CRUISE REPORT

NOAA Ship *Ronald H. Brown*

Extended Continental Shelf Mapping Cruise in Vicinity of Palmyra Atoll

CRUISE RB-16-01 Leg 2

January 12, to February 9, 2016

Honolulu, HI to Honolulu, HI

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Introduction

The objectives for this cruise **(Leg 2 of RB16-01**) were to acquire multibeam echo sounder data and high resolution subbottom profile data in the Kingman Reef and Palmyra Atoll region of the U.S. Pacific Islands. These data will support ocean mapping research and the U.S. Extended Continental Shelf Program. The cruise was funded by the National Oceanic and Atmospheric Administration (NOAA) and led by NOAA/University of New Hampshire Joint Hydrographic Center Chief and Co-Chief Scientists. The cruise began on January 12, 2016 from Pearl Harbor, Hawaii, and ended on February 9, 2016, also at Pearl Harbor, Hawaii (See Table 1).

A 4-day system testing and calibration cruise, Leg 1 of RB16-01 (Gardner and Armstrong, 2016, appended), preceded the operational cruise. Leg 1 completed testing and calibration of the Kongsberg EM122 multibeam system, integrated the Knudsen subbottom profiler and Sippican Mk 21 XBT/XSV system with the Kongsberg SIS, and completed and successfully tested a rebuild of the Applanix POS/MV system. Leg 1 also demonstrated that the hull-mounted Reson sound-speed profiler and the ship's seawater system-mounted Seabird thermosalinograph systems are working and providing accurate and consistent computations of transducer-depth sound speed. A simultaneous CTD, XBT (with World Ocean Atlas salinity values), and XSV cast demonstrated that these three independent means of creating a sound speed profile were also producing consistent results. The cruise report for Leg 1 is attached to this report as Appendix 8.

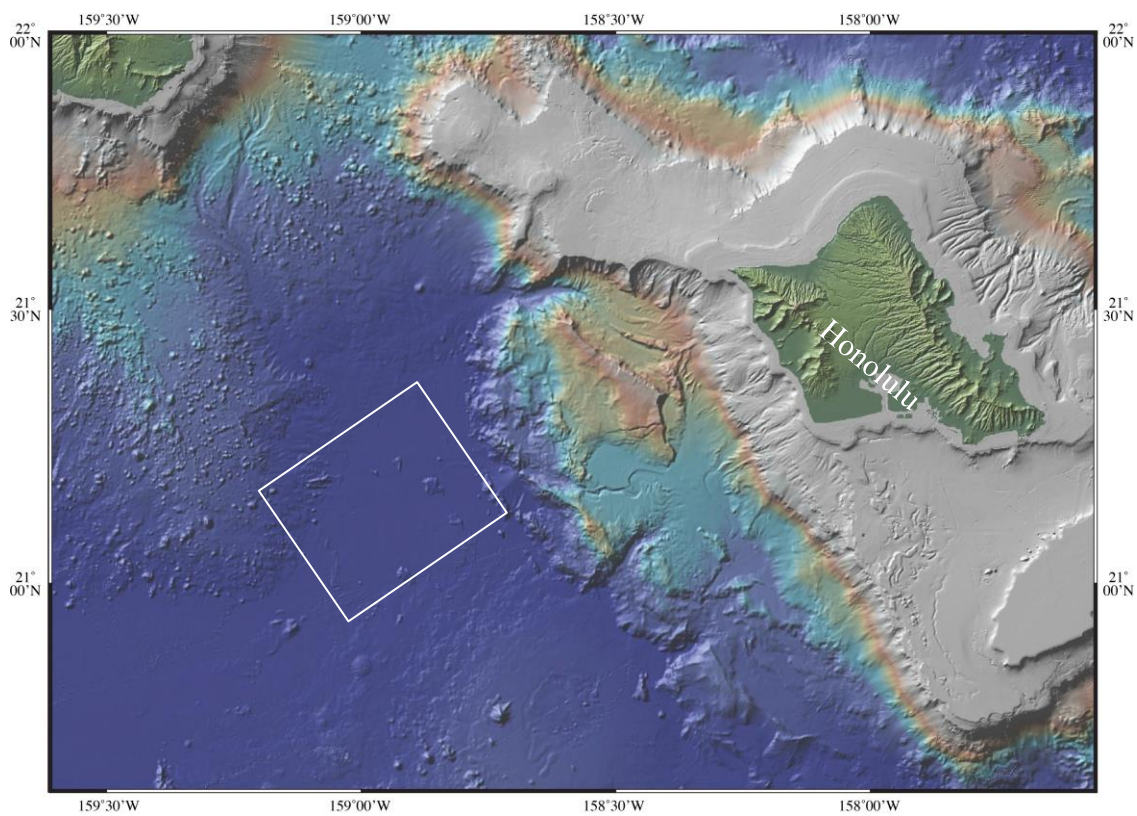


Figure 1. Location of the University of Hawaii deep-water calibration site (white box) where the patch test and MBES calibrations were run.

Table 1. Cruise Statistics

Dates	January 12 to February 9, 2016
Julian days	JD 012 to JD 040
Total days	29 days
Ports	Pearl Harbor, HI to Pearl Harbor, HI
Total mapping line km	10,106 km
Total area mapped in target area	166,756 km^2

Figure 2. NOAA Ship *Ronald H. Brown*

The Multibeam Echosounder System

Kongberg Maritime EM122

The NOAA Ship *Ronald H. Brown* (Fig. 2) has a gondola-mounted (Fig. 3) Kongsberg Maritime EM122 multibeam echo sounder (MBES) system. The systems, offsets, and operating modes for Leg 1 and Leg 2 were the same, and are fully described in Appendix 8.

Positioning System

Applanix POS MV

An Applanix POS/MV V5 s/n 7277 with integral Marinestar subscription satellite differential corrections, dual RF-shielded antennas on the mast, and an IMU 7 model inertial motion unit (IMU) s/n 3221 provides position fixes with an accuracy of ~0.5 m. The IMU is installed on a precisely surveyed-in granite block near the center of gravity of the ship and provides roll, pitch and yaw at accuracies of better than 0.1˚ at 1 Hz. All horizontal positions were georeferenced to the WGS84 ellipsoid and vertical referencing was to instantaneous sea level.

Sound Speed Systems

Sippican XBT/XSV System

Sound-speed profiles of the water column were calculated from measurements of temperature versus depth using Sippican Deep Blue expendable bathythermographs (XBT). The data were processed with a Sippican MK21 unit (S/N 0126). The calculations were made using Sound Speed Manager v. 0.1.4 software developed by UNH and distributed by the National Science Foundation Multibeam Advisory Committee, with a patch written by Glen Rice, and fed directly into the MBES SIS system.

The derived sound-speed profiles from XBT casts taken throughout the cruise (see Appendix 2) were used to raytrace each MBES beam to the seafloor and back to the receiver to compensate for the refraction effects within the water column. An inter-comparison of the shipboard CTD system, Sippican expendable sound velocimeter (XSV) and Sippican XBT corrected for salinity with World Ocean Atlas 2009 data via Sound Speed Manager software that was completed on the Leg 1 System Test Cruise demonstrated the validity of XBT-derived sound speed profiles from this system for sound speed and refraction corrections.

Reson SVP

Sound speed at the transducer for beam forming and steering was provided by a calibrated Reson model 70 Sound Velocity Profiler installed on the transducer gondola. Reson SVP calibrations sheets are included in the Leg 1 Cruise Report, which is included as Appendix 8 of this Leg 2 Report.

MBES Data Processing

Each Kongsberg .all file and .wcd file collected by the EM122 was made available on the NOAA Ship *Ronald H. Brown's* internal network using a network share from the ship's primary server. Files were copied from the server to local storage for archive and processing at the completion of each line. All raw MBES files were initially labeled with a unique Kongsberg file designator but the files were renamed to KingmanPalmyra_line_X, where X is a consecutive line number starting with 400 (see Appendix 1). The renaming of MBES and Knudsen lines was done to be consistent with the other Kingman-Palmyra cruise line-naming convention. The data were processed within one master project. Data processing for the MBES bathymetry data was conducted using CARIS HIPS and SIPS 9.0.20. Visualization products were created with QPS Fledermaus 7.4.5b. Raster GeoTiff images were composed daily for reference in ArcGIS.

The MBES bathymetry data were processed using the CUBE algorithm, implemented in CARIS HIPS and SIPS. A grid resolution of 100 m was used for all depths, ranging from 1,028 m to 6,026 m. IHO S-44 Order 2 was selected in the gridding process for uncertainty calculations. The CUBE calibration parameters used were the standard parameters for the deep setting and are given in Table 1. Quality control of the MBES data was carried out by the MBES processors to insure the depth solutions from the CUBE algorithm were appropriate, manually cleaning the data whenever necessary. The CUBE Parameters used in onboard processing are tabulated in Table 2. Comparisons between the cross-lines collected and the main-scheme lines were computed in CARIS base Editor 4.1.15, in order to assess the consistency of the data; comparisons between the main-scheme lines and the data collected during km10-09 were also conducted to assess stability of depth determination. These assessments confirmed that the survey data remained within acceptable bounds of uncertainty. File exports were created only after grid products were finalized to insure that the surfaces generated from legacy point-cloud files would be identical to surface generated from this project and sent to archive. The files exported were sourced from HIPS data or Side Scan mosaics and written in ASCII format, .xyz or .xyb respectively, for use in future products. Separate SD grids were constructed for each line and day composite in Fledermaus from the exported ASCII data for visualization purposes. The MBES backscatter data were processed using the SIPS Side Scan algorithm in CARIS HIPS and SIPS. A grid resolution of 100m was used for all depths of water encountered. Mosaics of backscatter were exported in Raster GeoTiff format for review and combination with bathymetric data in the ArcGIS visualization environment.

Table 2. Onboard CUBE Processing Parameters

CUBE Parameters		
Disambiguation Method		Density & Local
Configuration		Deep
Surface Creation	*Estimate Offset:*	3
	Capture Distance Scale:	20%
	Capture Distance Minimum:	2.00m
	Horizontal Error Scalar:	2.95
Disambiguation	*Density Strength Limit:*	2.00
	Local Strength Maximum:	2.50
	Locale Search Radius:	1 pixel

Additional data processing, and quality assurance checking, including the creation of final bathymetric grids and backscatter mosaics, occurred at UNH after the cruise.

Subbottom Profiling System

Knudsen CHIRP 3260 subbottom profiler

The ship's installed Knudsen CHIRP 3260 subbottom profiler was operated throughout the cruise. The system is a ~3.5-kHz system with a hull-mounted 4 x 4 transducer array that produces an FM signal with a 3-kHz bandwidth. The system has adjustable pulse lengths, power

and gain settings allowing it to maintain good bottom detection and subbottom resolution to about 50 m of sediment penetration. The digital data were recorded in both KEB and SEG-Y format. A complete subbottom profiler report in included as Appendix 3. The Knudsen system was synchronized with the EM122 MBES so that it did not interfere with the multibeam data and vice versa.

Seabird Observations

A trained seabird and marine mammal observer was provided by the U.S. Fish and Wildlife Service to conduct daylight observations and counts of seabirds and marine mammals sighted during the cruise. The seabird observation reports are included as Appendix 4.

Underway Operations

The Science Party maintained a continuous around-the-clock underway watch in the ship's computer lab where the mapping system topside units, controls, and displays are located. The chief scientist on watch maintained a science log recording significant mapping events and evolutions. The science watch monitored the EM 122 performance and the surface (transducer depth) sound speed through the SIS software, the POS MV status through the POS View software, and the Knudsen CHIRP performance and range/phase settings through the Knudsen Echo Control Client software. All data and records were kept on Coordinated Universal time (UTC). Data files were typically broken into survey lines of six-hour duration at 0000, 0600, 1200, and 1800 UTC times, and at significant course changes or other notable events.

Key Shipboard Science Computing System (SCS) sensor outputs including the SBE 21 and SBE 45 TSG-based sound speed, The SBE 38 seawater temperature, the Reson SVP, and wind speed indicators, as well as the Acoustic Doppler Current Profiler were monitored continuously on displays in the computer lab. SCS data are submitted by the ship to NOAA for archive. ADCP data are provided to the University of Hawaii for additional processing, analysis, and archive; See Appendix 7 for a description of the shipboard science systems.

A planned survey track with lat/lon waypoints was provided at the beginning of the cruise to the ship's operations officer for input into the ship's navigation and ECDIS systems. Changes to these tracks were provided on paper, as they occurred, by the chief scientist to the operations officer or the officer of the deck as new or revised waypoints to enter manually. The survey watch in the computer lab and the ship's navigation watch on the bridge coordinated all course speed changes.

Raw data files from the SIS were recorded onto the hard drive of the SIS computer. After each file break, the Kongsberg .all and .wcd files were copied from the SIS machine to the separate ship's "Survey" server storage. From there, they were copied to the onboard CCOM-provided RAID for processing, backup, and ultimate archive ashore.

Shipboard data processing of both MBES and SBP data was maintained up to date on a daily basis.

The science personnel and key shipboard personnel are listed in Table 3 and Table 4, respectively.

Table 3. Cruise Science Personnel

Andrew A. Armstrong	NOAA Chief Scientist
David Mosher	UNH Co-Chief Scientist
Joyce Miller	UH Senior Scientist
Barry Eakins	NOAA/CIRES Scientist
Will Fessenden	UNH Data Manager
David Armstrong	Science Watch Stander/Data Processor
Kelly Nifong	Science Watch Stander/Data Processor
Lt.(j.g.) John Kidd, NOAA	Science and Bridge Watch Stander/Lead Data Processor
Michael Force	USFWS Bird Observer

Table 4. Ship's Science Operations Personnel

Capt. Robert Kamphaus, NOAA	Commanding Officer
Lt. Cdr. Nicole Manning, NOAA	Executive Officer
Lt. Adrienne Hopper, NOAA	Operations Officer
Jeffrey Hill	Chief Electronics Technician
Josh Gunter	Senior Survey Technician
Mark Badley	Survey Technician

RB 16-01-Leg 2 Daily Science Log (UTC)

JD 011 (Monday, January 11, 2016)

Arrived at the ship at 1300 L and set up computers, networking, etc. Local time in Hawaii is UTC minus 10 hours. Log times are in UTC

JD 012 (Tuesday, January 12, 2016)

First sea day of cruise.

1900 The ship departed the Ford Island pier in Pearl Harbor and swung ship in the harbor for magnetic compass adjustment. Upon completion of the compass adjustment, the ship cleared Pearl Harbor for sea. Began transit to survey area.

2015 Ships Drills

2317 Began logging EM122 multibeam echo sounder (MBES) data

2351 Began logging Knudsen sub-bottom profile (SBP) data. We will be adjusting SBP range, phase, power, pulse duration and gain to maintain record quality.

We will increment line count every 6 hours and at turns, and deploy a Deep Blue XBT every 6 hours; more frequently if surface sound speed differs from profile for more than a short time. The XBT temperature profile will be converted to a sound-speed profile with average historical salinity for the location from the World Ocean Atlas. We will deploy XSV-01 probes from time to time to obtain a direct sound speed profile.

JD 013 (Wednesday, January 13, 2016)

Continuing transit to survey area; Collecting MBES and SBP.

0200 Noticed erratic sound velocity values in both back-up thermo-salinograph values. The ship's science seawater system was losing pressure. Adjustments to seawater system valve solved the problem, but the system appears to be somewhat fragile. The SBE 21 SV is within 0.3 m/s of the Reson SV probe at the transducer; the SBE 45 SV is running about 1 m/s faster than the SV probe.

0702 Reconfigured the Knudsen system and restarted.

0725 Changed course to 208° to follow planned track to survey area. This track should overlap with transit swath from the KM15-20 cruise.

1501 Unable to track seafloor on SBP at 500-m range scale; shifted to 1000-m scale.

1757 Increased Knudsen pulse duration to 64 ms; now able to track seafloor on 500-m range scale.

2217 EM122 data has been showing beam dropouts near outer limit of swath on starboard side (Figure 1). We experimented with auto vs. deep mode and swath limits and fore-aft pointing angle without improvement. We did notice that possible near-nadir artifacts occurred when beams were pointed 0 degrees fore/aft. Returned EM122 to 65/65 auto and 3 degrees forward. Left system in deep mode.

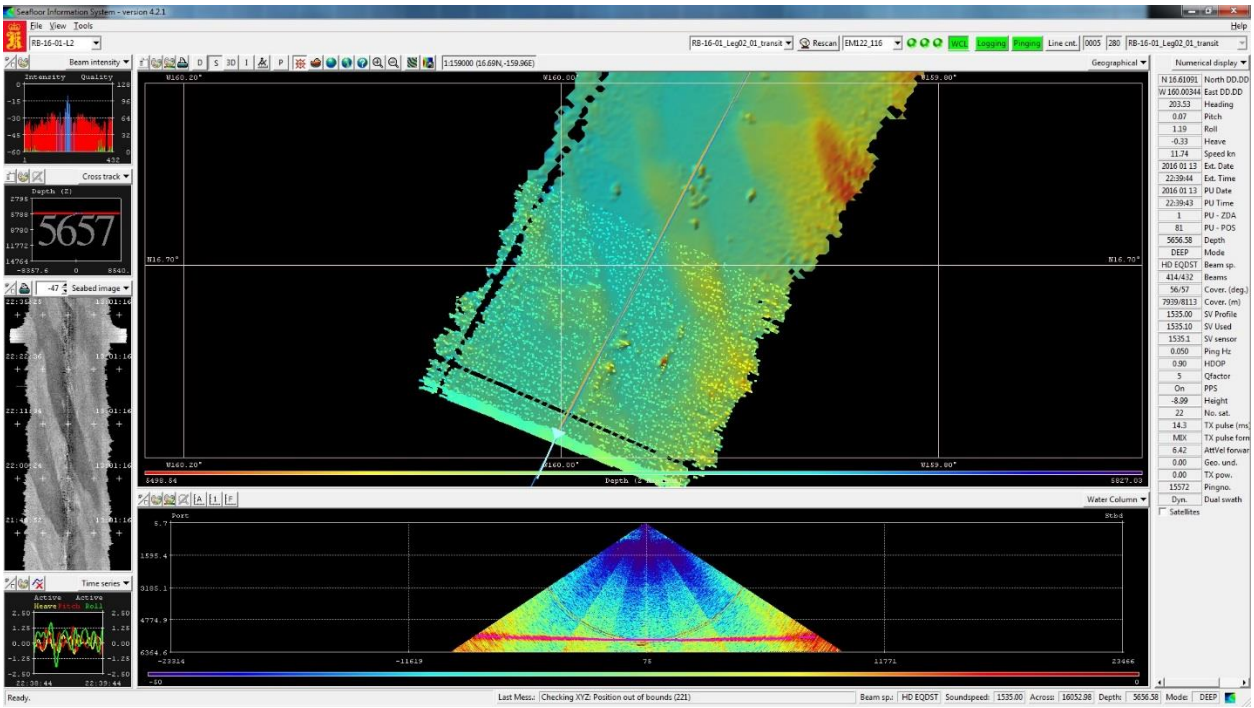


Figure 1. SIS display showing beam dropouts on starboard side. SIS screen capture.

2245 Chief ET reset SBE 45 configuration; SBE 45 and SBE 21 now reading same SV; both are 0.3 m/s higher than transducer SVP.

JD 014 (Thursday, January 14, 2016)

Continuing transit to survey area; Collecting MBES and SBP.

0501 Changed course to 196° to conform to planned trackline.

1040 Altered course to 202° to conform to planned trackline.

2000 Mapping across an abrupt linear seafloor depression trending ENE-WSW with bordering elevated volcanic features. We are crossing the Clipperton Fracture Zone. (Figure 2).

