrong on watch; traveling SW on line down slope to Nautilus Basin

1610Z dropped XBT T7_00041 s/n 0153453 at 82-46.75N 169-57.98W. Closely matches 00039; no change in sound speed profile entered.

2000Z Calder on watch.

2005Z Outgoing watch reported PC clock time on SIS machine is different by several minutes from the PU time. Chayes confirmed that the time on the PC was different, but that it is not used in the datagrams, only in error message logs. This difference is therefore not significant.

2018Z Attempting back-and-forth (even though we're not stuck) to recover bottom after extended data loss due to ice thickness. A small communications difficulty caused a little delay; deployed scan-tilt mode on EM122 to capture more data while getting this resolved.

2210Z Stopped to take XCTD in solid ice. Scan-tilt mode on EM122 attempted; ice under keel means that we're not getting much. XCTD-2 launched (Serial No. 12078412, Launch No. 43) in 82d 43.82N/165s 23.81W; looks good, will apply. Underway 2220Z.

2230Z Passing apparent (although less than fully distinct) FOS heading from Alpha-Mendeleev Ridge onto Nautilus Basin:

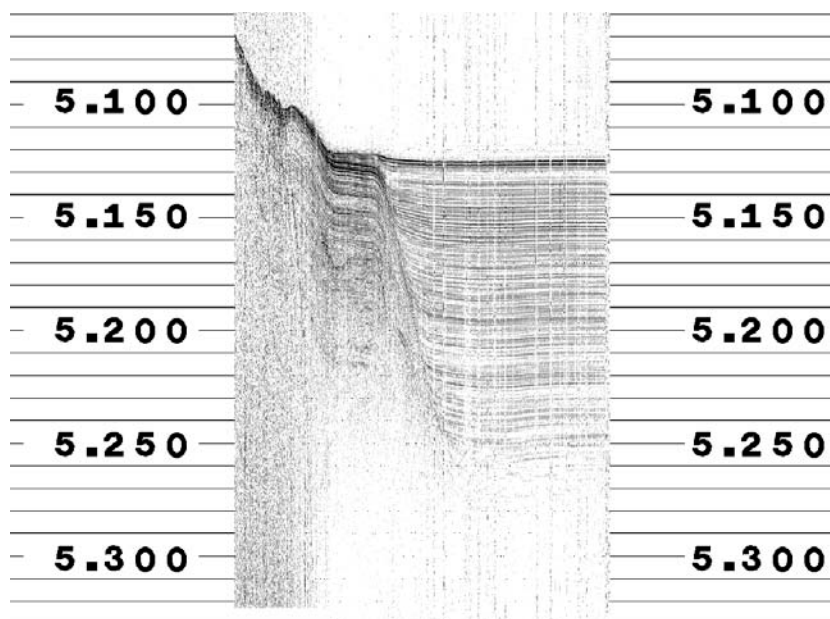


Figure 4-13: Knudsen SBP profile of Foot of the Slope going from Alpha-Mendelev Ridge into Nautilus Basin.

4 September 2012: JD 248

0000Z Relying on previous XCTD rather than repeating XBT launch on schedule (i.e., < 2 hr from last cast).

0200Z Passing apparent FOS heading from Nautilus Basin onto Alpha-Mendelev Ridge.

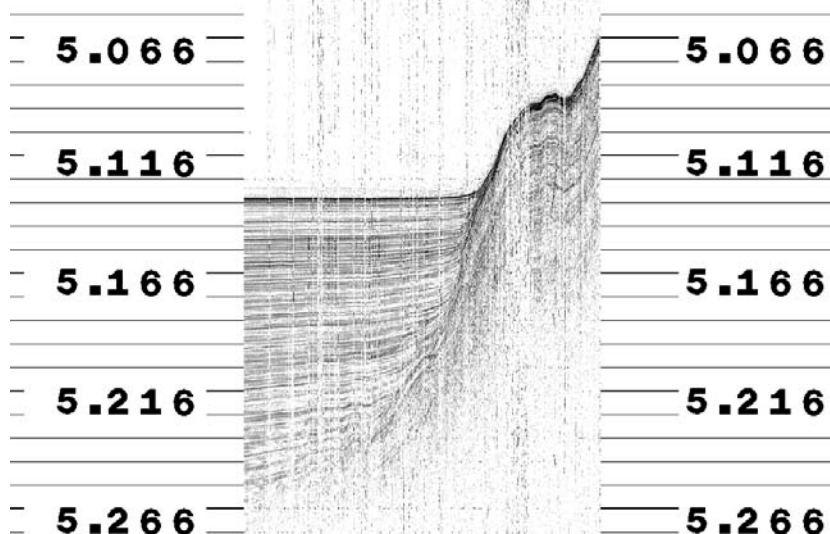


Figure 4-14: Knudsen SBP profile of Foot of slope crossing from Nautilus Basin onto Alpha-Mendelev Ridge

0400Z Mayer on watch – moving up A/M Ridge after crossing FoS – moderate ice yet very poor bottom tracking – have switched to Deep mode – equiangle – 60 60. Have asked to slow down to 2 knots to see if we can get the bottom – and then will speed up. Steve suggests shutting off “penetration filter” in filter and gain menu – will try and see what happens.

HLY1202 Cruise Report

0434Z Back to Very Deep Mode at Steve's suggestion.

0620Z Took XBT-T7_00045 Sequence #45 Serial Number 01053589 – at 83d 18.10156N 166d 32.85547W – XBT was good to 680 m then broke – identical to XCTD C4_00043 – so will just continue to use XCTD C4_00043.

0630Z We have noted a distinct improvement in the noise at the sector boundaries – this may be related to the removal of the penetration filter

0754Z Slowing to 4.5 knots to see if it improves data quality.

1050Z Some data lost on port side because – depth range was set too narrow – minimum was set to 2500 m – minimum now changed to 2000m

Looking at lines on western side of “porch” where they come off the higher part of the porch (to east) to see if an argument can be made to put the FoS there – here are the two lines:

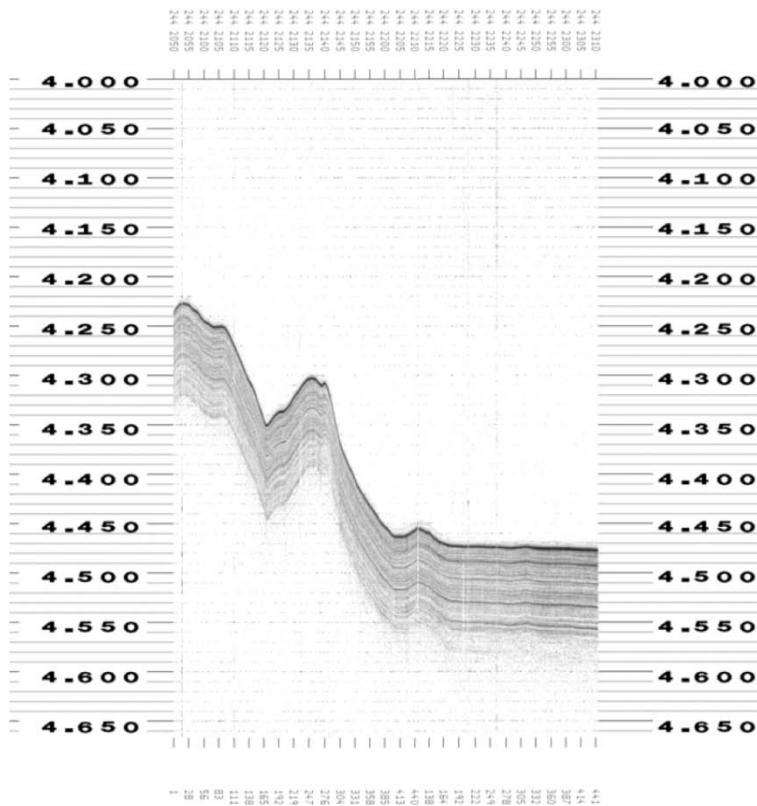


Figure 4-15 Day 244 2050-2310Z

HLY1202 Cruise Report

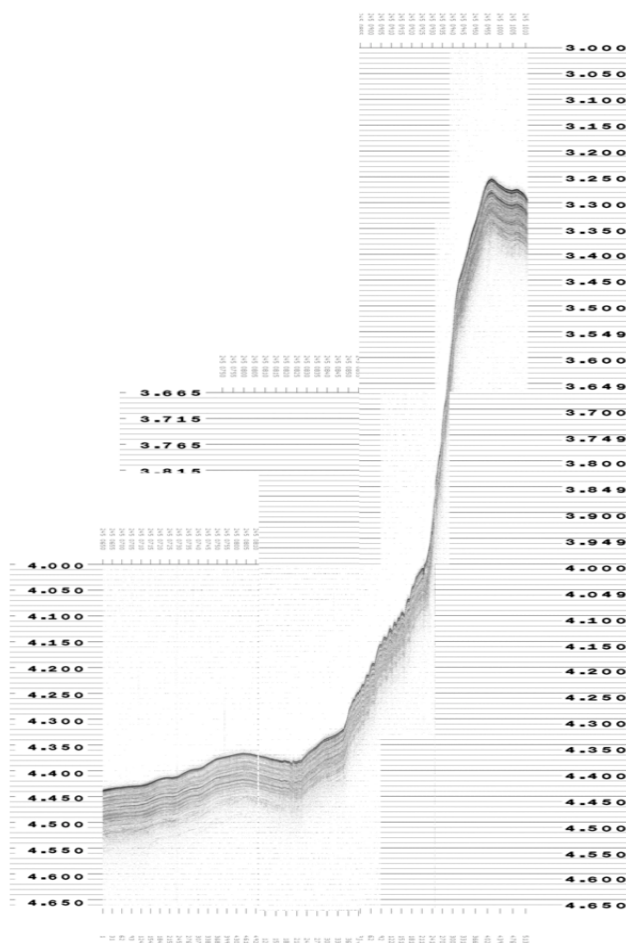


Figure 4-16 8 245 0650-1010Z

1200Z Armstrong on watch

1317Z Crossed 2500-m contour

1335Z Turned to south on planned track

1515Z Had to stop, back, and ram to move through heavier ice. Frequently losing EM122 data

1620Z Stopped for full-depth CTD with water bottles; about 2750 m.

1648Z CTD in the water.

1720Z Ocean Acidification team obtained ice sample from bucket over the side.

1849Z CTD cast complete; CTD on deck

1852Z Resuming mapping headed S toward Nautilus Basin.

2000Z Calder on watch.

2311Z Passing the Foot of the Slope moving onto Nautilus Basin:

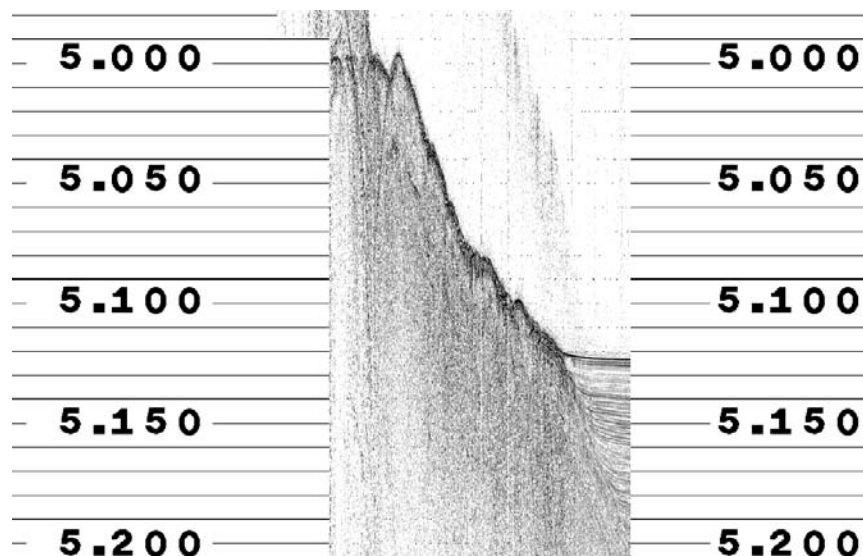


Figure 4-17: Foot of the Slope transiting into Nautilus Basin (JD248 2310Z)

Note that the slope immediately prior to this transition is steep, and might make a decent dredging target, although the morphology exposed by the MBES data indicates a series of canyons that might make finding a simple slope difficult.

5 September 2012: JD249

0005Z XBT launched (T-7, Serial No. 00105359, Launch No. 47) in 82d 52.92'N/162d 13.11'W.

0050Z Slowing to a halt in a large floe in order to deploy an ice buoy (by crane operations) and take a second ice sample.

0132Z Buoy deployment complete; starting back to track.

0400Z Mayer on watch – continuing at 5.5knots west for crossing of FoS and to pickup shallow feature to west. MB is on VERY DEEP, 60 60, ice is 9/10 of first year ice and swath is quite narrow. Will experiment with settings on transit across basin.

0508Z Disabling FM as an experiment.

0514Z Enabling FM – swath was less robust and narrower – real question is whether it helps outer sector ripple – we will see when processed.

0700Z Laying out tracks for next several days – will start filling gaps on “front porch”

HLY1202 Cruise Report

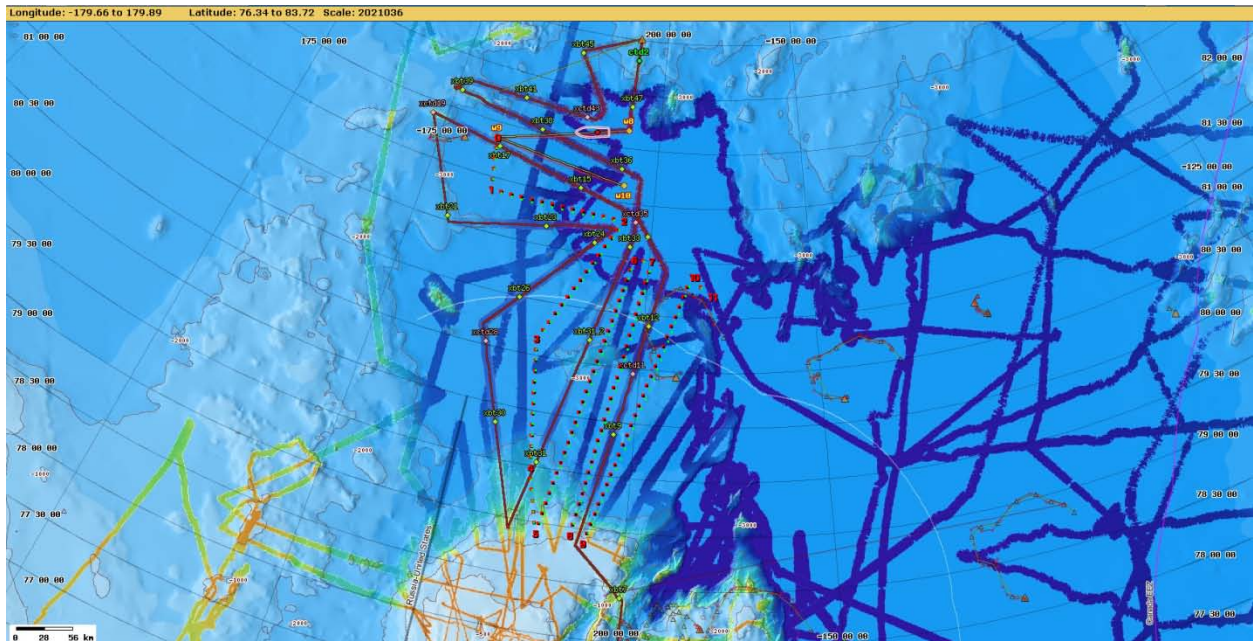


Figure 4-18. Survey Plan 4 Sept

0800Z Slowing for XBT – T5 – first broke at 50 m – second broke at 900 m but deep enough to use – this is Sequence Number 48 (both had same number). T5_00048 at 82d 35.6543N 164d 58.27539W Serial Number 00349512. File did not overwrite – so second XBT is labeled XBT-00048_2. Neither will be used as they are very close to CTD-002 and XCTD-00043. XCTD-43 will be used.

0855Z Crossing the FoS out of Nautilus Basin – much less pronounced and in several steps.

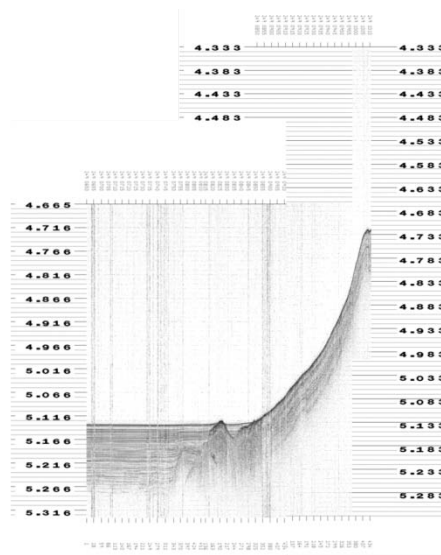


Figure 4-19 FoS JD 249 0830Z

1200Z Armstrong on watch

HLY1202 Cruise Report

1700Z Passed over knoll from 31 Aug at waypoint w9 as shown in figure 18 to see if 2500-m contour exists. First pass suggests not, but we are doing a 270° turn to pass over a gap in coverage and resume track to south.

1800Z Completed second pass over knoll and resumed track. Did not find 2500-m depth.

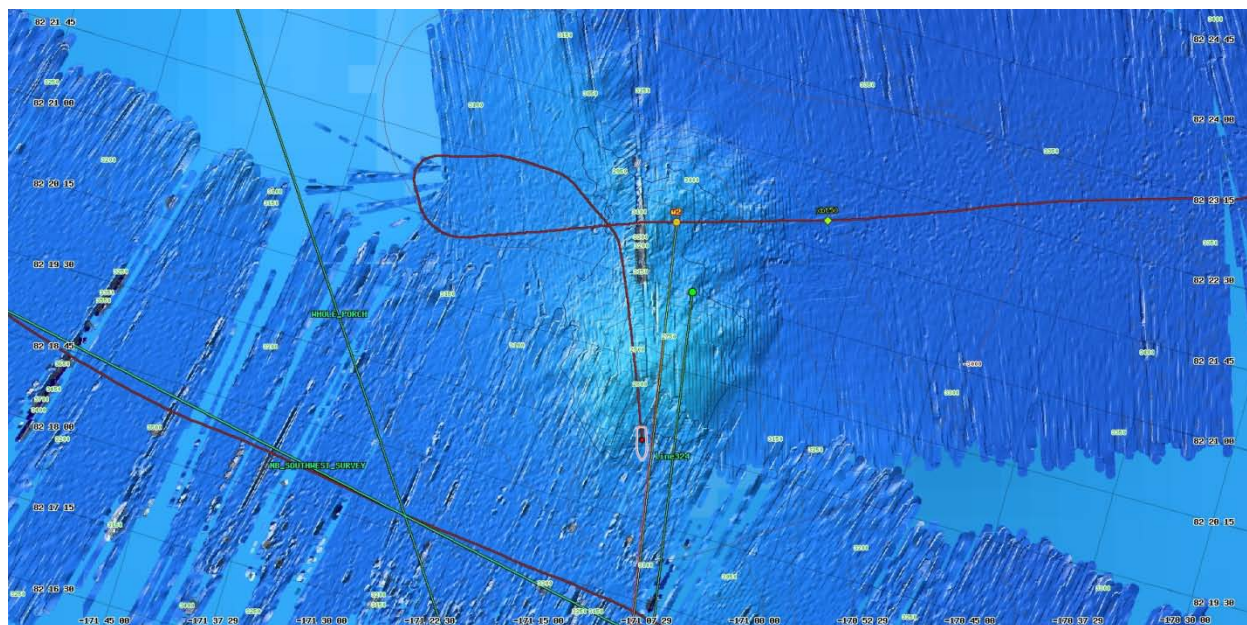


Figure 4-20 Development of knoll

2000Z Calder on watch.

2140Z XBT 50 discovered not to be entered; formatted and uploaded.

2310Z XCTD-2 launched (Serial No. 12078409, Launch Seq. 52) in 81d 52.88'N/170d 28.77'W. Data capture stopped after 1200m, but profile above that depth appears good. Profile shows small changes at ~50m from previous profile, and will be entered.

6 September 2012: JD 250

0400Z Mayer on watch – steaming 6 knots to east minimal ice though patches appear at times – MB set on Very Deep mode equiangle – 60 60 \

0555Z Crossed the FoS into Nautilus Basin

HLY1202 Cruise Report

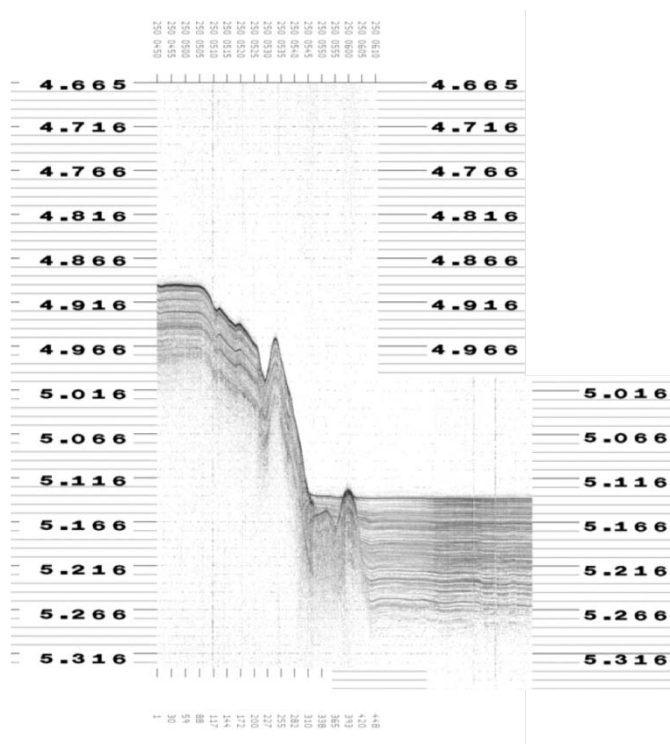


Figure 4-21. FoS - 250_0520Z

0800Z XBT taken – XBT-T7_00060 Serial Number 01053461 at 81d 51.5581N 164d 1.28906W . There is a strange kick in the XBT – Steve will see if others around had this – he is concerned that the props were not disengaged and that ice hit wire. **CONCLUSION** – it was real – use XBT_00060 with XCTD_0035 salinity.

1200Z Armstrong on watch.

1530Z Crossed FoS southbound onto northern slope of Chukchi:

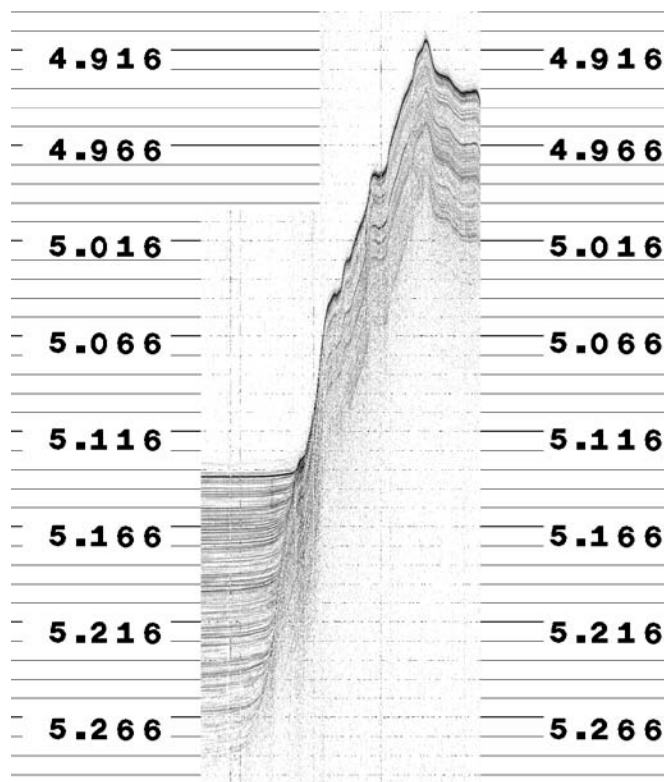


Figure 4-22: Foot of the slope going from Nautilus Basin onto Chuckhi Plateau (Day 250, 1530Z).

1620Z Dropped XBT T7_00062 s/n 01118650; negligible difference from 00060; did not apply.

1737Z Increasing speed to about 10 kt while we are out of the ice.

2000Z Calder on watch.

2040Z No ice ahead; bridge has brought another main on line, and will proceed at 12 kt.

2050Z General alarm sounded due to a burst pipe in the CO₂ room at O1-65; watch to the science conference room for muster.

2125Z Back on watch after stand-down from general (the leak is isolated).

2140Z Switched MBES to automatic swath mode, high-density beamforming and automatic ping mode (which put us into Deep mode, with dual ping on). Monitoring for swath width to see whether it's worthwhile to switch back to Very Deep.

2336Z Returned to Very Deep mode to see if performance is improved in current conditions.

2355Z Launched XBT (Deep Blue, Serial 00888144, Launch Seq. 64), but probe appeared to be defective; launched T-7 to confirm (Serial No. 01118646, Launch No. 66) in 80d 06.31N/165d 27.74W; second launch good, will be used (with salinity from nearest XCTD).

7 September 2012: JD 251

0025Z Ship slowing to 11kt; can't sustain 12kt on one main, but can't run efficiently at 12kt on two mains. Will assess data quality for an hour, and then decide whether to stick at one main or increase to two.

0400Z Mayer on watch. Running south up onto the Cap – about 12 knots in open water with bright sun – are really in the Arctic? MBES is running on auto in Deep Mode – 60 60 data looking good.

0650Z Starting turn back up north – will take an XCTD once steady on course.

0655Z Launched an XCTD-3 – broke at 20 m – will try again with an XCTD-2 and slowing down.

0703Z Launched an XCTD-2 while dead slow – wire broke at 75m out – will try one more

0730Z XCTD-3 taken – this one worked. XCTD-C3_00072 Serial number

0754Z Disabled FM to see if it cleans up outer beam problems that appear to have been accentuated with vessel motion.

0913Z FM enabled

1200Z Armstrong on watch

1300Z Processing watch reports no discernible difference between FM 'off' and FM 'on' in outer beam data quality.

1503Z Reduced speed because of appearance of some ice bits.

1617Z XBT T7_00074 s/n 01118642 dropped successfully.

1705Z Minimal ice, but visibility somewhat limited by wet snow. Will increase speed.

1743Z Reducing speed to 6-7 kt as we enter marginal ice zone.

2000Z Calder on watch. Intermittent ice and wet snow. MBES in automatic mode for aperture, depth mode and dual swath; currently in high-density equidistant beamforming mode, and deep depth mode.

