STARC

Ship-based Science Technical Support in the Arctic

An NSF award to enhance marine science and technical services provided to NSF-supported research cruises on U.S. Coast Guard cutters Healy, Polar Star and Polar Sea. Scripps Institution of Oceanography and Oregon State University are working together in a joint venture to provide basic services to the level provided by the University-National Oceanographic Laboratory System (UNOLS) for supporting academic research.

Healy – Science support

EM122 Multibeam

Knudsen Echosounder

ADCP 75/150khz system

GPS receivers

MET and Science seawater sensors

CTD equipment and sensors

XBT equipment

Gravity Meters

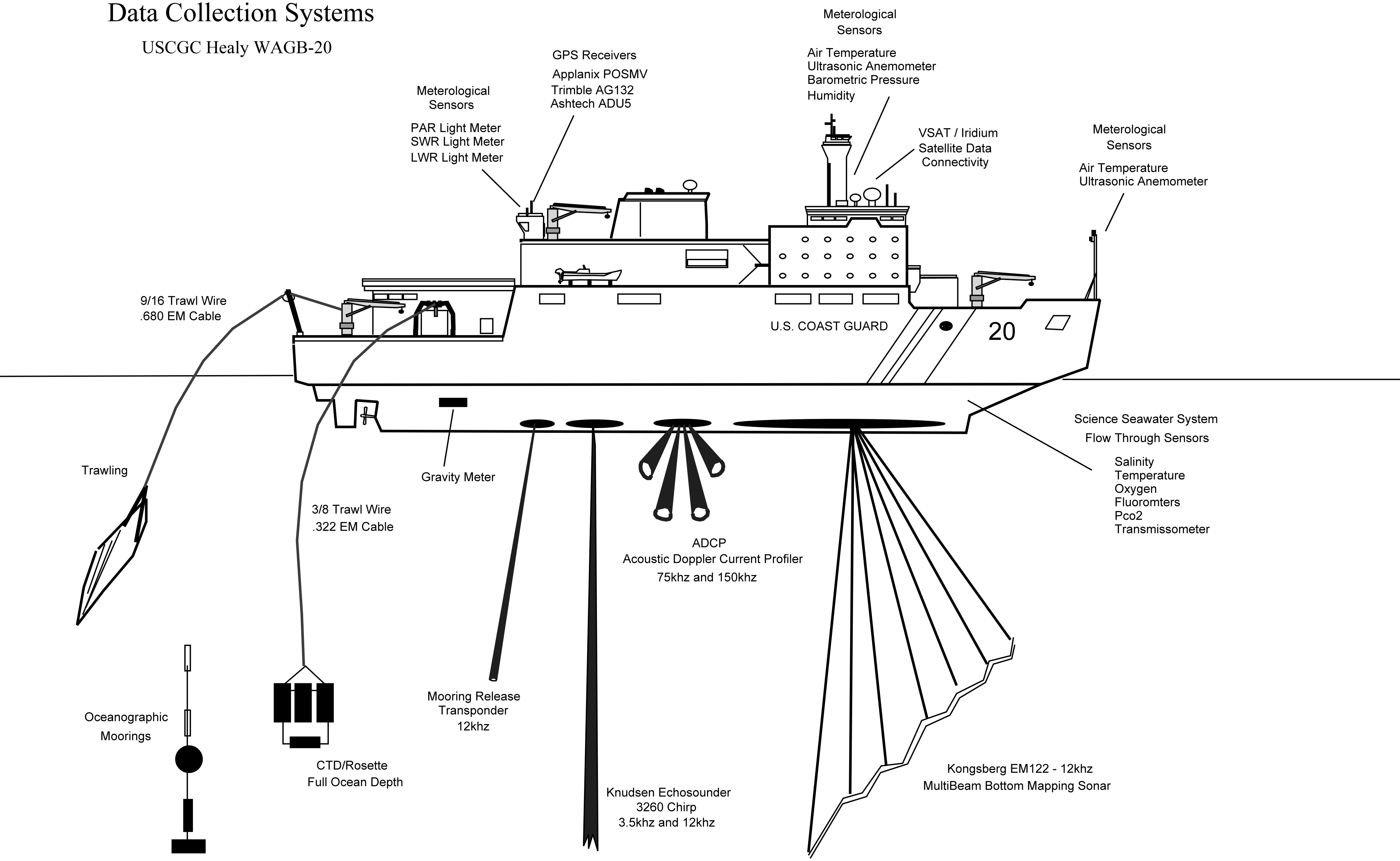
Lab equipment

Hazmat / Isotope procedures and compliance

ICEFLOE.NET administration

Shipboard Science
Data Collection Systems

USCGC Healy WAGB-20



Healy – Drydock 2013

Work with the Coast Guard and Shipyard to ensure access to science related systems and equipment for repairs, maintenance and completion of outstanding science TCTO projects.