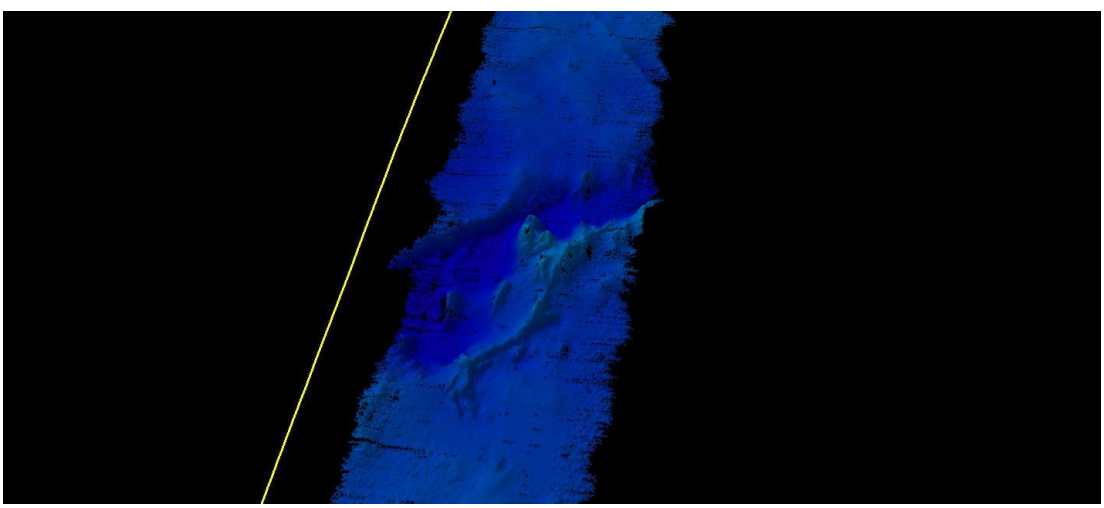


Figure 2. Clipperton Fracture Zone crossing. Qimera image before cleaning.

JD 015 (Friday, January 15, 2016)

Continuing transit to survey area; collecting MBES and SBP.

0229 Slowed ship to 5 kt; deployed Argo Buoy (Figure 2) and resumed speed.

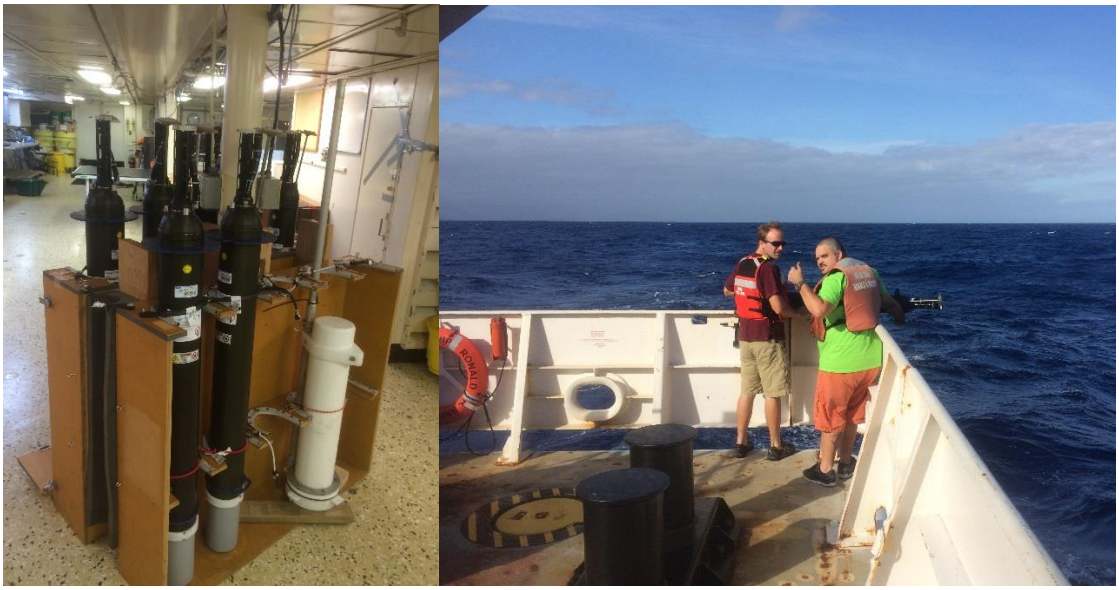


Figure 3. Argo Floats; in RHB main lab, left, and ready for deployment, right. NOAA photos

1000 Passed directly over significant seamount rising from 4710 m depth to 1840 m depth. (Figure 4). This seamount appears in the Smith and Sandwell compilation, but apparently has not been previously mapped with MBES.

1056 Start of Line 12 (first segment of actual line)

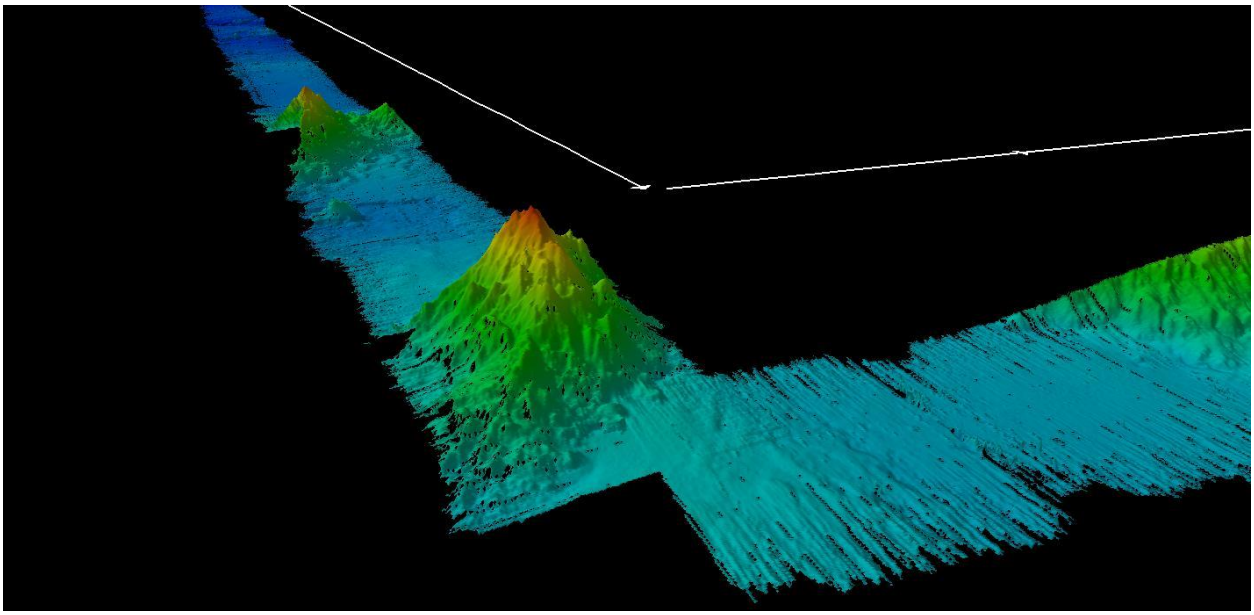


Figure 4. Seamount near start of main survey. Qimera image before cleaning.

1042 Dropped an XBT and an XSV in preparation for starting main survey. Processed both to sound speed profile and noted that the two profiles were practically the same. Applied the XSV cast in SIS.

1053 Stopped logging MBES and SBP as ship turned onto first line; resumed logging new line upon coming onto new course 118° at 1053. Ship switched to one large and one small generator for propulsion and reduced speed to about 8 to 9 knot. We will assess average survey speed after running this line and the next (reciprocal) line.

2100 Experiencing bottom tracking loss in outer third of the swath (Figure 5). Likely due to head seas and soft bottom sediment.

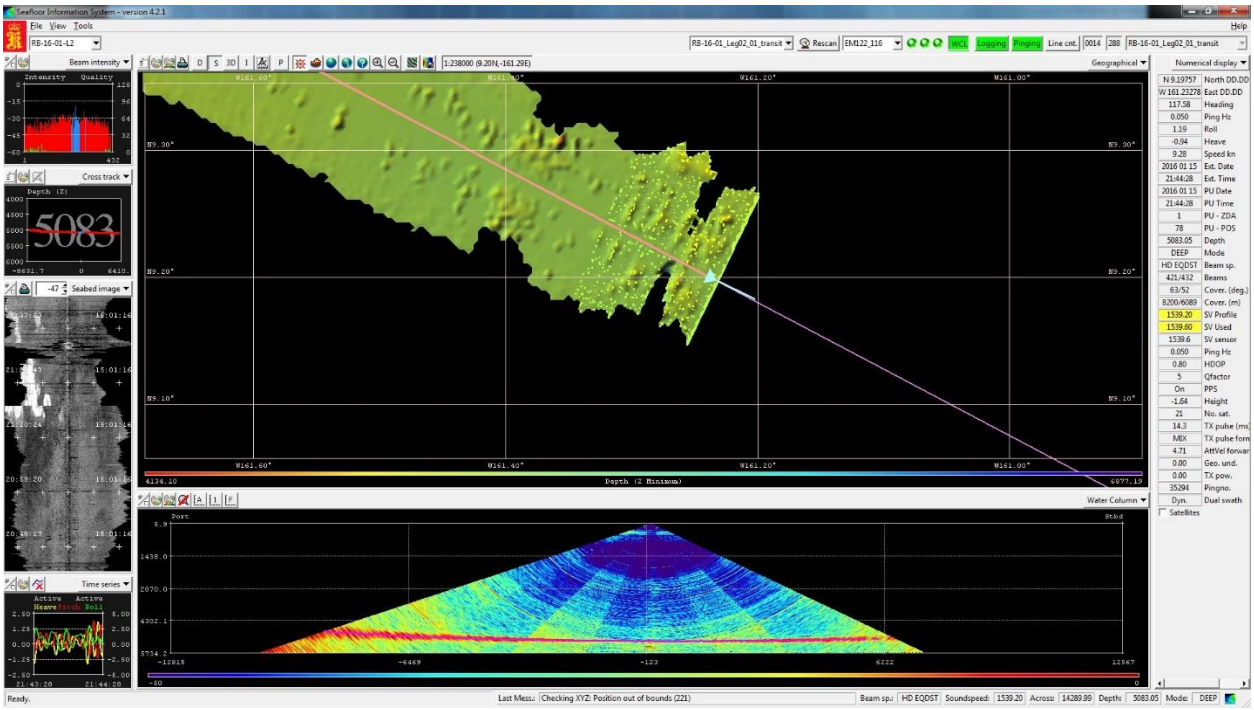


Figure 5. Loss of coverage in head seas. SIS screen capture.

2252 Ship is shifting ballast to trim down by the bow. We have recovered swath width, but are getting lots of apparently spurious soundings along the first MBES sector boundary.

JD 016 (Saturday, January 16, 2016)

Collecting MBES and SBP in the survey area.

0828 Ended Line 16 (first full line of survey includes Lines 12-16).

0833 Start of Line 17_turn (joining segment)

1055 Stopped logging to turn onto line 18; resumed logging at 1056, heading 298°, with following seas.

JD 017 (Sunday, January 17, 2016)

Collecting MBES and SBP in the survey area.

0446 End of Line 21 (second long survey line)

0450 Start line 22 (connector line)

0638 End of Line 22 (connector line)

0643 Start line 23 (third long survey line) sea state fair to moderate

1800 Kongsberg SIS crash …no trigger to subbottom either, as a result. Chirp SBP on internal trigger.

1808 Kongsberg SIS back up… required computer restart; shifted SBP back to external trigger.

1910 Losing bottom track on EM122, likely due to bubbles coming under the hull in 3-m head seas. We had to narrow swath to 50 degrees, reduce speed to 7 kt. and force depth multiple times to regain bottom track. We were able to maintain the bottom track with 60-degree swath angle.

JD 018 (Monday, January 18, 2016)

Collecting MBES and SBP in the survey area.

1021 End of Line 27 (third long survey line)

1023 Start of Line 28 (connector line)

1200 Start of Line 29 (connector line)

1239 End of Line 29 (connector line) for turn

1242 Start of Line 30, heading 298. (fourth long survey line); Increased speed to 10 kt for downwind down seas line.

1630 Crossing smooth-topped elongated seamount with layered sediments showing up well in the SBP record (Figures 6 and 7).

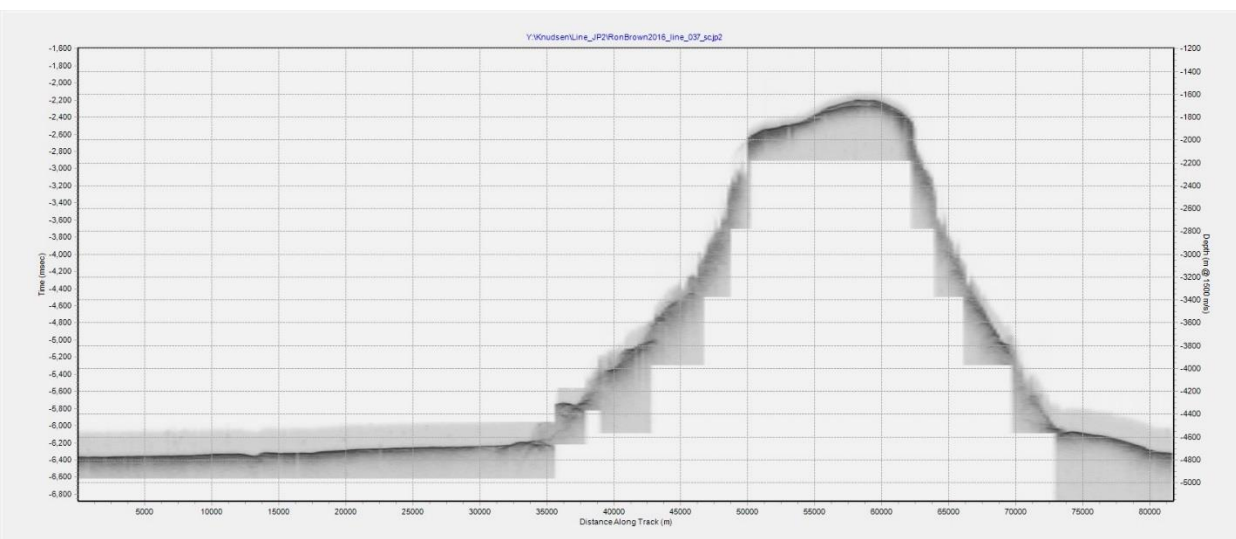


Figure 6. Cross section of smooth-topped seamount, crossing orthogonally to the long axis of the feature. Image from SGYJP2 software.

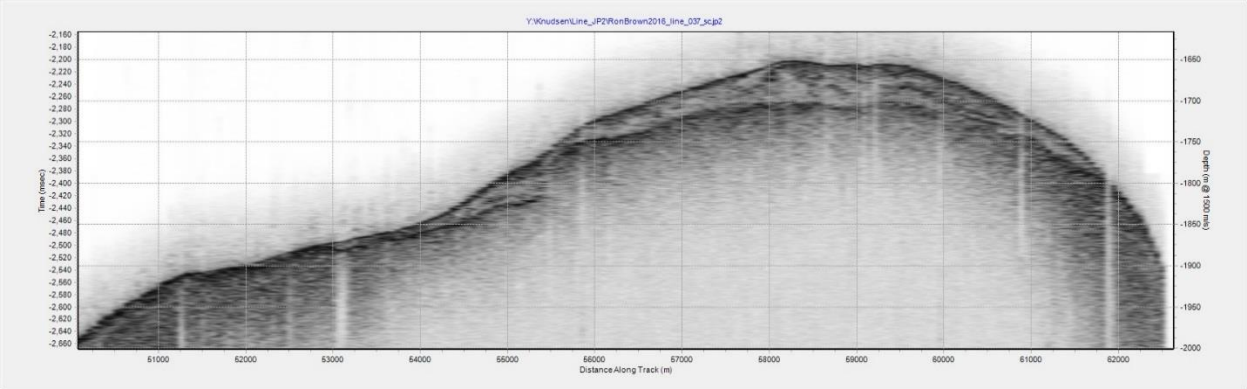


Figure 7. Detail, showing sediment layers on the top of the seamount. Image from SGYJP2 software.

1828 Kongsberg SIS computer crash. Put Chirp SBP on internal trigger.

1830 Remained on course, but reduced speed to minimize survey gap.

1844 Kongsberg SIS back up; required computer restart; shifted SBP back to external trigger. Resumed 10 kt, speed.

JD 019 (Tuesday, January 19, 2016)

Collecting MBES and SBP in the survey area, running northwestward with the seas on the starboard quarter.

0952 Turned south onto connector line 34.

1131 Turned to course 117° onto long survey line into wind and seas. The seas have diminished enough to maintain survey speed of 9.5 kt.

1227 For some unexplained reason, SIS stopped logging MBES data although the system continued pinging.

1305 The watch noticed the lack of logging and restarted logging; about 30 minutes of data over a flat section of the seafloor was lost. The SBP line was incremented in order to keep MBES and SBP lines concurrent.

JD 020 (Wednesday, January 20, 2016)

Collecting MBES and SBP in the survey area, running southeastward at 10 kt. with the 6-8 ft. seas on the port bow.

1052 End line 40 for turn at way point 14.

1054 Start line 41. This is the beginning of a zig-zag track requested by the Government of Kiribati along seafloor features that cross through their Exclusive Economic Zone (EEZ). We are incrementing the line count for the MBES and the SBP at each waypoint, and logging data through the turns.

1101 Launched XSV #54 to have definitive sound speed profile at the start of this set of lines.

1148 Reduced speed to 8 kt. because of noise in MBES, likely bubbles from heading into seas.

1154 Crossing into Kiribati EEZ.

1400 Increased speed to 10 kt.

JD 021 (Thursday, January 21, 2016)

Collecting MBES and SBP in the Kiribati EEZ survey area, running eastward in zig-zag lines at 8 - 9 kt. with 8-ft. seas on the port bow.

0324 Start line 47 with a 90+ degree turn to north.

0457 Turned east onto line 48.

0624 Turned SE to start line 49

JD 022 (Friday, January 22, 2016)

Collecting MBES and SBP in the Kiribati EEZ survey area, running westward in zig-zag lines at 12 kt. with 8-ft. seas on the quarter.

0524 Came on new line (57) heading north to resume our regular track.

0528 Crossed out of Kiribati EEZ into US EEZ, completing mapping requested by the Government of Kiribati.

0712 Reduced speed to maintain data quality

0823 End Line 057. Started turn onto line 058

0827 Steady on line 058, heading WNW

0829 Increased speed to 10 kt.

0840 Increased speed to 12 kt.

1300 Crossed interesting rounded-off 'guyot' with nice sediment section (Figures)

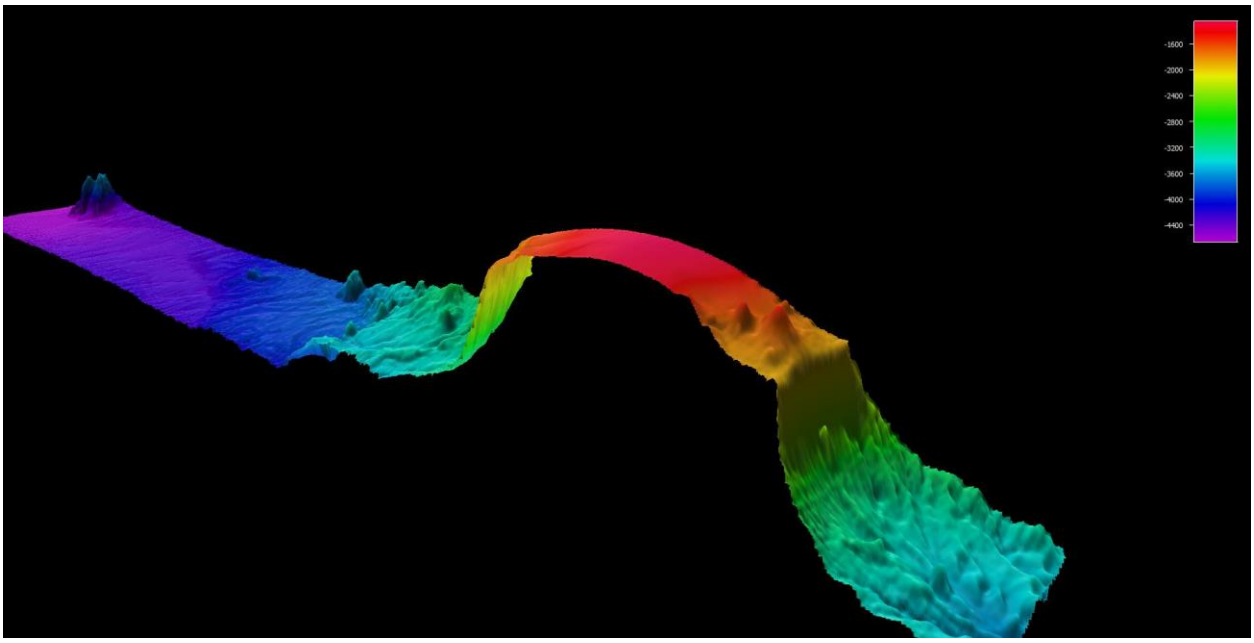


Figure 8. Rounded-off [guyot?] crossing. Fledermaus image

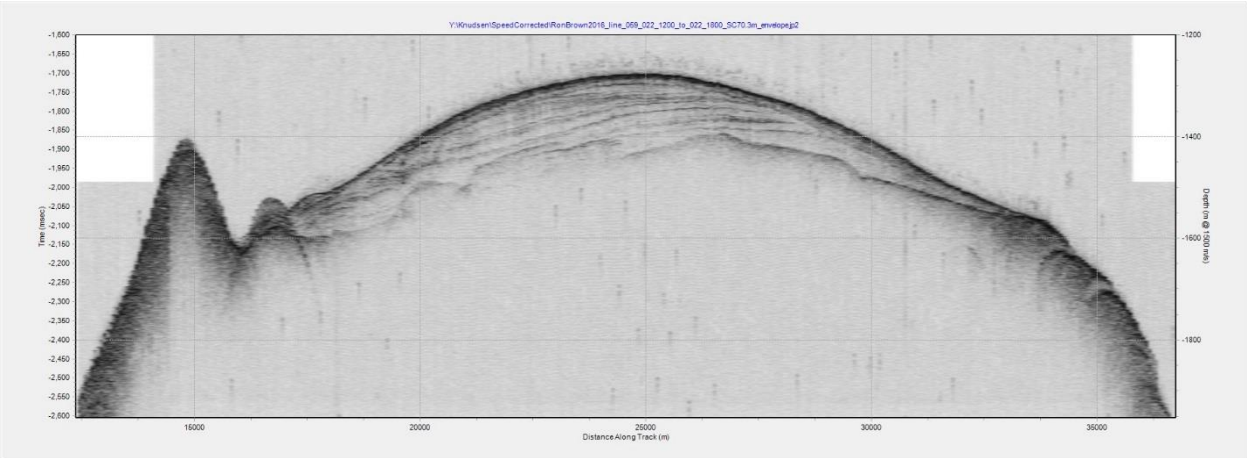


Figure 9. Detail from SBP record showing sediment section capping rounded [guyot?]. SGYJP2 image.