2340Z Passing foot of the slope heading into Nautilus basin:

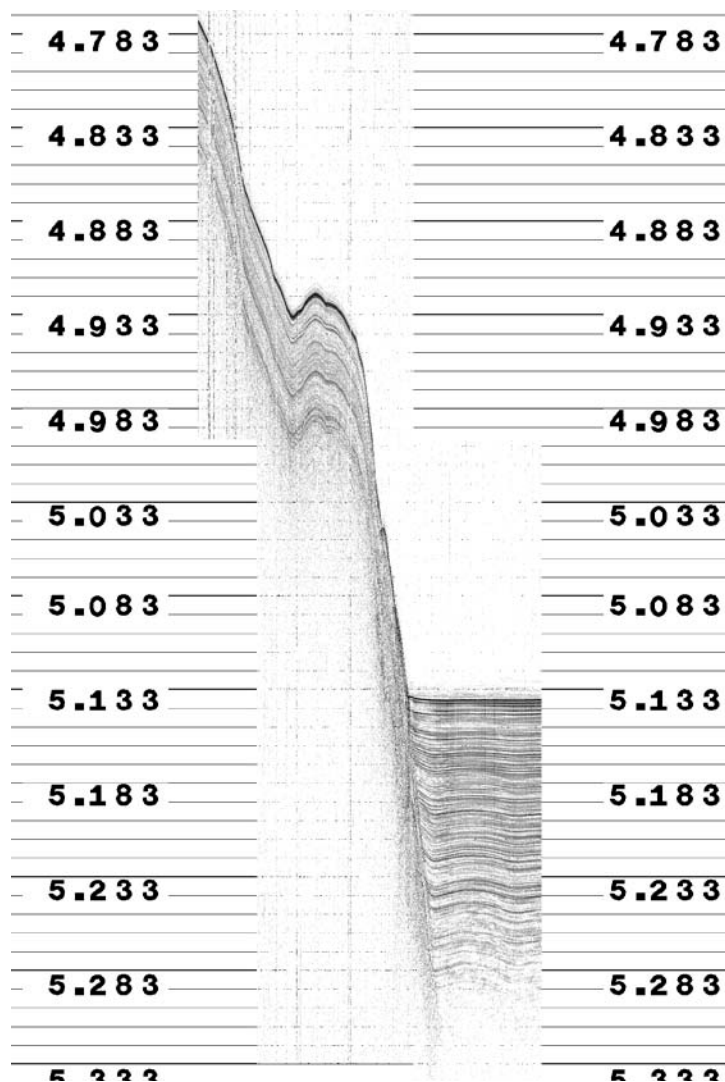


Figure 4-23: Foot of the slope going from Chuchki Plateau to Nautilus Basin (Day 251, 2340Z)

8 September 2012: JD 252

0003Z Put system into manual aperture with maximum gate of 55 degrees on each side in an attempt to improve overall swath width. Swath width is being affected much more strongly by the current ice conditions than was previously the case in this location.

0020Z XBT launched (T-7, Serial No. 01118643, Launch No. 76) in 81d 20.72°N/161d 08.64°W.

0800Z Mayer on watch. Clear skies minor amounts of ice. Steaming south at approximately 7.2 knots MB on manual equiangle 60 60. Should be approaching FoS soon.

0530Z Crossing the FoS moving out of Nautilus Basin.

HLY1202 Cruise Report

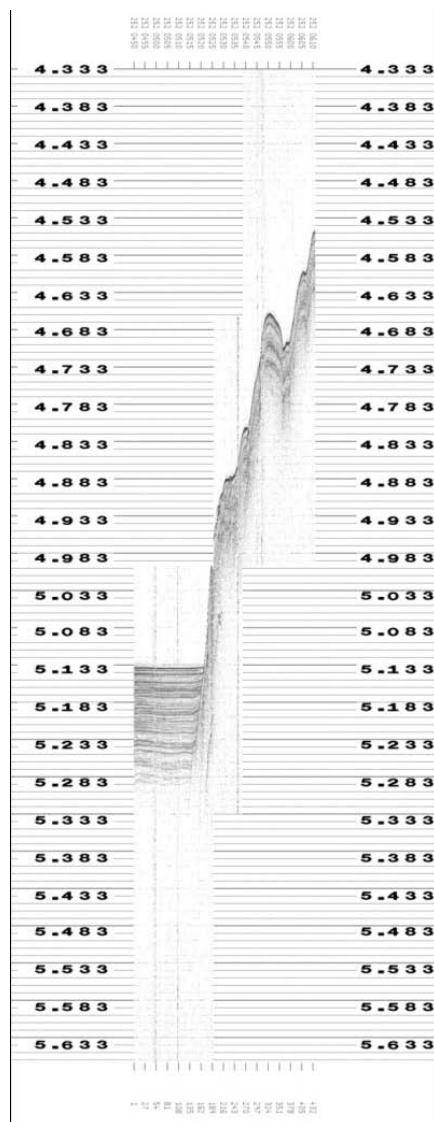


Figure 9 FoS JD252_0530Z

0740Z Ice is abating – open water – will change sonar to auto ping mode and auto angular coverage – HD equidistant.

0800Z XBT_T7_00078 Serial Number 01118647 at 80d 57.14014N and 160d 31.23926W. Good profile to 760 m. Will use this with XCTD C4_00011 salinity.

1200Z Armstrong on watch

1300Z Increased speed to 12 kt in open water.

1630Z Launched XBT T7_00080. Applied at 1651Z with salinity from CTD C4_00011.

HLY1202 Cruise Report

1845Z Lost some EM122 data due to depth filter setting.

2000Z Calder on watch. Completion of buoy deployment during watch change. Ship is now heading back to track, and will come up to 12 kt until we sight ice. Meanwhile, the engine room is working on some self tests as required for preventative maintenance. This should, apparently, be transparent to us. (It says here.)

2105Z Ship coming to 14 kts in order to conduct engine tests.

2315Z Engineering testing completed, coming back to one main and attempting to maintain 11-12 kt depending on sea and ice conditions.

9 September 2012: JD 253

0005Z XCTD launched (XCTD-3, Serial No. 11074186, Launch No. 82) in 79d 40.04'N/160d 45.72'W.

0400Z Mayer on watch – sunny -2 deg outside – no ice just a few bergy bits – steaming 10.5 knts MBES on auto settings – equidistant deep 60 60

0600Z Speed being adjusted as ice and fog comes and goes.

0800Z XBT-T7 launched (XBT-T7, Serial No. 01118652, Launch No. 84 at 80d 53.82617N, 158d 55.12207W -- looks good will use with XCTD-C3 No. 82 for salinity.

1020Z Into the ice – changing to manual equiangular, very deep mode – to recover bottom.

1111Z Crossing FoS into Nautilus Basin

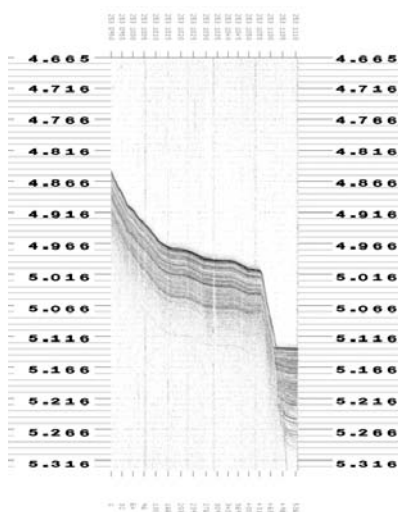


Figure 4-25 FoS 253_1100Z

1200Z Armstrong on watch. Traversing Nautilus Basin in light ice cover.

HLY1202 Cruise Report

1315Z Making gradual turn to east.

1415Z Turned to south.

1600Z Crossing FoS.

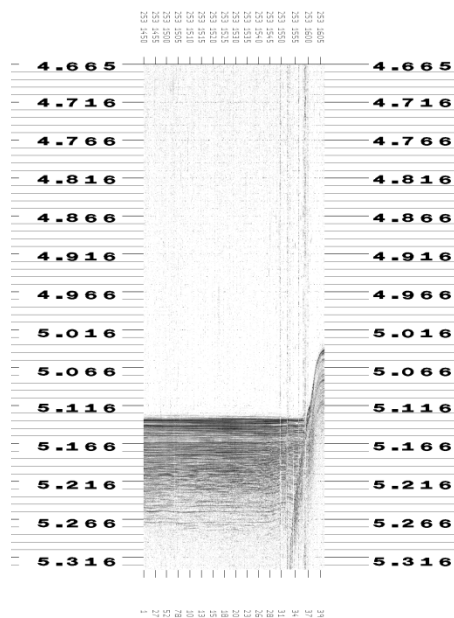


Figure 4-26 FoS 253_1615Z

1615Z Dropped XBT T7_00085 s/n 01118648; record looks good. A thin sheet of new ice is forming over open water.

1636Z Entered new sound speed profile using XBT 85 with salinity from CTD 11.

1750Z Increasing speed as we leave the ice.

2000Z Calder on watch. Continuing at 12kt in mostly ice-free water, with occasional speed reduction when ice is sighted.

2345Z XBT launched (T-7, Serial No. 01179027, Launch No. 87) in 79d 51.96°N/159d 52.13°W. Profile matches XCTD launch 82 very closely below the surface layer to ~20m, so converted with salinity from XCTD launch 82, and applied 2012-254/0010Z.

10 September 2012: JD254

0310Z Changed to 'drive by cursor,' providing the bridge with waypoints from the SIS console and having them keep to the line. The cross-track error on SIS appears to be approximately functional, although the 'time to waypoint,' 'range,' and 'time to arrive' appear to be tracking something other than the first waypoint. It is currently unclear why this is the case.

HLY1202 Cruise Report

0400Z Mayer on watch – continuing to drive by cursor – have given them an end point and from there they will head to WP 5 on the original track. All settings on auto – open water.

0800Z XBT launched (DB, Serial No. 01179023, Launch No. 89) at 79d 41.99951°N/159d 6.66797W. Profile matches XCTD 82 – will use this with the XBT for SVP.

1200Z Armstrong on watch.

1600Z Dropped XBT T7_00091; broke off at ~200 m. Dropped another, which was inadvertently also labeled T7_00091. Good cast, applied new sound speed profile using salinity from nearby XCTD C4_00011

1730Z Suffering loss of coverage on port side. We examined the flow of water off the bow and stern, and could detect no indication that ice was lodged under the hull.

1745Z Still suffering loss of data on the port side. Coverage seems to come and go. Spoke to bridge and they indicated that no unusual steering or engine operations were taking place.

1800Z Began 360 degree turn to starboard to see if something might dislodge from under the hull.

1820Z Concluded that turn did not resolve the problem. Will stop and back down to see if that helps.

1845Z Resumed track; backing seems to have resolved the problem. Will monitor.

1900Z Began seeing problems again, but will wait and see what happens.

1945Z Situation seems to be improved.

2000Z Calder on watch. Data issues continue. Switched to manual angular sector mode to avoid the system tracking conservatively, and this appears to help slightly. The problem appears to be worse in areas where there is very thin ice coverage; the consensus appears to be that the problem is to do with very thin ice moving conformally across the hull, rather than breaking. The asymmetry is likely due to a general weakness of returns on the port side which is evident at all times. Deviating either north or south to improve sea ice conditions would reduce the utility of the line (and we would have to travel further than just going to the end of the line).

2330Z Ship transitioned into open water, and the swath width recovered very quickly. This seems to support the suggestion that the problem is the particular form of ice that has been encountered for the last few hours.

11 September 2012: JD 255

HLY1202 Cruise Report

0000Z XBT launched (T-7, Serial No. 01118645, Launch No. 93) in 80d 49.79'N/162d 32.24'W. Converted with salinity from XCTD-3 Launch No. 28. Added 0032Z.

0005Z Moved back into thin ice, and port side swath dropped out again; moved to heavier ice and the swath recovered. More evidence to suggest that the problem being observed is being driven primarily by the ice type.

0400Z Mayer on watch – steaming west at about 10 knots – MBES set on manual mode equiangular 60 60 Very DEEP

0800Z XBT taken - XBT launched (T-7, Serial No. 01053466, Launch No. 95) in 80d 31.48242N/170d 11.63477W. Converted with salinity from XCTD-3 Launch No. 28.

1105Z At end point of line running west – switching over to all AUTO settings on MB as we are ice free. Will take XCTD-3 after turn is complete.

1135Z XCTD taken – XCTD-3 , Serial No. 11074183, Launch No. 97) in 80d 19.70459N/173d 13.54883W. Good cast – Steve will enter

1152Z XCTD-C3-00097 entered for SVP

1200Z Armstrong on watch

1620Z XBT T7_00099 s/n 01118653 dropped successfully and entered with salinity from XCTD 00028.

2000Z Calder on watch.

2050Z Bridge requested a track deviation to assist in staging wind-flow across the flight deck; requested that they slow down in order to minimize deviation during subsequent events.

2100Z [Mayer] Photo on the hanger deck – Davey Jones and crew visited and took WOGS away – what will become of them we do not know.

2252Z Spotted ice ahead; slowing to 6 kts.

12 September 2012: JD 256

0005Z XBT launched (T-7, Serial No. 01118606, Launch No. 101) in 80d 23.48'N/160d 45.61'W. Small deviation from track (mainly in heading) due to ice push while slowed to allow for stable launch.

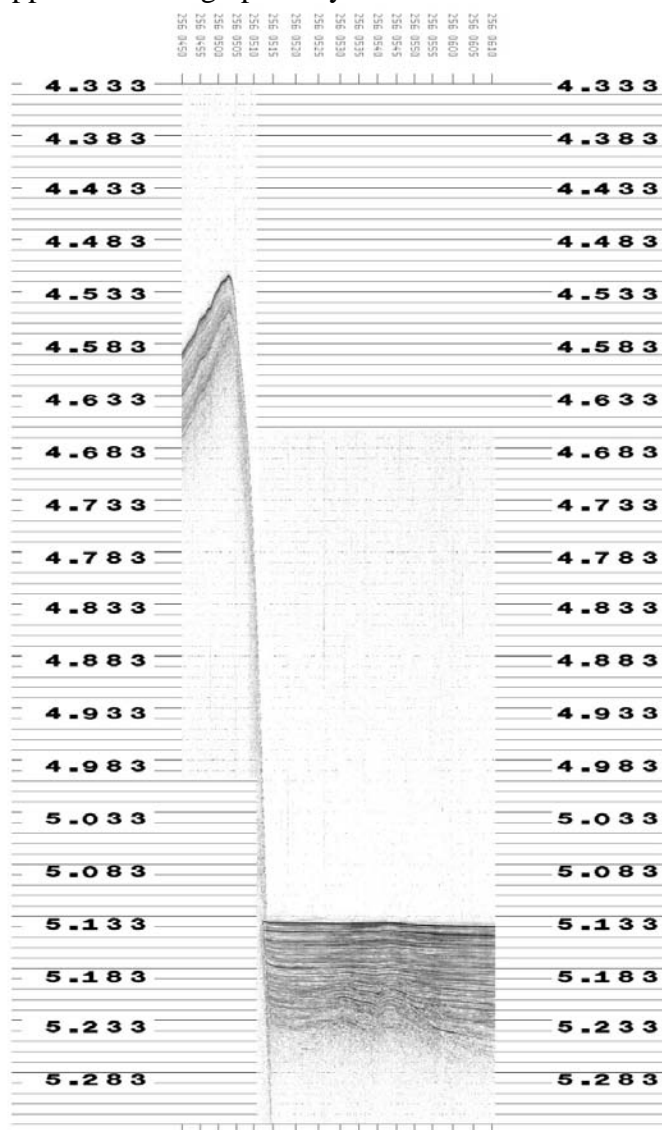
0050Z Flow through TSG feeding sound speed to the MBES stopped; switched to manual sound speed while troubleshooting the cause.

0105Z Back to sensor source on MBES since TSG is recovered from an O₂ sensor failure.

HLY1202 Cruise Report

0400Z Mayer on watch – coming to eastern end of line – MB set on Auto Ping Mode – Equidistant HD 60 60 actual 47 49 some ice moderating speed between 5 and 12 knots depending on ice conditions. Temp -3 C – -12 with wind chill.

0515Z Crossing what appears to stratigraphically be FoS across basin from “foot” structure.



HLY1202 Cruise Report

1140Z Slowing for XCTD-2 at request of Jon Wynne.

1150Z XCTD taken – XCTD-2 , Serial No. 12078407 , Launch No. 105 at 79d 45.88232N/155d 39.3457W. Good cast.

1200Z Armstrong on watch. Following track to fill gaps in coverage.

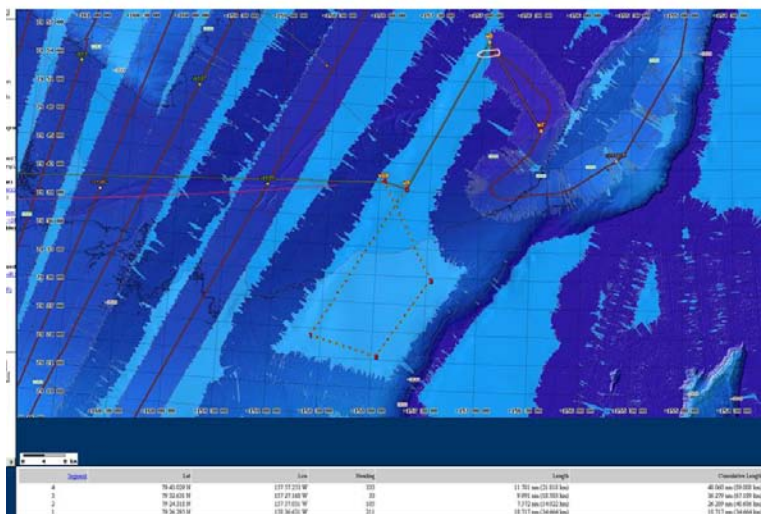


Figure 4-28 Plan to fill in gap in coverage

2000Z Calder on watch. Routine survey in mostly open water (with some motion!)

13 September 2012: JD 257

0005Z XBT launched (Deep Blue, Serial No. 001179022, Launch No. 109) in 79d 41.62'N/160d 26.34'W.

0400Z Mayer on watch – continuing to steam west – MB set on auto – very deep mode – 60 60 actual coverage 54 52. Snowing - -1C -9C with wind chill

0408Z Bridge will be practicing driving from AFTCON – will have to slow down to try out bowthruster.

0430Z Finished testing bowthruster

0640Z Seastate has picked up quite a bit and data degraded – in particular lost port side beams -- bridge had slowed to 9 knots – Steve suggested speeding up to 11.5 and that actually helped significantly – clearly HEALY's EM122 performs better at high speed in rough seas.

0800Z XBT launched (T-7, Serial No. 01053470, Launch No. 111) in 79d 30.6855'N/168d 05.69922'W. Looks good – entered with XCTD-0082

1007Z Slowing to launch XCTD-3 at request of Jon Wynne.

HLY1202 Cruise Report

1010Z XCTD-3 launched (Serial No. 11074185, Launch No. 113) in 79d 23.88916N/169d 33.32812W. Looks good – will use.

1200Z Armstrong on watch. Mayer completed final plan for survey of dredge site.

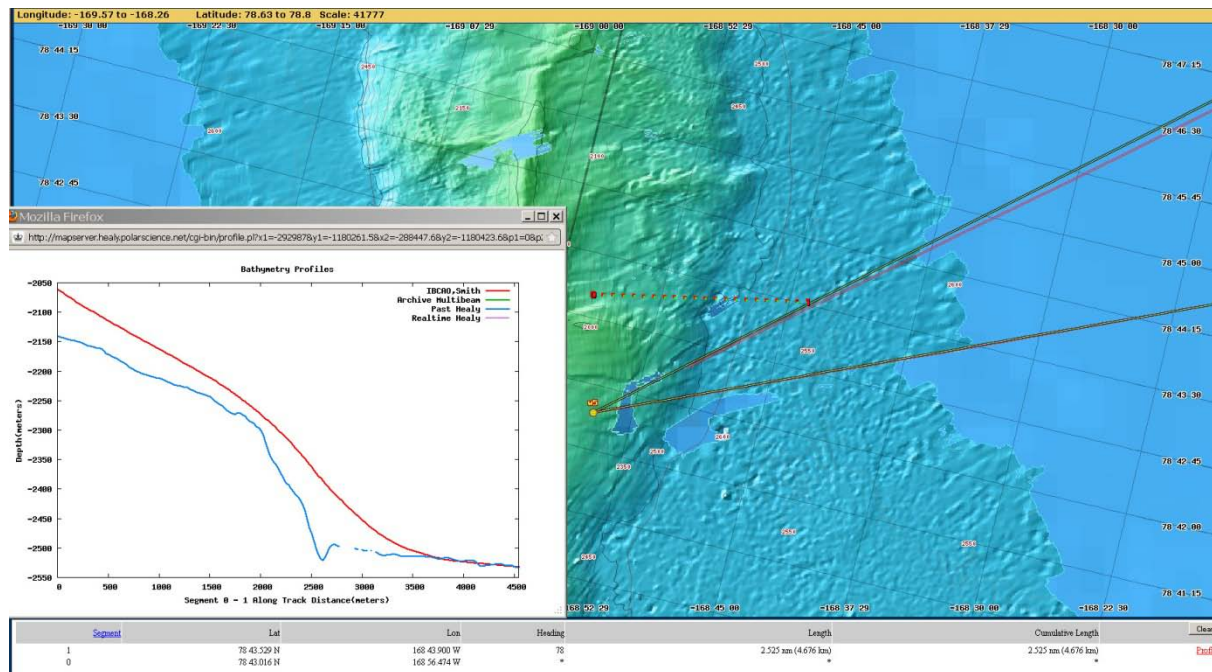


Figure 4-29 Dredge site 1 survey and dredge line plan

1215Z Knudsen showing indications of pockmarks.

HLY1202 Cruise Report

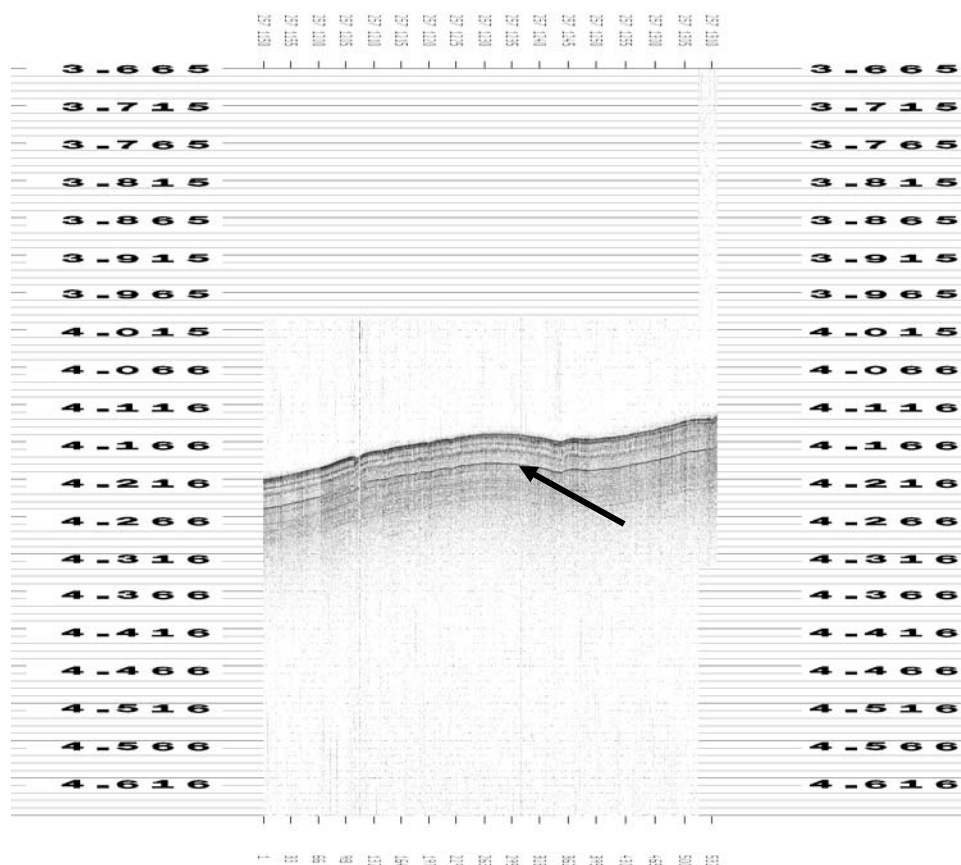


Figure 4-30 Pockmark indications on Knudsen

1445Z Came right to run dredge site survey line. Slow speed resulted in no bottom detection on EM122. Wind is 25 kt from 358°, seas from the north also. Had to speed up to 10 kt to get anything.

1458Z Increased speed to 12 kt to improve data quality

1530Z Conducting survey of potential dredge site. Wind and seas remain from the north.

1615Z Dredge planning team concluded that dredging this site was not feasible in these wind and sea conditions. We will resume swath mapping in N-S zigzags toward the east.

1700Z Dropped XBT T7_00116; applied salinity from XCTD 00113 and applied to EM122.

2000Z Calder on watch.

2315Z Converted waypoints for current track from MapServer to degrees and decimal minutes to satisfy bridge, and passed on for conversion into voyage management system.

2340Z Slowing intermittently as we see more ice; speeds down to 7-8 kt but averaging 9 kt.

HLY1202 Cruise Report

14 September 2012: JD 258

0005Z XBT launched (T-7, Serial No. 01118607, Launch No. 117) in 79d 45.09'N/168d 23.00'W.

0400Z Mayer on watch – running N-S lines – zig-zagging towards the east. Winds 25-30knts seastate 3-7 feet - -steaming at 11-12 knots – MB set on manual HD Equidistant – 60 60 actual coverage 55 55.

0630Z Ship takes sharp turn to starboard – and slows to 5 knots – call bridge – they say they are avoiding ice and can't go faster – there is are a few bergy bits but certainly no ice – call OPS – ask him to speak to bridge.

0800Z Changed MB system to auto coverage mode.

XBT launched (T-7, Serial No. 01053463, Launch No. 119) in 79d 37.6377'N/166d 18.97656'W. Good; will use with XCTD 113

1123Z Cyclo trip – slowing until engine comes back on.

1200Z Armstrong on watch.

1245Z Both shafts available again; resuming speed as ice conditions permit.

1600Z Breaking survey line to take station for CTD.

1630Z Deploying CTD at lat 80-16.47 N, lon 163-18.49 W, 3044-m depth.

1700Z Collecting pieces of ice from the sea with net off the fantail.

1720Z Collecting slush ice from the sea surface with bucket off the fantail.

1729Z Cast at maximum deployment; 2959 m wire out. Rossette coming up.

1751Z Ice and slush collection from fantail completed successfully.

1910Z CTD out of the water and on deck.

1915Z Taking surface water sample by bottle over the fantail.

1920Z Making way in a 270 ° turn to the right to come on line for mapping.

2000Z Calder on watch. Taking course for track. Bringing speed up gradually to ~12-13kt with occasional slow-down for ice sightings (even small ice sightings).

HLY1202 Cruise Report

15 September 2012: JD 259

0005Z XBT launched (T-7, Serial No. 01118611, Launch No. 120) in 79d 30.91'N/164d 00.33'W.

0045Z Ship slowed from 12.5kt to 6.5kt in order to negotiate the turn to the next line without overshooting.

0115Z Turn completed, returning to survey speed.

0400Z Mayer on watch. Steaming north at 12.65knts – open water, light winds (4-5 knts), seas 1-2 feet. MB set on auto equidistant high density. 60 60 actual coverage 49 50.

0800Z XBT launched (T-7, Serial No. 01053467, Launch No. 122) at 80d 18.91748'N/161d 33.18555'W. Steve used this with CTD 003 for salinity

In preparation for dredge site we have been exploring means to directly provide geographic coordinates to bridge. We have tested converting FM files to geographic (WGS-84) cords and this works though the image is of course distorted. I have also created a reprojection file in FM called MAPSERVER_Polar_Stereographic which reprojects data to the same projection as MAPSERVER (Polar Stereographic, True Scaling Lat of 67.5 and projection meridian of -155. For some reason for this to work we needed to change the latitude of origin to 67.5, rather than adjusting the standard parallel.

1200Z Armstrong on watch.

1214Z Altered course to starboard to obtain coverage of channel bifurcation.

1302Z Altered course to port to regain track at southern end of zig-zag.

1545Z Crossing channel; beds on northern “bank” are distinctly truncated.

1610Z Crossing area of rippled seabed; ripples are reflected most of the way through the sediment layers visible in the Knudsen chirp record.

