R/V Ewing Cruise (EW0107)

report of the

Hydrosweep DS2 upgrade

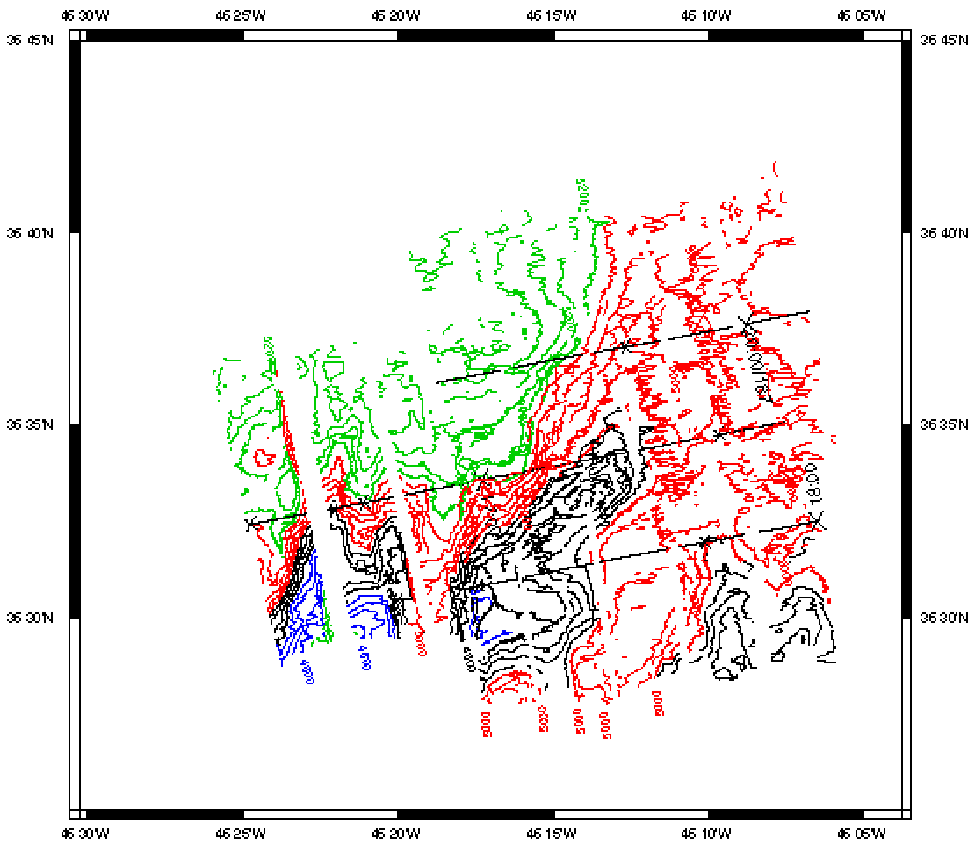
St. Georges Bermuda

to

Ponta Del Gada, Azores

July 2, 2001 - July 10, 2001

Dale Chayes & Angela Slagle



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2 Introduction

The principle goal of this cruise was to test the performance of the recently upgraded Hydrosweep DS multibeam sonar on the R/V Ewing. The hardware, wiring, and initial software for the upgrade were installed in Panama and initially evaluated on the transit (EW0105) from Panama to San Juan, Puerto Rico in late May 2001. On-board evaluation of the performance of the upgraded system during EW0105 was highly encouraging but a number of items remained unresolved. During this cruise (EW0107) all but a few of these details remained. STN ATLAS has been responsive and cooperative in addressing these remaining items.

3 Summary

The performance of the system was evaluated under various circumstances and the data quality looks is quite good. The per-beam repeatability of the system was evaluated at several locations during cruise EW0107 with positive results. Software upgrades were installed and tested to resolve most of the outstanding issues. A minor wiring change in the backplane of the new Hydrosweep Interface Processor (IP) was made to enable the output to the autopilot. The autopilot interface was successfully tested.

The captain, officers, crew and science support staff of the Ewing were enthusiastically supportive of our continued work on upgrading the Ewing and contributed significantly to many of our efforts including testing the autopilot interface and sleuthing out network issues.

4 Operations

The Ewing departed from St. Georges, Bermuda on the morning of July 2, 2001. Except for the few hours at survey site #1, we transited at full speed to Ponta Delgada, Azores. Chayes, Slagle and Brinkman got off the Ewing onto a pilot boat about 0700 local time in Ponta Delgada on Monday, July 9th, 2001. The Ewing continued on toward Patras, Greece, arriving on the morning of July 19, 2001. The transit from Bermuda to the Azores is shown in Figure 1.

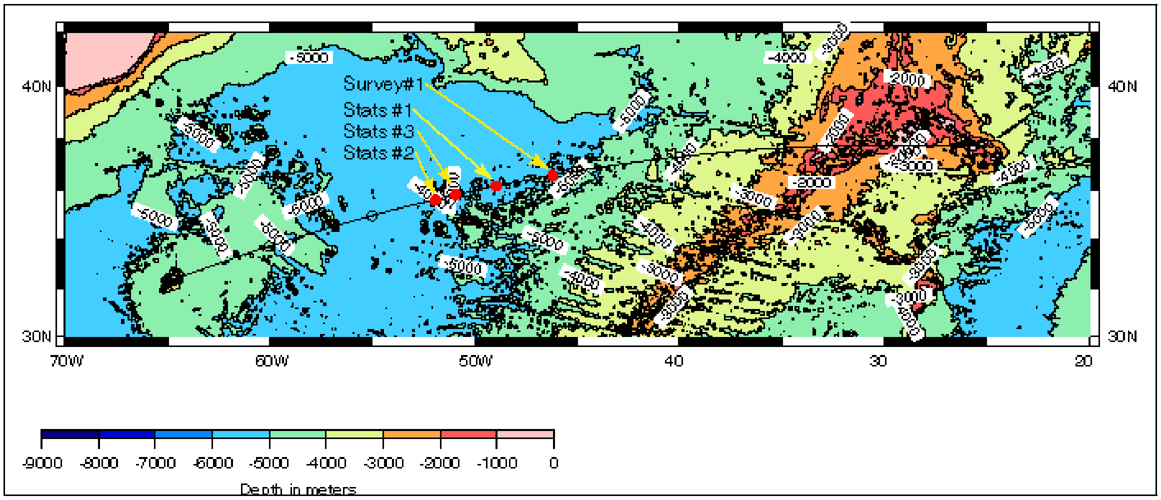

Figure 1: Track plot of the Ewing for the first portion of the transit from St. Georges, Bermuda to Patras, Greece with a brief personnel transfer at Ponta Delgada, Azores.

5 Analysis

The per-beam repeatability of the upgraded Hydrosweep on the Ewing is routinely better than 0.3% of water depth after flagging of artifacts. The effective swath width is about 5 degrees less than expected and STN ATLAS is currently working on improvements to address this issue and to eliminate other anomalies that occasionally occur in the bathymetry.

5.1 Repeatability

As one method of evaluating the data quality, per beam repeatability was estimated done in several different water depths ranging from 1,700 meters to 5,200 meters. This method assumes that the ping to ping depth variation along track is small compared to the total error of the sonar system and its supporting inputs such as heading, attitude and position.

5.1.1 Method

Areas with relatively uniform bathymetry and in a variety of water depths were identified. The raw (".fsw" also now known as mb182) Hydrosweep DS2 data files were translated to an intermediate MB-System[1, 2] format (mb71). These data files were flagged for artifacts using *mbedit* and plotted w/ *mbm_plot* to verify the results of artifact identification. Per-beam statistics were extracted with *mbinfo* using a five-ping window (*mbinfo –f71 –I datafile.mb71 –P > stats.file*). The bathymetry statistics were extracted, scaled and plotted with a Matlab script.

5.1.2 Site 1

The first location for repeatability analysis was chosen in deep water at the eastern edge of the abyssal plain of the transit from Bermuda toward the Azores. After flagging of the outliers (with *mbedit*). Very good results were obtained. Ninety percent good returns were obtained in 5,200 meters of water across a swath of approximately 110 degrees and the per-beam repeatability was well below 0.3% of water depth across nearly the entire swath. It is also impressive to note that 100% of the beams were good for the inner 102 degrees of the swath.

Having the tunnel covers installed and good weather helped provide optimum conditions for collecting this data.