JD 023 (Saturday, January 23, 2016)

0210 End of line 061

0212 Start line 062 (connector line) on southerly heading.

0310 End connector line 062

0313 Start of line 063 on ESE heading. Reducing speed as necessary to maintain data quality in head seas.

0409 The SIS planning module has become unresponsive. We stopped logging to end line 63 and restart SIS. We are over a featureless seafloor, and at approximately 8.5 kt, we will not miss any seafloor feature by maintaining course and speed.

0412 Restarted SIS and resumed pinging and logging with line 64. Left planning module off.

0600 Inadvertently incremented the line count in SIS twice resulting in skipping line 65 and beginning line 66. Incremented the SBP lines to stay in synch with the MBES.

1610 Reduced speed to maintain data quality in head seas.

1930 Turned to heading 145° and began line 68.

2130 Turned to heading 125° and began line 69.

JD 024 (Sunday, January 24, 2016)

Collecting MBES and SBP in the survey area, running southeastward at 9 kt. with 20 kt. winds and 8 ft. seas on the port bow.

0048 Stopped logging and began turn to heading 198°

0057 Began connector line 070, increasing speed as possible while maintaining data quality.

0135 Turned to WNW and began line 71 at 11 kt.

1148 Turned SW and began connector line73.

1243 Turned SE and began line 74, slowing to about 9 kt. as a result of head seas.

2100 Crossing over another rounded-off seamount with complex sediment cap (Figure)

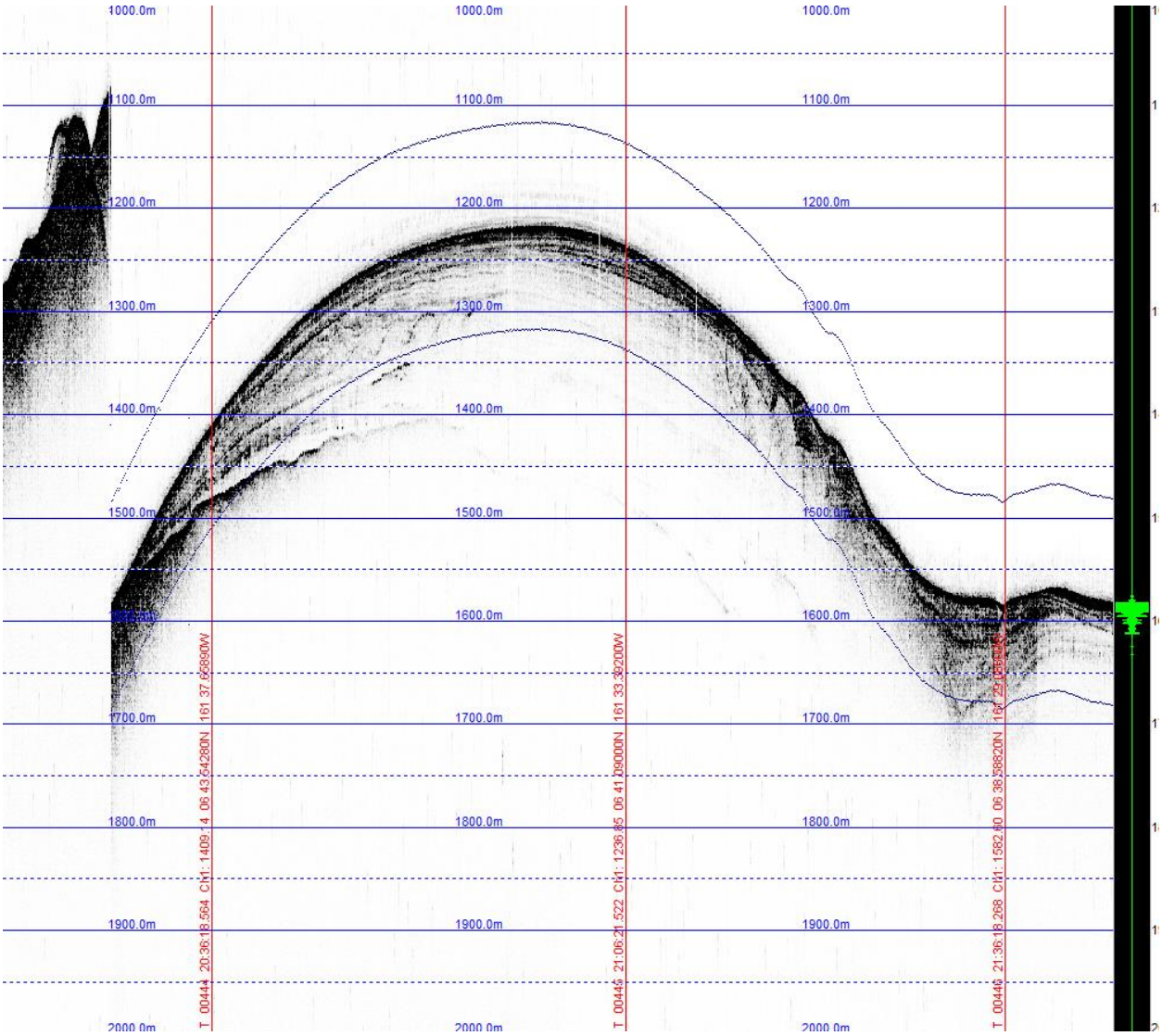


Figure 10. Sediment cap on smoothly rounded seamount. Knudsen screen capture.

JD 025 (Monday, January 25, 2016)

Collecting MBES and SBP in the survey area, running southeastward at 9 kt. with 20 kt. winds and 6-8 ft. seas on the port bow.

0010 Discovered that although SBP was chirping, the recording software had crashed, and the record was lost for about the past hour. We missed obtaining a profile along the top of another smooth-topped seamount. We had to restart the Knudsen Sounder Suite Echo Control software to resume recording. The MBES record continued uninterrupted throughout this time, and we reset the SBP line number and incremented SIS to maintain common file/line numbers in the two systems.

0030 Turned SW and started connector line 76.

0115 Turned NW and began line 77.

1156 Turned SSW and began line 79.

1249 Turned to 119° and began line 80.

2100 We have lost the SBP trace; stopped ping and recording and restarted the echo control client a couple times; re-tuned, and finally regained bottom track.

2341 Turned to 220°; speed over ground increasing with wind and seas on the quarter.

JD 026 (Tuesday, January 26, 2016)

Collecting MBES and SBP in the survey area, running southwestward at 12kt. with 20 kt. winds and 6-8 ft. seas on the quarter.

0020 Turned to 300° and began line 83.

0927 Turned to 205° and began line 85.

1006 Turned to 122° and began 86, the beginning of our final swath in the northern part of the survey area.

1912 Alterrd course to 149° and started line89.

2031 Altered course to 125° and began line 90.

2324 Turned south to 212° and began line 91, heading along the U.S.-Kiribati EEZ line toward the southern part of the survey area.

JD 027 (Wednesday, January 27, 2016)

Collecting MBES and SBP in the survey area, running south at 12kt. with 20 kt. winds and 6-8 ft. seas on the stern. Today is the halfway point in the cruise.

0436 Crossed into the Kiribati EEZ and began the southern Kiribati track line requested by the Government of Kiribati. Began line 92.

1126 Altered course to 156° to follow the survey track.

1613 Altered course to 235° to follow the survey track.

1714 Altered course to 252 to follow the survey track.

1747 Slowed to 5 kt. and deployed ARGO Buoy by dropping off the stern; the resumed speed.

1748 Turned to 343° for last line in the Kiribati survey.

2200 (Approximately) Crossed out of Kiribati EEZ and into U.S. EEZ.

2204 Turned northward on first leg of the southern set of NE—SW lines in the southern part of the survey area. We are heading almost directly into the seas and our speed over the ground has dropped to 8 kt.

JD 028 (Thursday, January 28, 2016)

Collecting MBES and SBP in the survey area, running northeast at 8 kt. with 20-25 kt. winds and 6-8 ft. seas on the bow.

0005 Having engineering problems with the thrusters, losing headway altogether for a period. Varying speed as the ship is resolving the problem.

0051 Resumed normal operating speed, but only making about 8 kt. or less into the seas.

Data quality on the northward line has been poor much of the time despite the reduced speed. The seafloor has been featureless, however, and the SBP data quality remains good with excellent seafloor penetration revealing layered sediments.

0741 Turned westward to begin connector line 99, and began increasing speed to 11 kt.

1001 Turned onto southerly line 100.

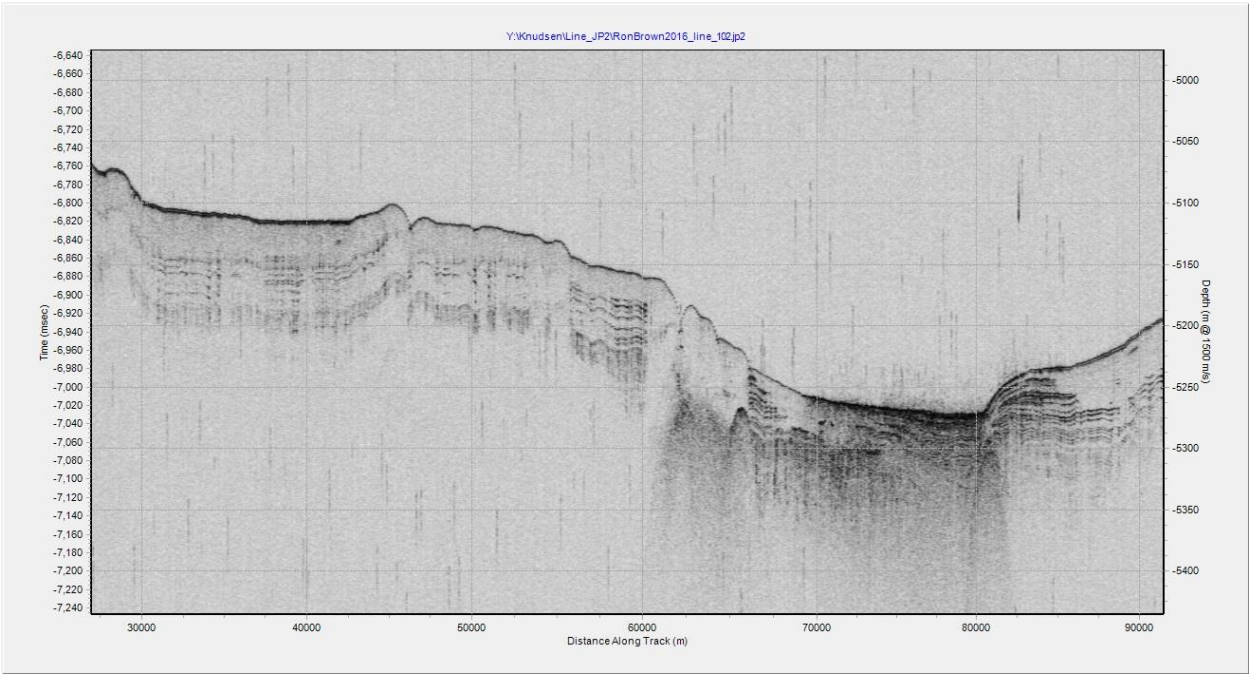


Figure 11. SBP profile at southern end of survey area. SGYJP2 image.

2304 Reached the end of the first long southerly line in the southern part of the survey area. The line traveled down a sloping seafloor with layered sediments showing well in the SBP, changing slope onto a nearly flat seafloor before rising again at line end. (Figure 11). The ship being outside of the EEZ, began pumping water overboard and transferring liquid load within the ship. Upon completion our trim will be down by the bow, which should improve MBES performance.

2307 Turned to west to begin connector line 103.

2339 Turned north and began line 104 into the seas. Data quality is much improved over last night's northerly line, likely due to a combination of trim and somewhat reduced head wind and sea.

JD 029 (Friday, January 29, 2016)

Collecting MBES and SBP in the survey area, running north at 9.6 kt. with 15-20 kt. winds and 6 ft. seas on the bow.

1407 Turned west at end of northerly line. During processing of line 106, where the track crossed a volcanic cone, we discovered that the EM122 was flagging nadir soundings on the top of such cones. As a result, the depth data did not appear for evaluation by the processor in Caris HIPS when filters were set in our standard configuration (Caris could be reconfigured to display these

soundings). In parallel processing by Qimera, the EM122-flagged data are visible in the more readily available "display filter off" view (Figure 12 upper) and were un-flagged and retained (Figure 12 lower).

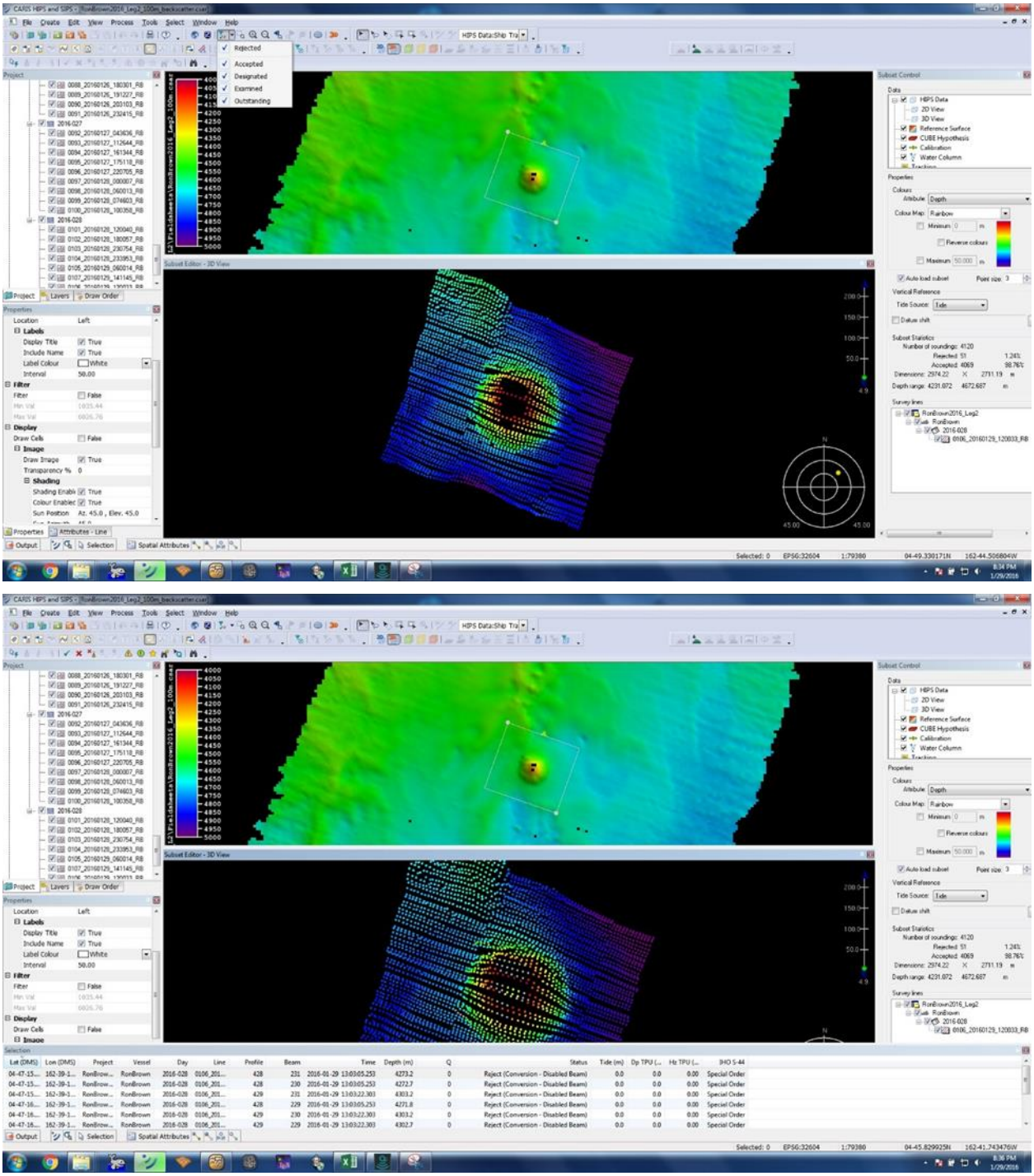


Figure 12. View of volcanic cone in at nadir; top with EM122 flagged data removed; bottom, flagged data visible. Qimera screen captures

1411 Began line 107, increasing speed to 12 kt.

1531 Turned and began long southerly line 109; making about 12 kt. throughout the line with following seas.

JD 030 (Saturday, January 30, 2016)

Collecting MBES and SBP in the survey area, running south at 12 kt. with 15 kt. winds from astern, diminishing seas and occasional rain squalls. Crossed what appears to be a segment of a fracture zone that also has characteristics of a seafloor channel (Figure 13).

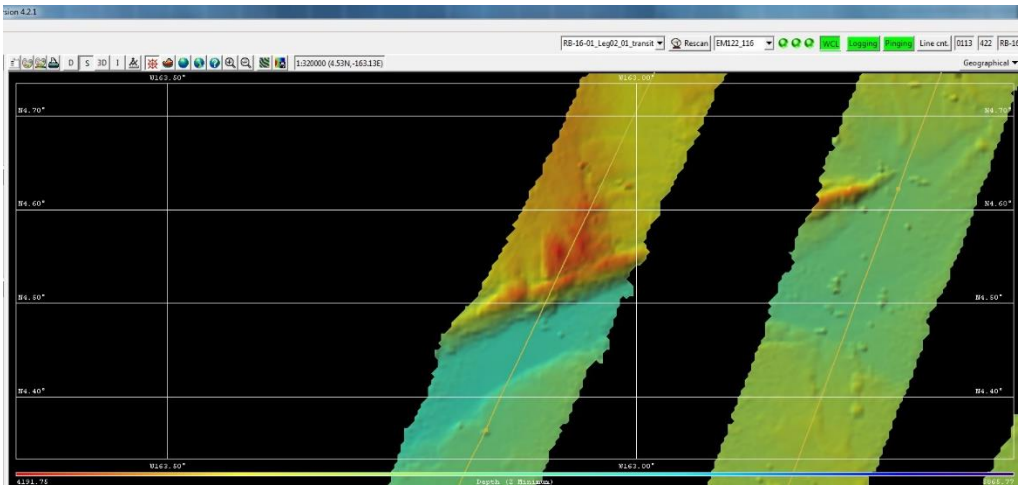


Figure 13. Swaths across eastern end of apparent fracture zone. SIS screen capture.

0202 Turned westward and began connector line 112 at 0207, maintaining 12 kt. speed.

0446 Turned onto to northerly line 113, shifting from two big to one big, one small generator, and reducing speed to about 9.3 kt. into the wind and seas. Data quality remains good in lower sea state.