HLY1202 Cruise Report

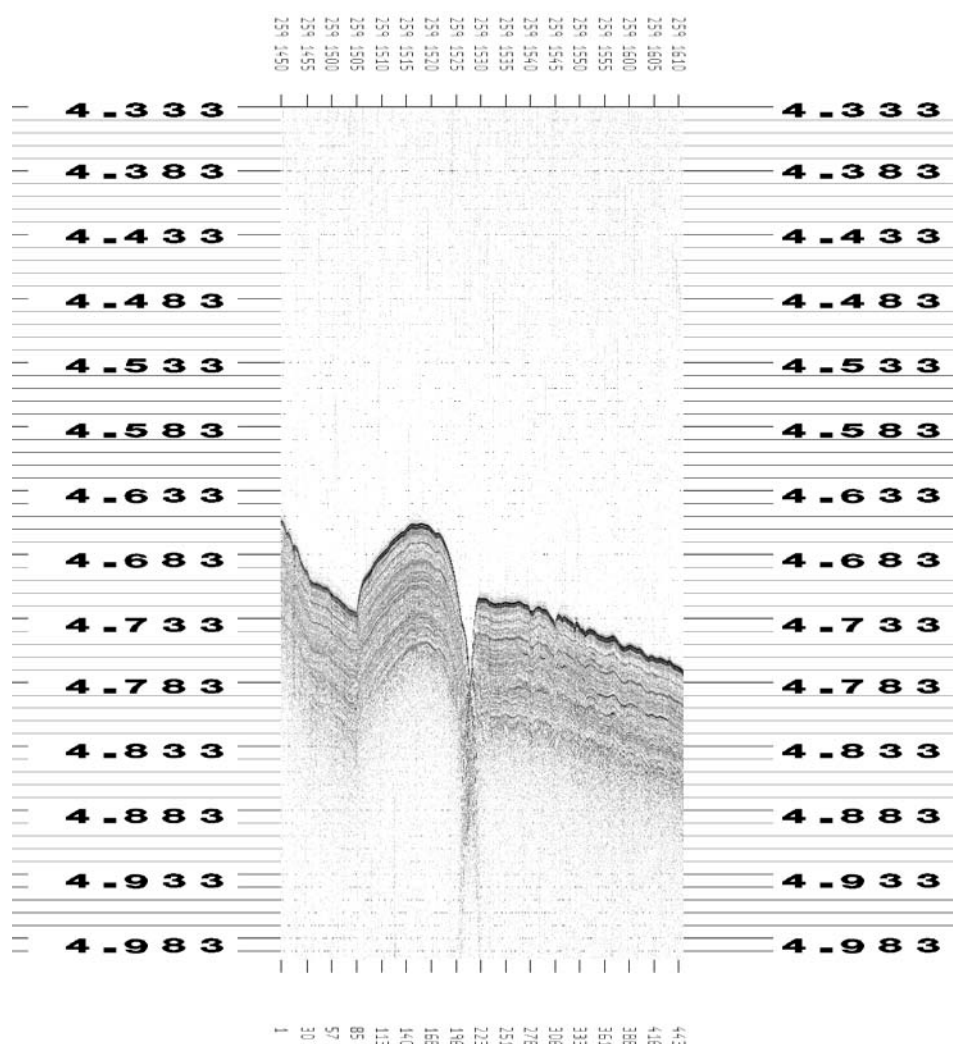


Figure 4-31 Truncated beds and seabed ripples throughout sediment layers on northern side

1700Z Slowed to allow view of polar bear on ice 500 m to port

1720Z XBT T7_00124 dropped successfully. Maintaining slow speed to stow equipment with ship's crane.

1734Z Resuming survey speed as ice permits. Presently running in area of dispersed ice bit and small floes.

1815Z Adjusted track to starboard for better multibeam coverage.

1841Z Entered sound speed profile from XBT 124 using salinity from XCTD 11. Lost bottom on both EM122 and subbottom profile. Increased speed briefly to clear transducers and reacquire bottom.

1945Z Losing some coverage in area of thin, slushy ice. Likely that ice is sliding under the hull.

HLY1202 Cruise Report

2000Z Calder on watch. Performance recovering somewhat as we move to areas of broken first year ice.

2253Z Polar bear sighted on starboard bow at approximately 800 yds. Slowing to investigate.

16 September 2012: JD 260

0005Z XBT launched (T-7, Serial No. 01118612, Launch No. 126) in 80d 03.15'N/160d 29.04'W.

0230Z Having come out of the ice, the ship is now speeding up to 12 kt.

0250Z Slowing down again: more ice ahead.

0400Z Mayer on watch – continuing to run basically N-S lines as we move east to the dredge site. Speed is being adjusted between 12 knots in open water and 6 in ice. Currently in reasonably open water – MB set on manual Very Deep HD Equidistant – 60/60 actual coverage – 54 54.

0639Z Open water – 12 knts – switching to Auto mode on MB

0800Z XBT launched (T-7, Serial No. 01118608, Launch No. 128) at 79d 51.11768'N/160d 8.80273'W. Looks good – entered with CTD-003 for salinity.

1200Z Armstrong on watch; on track toward 1st dredge site; speed as ice allows.

1641Z XBT T7_00130 dropped successfully.

1659Z New sound speed profile entered.

2000Z Calder on watch. Briefing on dredging, ready for getting to the first site.

2105Z End of line over the dredging site, starting data processing while the ship moves to position for ice drift determination.

2202Z Starting southward run through the planned dredge line to investigate the ice conditions and break up the route.

2335Z Dredge off the deck, ready for deployment.

2338Z Dredge in the water. Control passed to AFTCON. Dredge descending, troubleshooting speed and wire measurements. Wire out measurement appears to be incorrect. Dredge halted at water surface. Broken ice passing port to starboard aft.

17 September 2012: JD 261

HLY1202 Cruise Report

0020Z Indications are that the problems with the wire out counter are going to take some time to fix; recovering the dredge to the deck in the meantime.

0030Z Dredge on deck.

0040Z Underway for more mapping while the wire out counter is being fixed.

0142Z Ship stopped for testing of wire counter (need to deploy a little wire to test the fix).

0238Z Collecting ice samples at the side of the ship while stopped to test the wire counter problems.

0255Z Ice collection complete.

0300Z Wire out indicator appears to now be fixed, getting ready to bring test weight back to deck and re-attach the dredge. The problem appears to have been a faulty calibration of the wire sheave, which caused the wire out and speed of descent indicators to mis-read.

0313Z Underway for dredge site 1.

0400Z Mayer on watch

0810Z XBT launched (T-7, Serial No. 01118596, Launch No. 159) at 74d 42.99365.'N/161d 37.04004'W. Entered as new sound speed profile.

HLY1202 Cruise Report

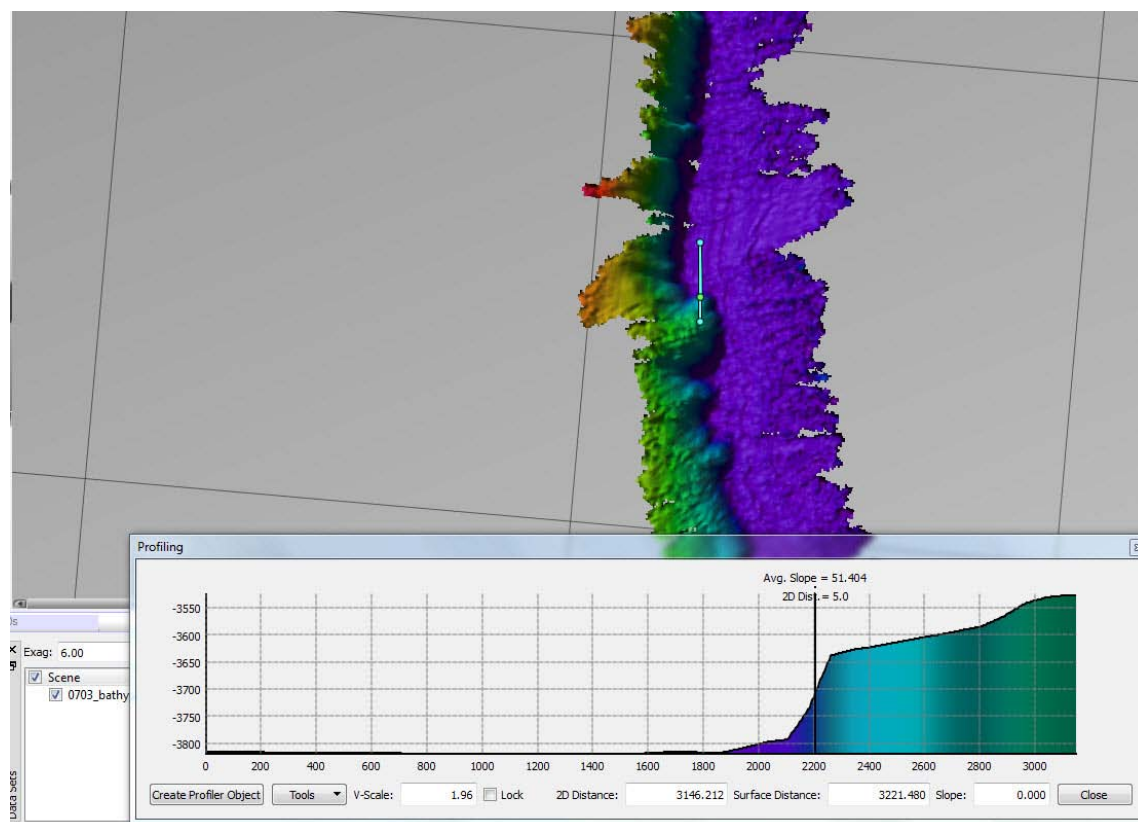


Figure 4-32 DREDGE SITE 1

0442Z Dredge in the water.

Mayer on watch

1000Z Dredge on board – mostly mud – being washed out on deck – some smaller rocks – will have to wait for report from crew

1010Z XCTD-2 launched at request of Jon Wynne (Serial No. 12078404, Launch No. 132) at 80d 46.83594N/155d 54.37305W. BROKE AT 1300 m – but still looks good enough to use.

1020Z Washing dredge out and getting underway – will map for about next 12 -14 hours ending up at dredge site 2

1200Z Armstrong on watch, mapping *en route* to dredge site 2

1310Z Crossing FoS heading south.

HLY1202 Cruise Report

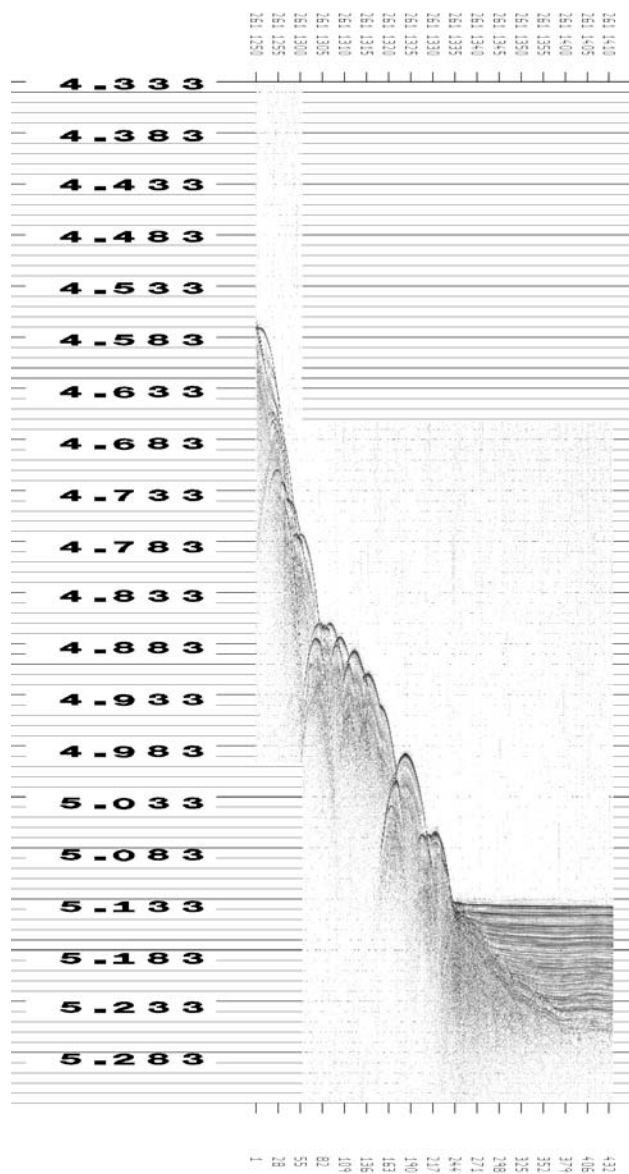


Figure 4-32a FoS heading south

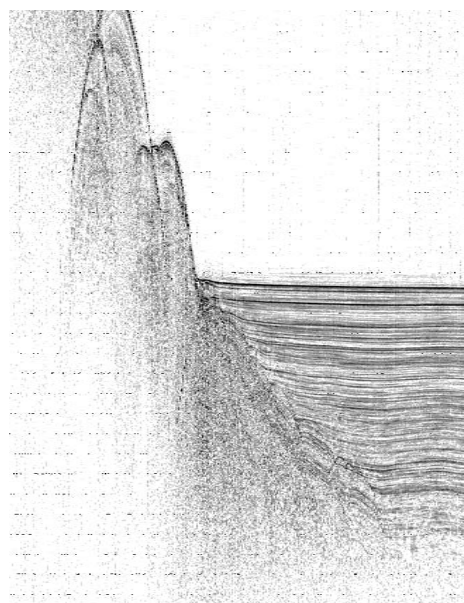


Figure 4-32b Detail of FoS

HLY1202 Cruise Report

1600Z XBT T7_00134; good until approx. 420 meters depth, when broken off by ice.

2000Z Calder on watch.

2050Z Ship turned early on a waypoint, called and asked them to reconsider and recover more of the space. The consequent turn took a little longer, but did fill in some bigger gaps very nicely.

18 September 2012: JD 262

0010Z XBT launched (T-7, Serial No. 01118613, Launch No. 135) in 80d 29.09'N/156d 54.31'W. Profile appears to deviate from norms after approximately 500m depth, but is usable down to this level.

0210Z Passing last waypoint going downhill west to east at dredge site 2. Ship is moving ahead so that they can turn back and set up to assess local wind and ice flow directions.

0218Z MBES tilt set to -1.0 deg. to allow us to assess the likely depth of the dredge with the MBES output (1.0 deg. at the dredge starting depth of approximately 3810m and a ship offset from antennae to stern of ~65m should make the beam point at the dredge's likely location on the bottom at the start of the evolution).

0225Z Ship drifting to assess ice and wind set. Wind currently 21kt/035T, 20k/103 bow relative.

0245Z Bucket over the side collecting ice samples.

0320Z Moving ahead to deployment site. Wind now 17kt/032T, 16kts/085 bow relative.

0336Z At deployment location

HLY1202 Cruise Report

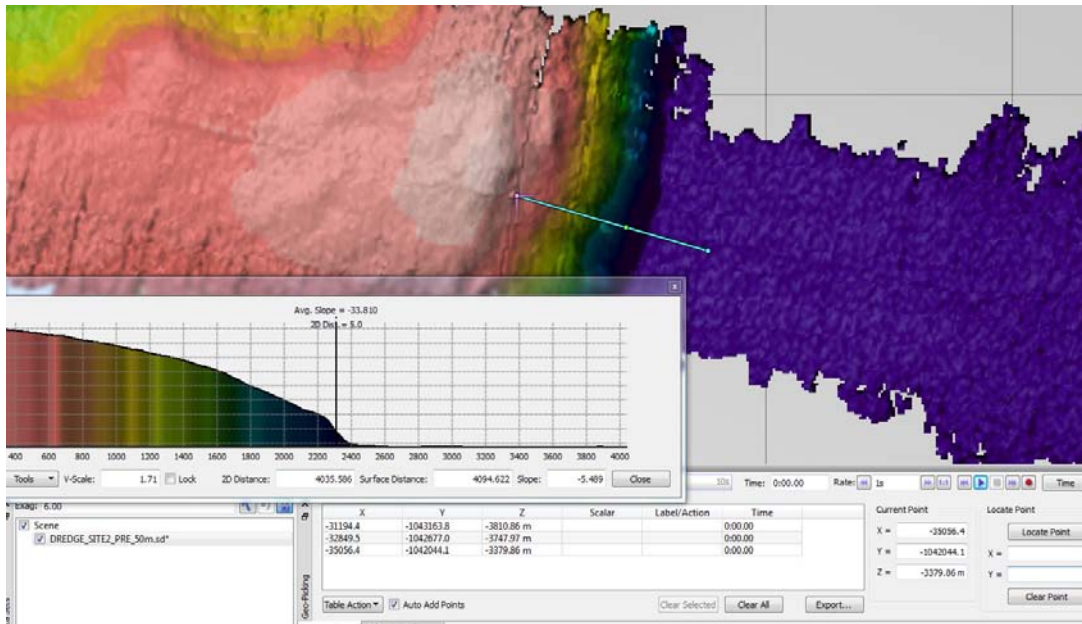


Figure 4-33 DREDGE SITE 2

0350Z Dredge weighed for lowering.

0355Z Dredge at the waterline, control passed to AFTCON. Wind now 16kt/035T, 15kt/019 bow relative, variable with gusts to 20kt. Descending at 20m/min.

0515Z Dredge at the bottom (maybe).

0555Z Bottom not acquired; dredge ascending for another attempt.

0625Z Dredge descending again for a second attempt.

0634Z Plausible second hit, dredge coming up to allow us to move towards the dredge site.

Mayer on watch

1045Z Dredge recovered and underway for about 100nm of mapping until we are at next dredge site (probably a re-occupation of Dredge Site 1). Dredge 2 had some mud in it but also many pieces of Mn crust and pavement, several pieces of basalt and of course some small pieces of IRD.

1200Z Armstrong on watch

1300Z Data quality is quite poor, even though we seem to be in open water.

1325Z Survey requested that bridge stop and back down briefly to see if that cleared the problem.

HLY1202 Cruise Report

1328Z Resumed track at survey speed; backing seems to have resolved the problem.

1420Z Completely lost the bottom return in 1-inch thick new ice. Regained in open water.

1639Z XBT T7_00136 with engine turns at zero; good profile

1714Z We have lost bottom completely in thin new ice. There is a lead off to starboard. We will divert the ship and try to follow the lead for a while.

1815Z Stopping for Hokey Pokey.

1830Z Resuming track at 3 kt.; adjusting pitch steering to zero degrees (straight down).

1848Z Breaking off systematic mapping and heading for dredge site 1 at best speed.

2000Z Calder on watch.

2345Z At waypoint, getting ready to deploy the dredge.

19 September 2012: JD 263

0015Z Dredge planning meeting and risk assessment in AFTCON; meanwhile drifting to assess local ice and wind conditions. Wind is currently 22kt/046T, 22kt/108 bow relative.

0105Z Underway to recon path through the ice likely to be taken.

0215Z Repositioning to take station to start the dredge.

0235Z Decision made to cancel dredging due to environmental conditions: the ice is moving too fast for us to safely keep station and have a more than average chance of getting the dredge back on deck at the end of the evolution. Returning to mapping while we wait for the weather to improve (hopefully).

0400Z Mayer on watch – soft ice conditions causing difficulty mapping – mostly keeping sonar on very deep mode manual equiangle but switching occasionally to auto equidistant HD – nothing really seems to help. Have asked bridge to speed up as much as they can – best they will do is 7.5 knots. Again not clear if this makes a difference.

0500Z Slowed to dead slow to at least find the bottom – slowly raising speed – now up to 4 knots – so far so good. The sweet spot appears to be 3.5 knots – a slow boat to China. As we turned west we sped up because we were covering an area already mapped – data quality was still acceptable even at 6.5 knots. Data maintained quality until we turned north --- hmmm...

0831Z Slowed to take an XBT – T7. We will stop and while stopping do the hokey pokey.

HLY1202 Cruise Report

XBT launched (T-7, Serial No. 01118617, Launch No. 136) at 80d 27.3857'N/159d 10.1318'W. Profile is good and will be entered using XCTD-00132 for salinity.

1026Z Finally BACKED AND RAMMED – 1st time all leg.

1200Z Following mapping track, adjusting speed as able and needed to hold bottom track.

1653Z Took turns off ship and deployed XBT T7_00140. Valid to only ~400 m.

2000Z Calder on watch. Currently in 9/10 broken ice, mostly first year, with some small sections of open water. Wind conditions similar to yesterday, so we are continuing to map rather than returning to the dredge site. Wind currently 21kt/042T; air at -4.13C. Mapping west, and then north to cover gaps in the northern section of the front porch.

2230Z Speeding up to 7 kt to see if we can improve data collection conditions in thinner new freeze ice. Seems to be better, or at least not worse. Continuing at 7 kt except when turning.

20 September 2012: JD 264

0015Z Launched XBT (T-7, Serial No. 01118595, Launch No. 142) in 80d 27.37'N/161d 28.55'W.

0400Z Mayer on watch – mapping through 9/10 ice at about 6 knots – MB on manual equiangle very deep -- actual coverage approximately 40 40

0705Z Have crossed into previously mapped area – asked bridge to speed up as much as they can.

0800Z Launched XBT (T-7, Serial No. 01118599, Launch No. 144) at 80d 23.3125'N/160d 06.6533'W. Will use with salinity from CTD 003

1200Z Armstrong on watch; dark outside; snow

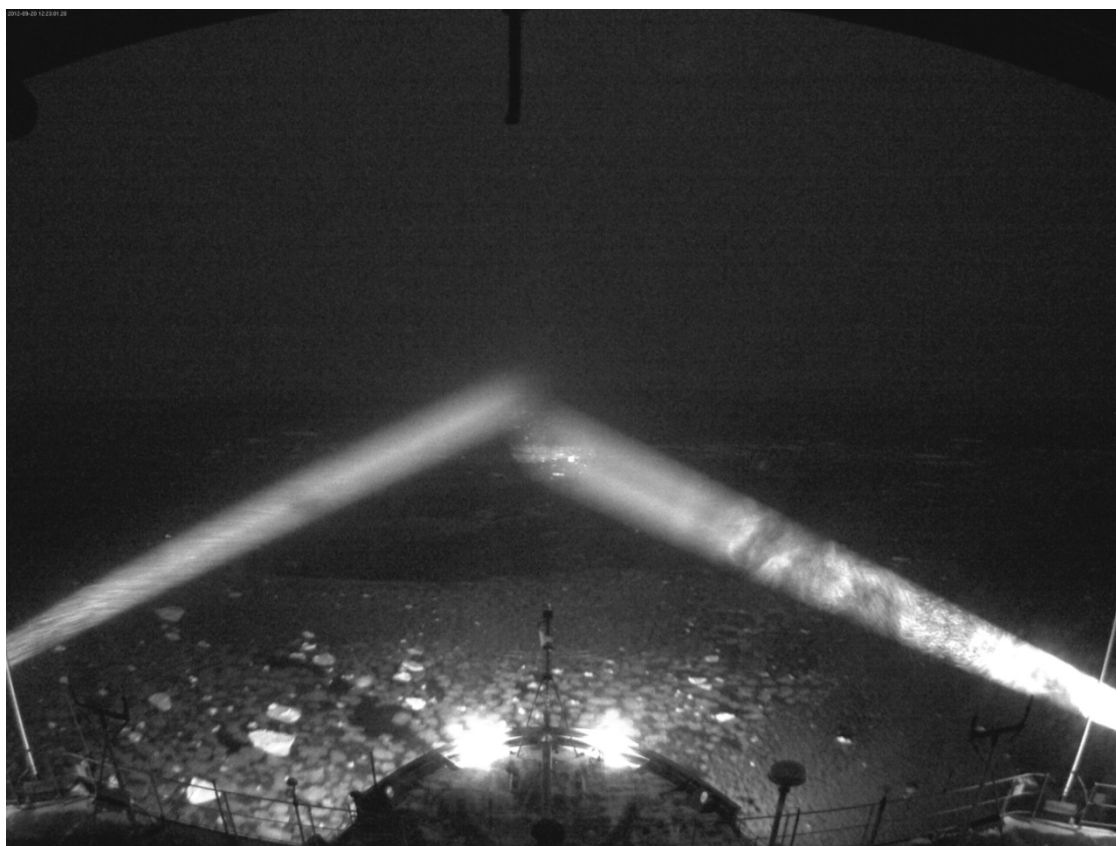


Figure 4-34 View from Aloft Conn Camera 1225Z-Day 264

1639Z Launched XBT T7_00146. Multibeam coverage has been degraded somewhat on the NE heading, especially on the port side.

1704Z Applied new sound speed profile from XBT 146, using salinity from XCTD 105.

1825Z Entering marginal ice zone.

2000Z Calder on watch. Mapping near the channel feature in mixed, broken fresh freeze pancake ice. Warmer than yesterday (-1.5C) with barometer falling; overcast and wet snow; strong swell lifting and breaking the ice.

2138Z Speeding up since we now have mostly grease ice with small pancakes.

2357Z Changing course to survey the end of the channel feature.

21 September 2012: JD 265

0005Z XBT launched (T-7, Serial No. 01118603, Launch No. 147) in 79d 44.57'N/158d 10.88'W.

HLY1202 Cruise Report

0045Z Increasing speed to 12 kt in an attempt to improve data quality as we map in the channel structure.

0220Z Rebooted navigation machine since an expired password had caused network mounted discs to become unavailable, and un-mountable!

0400Z Mayer on watch – steaming towards Dredge Site 3 across from Healy Seamount (west of it) – no more ice. Steaming 12 knots MBES on auto ping, auto angle coverage, beam spacing equiangular HD

0800Z XBT launched (T-7, Serial No. 01118600, Launch No. 149) at 78d 43.8833'N/159d 43.12793'W. Will use XCTD 0072 for salinity.

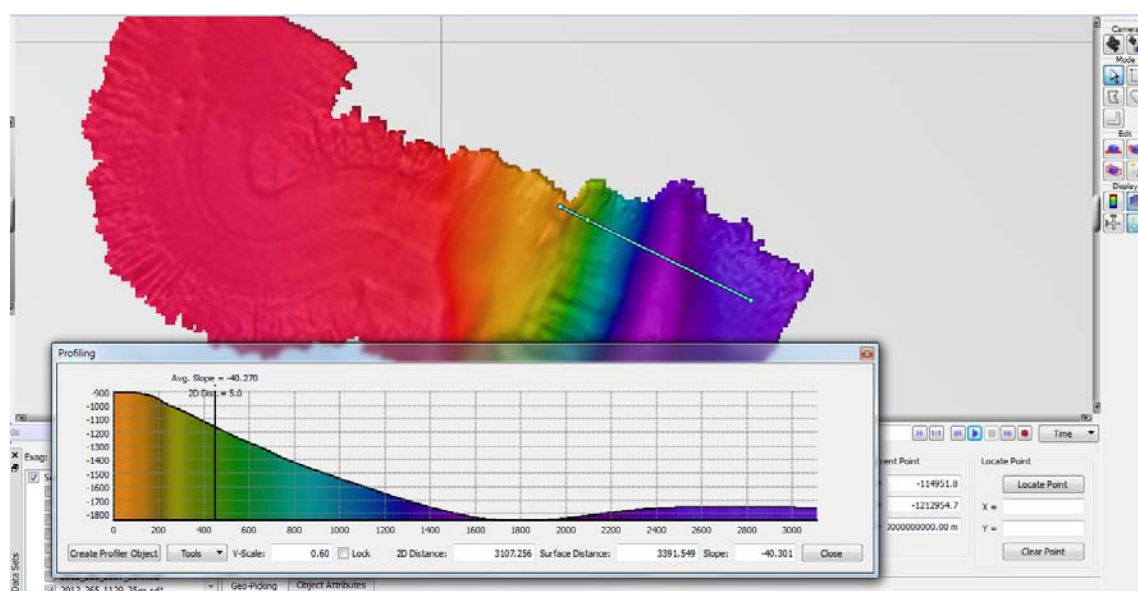


Figure 4-35 DREDGE 003 PROFILE

1200Z Armstrong on watch. Mayer finalizing position and depth of Dredge Site 3.

1315Z Dredge in the water, going down

1355Z Dredge touched bottom for cable out comparison and then raised to dredge target depth, ~1150m.

1450Z Dredge on the seafloor at target site.

1615Z Dredge clear of the seafloor and coming up.

1648Z Dredge on deck with mud and rocks.

HLY1202 Cruise Report

1700Z Attempted XCTD C3_00150; no data returned from probe. Will try new probe.

1715Z Completed XCTD C3_00152, s/n 11125775; good data to 1100 m.

1720Z Departed Dredge Site 3 en route to Dredge Site 4.

2000Z Calder on watch. Underway for dredge site 4. Wind 10kt/116T; warmer at -0.6C. No ice, but occasional snow showers.