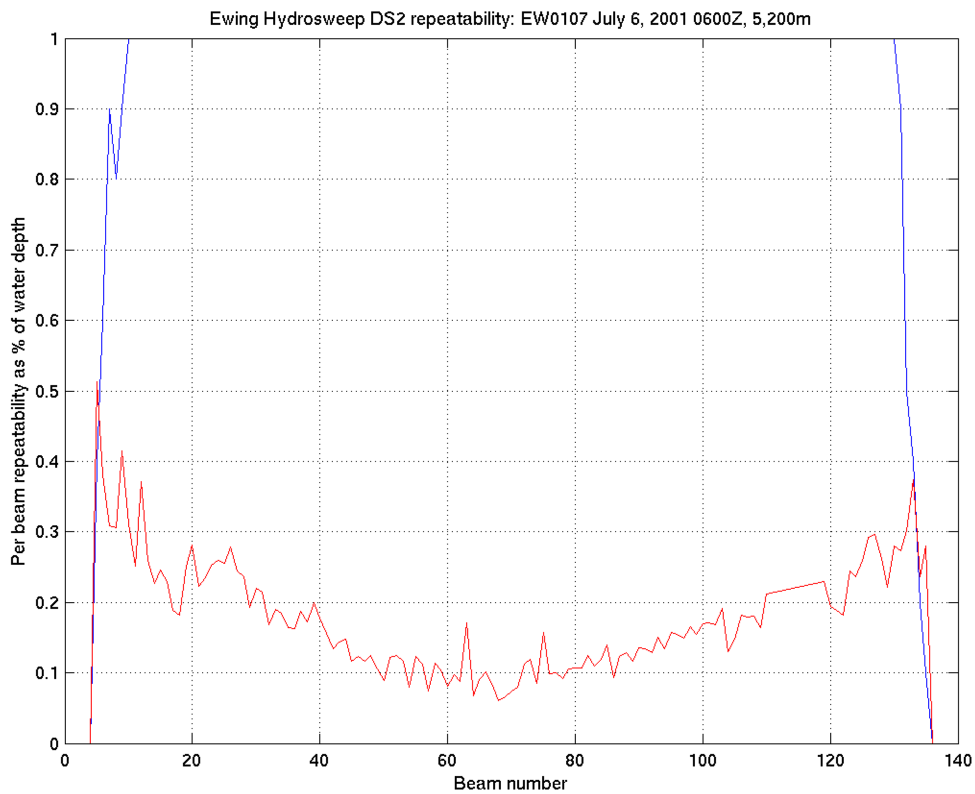

Figure 2: Per-beam repeatability plot for the first location in deep water (~5,200m). Port is to the left (beam #0 is the port-most beam) and starboard is the to the right. The red line is the standard deviation (calculated over five pings) of water depth per beam, normalized to the nominal water depth. The blue line is the percentage of good (non-flagged) depths per beam

Figure 3: Swath plot of the Hydrosweep DS2 bathymetry in color fill and contours for the data sample used to estimate repeatability in deep water. The nominal water depth is about 5,200 meters

5.1.3 Site 2

Site two is located at 35 degrees 36 minutes North, 051 degrees 55 minutes West on the western flank of the Mid Atlantic Ridge. Most of the seafloor in this area is about 1,700 meters deep. Figure 5 shows a significant topographic feature on the south side of the swath that substantially impacts the repeatability analysis. This high gradient bathymetric feature drives the per-beam repeatability up to approximately 1.25% of water depth in the vicinity of beam 115.

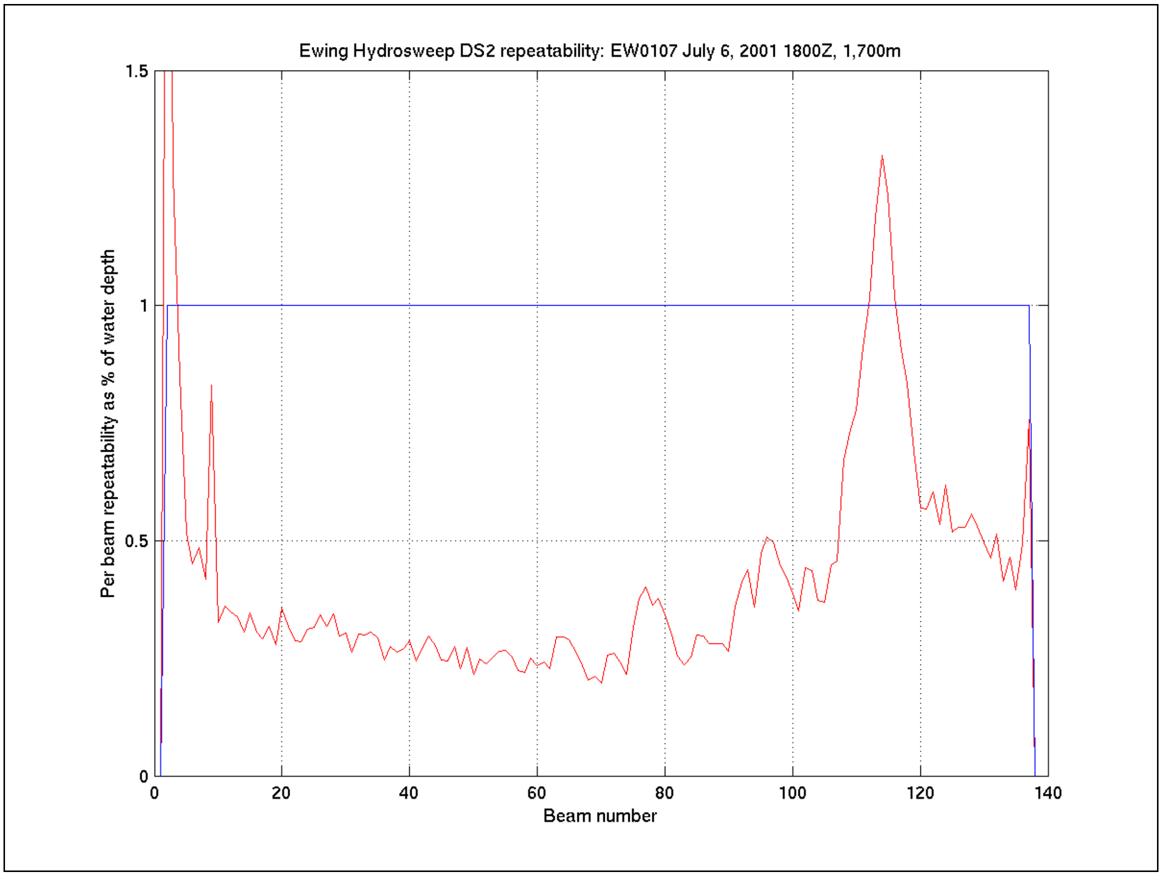

Figure 4: Plot of per-beam repeatability for the Hydrosweep DS2 on the R/V Ewing. Port is to the left (beam #0 is the port-most beam) and starboard is the to the right. The red line is the standard deviation (calculated over five pings) of water depth per beam normalized to the nominal water depth. The blue line is the percentage of good (non-flagged) depths per beam