EM122 / Knudsen / Transducer repairs and maintenance

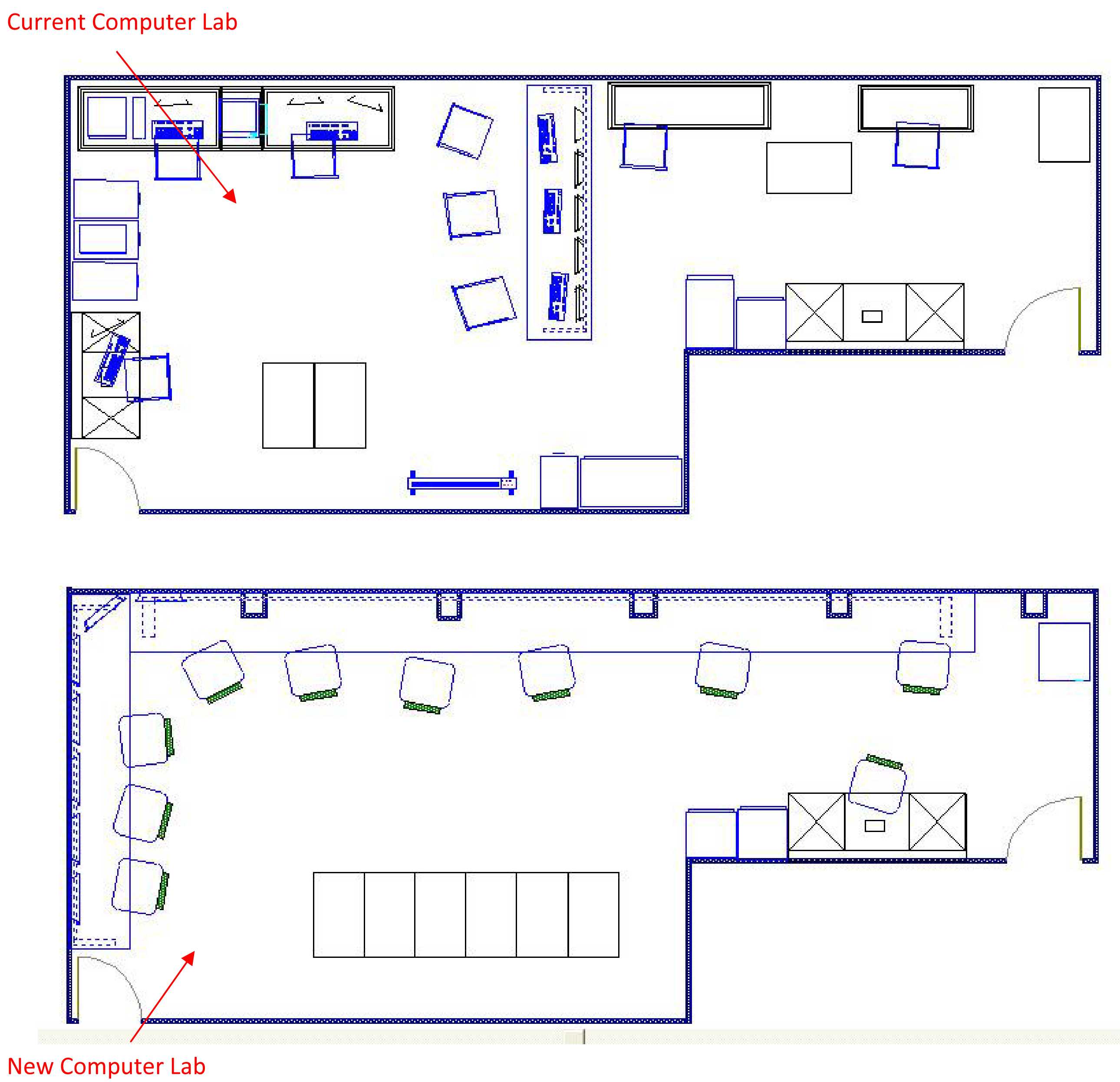
TSG / PCO2 relocation project

Computer Lab renovation project

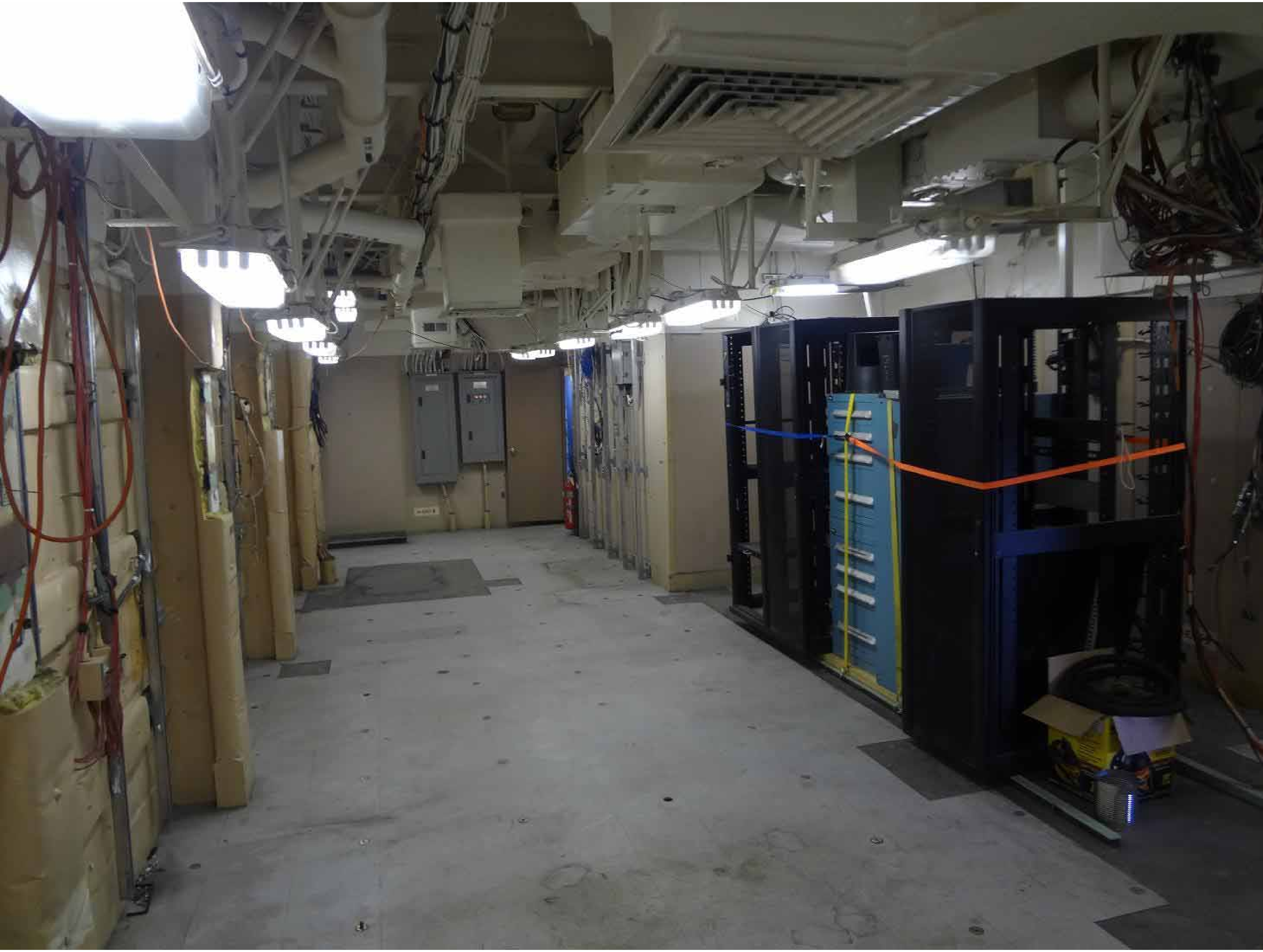
Future Lab renovation project

Photo Lab renovation project

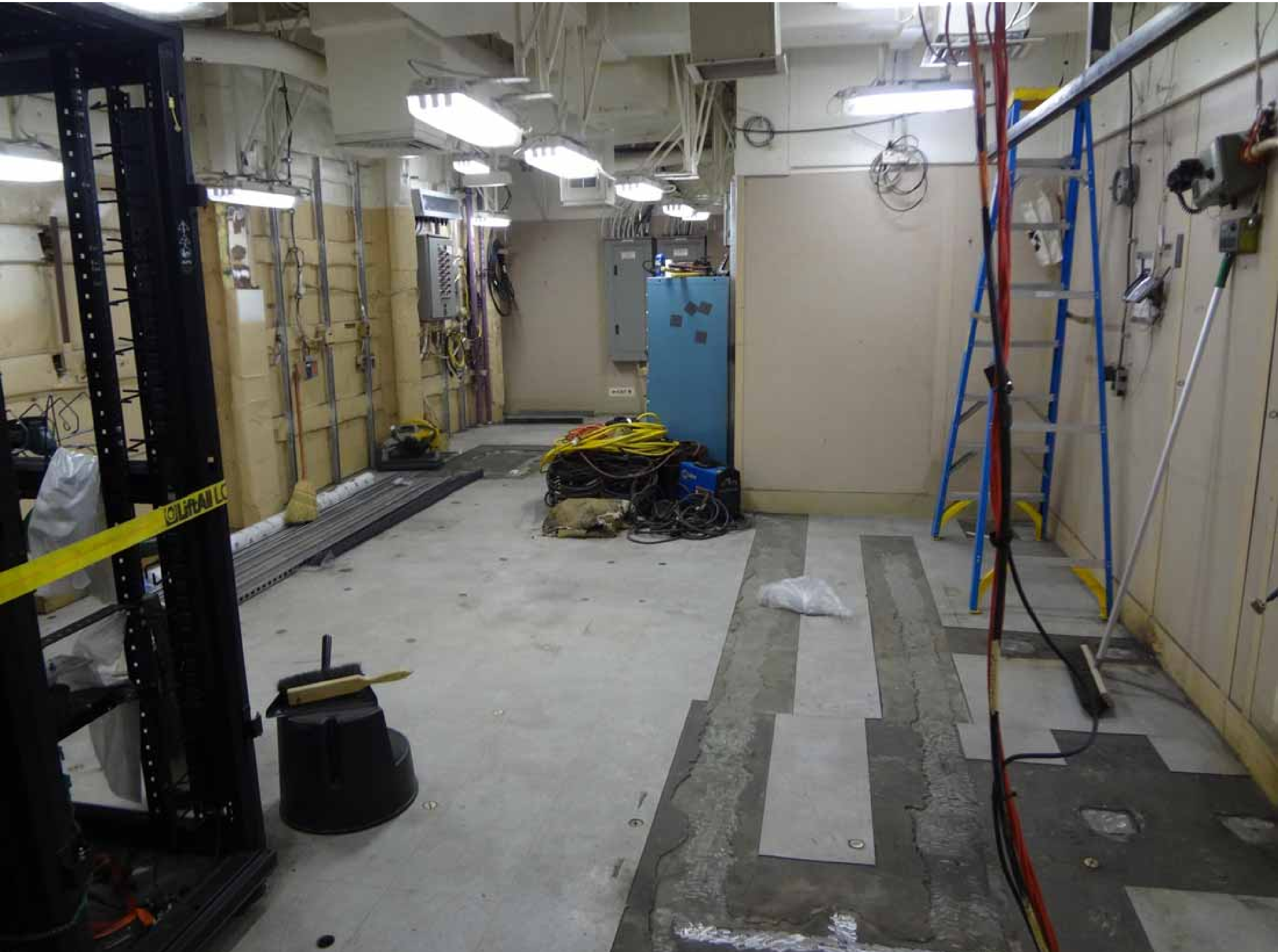
Routine sensor / equipment maintenance

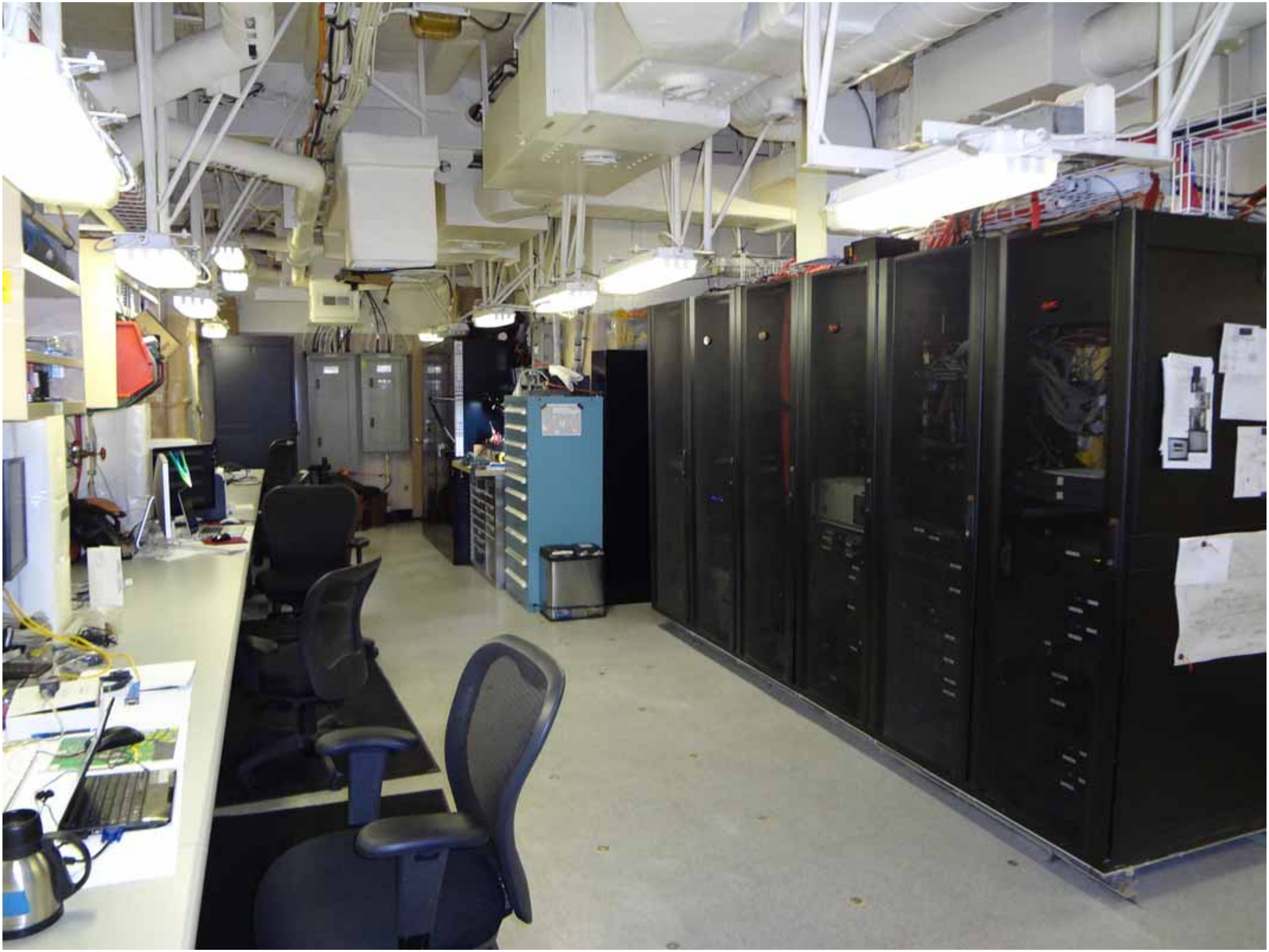


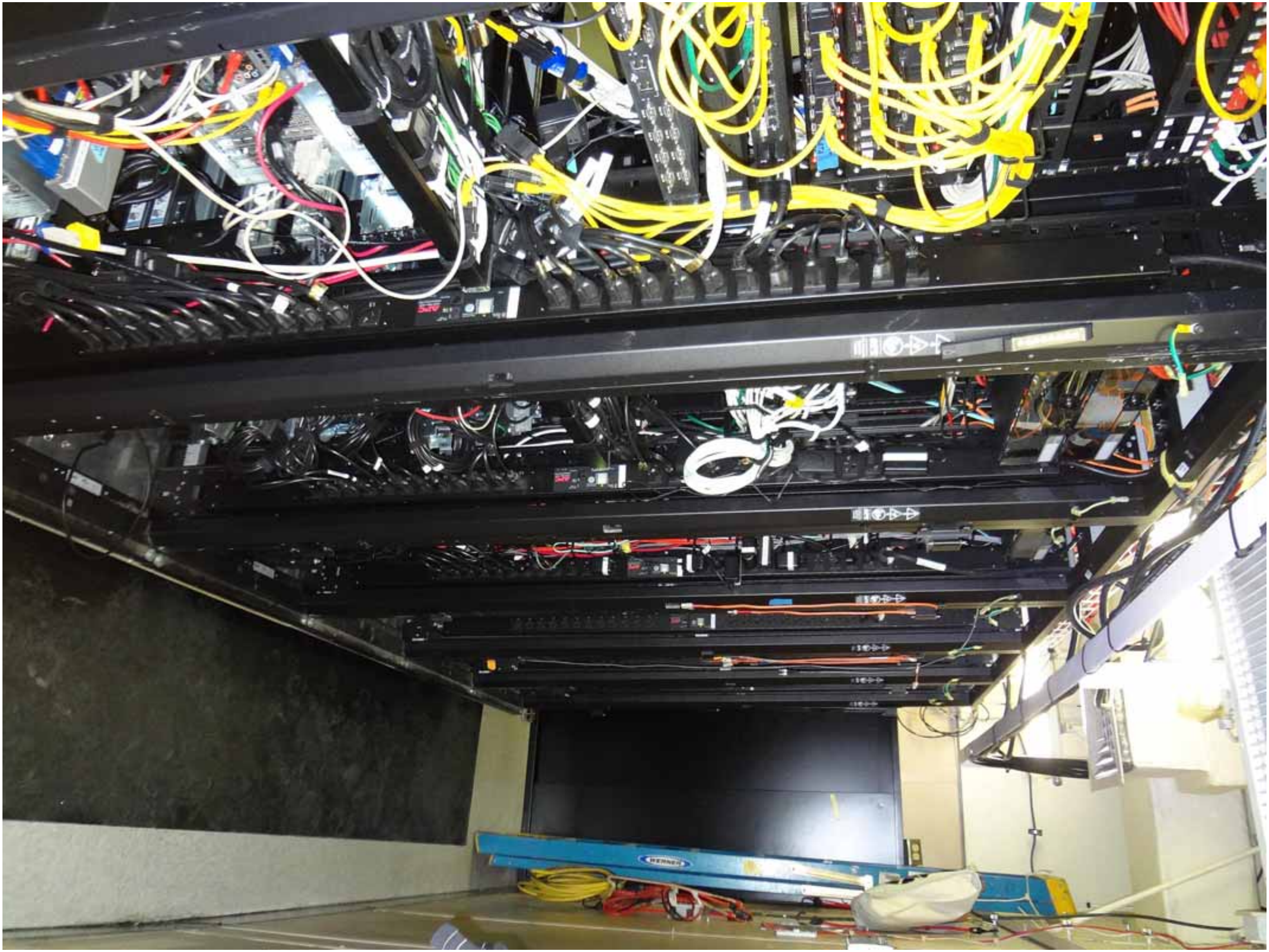
Current Computer Lab
New Computer Lab




EXIT








DANGER
HIGH VOLTAGE
EXIT


BLE
WAY
LE
DEL FUEGO
BLE
FR.93
EXIT


BALLAST TK.

Healy ADCP Status, 2010-2013

-ADCPs: 150kHz Ocean Surveyor, 75kHz Ocean Surveyor

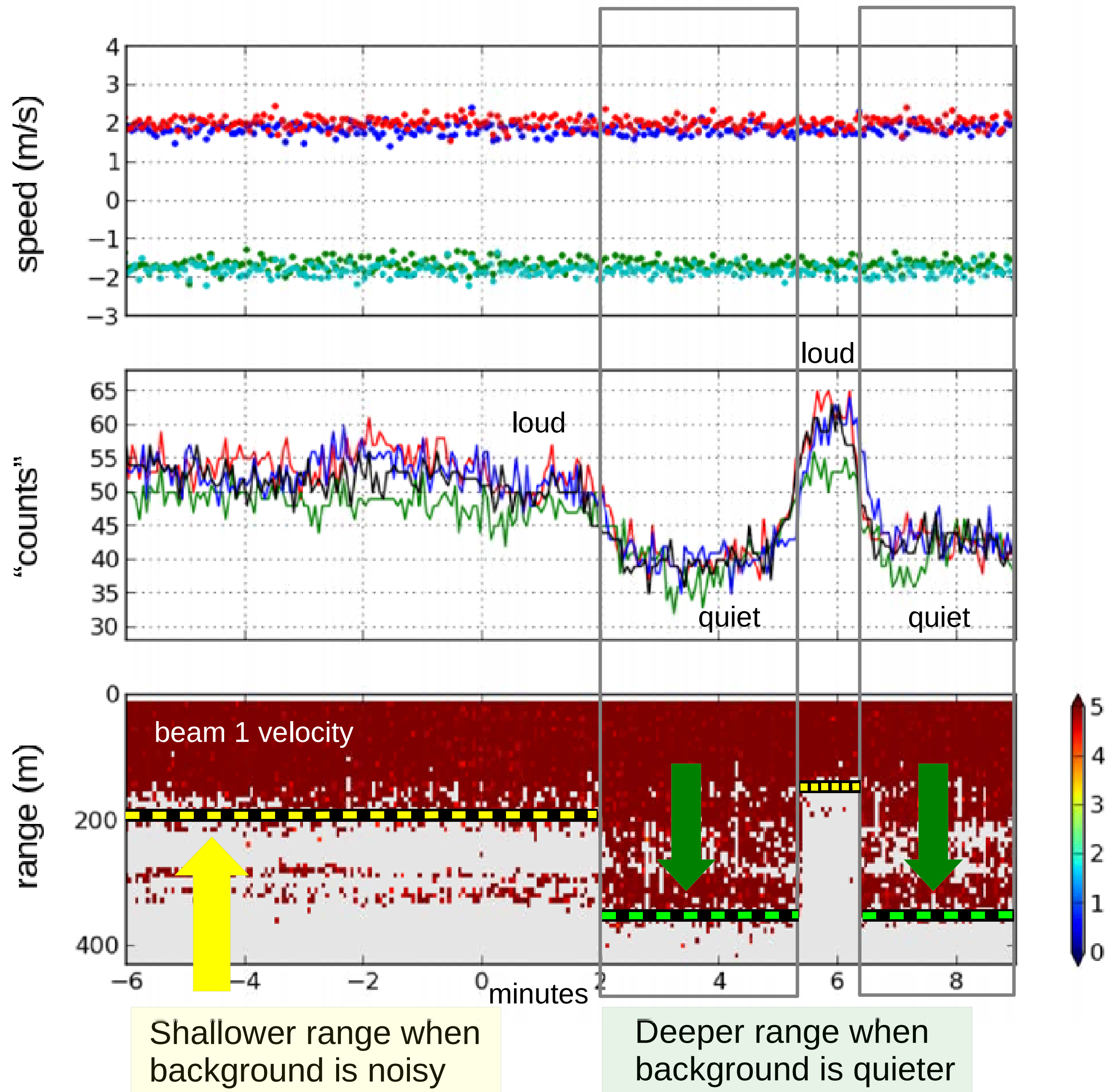
- both ADCPs are functioning
- UHDAS installed prior to field season 2010 (VmDAS earlier)
- processing: headings are excellent (two POSMVs, Ashtech, and MK39)
- electrical noise causes bias and loss of range
    - repeated struggle to defeat electrical noise

Lessons:

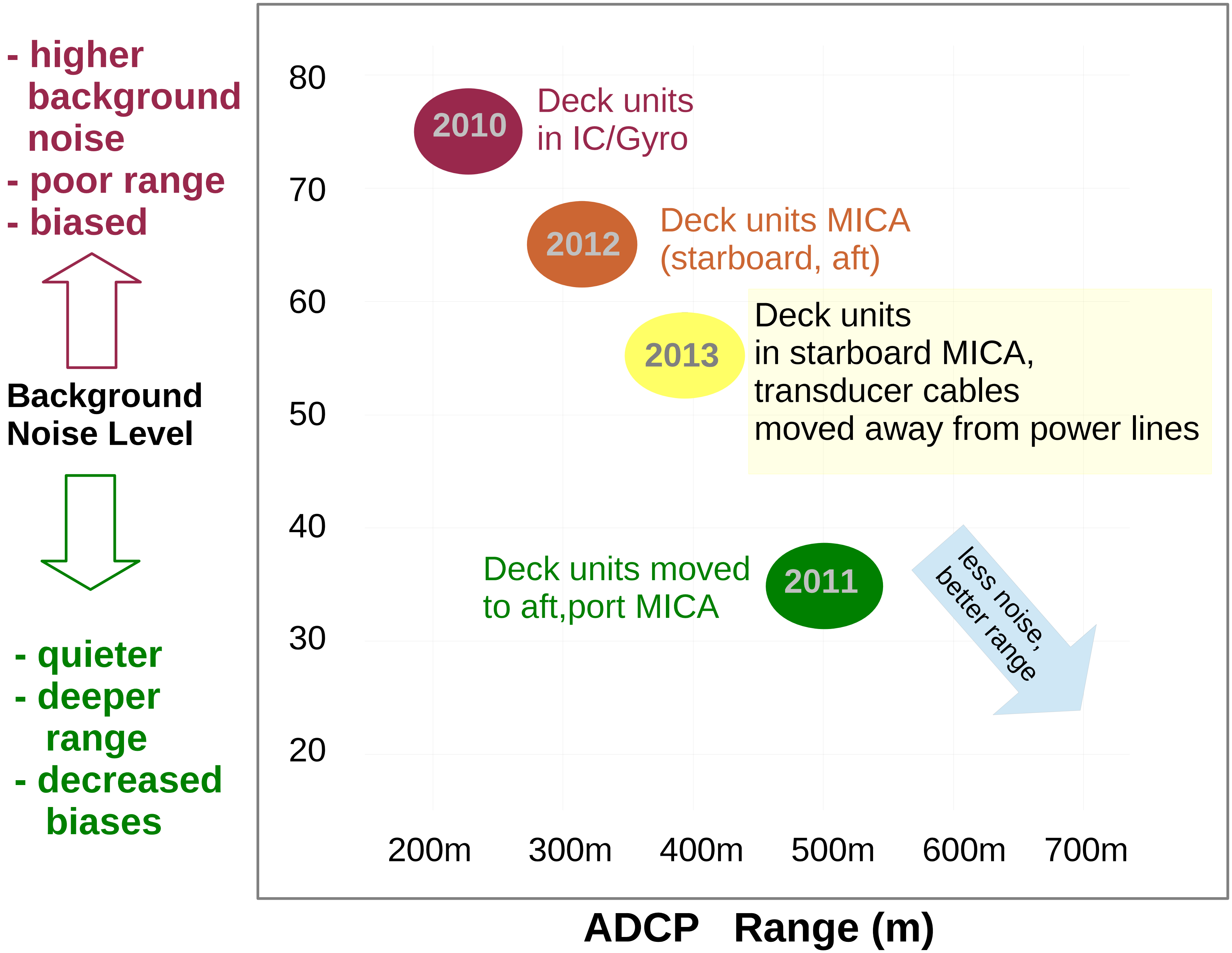
- ADCP data are very susceptible to electrical noise
- electrical noise on Healy is ubiquitous but variable in space and time
- there are better and worse configurations (deck unit + transducer cable)
- a good transducer cable run and good power to deck unit are critical
- the only way to test is “in situ”: requires time during shakedown cruise, eg.
    - ship steaming at 12kts
    - acquiring data, looking at background noise + range
    - experimenting with different configurations on the fly (see next slide)

There is still demonstrated room for improvement (2011 was best)

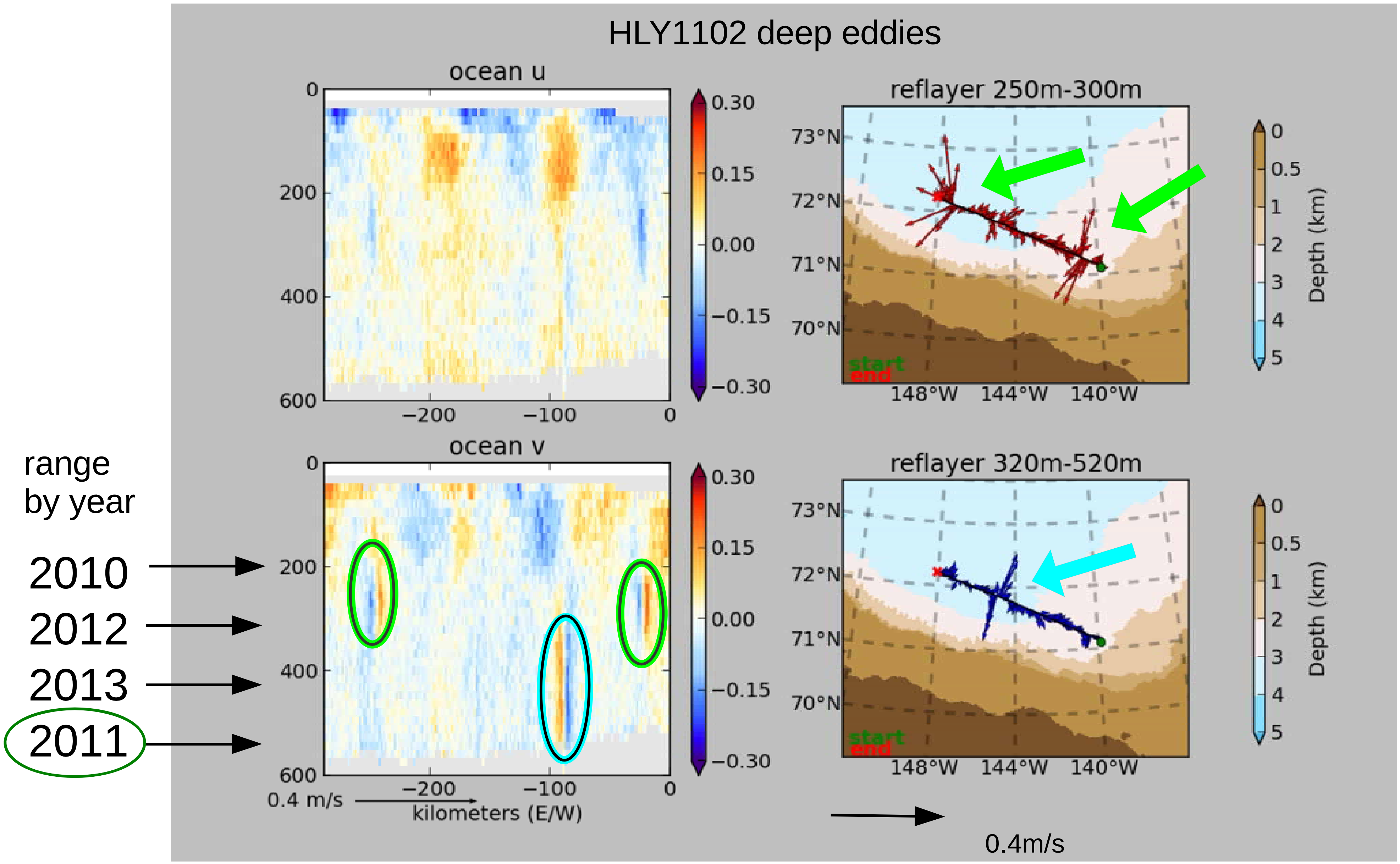
Transducer Cables:
Proximity to Ship Cable Bundle Affects Range