0824 Weather freshening and sea state worsening. Data were getting noisy. Slowed the ship by 20 RPM's taking us down to about 8.7 – 9.0 knots.

1050 Slowed further to about 8 kt. in slightly worsening sea state (Figure 14).

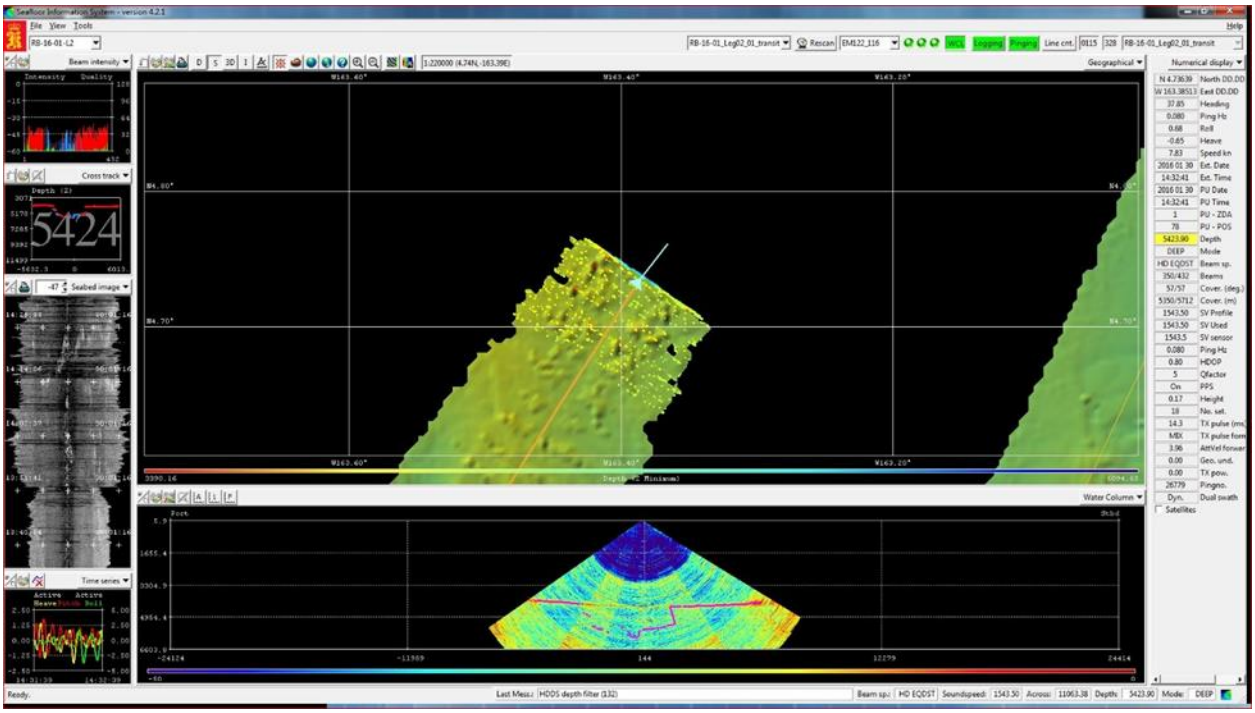


Figure 14. Loss of bottom track at nadir and reduction of data quality in head seas. SIS screen capture.

1907 Turned and began westward connector line 116.

2003 Turned to 205° to begin intermediate southerly line 117 with seas on the stern. Increased speed to about 10 kt.

JD 031 (Sunday, January 31, 2016)

Collecting MBES and SBP in the survey area, running south at 10 kt. with 15 - 20 kt. winds and 7 – 9 ft. seas from astern.

0344 Turned to the west for short connector line 119.

0416 Turned to the NW again for intermediate line 120.

0519 Reduced speed to about 9 kt. to maintain data quality in head seas.

1225 Turned west on connector line 122.

1318 Turned south to begin long line 123; increased speed to11.8 kt

2210 Ended long southerly line and turned west on connector line 125.

2350 Turned north to begin long line into winds and seas.

JD 032 (Monday, February 1, 2016)

Collecting MBES and SBP in the survey area, running north at 10.5 kt. into wind and seas. The Knudsen SBP is just barely maintaining bottom track, with a very weak trace despite high power levels and high gain settings. It is unclear as to whether this is just an area of very poor bottom return, or if the system is not operating properly.

0452 Secured the SBP and shut off and restarted the Echo Control Client software; restarted transmitting, slowly bring up the power, gain, and pulse duration.

0756 Reduced speed to 8.5 kt. maintain data quality in worsening sea state.

0907 Reduced speed again as sea state continues to worsen and cause loss of beams and bottom tracking on the MBES. The SBP record is very strong, so we will continue on this track through the rest of line.

1123 Reached end of line into the seas, turned west and began connector line 128 at 1125.

1249 Began long southerly line 129 with the seas behind us, and increased speed to 11 kt.

1930 SBP profile weakening again as we go south and water depth increases. Increasing gain and power.

2357 Turned west at end of southerly line and began connector line 131.

JD 033 (Tuesday, February 2, 2016)

Collecting MBES and SBP in the survey area, with overcast skies, light rain, and 7 – 9 ft. seas from the NE.

0001 Stopped the Knudsen SBP for another reboot and reset.

0017 Restarted Knudsen, without much improvement.

0045 Stopped Knudsen. Experimented with Syquest SBP system to see if it would have similar problems. Unfortunately, the Syquest system had too many other limitations to evaluate.

0100 Turned north and began long line 132, crossing the fracture zone segment.

0114 Reduced speed into head seas as the ship shifted generator configuration for lower speed to windward.

0133 Restarted the Knudsen SBP, without apparent improvement.

Although the MBES data quality had been diminished by heading into the seas, it deteriorated significantly and suddenly at approximately 0200. Some investigation indicated that needle-gunning had begun in the bow-thruster room, forward on the lowest deck. Coverage and bottom tracking was regained when the needle-gunning was ceased at approximately 0215. The results are visible in Figure 15.

1427 Turned west and began connector line 136.

1621 Turned south and began line 137.

JD 034 (Wednesday, February 3, 2016)

Collecting MBES and SBP in the survey area, making 12 kt. on course 205° with 7 – 9 ft. seas from the NE.

0313 Turned to the west to begin a bathymetric development of a region of complex seafloor and significant change in seafloor gradient. Discovered that the SBP had inexplicably stopped logging data at 0053, although the display continued to advance.

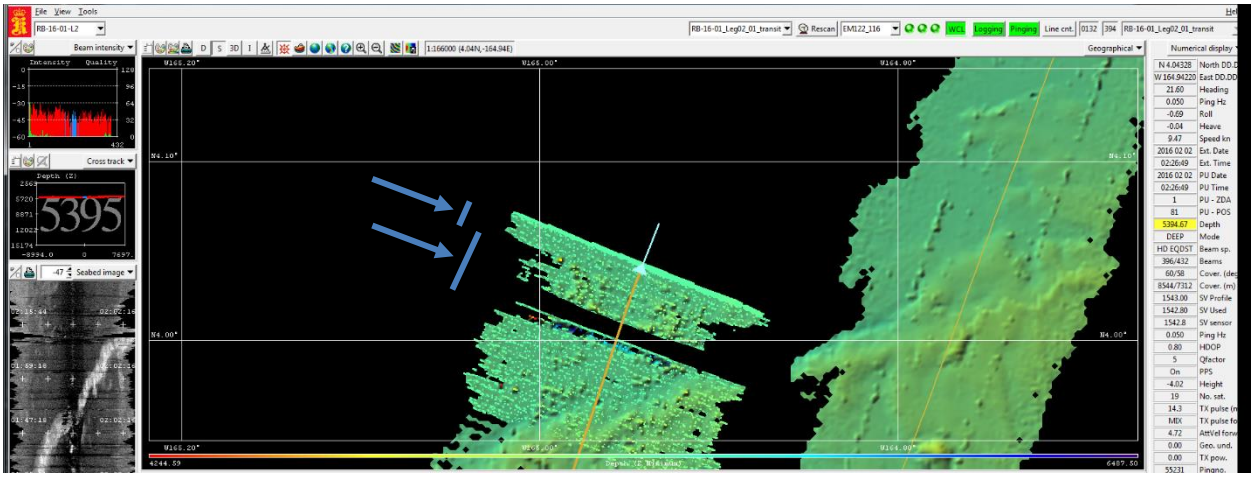


Figure 15. Impact of lower deck needle gunning on EM122. Image shows loss of data during needle-gunning and recovery afterwards. Needle-gunning in lower marked segment, recovery in upper segment. SIS screen capture.

0315 Began connector line 140 and resumed logging on both the MBES and the SBP.

0355 Turned north and began interline 141 into the seas, reducing speed to about 9 kt.

0812 Turned east onto line 142 to cross our southbound primary track and connect to our next interline.

0954 Turned south onto interline 143.

1259 Completed the interline development, turned to the west, and started short connector line 144.

1303 The SIS bogged down, so stopped pinging and restarted the SIS software.

1310 Resumed pinging and logging with line 146.

1351 Turned back south onto our primary track and began line 147.

1806 Reached southern end of the survey line, turned west and began connector line148.

1950 Reached the southwestern-most point of our survey and turned north.

1954 Began logging on line 149. The line is being diverted to the east of our planned track to clear long line fishing gear on the track. The gear is marked with surface AIS beacons.

2010 (approximately) altered course 20° to port to regain planned track line.

2025 The MBES is losing bottom track frequently on this course directly into the, but the SBP is doing well.

2203 – 2259 Taking advantage of the strong seabed and sub-bottom return on the SBP, we experimented with large changes of gain (95 dB to 7 dB) on the Knudsen Echo Control Client

software interface. We could discern no difference in the trace or the data. We are not convinced that the gain circuitry on the system is performing as it should.

2318 Came left 5° to close the planned track more quickly and avoid overlapping with the prior swath.

JD 035 (Thursday, February 4, 2016)

Collecting MBES and SBP in the survey area, making 8.5 kt. on course 020° with 8 – 10 ft. seas from the NE.

0010 Intercepted planned track and altered course to 030°.

0100 Slowed to 6 kt. to maintain data quality on MBES. SBP data is poor also. We secured the SBP to open the Knudsen and see if any boards might need reseating. Upon examination, everything appeared to be firmly in place and we closed the box back up and restarted the system at 0130.

0308 Seas have diminished somewhat; increased speed to 8.5 kt.

0442 Increased speed again to 9 kt.

JD 036 (Friday, February 5, 2016)

Collecting MBES and SBP in the survey area, making 9 kt. on course 020° with 7 – 9 ft. seas from the NE.

0558 Turned to the east on the start of a mapping loop along the northern flank of a ridge feature.

0646 Increased speed to 11 kt. to take advantage of the favorable heading.

1113 Reached the southeastern end of the feature mapping loop, and turned back toward the north and west to map the southern flank of the feature.

1543 We have completed the mapping loop. Turned north to connect with a planned northwest heading track leg toward another mapping objective.

1557 Turned to the northeast, directly into the seas, and began line 158. Multibeam data are almost useless; we are over flat and mostly previously mapped area, so these data will be processed and inspected for unmapped features, but will not become part of the final data set for the region.

JD 037 (Saturday, February 6, 2016)

Collecting MBES and SBP in the survey area, heading on course 078°, directly into 12 – 14 ft seas and 25+ kt. winds. We are making best time possible at approximately 9 kt. without regard for data quality, as no significant mapping objectives lie on most of this line.

0200 Seas have diminished somewhat and data quality are improved. We are beginning to map a seamount over which only a small amount of bathymetry has been obtained previously.

0240 Reduced speed to 8 kt, turned to 116°, and began line 161 to map a section between seamounts. Data quality are very good on this heading at this speed.

0808 Completed line 161 and turned to 014° on a track directly to the Pearl Harbor sea buoy. Data quality are good for now; this track falls between previously mapped lines N – S swaths,

and will serve as a cross swath for data consistency comparison with both this project and KM 15-20.

JD 038 (Sunday, February 7, 2016)

At 0000, we began line 165, collecting MBES and SBP along the return track to Pearl Harbor, just leaving the main part of the survey area, heading on course 014°, directly into 7 – 9 ft. seas and 20 kt. winds. We are making best time possible for the return transit at approximately 10 kt. and data quality remain good. These data will be included in the return transit portion of the RB-16-01 mapping project.

0209 By prior agreement with the Chief Scientist, the engineering department began needle-gunning in machinery spaces. Data quality for both the MBES and SBP (Figure), and coverage for the MBES was significantly degraded, although the data remained usable.

0317 Needle-gunning complete. Mapping along the return track continues.

JD 039 (Monday, February 8, 2016)

Collecting MBES and SBP on line 170 along the return track to Pearl Harbor, outside of survey area, heading on course 014°, into 7 – 9 ft. seas and 20 kt. winds. We are making best time possible for the return transit at approximately 10 kt. and data quality remain good. We continue to deploy XBTs and apply sound speed profile corrections as needed, and increment line numbers every 6 hours. These data will be included in the return transit portion of the RB-16-01 mapping project.

1935 The ship altered course to 035° to improve the ride and move toward the lee of the island of Hawaii. Data quality also improved significantly on this heading.

JD 040 (Monday, February 9, 2016)

Returned to Pearl Harbor

Appendix 1. Conversion table of Kongsberg SIS-assigned .all file names to UNH file names by Julian Day

JD	Data Folder	Kongsberg file name RB.all	UNH file name .all	Notes
12	**160112**	**0001_20160112_231746**	**KingmanPalmyra_line_400tran**	**Start transit from HI**
13	**160113**	**0002_20160113_000057**	**KingmanPalmyra_line_401tran**	
		0003_20160113_055911	KingmanPalmyra_line_402tran	
		0004_20160113_120014	KingmanPalmyra_line_403tran	
		0005_20160113_191858	KingmanPalmyra_line_404tran	
14	**160114**	**0006_20160114_000018**	**KingmanPalmyra_line_405tran**	
		0007_20160114_060009	KingmanPalmyra_line_406tran	
		0008_20160114_120002	KingmanPalmyra_line_407tran	
		0009_20160114_180020	KingmanPalmyra_line_408tran	
15	**160115**	**0010_20160115_000017**	**KingmanPalmyra_line_409tran**	
		0011_20160115_060028	KingmanPalmyra_line_410tran	
		0012_20160115_105642	KingmanPalmyra_line_411	Start survey
		0013_20160115_120142	KingmanPalmyra_line_412	
		0014_20160115_183224	KingmanPalmyra_line_413	
16	**160116**	0015_20160116_000007	**KingmanPalmyra_line_414**	
		0016_20160116_060009	KingmanPalmyra_line_415	
		0017_20160116_083325	KingmanPalmyra_line_416	
		0018_20160116_105646	KingmanPalmyra_line_417	
		0019_20160116_121757	KingmanPalmyra_line_418	
		0020_20160116_180022	KingmanPalmyra_line_419	
17	**160117**	**0021_20160117_000019**	**KingmanPalmyra_line_420**	
		0022_20160117_045025	KingmanPalmyra_line_421	
		0023_20160117_064324	KingmanPalmyra_line_422	
		0024_20160117_120621	KingmanPalmyra_line_423	
		0025_20160117_180804	KingmanPalmyra_line_424	
18	**160118**	**0026_20160118_000010**	**KingmanPalmyra_line_425**	
		0027_20160118_060029	KingmanPalmyra_line_426	
		0028_20160118_102359	KingmanPalmyra_line_427	
		0029_20160118_120114	KingmanPalmyra_line_428	
		0030_20160118_124301	KingmanPalmyra_line_429	
		0031_20160118_180115	KingmanPalmyra_line_430	
		0031_20160118_184248	KingmanPalmyra_line_431	
19	**160119**	**0032_20160119_000009**	**KingmanPalmyra_line_432**	
		0033_20160119_060133	KingmanPalmyra_line_433	
		0034_20160119_095518	KingmanPalmyra_line_434	
		0035_20160119_113157	KingmanPalmyra_line_435	
		0036_20160119_120016	KingmanPalmyra_line_436	
		0037_20160119_130541	KingmanPalmyra_line_437	
		0038_20160119_180022	KingmanPalmyra_line_438	

Appendix 1 (cont.)

JD	Data Folder	Kongsberg file name RB.all	UNH file name .all	Notes
20	**160120**	**0039_20160120_000005**	**KingmanPalmyra_line_439**	
		0040_20160120_060012	KingmanPalmyra_line_440	
		0041_20160120_105400	KingmanPalmyra_line_441	
		0042_20160120_135012	KingmanPalmyra_line_442	
		0043_20160120_162120	KingmanPalmyra_line_443	
		0044_20160120_185441	KingmanPalmyra_line_444	
		0045_20160120_215935	KingmanPalmyra_line_445	
21	**160121**	**0046_20160121_003533**	**KingmanPalmyra_line_446**	
		0047_20160121_032454	KingmanPalmyra_line_447	
		0048_20160121_045726	KingmanPalmyra_line_448	
		0049_20160121_062314	KingmanPalmyra_line_449	
		0050_20160121_083539	KingmanPalmyra_line_450	
		0051_20160121_102449	KingmanPalmyra_line_451	
		0052_20160121_110333	KingmanPalmyra_line_452	
		0053_20160121_144112	KingmanPalmyra_line_453	
		0054_20160121_172158	KingmanPalmyra_line_454	
		0055_20160121_205012	KingmanPalmyra_line_455	
		0056_20160121_234005	KingmanPalmyra_line_456	
22	**160122**	**0057_20160122_052422**	**KingmanPalmyra_line_457**	
		0058_20160122_082734	KingmanPalmyra_line_458	
		0059_20160122_120003	KingmanPalmyra_line_459	
		0060_20160122_180017	KingmanPalmyra_line_460	
23	**160123**	**0061_20160123_000008**	**KingmanPalmyra_line_461**	
		0062_20160123_021256	KingmanPalmyra_line_462	
		0063_20160123_031333	KingmanPalmyra_line_463	
		0064_20160123_041259	KingmanPalmyra_line_464	
		0066_20160123_060015	KingmanPalmyra_line_465	**No line 0065**
		0067_20160123_120215	KingmanPalmyra_line_466	
		0068_20160123_193030	KingmanPalmyra_line_467	
		0069_20160123_212102	KingmanPalmyra_line_468	
24	**160124**	**0070_20160124_005148**	**KingmanPalmyra_line_469**	
		0071_20160124_013456	KingmanPalmyra_line_470	
		0072_20160124_060005	KingmanPalmyra_line_471	
		0073_20160124_114846	KingmanPalmyra_line_472	
		0074_20160124_124313	KingmanPalmyra_line_473	
		0075_20160124_180009	KingmanPalmyra_line_474	
25	**160125**	**0076_20160125_003029**	**KingmanPalmyra_line_475**	
		0077_20160125_011525	KingmanPalmyra_line_476	
		0078_20160125_060028	KingmanPalmyra_line_477	
		0079_20160125_115648	KingmanPalmyra_line_478	
		0080_20160125_124918	KingmanPalmyra_line_479	
		0081_20160125_180022	KingmanPalmyra_line_480	
		0082_20160125_234103	KingmanPalmyra_line_481	

Appendix 1 (cont.)