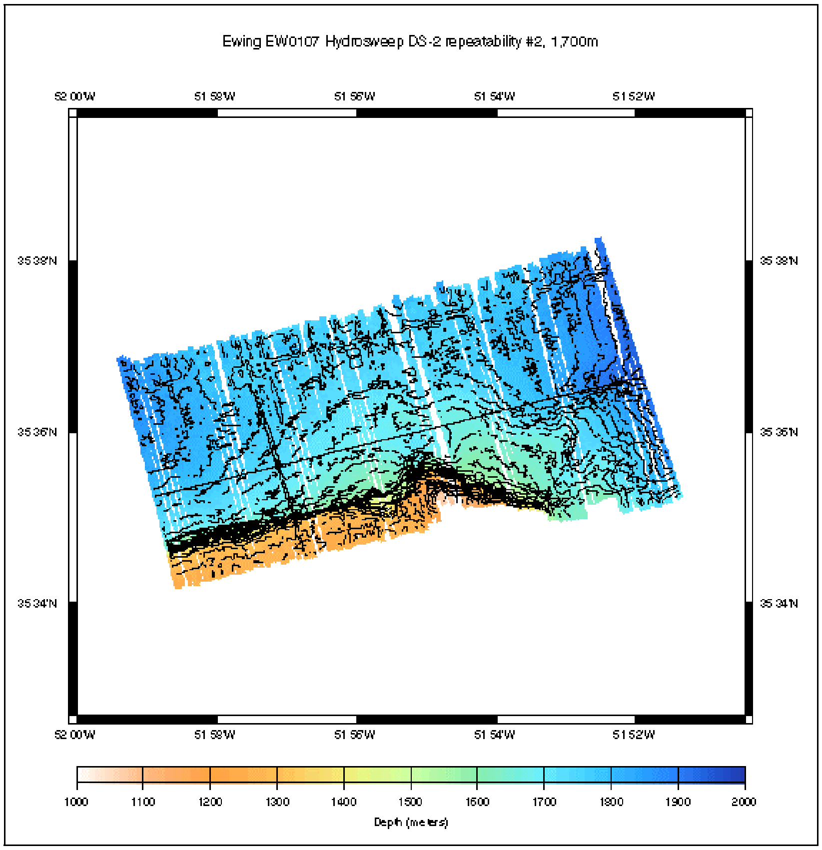

Figure 5: Swath plot of data used in the second repeatability analysis during EW0107. The bathymetric feature on the south side of the swath is the principle cause of the relatively high standard deviation (normalized to water depth) in Figure 4.

5.1.4 Site 3

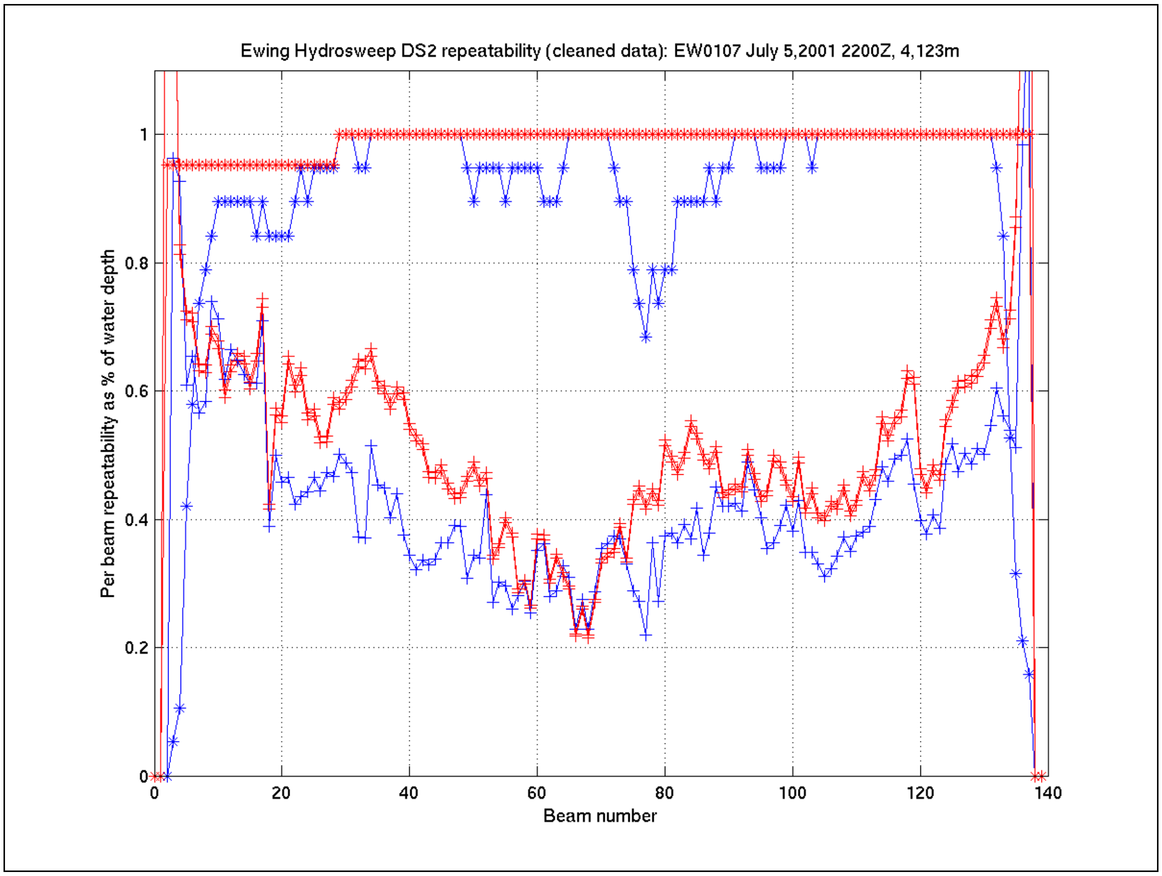

Figure 6: Plot of per-beam repeatability from site #3. Plus signs (+) represent the standard deviation for each along track beam as a percentage of the water depth. The star symbols (*) represent the number of returns for each ping. Red is the raw, (as-logged) data. Blue is the data following manual beam editing.

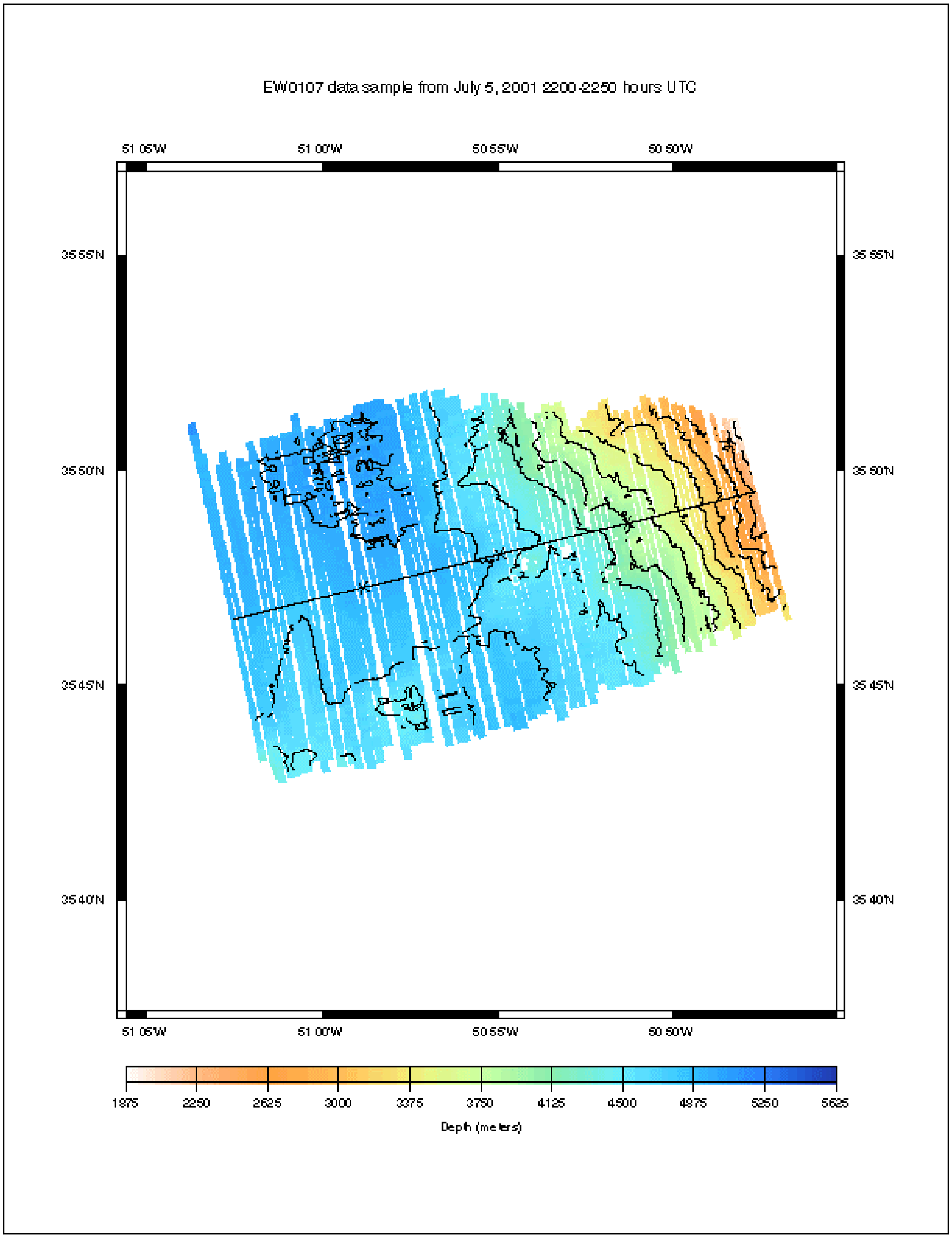

Figure 7: Swath plot (contoured and color filled) of the bathymetry from which the statistics presented in Figure 6. No significant topographic features appear that would be expected to negatively influence the per-beam statistics.