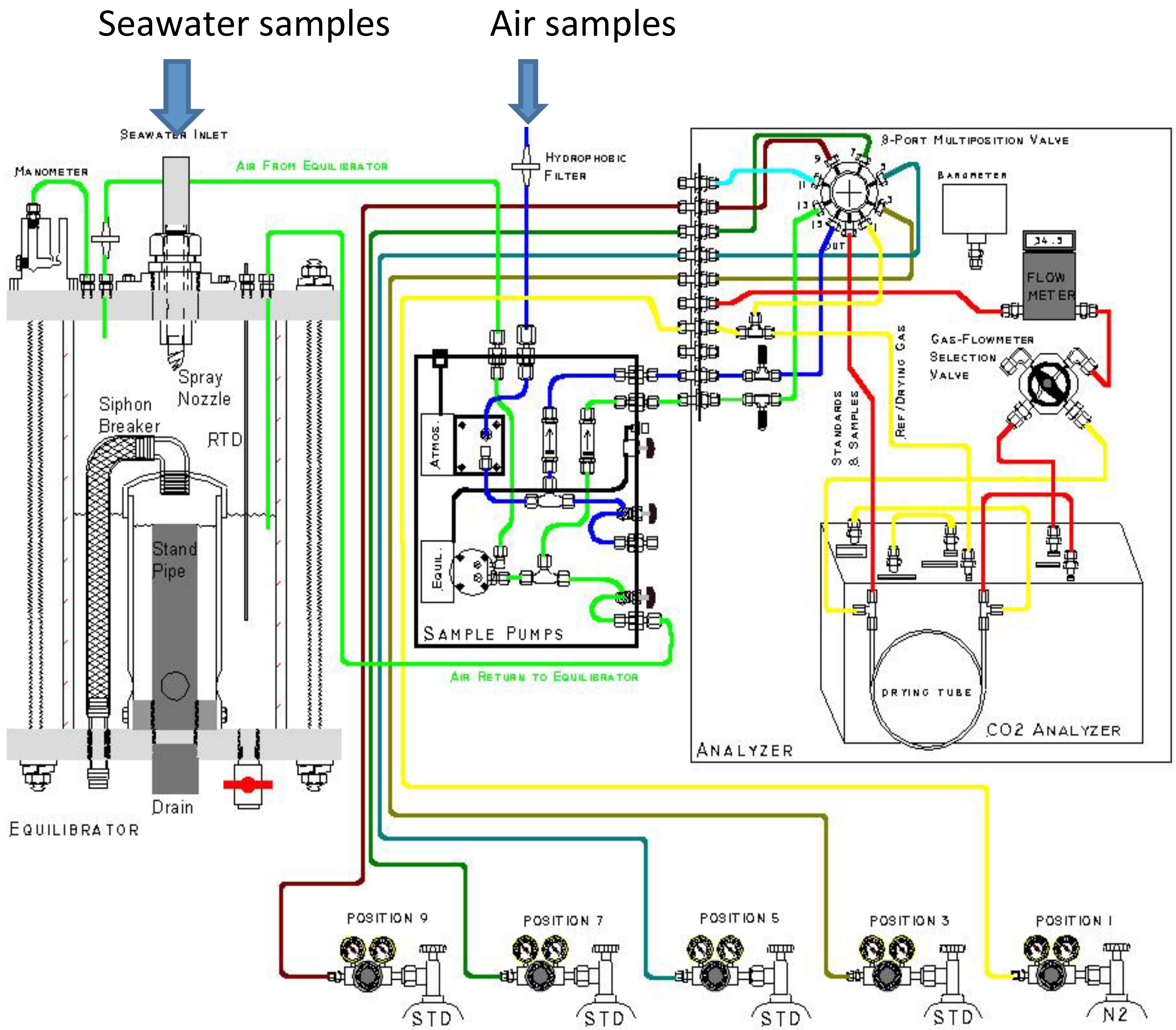
ADCP 2010-2013: Attempts to decrease Electrical Noise



Example: Deep eddies in the Beaufort Sea can only be seen with sufficient range

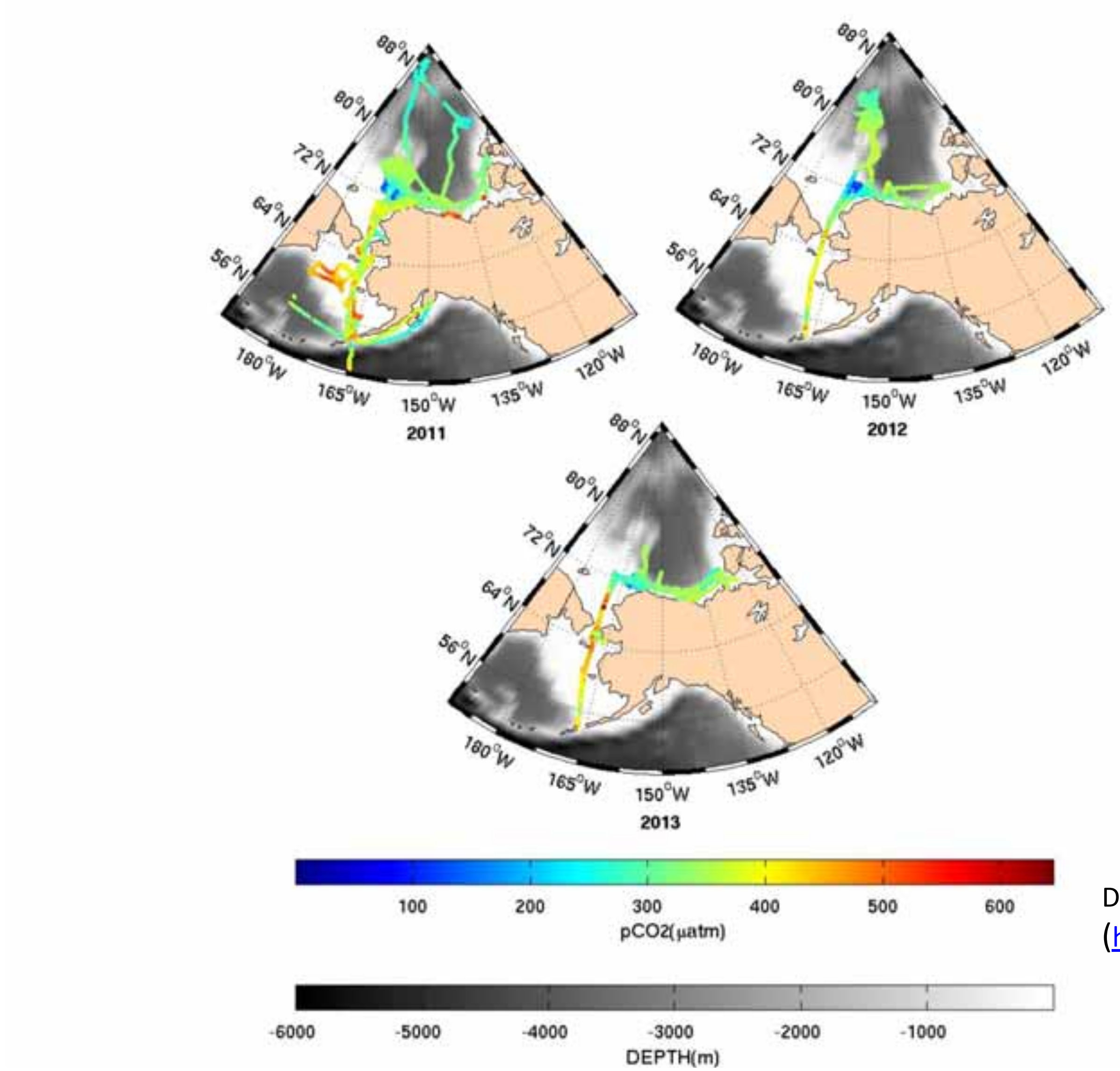


LDEO UNDERWAY PCO2 SYSTEM FOR SURFACE WATER MEASUREMENTS
Tim Newberger (2004)

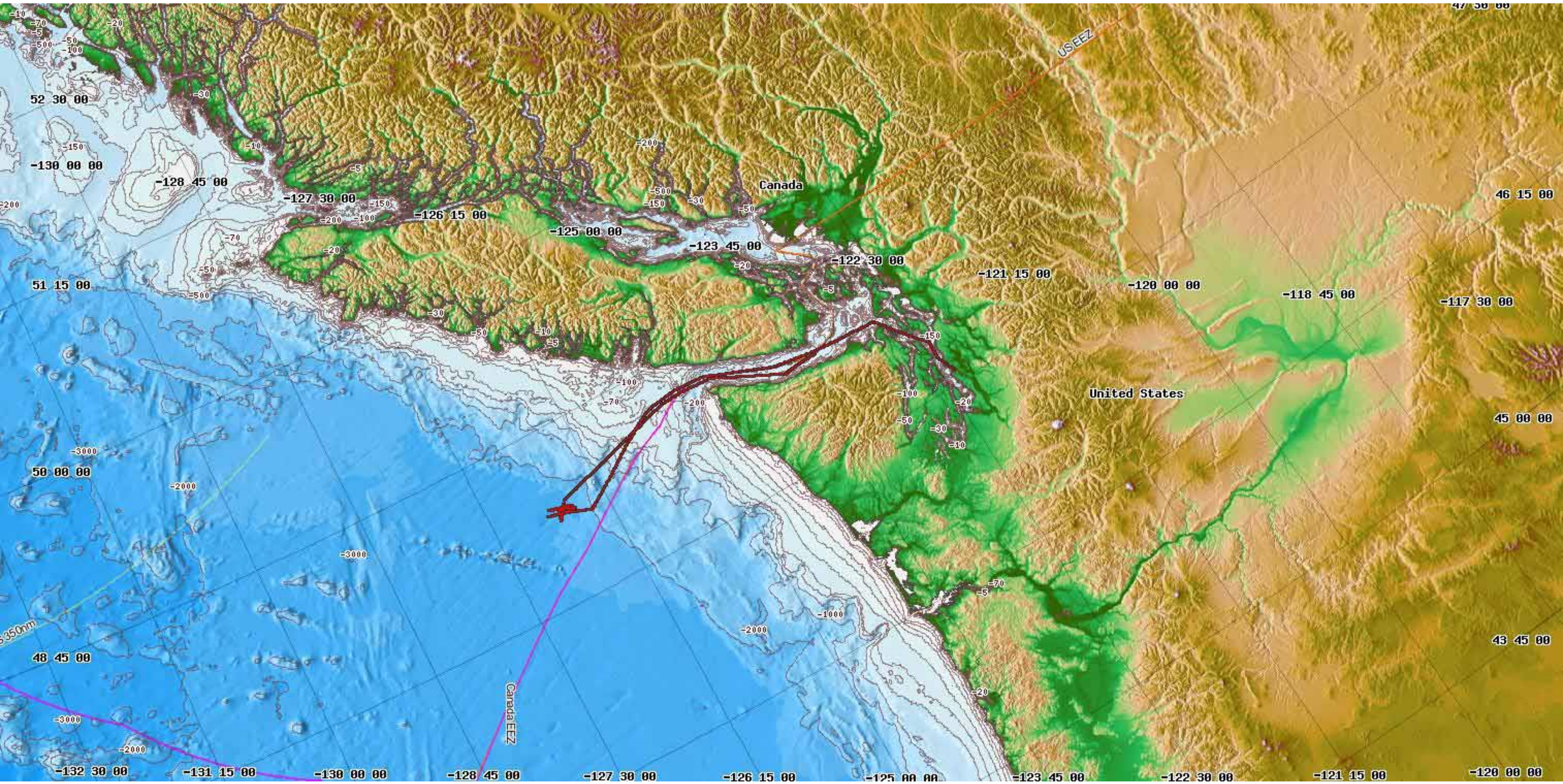


SURFACE WATER PCO2 FROM THE USCGC HEALY, 2011-2013 (LDEO PROGRAM).

The ocean areas with pCO_2 values less than the atmospheric value of 390 micro-atm are a sink for atmospheric CO_2 (green-blue dots); the high pCO_2 (orange-red) areas are a source; and the yellow areas are near neutral with atmospheric CO_2. The Chukchi and Beaufort Sea areas are strong sink for atmospheric CO_2. The water depths are indicated with the grey scale.



Data from
(http://www.ldeo.columbia.edu/CO2)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-130 00 00
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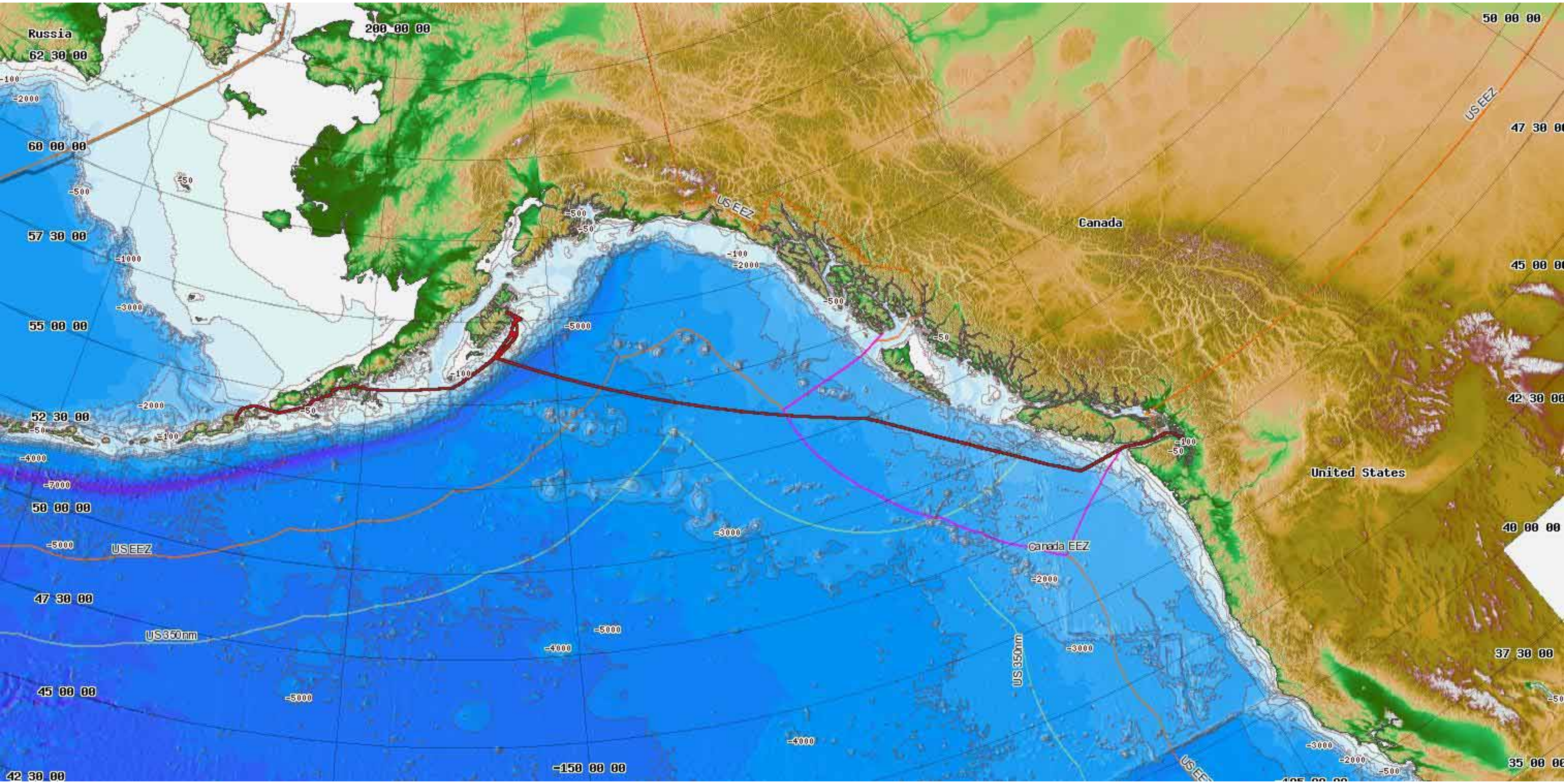