JD	Data Folder	Kongsberg file name RB.all	UNH file name .all	Notes
26	**160126**	**0083_20160126_002120**	**KingmanPalmyra_line_482**	
		0084_20160126_060005	KingmanPalmyra_line_483	
		0085_20160126_092715	KingmanPalmyra_line_484	
		0086_20160126_100643	KingmanPalmyra_line_485	
		0087_20160126_120013	KingmanPalmyra_line_486	
		0088_20160126_180301	KingmanPalmyra_line_487	
		0089_20160126_191227	KingmanPalmyra_line_488	
		0090_20160126_203103	KingmanPalmyra_line_489	
		0091_20160126_232415	KingmanPalmyra_line_490	
27	**160127**	**0092_20160127_043636**	**KingmanPalmyra_line_491**	
		0093_20160127_112644	KingmanPalmyra_line_492	
		0094_20160127_161344	KingmanPalmyra_line_493	
		0095_20160127_175118	KingmanPalmyra_line_494	
		0096_20160127_220705	KingmanPalmyra_line_495	
28	**160128**	**0097_20160128_000007**	**KingmanPalmyra_line_496**	
		0098_20160128_060013	KingmanPalmyra_line_497	
		0099_20160128_074603	KingmanPalmyra_line_498	
		0100_20160128_100358	KingmanPalmyra_line_499	
		0101_20160128_120040	KingmanPalmyra_line_500	
		0102_20160128_180057	KingmanPalmyra_line_501	
		0103_20160128_230754	KingmanPalmyra_line_502	
		0104_20160128_233953	KingmanPalmyra_line_503	
29	**160129**	**0105_20160129_060014**	**KingmanPalmyra_line_504**	
		0106_20160129_120033	KingmanPalmyra_line_505	
		0107_20160129_141145	KingmanPalmyra_line_506	
		0109_20160129_153052	KingmanPalmyra_line_507	No line 0108
		0110_20160129_193646	KingmanPalmyra_line_508	
30	**160130**	**0111_20160130_000004**	**KingmanPalmyra_line_509**	
		0112_20160130_020721	KingmanPalmyra_line_510	
		0113_20160130_044804	KingmanPalmyra_line_511	
		0114_20160130_060024	KingmanPalmyra_line_512	
		0115_20160130_120023	KingmanPalmyra_line_513	
		0116_20160130_190729	KingmanPalmyra_line_514	
		0117_20160130_200340	KingmanPalmyra_line_515	
31	**160131**	**0118_20160131_000000**	**KingmanPalmyra_line_516**	
		0119_20160131_034423	KingmanPalmyra_line_517	
		0120_20160131_041631	KingmanPalmyra_line_518	
		0121_20160131_060001	KingmanPalmyra_line_519	
		0122_20160131_122756	KingmanPalmyra_line_520	
		0123_20160131_131803	KingmanPalmyra_line_521	
		0124_20160131_180009	KingmanPalmyra_line_522	
		0125_20160131_221047	KingmanPalmyra_line_523	
		0126_20160131_235019	KingmanPalmyra_line_524	

Appendix 1 (cont.)

JD	Data Folder	Kongsberg file name RB.all	UNH file name .all	Notes
32	**160201**	**0127_20160201_060009**	**KingmanPalmyra_line_525**	
		0128_20160201_112554	KingmanPalmyra_line_526	
		0129_20160201_125001	KingmanPalmyra_line_527	
		0130_20160201_180008	KingmanPalmyra_line_528	
		0131_20160201_235724	KingmanPalmyra_line_529	
33	**160202**	**0132_20160202_010018**	**KingmanPalmyra_line_530**	
		0133_20160202_060029	KingmanPalmyra_line_531	
		0134_20160202_103847	KingmanPalmyra_line_532	
		0135_20160202_120030	KingmanPalmyra_line_533	
		0136_20160202_142734	KingmanPalmyra_line_534	
		0137_20160202_162333	KingmanPalmyra_line_535	
		0138_20160202_180007	KingmanPalmyra_line_536	
34	**160203**	**0139_20160203_000142**	**KingmanPalmyra_line_537**	
		0140_20160203_031533	KingmanPalmyra_line_538	
		0141_20160203_035638	KingmanPalmyra_line_539	
		0142_20160203_081521	KingmanPalmyra_line_540	
		0143_20160203_095615	KingmanPalmyra_line_541	
		0144_20160203_125910	KingmanPalmyra_line_542	
		0145_20160203_130337	KingmanPalmyra_line_543	
		0146_20160203_131053	KingmanPalmyra_line_544	
		0147_20160203_135134	KingmanPalmyra_line_545	
		0148_20160203_180652	KingmanPalmyra_line_546	
		0149_20160203_195442	KingmanPalmyra_line_547	
35	**160204**	**0150_20160204_000454**	**KingmanPalmyra_line_548**	
		0151_20160204_060028	KingmanPalmyra_line_549	
		0152_20160204_120026	KingmanPalmyra_line_550	
		0153_20160204_180023	KingmanPalmyra_line_551	
36	**160205**	**0154_20160205_000015**	**KingmanPalmyra_line_552**	
		0155_20160205_060113	KingmanPalmyra_line_553	
		0156_20160205_111716	KingmanPalmyra_line_554	
		0157_20160205_123026	KingmanPalmyra_line_555	
		0158_20160205_155733	KingmanPalmyra_line_556	Begin cross line
		0159_20160205_180010	KingmanPalmyra_line_557	Cross line
37	**160206**	**0160_20160206_000009**	**KingmanPalmyra_line_558**	**Cross line**
		0161_20160206_024129	KingmanPalmyra_line_559	
		0162_20160206_081129	KingmanPalmyra_line_560	Begin cross line
		0163_20160206_120014	KingmanPalmyra_line_561tran	Cross line
		0164_20160206_180027	KingmanPalmyra_line_562tran	
38	**160207**	**0165_20160207_000009**	**KingmanPalmyra_line_563tran**	
		0166_20160207_032056	KingmanPalmyra_line_564tran	
		0167_20160207_060018	KingmanPalmyra_line_565tran	
		0168_20160207_120008	KingmanPalmyra_line_566tran	

Appendix 1 (cont.)

JD	Data Folder	Kongsberg file name RB.all	UNH file name .all	Notes
		0169_20160207_180011	KingmanPalmyra_line_567tran	
39	**160208**	**0170_20160208_000016**	**KingmanPalmyra_line_568tran**	
		0171_20160208_060022	KingmanPalmyra_line_569tran	
		0172_20160208_120016	KingmanPalmyra_line_570tran	
		0173_20160208_180032	KingmanPalmyra_line_571tran	
		0174_20160208_193357	KingmanPalmyra_line_572tran	
40	**160209**	**0175_20160209_000012**	**KingmanPalmyra_line_573tran**	
		0176_20160209_030209	KingmanPalmyra_line_574tran	
		0177_20160209_051640	KingmanPalmyra_line_575tran	
		End of Cruise	**End of Cruise**	

Appendix 2. Location of XBT/XSV/XCTD casts

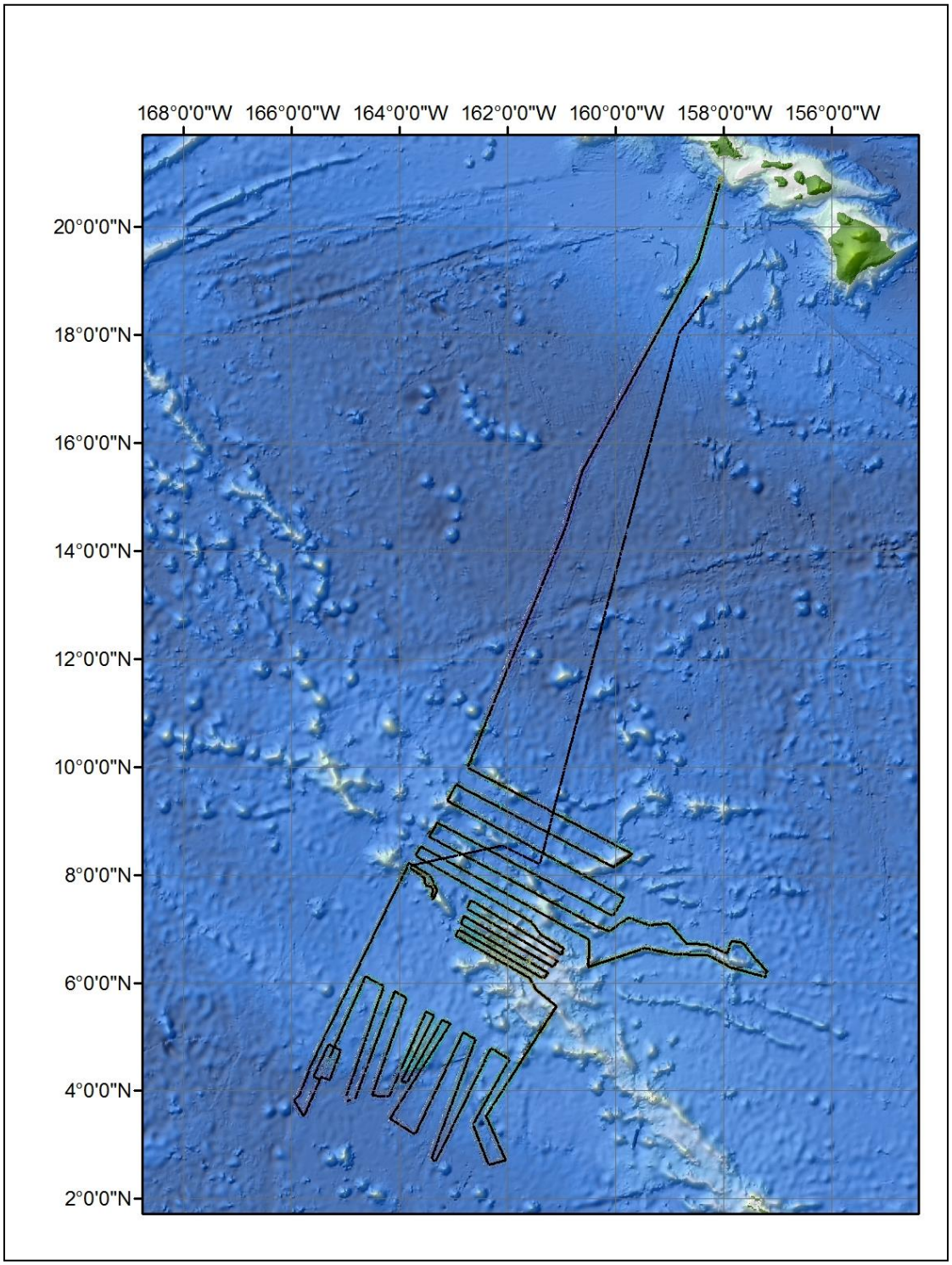
Sequence Number	Date	Longitude	Latitude	Serial Number	TYPE
4	01/05/2016	158 37.65137W	21 7.90747N	-	XSV-01
28	01/15/2016	162 43.39062W	10 1.94849N	-	XSV-01
48	01/19/2016	162 40.12598W	8 37.96613N	00032610	XSV-01
55	01/20/2016	160 5.96973W	6 58.26123N	00322611	XSV-01
86	01/27/2016	161 37.2666W	4 45.0943N	00032609	XSV-01
103	01/31/2016	163 43.72266W	4 23.9339N	00032608	XSV-01
118	02/03/2016	165 14.52344W	4 44.6582N	00032613	XSV-01
124	02/04/2016	164 27.94336W	6 54.63721N	00032607	XSV-01
137	02/06/2016	160 45.21582W	10 42.58765N	00032614	XSV-01
4	01/05/2016	158 37.65137W	21 7.90747N	-	XSV-02
3	01/05/2016	-	-	-	Deep Blue
5	01/06/2016	-	-	-	Deep Blue
6	01/06/2016	158 56.48633W	21 1.84912N	01244676	Deep Blue
7	01/06/2016	158 57.70703W	21 10.47827N	01244675	Deep Blue
8	01/06/2016	158 57.70996W	21 2.8042N	01244677	Deep Blue
9	01/07/2016	158 57.71191W	21 1.61499N	01244677	Deep Blue
10	01/07/2016	157 51.07031W	21 9.48584N	01244679	Deep Blue
11	01/08/2016	157 51.36914W	21 11.76758N	01244680	Deep Blue
12	01/08/2016	157 49.47656W	21 9.47656N	01244684	Deep Blue
13	01/08/2016	157 48.79688W	21 7.46606N	01244683	Deep Blue
14	01/12/2016	158 3.40234W	20 52.01855N	01244682	Deep Blue
15	01/13/2016	158 7.98047W	20 35.28479N	01244681	Deep Blue
16	01/13/2016	158 22.13672W	19 44.97815N	01244745	Deep Blue
18	01/13/2016	158 56.29199W	18 33.22839N	-	Deep Blue
19	01/13/2016	159 12.99609W	18 2.93396N	-	Deep Blue
20	01/13/2016	159 50.62012W	16 54.15796N	01244750	Deep Blue
21	01/14/2016	160 25.02539W	15 50.96375N	01244746	Deep Blue
22	01/14/2016	160 45.62402W	14 59.75146N	01244747	Deep Blue
23	01/14/2016	161 6.75684W	13 59.24597N	01244751	Deep Blue
24	01/14/2016	161 33.42871W	12 54.07666N	01244756	Deep Blue
25	01/15/2016	162 0.81445W	11 47.06177N	01244748	Deep Blue
26	01/15/2016	162 22.2041W	10 54.33423N	01244721	Deep Blue
27	01/15/2016	162 34.67383W	10 23.4173N	01244725	Deep Blue
29	01/15/2016	162 43.77051W	10 0.97888N	01244729	Deep Blue
30	01/15/2016	162 13.81738W	9 43.21179N	-	Deep Blue
31	01/15/2016	161 31.06055W	9 20.81012N	01244726	Deep Blue
32	01/15/2016	160 57.55176W	9 3.2439N	01244722	Deep Blue
33	01/16/2016	160 5.70996W	8 36.06329N	01244723	Deep Blue
34	01/16/2016	160 5.22852W	8 10.2934N	01244723	Deep Blue
35	01/16/2016	161 5.26953W	8 41.78101N	01244732	Deep Blue
36	01/16/2016	161 38.72852W	8 59.29633N	01244728	Deep Blue
37	01/17/2016	162 11.0332W	9 16.24823N	01244724	Deep Blue
38	01/17/2016	162 45.91504W	9 34.49017N	01244109	Deep Blue

Appendix 2. continued					
39	01/17/2016	162 41.70312W	9 8.62079N	01244113	Deep Blue
40	01/17/2016	162 19.37891W	8 56.41577N	01244117	Deep Blue
41	01/17/2016	161 29.19336W	8 28.94672N	01244110	Deep Blue
42	01/17/2016	160 56.84277W	8 11.22528N	01244114	Deep Blue
43	01/18/2016	160 19.59473W	7 50.80267N	01244118	Deep Blue
44	01/18/2016	160 0.06738W	7 19.30127N	01244111	Deep Blue
45	01/18/2016	160 53.875W	7 41.5473N	01244115	Deep Blue
46	01/19/2016	161 46.93457W	8 9.77643N	-	Deep Blue
47	01/19/2016	162 10.33301W	8 22.1944N	01244112	Deep Blue
50	01/19/2016	163 14.83594W	8 56.36877N	01244120	Deep Blue
51	01/19/2016	163 24.8877W	8 41.31653N	01244136	Deep Blue
52	01/19/2016	162 35.93945W	8 15.21582N	01244140	Deep Blue
53	01/19/2016	161 54.32715W	7 53.05127N	01244144	Deep Blue
54	01/20/2016	161 1.33984W	7 24.76233N	01244143	Deep Blue
56	01/20/2016	159 18.99414W	7 4.55243N	01224139	Deep Blue
57	01/20/2016	159 18.99414W	7 4.55243N	01244142	Deep Blue
58	01/21/2016	157 58.04785W	6 33.85632N	01244138	Deep Blue
59	01/21/2016	157 21.04199W	6 22.83868N	01244134	Deep Blue
60	01/21/2016	157 55.76562W	6 19.33771N	01244141	Deep Blue
61	01/21/2016	158 31.7832W	6 31.27679N	01244137	Deep Blue
62	01/22/2016	159 42.39258W	6 33.73523N	01244133	Deep Blue
63	01/22/2016	160 29.60645W	6 36.01367N	01244709	Deep Blue
64	01/22/2016	161 26.95117W	7 19.9624N	01244713	Deep Blue
65	01/22/2016	162 32.62402W	7 56.42841N	01244719	Deep Blue
66	01/22/2016	163 6.74902W	8 15.30847N	01244717	Deep Blue
67	01/23/2016	163 24.93262W	8 11.4585N	01244718	Deep Blue
68	01/23/2016	162 49.34863W	7 51.11353N	01244714	Deep Blue
69	01/23/2016	161 47.51758W	7 15.70898N	01244710	Deep Blue
70	01/23/2016	161 6.92285W	6 43.95007N	01244715	Deep Blue
71	01/24/2016	161 39.90527W	6 55.28381N	01244711	Deep Blue
72	01/24/2016	162 22.9209W	7 21.159N	01244720	Deep Blue
73	01/24/2016	161 59.05078W	6 55.93079N	01244716	Deep Blue
74	01/24/2016	161 17.65332W	6 32.0022N	01244712	Deep Blue
75	01/25/2016	161 45.65625W	6 38.47333N	01244649	Deep Blue
76	01/25/2016	162 31.77246W	7 4.72168N	12244653	Deep Blue
77	01/25/2016	162 4.97852W	6 39.45398N	01244657	Deep Blue
78	01/25/2016	161 39.29297W	6 25.04907N	01244658	Deep Blue
79	01/25/2016	161 17.21484W	6 12.59088N	01244650	Deep Blue
80	01/26/2016	161 59.66309W	6 27.6853N	01244654	Deep Blue
81	01/26/2016	162 56.01758W	6 51.45349N	01244651	Deep Blue
82	01/26/2016	162 54.50977W	6 50.58197N	01244655	Deep Blue
83	01/26/2016	161 54.52637W	6 16.39282N	01244652	Deep Blue
84	01/26/2016	161 24.05664W	5 49.034N	01244659	Deep Blue
85	01/27/2016	161 23.31641W	5 6.79959N	01244660	Deep Blue
87	01/27/2016	162 14.82129W	3 46.40399N	01244656	Deep Blue
88	01/27/2016	162 13.44629W	2 39.9989N	01244708	Deep Blue

Appendix 2. continued					
89	01/27/2016	162 32.74707W	3 33.2681N	01244704	Deep Blue
90	01/28/2016	162 9.19141W	4 15.21051N	01244700	Deep Blue
91	01/28/2016	162 16.16602W	4 46.30551N	01244707	Deep Blue
92	01/28/2016	162 54.07227W	3 34.7735N	01244706	Deep Blue
93	01/28/2016	163 24.26367W	2 46.1698N	01244703	Deep Blue
94	01/29/2016	163 4.64551W	3 39.35751N	01244699	Deep Blue
95	01/29/2016	162 50.8291W	4 16.7431N	01244702	Deep Blue
96	01/29/2016	163 0.23535W	4 41.8609N	01244698	Deep Blue
97	01/29/2016	163 30.76953W	3 37.18869N	01244705	Deep Blue
98	01/30/2016	163 51.68555W	3 59.2113N	01244701	Deep Blue
99	01/30/2016	163 44.53711W	4 10.4603N	01244697	Deep Blue
100	01/30/2016	163 9.83496W	5 5.0582N	01244128	Deep Blue
101	01/31/2016	163 34.71289W	4 39.87149N	01244132	Deep Blue
102	01/31/2016	163 40.11719W	4 30.2858N	01244124	Deep Blue
104	01/31/2016	163 47.11523W	4 32.8537N	01244123	Deep Blue
105	01/31/2016	163 38.57812W	4 49.7973N	01244127	Deep Blue
106	01/31/2016	163 33.15527W	5 0.5531N	01244122	Deep Blue
107	01/31/2016	163 35.33887W	5 17.23187N	01244122	Deep Blue
108	01/31/2016	164 1.88672W	4 16.43979N	01244126	Deep Blue
109	01/31/2016	164 6.61523W	4 5.5856N	01244130	Deep Blue
110	02/01/2016	164 21.01953W	4 22.63751N	01244129	Deep Blue
111	02/01/2016	163 59.16504W	5 23.74048N	01244125	Deep Blue
112	02/01/2016	164 25.00977W	4 57.7627N	01244691	Deep Blue
113	02/01/2016	164 48.5332W	3 53.77841N	01244696	Deep Blue
114	02/02/2016	164 45.00195W	4 36.4505N	01244687	Deep Blue
115	02/02/2016	164 32.81445W	5 12.2135N	01244688	Deep Blue
116	02/02/2016	164 43.8125W	5 54.15692N	01244692	Deep Blue
117	02/02/2016	164 56.73438W	5 25.01599N	01244695	Deep Blue
119	02/03/2016	165 28.47656W	4 12.88239N	01244686	Deep Blue
120	02/03/2016	165 54.05078W	3 52.5766N	01244690	Deep Blue
121	02/04/2016	165 34.58984W	4 36.7872N	01244694	Deep Blue
122	02/04/2016	165 12.45117W	5 22.7865N	01244693	Deep Blue
123	02/04/2016	164 51.44141W	6 6.16553N	01244689	Deep Blue
125	02/05/2016	164 5.17969W	7 41.44043N	01244685	Deep Blue
126	02/05/2016	163 56.10156W	7 59.78967N	01244768	Deep Blue
127	02/05/2016	163 21.00684W	7 48.22772N	01244764	Deep Blue
128	02/05/2016	163 24.07227W	7 36.72351N	01244759	Deep Blue
129	02/05/2016	163 26.02246W	8 15.1767N	01244767	Deep Blue
130	02/06/2016	162 24.54395W	8 28.46912N	01244760	Deep Blue
131	02/06/2016	161 34.82129W	8 17.06561N	01244763	Deep Blue
132	02/06/2016	161 19.50293W	8 30.32343N	01244758	Deep Blue
133	02/06/2016	160 59.93945W	9 45.8623N	01244762	Deep Blue
134	02/06/2016	160 55.95605W	10 1.25031N	01244766	Deep Blue
135	02/06/2016	160 50.03125W	10 24.10645N	01244765	Deep Blue
136	02/06/2016	160 45.37598W	10 41.88794N	01244761	Deep Blue
138	02/07/2016	160 28.93652W	11 45.03931N	01244757	Deep Blue

Appendix 2. continued					
139	02/07/2016	160 18.5293W	12 24.86218N	01244640	Deep Blue
140	02/07/2016	160 8.29688W	13 3.8103N	01244644	Deep Blue
141	02/07/2016	159 59.90918W	13 36.05713N	01244648	Deep Blue
142	02/07/2016	159 43.98633W	14 36.18237N	01244647	Deep Blue
143	02/08/2016	159 27.92578W	15 36.6626N	01244643	Deep Blue
144	02/08/2016	159 15.35938W	16 24.1543N	01244642	Deep Blue
145	02/08/2016	158 53.0918W	17 47.4165N	01244642	Deep Blue

Appendix 3. Knudsen 3260 Chirp Subbottom Profiler Report



Map of complete track of Knudsen Subbottom Profiler data: 116,314 km, 5.3 Gigabytes of Raw data

Equipment

NOAA Ship *Ronald H. Brown* is equipped with a hull mounted Knudsen 3260 Chirp Subbottom Profiler. The transducer bay consists of a 16 element array of TR109 transducers arranged 4x4 in a sea chest in the hull of the ship. The deck unit is in the rack of hardware at the aft end of the computer lab. The control computer and monitor is at the multibeam workstation where watch keepers could monitor both the multibeam and the subbottom profiler concurrently. Software running the Knudsen is the Echo Control Client Version 2.7.3.