5.2 Autopilot

One of the important new features of the HYDROMAP Online workstation of the Hydrosweep DS2 is the ability to layout track lines and to have the multibeam system automatically steer the ship. This is accomplished by feeding real-time steering corrections to the Sperry autopilot via an asynchronous serial interface.

The autopilot output is in NMEA “APB” format. This interface was configured and tested on the evening of July 7, 2001. After initial testing and collaborative debugging, minor software changes were made on-board to the message formatting to insert the bearing to the waypoint. This improvement eliminated an error indication on the Sperry autopilot.

5.3 Swath width

This version of the Hydrosweep DS-2 calculates as many as 140 “soft” beams based on the 59 “hard” beams generated by the ATLAS GE-6012 hardware signal processor. The total swath can be as much as approximately 120 degrees. The “soft” beam spacing is approximately 0.85 degrees.

For a specific installation, the actual swath width will vary depending upon bottom type (reflectivity), ambient noise and self-noise. During this cruise, the tunnel covers were installed and the weather conditions were calm. It is probably safe to assume that the results obtained here indicative of nearly as good a quality as one may expect on the Ewing while operating at relatively high speed. All of this data was obtained while operating at nearly full speed (~158 RPM to make 12+ knots through the water.

5.4 Data quality

5.4.1 <u>Survey #1</u>

A small 3.5 hour survey of about 45 track miles was conducted at 36 degrees 35 minutes North, 46 degrees 10 minutes West (Figure 8), along the western edge The depth in this area ranges from 4,800 to 5,900 meters, reflecting the geographic relief of the ridge flank. The processing of these data files included contouring and ping averaging using *mbm_plot*, manual beam editing using *mbedit*, and gridding of the bathymetry using *mbgrid*. A swath plot of the survey region (Figure 9) clearly shows a topographic feature rising from the seafloor. Figure 10 shows the gridded bathymetry of the same feature from a 200m by 200m grid cells.

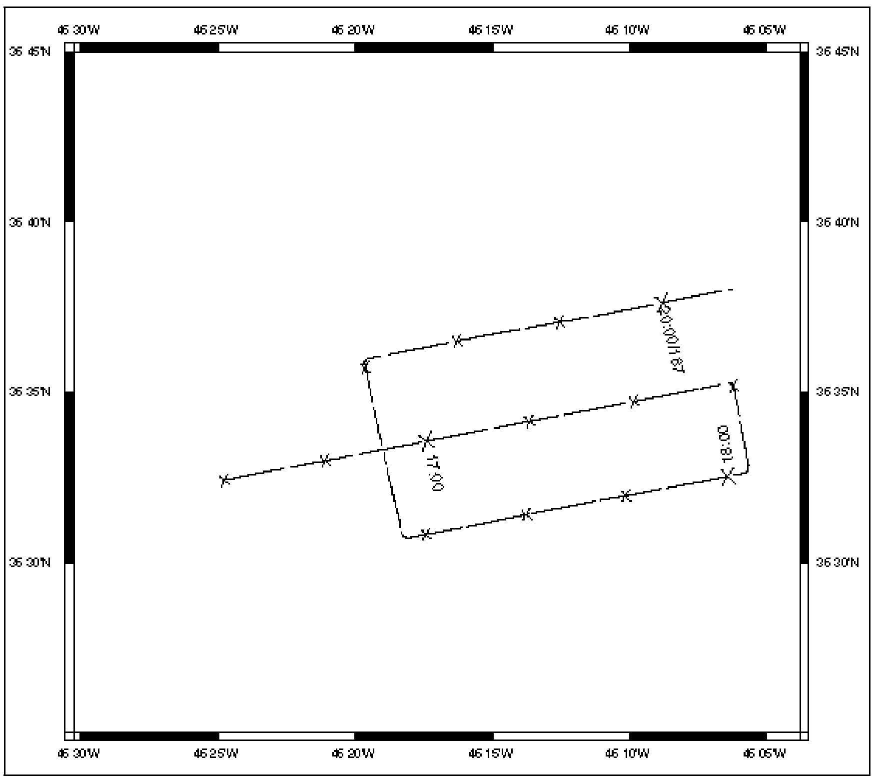

Figure 8: Ship track of a small survey done during EW0107 to check swath to swath repeatability of the upgraded Hydrosweep DS2.

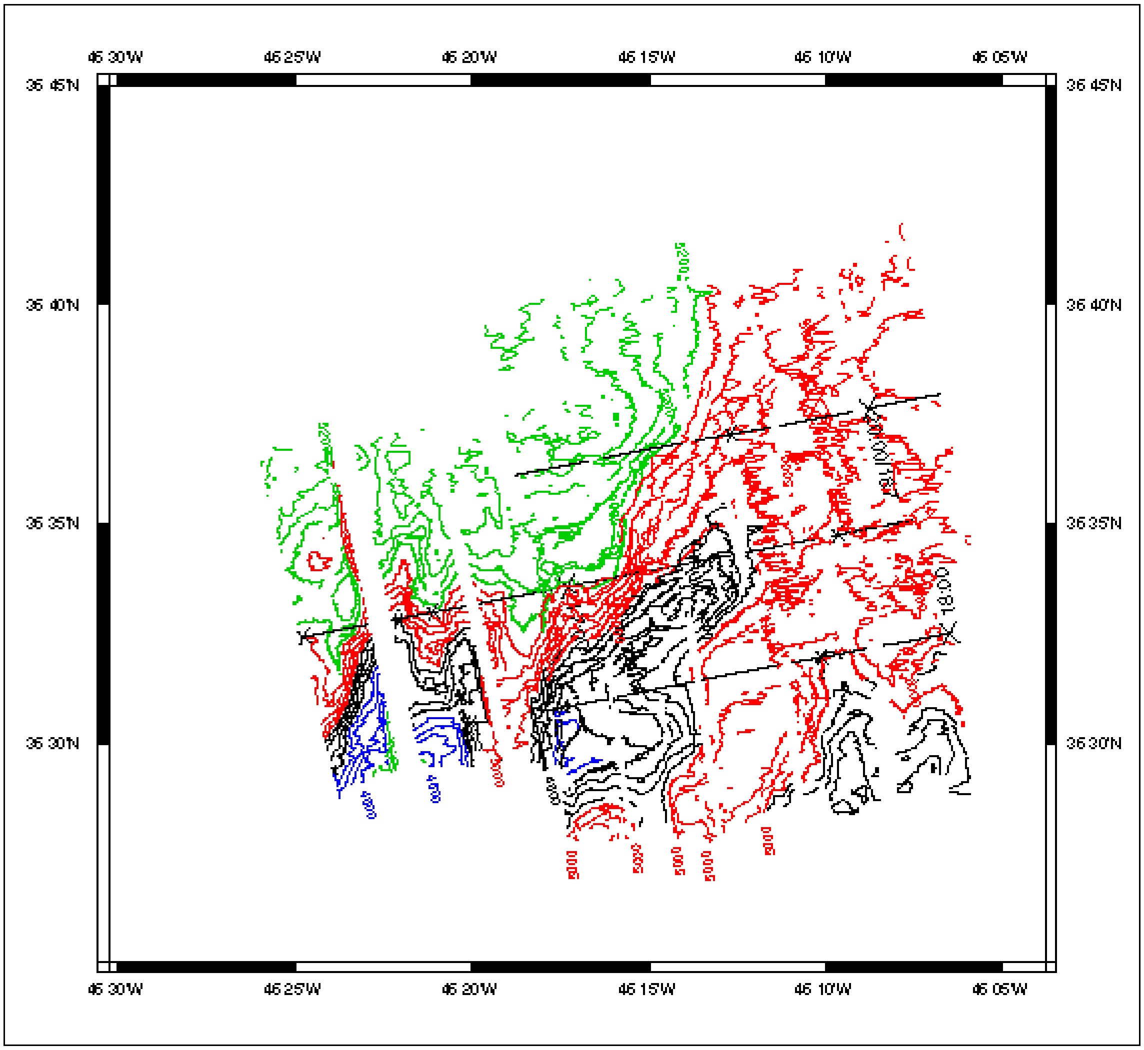

Figure 9: Swath plot made from manually edited Hydrosweep DS2 bathymetry of the three parallel lines from the survey area shown in Figure 8. The contours for each line are plotted independently. Visual inspection of the co-registration indicates very good swath to swath matching.