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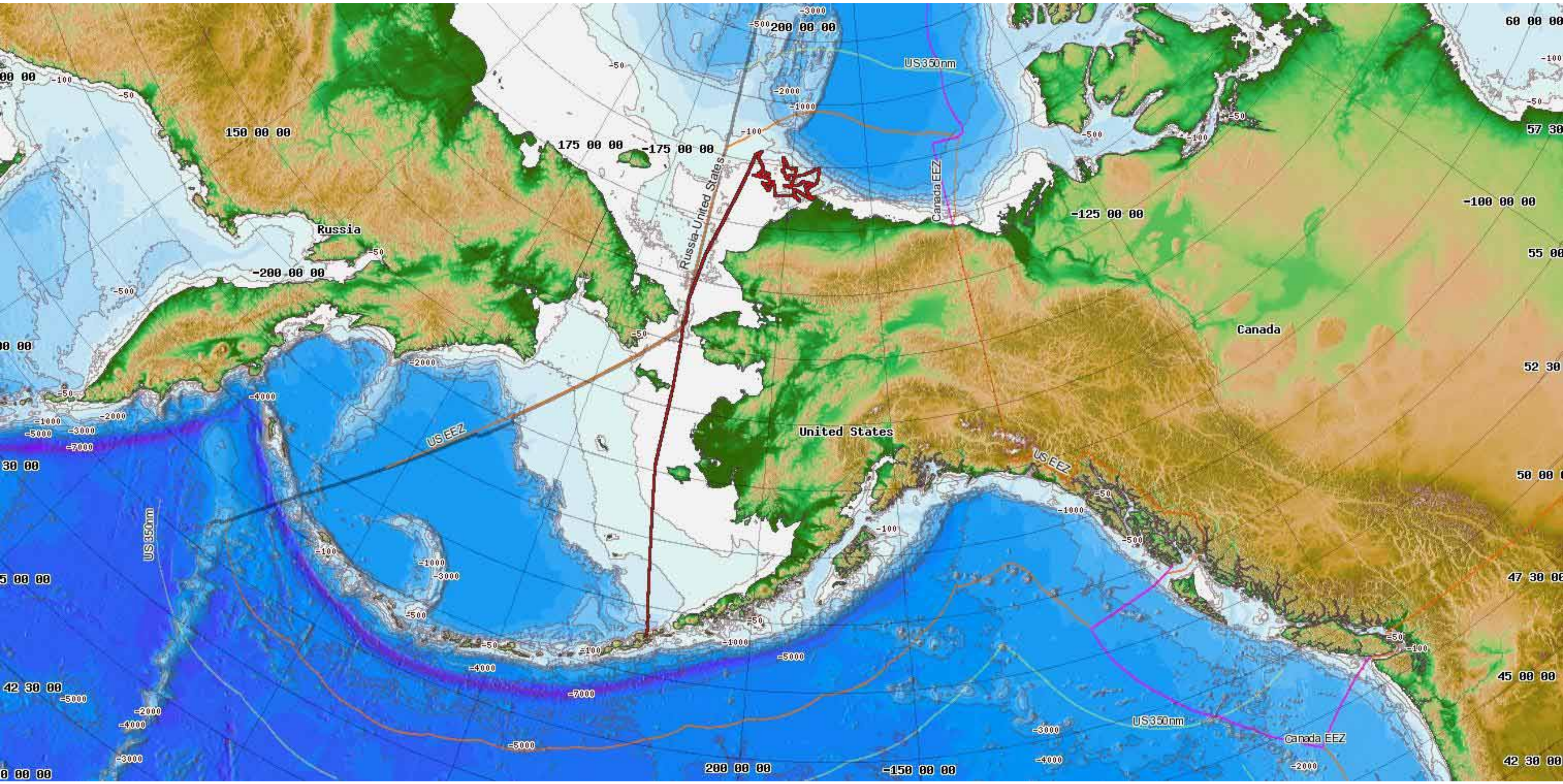
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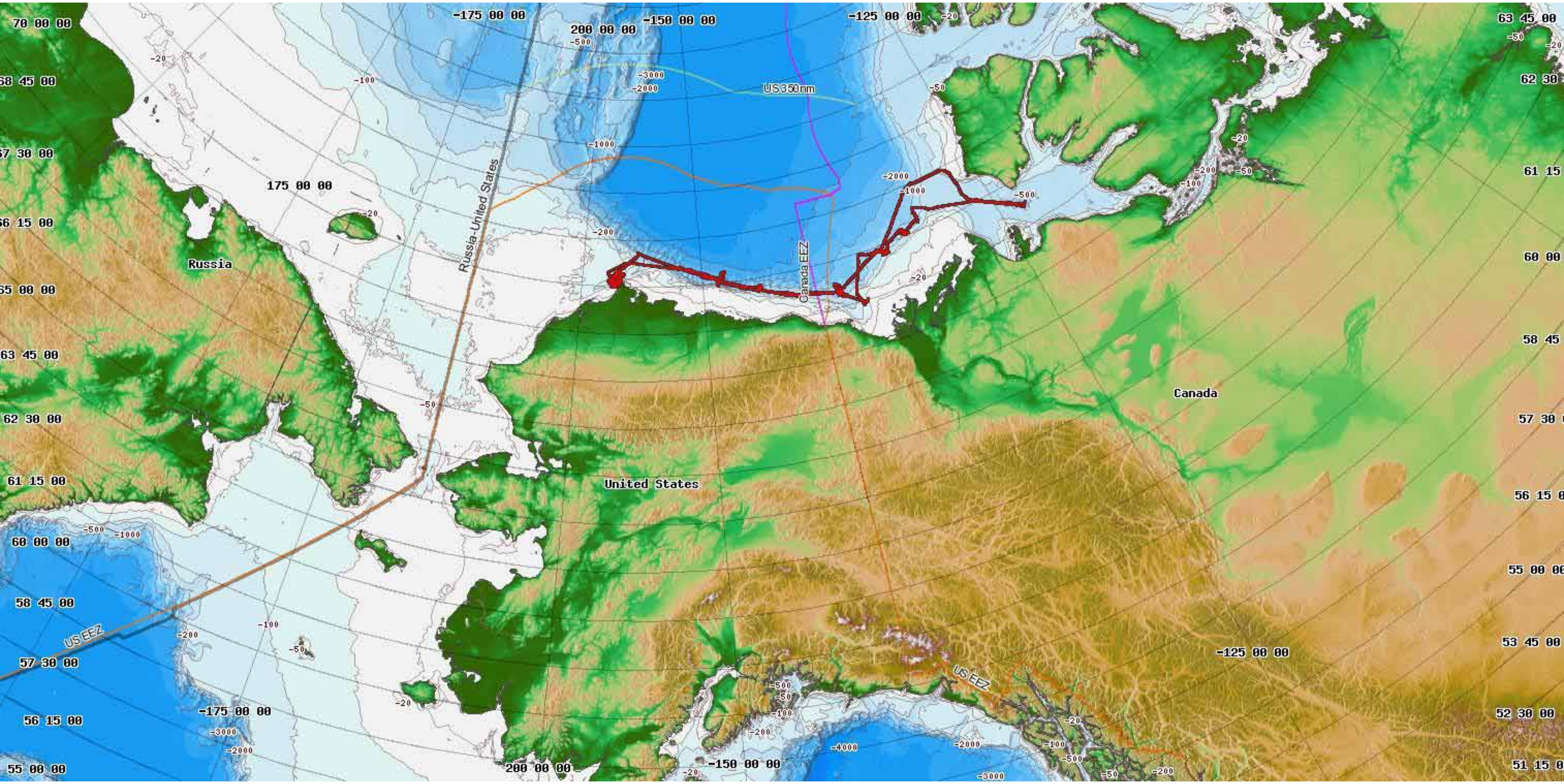
GMC


U.S.
COAST
GUARD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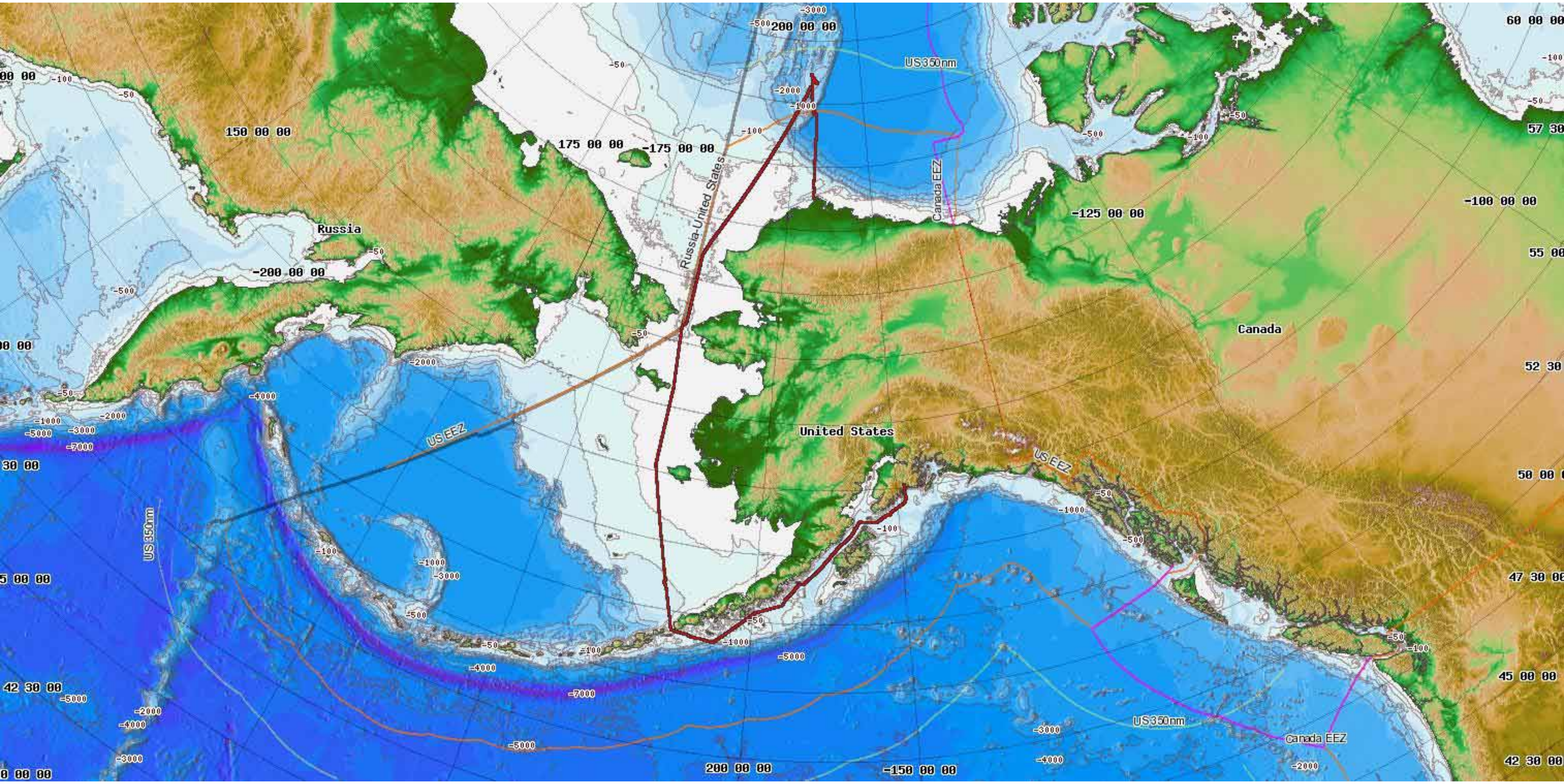
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COAST
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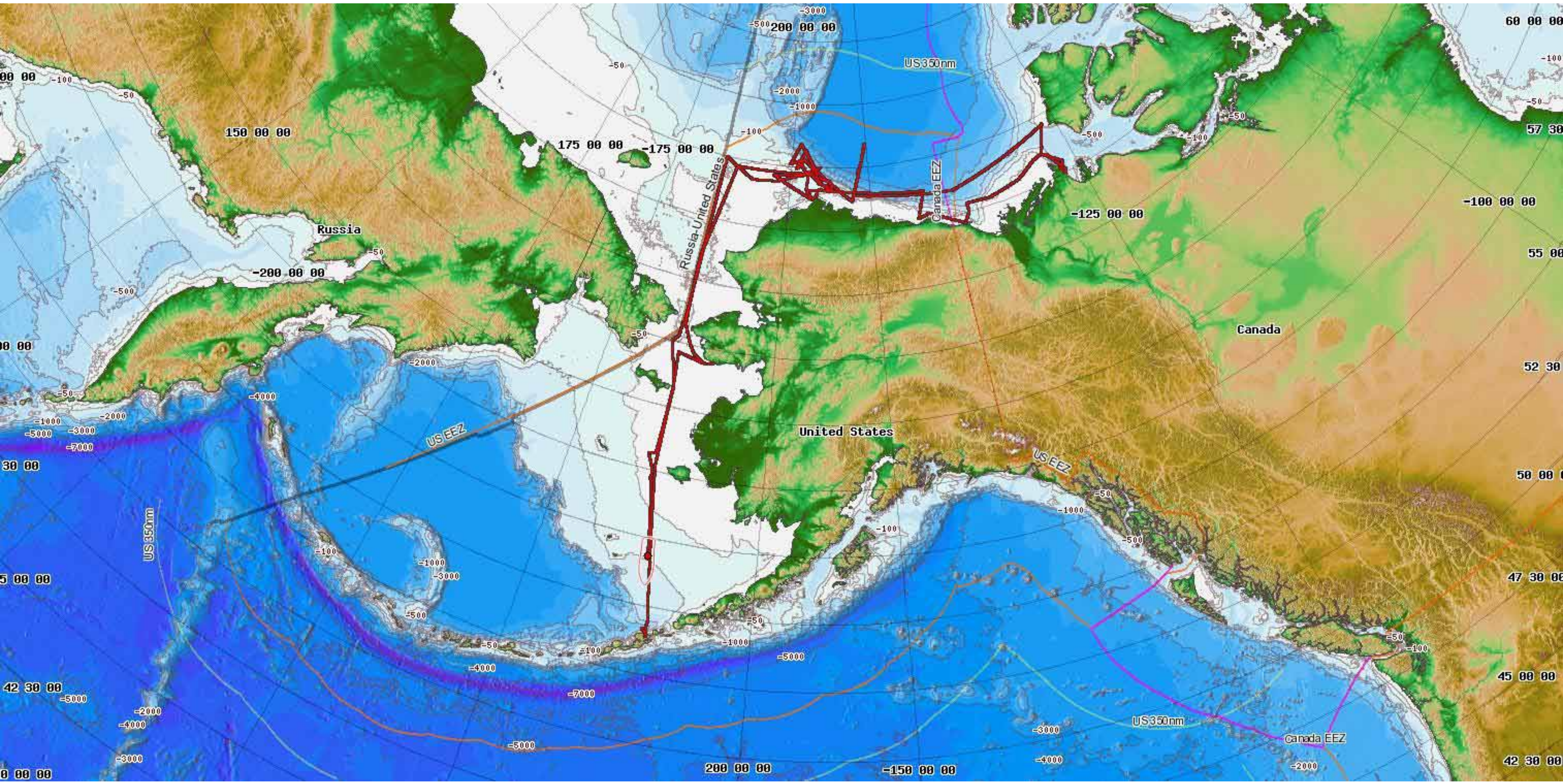
HEALY
20


NSF
NASA



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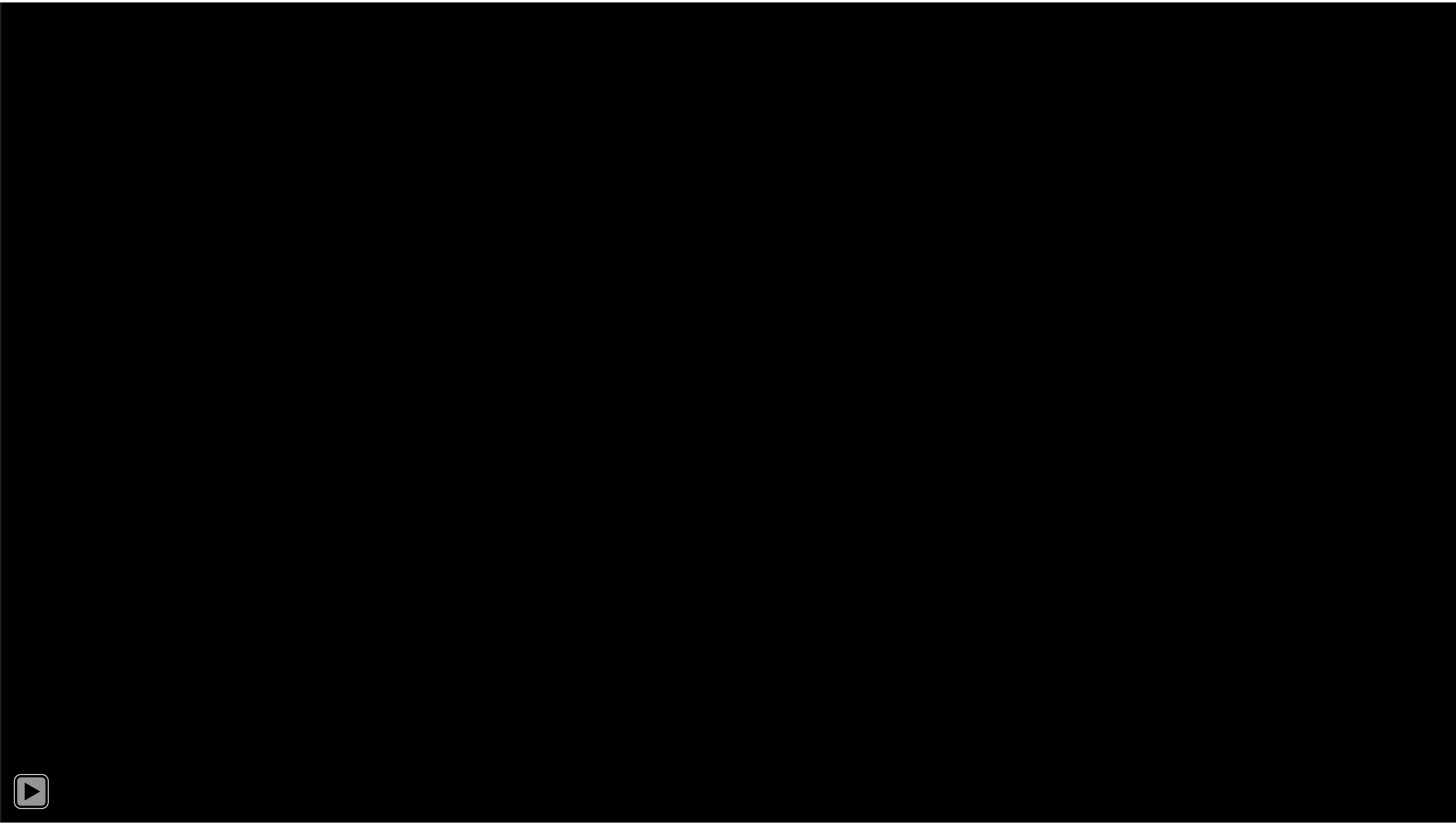
4962


U.S.
COAST
GUARD


BIX



HMRG Seafloor Mosaic Display System

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HMRG Seafloor Mosaic Display System

The Hawai'i Mapping Research Group (HMRG) of the University of Hawai'i has developed a Seafloor Mosaic Display software system designed for the visualization of bathymetric and sidescan seafloor map datasets generated by various shipboard multibeams and towed sonar instruments in near-real-time. This system is intended to provide substantial visual insight into a survey dataset for science users having minimal familiarity with the underlying sonar system independent of that sonar's own native operating software. It also provides an extensive survey planning feature set allowing for the creation, modification and output of survey tracklines and waypoints in conjunction with its swath data display capabilities. The software has been in use for several years aboard the University of Hawai'i's own *Kilo Moana* and *Ka'imikai-O-Kanaloa* research vessels and has also been installed aboard Scripps Institution of Oceanography's *Melville* and *Revelle* and the University of Washington's *Thomas G. Thompson.*

This document is intended as an introductory description of the feature set provided by the software so that prospective operators may quickly determine whether or not it might be of interest to them. More detailed technical documentation may be requested from HMRG as noted at the end of this publication.