Acquisition

The Knudsen was activated on departure from Honolulu and left running continuously throughout the expedition. It was set at a center frequency of 3.5 kHz with a bandwidth of 3 kHz; thus spans a bandwidth of 2 to 5 kHz. The system was continuously tuned by the watchkeepers to maximize subbottom imaging. For the most part, pulse length varied between 32 and 64 milliseconds. Gain levels varied significantly. Initial settings had a TVG activated at the water bottom, but due to problems with bottom tracking over highly variable terrain, the system was set at a constant spherical gain recovery of 30logR. Overall power and gain levels varied with bottom imaging. The system was synchronized with the Kongsberg EM122 multibeam system, thus signal initiation was triggered by the EM system to avoid interference with multibeam signals (External Trigger Control, on the Knudsen interface). This synchronization limited trigger frequency to about once every 16-24 seconds in deep water (>4000 m), resulting in a sample spacing of one shot every 60 to 90 m, depending on ship speed and water depth, during the majority of this survey

Sound speed velocity was set to 1510 m/s. At this velocity, water depths from the multibeam system and from the subbottom profiler generally agreed to within +/-20 m. Data display and record window length varied between 500 m and 1000 m; the latter part of the cruise is almost entirely on 1000 m range. Deep water delays were managed by the operator through phase shifting on the GUI interface to track bottom. Data were recorded to Knudsen native binary KEB file format and to Society of Exploration Geophysics Standard Y (SEGY). Segy record parameters were as follows:

Sample Format:	3 (short integer)
Byte Order (Big = true) :	True (Big Endian)
Number of Samples/Trace :	22075 (for 1324.5ms / 1000 m record window)
Sample Interval (usec) :	60
Number of Bytes/Samples :	2
Number of Traces :	299
Deep Water Delay	3311 (operator managed, depending on water depth)
Source X	Position Longitude in radians
Source Y	Position Latitude in radians

Navigation data are supplied to the Knudsen acquisition unit and are written to the headers of the SEGY files. No other POS-MV data are available, so there is no heave compensation, for example.

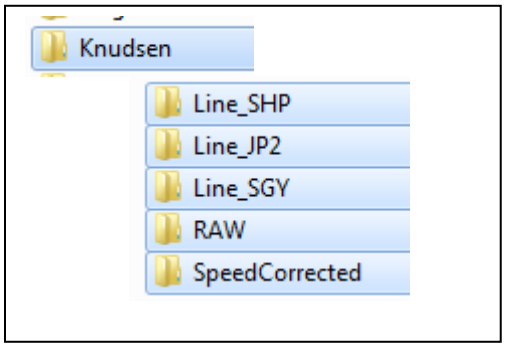
SEGY and KEB files were recorded to the SIS drive (survey(\\10.48.13.229). Files from there were copied to the backup drive rb-16-01_12 (\\10.48.13.198). Naming convention on the raw files included line number followed by Day of the Year and Time, as follows:

0154_036_0000_002.keb
0154_036_0000_150034_CHP3.5_FLT_002.sgy

Where 0154 is the Line Number, 036 is the Day of the Year, 0000 is the Time of Day (UTC).

Line numbers coincide precisely with those of the multibeam data.

On the backup drive, files are stored in the RAW folder under Knudsen. The following is the directory structure:

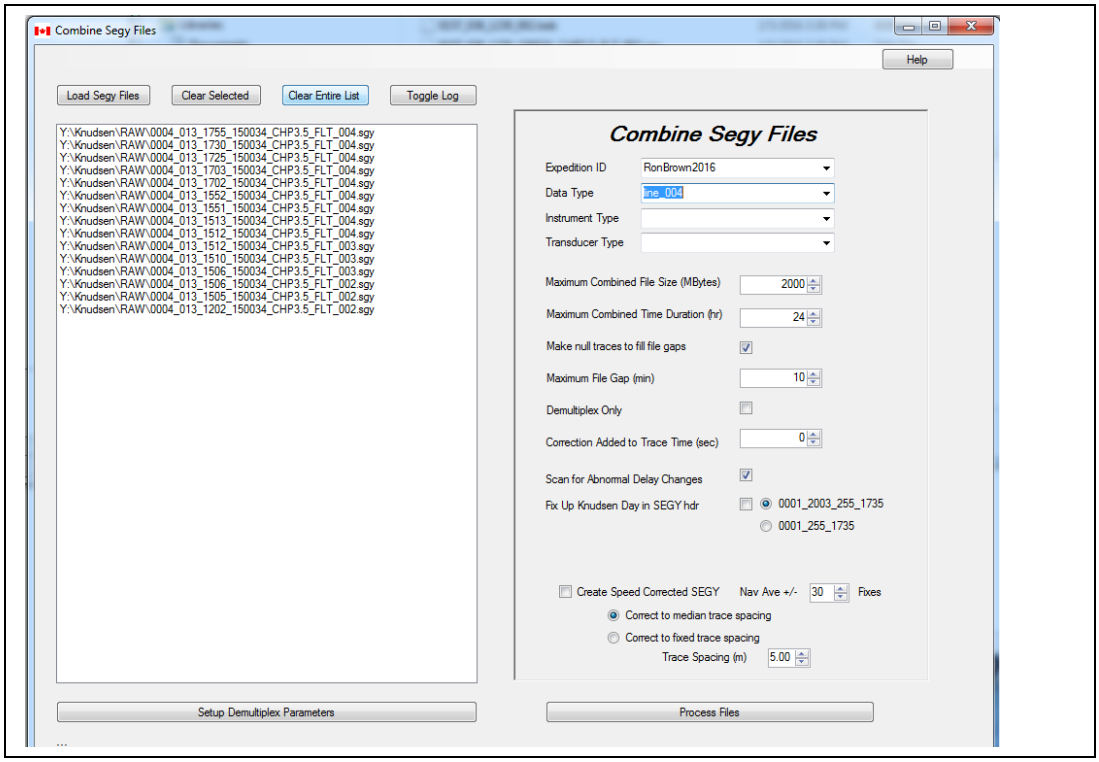


From this point raw SEGY files were copied to the Line_SGY directory and renamed with the expedition name and line number

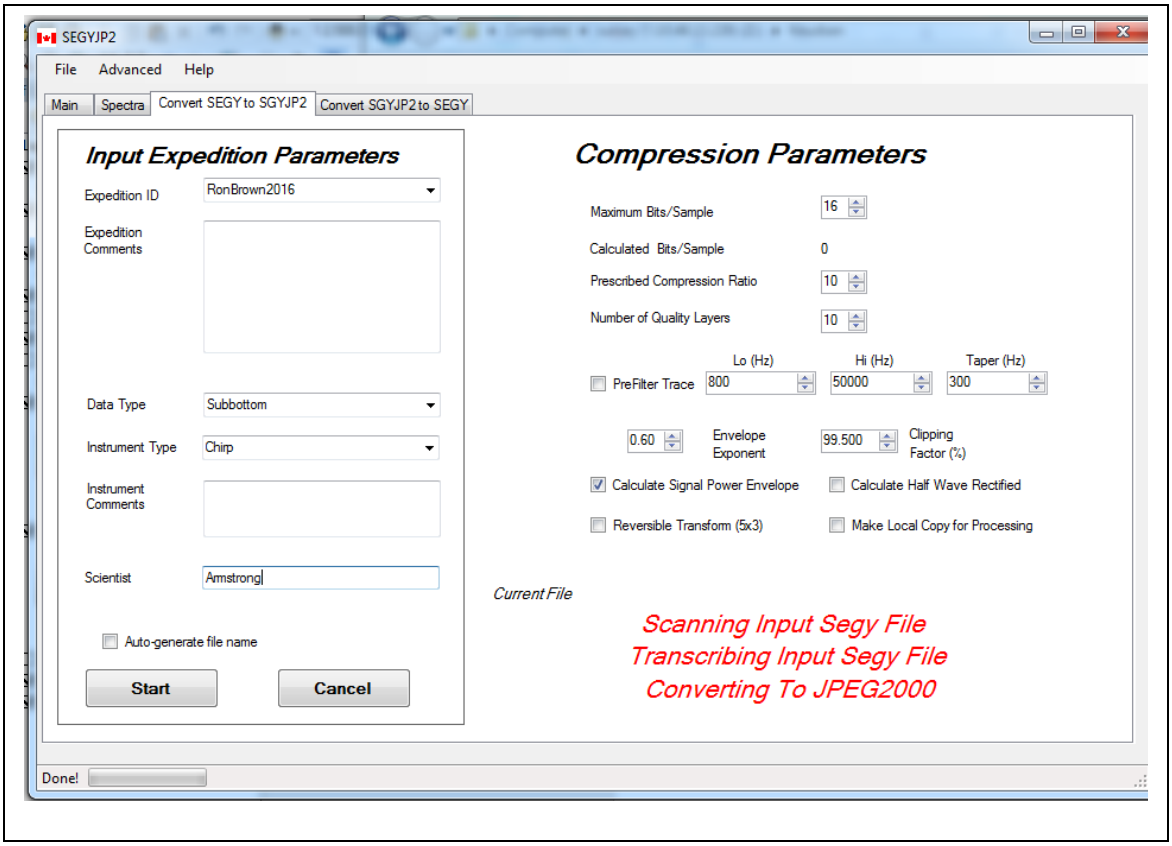
RonBrown2016_line_###.sgy

Processing

If multiple raw SEGY files occurred per line, then they were combined into a single file, using the NRCan SEGYJP2 suite of software, called Combine_Segy. This software handles multiple files and sorts them according to time in the headers of the SEGY files and outputs them as a single file. It will resample and re-window data if necessary. If a data gap exists, it will not bridge the gap and make separate files, unless over-ridden by the operator (a setting in the GUI of the software).



Files from the Line_SGY directory were then converted to a specialized JP2000 format for viewing. The NRCan software SegyJp2 does this conversion. It performs a wavelet compression of the SEGY data to produce a compressed image format, but all of the SEGY metadata from the SEGY headers remains in the image headers. Data can be converted back to SEGY format with this same software. For these files the least amount of data compression was utilized (Compression Ratio of 10). Maximum compression (1) would result in much smaller image files, but likely little loss of quality is expected.



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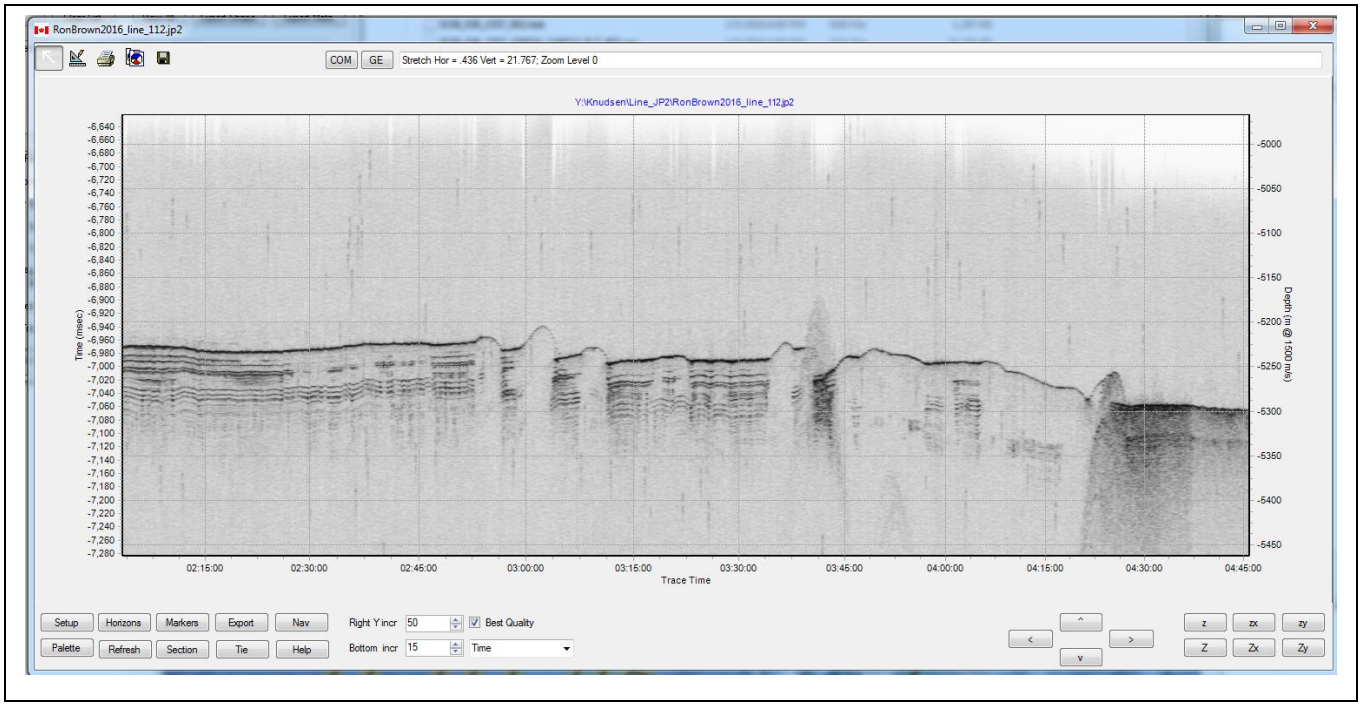
Data were converted with a small clipping factor (99.5%) to eliminate outliers that affect the overall image gain levels, and were converted to display as envelop data (sounder data have little useful phase information and almost always are presented as envelop). Jp2 files maintain the Cruise and line identifiers in the name of the file and are stored in the Line_JP2 folder.

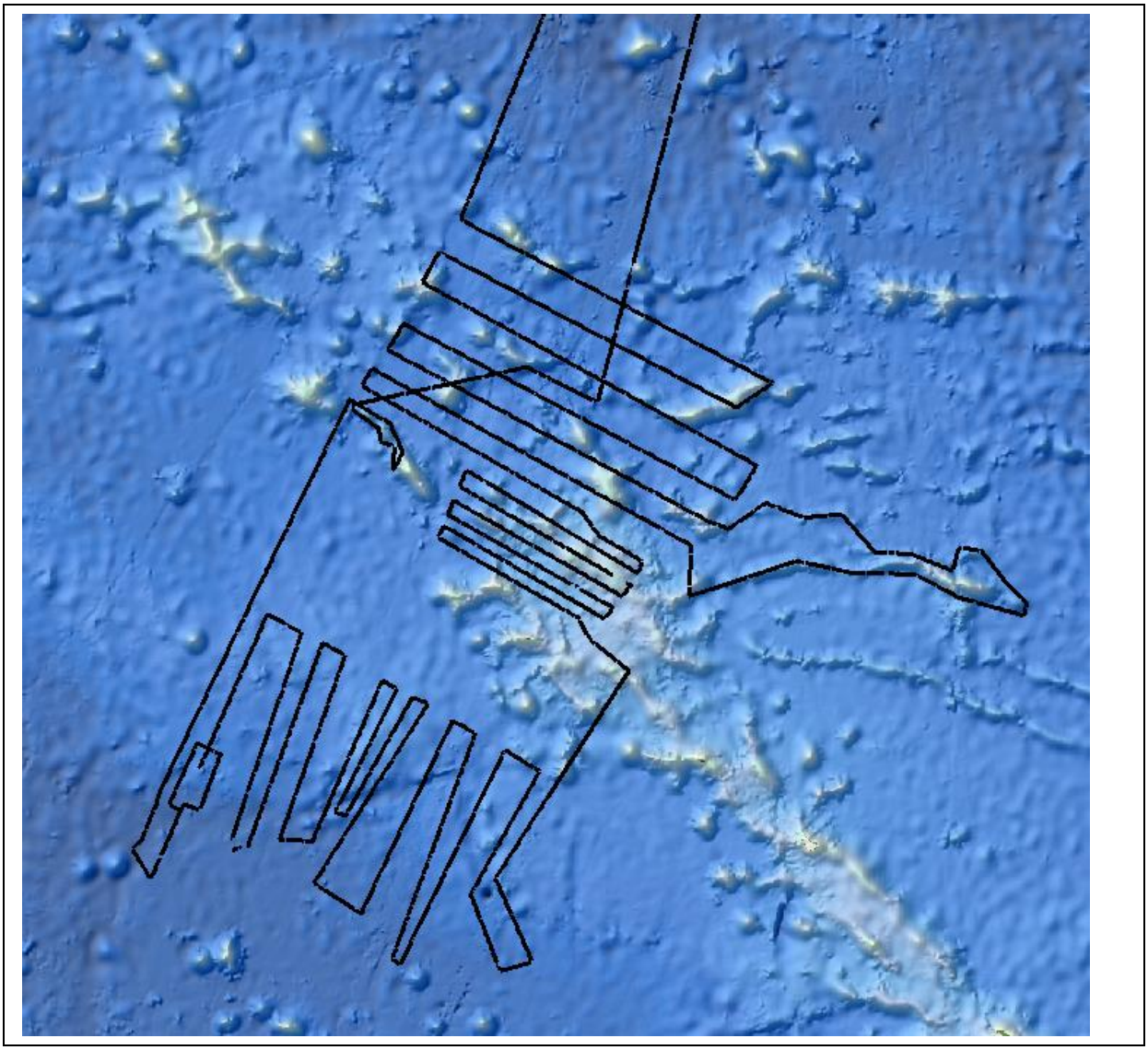
RonBrown2016_line_xxx.jp2

These JP2 files can be displayed in the NRCan SegyJp2Viewer software. This software allows full manipulation of the image for aspect ratio, zoom, display gains etc. It also is able to display trace, time or distance along the X-axis. Distance is only available if navigation is in the headers of the Segy file, which in this case it is integrated. Static images in a variety of formats can be output from this software.



This SegyJp2Viewer software also allows export of Shape files of the navigation data, suitable for loading into GIS software such as ArcMap. The Shape files provide a ship's track within ArcMap; a click on the track with the Arc identify tool ( ) provides a hyperlink to the Jp2 file, and the subbottom profile data will be displayed. Shape files are kept within the folder Line_SHP. All lines were merged into one shape file (**Line_meged_2016_02_08.shp**). This single shape file can be loaded and contains all of the hyperlinks to the jp2 files.

Additional functionality can be achieved with virtual serial port software implemented. A mouse click on the subbottom record will identify that position on the ArcGIS map.