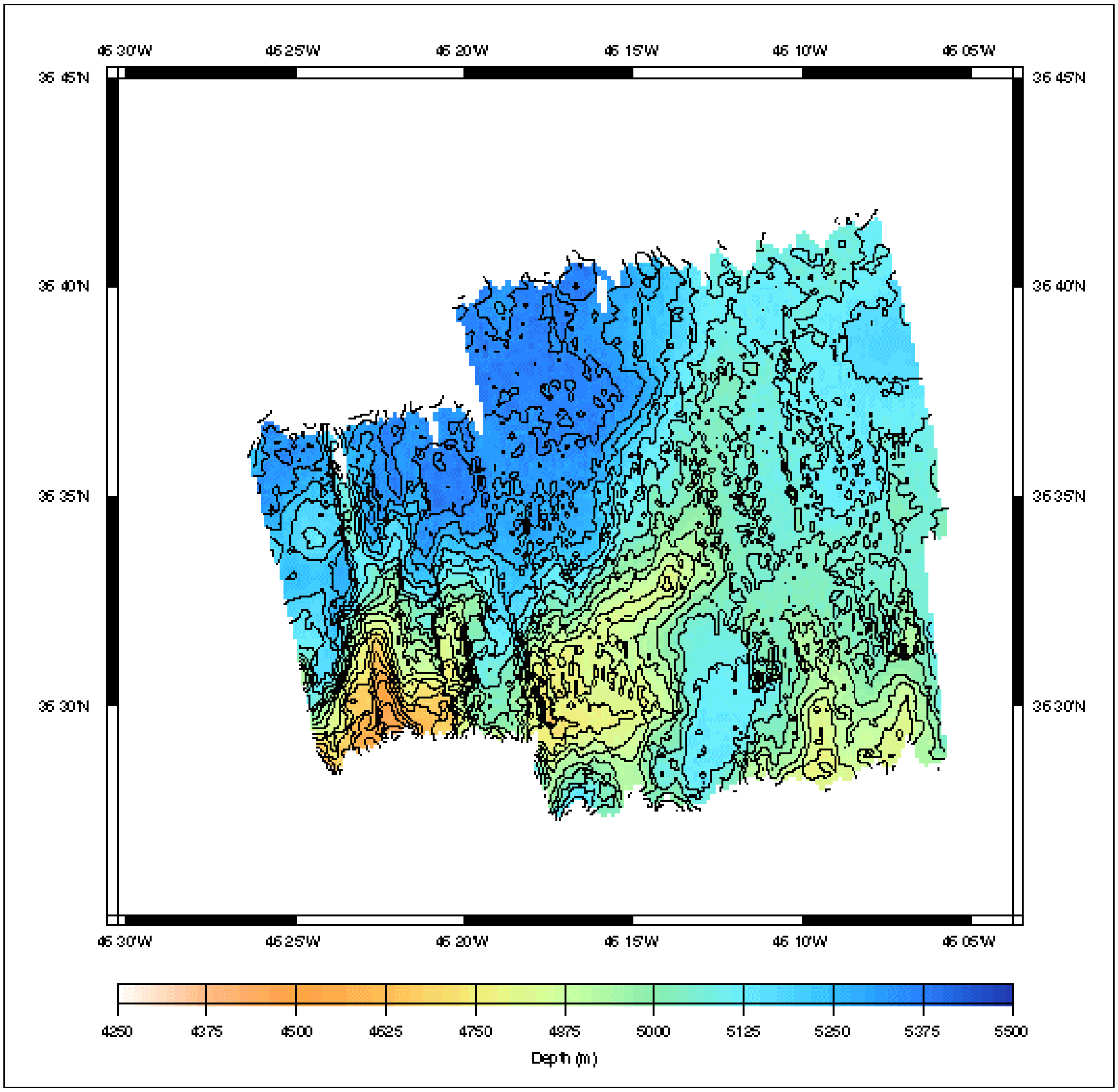

Figure 10: Gridded bathymetry from survey area #1. Grid cells are 200m by 200m.)

5.4.2 <u>EW0105 Survey</u>

At the very end of the initial evaluation cruise (EW0105) we did two short surveys in the head of Mona Canyon. During the first survey, the Hydrosweep was operated without the software beamformer. During the second survey, the software beamformer was configured and operating to produce up to 140 beams over 120 degree swath. The track for this survey is shown in Figure 11.

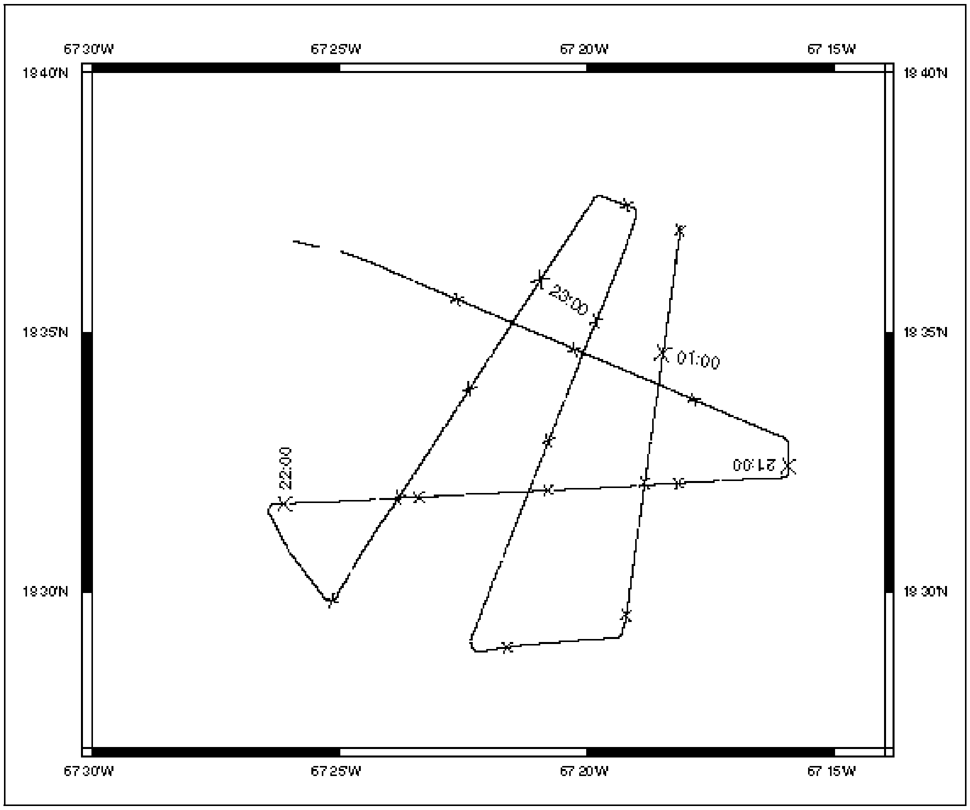

Figure 11: R/V Ewing survey track at the head of Mona Canyon (northeast of Puerto Rico) during EW0105. The upgraded Hydrosweep DS2 data is shown in the following figures.