22 September 2012: JD 266

0010Z XCTD launched on request of Wynn; slowing down to take cast. (XCTD-2, Serial No. 12078406, Launch No. 153) in 77d 36.69°N/157d 28.92°W. Cast good to 1580m.

0300Z Surveying in Dredge Site 4.

0430Z Surveyed over the edge of the drop-off at Dredge Site 4; coming about to position for dredge.

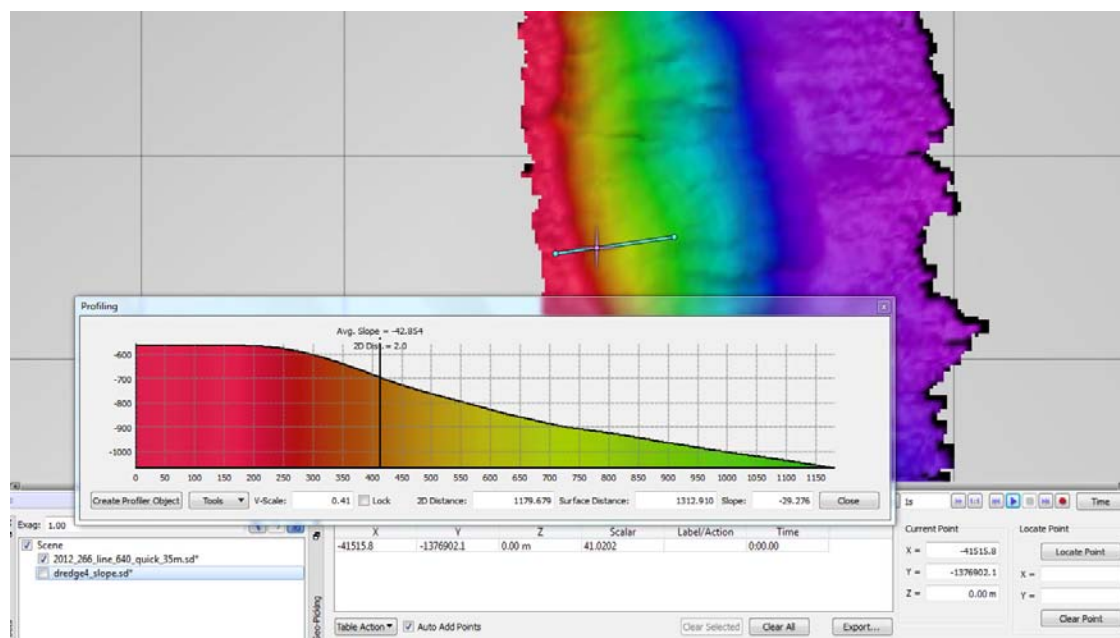


Figure 4-36 DREDGE SITE 004

0506Z Dredge in the water; begin lowering the dredge and maneuvering the ship to bring the dredge onto the seafloor at Dredge Site 4.

0608Z Dredge on the bottom, on target.

Mayer on watch

0716Z Dredge on board – good dredge – nice pieces of metasediment clearly broken off cliff

HLY1202 Cruise Report

0757Z XBT launched (T-5, Serial No. 00328324, Launch No. 155) at 77d 12.14209°N/156d 39.37828°W. Will use XCTD 0153 for salinity.

We are mapping around the topographic high that we dredged on to better see its context on the plateau. We will map until about 5AM and then head towards Dredge Site 5 on the outer edge of the Northwind Ridge.

1200Z Armstrong on watch, en route to Dredge Site 5.

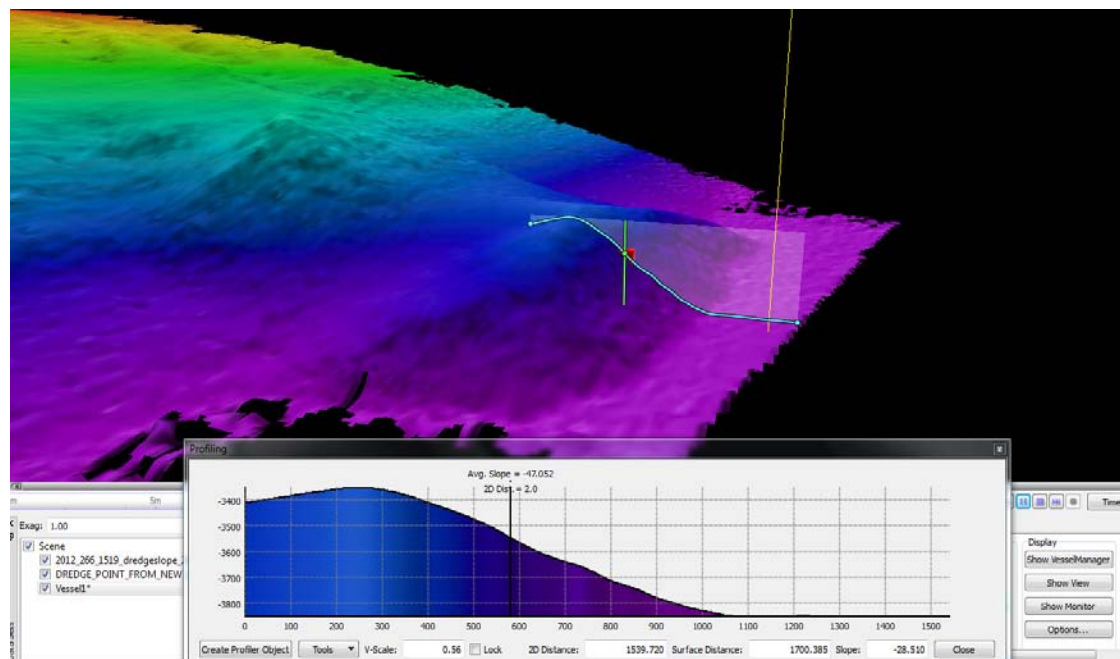


Figure 4-37 DREDGE 5

2000Z Calder on watch. Dredging at Site 5, getting good hits on the bottom.

2201Z Dredge at water's edge, ready for recovery.

2205Z Dredge on deck. Excellent dredge with lots of large pieces of schist clearly broken off of the outcrop. Proceeding with deployment of USNA buoy in the same location.

2215Z Ice Goat Buoy deployed. Starting transit while sorting rocks on the fantail; 154 46.4W 76 15.81 N

2250Z Underway towards Dutch Harbor -- 12.3 knots MB set on auto ping auto angle

23 September 2012: JD 267

0005Z Somebody on the bridge found the hidden “warp speed” button: HEALY is now doing 15.8 kt.

HLY1202 Cruise Report

0015Z XBT launched (Deep Blue, Serial No. 01179026, Launch No.157) in 76d 03.83'N/155d 44.51'W.

0400Z Mayer on watch – steaming to Dutch – still mapping 15.6 knts – MB on auto settings.

0814Z Dropped XBT T7_00159; applied as new sound speed profile with salinity from XCTD C4_00016

1037Z Stopped for CTD

1050Z Deployed CTD 04

1144Z Recovered CTD and applied as new sound speed profile

1151Z Deployed ice buoy

1155Z Deployed APEX profiler

1420Z Concern for refraction problems in EM122 as sea temperature and transducer sound speed have changed significantly from CTD. Dropped XBT Deep Blue TD_0016. Applied new sound speed profile using salinity from CTD 04.

1505Z Temperature changed again, applied sound speed profile from CTD 04

2000Z Calder on watch. Still steaming to Dutch in ~50m water; MBES data of marginal quality in this depth, but still collecting and seeing large iceberg scours.

2100Z PU warning lights on EM122; Chayes believes that this is due to intermittent 1PPS delivery (or, at least, that's what SIS believes). This problem appeared to resolve itself after a short while, but appeared intermittently thereafter.

2227Z Slowing to allow an Ice Center SVP buoy to be deployed; returning to ~16kt 2132Z.

24 September 2012: JD 268

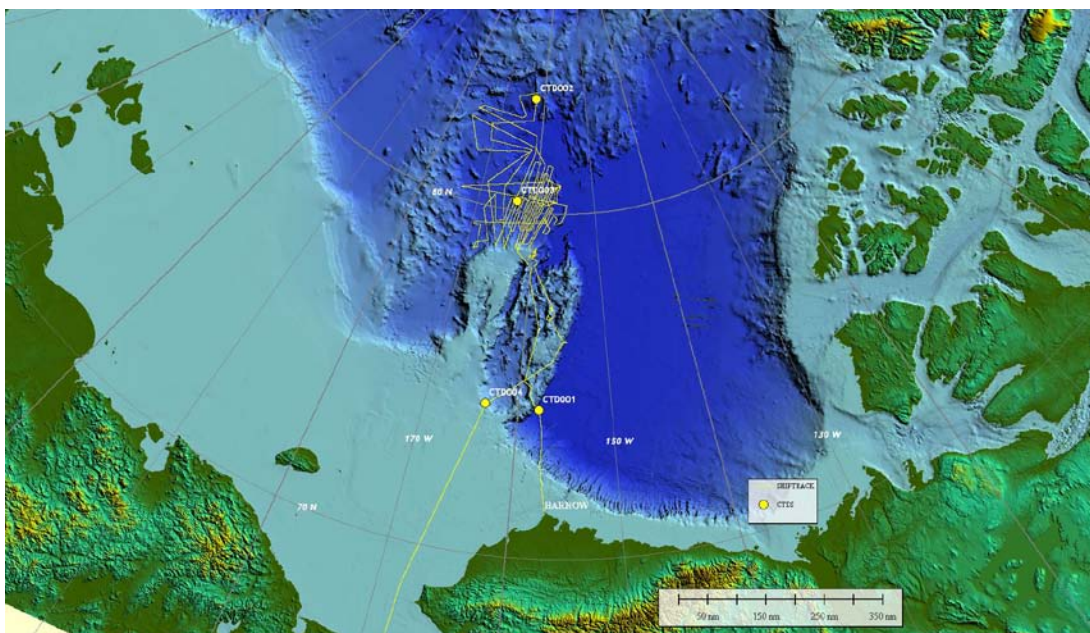
0020Z XBT launched (Deep Blue, Serial No. 01179025, Launch No. 163) in 71d 12.09'N/166d 27.41'W.

0055Z Logging secured on MBES for end of formal data collection on ECS mapping mission. Backups and report writing commencing.

27 September 2012: JD 271

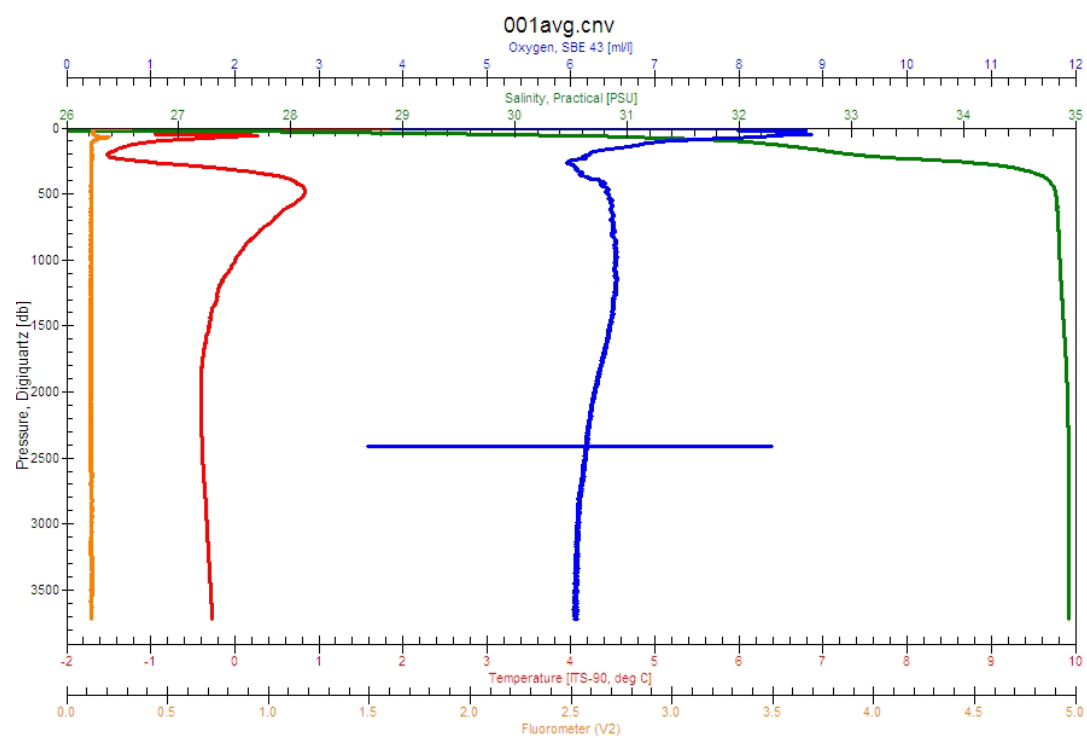
1800Z (1000L) Arrival Dutch Harbor

HEALY CTD LOG

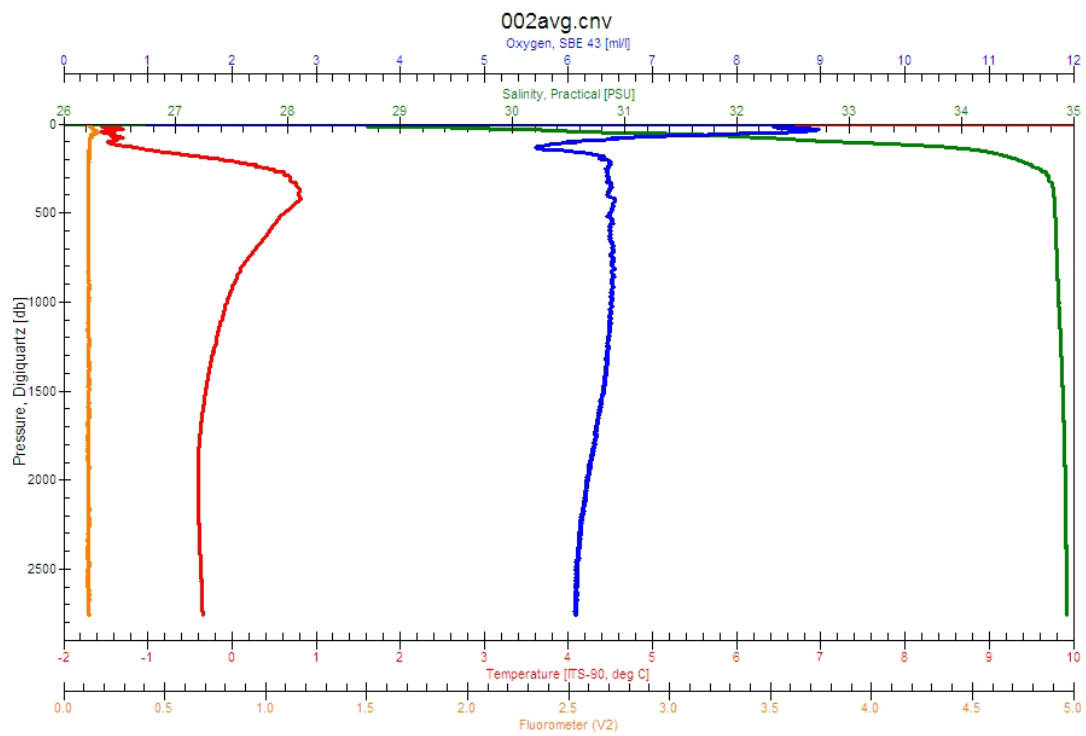


ID	LAT	LONG	Month	Day	Year	time	FILENAME
CTD001	74.2673	-157.768	Aug	27	2012	13:20:04	CTD\001avg.jpg
CTD002	83.3137	-162.145	Sep	4	2012	16:45:27	CTD\002avg.jpg
CTD003	80.2815	-163.298	Sep	14	2012	16:28:30	CTD\003avg.png
CTD004	74.33167	-163.53	Sep	23	2012	10:40:53	CTD\004avg.png

HLY1202 Cruise Report

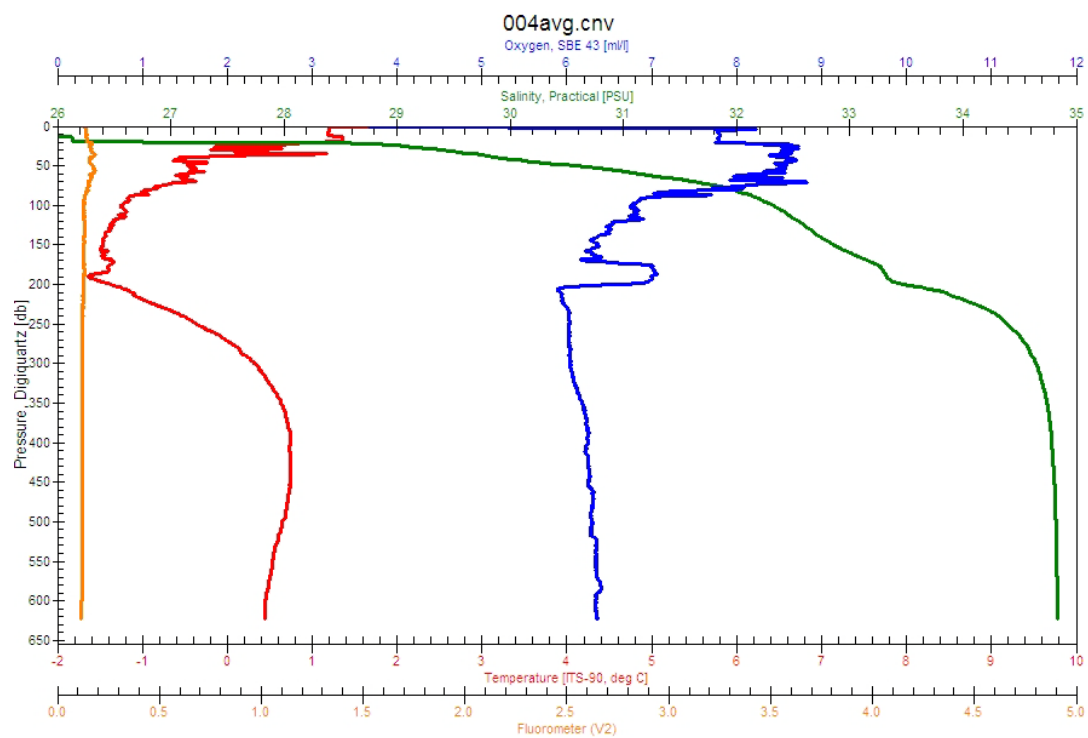


CTD 001



CTD 002

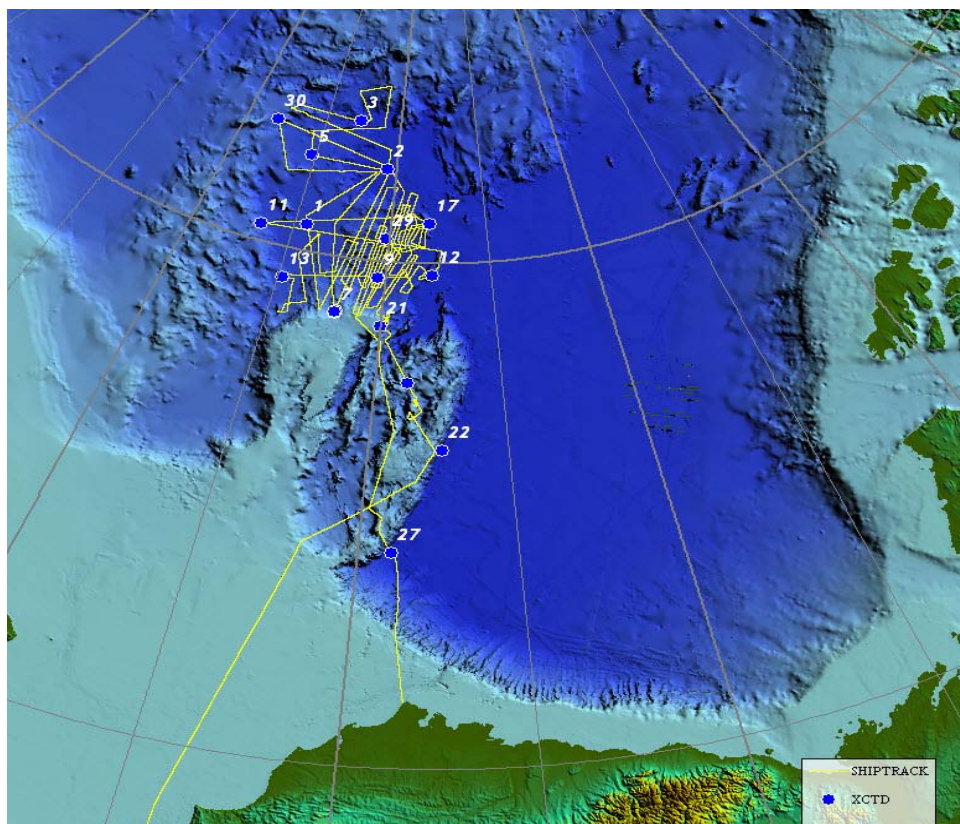
HLY1202 Cruise Report



CTD 004

HLY1202 Cruise Report

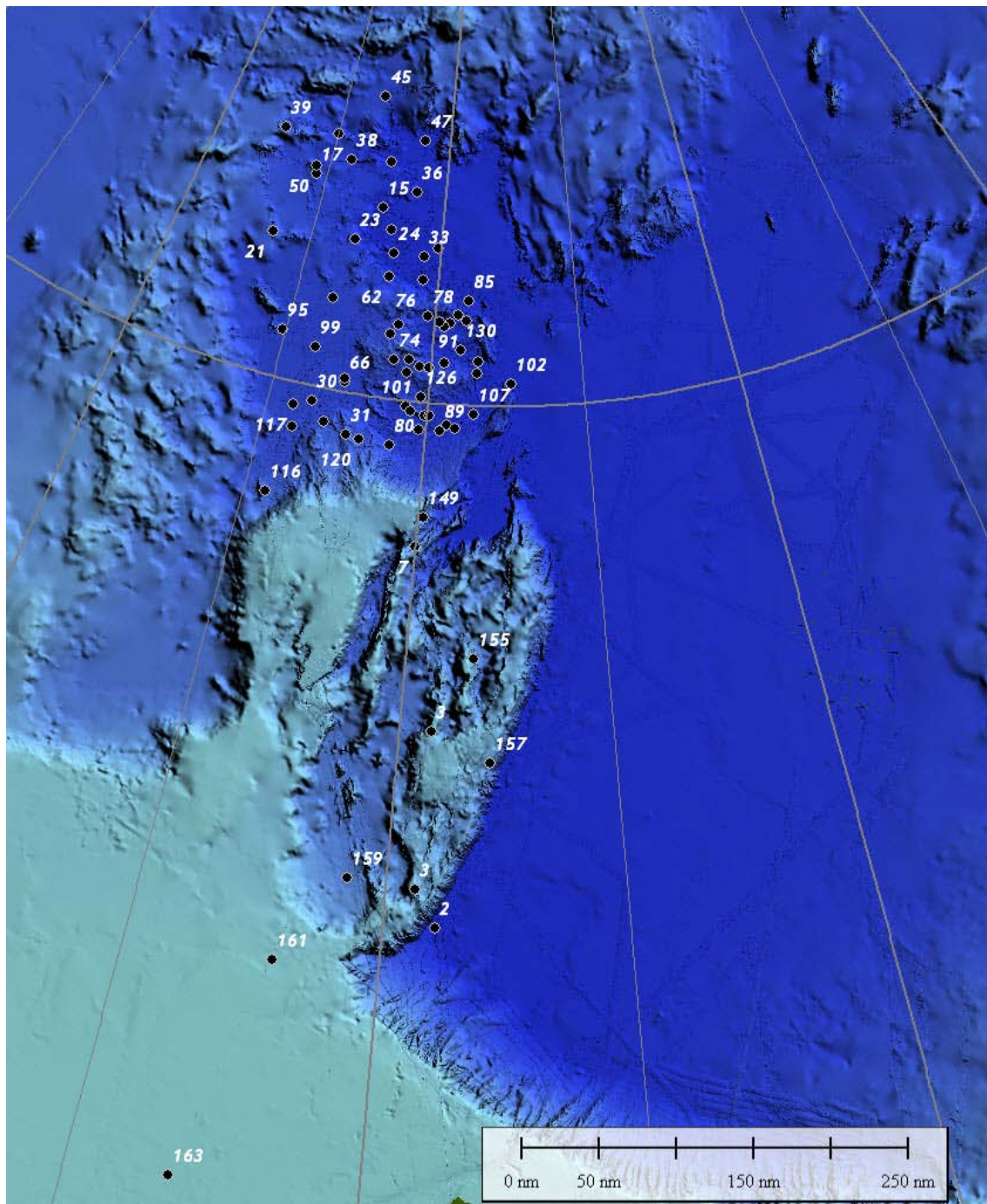
XCTD LOG



ID	SerialNum	Year	Month	Day	Hour	Min	Sec	LONGITUDE	LATITUDE	ProbeType	Terminal	DepthEqu	FILENAME
3	12078414	2012	8	27	16	12	57	-157.896	74.23478	XCTD-2	1850	Standard	..\XBT\C4_00003.png
11	12078408	2012	8	29	4	30	22	-160.35	80.45471	XCTD-2	1850	Standard	..\XBT\C4_00011.png
16	11074188	2012	9	22	16	44	49	-154.738	76.26746	XCTD-1	1000	Standard	..\XBT\C3_00016.png
19	12078413	2012	8	30	15	3	29	-175.995	82.38958	XCTD-2	1850	Standard	..\XBT\C4_00019.png
28	11074187	2012	9	1	4	10	32	-168.696	80.52972	XCTD-1	1000	Standard	..\XBT\C3_00028.png
35	12078410	2012	9	2	10	19	13	-161.084	81.83862	XCTD-2	1850	Standard	..\XBT\C4_00035.png
43	12078412	2012	9	3	22	8	37	-165.397	82.73032	XCTD-2	1850	Standard	..\XBT\C4_00043.png
52	12078409	2012	9	5	23	6	46	-170.479	81.88128	XCTD-2	1850	Standard	..\XBT\C4_00052.png
68	11074184	2012	9	7	6	51	33	-164.194	78.8811	XCTD-1	1000	Standard	..\XBT\C3_00068.png
70	12078405	2012	9	7	7	3	44	-164.186	78.90673	XCTD-2	1850	Standard	..\XBT\C4_00070.png
72	11074189	2012	9	7	7	21	30	-164.181	78.92172	XCTD-1	1000	Standard	..\XBT\C3_00072.png
82	11074186	2012	9	9	0	0	13	-160.762	79.66733	XCTD-1	1000	Standard	..\XBT\C3_00082.png
97	11074183	2012	9	11	11	33	16	-173.226	80.32841	XCTD-1	1000	Standard	..\XBT\C3_00097.png
105	12078407	2012	9	12	11	39	28	-155.656	79.76471	XCTD-2	1850	Standard	..\XBT\C4_00105.png
113	11074185	2012	9	13	10	17	11	-169.555	79.39815	XCTD-1	1000	Standard	..\XBT\C3_00113.png
132	12078404	2012	9	17	10	5	44	-155.906	80.7806	XCTD-2	1850	Standard	..\XBT\C4_00132.png
152	11125775	2012	9	21	17	7	51	-160.083	78.69512	XCTD-1	1100	Standard	..\XBT\C3_00152.png
153	12078406	2012	9	22	0	16	33	-157.482	77.61154	XCTD-2	1850	Standard	..\XBT\C4_00153.png