Speed Correction

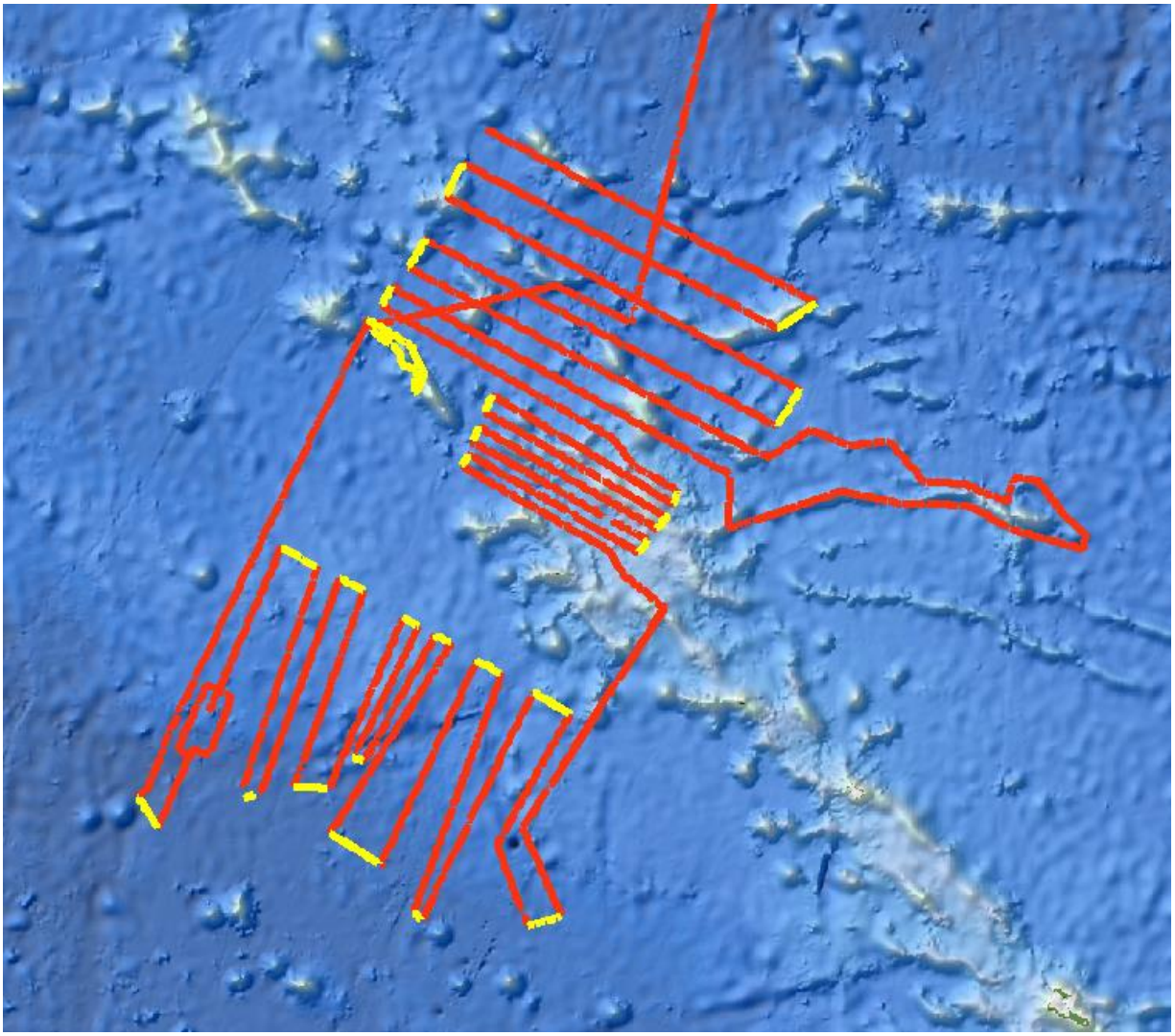
Trigger time of the multibeam, and consequently the subbottom profiler, is variable, depending on water depth. As a result of this synchronization, the shot speed is variable. With variable shot speed, the aspect ratio of the horizontal to vertical on the subbottom plot is variable. To compensate, shot spacing can be managed in the NRCan Combine_Segy software to produce constant shot spacing. Official "lines" are a maximum of six (6) hour increments, or at line turns. Line_SGY files were combined over the lengths of long segments and speed corrected to 100 m interval shot spacing. In this way, the aspect ratio is constant for all data. The long lines were combined with the cruise identifier followed by a Long Line number, followed by the line numbers of which it is composed.

RonBrown2016_LL5_35-40.sgy = Long Line 5, consisting of lines 35-40.

For the shorter cross lines, the same convention was followed

RonBrown2016_CL14_103.sgy = Cross Line 14, consisting of line 103.

JP2 and subsequent shape files were generated from these speed-corrected files as well,



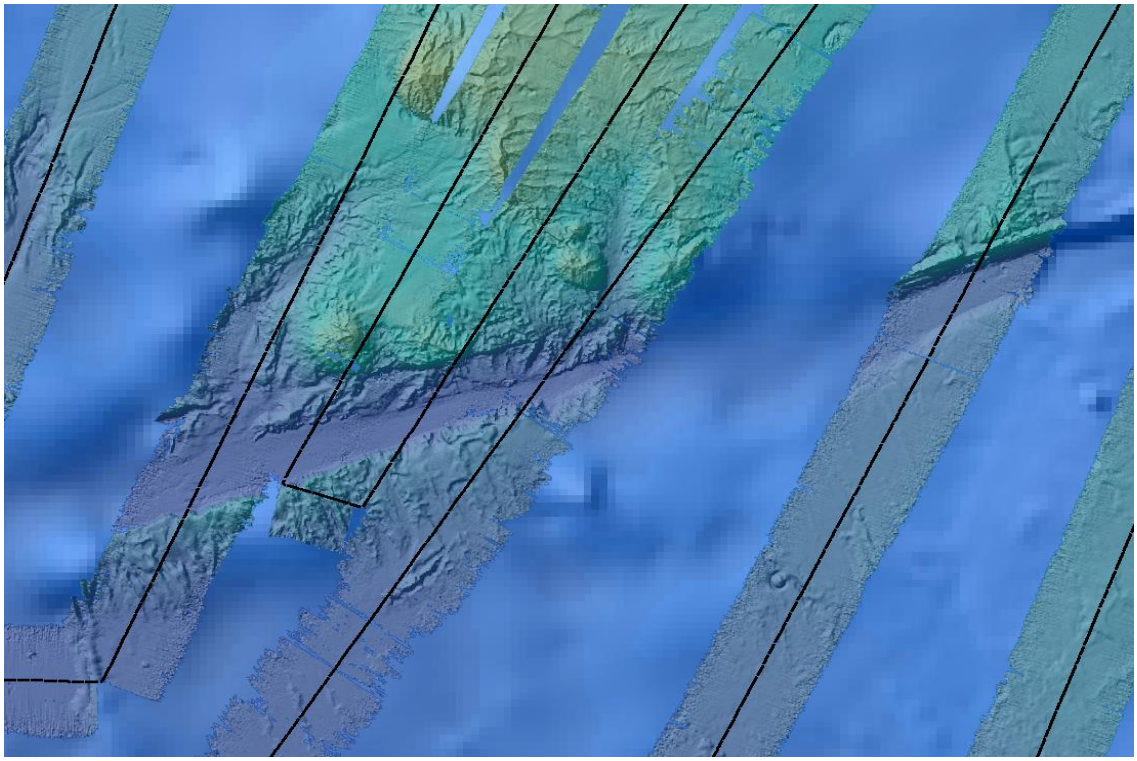
Red are "Long Lines (LL)", speed corrected to 100 m per trace. Yellow are "Cross Lines (CL)" corrected to 100 m per trace.

following the same naming convention. All data are stored within the folder called "SpeedCorrected". The traces are hyperlinked to the speed-corrected jp2 file.

ArcGIS project

Shape files for the tracks were loaded into an ArcGIS project called "RonBrown2016.mxd". A backup of the project is called "RonBrown2016_2.mxd". The project hosts the GEBCO_08 background grid and the along-track multibeam acquired during this expedition. The Knudsen

tracks overlie the multibeam and backscatter to assist in feature identification. All lines and speed-corrected lines were merged into single shape files (**Line_meged_2016_02_08.shp** and **SC_Lines_Merged_2016_02_08,shp**). These single shape file can be loaded and contain all of the hyperlinks to the jp2 files. The paths for the hyperlinks are drive specific (absolute paths), so in order to install the entire directory structure on another CPU will require editing the hyperlink paths. This is a simple matter of editing the attribute table of the shape file within Arc and changing the drive letter.

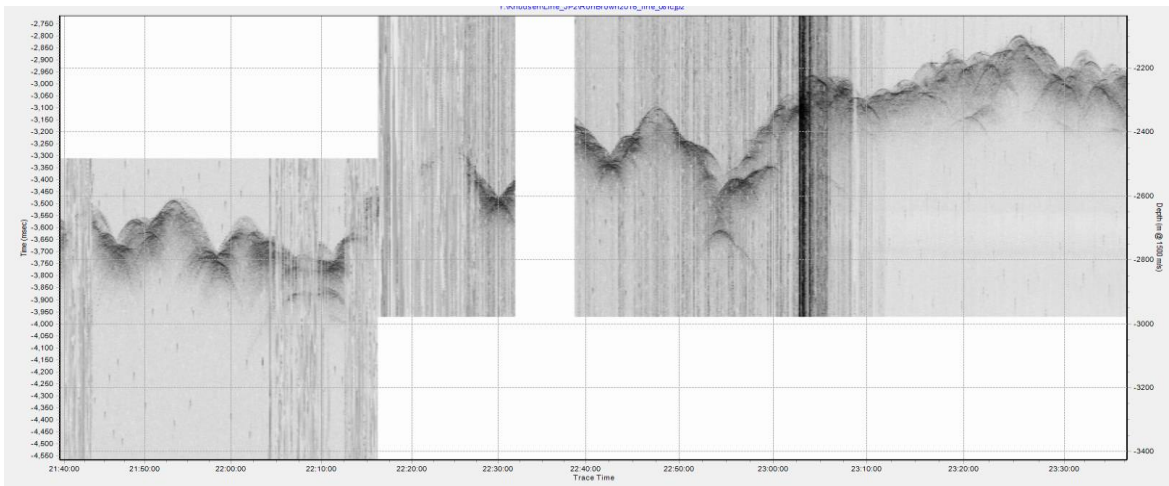


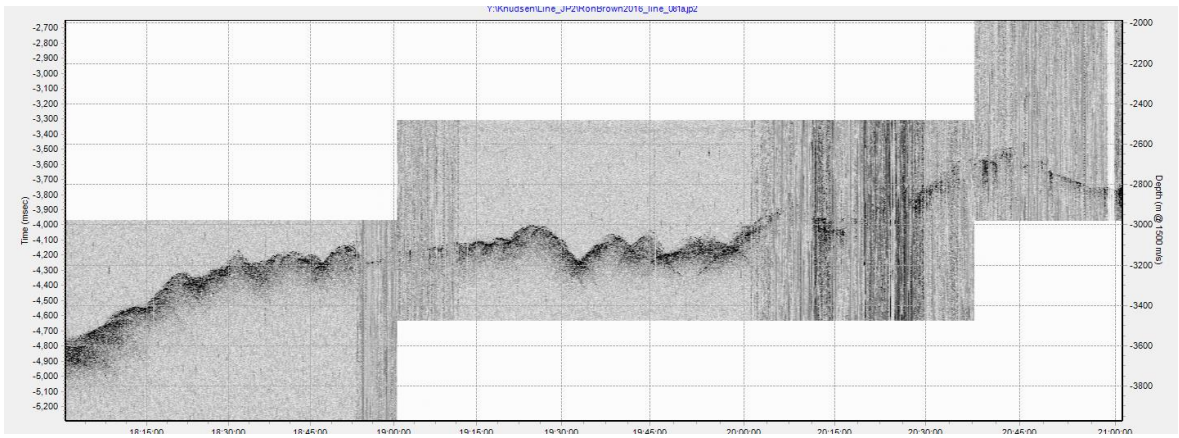
Example of subbottom tracks overlying the multibeam data within the ArcGIS project. Each black line is hyperlinked to the appropriate Jp2 file.

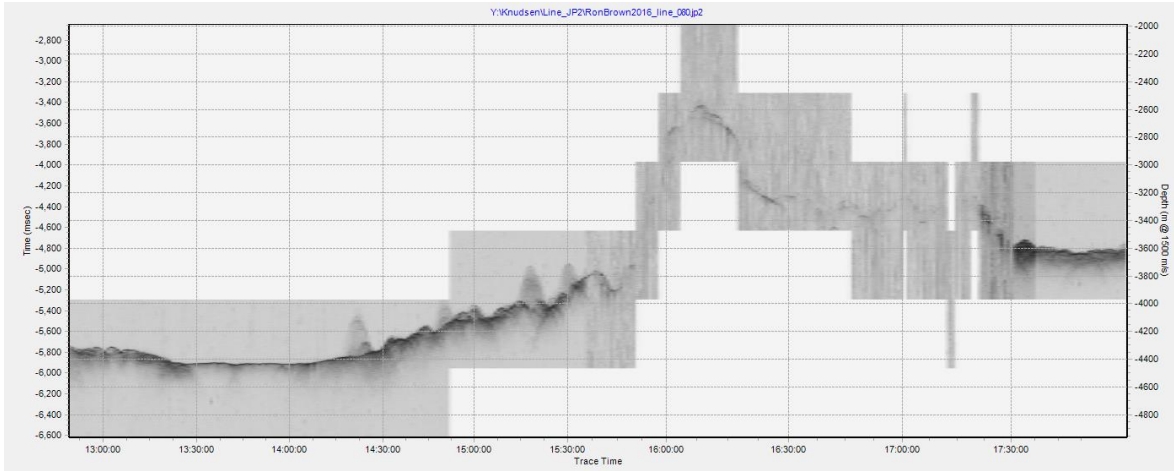
Issues

JD 24, 23:15 UTC Knudsen stopped logging. Not noticed until JD 25, 00:12, when recording was restarted.

On JD 25, 15:36 UTC, Line 80, we started to get poor signal to noise ratio on the Knudsen records. This continued, intermittently, so we powered off the system at 21:01 and restarted. The restart did not seem to fix the issue. Ship's tech made some gain adjustments, and signal restored to normal by 22:38 UTC. We don't believe it was the adjustments…there was either something happening with signal boards or some form of unexplained interference. The noise does not coincide with needle-gunning/paint chipping.

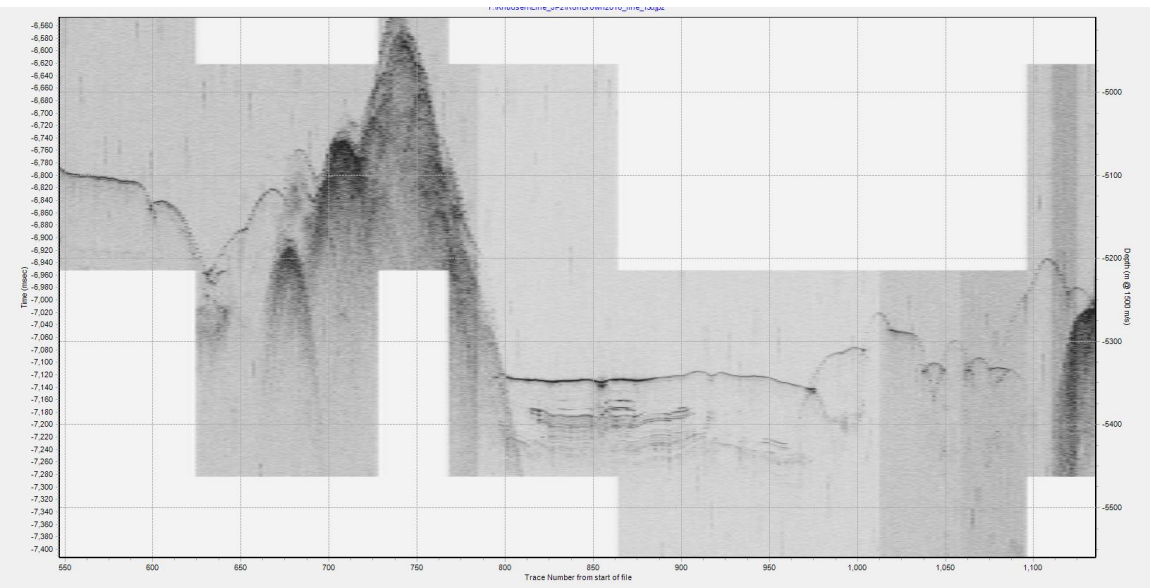






Intermittent poor signal to noise ratios? A gain board issue or tuning issue?

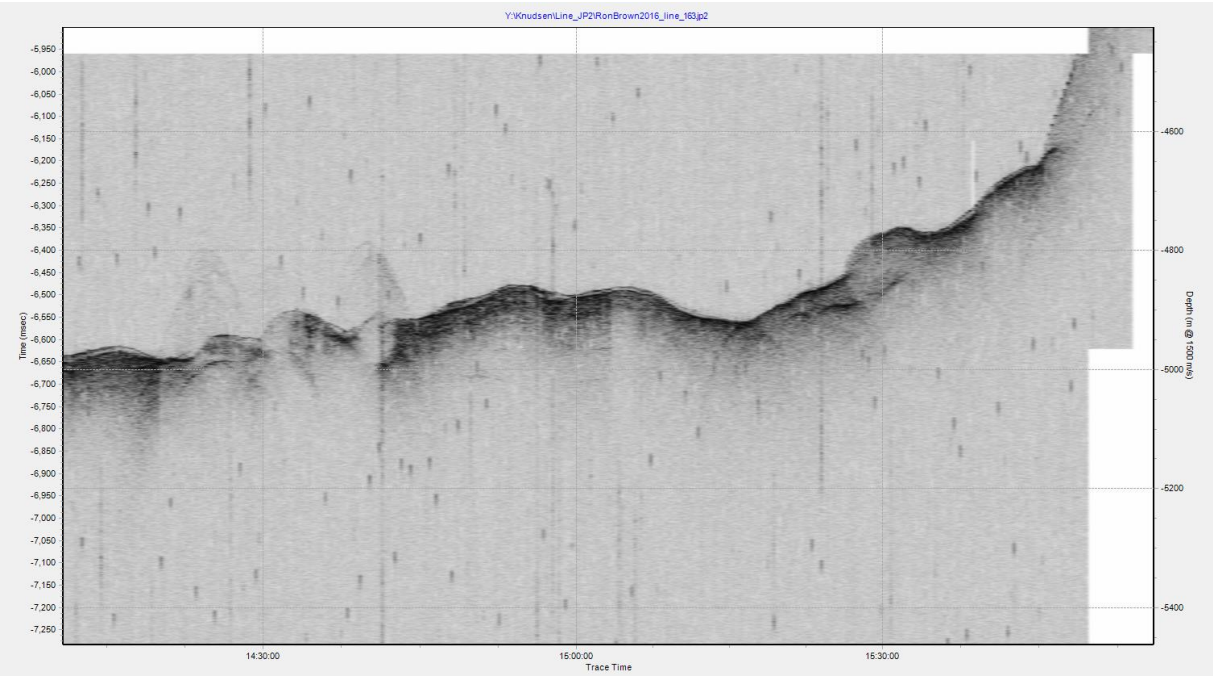
Inexplicable low amplitude returns appear occasionally, such as the example below at JD 32 20:26. Turning up gains had no apparent effect, nor did power level or pulse length. A function of the bottom and water depth? We powered off the system again, at JD 33, 00:01 UTC to investigate. This was at the end of Line 130 on the crossing line of Line 131. Started logging again at 00:17. Stopped logging at 0045 to try out the ODEC/SyQWest system to see if the bottom was the same response but were unable to get a decent record from it at all. Returned to logging Knudsen at 01:33.



Weak return signals are unexplained. Seem to appear on bedrock highs and from sediments, so not certain it is a function of the geology. Possibly related to fluids close to the fracture zone (see below).