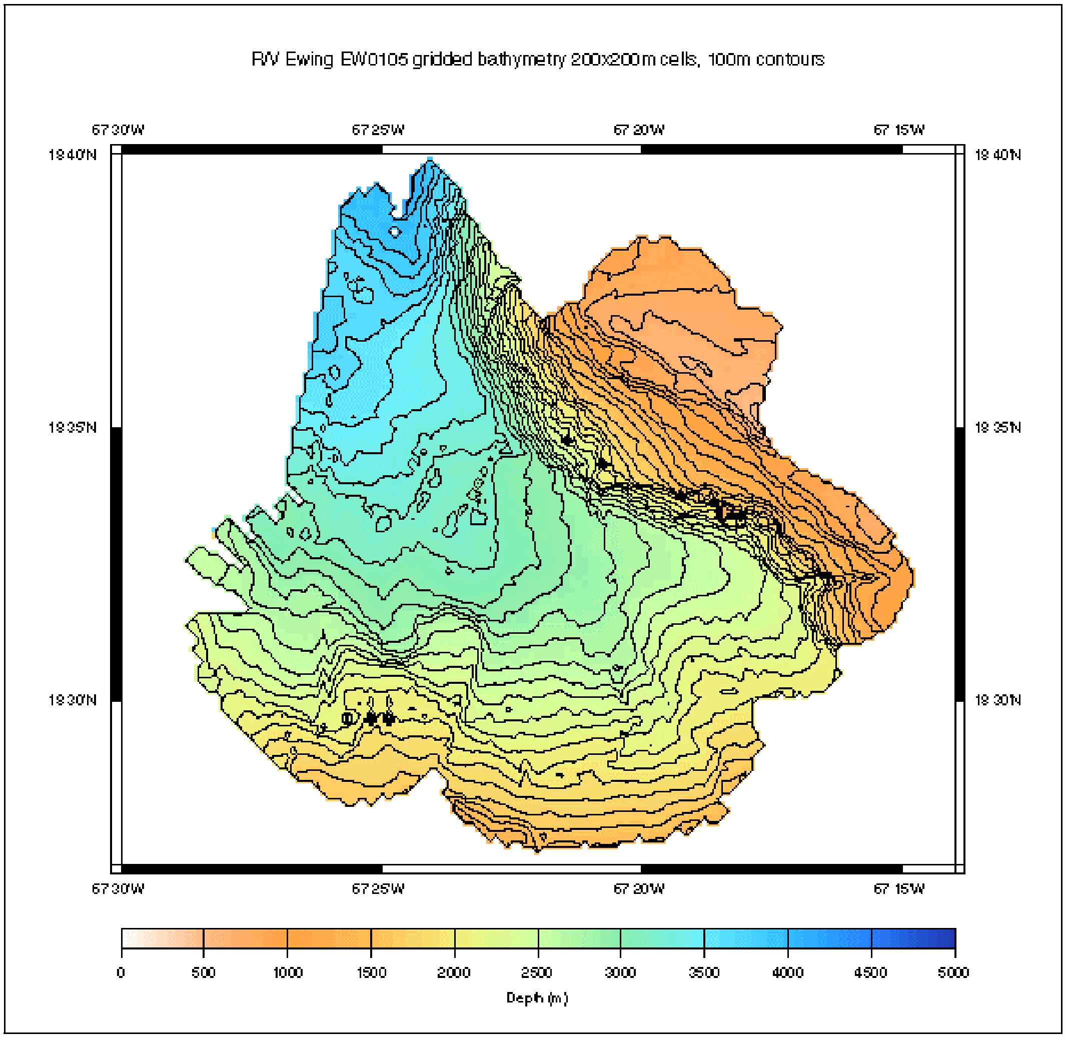

Figure 12: Contoured gridded data from a survey of Mona Canyon at the end of EW0105. This data has been gridded at 200-meter grid cells and contoured at 100m contour intervals. With the exception of a couple of small artifacts that were not identified in beam editing, the smooth, well behaved nature of the contour indicates the limit of the ability of the system to resolve small scale features has not been reached at this gridding interval.

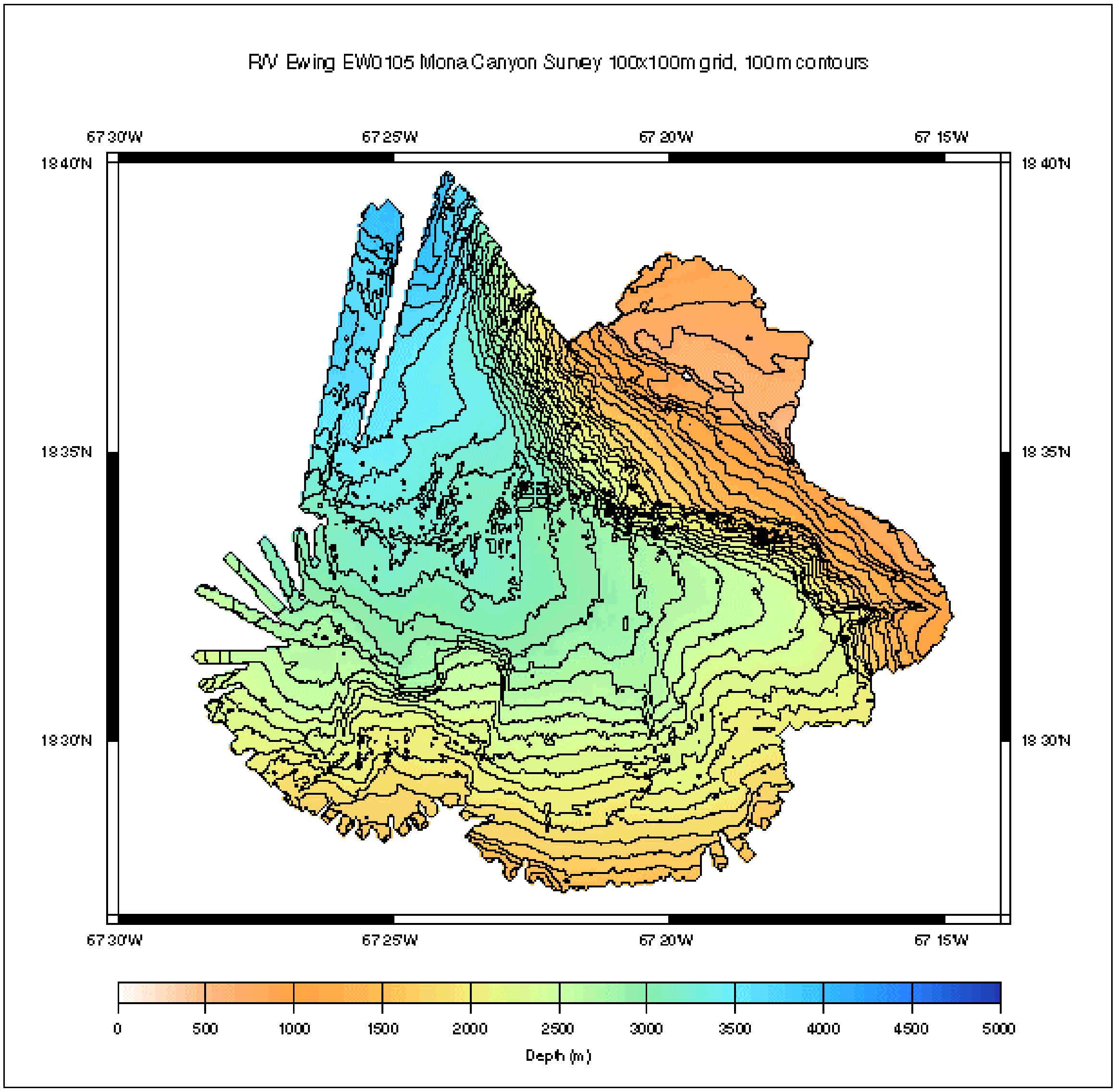

Figure 13: Contoured gridded data from a survey of Mona Canyon at the end of EW0105. This data has been gridded with 100 meter grid cells and contoured at 100m contour intervals. With the exception of a few small artifacts that were not removed in the editing process, the well behaved nature of the contour lines suggests that the limit of the ability of the system to resolve small scale features has not been reached.