XBT LOG

HEALY 1202 XBT/CTD LOG



HLY1202 Cruise Report

XBT LOG

ID	Serial #	Year	Month	Day	Hour	Min	Sec	Longitude	Latitude	Probe Type	Terminal Depth	Depth Equation
"T5_00002"	349502	2012	8	27	16	1	0	-157.8803712	74.23492017	T-5	1830	Standard
"TD_00003"	888134	2012	8	28	0	4	21	-158.80861	74.65423183	Deep	760	Standard
"TD_00003_2"	973500	2012	8	28	8	8	49	-158.5029948	76.393986	Deep	760	Standard
"T5_00007"	349511	2012	8	28	17	5	57	-160.0098795	78.40379233	T-5	1830	Standard
"TD_00009"	888135	2012	8	29	0	11	48	-161.074821	79.88866367	Deep	760	Standard
"T5_00012"	349507	2012	8	29	8	19	21	-159.7034993	80.90437017	T-5	1830	Standard
"T5_00013"	349501	2012	8	29	16	16	0	-160.2143067	81.7139405	T-5	1830	Standard
"TD_00015"	888136	2012	8	29	23	51	24	-164.9347005	82.08100583	Deep	760	Standard
"T7_00017"	1053458	2012	8	30	8	17	55	-170.8886393	82.28857417	T-7	760	Standard
"TD_00021"	888139	2012	8	31	0	12	39	-172.8610677	81.53970533	Deep	760	Standard
"T7_00023"	1053584	2012	8	31	8	9	13	-166.6809245	81.68056633	T-7	760	Standard
"T7_00024"	1053459	2012	8	31	16	35	28	-163.530599	81.60444333	T-7	760	Standard
"TD_00026"	973945	2012	9	1	0	14	34	-167.3653972	80.9954915	Deep	760	Standard
"T7_00030"	1053460	2012	9	1	8	0	57	-167.2298503	79.83067217	T-7	760	Standard
"T7_00031"	973491	2012	9	1	16	17	39	-164.7844075	79.541447	T-7	760	Standard
"TD_00031_2"	888140	2012	9	1	23	53	52	-162.9908367	80.71416833	Deep	760	Standard
"T7_00033"	1053456	2012	9	2	8	4	26	-161.2685872	81.61130367	T-7	760	Standard
"T7_00036"	973605	2012	9	2	16	28	38	-162.3842448	82.30506183	T-7	760	Standard
"T7_00038"	1053585	2012	9	3	0	9	3	-168.3267903	82.533317	T-7	760	Standard
"T7_00039"	1053452	2012	9	3	7	58	46	-174.5786458	82.672819	T-7	760	Standard

ID	Serial #	Year	Month	Day	Hour	Min	Sec	Longitude	Latitude	Probe Type	Terminal Depth	Depth Equation
"T7_00041"	1053453	2012	9	3	16	2	42	-169.9663737	82.7791015	T-7	760	Standard
"T7_00045"	1053589	2012	9	4	6	14	43	-166.5475912	83.30169267	T-7	760	Standard
"T7_00047"	105359	2012	9	5	0	4	38	-162.218457	82.88286133	T-7	760	Standard
"T5_00048"	105359	2012	9	5	8	3	8	-164.955599	82.59550783	T-5	1830	Standard
"T5_00048_2"	349512	2012	9	5	8	6	33	-164.9712565	82.59423833	T-5	1830	Standard
"T7_00050"	1053457	2012	9	5	16	25	57	-171.0480795	82.3673015	T-7	760	Standard
"T7_00060"	1053461	2012	9	6	8	5	26	-164.0214843	81.85930183	T-7	760	Standard
"T7_00062"	1118650	2012	9	6	16	19	43	-163.6421223	81.34428717	T-7	760	Standard
"TD_00064"	888144	2012	9	6	23	56	7	-165.4942383	80.1456625	Deep	760	Standard
"T7_00066"	1118646	2012	9	7	0	7	49	-165.4623698	80.10511067	T-7	760	Standard
"T7_00074"	1118642	2012	9	7	16	11	30	-162.4881673	80.43406583	T-7	760	Standard
"T7_00076"	1118643	2012	9	8	0	13	23	-161.1439617	81.34537767	T-7	760	Standard
"T7_00078"	1118647	2012	9	8	7	59	2	-160.5206543	80.95233567	T-7	760	Standard
"T7_00080"	1118651	2012	9	8	16	33	20	-162.1014648	79.49821783	T-7	760	Standard
"T7_00084"	1118652	2012	9	9	8	6	15	-158.9187012	80.89710283	T-7	760	Standard
"T7_00085"	1118648	2012	9	9	16	15	9	-157.7058268	81.15646967	T-7	760	Standard
"TD_00087"	1179027	2012	9	9	23	41	22	-159.8689128	79.8659505	Deep	760	Standard
"TD_00089"	1179023	2012	9	10	8	1	22	-159.111328	79.69999183	Deep	760	Standard
"T7_00091"	1118649	2012	9	10	16	12	40	-157.7950358	80.93098967	T-7	760	Standard
"T7_00093"	1118645	2012	9	11	0	0	41	-162.5373535	80.82981767	T-7	760	Standard
"T7_00095"	1053466	2012	9	11	8	2	15	-170.1939128	80.524707	T-7	760	Standard
"T7_00099"	1118653	2012	9	11	16	13	51	-167.7586913	80.42215983	T-7	760	Standard
"T7_00101"	1118606	2012	9	12	0	4	20	-160.7601725	80.39139	T-7	760	Standard
"T7_00102"	1053462	2012	9	12	7	51	9	-154.6882975	80.243042	T-7	760	Standard
"T7_00107"	1118610	2012	9	12	16	18	29	-157.0965332	79.90821933	T-7	760	Standard
"TD_00109"	1179022	2012	9	13	0	2	31	-160.43903	79.69368483	Deep	760	Standard
"T7_00111"	1053470	2012	9	13	8	3	46	-168.094987	79.51142583	T-7	760	Standard
"T7_00116"	1118614	2012	9	13	17	2	11	-168.7642578	78.75313317	T-7	760	Standard
"T7_00117"	1118607	2012	9	14	0	1	42	-168.3832682	79.75153	T-7	760	Standard
"T7_00119"	1053463	2012	9	14	8	14	16	-166.316276	79.627295	T-7	760	Standard
"T7_00120"	1118611	2012	9	15	0	3	18	-164.0055013	79.51521817	T-7	760	Standard
"T7_00122"	1053467	2012	9	15	8	17	18	-161.5530925	80.31529133	T-7	760	Standard
"T7_00124"	1118615	2012	9	15	17	19	48	-161.3928712	79.93394367	T-7	760	Standard
"T7_00126"	1118612	2012	9	16	0	3	22	-160.484082	80.05249017	T-7	760	Standard
"T7_00128"	1118608	2012	9	16	8	0	59	-160.1467122	79.85196133	T-7	760	Standard
"T7_00130"	1118616	2012	9	16	16	36	34	-158.1235515	80.61402183	T-7	760	Standard
"T7_00134"	1118609	2012	9	17	16	6	57	-156.9318197	80.3522705	T-7	760	Standard
"T7_00135"	1118613	2012	9	18	0	9	43	-156.9051595	80.484904	T-7	760	Standard
"T7_00136"	1118617	2012	9	18	16	34	24	-159.168864	80.456429	T-7	760	Standard
"T7_00138"	1118594	2012	9	19	8	34	30	-158.4488443	80.99727383	T-7	760	Standard
"T7_00140"	1118598	2012	9	19	16	12	21	-159.3569498	80.85974117	T-7	760	Standard
"T7_00142"	1118595	2012	9	20	0	15	8	-161.4758952	80.456136	T-7	760	Standard
"T7_00144"	1118599	2012	9	20	8	7	7	-160.1108887	80.38854167	T-7	760	Standard
"T7_00146"	1118602	2012	9	20	16	39	23	-158.7312175	79.76622717	T-7	760	Standard
"T7_00147"	1118603	2012	9	21	0	11	56	-158.1812663	79.7427815	T-7	760	Standard
"T7_00149"	1118600	2012	9	21	8	9	24	-159.7187988	78.73138833	T-7	760	Standard
"T5_00155"	328324	2012	9	22	7	48	25	-156.6623047	77.20236817	T-5	1830	Standard
"TD_00157"	1179026	2012	9	23	0	16	38	-155.7418945	76.06383467	Deep	760	Standard
"T7_00159"	1118596	2012	9	23	8	9	1	-161.617334	74.71656083	T-7	760	Standard
"TD_00161"	1179024	2012	9	23	14	17	21	-164.1786458	73.71507167	Deep	760	Standard
"TD_00163"	1179025	2012	9	24	0	18	33	-166.456901	71.2014485	Deep	760	Standard

APPENDIX A

Gravity Report

Bernard Coakley
University of Alaska Fairbanks

Gravity data acquisition on board USCGC Healy 1202 has unusual in that there have been two BGM-3 gravimeters (Figure N; Sensor SN #221 and #222) running during the cruise. The two independent data streams offer unusual opportunities for validation of gravity anomaly measurements while underway.



Figure A1 - Dual BGM-3 gravimeters installed on board USCGC Healy

Gravity data were acquired continuously off Barrow during the change from HLY12-01 to HLY12-02, shifting from HLY12-01 on 25 August at 08:13:29 Z. Gravity data were acquired until the ship docked in Dutch Harbor (27 September at 00:00:00 Z) when data logging was shifted to HLY12-03. The gravimeters ran continuously dockside in Dutch Harbor to constrain the meter drift at the USCG dock, where the value has been estimated by repeated visits since 2008 (981535.78 mGals). A final tie for the 2012 season will be made in Seattle after USCGC Healy returns home in November.

Scale factors determined during factory calibration by Lockheed Martin were used to scale the counts into mGals. These were 5.017387349 mGals/count for Sensor #221 and 4.949006443 mGals/count for Sensor #222.

HLY1202 Cruise Report

For the purposes of this cruise, ties performed dockside in Seattle earlier in the season sufficed for preliminary data reduction.

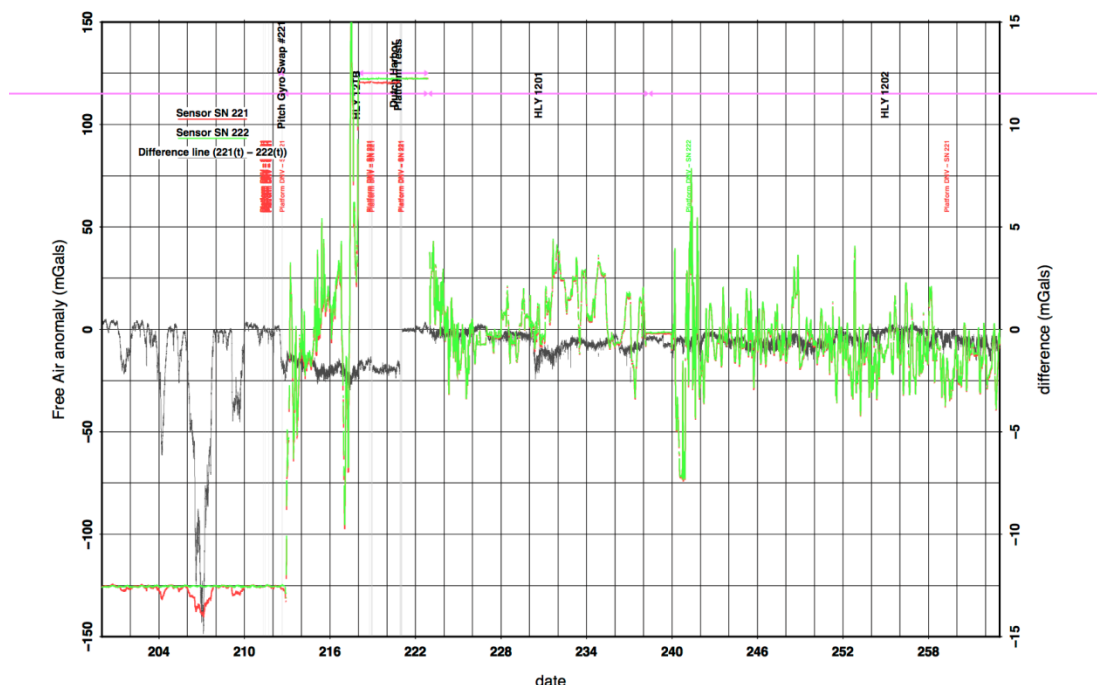


Figure A2 - Data from Sensors #221 (red) and #222 (green). The agreement is very good. The gravity anomaly data from #222 almost completely masks that of #221. The thicker grey is the difference between two signals. Relying on the drift projected forward across a couple months, the data still agree to within less than a mGal.

221 3 March 2012 (063) 22:00 855284.18

9 August 2012 (222) 12:00 855283.62

222 3 March 2012 (063) 22:00 856803.06

19 June 2012 (171) 12:00 856808.09

By projecting this drift rate forward in time, through the span of the cruise, the estimated gravity anomalies agreed to within less than a mGal (Figure A2)

During HLY12-02, both systems performed well. Only occasional DNV values were observed. Raw data were relatively low noise and required only standard filtering (4 minute Gaussian) to yield good results. As is typical, the data were very well correlated with bathymetry. The gravity anomaly data collected during HLY12-02 provide a relatively dense data set over a region that has not been previously sampled by surface ship. These data, used with other gravity anomaly

HLY1202 Cruise Report

data collected during previous USCGC Healy cruise since 2005, RV Mirai cruises and others are sufficient to support a high resolution grid of gravity anomaly values (Figure A3).

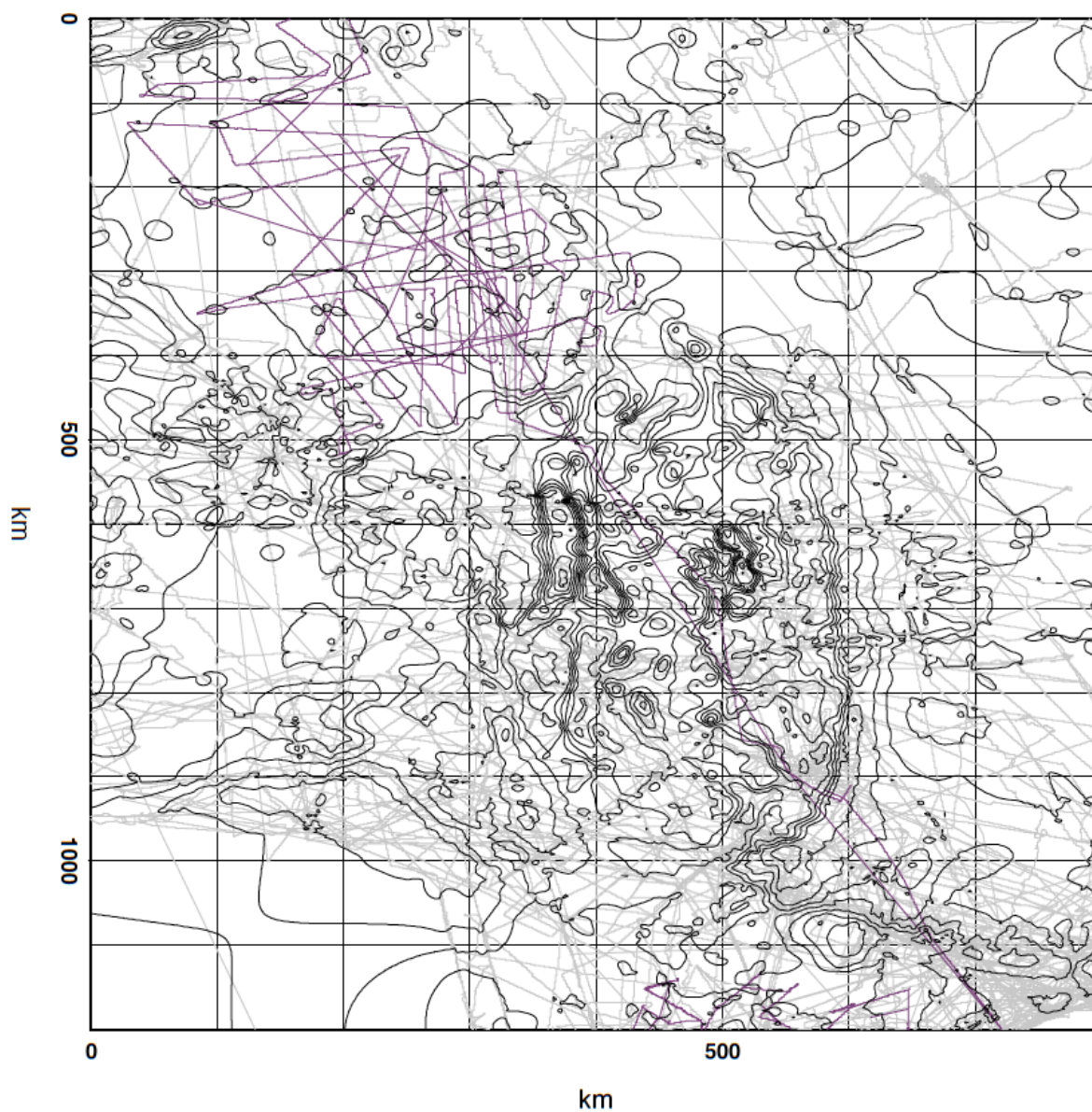


Figure A3 - Gridded gravity anomaly data (2 km; contour interval = 20 mGal). HLY12 (01 and 02) tracks are shown in purple. Other tracks (eg. Healy 2005-2011; Mirai, Langseth, Louis St Laurent and others) shown in grey.

APPENDIX B

National Ice Center Report

Pablo Clemente-Colon
Chief Scientist
National Ice Center - NOAA

Sea Ice Science Team Trip Report – USCGC HEALY HLY1202 Arctic Cruise, Barrow, AK/Dutch Harbor, AK, August 25 to September 27, 2012

HIGHLIGHTS

- NIC provided cruise sea ice analyses and routine on board sea ice observations of thinned out ice cover during record minimum extent conditions
- NIC provided targeted remote sensing data collection coordination and analysis in support of cruise routing and science
- Expanded UNH GeoCam collaboration
- USIABP and research buoys were deployed throughout the cruise on a non-interference basis

The primary science objective of the 2012 USCGC *Healy* cruise HLY1202 was to collect multi-beam bathymetric data in the Chukchi in support of determining the extended continental shelf (ECS) of the United States. The *Healy* departed from Barrow, AK on 25 August, 2012 and returned to Dutch Harbor, AK on 27 September with this year's cruise being carried as a single icebreaker mapping mission following previous joint ECS data collection with the Canadian Coast Guard *Louis S. St. Laurent* in 2008, 2009, 2010 and 2011.

The cruise Chief Scientist was Larry Mayer, from the Center for Coastal and Ocean Mapping (CCOM)/Joint Hydrographic Center (JHC) at the University of New Hampshire (UNH) sharing Chief Scientist responsibilities with Andy Armstrong, from NOAA/NOS and JHC and Brian Calder of JHC. The area of operations included the Chukchi Sea, Chukchi Cap, Northwind Ridge and areas to the north as far as 83° 30' N with a total mapping track of over 5 thousands nautical miles covered. Throughout the cruise, the National Ice Center (NIC) provided sea ice guidance for mission science and icebreaker navigation and acquired routine characterization and assessment of sea ice conditions.

The *Healy* Sea Ice Science Team included AG1 Chad McClaren and Behnjamin Zib, NIC Analysts, Roland Arsenault, a data visualization Research Scientist from the University of New Hampshire, Mathew Ayres, a Ph.D. student at the University of Sunderland in the U.K., and myself.

HLY1202 Cruise Report

NIC personnel both on land and aboard worked before and during the cruise to secure access to extensive imagery for tactical support providing near-real time analysis and daily tailored sea ice support during icebreaking operations. Increased support from the National Geospatial Intelligence Agency (NGA) has resulted in increased RADARSAT-2 collections over an expanding Arctic marginal ice zone (MIZ) benefitting the HLY1202 cruise with an unprecedented amount of synthetic aperture radar (SAR) data coverage.

The Sea Ice Team carried out a program of routine observations for characterization of the sea ice cover for the validation of remote sensing imagery, techniques, and operational analysis. This included the collection of photographic evidence for assessment of ice type and thickness as the *Healy* navigated through an expanded marginal ice zone (MIZ) and a retreated and significantly thinner pack ice that observed in previous years. The Sea Ice Team routinely provided input to the onshore NIC and CIS analysts during the cruise as well as compared the in-situ observations with other remote sensing analyses and products available, particularly, confirming the relative high presence of FYI and Second Year Ice (SYI), versus MYI in the pack and positively impacting the centers assessment and analysis.

A daily sea ice brief was given by the NIC Analysts to CAPT Beverly Havlik, *Healy's* Commanding Officer (CO), and the Chief Scientist after remote sensing data were obtained and analyzed along with other forecast products to produce analyses or forecast trends of sea ice conditions throughout the upcoming segments of the cruise. Initially, sea ice briefs were alternated between Chad and Behnjamin until Chad was asked to provide the weather forecast for the CO brief on a regular basis with Behnjamin taking full care of sea ice reporting. Before briefings, sea ice science coordination team meetings were conducted where we reviewed weather forecast and potential impact on sea ice conditions, analyzed imagery, data access issues, visual sea ice observations and charting. Progress with the data acquisition and processing from three geoCameras (GeoCams) was also discussed. Help with data management and network support for satellite remote sensing and GeoCam data was provided by Steve Roberts, Donny Graham and Frank Landy.

The GeoCam software system developed by Roland and deployed in 2011, which used forward looking cameras, was updated to integrate additional fixed AXIS cameras provided by the Arctic Collaborative Environment (ACE) for port and starboard observation to the existing *Healy* aloftcon forward camera and in lieu of a panning camera. The new cameras are installed to further exploit the capability to support sea ice type characterization shown by the forward camera in 2011 through mosaicing of all observation over a wider field of view and were attached to permanent brackets installed by the USCG inside the *Healy* aloft conning tower (aloftcon). From the photographs collected, map compatible images of ice conditions in geotiff format are produced while underway using recorded position from GPS and platform motion from an attitude sensor to ortho-rectify and georeferenced the images. Both, the rectified imagery as well as the original photos are added then to the remote sensing database for analysis and validation of sea ice concentration and floe sizes and other potential applications. As in 2011, remapping and mosaicing of the geoCamera imagery was achieved during the cruise with additional tuning and reapplication of correction parameters to the full set of the collected data still required after precise recalibration in port. Color balance corrections as well as GIS user

interface linking geocorrected images and original photographs will also be addressed. Future refinements under examination include the addition of a fourth port side camera looking downward and sideways to collect information on ice floe thickness, freeboard and snow thickness.

As part of his Ph.D. research at the University of Sunderland, Matthew Ayre is analyzing log books belonging to whaling vessels, between 1750 and 1850, which contain descriptions of sea ice as well as early charts of sea ice extent. During the cruise, Matthew made sea ice observations utilizing the limited descriptive nomenclature of the time and will compare modern and past observation to better understand how the data relates to today's ice cover description and the utility of early observations to a climatological sea ice database. Aboard was also John Farrell, Executive Director of the U.S. Arctic Research Commission with whom I shared the stateroom as well as insightful conversations on Arctic research during the cruise. I also provided a science talk aboard covering sea ice characterization, changes of the Arctic sea ice pack, and NIC sea ice charting and analysis.

Supporting the maintenance and expansion of the U.S. Interagency Arctic Buoy Program (USIABP) network coverage, a major component of the International Arctic Buoy Programme (IABP), buoy deployments were carried out as an ancillary program and on a non-interference basis as time, weather and operational conditions permitted during the cruise. The buoys and equipment were brought on board at Seattle and in Dutch Harbor, AK. The HLY1202 shipboard deployments included an LBI AXIB seasonal buoy, five Pacific Gyre Surface Velocity Program (SVP) ocean drifters, a Marlin-Yug Ltd UpTempO ((Upper Temperature of the Ocean) temperature-profiling buoy, an APEX ARGO salinity and temperature profiler, and the U.S. Naval Academy (USNA) Polar Science Program IceGoat-1 seasonal buoy (based on the AXIB hull). The UpTempO and ARGO profilers are part Mike Steele research at the University of Washington.

The deployment of the AXIB seasonal buoy from the A-frame crane was done in local open water but at the edge of the ice pack on 30 August. During crossing of a well-rounded FYI floe a request to deploy an SVP as an ice beacon was granted. The drogue from one of the SVP drifting buoys was cut, a string cradle was built around the body of the round buoy and deployment on the ice was completed using the port crane on 5 September. Next, open water deployments followed starting with the UpTempO profiler hand-deployment on 8 September. The USNA IceGoat-1 buoy was deployed using the A-Frame crane on 22 September. As part of the outreach activities, a Glass Planet made by artist Josh Simpson was given to the Chief Scientist by NASA Astronaut Cady Coleman and the artist's spouse, was encased in a monkey's fist knot and attached to IceGoat-1 before deployment. As students and the public follows the buoy for hopefully the next 4 years they will be tracking as well the whereabouts of this remarkable piece of art. The ARGO profiler, prepared for deployment by Dale Chase, and an SVP drifter were hand-deployed at the location of the fourth and last CTD station of the cruise on 23 September. Three other SVP drifting buoys were later deployed as the cruise head back south to the Bering Strait.

The planned deployment of a second AXIB seasonal buoy (AXIB hull #016 ARGOS ID #113550) was aborted after the buoy failed to communicate. Dale Chayes, aboard with the UNH

HLY1202 Cruise Report

science party, attempted to investigate the reason for the failure with the support of the buoy and electronics manufactures by opening the buoy and testing the batteries and circuits but no solution was found. A sixth SVP drifter also failed to communicate after being staged in the fantail during bad weather. Both of these buoys as well as the drogue removed from the first SVP buoy, which was deployed as an ice beacon, are staying on board for return to Seattle, pickup by Polar Science Center personnel and eventual shipping to manufacturers for investigation and refurbishment.

Nine additional SVP drifters are coming on board in Dutch Harbor for further deployments in the Bering, Chukchi, and Beaufort Seas as needed to be done by David Forcucci, USCG, during the third and final cruise of the season.

ACTION ITEMS

- Assemble all NIC RADARSAT-2 imagery and all other imagery and data collected during the cruise period including passive microwave, visible, and sea ice analyses
- Obtain from UNH updated geocorrected GeoCameras sea ice imagery collected during the cruise for further analysis
- Discuss with UNH, USCG and colleagues at the University of Texas San Antonio the potential and estimated cost of adding a fourth port side down-looking camera to the suite of GeoCams for next year's testing
- Discuss with CRREL, NASA and others potential participation on an earlier in the season cruise into the pack ice with routine on ice opportunities for characterization of the ice floes via coring
- Catalog by day and UTC hour all photo observations from multiple camera sources available during the cruise
- Follow-up with Matthew Ayre on the development of the historical nomenclature dictionary and its impact on the interpretation of historical sea ice observations and charts

Summary of Buoy Deployments

Buoy Type	ARGOS #	Longitude	Latitude
<i>On Ice</i>			
SVP beacon	101624	162° 18.88' W	82° 51.28' N
<i>In Water Within Pack</i>			
AXIB #018	113549	175° 59.69' W	82° 23.37' N
<i>In Open Water</i>			

HLY1202 Cruise Report

IceGoat-1	114527	154° 59.56' W	76° 15.52' N
UpTempO	Iridium	161° 56.59 W	78° 55.45' N
ARGO profiler	Iridium	163° 36.54' W	74° 18.97' N
SVP drifter	101621	163° 36.54' W	74° 18.97' N
SVP drifter	101625	166° 03.61' W	71° 41.95' N
SVP drifter	101626	168° 06.54' W	68° 48.12' N
SVP drifter	101627	168° 32.83' W	66° 00.46' N



Figure B1 - Deployment of an SVP buoy as an ice beacon on FYI floe on 5



Figure B2 - Deployment of AXIB 018 seasonal buoy from the Healy fantail using the A-frame crane on 30 August 2012



Figure B3 - Deployment of UpTempO temperature-profiler on 8 September



Figure B4 - Deployment of USNA IceGoat-1 seasonal buoy with Glass Planet monkey's fist from the Healy fantail using the A-frame crane on 22 September



Figure B5 - Deployment of ARGO profiler on 22 September



Figure B5 - Typical two-person deployment of SVP drifting buoys from the *Healy*

APPENDIX C

Historical Ice Terminology Studies

Matthew Ayre

University of Sunderland, UK

I joined Healy 1202 in my role as a member of the ARCdoc project to conduct a series of sea ice observations using historical terminology used in the logbooks of vessels sailing within the Arctic in the years 1750 to 1850. The observations that I am making are with assistance of the National Ice Centre observers and these two parallel data sets will be compared to ascertain the historic terms' meanings and correspondence with contemporary sea ice descriptions.