Supported Mapping Systems and Computer Requirements

The software was originally developed for use with HMRG’s own towed systems including the MR1, DSL-120 and IMI-30, but subsequently adapted for use with shipboard multibeam systems built by other vendors via the development of additional logging and format conversion software. External systems currently supported include Kongsberg/Simrad sonars which output their data in EM datagram format (e.g., EM120, EM122, EM302, EM710 and EM1002) and SeaBeam systems using the Elac/Nautik HydroStar XSE-format logging software (e.g., SB3012). Adaptation for use with other mapping systems is of course possible with the required effort inversely proportional to their similarity to the aforementioned sonars.

The software operates best on a dedicated computer system with hardware features typical of a circa 2012 scientific workstation, i.e., two or more 64-bit processors, 8 Gb or more of memory and several hundred Gb of local disk storage. A large display (e.g., 30”, 2560x1600 pixels) is also highly recommended. Systems with hardware inferior to that described here may be usable depending upon various circumstances but are greatly discouraged. The software is developed, tested and maintained on Apple and PC hardware running current (or at least very nearly so) MacOS X and CentOS Linux releases and will probably work fine on nearly any other current Linux release as well.

Software Usage Overview

The Seafloor Mosaic Display system is actually a collection of independent modules which can be invoked separately by sophisticated users but is more commonly run as a single integrated environment when used to support typical shipboard multibeam operations. This document is oriented towards a description of usage under the latter circumstances.

The software is normally started at the beginning of a survey by a marine technician, at which time a configuration tool provides access to a reasonably flexible set of initialization options (which are hopefully constrained enough to remain intelligible to the average operator). These options control the behavior of all of the software’s various modules and include settings for such things as data source specification, mosaic grid cell sizes and projection parameters, etc. Figure 1 below shows the configuration tool.

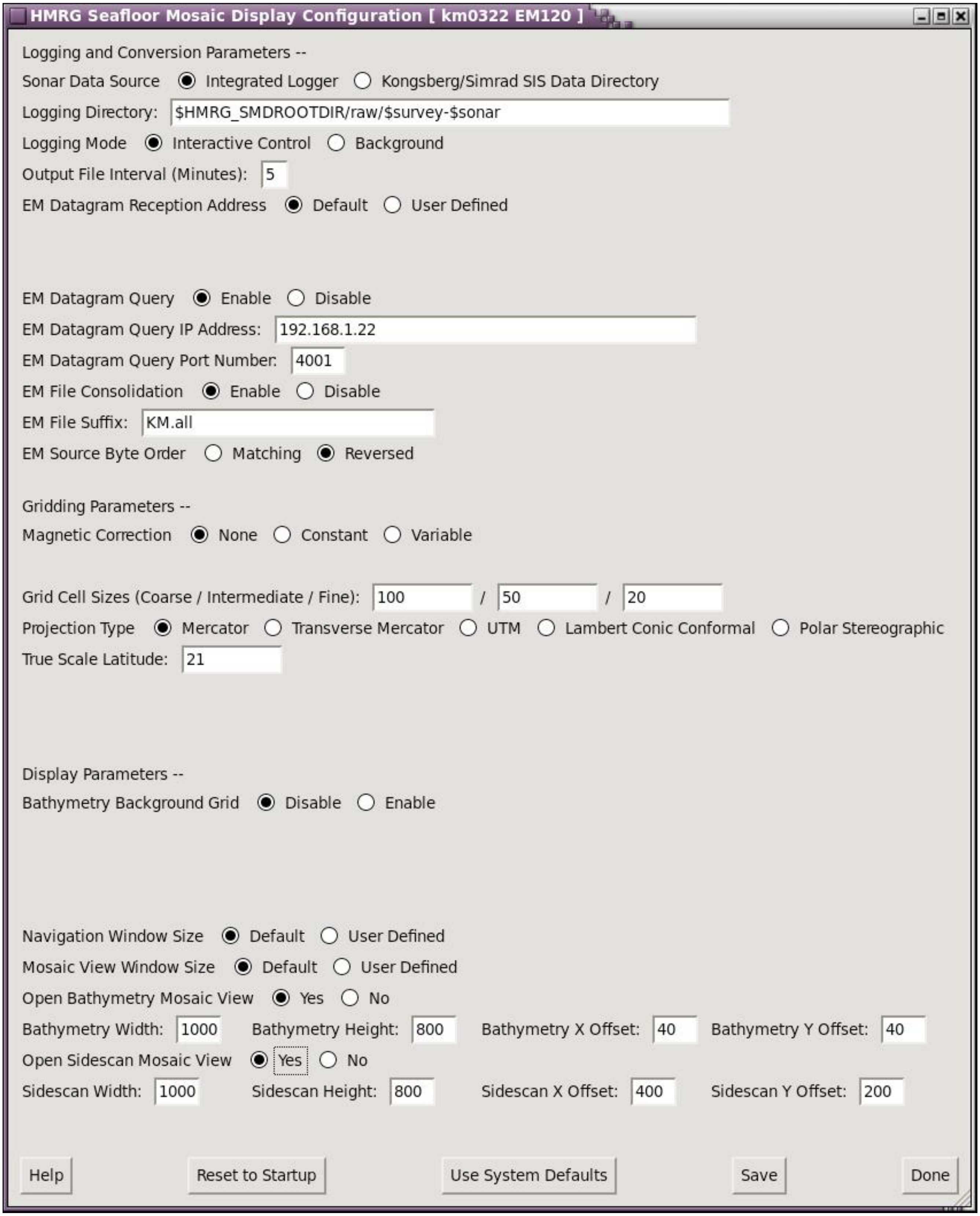


Figure 1. Configuration tool.

The system was originally designed to access multibeam datasets simply by reading the sonar system vendor's own logging directory via a read-only remote filesystem mount over the local network (e.g., via CIFS). It has since been enhanced to also offer the use of an integrated data logger capable of reading ping-by-ping network data broadcasts originated by vendor logging software and saving those data to local disk for more immediate processing and display. Operating environments with a naive science user audience can hide this integrated logger from general view to minimize opportunities for unwanted interference with the logging process, while those with a more technologically sophisticated user base can run it in a visible foreground interface mode which allows a reasonable level of real-time control from its main control panel as shown in Figure 2A below.

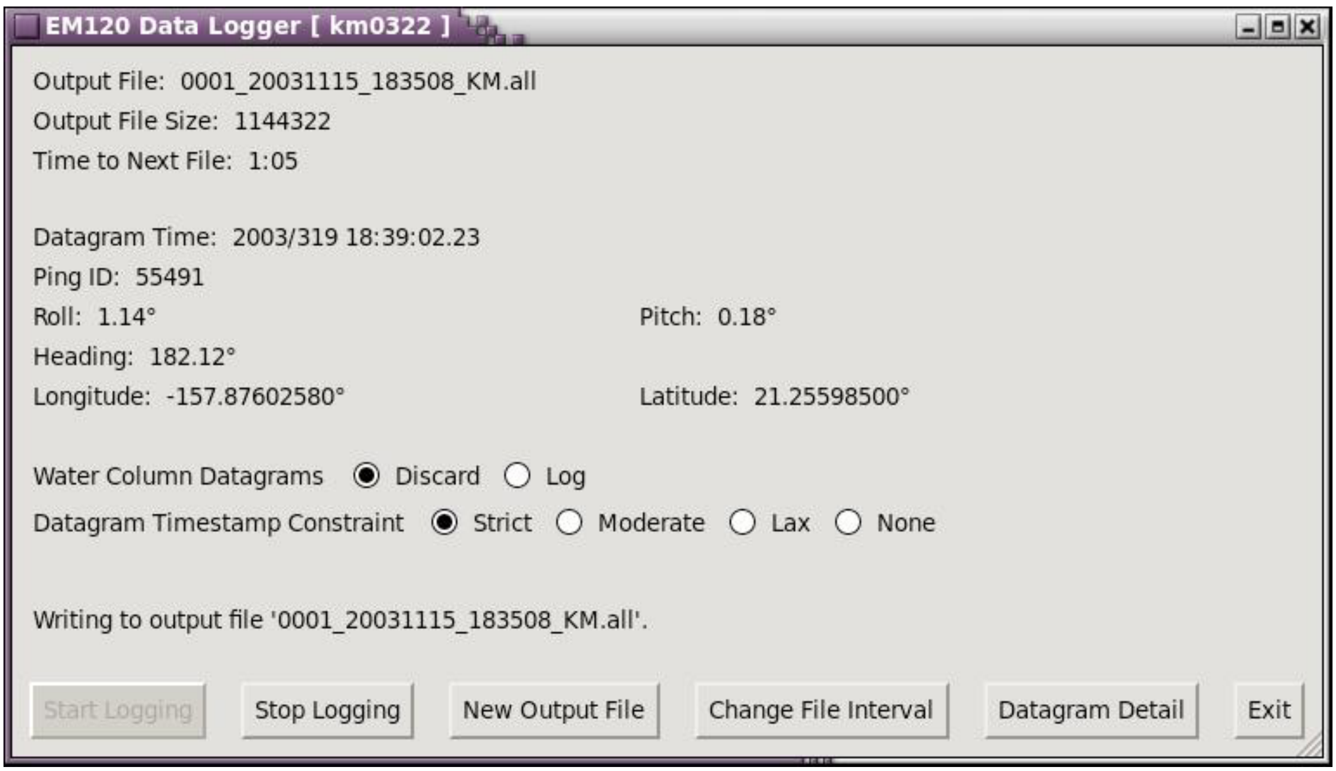


Figure 2A. Main control panel of integrated data logger for Kongsberg/Simrad EM-class systems.

Additional input data monitoring features are available with the system's Kongsberg/Simrad EM-class integrated logger, which maintains counts of the various types of input datagrams read from the sonar (Figure 2B) and allows detailed inspection of individual datagrams (Figure 2C).

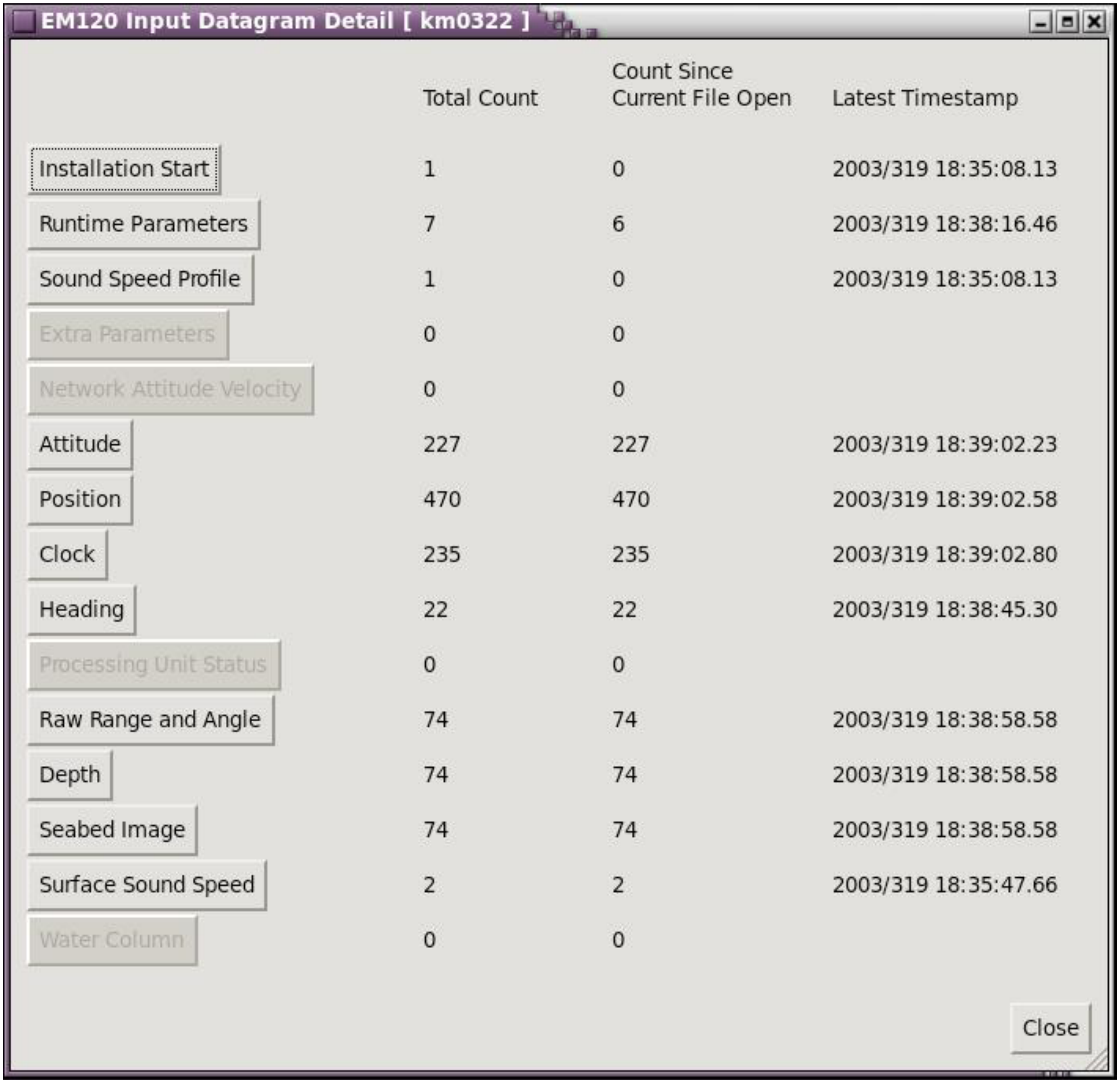


Figure 2B. Input datagram counts maintained by the integrated EM-class logger.

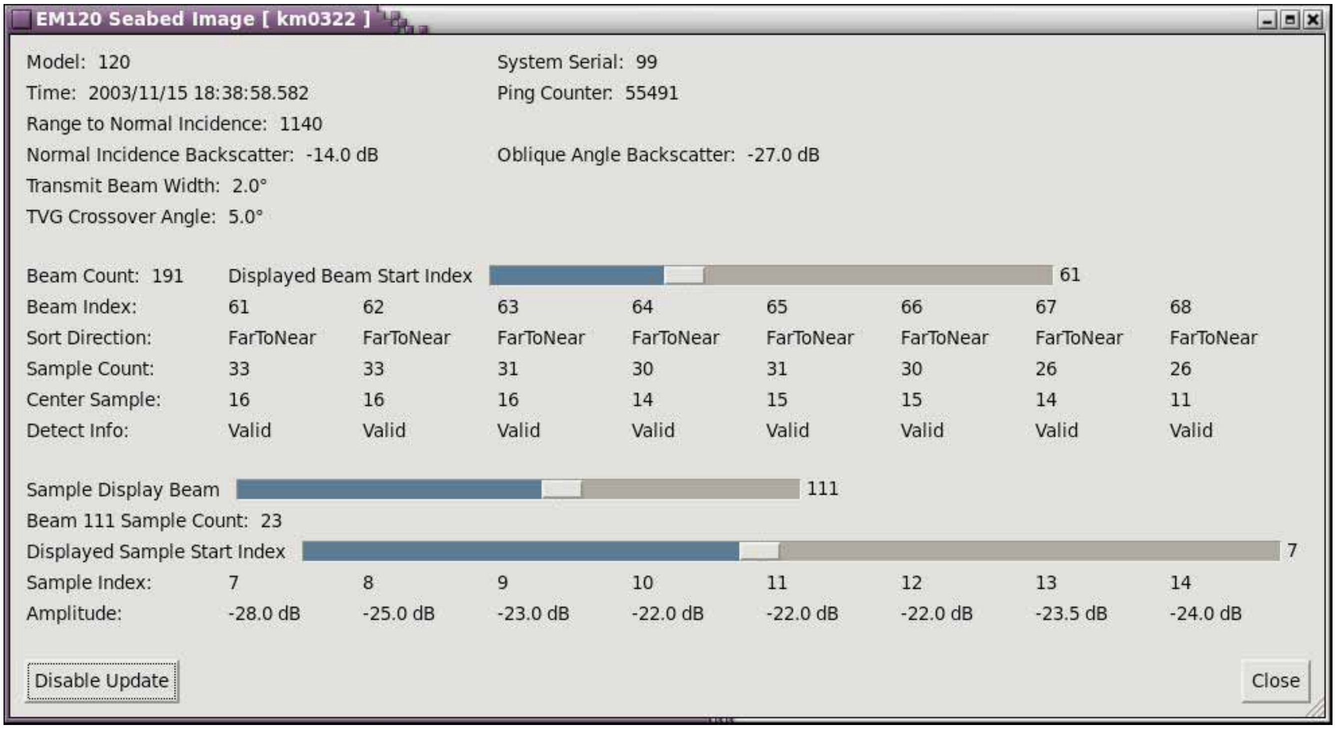


Figure 2C. Sample detail of a seabed image datagram read by the integrated EM-class logger.

Regardless of whether the data are read from the sonar system vendor's own logging directory or via an integrated logger as shown immediately above, they are next converted into an HMRG format and gridded into a projected two-dimensional space at arbitrary grid cell sizes, e.g., Mercator projection at 250, 100 and 50 meter cell sizes. These conversion and gridding operations run continuously as background processes which are invisible to users and essentially invariant in their behavior once they have been initialized by the configuration tool.

Virtually all of the science user's interaction with the software will occur via the mosaic user interface module **smdi** (**s**eafloor **m**osaic **d**isplay **i**nterface). This program displays the swath data logged, converted and gridded by the system modules described above. It also provides access to the system's survey planning features which allow tracklines to be laid out in superimposition upon recently acquired and/or historical swath datasets. This is the final and largest module of the system and is described in detail in the next section of this document.

The smdi Seafloor Mosaic Display Interface

The only component of the mosaic system which is normally visible to the science user after the system has been initialized by a shipboard technician (unless an integrated data logger has been activated in interactive control mode as shown above) is the display interface program **smdi**. This is a very large program with an extensive feature set which is fully documented within its own manual page as well as a context-sensitive online help facility. The average overworked marine technician cannot be expected to be fully conversant with all of its features but will probably find it useful to have enough overall familiarity as well as specific knowledge of a small but critical feature subset to be able to effectively introduce it to interested science users. The latter will then hopefully be capable of exploring a dataset in detail at their leisure aided by the online help without distracting technical staff from other tasks.