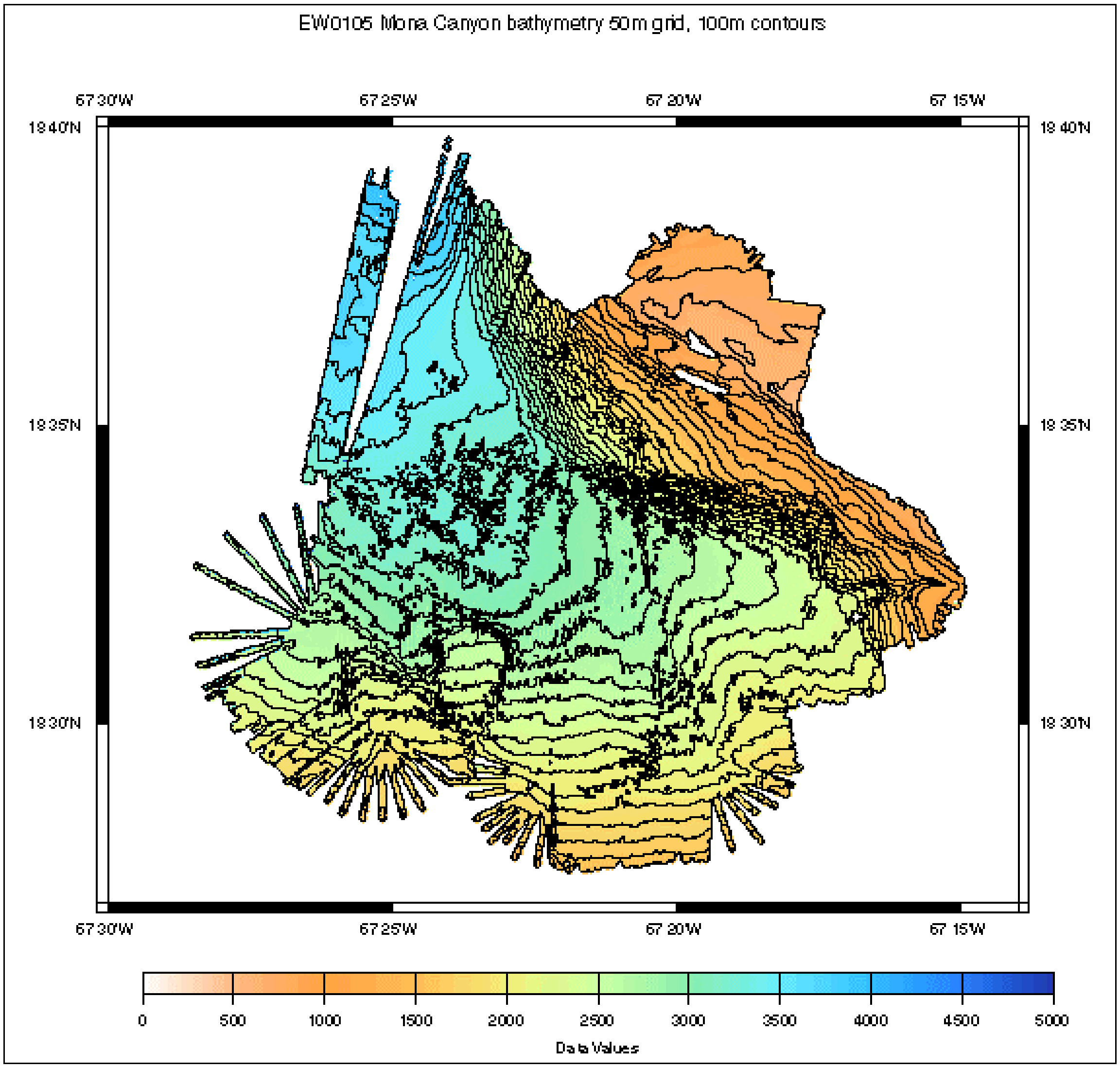

Figure 14: Contoured gridded data from a survey of Mona Canyon at the end of EW0105. This data has been gridded at 50 meter grid cells and contoured at 100m contour intervals. The apparent 'fuzz" in the contour lines probably indicates the limit of the ability of the system to resolve small scale features. The radial "spokes" during turns are indicative of the high rate of turn allowed by the POS/MV vertical reference subsystem. There are no indications of roll induced artifacts during or after the turns.

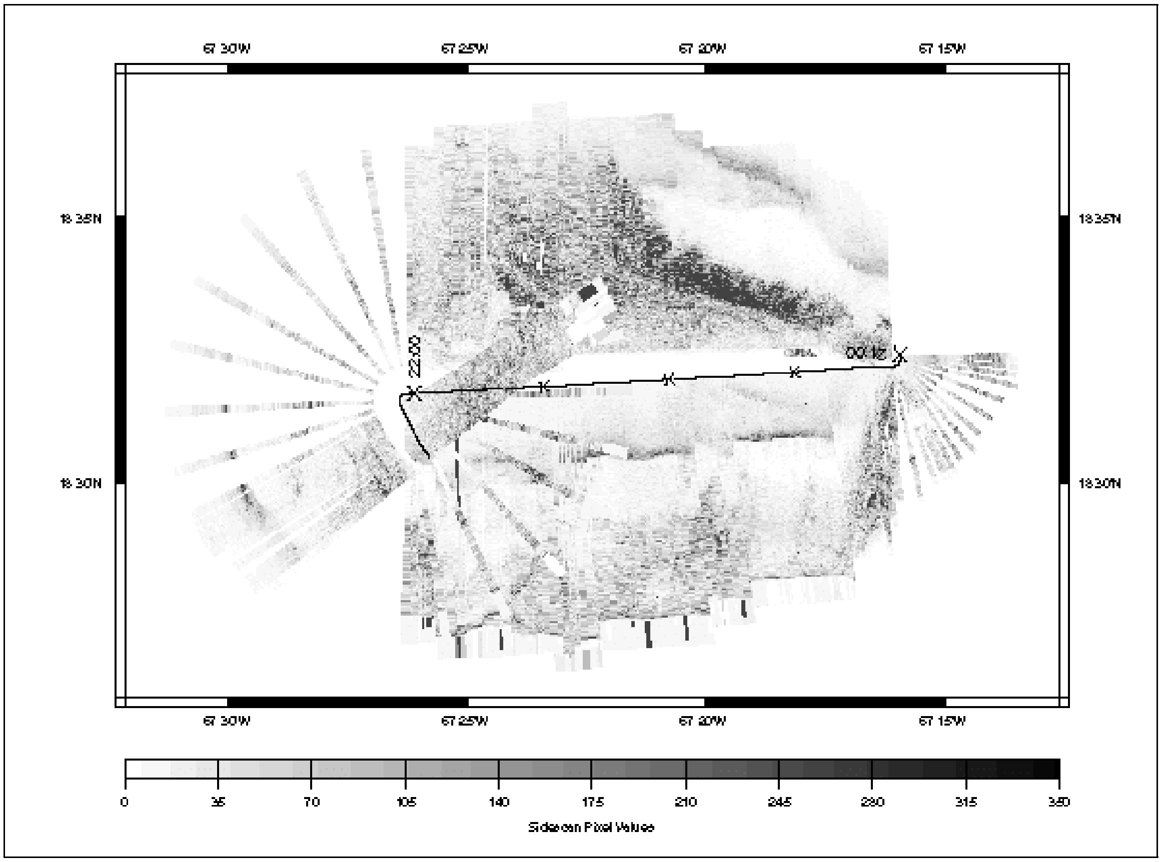

Figure 15: Raw sidescan data from the Hydrosweep DS2 on the Ewing. Data is taken from a single line of the survey at the head of Mona Canyon during EW0105. MB-System is not yet locating the pixels correctly, this rough, initial image indicates that the sidescan data exists and generally correlates with bathymetry.

6 Other issues

A number of other issues came up during this cruise. Attention to some of these is important to improving the performance and maintainability of the Hydrosweep and to the general improvement of the quality and quantity of data we collect.

6.1 Network

We have seen evidence on this leg that there are periods when the network loading is high enough to cause noticeable user interface response delays.