ARCdoc is a three-year project lead by the University of Sunderland and funded by the Leverhulme Trust. ARCdoc seeks to reconstruct the Arctic climate of 1750 to 1850 using the meteorological observations recorded in the logbooks of vessels sailing in this treacherous region. In conjunction with the climatic reconstruction element of the project, an imaging program of all the logbooks utilised has also been implemented, ensuring their preservation and increased accessibility.

ARCdoc's data comes from three principle sources; the logbooks of the Royal Navy's voyages of discovery and of those vessels on patrol in the region held at the National Archives in London. The logbooks of the Hudson's Bay Company ships; whose voyages consist of an annual passage of up to three vessels from London to Hudson's Bay and back. These records are held at the Hudson's Bay Companies archives in Winnipeg, Canada. Microfilm copies are also held at the National Archives. The final source is the logbooks of British Arctic whaling vessels. The whalers sailed to the Arctic fishing grounds around Svalbard and the Davis Straits annually, leaving in late March and returning in September. The main collection of whaling logbooks is held in the archives of Hull History Centre (Hull once being Britain's largest whaling port) with smaller numbers of additional logbooks being held in private collections and other archives across the country.

The observations recorded in the logbooks, for the most part, take the form of narrative description. The data abstracted for the purposes of climatic reconstruction are wind direction, wind force, precipitation, and ice observations. Importantly the locations and dates where these observations were made are clearly indicated.

Of ARCdoc's three sources it is the whaling logbooks that have been proven to be most valuable in their observation of a crucial element of the Arctic climate; sea ice. Prior to the first satellite imagery in 1979 very little informational on historical sea ice conditions is available. The whaling logbooks hold the potential for Marginal Ice Zone (MIZ) analysis and historical sea ice edge reconstruction.

British Arctic whaling essentially started in small numbers with the discovery of Svalbard the late sixteenth century but did not expand to any notable amount until 1750 when the British government introduced a substantial bounty to encourage the growth of the trade. The conditions of the bounty required captains to present a logbook of the voyage detailing daily events including meteorological observations. Between 1750 and 1850 there was over 10,000 Arctic whaling voyages, however out of these fewer than 100 logbooks survive.

The whaler's prize was the Bowhead whale (*Baleana mysticetus*), a long lived, slow moving whale that yields large amounts of blubber (which was rendered down into oil). For most of the year the Bowhead's habitat spans the MIZ and this is where they were hunted. The whalers are the only vessels in history, with the exception of modern ice breakers, to actively seek out the ice edge and follow it north as it melts back through the whaling season making them an important proxy for ice edge reconstruction.

The whaling logbooks from 1750 onwards contain a detailed and wide vocabulary of terms to describe the sea ice they encountered. So far 21 individual terms have been identified that were in consistent use, not just by officers of different whaling vessels, but also officers of the Royal Navy and Hudson's Bay Company.

Of these 21 terms, 17 of them were defined in a publication by William Scoresby Junior in 1821. Scoresby was a whaler from Whitby, a small fishing village on the North East coast of the England. Along with being a successful whaler he was also an eminent scientist who produced extensive writings on the Arctic regions that later earned him a Fellowship of the Royal Society. Many of the terms Scoresby defined are still part of the sea ice description vocabulary but that does not necessarily mean they enjoy the same definition.

In order to compare the historic ice conditions derived from the logbooks with the conditions that prevail at present it is necessary to convert the historic terms into their modern equivalents. It is also necessary to assign coverage values to the terms so the position of the ice edge and extent of the MIZ can be mapped. Initially every sea ice description published in the UK from the earliest (Scoresby 1821) to the most recent (Marine Observers Handbook 1995) was collated into a glossary where the lineage and evolution of each term could be traced. It was soon evident however that in order to get an accurate conversion and coverage term observations would have to be made in the field.

To achieve the above I joined Healy 1202 to conduct ice observations using the historic terms defined by Scoresby (1821). In order to get the necessary conversions, my observations needed to be made in parallel with on board ice observers. Ice observations were co-ordinated with on board Ice observers from the National Ice Centre (NIC) and an agreed framework for making observations was decided. In order to eliminate bias, the ice descriptions (historic and modern) were made independently at the agreed times and the data collated at the end of each day.

Ice observations were made every two hours starting at 10:00 and ending at 20:00. In accordance with the style of the whaling logbooks, ice observations took the form of a three to four word descriptions. The co-ordinates, wind direction and wind speed were also recorded at the time of each observation. The NIC observer's daily description and total coverage value for each observation was also recorded. The NIC's database of ice observations from Healy 1202 will be

HLY1202 Cruise Report

stored as a separate file for reference purposes. In the interest of quality control, geo-camera images from the time of each individual observation will be stored and referred to post cruise. These images will be used to ascertain observation consistencies.

A secondary objective of joining Healy 1202 was to attempt to create descriptions for the four undefined terms that appear frequently within the whaling logs but are not present in any publication of sea ice terminology. No structured approach was assigned to this as it was deemed necessary that only experience of observing different sea ice conditions could yield possible inferences about the terms' meanings.

In total 81 individual parallel observations were recorded, consisting of 11 full days of and five partial days of ice observations.

My time on Healy 1202 has proved extremely valuable, providing the desired observations and the chance to observe the sea ice first hand, an experience that cannot be under-estimated. These observations are the first step in producing an historical sea ice dictionary, a tool which will aid in the interpretation and use of the many and under-utilised historical documents relating to past sea ice conditions.

I have made many contacts while on board and hope to follow up with some collaborative work in the future. I believe the geo-camera has great potential to make the collecting of these parallel observations more cost and time effective, allowing for quicker expansion of the sea ice dictionary; this would however involve a specific field test.

Acknowledgements:

Larry Mayer, Crew of the Healy, NIC (Pablo Clemente-Colon, Behnjamin Zib, Chad McLaren), Leverhulme Trust, University of Sunderland, Jack Wolfskin York.

APPENDIX D

GeoCamera Report

Roland Arsenault

Center for Coastal and Ocean Mapping/Joint Hydrographic Center
University of New Hampshire
Durham, N.H. 03824
roland@ccom.unh.edu

Background

The original geoCamera was conceived to help quantify ice coverage during the MishapX cruise to the western Antarctic peninsula in 2010 on the Nathaniel B Palmer. The marine mammal observers were seeking a method to augment their population data with ice coverage along their survey routes. The system implemented was based on a Canon 40D Digital SLR camera and a digital pan and tilt unit controlled by a laptop. The system was not waterproof and had to be under constant supervision, therefore it was deployed in the mornings, weather permitting, and recovered nightly or when threatening weather approached. The system successfully captured imagery and metadata which were processed into ice maps with a radius of up to 1KM around the ship. This initial prototype was deemed a success, but some weaknesses were identified in order to make the system more robust and capable of continuous deployment.

Version 2.0 of the geoCamera, based on new hardware, was deployed on HLY1102. The camera used was an Axis Q6034-E PTZ Dome Network Camera, an off the shelf security camera capable of operating in cold climates. The camera was installed outside of the AloftCon on the forward rail at an approximate height of 30 meters above the water line.

Despite addressing the issues identified with the first iteration of the geoCamera, the Axis Q6034-E did start to fall apart due to ship vibrations after a few weeks of use. Its built in heater also didn't always succeed in keeping the dome free of frozen precipitation.

Those issues were addressed this year by using fixed cameras without moving parts and placing them inside the Aloftcon.

Hardware

The hardware for version 3.0 of the geoCamera consists of 3 Axis P1347 network cameras. The front looking camera is the pre-existing Aloftcon camera, looking forward with a field of view of 89 degrees. With such a wide field of view, projected pixel size grows quickly at a short distance from the camera, as seen in Figure D1.

Two additional cameras were added with lens set to a field of view of 17 degrees. The narrower field of view allows smaller projected pixels as distance increases as can be seen in Figure D2.

The two additional cameras arrived on board with the science party and were attached to mounts previously constructed in Aloftcon (Figure D3). Without proper reference points, an attempt was made to aim the camera 90 and 270 degrees relative to the ship's heading and to point the down so the horizon in close to the top of the frame, but leaving room for about a degree of ship roll while still keeping the horizon within the frame. Determining the actual heading, pitch and roll values of the cameras is left to the calibration procedure, which is still being refined.

HLY1202 Cruise Report

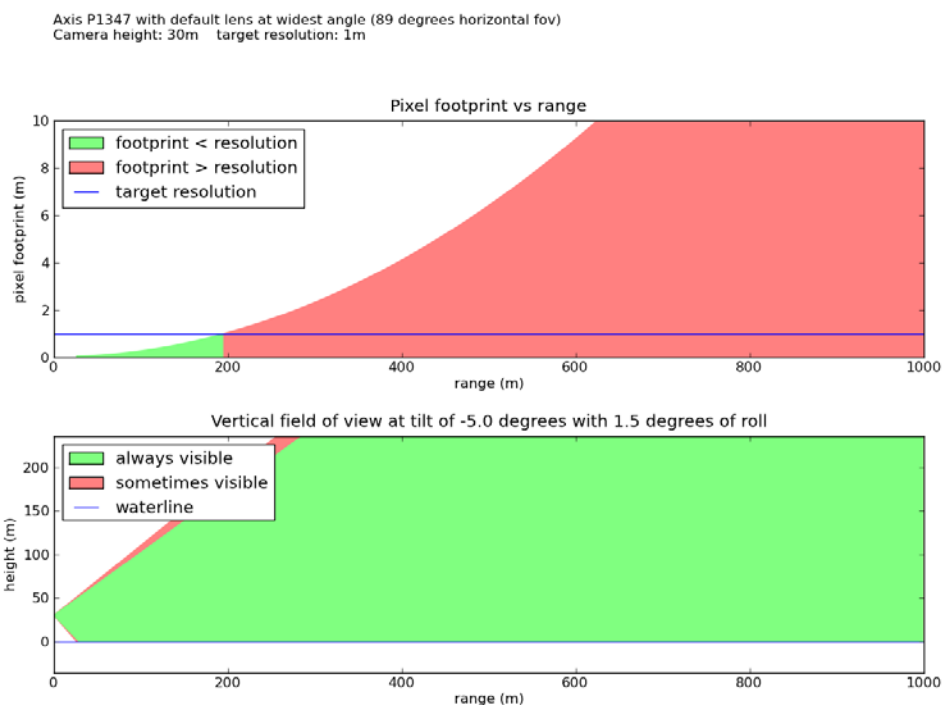


Figure D1: Projected pixels for the forward looking camera, with an 89 degree field of view, grow to over 1 meter in size before reaching a distance of 200 meters away from the camera.

Data collection occurred simultaneously on a ship-provided Windows XP server and a Linux laptop used for development. At the end of the cruise, the ship server will continue collecting data during the remainder of the field season.

Data was stored simultaneously to a removable drive provided by the National Ice Center, a removable drive provided by CCOM/JHC and a public area on a ship provided network attached storage node. The scheme essentially allowed real time backups of the data to exist without the need to periodically transfer large amounts of data.

HLY1202 Cruise Report

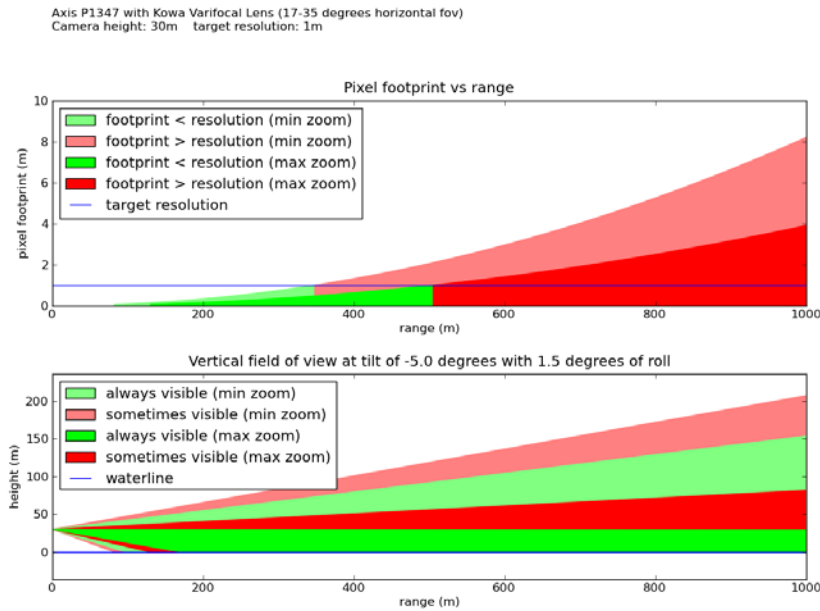


Figure D2: The side looking cameras, with 17 degree fields of view, can project 1 meter pixels up to 500 meters away and 4 meter pixels up to a distance of a kilometer.

Software

A data collection script written in Python was running on both the ship's server and the development laptop. The script monitored POSMV data broadcast over the network and adjusted data acquisition rate according to the ship's speed. Speeds were clamped to a range of 3 knots to 9 knots resulting in times between captures of 15 seconds at 3 knots or less to 5 seconds at 9 knots or more.

Software written during the HLY1102 cruise was adapted to process the images and create maps. The software originally designed to operate with a graphical user interface and have maps created interactively by an operator was split into an automated tool for creating maps and a tool to be used by an operator to calibrate the camera system. The software was developed in C++ on a Linux system, and the tools to port to a Windows system were not readily available during the cruise. As a result, the automated map making only occurred on the development laptop and that capability is not yet available on the ship's server. A Linux based server was expected to be available on the ship for the purpose of processing the images into maps in an automated fashion. When it was discovered, once under way, that only a Windows XP based server was available, it was too late to have the proper development tools made available to target that platform.



Figure D3: Customs mounts built for the side looking cameras.

Results

Data collection started at 1:11:23 UTC on August 28th, 2012 and is ongoing. Hourly maps were produced starting at 0:00 UTC on August 29th, 2012 until the end of data collection for the HLY1202 cruise with the final hourly maps covering the first hour UTC of September 24, 2012. Two maps were produced for each hour of data: a 2 meter resolution map using data projected up to 1000 meters away from the ship, resulting in a 2000 meter wide swath and a 5 meter resolution map using data projected up to 2500 meters away from the ship, resulting in a 5000 meter wide swath.

The maps were created in Geotiff format suitable for use in GIS software. On the ship's mapserver, two new layers were added to display the 5m and 2m maps.

Challenges

The cameras were calibrated before the cruise to determine lens geometry and account for distortions. Determining the pointing angle of the cameras can obviously only be done after the cameras were installed so a procedure to do so is still being developed. The fact that no fixed targets with known positions were visible during the cruise made this task more difficult. It is hoped that post-cruise calibration will be more successful using images captured of known points in Dutch Harbor.

Another challenge needing further attention is the movement of ice. Attempts to determine ice flow by measuring optical flow between overlapping projected images uncovered calibration errors that manifested itself as motion which was confounded with ice motion.

Conclusion

A system was established to collect imagery from 3 cameras producing maps in an automated fashion. Ice scientists have already expressed great interest in the resulting maps despite their imperfections and other scientists studying water chemistry are finding the maps useful in matching ice coverage with their water samples.



Figure D4: Existing forward looking Alofton camera.



Figure D5: New camera looking out the port side of the Aloftcon.



Figure D6: New camera looking out the starboard side of the Aloftcon.

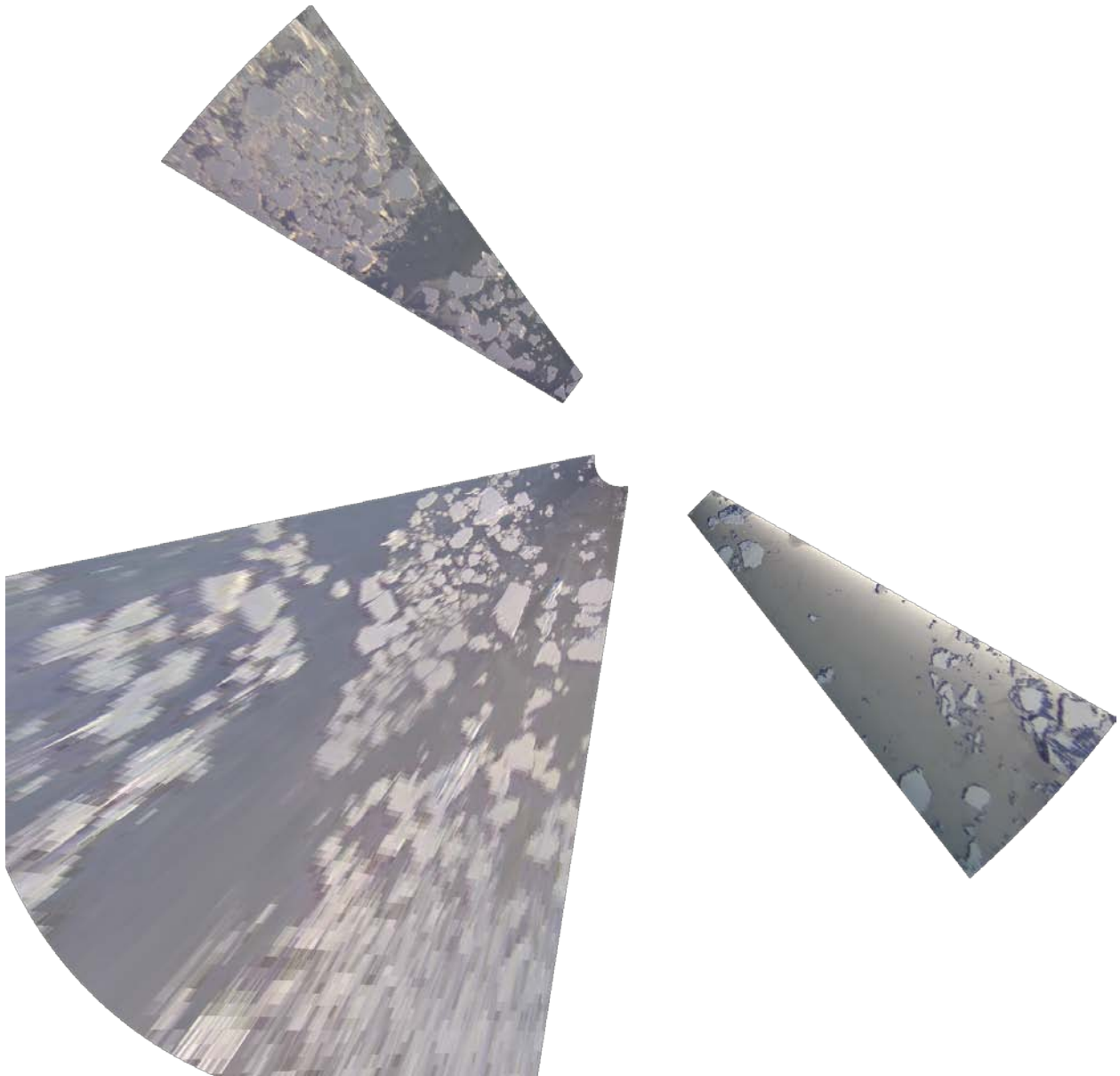


Figure D7: Images projected at a 1 meter resolution up to a distance of 1000 meters.

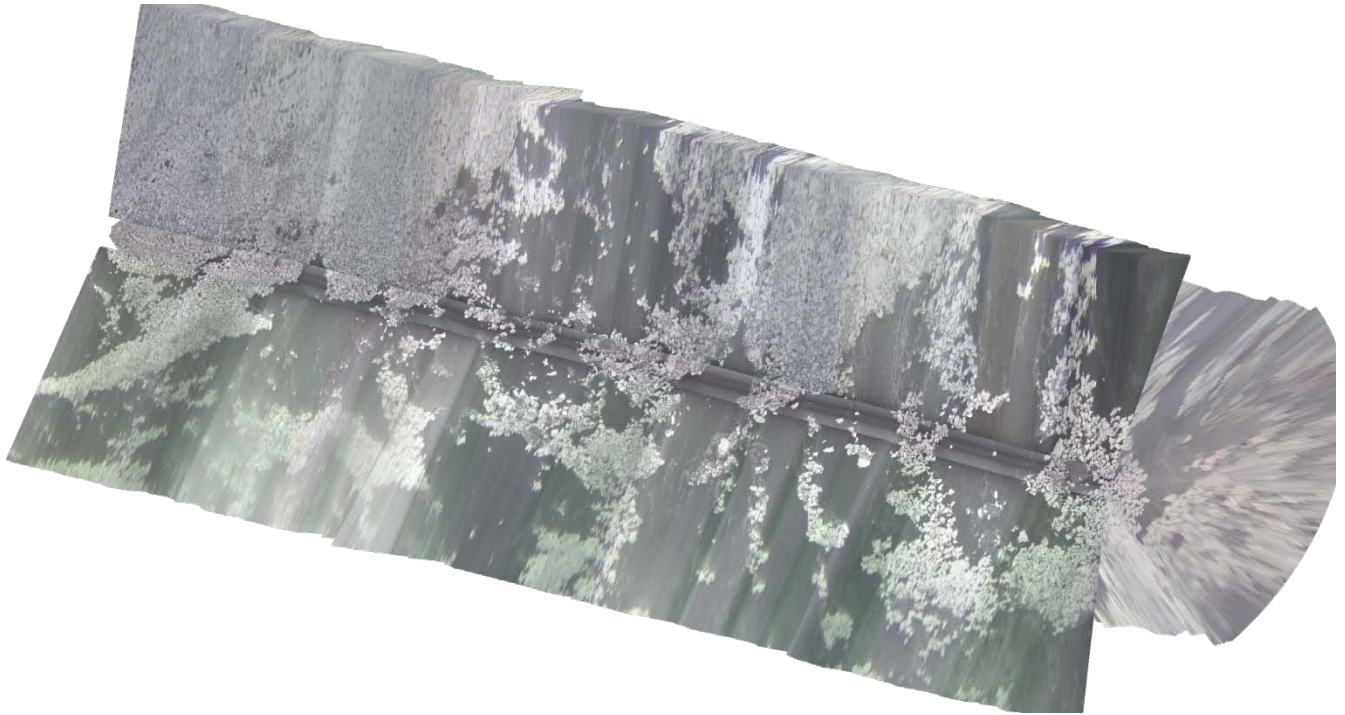


Figure D8: 5 meter resolution map from 07:00 to 08:00 UTC on September 6th, 2012

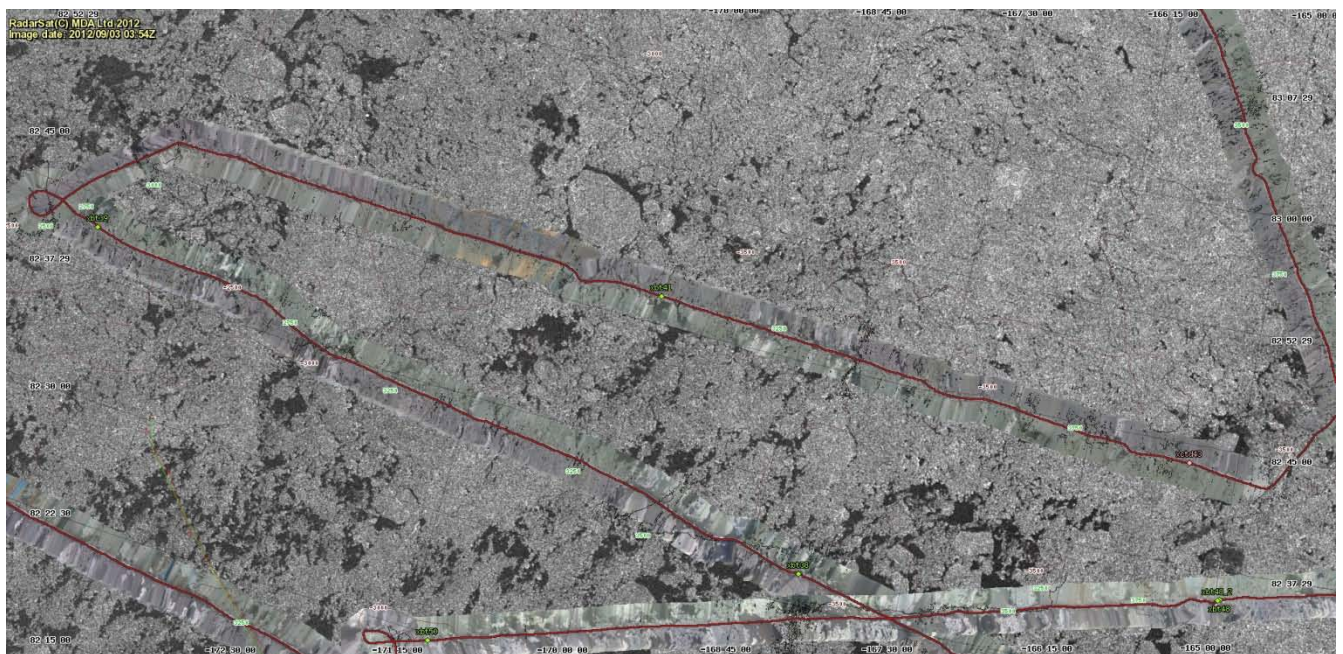


Figure D9: geoCamera map from September 3rd, 2012 overlaid over RadarSat imagery on the ship's mapserver.

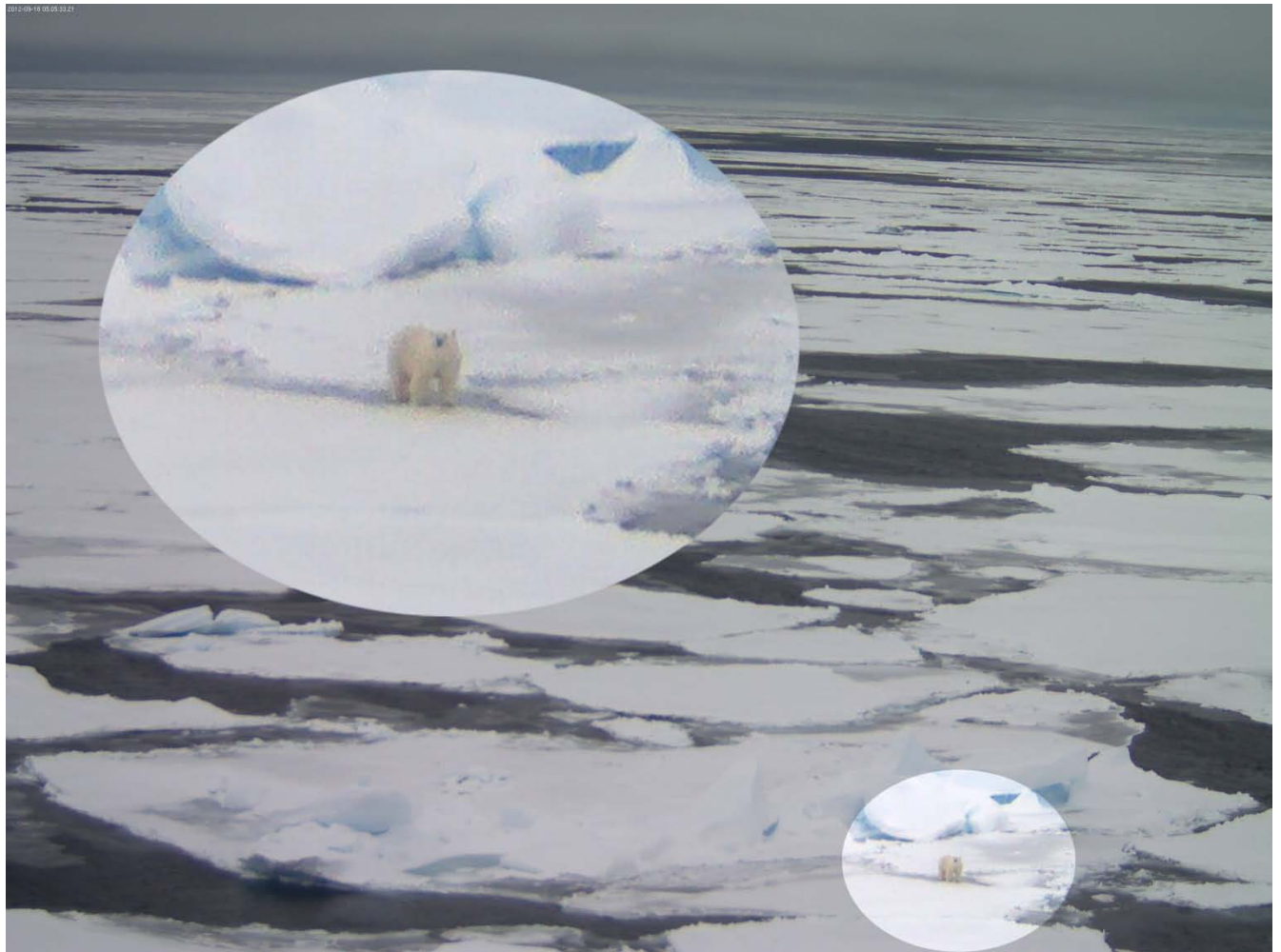


Figure D10: Polar bear sighting in the starboard camera on September 18th 2012 at 5:05 UTC.