The program always displays a main navigation window showing ship tracks completed during the current survey. This is essentially an overview/coverage display intended to show ship position over the entire survey as well as the actual across-track extent of the acquired swath data. This window is continually updated by new swath data from the sonar system in near-real-time as soon as they become visible to the mosaic software, and is usually configured to display the GMT coastline dataset along with a customizable background GMT gridfile dataset (typically a compendium of the best historical gridded datasets available to date for a particular survey area) and the current ship and/or towed instrument position (regardless of whether swath data are being acquired at the moment). The following Figures 3A and 3B show sample navigation window views at two different scales of a Maui/Molokai/Lanai survey area. The purple and teal lines which bracket each ship trackline show the limits of the port and starboard datasets respectively. The GMT background gridfile dataset shown here is the Hawai'i multibeam synthesis dataset, a combination of numerous earlier multibeam survey datasets from the region compiled and maintained by HMRG.

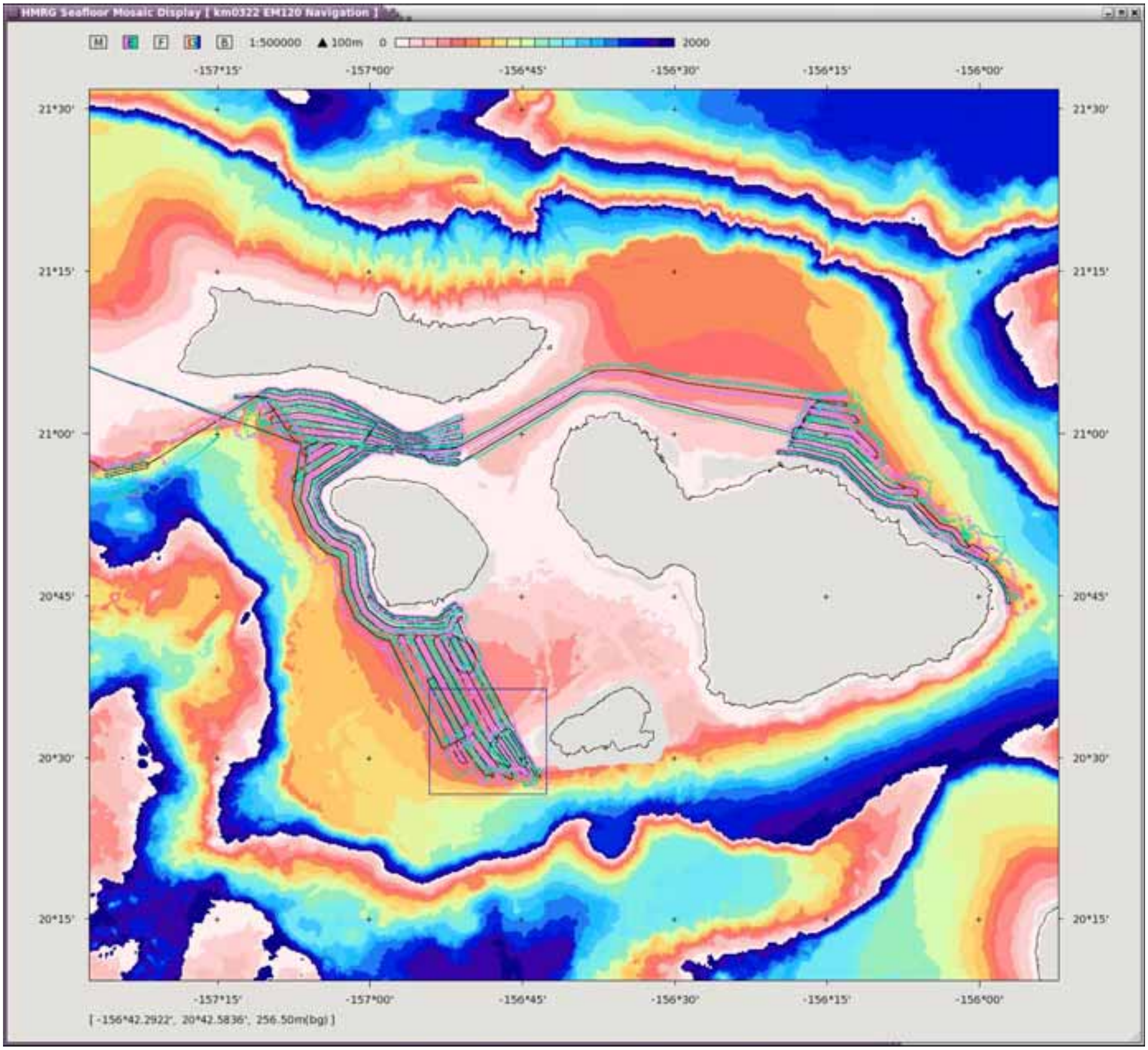


Figure 3A. Navigation window at 1:500000 scale.

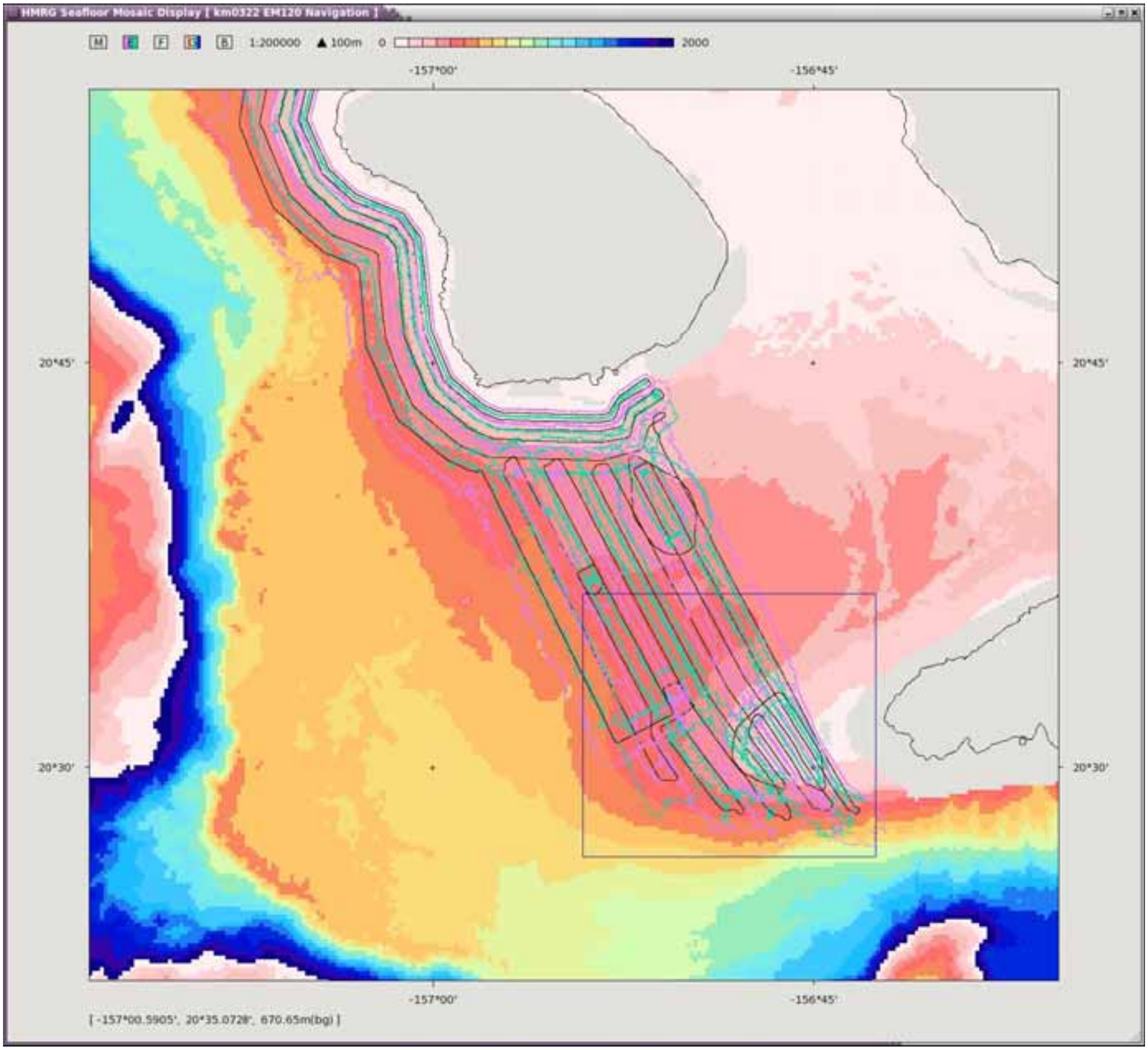


Figure 3B. Navigation window at 1:200000 scale.

The various display settings affecting the navigation window are highly customizable via a dialog panel as shown in Figure 4 below. Certain display attributes which users change often (e.g., scale, color palette, color key depth interval, etc.) can also be accessed very quickly outside of the dialog panel interface via little accelerator widgets ranged along the top edge of the navigation window, and the display can be quickly panned left, right, up or down via the keyboard arrow keys.

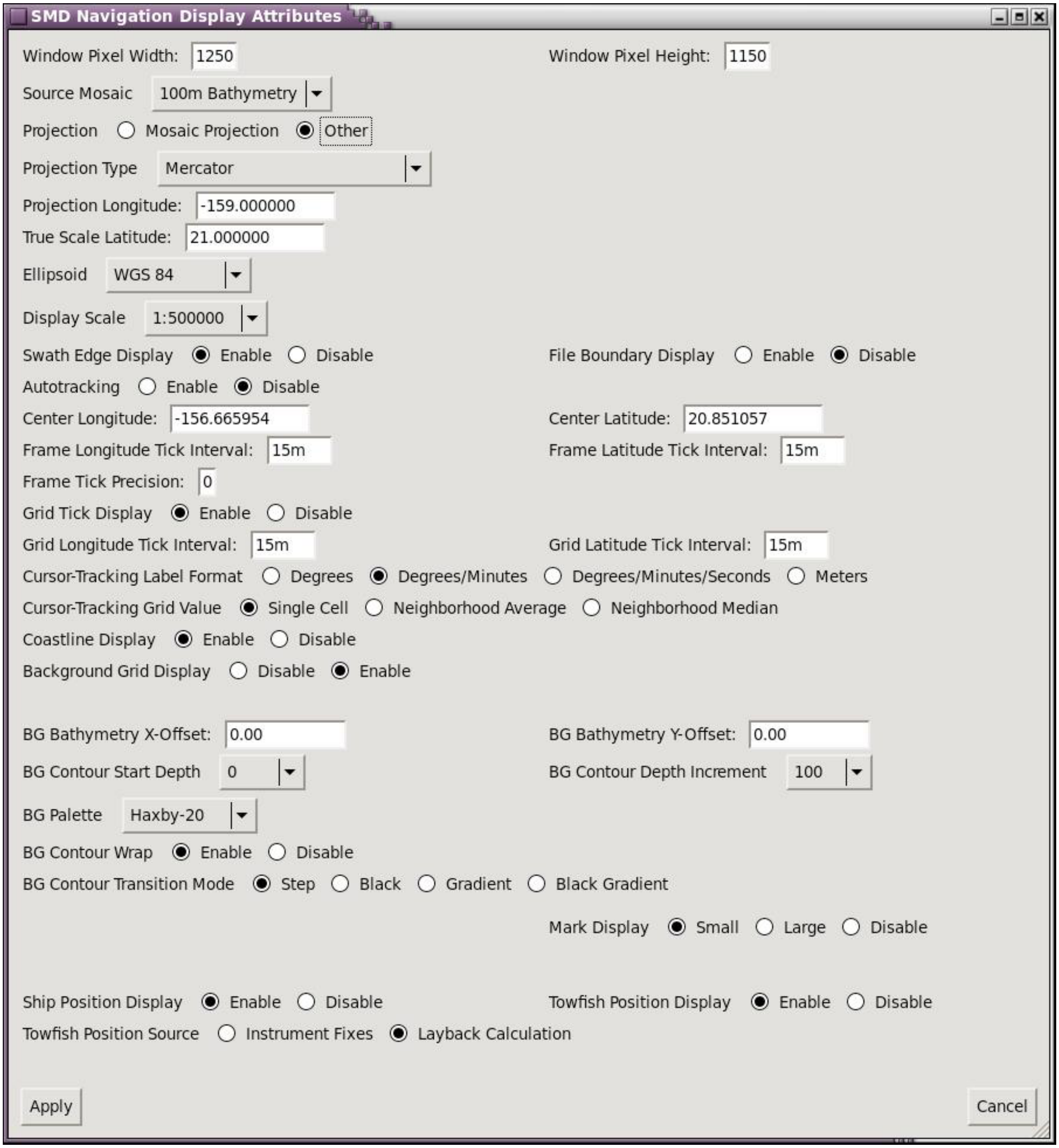


Figure 4. Navigation window display attributes dialog.

The user may from the main navigation window select up to six independent regions of interest from which the gridded bathymetry or sidescan imagery may be shown at one fixed unchanging projection and three different resolutions (as defined by the marine technician when configuring the mosaic software system at startup). Each of these regions of interest will be displayed within its own mosaic view window. These views together with their associated display parameters (scale, color palette, etc.) are completely independent – the user can look at the same region with six different sets of display parameters, or look at six different regions with the same display parameters, etc. Figures 5A and 5B below show mosaic views of bathymetry and sidescan data respectively for the same region of interest, which is also delineated within the navigation window by a rectangular box. (See Figures 3A and 3B above.) Note the finer resolution of Figure 5A's active survey bathymetry dataset (upper left corner and center of mosaic view) in comparison with the coarser resolution of the background grid dataset (upper right corner and lower edge of view).

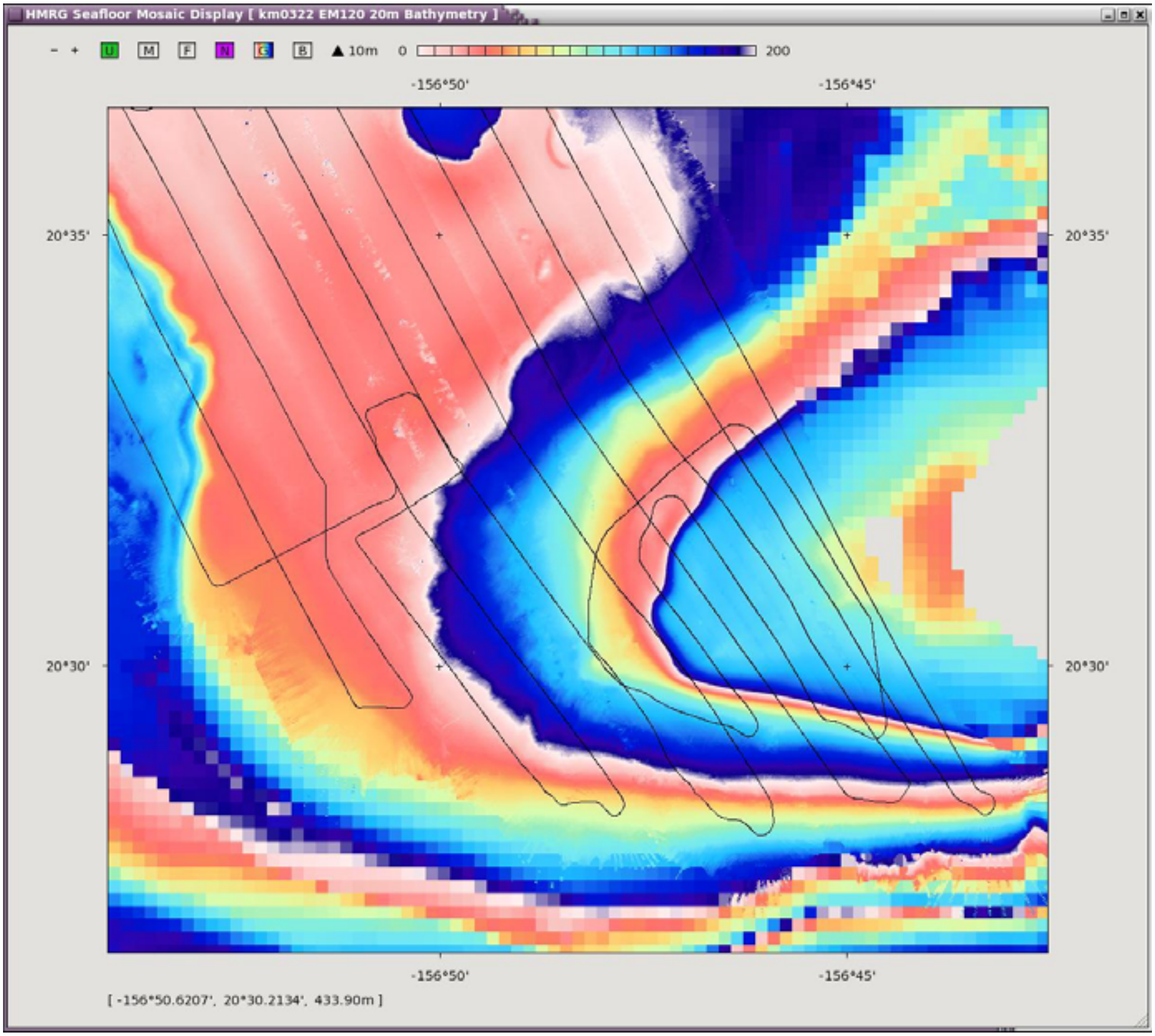


Figure 5A. Bathymetry mosaic view window.