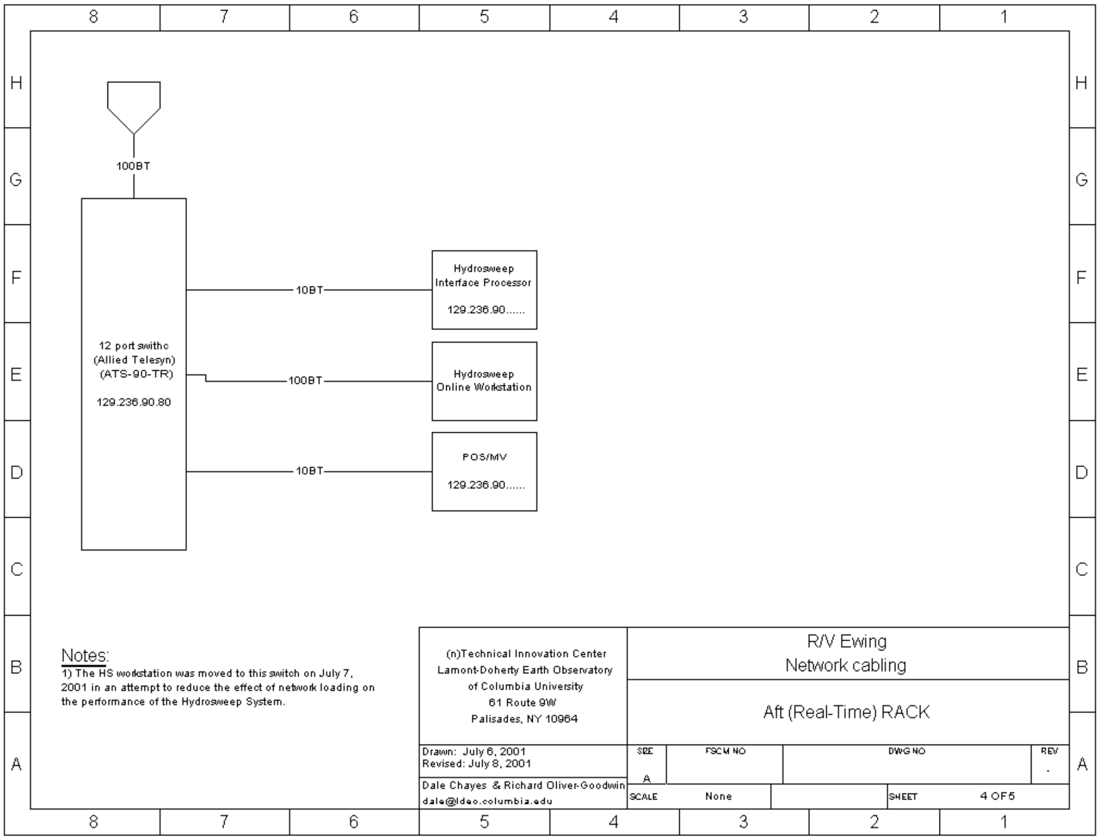

Figure 16: An example network diagram developed during this cruise. Additional detail such as port numbers, wire numbers, and equipment serial numbers should be added. The shipboard technical staff should be provided with the software and hardware tools to develop and maintain such documentation as part of the NSF/OCE mandated Quality of Service effort.

To understand the apparent performance issues requires understanding the current arrangement. There is only limited documentation on the current wiring and connectivity. Efforts to develop (and maintain) a set of drawings of the connectivity are urgently needed.

6.2 Email

A problem was identified which causes command line email (such as is used to automatically send the Hydrosweep daily data statistical summary ashore) to generate incorrect email addresses. This is a byproduct of the ongoing effort to migrate the Ewing's email system from the ten year old Sun IPC workstation (shark.)

6.3 MB-System

A beta release of MB-System (Version 5.0 beta 02) was installed in */usr/local/metadata/dev/'mbsystem* which is a symbolic link to the current version with binaries and man pages. This is the first release that supports, in a limited way, the new file formats produced by the Hydrosweep DS-2. Users who do not need to use the new file formats should stick with the existing, stable, 4.6.10 release which is in */opt/mbsystem*.

The real-time code that drives the Calcomp pen plotters is a very old release (4.3) dating from approximately 1993. It will be necessary to update the real-time plotting scripts and perhaps some of the plotting code in order to migrate to a suitably modern version of MB-System if we are to retain our ability to plot the new, wide-swath data in real-time.

6.4 POS/MV

The POS/MV performed well on this cruise except that it occasionally looses its network connection. I have asked TSS (the representative) and Applanix (the manufacturer) about this problem and they have indicated that they have seen other installations where the system looses the network connection on "heavily loaded" networks.

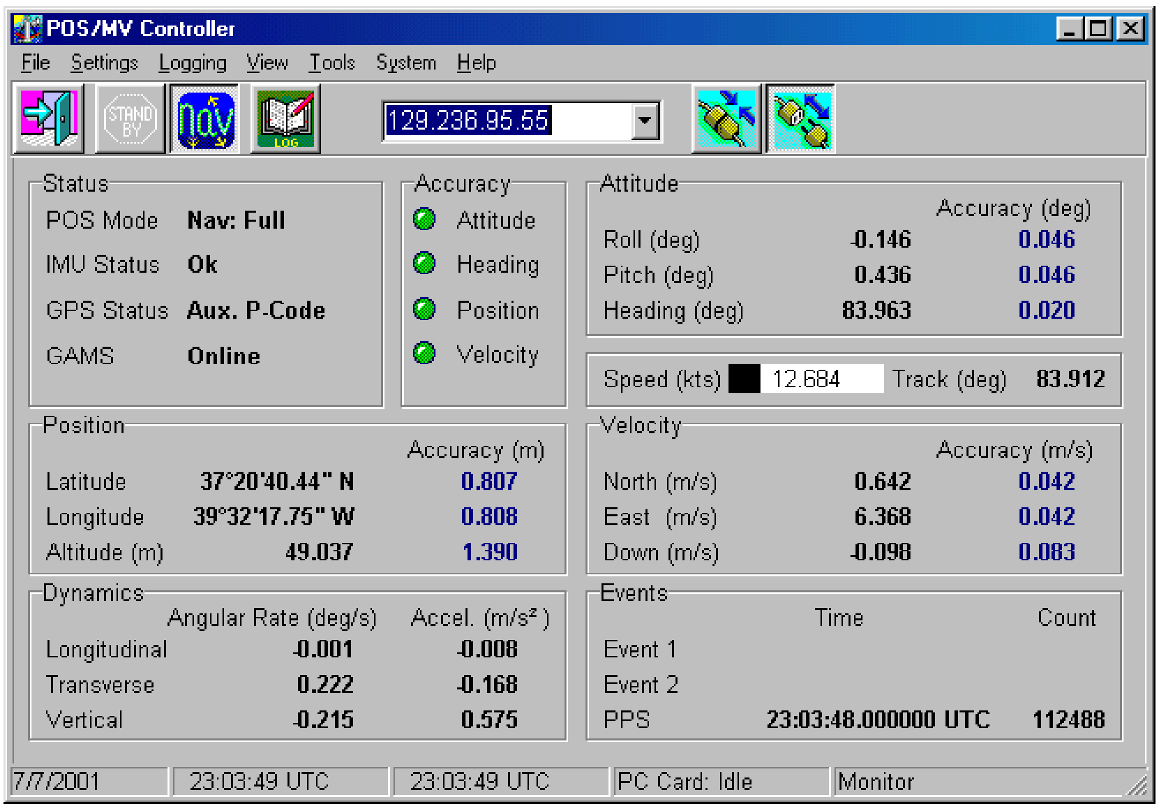

Figure 17: Screen shot of the Win9x application for monitoring the status of the POS/MV attitude and navigation system. Note that it is reporting attitude accuracy on the order of 0.046 degrees, heading accuracy of 0.02 degrees, position (w/ P-Code aiding) of less than one meter and altitude of less than 1.5 meters.

There is some anecdotal evidence that the POS/MV network connection is more stable if the Win9X display application is running. This should not be the case since the Windows application is represented as being a receive only application which is listening to the UDP broadcast datagrams.

7 Appendix I: Participants

Science Party:

Joe Stennett	Science Officer	OMA, LDEO/CU
Richard Oliver-Goodwin	System administrator	OMA, LDEO/CU
Karl Hagel	Electronic Technician	OMA, LDEO/CU
Justin Walsh	Air Gunner	OMA, LDEO/CU
Ropate Maiwiriwiri	Core Bosun	OMA, LDEO/CU
John Byrnes	Air Gunner	OMA, LDEO/CU
Dale Chayes	Chief Scientist/Engineer	LDEO
Angela Slagle	Graduate Student	LDEO/CU
Joachim Brinkman	Software engineer	STN ATLAS

8 References:

[1] D. N. Chayes and D. W. Caress, "Processing and Display of Multibeam Echosounder Data on the R/V Maurice Ewing," presented at Fall Meeting, San Francisco, CA, 1993.
[2] D. W. Caress and D. N. Chayes, "Improved Processing of Hydrosweep Multibeam Data on the R/V Maurice Ewing", *Marine Geophysical Researches*, vol. 18, pp. 631-650, 1996.