APPENDIX E: OCEAN ACIDIFICATION REPORT

Cruise Report: HLY1202
USGS/USF research on ocean acidification

Submitted by Lisa L. Robbins, USGS

Participants: Dr. Lisa L. Robbins, USGS – St. Petersburg, FL PI- Ocean Acidification Project, Paul O. Knorr, USGS, Kate McMullan, USGS – Woods Hole, MA, Drs. Jonathan Wynn and Bogdan Onac, University of South Florida

Background on Ocean Acidification:

The ocean has absorbed approximately one-third to one-fourth of the total carbon dioxide (CO₂) emissions from fossil fuel combustion, cement production, and land use change during the past 200 yrs (Sabine and others, 2004). While this uptake may have moderated the rate of climate change, the uptake of CO₂ has also caused unprecedented changes to ocean chemistry, decreasing pH of the water and leading to a suite of chemical changes collectively known as ocean acidification. As another aspect of climate change, ocean acidification is an emerging global problem that will intensify with continued CO₂ emissions and will likely significantly impact marine ecosystems.

The average pH of ocean surface waters has decreased by about 0.1 unit—from about 8.2 to 8.1—since the beginning of the industrial revolution, with model projections showing an additional decrease of 0.2-0.3 by the end of the century, even under optimistic scenarios (Caldeira and Wickett, 2005; NRC report, 2010). This change exceeds any known change in ocean chemistry for at least 800,000 years (Ridgwell and Zeebe, 2005).

While ocean chemistry and the changes caused by increasing atmospheric CO₂ are well understood and can be precisely calculated, the direct biological effects of ocean acidification are less certain and will vary among organisms, with some adapting well and others not at all (i.e., so called winners and losers). Within the next 100 years, it is likely that society will see significant changes in marine ecosystems and their services, based on the long-term effects of ocean acidification (Raven and others, 2005).

Arctic Science

The Arctic Ocean covers an area of 14,056,000 km², has a fairly constant temperature near 0° C, and has some of the most and least productive areas in the world. Its cold waters absorb more carbon dioxide than warmer seawater. Meanwhile increasing mean annual temperatures in the region (1.8 degrees Fahrenheit over the past 150 years) has increased melting of Arctic ice. Up until recently, the perennial ice cover has prohibited significant equilibration with the post-industrial atmosphere, creating a polar mixed layer that is under saturated with respect to atmospheric CO₂. Over the last three decades, retreat of summertime sea ice cover has increasingly exposed shelf and slope waters to the atmosphere and has allowed additional absorption of atmospheric CO₂. The combination of these processes accelerates the rate at which pH and carbonate mineral saturation state decrease. Models have projected that the Arctic Ocean will become undersaturated with respect to carbonate minerals in the next decade. However, some recent field results indicate that parts of the Arctic Ocean may already be undersaturated in the late summer months when ice melt is at its largest extent. The uncertainty of the models is based on lack of data. The USGS Ocean Acidification Team initiated establishing baselines to gauge future change as a response to the recognition by Department of Interior of this vulnerable ecosystem (Robbins and others, 2010a).

Cruise Details
Sampling water

During the 5-week (August 26-September 27, 2011) UNCLOS (United Nations Convention Law of the Sea) cruise on the US Coast Guard Cutter Healy (Co-Chief Scientists: Larry Mayer and Andrew Armstrong), discrete and continuous underway water samples were collected and when possible, analyzed onboard, to document the carbonate chemistry of the waters in the Nautilus Basin, and Chukchi Cap areas (Figure 1). These data are being used to test the waters' saturation state with respect to calcium carbonate, with additional data to identify processes that drive changes in saturation state. These data are critical to refine existing models, which fail because of lack of baseline data.

Discrete water samples

Discrete water samples were collected while underway following protocols outlined in Dickson and others (2007). Surface water samples were collected for measurement of pH, alkalinity, total alkalinity/total carbon, nutrients (NH_4 , Silica, PO_4 , and NO_2+N), stable carbon and oxygen isotopic composition, major elemental analysis, dissolved organic carbon (DOC) and particulate organic carbon (POC). Discrete water samples were removed from the sampling port of the vessel's flow-through seawater system in the main laboratory (Figure 2).

More than 625 pH and 614 alkalinity discrete samples were measured underway. Discrete samples were collected aboard the Healy and those that were either analyzed or were stored for analyses back onshore. These include: pH, alkalinity, CO_3^{2-} , nutrients, $\delta^{18}\text{O}$ isotope, $\delta^{13}\text{C}$ isotope, metals, DOC, POC, DIC/Alkalinity. Every hour, pH and alkalinity samples were taken and analyzed shipboard. Generally, when the ship was traveling at a slower speed 4- 7 knots, the rest of the samples were taken every 3-4 hours. When the ship traveled faster ($\sim 12\text{kn}$), the suite of samples were taken every 4 hours. Particulate organic carbon samples were collected twice daily.

Shipboard pH and $[\text{CO}_3^{2-}]$ Analyses

Approximately 30 mL of seawater were collected directly into cylindrical optical glass cells for pH_T measurements on the total hydrogen ion scale following the procedure of SOP6b (Dickson and others, 2007) (Figure 3). Cuvettes were then placed into an aluminum cell warmer attached to a water bath at 25°C for approximately 20-30 minutes. Shipboard pH measurements were performed using an Agilent 8453 spectrophotometer, purified metacresol purple indicator dye, and equations modified by Liu and Byrne (in press). Measurement of carbonate ion concentration was performed using an Agilent 8453 spectrophotometer, and methods of Byrne and Yao (2008). Figure 4 shows set up of both spectrophotometers. Figure 1 shows location of pH and alkalinity samples that were measured.

Underway Continuous Measurements

Approximately 4000 continuous measurements of pH, and TCO_2 were performed between August 27, 2012 to September 1, 2012 using a flow-through Multiparameter Inorganic Carbon Analyzer (MICA) (Figure 5) and Seabird SBE49 CTD attached to the flow-through system of the USCGC Healy. Geographic, salinity, temperature, and fluorometric data were

also collected using a shipboard Ashtech ADU5 GPS system, a SeaBird SBE45 Thermosalinograph, and a Seapoint SCF Fluorometer. A complete description of these can be found in Chayes et al. 2010. The intake of the shipboard flow-through system was located approximately 8 m below the sea surface on the port side of the vessel. Water entered the sampling baffles at depth, was pumped to a sea chest for separation of ice, and was then pumped to a multi-port sampling manifold located in the ship's main laboratory. Seawater was then fed to a custom made PVC de-bubbler containing a Seabird SBE49, prior to being transported to the intake port of the MICA. Measurements were taken and logged approximately every 2-3 minute except for during a MICA flushing cycle that occurred for approximately 10 minutes each hour. The MICA was calibrated using Certified Reference Material from Professor Andrew Dickson of the University of California at San Diego. Precision and accuracy for each channel 0.002 for pH, 2 ppm pCO₂, and 2 µmol/kg for TCO₂. Problems with the equipment did not permit its full functioning and was discontinued after September 1.

CTD Stations

Discrete Vertical Profile Samples

Discrete samples from vertical profile (CTD Stations) casts were collected at 4 locations (see map in Main Report). For these casts, a 24-bottle Niskin rosette (12 L bottle volume) with an electronic trigger was fitted with a Seabird SBE 911plus CTD and altimeter. The CTD provided salinity, temperature, depth, fluorescence, and dissolved oxygen data. The rosette was lowered to determined depth and bottles were tripped at select depths as the rosette was brought to the surface. Water samples were collected from the Niskin bottles for the full suite of discrete analyses and included pH, CO₃⁻², δ¹⁸O, δ¹³C, nutrients, metals (i.e., alkalis and alkaline earths), total dissolved inorganic carbon/alkalinity. Selected samples were collected for Tritium/³He dating (He ingrowth method), to be completed at Lamont-Doherty Earth Observatory through a USGS contract with LDEO (Figure 6). These were collected by crimping in purpose-built copper tubes provided by LDEO (a total of 16 copper channels). Additional samples were collected for Tritium dating, but the Tritium vintage method. These were simply collected in 1L bottles. In addition, waters from specific bottles were collected and filtered for identification of microbial components. These analyses will be performed post-cruise. Samples for microbiological analyses were collected from bottles retrieved at certain depths, filtered through 5.0µm and 1.0µm Pall cartridge filters and a 0.22µm Sterivex filter (Figure 7), and stored at -80C.

XCTDs

Expendable CTDs (xCTD) were also deployed during the cruise to provide data on temperature-salinity profiles used in the calculation of freshwater content and identification of water masses. A total of 24 xCTDs were deployed (12 xCTDs provided by the OA team, in addition to the 12 xCTDs provided by Dr. Mayer's group). However, combined a total of only 16 produced profile data (8 failed during deployment).

Ikaite and Ice experiments/samples

Seawater has a higher salinity compared to freshwater, and its freezing only begins when water temperature is ~ -3-4°C. During the crystallization process, the seawater expels all

salts and impurities, which concentrate at the surface of the newly formed ice or between the crystals. Recent studies in Antarctic and east Arctic polar oceans identified a rare hydrated calcium carbonate mineral, called ikaite ($\text{CaCO}_3 \cdot 6\text{H}_2\text{O}$) among the products precipitated during freezing of cold seawater. During our Arctic cruise this year, our team member, Bogdan Onac is studying this mineral formation in ice.

Ikaite is a highly unstable mineral, which readily transforms into calcite (the most common and stable calcium carbonate mineral) if the temperature in the surrounding environment rises above 4°C. Since ikaite's discovery in polar oceans sea ice, scientists are trying to understand whether its precipitation triggers changes in the pH and CO₂ content of the sea surface waters. These issues are important in quantifying the amount of CO₂ uptake by the ocean and when investigating the role played by the polar regions in the global carbon cycle.

During this cruise, samples of various types of sea ice were collected at different locations. The samples were stored in the refrigerator where they slowly melted at temperature below 2°C to avoid transformation of ikaite into calcite. Once sea ice completely melted, the meltwater was filtered through 2.0 µm filters and then studied under microscope in the refrigerator (Figure 8). Samples of meltwater were collected for various physical, chemical, and biological analyses that Lisa and Jonathan are performing.

Data Analyses

On board, discrete data and MICA data were merged with ship's sensor data to provide cross validating of data using CO₂calc (Robbins and others, 2010) analyses.

Funding

Shiptime was provided by UNCLOS ECS project (Larry Mayer and Andy Armstrong). USGS (LLR) and NSF (JW and LLR grant ARC-1220032) provided monies for expenses.

Disclaimer

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof.

References Cited

Dickson, A.G., Sabine, C.L., and Christian, J.R., editors. 2007. *Guide to Best Practices for Ocean CO₂ Measurements*. PICES Special Publication 3, 191 pp.

Byrne, R.H. and Yao, W.S., 2008, Procedures for measurement of carbonate ion concentrations in seawater by direct spectrophotometric observations of Pb(II) complexation. *Mar Chem* **112**: 128-135.

Caldeira, K.; Wickett, M.E., 2003, "[Anthropogenic carbon and ocean pH](#)". *Nature* **425** (6956): 365–365. [doi:10.1038/425365a](#). [PMID 14508477](#).

http://pangea.stanford.edu/research/Oceans/GES205/Caldeira_Science_Anthropogenic%20Carbon%20and%20ocean%20pH.pdf.

National Research Council (NRC), 2010a, Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean. Committee on the Development of an Integrated Strategy for Ocean Acidification Monitoring, Research and Impacts Assessment, National Academies Press, Washington, DC.

Raven, J. A. and others, 2005, [Ocean acidification due to increasing atmospheric carbon dioxide](#). Royal Society, London, UK.

Ridgwell, A., and Zeebe, R. E., 2005, The role of the global carbonate cycle in the regulation and evolution of the Earth system. *Earth Planet. Sci. Lett.*, 234, 299-315.

Robbins, L.L., Yates, K., Feely, R., and Fabry, V., 2010a, Monitoring and assessment of Ocean Acidification in the Arctic Ocean: Scoping Paper for Arctic Mapping and Assessment Program, Open-File Report 2010-1227, 9p.

Robbins, L.L. , Hansen, M., Kleypas, J.A., and Meylan, S.C., 2010b, CO2calc Application for desktop and iPhone, Florida Shelf Ecosystems Response to Climate Change Project Ocean Acidification Task: U.S. Geological Survey Open File Report 2010-2010-1280, 17p.

Sabine, C.L., Feely, R.A., Gruber, N., Key, R.M., Lee, K., Bullister, J.L., Wanninkhof, R., Wong, C.S., Wallace, D.W.R., Tilbrook, B., Millero, F.J., Peng, T.-H., Kozyr, A., Ono, T., Rios, A.F., 2004, The oceanic sink for anthropogenic CO₂. *Science* 305:367–371.

Yamamoto-Kawai, Michiyo., McLaughlin, F.A., Carmack, E.C., Nishino, Shigeto. and Shimada, Koji., 2009, Aragonite undersaturation in the Arctic Ocean: Effects of ocean acidification and sea ice melt: *Science*, v. 326, no. 1098, p. 1098-1100.

Figures:

Figure E1. Location of pH and alkalinity samples taken aboard HLY1202

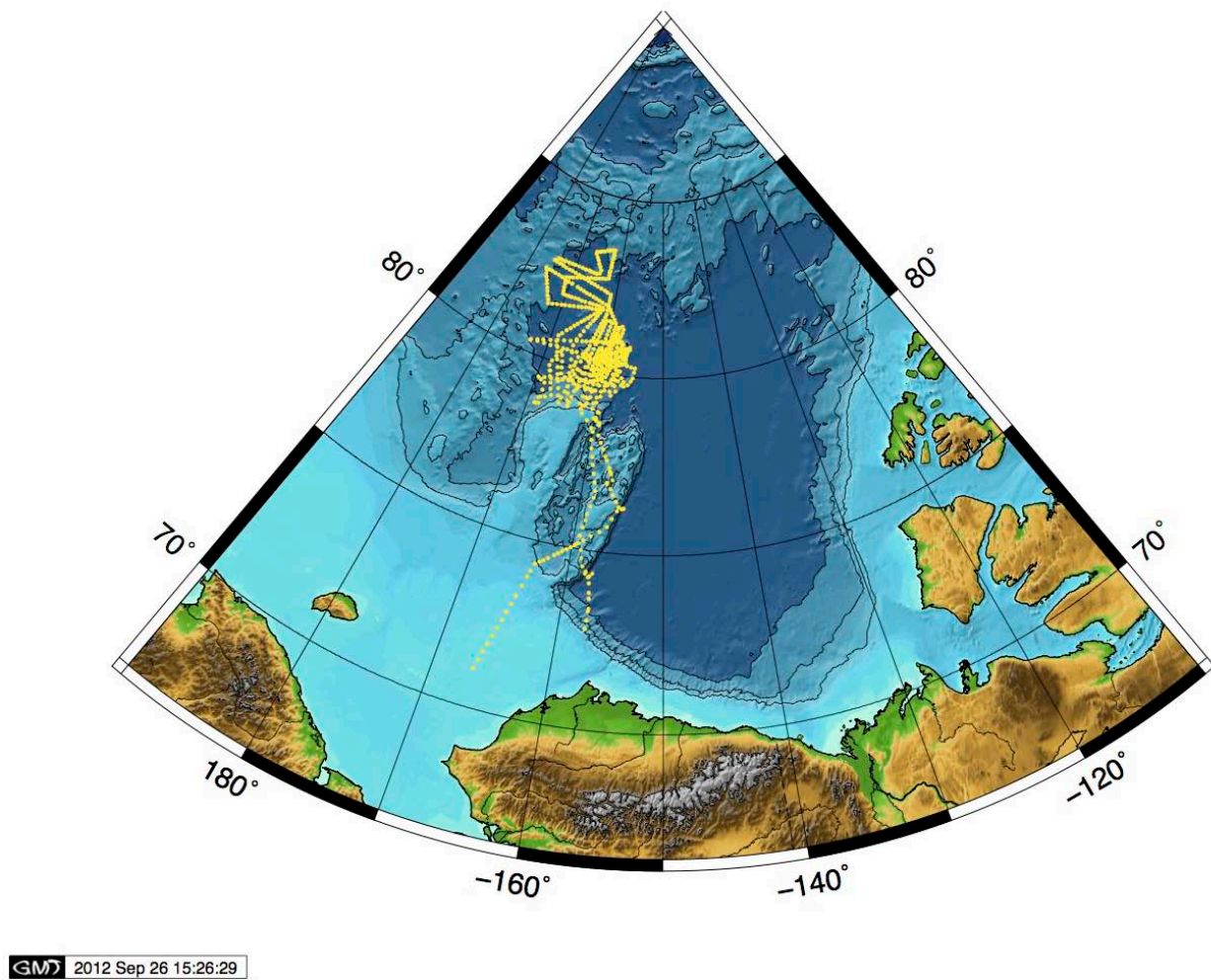




Figure E2. Discrete water sampling



Figure E3. Discrete water sampling for pH measurements



Figure E4. Titrimeter for alkalinity



Figure E5. Water collected from CTD for tritium analysis



Figure E6. Water from different depths from CTD were collected and filtered for microbiological analysis on-shore.



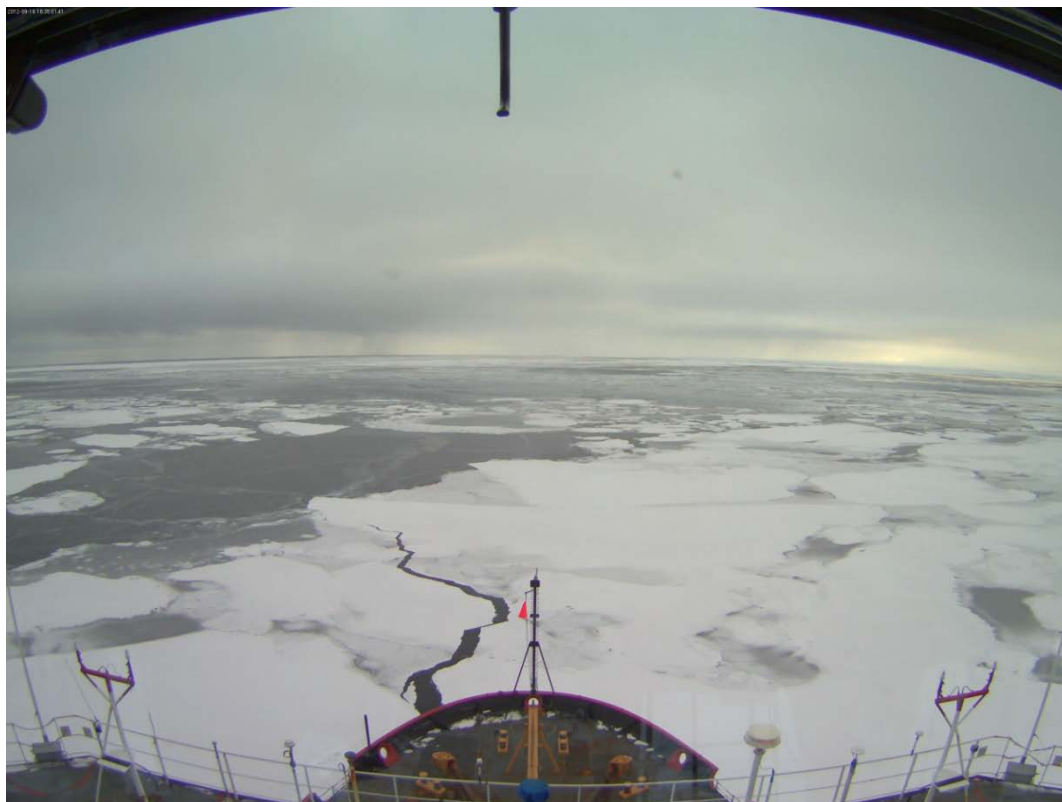
Figure E7. Bogdan Onac uses a microscope in the walk-in refrigerator to analyze filtered sea-ice.



Figure E8. Multiparameter Inorganic Carbon Analyzer, which collected DIC, pH and pCO₂ data for part of the cruise.

APPENDIX F

Community Observer Observations US Extended Continental Shelf Survey



August 25 – September 27
2012

Mabel Smith
COMMUNITY OBSERVER

UMIAQ INUPIAT CORPORATION

HEALY CRUISE 1202

Introduction

The United States embarked on a cruise in the Arctic Ocean on the U.S. Coast Guard Cutter *Healy* from August 25 through September 27, 2012 to collect bathymetric data and samples in support of the U.S. Extended Continental Shelf Project. A Community Observer, Mabel Smith, participated in the cruise.

Description of Daily Activities

The Healy Community Observer observed from the bridge of the *Healy* and was allowed unobstructed access to all areas and instruments required for data collection. All operations aboard the Healy were made during daylight hours. Systematic scans or sweeps with binoculars and naked eye were directed forward while the vessel was underway and in all directions during stationary periods. During transit to and from data collection sites, Community Observer monitored for marine mammals up to 8 hours within a 24 hour period. Healy observers were able to be contacted by phone or page during off-watch periods. Bridge personnel were willing to monitor for marine mammals during these periods and were supplied with forms to accompany any sightings while Community Observer was off-watch.

Responsibilities of the Community Observer

- Keeping up a logbook of daily operations (activities and results); ensuring data are recorded correctly for data entry.
- Acting as a source of marine mammal information;
- Abiding by the safety procedures of the vessel and acting in a responsible manner at all times.

Data Recording

The Community Observer recorded the following information.

- Date;
- Time and latitude/longitude when daily visual survey began
- Weather conditions (e.g. rain, fog, haze, clear skies, cloud cover, ice conditions, etc.);
- Ice Cover (% of water surface);
- Overall visibility (based on distance to horizon in kilometers) .

Information necessary to complete the data forms was available from instruments on the bridge and personal observation.

Logbook

The Community Observer completed a daily logbook, which is included in Appendix 1 at the end of this report.

HLY1202 Cruise Report

Summary Sightings

The following is an overview of individual sightings made by Mabel Smith onboard the Healy. Although sighting conditions were less than ideal due to heavy fog conditions for much of the cruise, the Healy Community Observer observed 9 polar bears, 2 seals, and numerous Arctic Terns.

Sightings of tracks and other types of marine mammal signs, as well as anything unique were recorded in the Sighting Log. For a more detailed description of individual sightings, refer to the completed forms and logbook.

September 1, 2012

Very little ice was present. No sightings.

September 2, 2012

12:10 am – polar bear sighting. Small amount of ice present. 82.18.09 N; 162.18654W

September 3, 2012

9:50 am, polar bear tracks sighted - No animals sighted. 82.46.435N; 169.12.817W

September 4, 2012

12 pm polar bear tracks sighted. 83.13N; 16211W; heavy ice cover.

9:15 pm - Arctic tern sighted at 8238.626N; 163.108591W

September 5, 2012

Seal sighting by Coast Guard personnel on bridge. Time and location unknown.

September 6, 2012

8:35 am Arctic Tern sighted;

8:40 Arctic tern sitting on ice. 81.18 545N; 163.45.987W

September 7, 2012

No sightings, first year ice on water.

September 8, 2012

No Sightings.

September 9, 2012

10:50; saw Arctic Tern at 80.47330N; 158.15882 W

2:30 pm; saw another Arctic Tern at 8005.41 N; 8005; 159.198 W. No ice visible.

September 10, 2012

Saw Arctic Tern at 80.54.211N; 159.24047 W; lots of ice cover.

September 11, 2012

No sightings.

September 12, 2012

No sightings.

September 13, 2013

No observations – sick day.

September 14, 2012

1:20 Arctic Tern sighting at 80.01.431N; 163.35.565W

1:40 Arctic Tern sighting at 79.53.7981N; 163.38.908W

5:00 pm; polar bear sighted. No position reported.

September 15, 2012

9:05 am; polar bear sighted at 79.55.38N; 161.244.38W

2:50 pm; polar bear sighting at 8010.407N; 160.16776W

September 16, 2012

Arctic Terns sighted in morning.

2:30 pm sighted a spotted seal at 80.46456N; 155.53.957W

4:00pm scientist sighted a seal; no position.

September 17, 2012

Arctic Terns sighted around ship

8:00 pm, Polar Bear sighted at 80.1991N; 156.45.103W

September 18, 2012

No sightings.

September 19, 2012

9:30 am sighted a polar bear with cubs at 80.44.045N; 159.32.463W

1:00 spotted polar bear tracks at 8027.288N; 159.55.46W,

1:30 sighted polar bear tracks at 80.27.288N; 159.55.461W

1:40 sighted polar bear tracks at 80.26.663N; 159.56.662W

2:45 sighted polar bear tracks at 80.26.437N; 159.57.366W

3:00 pm sighted polar bear tracks at 80.26.503N; 159.57.023W

5:00 pm sighted polar bear tracks at 80.262.88N; 159.58.906W

September 20, 2012

No sightings.

September 21, 2012

12:25 pm sighted Arctic Tern.

September 22, 2012

No sightings.

September 23, 2012

No sightings.

Conclusion

During the duration of this cruise everyone aboard the Healy was very willing, helpful, and responsive when marine mammals were encountered. The communication between the Community Observer, scientists, and Coast Guard personnel was excellent.

APPENDIX G: DESCRIPTION OF EM122, KNUDSEN and CTD Data Formats

Kongsberg EM122 multibeam

Verification of real-time logging of EM122 data is still in process. Until this data stream is validated, the raw data files as logged on the Kongsberg SIS Hyrdographic Workstation (HWS) is included in the "raw" section of the data distribution.

Description: The Kongsberg EM122 multibeam bottom mapping sonar was installed on the Healy during the CY2009-2010 maintenance period at Todd Pacific Shipyard in Seattle, WA. This sonar routinely collects bathymetry and seafloor image data as well as water column. It is also capable of collecting raw "stave" (or hydrophone data) but this is not done routinely.

Directory: Raw/EM 122 RawData/

Within this directory, there are separate directories for each "survey" collected by the SIS application. Survey's tend to end when the SIS is restarted for some reason. Under special circumstances, survey's may be used to separate data from different events. Survey directories are named: HLY1102_01/

Table G1. Kongsberg EM122 Raw data file types

Item	File Name	Extension	Content
1	0000_20100619_233632_Healy	.all	Binary Kongsberg ".all" format. MB-System type 58 file or .mb58
2	0000_20100619_233632_Heal	.wcd	Binary Kongsberg water column data

Raw Multibeam data

Raw data from the Kongsberg EM122 multibeam is logged in real-time by LDS over a network connection. Two types of files are logged: bathymetry and watercolumn data.