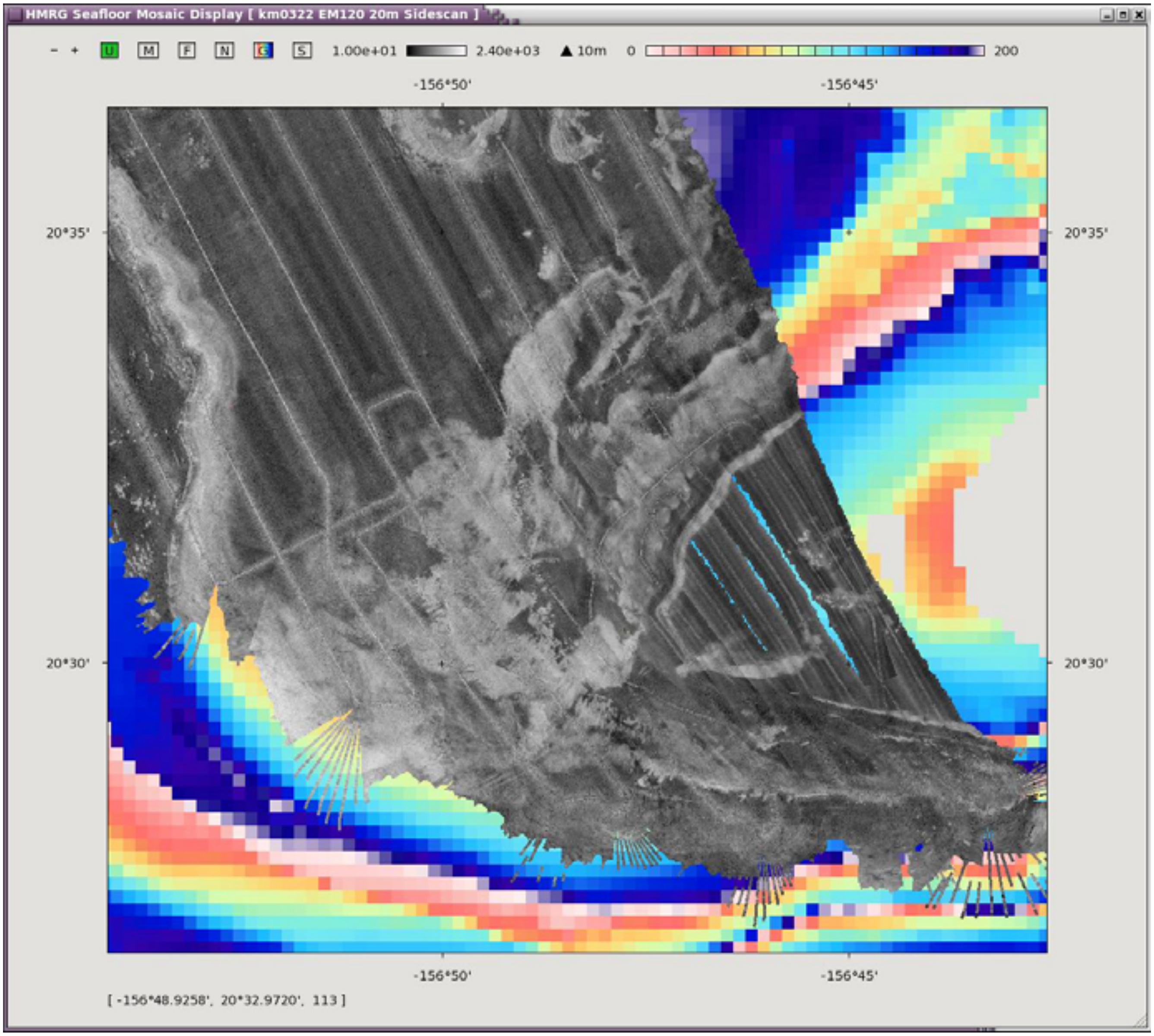


Figure 5B. Sidescan mosaic view window.

Mosaic views are typically configured, like the main navigation window, to show incoming swath data updates in near-real-time as well as background GMT coastline and gridfile datasets and current ship and/or towed instrument position. Extensive display setting configuration is available via a dialog panel similar to that shown for the navigation window display in Figure 4 above, and analogous on-screen accelerator widgets and keyboard arrow key panning features are likewise available.

The system's gridder grids incoming data into a sequence of independent swath section files, segregating port and starboard data into separate sections and segmenting the survey into temporal units spanning between 5 and 60 minutes each. The mosaic display interface allows the display/suppression of individual sections and their stacking order to be configured in arbitrary ways via a number of different techniques. The following Figure 6 shows the same view as Figure 5B above with altered swath section display parameters. Note how the diagonal crossing lines running from southwest to northeast across the center of the sidescan imagery in Figure 5B have been moved beneath the longer primary tracklines running from northwest to southeast in Figure 6.

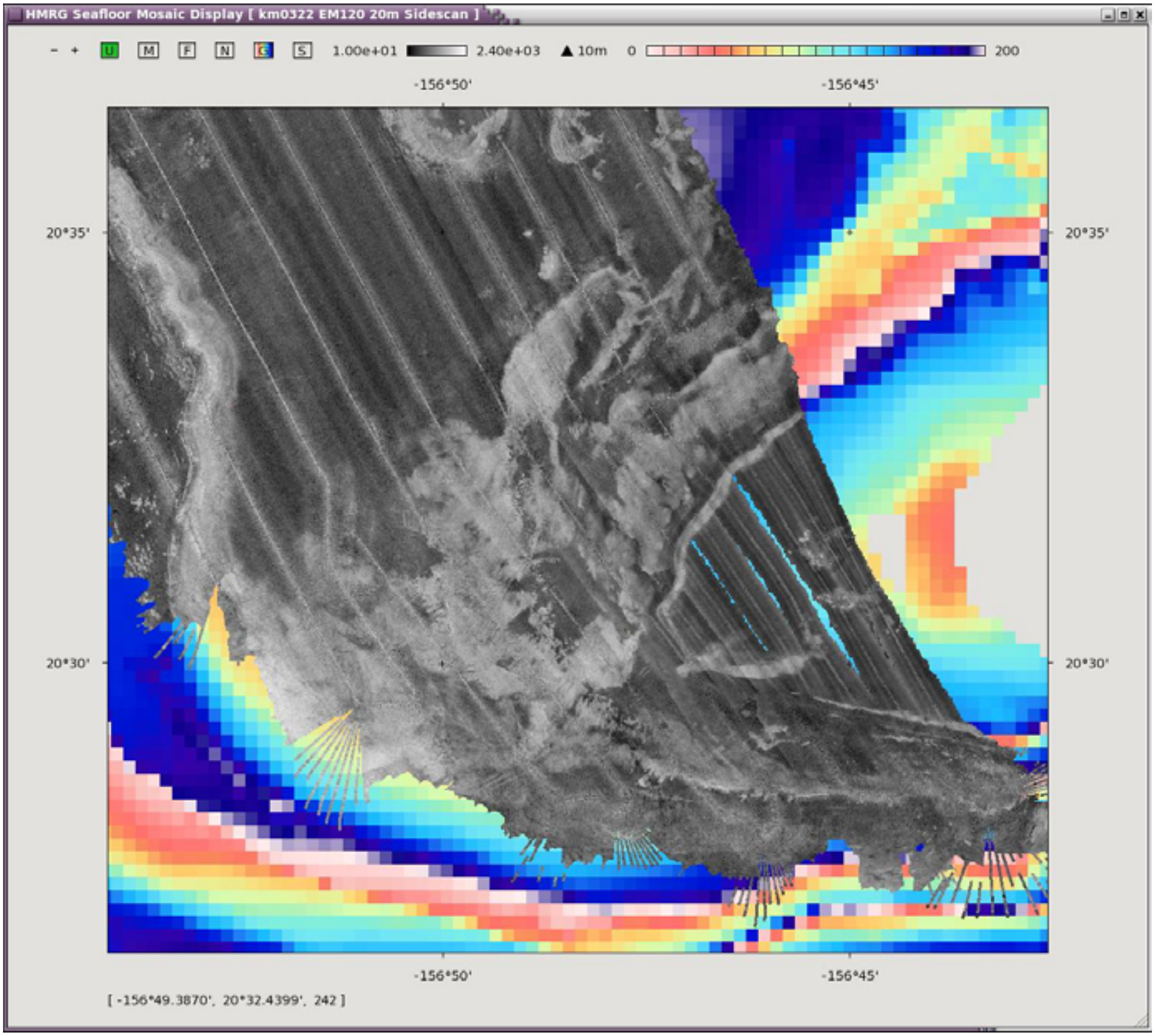


Figure 6. Sidescan mosaic view window with modified swath section stacking order.

The display interface, besides rendering the current swath data from the survey, also has an extensive set of track planning and layout tools as noted above. Science users can create a series of survey tracks within the navigation or mosaic view windows visually aided by the presence of historical or current gridded datasets, etc., then save the waypoint coordinates to text files in a variety of formats. Existing waypoint files may conversely be imported into the program to display a survey track plan created with other software.

A user designing a typical back-and-forth survey will normally create an initial trackline and then specify a quantity of adjacent tracks together with their desired spacing and overlap, as shown in Figure 7A below. The initial trackline here has been placed just to the left of the survey's existing sidescan imagery and the user is now requesting the generation of an additional 6 parallel tracklines to its left.

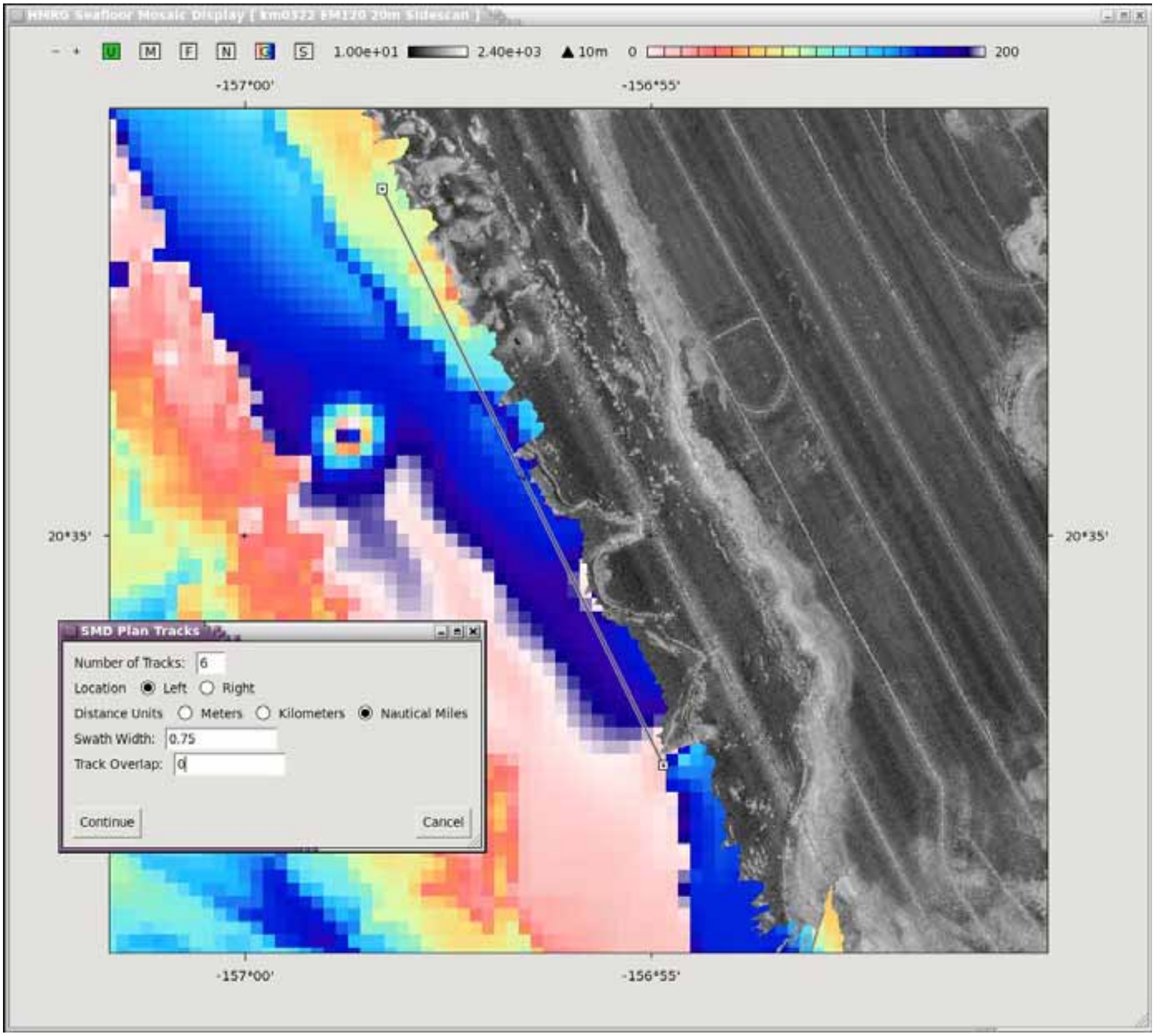


Figure 7A. Single initial trackline with track append dialog.

Figure 7B below shows the result of the track specification procedure illustrated by Figure 7A.

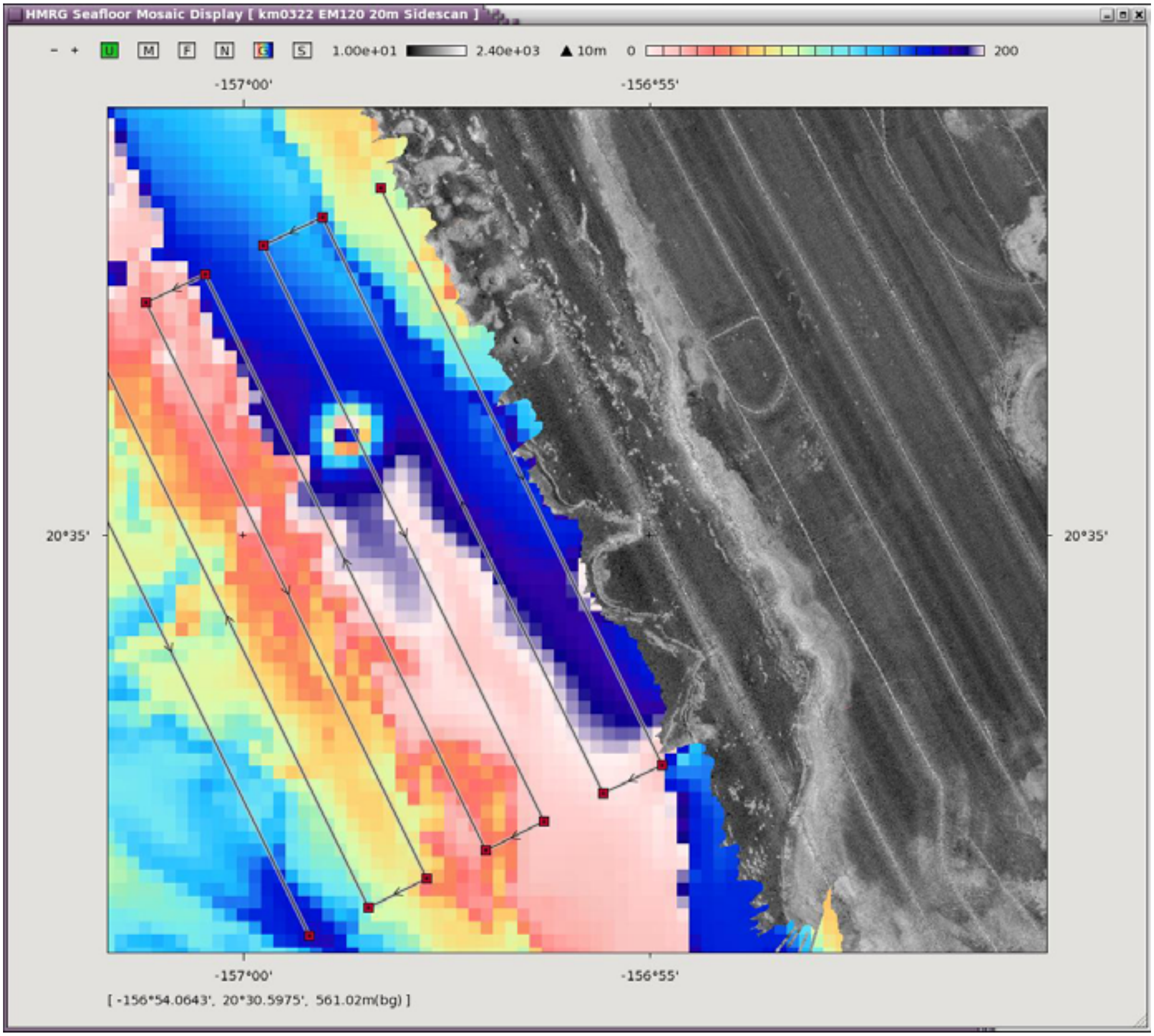


Figure 7B. Multiple parallel tracklines.

Other techniques allow a set of existing tracklines to be re-spaced, lengthened or shortened, as shown in Figure 8. Here, the user is in the process of simultaneously adjusting the inter-track spacing of all tracks, holding the initial right-most track fixed and shifting all of the other tracks to the right while maintaining equal spacing between all tracks.