Verification of real-time logging of EM122 data is still in process. Until this data stream is validated, the raw data files as logged on the Kongsberg SIS Hyrdographic Worksatin (HWS) is included in the "raw" section of the data distribution.

Description: Raw data from the Kongsberg EM122 multibeam is logged by LDS in two types of files. Files ending in .mb58 contain traditional multibeam data in the manufacturer's "Raw.all" format. These files have a file name extension of .mb58 . The EM122 also generates beam formed water column data which is logged in files with a ".wcd" extension.

HLY1202 Cruise Report

Water column data is very voluminous and is not normally included in the end of cruise distribution provided to the departing chief scientist. It is archived ashore and can be provided by request.

Multibeam Center Beam

Central beam water depth extracted in real-time from the Kongsberg EM122 data.

Description: This entry describes the format of LDS centerbeam record derived from the EM122.

[Directory: LDS Data/emctr](#)

File Name: HLY1001-emctr.y2010d192

Data Examples : A typical sequence from the a data file:

```
emctr 2010:192:14:31:00.5425 $EMCTR,2010,07,11,14:30:59.922,71.952202,-  
156.542031,69.88,432*56  
emctr 2010:192:14:31:01.0698 $EMCTR,2010,07,11,14:31:00.441,71.952202,-  
156.542031,69.82,425*5F  
emctr 2010:192:14:31:01.0863 $EMCTR,2010,07,11,14:31:00.465,71.952202,-  
156.542031,69.85,427*5C
```

Table G2. LDS Kongsberg EM multibeam center beam Message

Field	Data Type	Example	Units
1	Tag	emctr	Data type/source ID in LDS
2	LDS logged date & Time	2010:192:14:31:01.0698	YYYY:DDD:HH:MM:SS.ssss
3	NMEA Header	\$EMCTR	NMEA-0183
4	Year	2010	UUUU
5	Month	07	MM
6	Day	11	DD
7	Time of the ping	14:30:59.922	HH:MM:SS.sss
8	Latitude	71.952202	Decimal Degrees (+/-DD.ddddd)
9	Longitude	-156.542031	Decimal Degrees (+/-DDD.ddddd)
10	Depth	69.82	Meters
11	Number of reported beams	432	Integer.
12	Separator	"*"	NMEA-0183
13	Checksum	55	NMEA-0183

Sound Speed at the keel

sound speed at the keel formatted in real-time for the EM122 real-time input by LDS.

Description: This entry describes the format of LDS centerbeam record derived from the EM122.

Directory: LDS Data/emsv

File Name: HLY1001-emsv.y2010d192

Data Examples : A typical sequence from the a data file:

```
emsv 2010:192:14:51:15.7117 $KSSIS,80,1435.79,-1.37,
emsv 2010:192:14:51:17.6958 $KSSIS,80,1435.79,-1.37,
emsv 2010:192:14:51:19.7098 $KSSIS,80,1435.78,-1.37,
```

Table G3. LDS sound speed at the keel for the Kongsberg EM122 multibeam

Field	Data Type	Example	Units
1	Tag	emsv	Data type/source ID in LDS
2	LDS logged date & Time	2010:192:14:31:01.0698	YYYY:DDD:HH:MM:SS.ssss
3	NMEA Header	\$KSSIS	NMEA-0183
4	EM datagram type	80	hexadecimal
5	Speed of sound	1435.79	meters/second
6	Water Temperature	-1.37	degrees Celsius

Knudsen 320B/R

Description: The Knudsen 320B/R depth sounder has two independent transceivers. One is tuned for and connected to an ODEC TC12/36 hull mounted transducer. The other is matched to an array of 16 tr-109 subbottom transducers. It is capable of simultaneously operating at 12 kHz and as a subbottom profiler in either tone burst (3.5 kHz) or "chirp" (3-6kHz) mode. The Healy routinely operates the 3 - 6kHz "chirp" (Sub Bottom Profile) mode except in special situation

such as communicating with and, or ranging on acoustic releases or bottom tracking pingers. We do not operate the 12 kHz sounder as it interferes with the multibeam. Historically, Knudsen data has been saved in all of the formats that the Knudsen can record data in. These files are ASCII, mixed ASCII/Binary and binary format (see the table below).

[Directory: Raw/ knudsen](#)

Knudsen File Types

Item	File Name	Extension	Content
1	2007_102_0005_004	.keb	Binary Knudsen format
2	2007_102_0005_004	.kea	Log file of configuration data, ASCII
3	2007_102_0005_HF_001	.sgy	SEG-Y subbottom data, Mixed

Knudsen 320B PKEL

Description: This entry describes the format of data in the Knudsen "PKEL" format from the Knudsen 320 B/R via RS-232C serial output from the IC-Gyro. This format can be changed too easily. As a result users should be careful using this format page without verifying that the coulomns desired are the right ones. More info is available from the Knudsen manuals.

[Directory: LDS Data/pkel](#)

File Name: HLY1003-pkel.y2010d258

Data Examples : (1 line from a data file):

```
pkel 2010:258:01:55:00.5980 $PKEL99,-----
,15092010,015454.027,05413,HF,00.00,0,+008.50,LF,3834.,1,+008.50,1500,0008 , 0,72 50.50
2637N,150 45.340869W,0981*09
```

Knudsen PKEL record

Field	Data Type	Example	Units
1	Tag	pkel	Data type/source ID in LDS
2	LDS logged date & Time	2010:258:01:55:00.5980	YYYY:DDD:HH:MM:SS.ssss
3	NMEA-like Header	\$PKEL99	NMEA-0183
4		-----	
5	Ping date	15092010	DDMMYYYY
6	Ping time	015454.027	hhmmss.sss

HLY1202 Cruise Report

Field	Data Type	Example	Units
7		05413	
8	Frequency key	HF	HF = 12 kHz
9	HF Depth	00.00	Meters, corrected for draft
10	HF Depth Valid	0	1 == valid
11	HF Draft	+008.50	Meters, used for draft correction
12	Frequency key	LF	Subbottom
13	LF Depth	3834.	Meters using sound speed
14	LF Depth Valid	1	1 == valid
15	LF Draft	+008.50	Meters
16	Sound speed	1500	meters/second
17		0008	
18		0	
19	Ping Latitude	72 50.502637N	DD MM.MMMMMMM
20	Ping Longitude	150 45.340869W	DDD MM.MMMMMMM
21	Position Latency	0981	units ?
22	Separator	"*"	from NMEA-0183 standard
23	Checksum	09	Not calculated, place holder only

SEABIRD SBE-9 CTD

CTD data was made available after each cast in Seabird data formats. This data is preliminary and not processed data. The raw CTD data is stored in hex format and the CTD operator converted the data into a readable ASCII format at the end of each cast.

[Directory: Raw/ctd](#)

HLY1202 Cruise Report

Description: Data for the each CTD cast are contained in subdirectories under this directory. These files are in the native format written by SeaBird's SeaSave application format. Each cast is in a separately numbered subdirectory. The names of the files vary by cruise but file extent examples below will be consistent.

CTD File Types

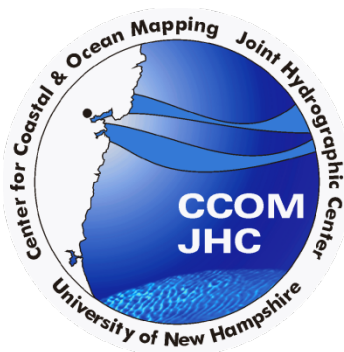
Item	File Name	Extension	Content
1	021	.BL	Bottle firing info
2	021	.CON	Configuration File for each cast
3	021	.HDR	Header information for the cast
4	021	.btl	ASCII bottle trip data
5	021	.cnv	ASCII output data
6	021	.hex	ASCII hexadecimal encoded raw data
7	021	.jpg	Cast plot
8	021	.ros	Bottle trip information
9	021	avg.cnv	ASCII 0.5 meter pressure bin data

APPENDIX H

PROCESSING PIPELINE

Data Processing Watchstander Checklist

**USCGC Healy (WAGB-20)
US LOTS Mapping Mission (HLY12-02)**



Modification Status of this Document

Date/Time	Author	Comment
2007-230/0600	Brian Calder	Initial revision
2007-230/1730	Brian Calder	Modified output products required
2007-231/0230	Brian Calder	Modified required frequency of output products
2007-231/2345	Brian Calder	Small comments on output file name conventions
2007-232/0610	Brian Calder	Added explicit instructions on sub-fieldsheets, and procedure for GIS-index file generation
2007-233/2319	Janice Felzenberg	Modified things to do (copy processed Knudsen images to local hard drive)
2007-234/0420	Brian Calder	Modified location for the ASCII sounding data at end of day to ArchiveData to match original intent
2007-234/0715	Brian Calder	Added instructions for converting the OziExplorer 'as run' route to HyPack/ArcGIS
2007-235/0025	Brian Calder	Reconfigured product creation to reflect making the projected grids in AvgGrid to beat out system noise.
2007-236/0600	Brian Calder	Added smoothing factors for AvgGrid and lower resolution grids, and naming convention for hyper-smoothed grid products.
2008-226/0020	Brian Calder	Updated locations of data from the servers to match the current configuration for HLY0805.
2008-229/1842	Brian Calder	Added instructions on processing Knudsen data from SEG-Y through SonarWeb, and Fledermaus object construct at end of day.
2008-229/1920	Brian Calder	Changed meta-data instructions from manual creation to automatic creation.
2011-227/2250	Brian Calder	First-pass modifications for HLY1102
2011-230/0215	Brian Calder	Modifications for HIPS 7.1 output and Fledermaus 7.3 product generation based on GSF outputs.
2011-231/0830	Brian Calder	Added low-resolution daily product, and updated end of day processing instructions for metadata and GIS products.
2011-240/0640	Brian Calder	Added modified UNCLOS-specific Fledermaus projection information, updated information on colourmap requirements for 4-hr and full-day products. Updated resolutions table in Table 1.
2011-256/0504	Brian Buczkowski	Modifications for processing Knudsen data from SEG-Y through SonarWiz5, and Fledermaus object construct at end of day.
2012-238/0240	Brian Calder	Modifications to adapt to locations for HLY12-02
2012-241/0700	Brian Calder	Updated locations of Knudsen files after copy, and new location for files in metadata creation

Data Locations

Raw data is on Healy's primary data server, copied from a number of different systems; this is the source of all of the data you'll need for the processing. If the data directory isn't already mounted, then mount `\\seaventure\data\hly1202` on `Z:` locally (seaventure is currently 192.168.10.18 and shouldn't move for the duration of this cruise). You should not have to provide login credentials for the system; if it starts asking for a username and password, that's probably a bad sign (and time to call for help).

It is very important that you copy the data from the server in a timely manner (as indicated below). The servers can be a little flakey; you don't want to lose the data because of a system crash. Don't leave it until the end of the watch to copy a chunk of data (no matter how tempting that might be).

All data is to be copied to the local hard drive, mounted as E:. The data for the current mission is in `E:\Healy1202`, with appropriate sub-directories for raw data (RawData), data being processed (Processing), and products being created (StaticProducts). Other directories reflect GIS/Mapping products, but don't concern the person working on processing the data at this station.

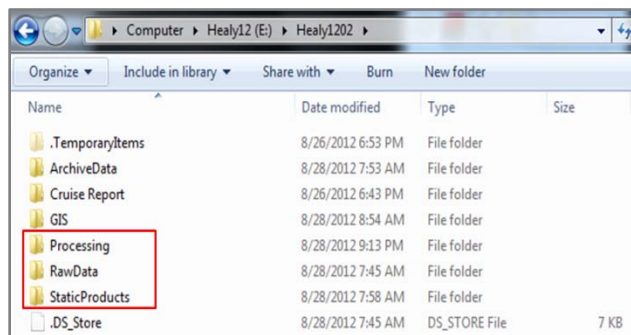


Figure H1 - In red, the sub-directories of interest.

Time Keeping

All timestamps on the data are referred to UTC (a.k.a. GMT, more or less). If you make a log entry, or comment in this file, please use this timestamp. Local ship's time is Alaskan standard time, which is eight hours behind UTC. That is, 2100 local time is 0500 UTC in the following day (0500+1).

Record Keeping

There will be, next to the processing station, a clipboard with a worksheet to record the stages of processing indicated below. The sheet has one line per MBES data line acquired. Fill in each line with the Julian day of capture and the line name when you start processing, and initial each stage of the sheet as you move forward. The stages at the end (grid construction and inspection) happen once every four hours; initial once at the last line of the set being used.

Things You Need To Do

Copy Data to Local Hard Drive

1. At the end of each hour, the EM122 system generates a new file. When the next hour's file appears in the raw data directory, copy the previous hour's file to the local RAID drive raw data directory, `E:\Healy1202\RawData\EM122\2012-DDD` where DDD is the Julian day when the data was collected. **Note that there are appropriate desktop shortcuts to the source and destination locations to make finding this easier.** At the end of each UTC day, you should have 24 files in this directory. Due to the way that the Simrad SIS software rolls over files, you can't guarantee that they will always roll over on the hour, so you might have one more or less file each day; this also means that you'll have to keep checking for the new files appearing. Windows 7 (in its infinite wisdom, blessed be the name of Microsoft) may warn you about potentially harmful files on each copy. Ignore it. (That's generally good advice.)
2. At irregular intervals during each day, the Knudsen sub-bottom profiler will generate new files in `Z:\Raw\knudsen`. When the next file appears, copy all of the components of the previous file (.kea, .keb, and several .sgy) into `E:\Healy1202\RawData\Knudsen320\2012-DDD`. **It is vital that you do not copy any files until the next one is started** (i.e., until the current file is finalized and closed). If you ingest partial files into SonarWiz5 (see below), they are difficult to remove cleanly or recover afterwards, and the only known solution is to rebuild the whole project.
3. At the end of each hour, copy PNG images of the post-processed Knudsen sub-bottom profiles appear in `Z:\plots\knudsen_hourly_plots`. Note: only download the data that starts on the hour (e.g. 0800, not 0830). When the new hourly PNG file appears in the catalog, copy the image to the local RAID drive directory, `E:\Healy1202\GIS\Knudsen_Images`.
4. When we do a CTD or take an XBT, data files will be generated in `Z:\Raw\ctd` or `Z:\Raw\ctd\xbt`. When the MST tells you that the data is available, copy to `E:\Healy1202\RawData\CTD` or `...\XBT` as appropriate.

CARIS/HIPS Processing of Data

1. Convert the EM122 data into the CARIS/HIPS project in `E:\Healy1202\Processing\HDCS_Data\HLY1202`. Use the "Healy" ship model, and construct a new day directory for each Julian day. Use the "Simrad" conversion module, and do not filter by either navigation or depth range. To open the new line, go to File, Open Project and select your new line.
2. Apply the `zerotide.tid` file to all lines just converted (a tide file is required, even if it's identically zero meters).
3. Merge all of the lines just converted. Leave all the options and sensors to be applied blank.. A warning that navigation data has not been examined will be issued for each line; this can be ignored.
4. Construct a new fieldsheet for the lines, or update the current day's fieldsheet if it already exists (select line then go to Process on the main menu and use 'Add To...')

from the BASE Surface's context menu). Use UPS (Universal Polar Stereographic) projection, and '75NORTH' for zone (this gives projection parameters consistent with the rest of the data for the project).

5. Create (or update) a BASE Surface for the new lines. Ensure that the 'Shoal' and 'Deep' layers are created. Use the 'Swath Angle' construction method and an appropriate resolution.
6. Check the newly added line to consistency with any overlap, and particularly any evidence of refraction (either 'smiles' or 'frowns' across-track). The most efficient remediation mode for the data is typically sub-set mode (i.e., 3D spatial editing), although line-oriented mode can sometimes be more useful for particular problems (for example nadir issues in shallow water). Common sense is the most useful guide, rather than a particular editing dogma: use whatever tool suits the problem. **Do not re-convert lines after you start editing: all edits will be lost!**
7. Check the shoal and deep layers for any significant outliers, and remove them from the sounding set. After you're done, the shoal, deep and mean depth layers should all show a full range of the color-map in use across the area. If not (e.g., most of the area is one color although you know there's a significant bathymetric difference), then you've probably still got an outlier somewhere.
8. Once all outliers are removed, recreate the BASE surface(s) (use the 'Recompute' option from their context menu).

SonarWiz5 Processing of Knudsen Data

1. Copy the folder containing raw SEG-Y files for each Julian Day from the RAID directory, `\\prawn\Healy1202\RawData\Knudsen320\2012-DDD`, and paste it into the local folder, `C:\SonarWiz-Projects\Raw_data`.
2. Open SonarWiz5 and ensure that it picks up the Healy1202 project (if not, it is an MML file in `C:\SonarWiz-Projects\Healy1202\Healy1202.mml`).
3. Click on the Post Processing tab to view all of the processing options, and choose Import→Sub-bottom Files... and then select the new SEG-Y files to process (you may select all in the folder to process at once). In the Open dialog window, Click the button labeled File Type Specific Options... to view the import settings for SEG-Y data. There is a settings file to load if any of the initial import settings have been changed, `C:\SonarWiz-Projects\Healy1202\Healy1202_Knudsen320.prp`.
4. After the SEG-Y files have been imported, choose File Manager to view the newly-created .CSF files so ensure that they look reasonable (i.e., appears like the sub-bottom image being shown in real-time at the watchstander station).
5. Save the project (SonarWiz5 button→Save), then exit.

Product Creation

Product creation doesn't have to happen at the end of every line (although you can do so if you want the practice). You should, however, make a set of products at the end of every 4 hr segment (i.e., after the line at 0300-0400 UTC, after 0700-0800 UTC, etc.) Note that the fieldsheets you might make in CARIS are unrelated to the products that you need to create for archive and visualization.

At the end of each 4 hr segment, follow these steps:

HLY1202 Cruise Report

1. Select all of the lines in the sub-product, and export as GSF files:
 - a. File→Export..., use 'HIPS to GSF'
 - b. Save files in `E:\Healy1202\ArchiveData\2012-DDD` using the default output name given by HIPS.
2. Open DMagic, and create an SD product:
 - a. File→Add Source Data...
 - i. Select 'Ungridded Data' radio button; click 'Next'.
 - ii. Click 'Add File(s)...', then select the appropriate GSF files; click 'Next'.
 - iii. Verify that the horizontal coordinate system defaults to FG_WGS_84
 - iv. Verify that the vertical coordinate system is set to FD_Unspecified_Meters
 - v. Click 'Finish' and wait for the files to be converted and scanned (you can watch this on the left in DMagic's main display).
 - b. Select all files in the project to be added to the sub-product grid.
 - c. Select 'Tools→Grid Ungridded Files...'
 - i. Verify that the appropriate files are in the active list; click 'Next'.
 - ii. Verify that 'Value to Grid' defaults to 'Depth'.
 - iii. Verify that the output coordinate system is set to FPC_US_UNCLOS_PolarStere for horizontal coordinate system, and FD_Unspecified_Meters for vertical; click 'Next'.
 - iv. Verify that the gridding type is set to 'Weighted Moving Average' with weight diameter and cell size selected from Table I.
 - v. Verify that the 'Rows' and 'Cols' elements at the bottom of the window seem appropriate (i.e., are not enormous); click 'Next'.
 - vi. Verify that the Color Map filename is set to 'colorsinterp.cmap', and that the shade parameters are set to 'Default Parameters'; click 'Next'.
 - vii. Verify that the output type is set to 'Surface (DTM)', then set the output filename to `2012_DDD_HHHH_HHHH_RRmm.sd` where DDD is the Julian Day, HHHH are the start and end hours for the file, and RR is the resolution tag from Table I; click 'Finish' and wait for the grid to be created.
 - d. Copy the SD file from the Fledermaus project directory, `E:\Healy1202\Processing\Fledermaus\HLY1202.fmproj\Output\SD`, to `E:\Healy1202\StaticProducts\2012-DDD`.
 - e. If further smoothing is required for a particular product, set the smoothing factor appropriately, and indicate the departure from the recommended values in Table I by appending the smoothing factor to the filename: save files as `2012_DDD_HHHH_HHHH_RRm_S.sd` for smoothing radius S.
3. Open the object just created in Fledermaus and ensure that (a) it's in the right place, (b) it looks right, and (c) there are no obvious fliers left in the data. If any of these checks fail, go back to CARIS/HIPS and repeat steps 1-4 until it looks right.
4. Export an ArcView grid for the product grid; in DMagic:
 - a. Select the appropriate grid, right click and select 'Export Surface...' from the context menu.
 - b. Select 'Export ArcView Grid'; click 'Save'.

- c. Save the file as 2012_DDD_HHHH_HHHH_RRm.asc in E:\Healy1202\StaticProducts\2012-DDD.

At the end of each Julian day (1600 ship's local time), do the following:

1. At the end of each Julian day (1600 local time), the POS/MV (motion and attitude sensor) completes a file in the Z:\LDS_Data\{posnav, emsv} directories on the server. When you see the next day's file appearing, copy the previous day's file to E:\Healy1202\RawData\AuxiliaryData. All files will be kept in this same directory. There is one source files in each of the Z:\LDS_Data\{...} directories; you need HLY1102-posnav.y2011dDDD, and HLY1102-emsv.y2011dDDD, where DDD is the Julian day for the data.
2. Open DMagic and make 'whole day' projected and geographic objects:
 - a. Select all of the GSF files for the day in DMagic, and follow the procedure for #2 in the 4-hr products to generate a projected grid for the full day; use the "arctic.cmap" colour map. Use the coarsest resolution used to make a product during the day. The file should be named 2012_DDD_ps_RRm.sd.
 - b. If the resolution of 1(a) is finer than 100m, select all of the GSF files for the day in DMagic, and follow the procedure for #2 in the 4-hr products to generate a projected grid for the full day at 100m. (This is used to accumulate a working view of the survey at lower resolution.) The file should be named 2012_DDD_ps_100m.sd.
 - c. Select all of the GSF files for the day in DMagic, and follow the procedure for #2 in the 4-hr products, except that at stage c(iii), set the horizontal coordinate system to FG_WGS_84. Smoothing factors and equivalent sizes are given in Table I. Name the file 2012_DDD_geo_GGs.sd where GG is the 'geolabel' column in Table I (i.e., the grid resolution in seconds of arc); for example a grid at 1.8×10^{-4} = 0.6" would be labeled 2012_227_geo_0.6s.sd.
3. Inspect the Fledermaus objects you've just created to ensure that they're stable; rinse and repeat process if required.
4. Export the projected grid as a GeoTIFF for the GIS; in DMagic:
 - a. Select the appropriate grid, then click on the 'DTM' tab in the 'Object Attributes' pane.
 - b. Select 'Tools→Export Surface as Image...', ensure the format is set to 'GeoTIFF', and save as 2012_DDD_ps_RRm.tif or 2012_DDD_geo_GGs.tif in E:\Healy1202\StaticProducts\2012-DDD.
5. Export the Fledermaus projected grid as an ArcView ASCII grid for the GIS; in DMagic:
 - a. Select the appropriate grid, right click and select 'Export Surface...' from the context menu.
 - b. Select 'Export ArcView Grid'; click 'Save'.
 - c. Save the file as 2012_DDD_ps_RRm.asc or 2012_DDD_geo_GGs.asc in E:\Healy1202\StaticProducts\2012-DDD.
6. Export the Knudsen data to Fledermaus:

HLY1202 Cruise Report

- a. Open SonarWiz5 and ensure that it picks up the Healy1202 project (if not, it is an MML file in `C:\SonarWiz-Projects\Healy1202\Healy1202.mml`).
 - b. Choose Export→Export Files to 3D Viewer→Export SBP Files to 3D... to view the export options. Select to export the selected files to Fledermaus SD files, SD version 7, and choose to Launch 3D Viewer when Export Completes (Note: Export can only handle 5 to 8 files at a time—multiple export sessions may be necessary if many .csf files are available for one Julian Day).
 - c. Select the proper projection and vertical scale (WGS84, and undefined_m) in Fledermaus, and close out the program.
 - d. Check that in `C:\SonarWiz-Projects\Healy1202\3DView` there are SD Files that correspond to the day's data, and which are loadable in Fledermaus.
 - e. Copy SD files from `C:\SonarWiz-Projects\Healy1202\3DView` to the RAID directory `\\prawn\Healy1202\Processing\SonarWiz\Fledermaus`.
7. Extract the navigation for the MBES data into the format required for the GIS database. Open a Terminal window, and do:
 - a. `cd /Volumes/Healy1102/ArchiveData/2012-DDD`
 - b. `nav_to_shape.pl 2012-DDD.gen *.gsf`
 - c. `posgga_to_shape.pl -a 2012-DDD_posmv_gga_navigation.gen /Volumes/data/hly1202/LDS_Data/posnav/HLY1202-posnav.y2012dDDD`
8. Construct the metadata for the day. Open a Terminal window and do:
 - a. `cd /Volumes/Healy1202/ArchiveData/2012-DDD`
 - b. `compute_day_metadata DDD`
9. Construct the XBT database and plots for any new XBTs:
 - a. Run `construct_xbt_database`
 - b. Start MATLAB, and ensure that `/Volumes/Healy1202/Processing/bin` is in the path; run the `plot_xbt_ssp.m` script.
 - c. Navigate to the `/Volumes/Healy1202/Processing/XBT` directory, select all the new XBT SSPs since the last batch (these are made by the `construct_xbt_database` script), and click 'Open'; the code will load all of the SSP files and generate plots as PNGs in the same directory.
 - d. Move the resulting PNGs into the `/Volumes/Healy1202/GIS/XBT` directory.
10. Tell the person running the GIS workstation that the products are available for ingestion into the GIS.

Recommended Grid Resolutions

The grid resolutions and smoothing factors in Table I are recommendations for product construction at 4hr intervals, and for full-day products when possible. In the case of full-day products where there is a lot of variability in the depth, you may need to make more than one grid to preserve resolution in the shallow areas. Don't make more than 2-3 grids, since it otherwise gets confusing.

The depth ranges in the 'Actual' column here are computed by empirical experimentation, and are approximate. You should endeavor to use the highest possible resolution that results in a grid product without holes; in practice, you should try the next higher resolution as well as the nominal one. So if the maximum depth in your data is 1500m, you would try 30m and 25m (and maybe even 20m) to see if the data will stand up to it, before choosing a final resolution. You can't really tell this from the DTM in DMagic; you need to see the Fledermaus object. If in doubt, you can make a grid at the lowest resolution you think is likely, and then examine it to see where the data starts to fall apart. Make the resolution decision in projected coordinates, and then match in geographic coordinates if possible: you may have to drop the resolution somewhat in geographic coordinates because of the latitude at which we're working.

Grid Resolution		Nominal (m)	Actual (m)	Weight Diameter	GeoLabel (second of deg)
(m)	(deg)				
5	4.500E-05	71.59063	<300m	3	0.2s
10	8.999E-05	143.1813	<500m	3	0.3s
15	1.350E-04	214.7719	<1000m	3	0.5s
20	1.800E-04	286.3625	<1250m	3	0.6s
25	2.250E-04	357.9532	<1500m	3	0.8s
30	2.700E-04	429.5438	<1750m	3	1.0s
35	3.150E-04	501.1344	<2000m	3	1.1s
40	3.600E-04	572.7251	<2500m	3	1.3s
45	4.050E-04	644.3157	<3500m	3	1.5s
50	4.500E-04	715.9063	<4000m	3	1.6s
75	6.749E-04	1073.859		3	2.4s
100	8.999E-04	1431.813			3.2s
125	1.125E-03	1789.766			4.0s
150	1.350E-03	2147.719			4.9s
175	1.575E-03	2505.672			5.7s
200	1.800E-03	2863.625			6.5s
225	2.025E-03	3221.578			7.3s
250	2.250E-03	3579.532			8.1s
275	2.475E-03	3937.485			8.9s
300	2.700E-03	4295.438			9.7s
325	2.925E-03	4653.391			10s
350	3.150E-03	5011.344			11s
375	3.375E-03	5369.297			12s
400	3.600E-03	5727.251			13s

Table H1: Recommended grid resolutions for the Kongsberg EM122 on USCGC HEALY during HEALY 12-02 (2012).