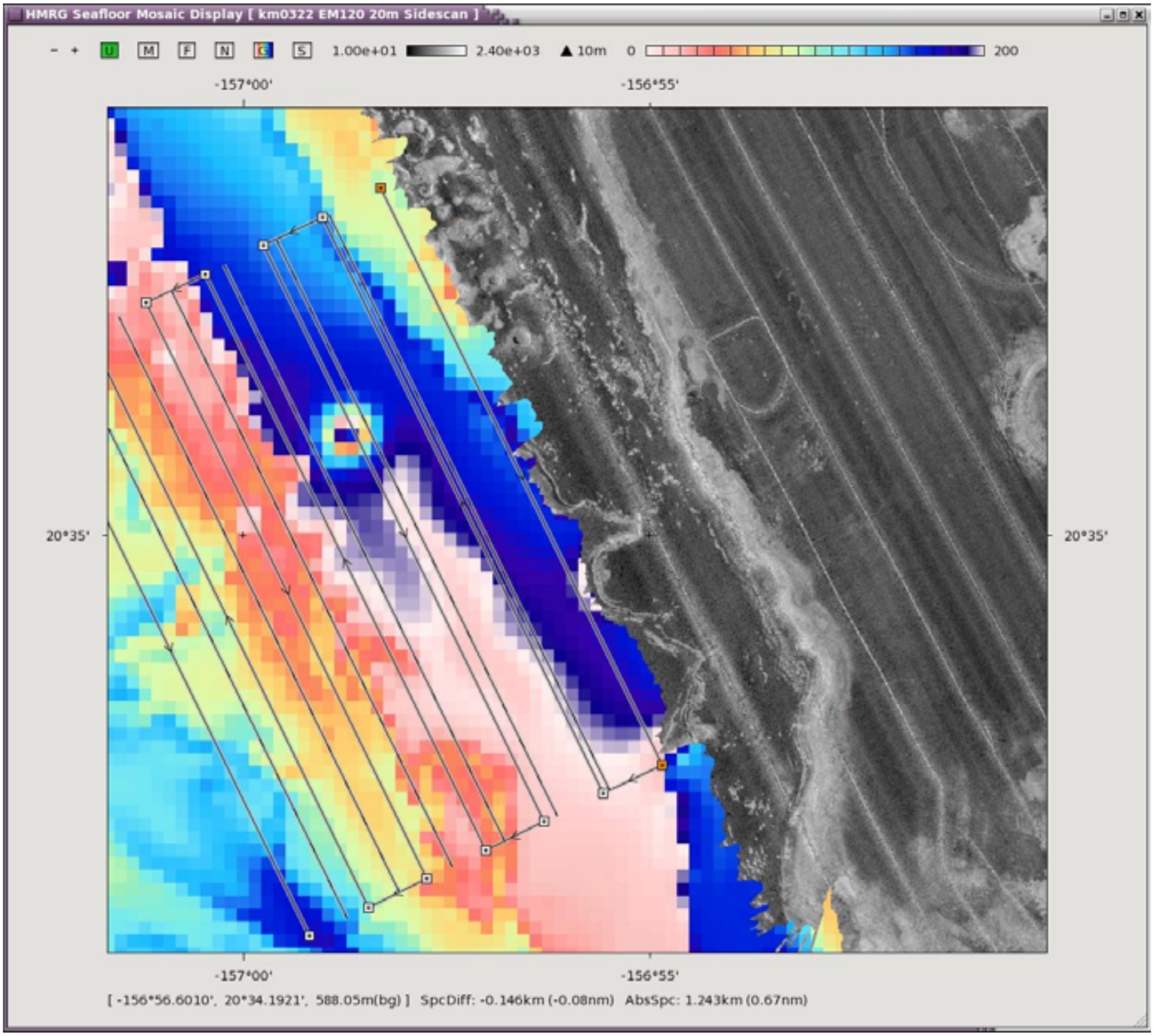


Figure 8. Adjustment of inter-track spacing.

Additional layout features allow individual waypoints to be added or deleted, sets of contiguous tracks to be shifted and/or resized, etc. Survey plan waypoints can be reordered to transform a back-and-forth plan into an offset racetrack plan. A small number of specialized waypoint insertion patterns (e.g., a half-circle pattern for precisely delineating intermediate points in a 180-degree turn, and a figure-8 pattern for magnetic calibration of towed instruments) are also provided.

A collection of informational functions allows the total span of any subset of contiguous waypoints to be measured to aid in the estimation of total survey time as shown in Figure 9.

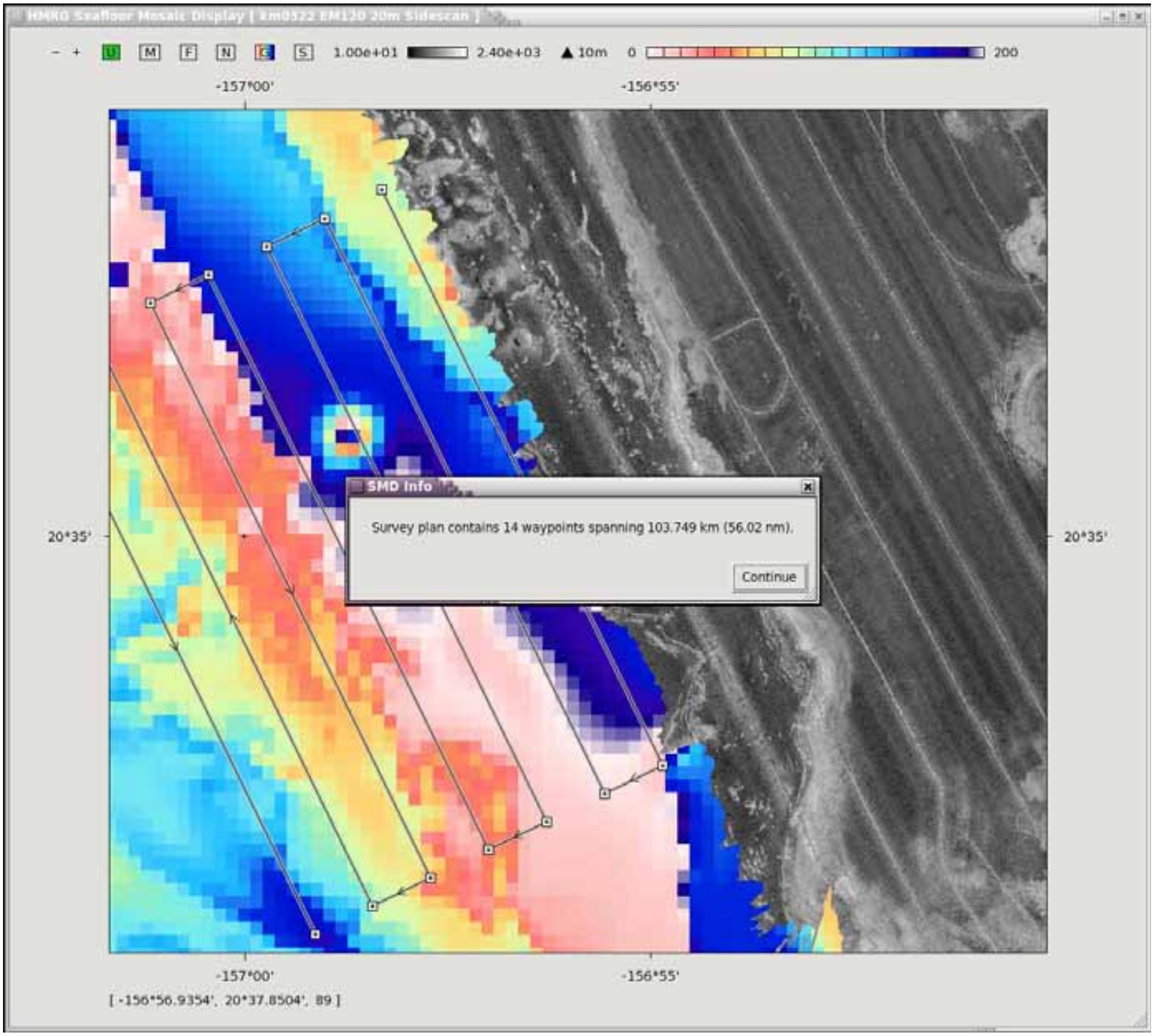


Figure 9. Survey plan information summary.

Planning for dredging and other bottom-sampling operations can be aided by the software's depth profiling feature, which creates a depth vs. horizontal distance plot along the line connecting any two arbitrary locations selected by the user within the navigation window or any mosaic view window. A multi-segment profile can be generated by the selection of any two non-adjacent waypoints within a survey plan, resulting in a profile along the nadir track of a survey between the chosen initial and terminal waypoints. Figure 10 shows a profile created by the selection of two arbitrary locations within a bathymetry mosaic view. (Notice the dark gray bar drawn near the lower right corner of the mosaic view window.) The profile plot itself is displayed in a separate profile window, with the live survey data and the background grid data respectively drawn in blue and green.

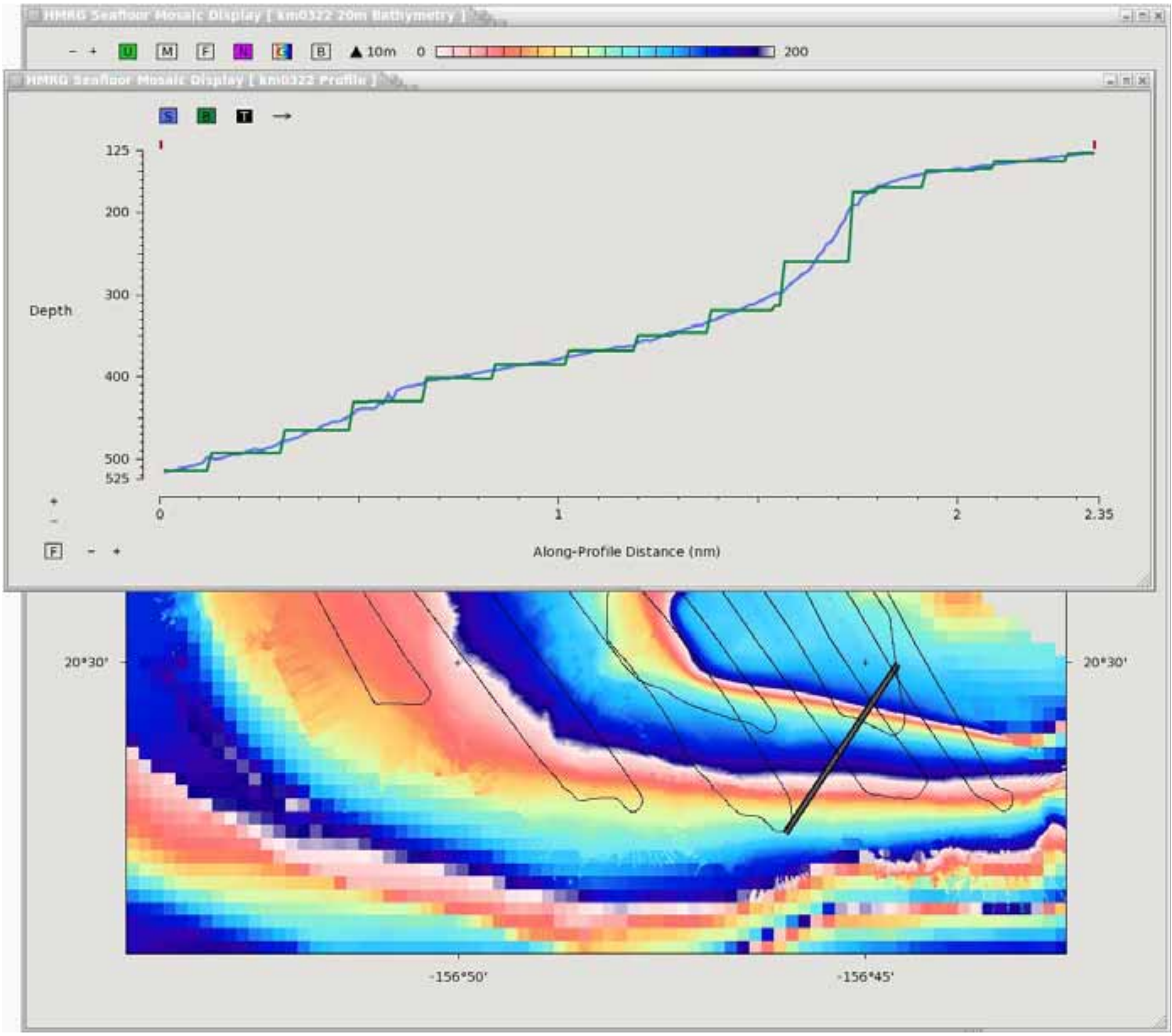


Figure 10. Depth vs. horizontal distance profile.

Other features of the mosaic display interface allow users to (i) annotate points of interest on the mosaics and save those annotations to output files (or import a set of annotations either previously saved by the program or created by external software), and (ii) dump the contents of any navigation or mosaic view window to a GeoTIFF file for importation into external documents or GIS software.

Development of this display interface and other components of the Seafloor Mosaic Display software system is an ongoing HMRG project. Future enhancements currently in planning are bathymetry gradient illumination and importation of a wider variety of external file formats for use as display backgrounds, e.g., nautical charts, etc. Specific requests for new features from the user community are welcome.

Availability and Contact Information

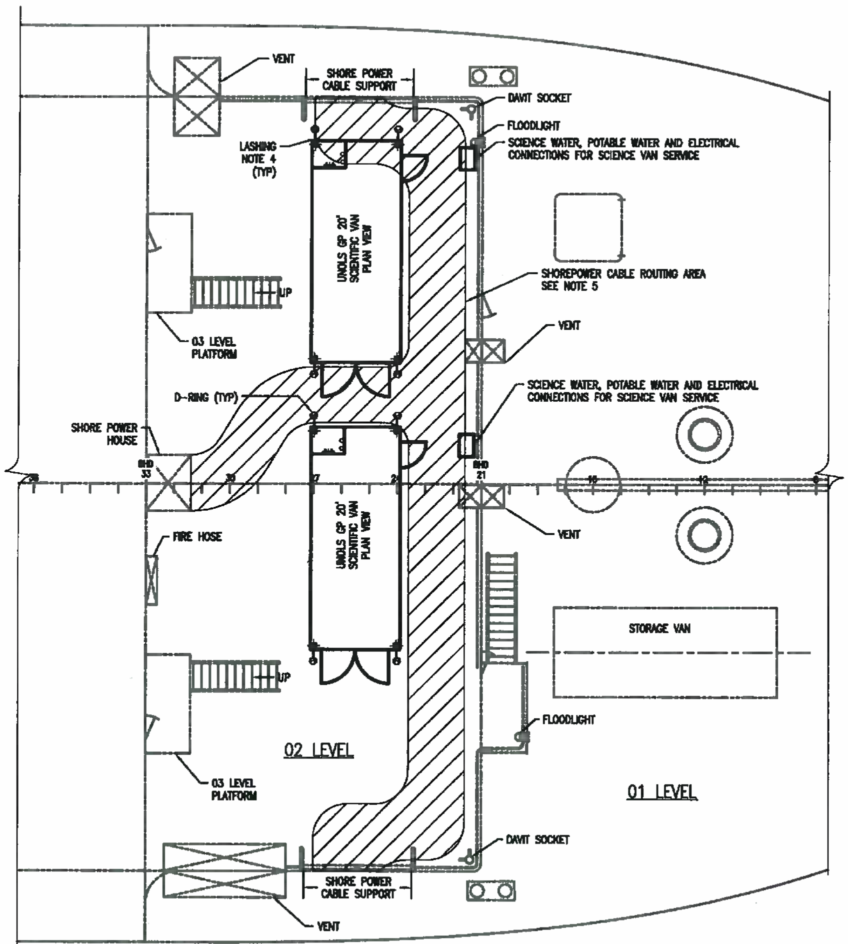
Please contact software author Roger Davis for further information.

GENERAL NOTES

1. THIS DRAWING SHOWS THE VAN INSTALLATION AND CONNECTIONS ON THE 02 DECK. ITEMS SHOWN ON THE 01 DECK ARE FOR REFERENCE ONLY AND WERE NOT VERIFIED BY ELLIOTT BAY DESIGN GROUP.
2. EXISTING SHIP STEEL SURFACES SHALL BE CLEANED TO BARE METAL, PRIMED AND PAINTED TO MATCH ADJACENT STRUCTURE.
3. LININGS AND INSULATION DISTURBED BY THE WORK SHALL BE RESTORED TO MATCH ADJACENT AREAS.
4. THE LASHING CHAIN SHALL HAVE A SAFE WORKING LOAD OF NOT LESS THAN 6 TONS.
5. THE SHADED AREA INDICATES POTENTIAL SHOREPOWER CABLE ROUTING BASED ON SPACE REQUIREMENTS MEASURED DURING A SHIPCHECK OF THE VESSEL.
6. D-RING SAFE WORKING LOAD SHALL BE NO LESS THAN 20 TONS. SEE REFERENCE 5 FOR DETAILS.

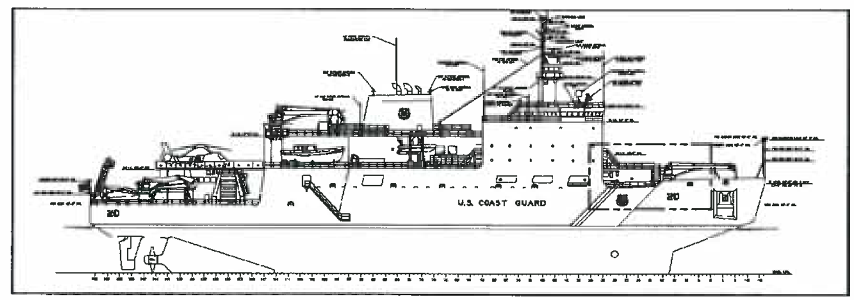
REVISIONS

REV	SH	ZONE	ITEM	DESCRIPTION	DATE	APPVL SIG & ORG
—						



KEY PLAN
UNOLS SCIENTIFIC VAN ARRANGEMENT

12" 0 2' 4' 6' 8' 10' 12'
SCALE: 3/16"=1'-0"



OUTBOARD PROFILE
NOT TO SCALE

REFERENCE PLANS

NO.	TITLE	DRAWING NO.
7	UNOLS SCIENTIFIC VAN 02 LEVEL RECEPTACLE POWER	10082-2-320-0
6	UNOLS SCIENTIFIC VAN PIPING INSTALLATION	10082-2-505-1
5	UNOLS SCIENTIFIC VAN INSTALLATION	10082-002-130-1
4	SCIENCE VAN STOWAGE	420-WAGB-591-001 SH29
3	02 SCANTLINGS	420-WAGB-101-062
2	PROFILE	420 WAGB 801-001 SH1
1	GENERAL ARRANGEMENT	420 WAGB 801-001 SH4

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APPROVED: EBDG	5/20/11
U.S.C.G. APPROVAL	MM/DD/YY
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UNOLS SCIENTIFIC VAN ARRANGEMENT

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SCALE: AS NOTED		6.00 SQ FT	SHEET 1 OF 1

10082-002-101-1


ORIGINAL
32"
DESK
STBD STRGE
SINK DRAIN
WET LAB
CARGO LADDER
RACK
Dry staging
AFT
LIGHTS // BREAKERS
Computer LAB LADDER
vent
vent
72"
40"
31"
50"
CABINET
38"
54"
31"
89"
43"
6600 volt
450 volt
AFT STAGING
Double head
FWD
VENT
VENT
FLUME
Hood

Proposed Improvement with Rotation - 1