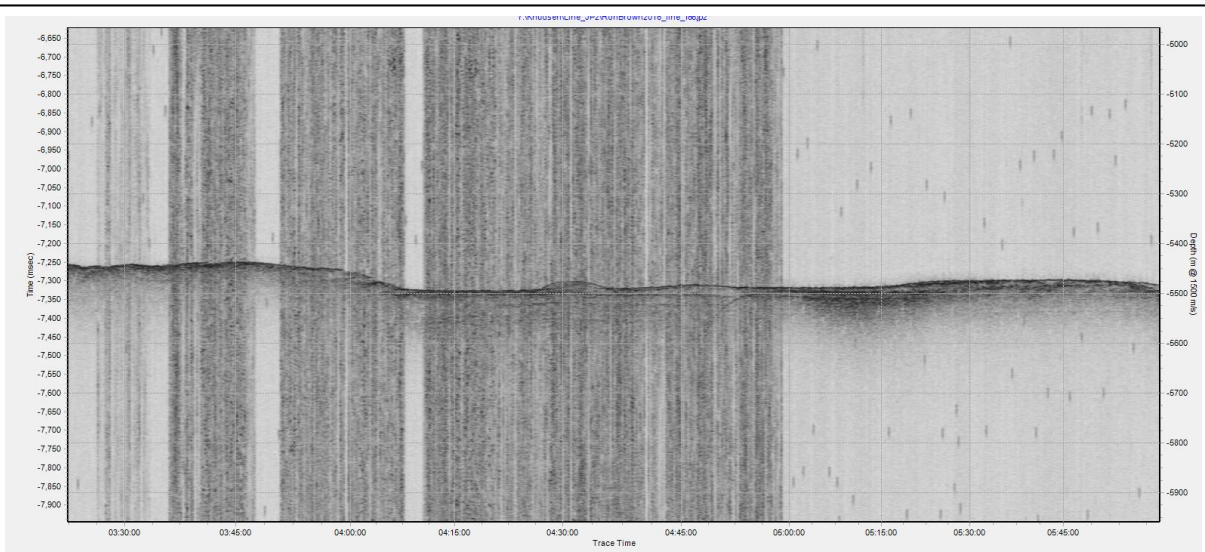
<u>JD 34 00:53 UTC Line 139.</u> Knudsen system inexplicably stopped logging, although continued to run. Was not noticed until start of Line 140 (03:15)

Noise bursts appear on all records, although more pronounced at some times more than others (see image below). The source is likely the multibeam system, but not sure as to why synchronization doesn't prevent this. Is this normal or is there an issue with the synchronization?



Noise bursts such as these are typical of all records during the survey.

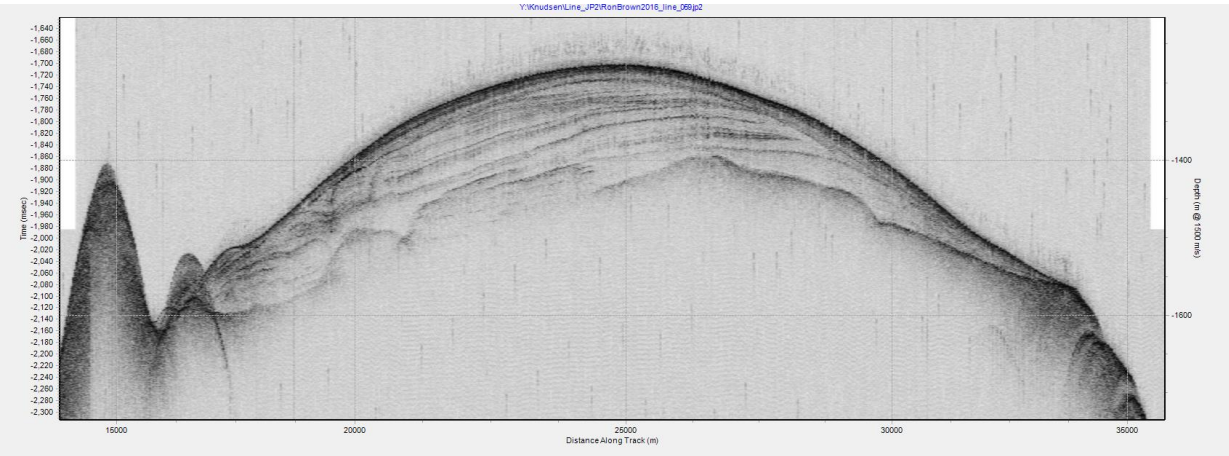
Needle gun (pneumatic paint chipper) anywhere on the hull of the vessel introduces noise on the records. Bottom can still be seen but the background noise level is substantial.



Effect of needle gunning as shown in this example from Line 166 JD 38 03:25

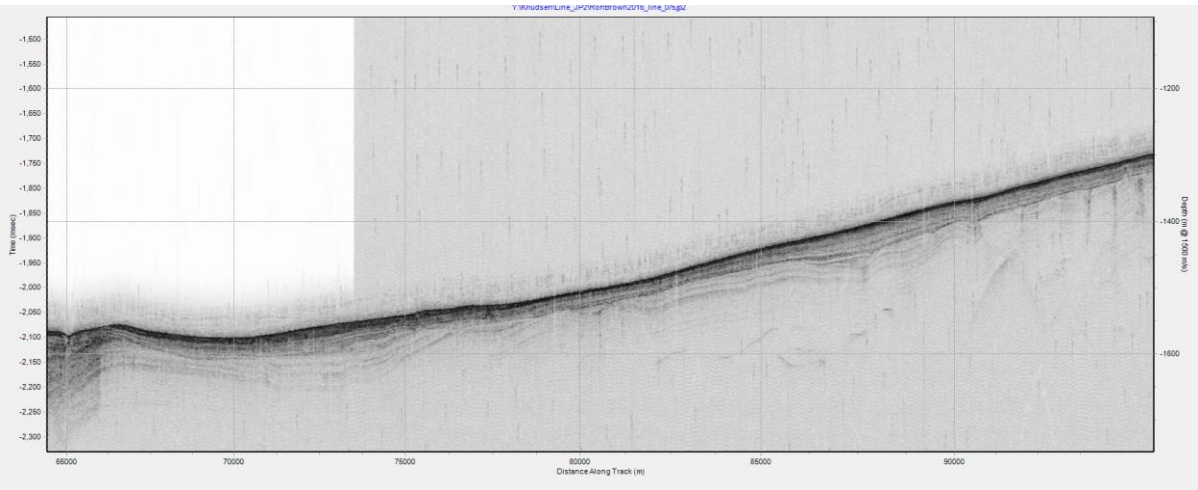
Interesting Tidbits

The tops of some of the broader seamounts have a sediment sequence on them that appears as though it has been reworked into sediment drifts, or at least shows an erosional surface near the top.



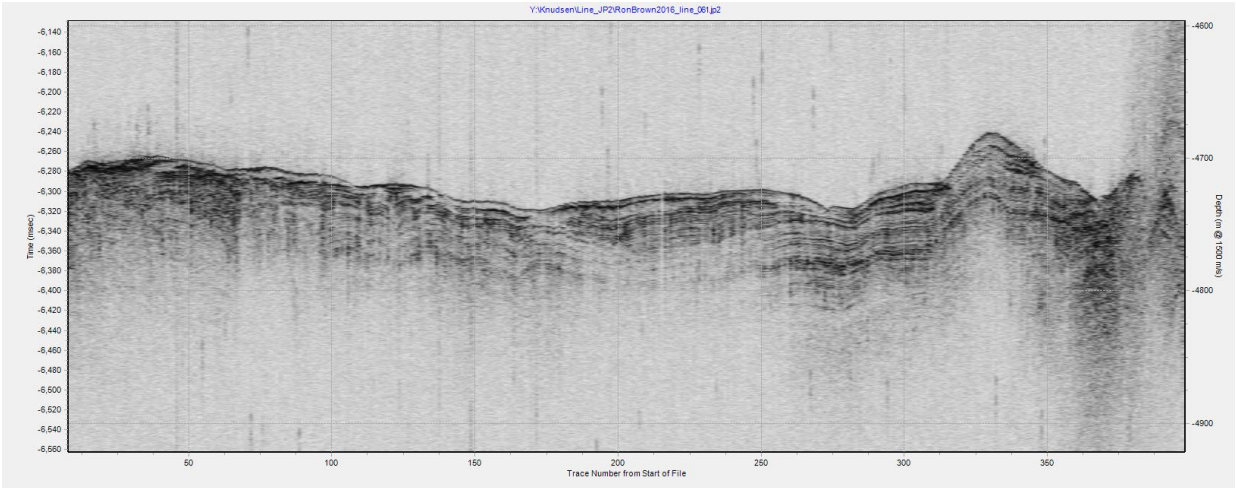
Line 59 JD 22 / 13:05:23

Evidence of erosion on one of the large platform north of Palmyra



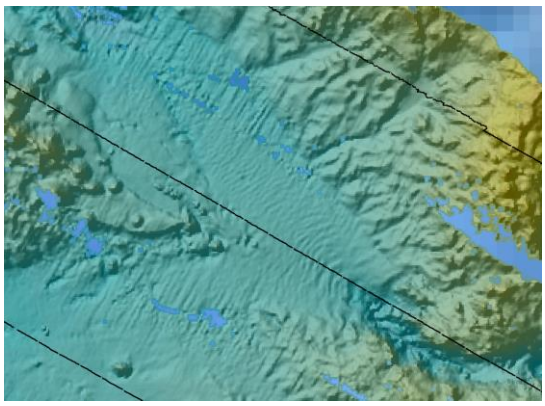
Line 75 JD 24 22:19:38

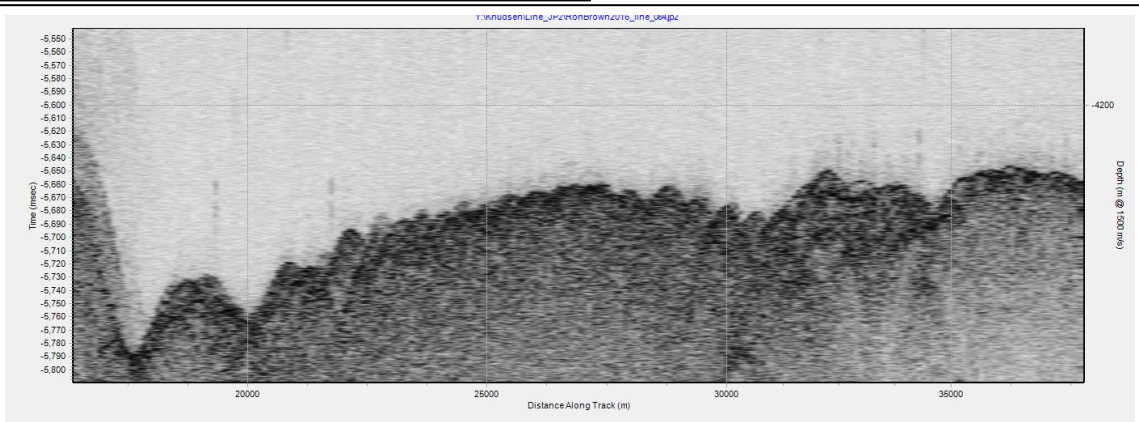
There appears to be thick accumulation of sediments in some basin settings. These are not just pelagic, but some units appear to be channel constrained.



Line 61 JD 23 / 00:53:15

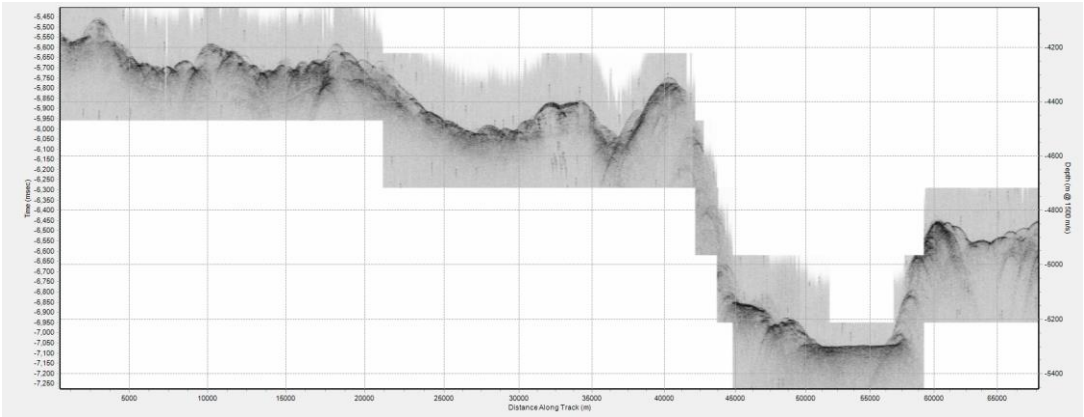
Sediment waves on the seafloor leading into the mouth of a channel.





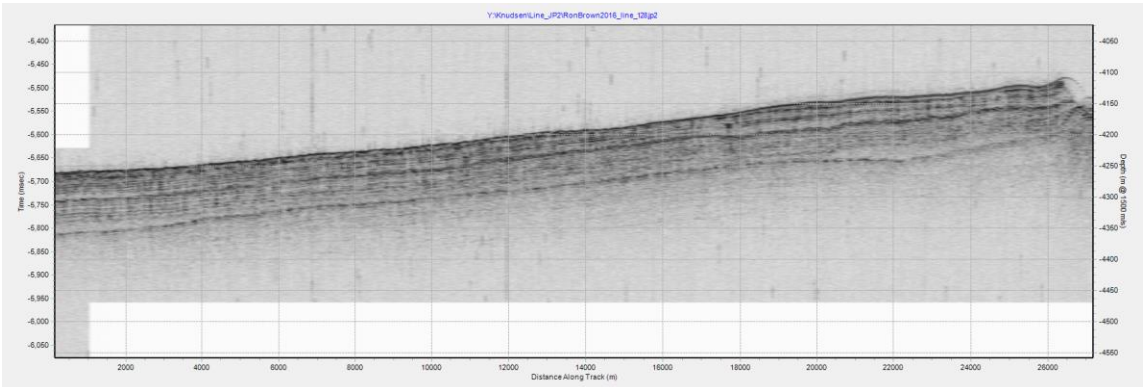
Line 84 JD 26 / 07:12:04

Fracture Zones typically show an asymmetry in profile and hyperbolic reflections off of the steep walls, but the floor contains sediment which shows high reflectivity in profile and on backscatter.



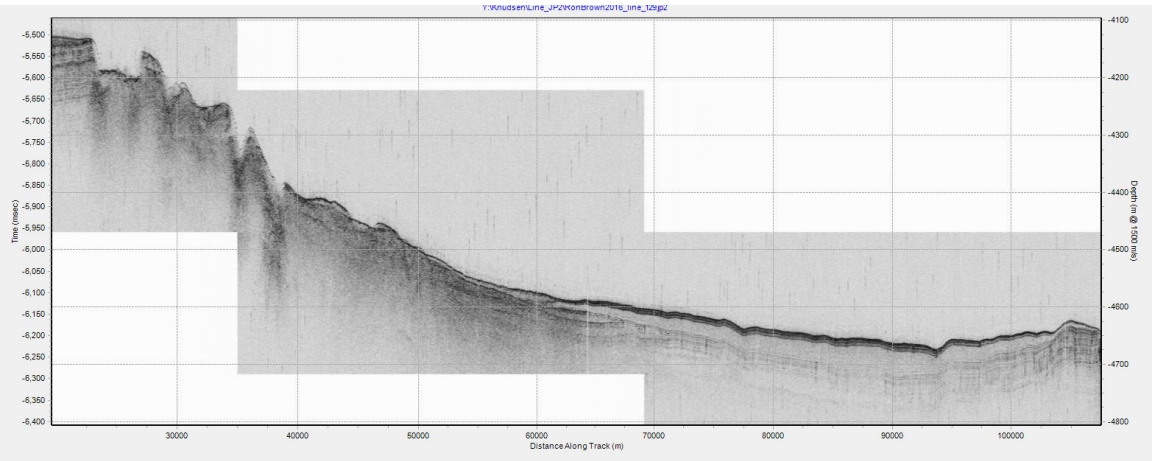
Line 118 JD 31 / 02:45:27

Thick accumulations of pelagic drape (or near pelagic) are actually not as common as expected.

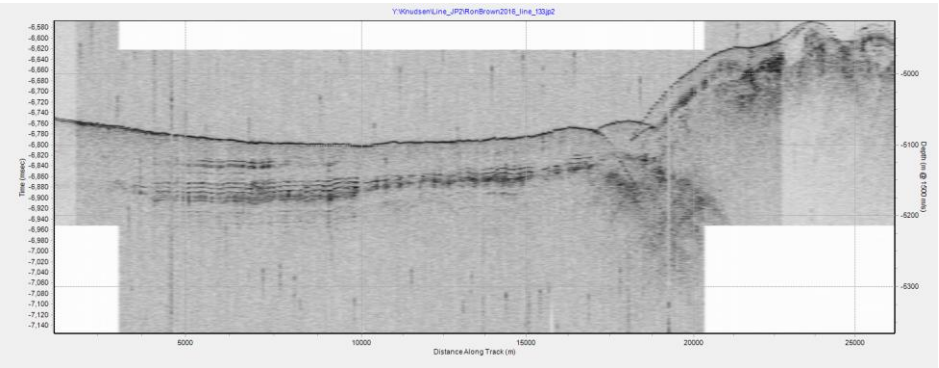


Line 128 JD 32 12:01:57

There is significant evidence of submarine mass failure, resulting in transparent deposits

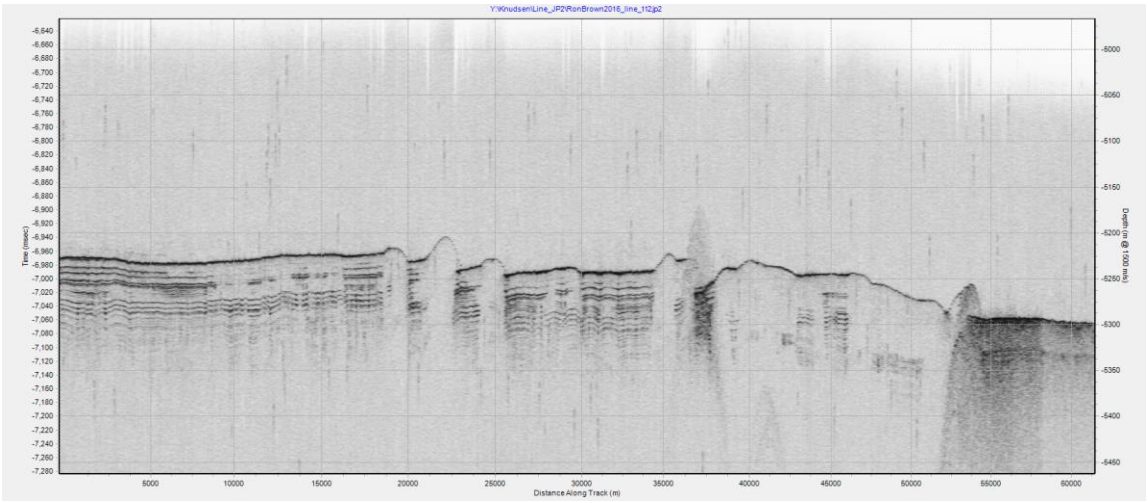


Line 129 JD 32 / 15:51:09



Line 133 JD 33 / 06:38:01

Other causes of acoustic blanking? Possibly fluids? Not gas, because we see below the blank zones. Interestingly, these zones seem to be proximal to the fracture zone in the south end of the survey.



Line 112 JD 30 / 03:27:27

Appendix 4: Weekly Seabird Reports

Palmyra ECS RB16-01 Seabird Survey Effort Weekly Report 1
12-18 January 2016

A standardised 300 metre strip transect survey for marine birds is being conducted while the NOAA ship *Ronald H. Brown* is underway. This week's results include the transit through the relatively cooler Subtropical Surface Water between Honolulu and the study area. The almost complete lack of transients and non-breeders from the Southern Hemisphere resulted in overall low diversity and abundance. Black-winged Petrel, for example, a fairly common and widespread species from the southwest Pacific Ocean, was not seen at all this week. Most sightings consisted of resident breeders such as Masked and Red-footed Boobies and a scattering of White Terns. A single Phoenix Petrel was noteworthy as were a couple of Bulwer's Petrels. Other than a few in a single feeding flock, no Wedge-tailed Shearwaters were seen anywhere! The only marine mammals seen this week was a small group of about eight (white-bellied) Spinner Dolphins.
A nod of appreciation goes to the ship's Lead Electronics Technician, Jeff Hill, for his expertise in providing a GPS link to the seabird data acquisition program.

	Week 1
total effort (hours)	55.5
average daily effort (hours)	7.9
trackline surveyed(km)	977.5
species	13
average species/day	5
total individuals	70
avg. individuals/day	10
average wind speed (knots)	19
average Beaufort	5

Michael Force
USFWS Seabird and Marine Mammal Observer

Palmyra ECS RB16-01 Seabird Survey Effort Weekly Report 2
19-25 January 2016

There was a marked increase in seabird abundance this week. The total number of seabirds observed on effort was dominated by three species—two local breeders and a non-breeding visitor. These three species, in decreasing order of abundance, White Tern, Red-footed Booby and Leach's Storm-Petrel, comprise 65% of the total. All three boobies were seen this week, Red-footed, Masked and one Brown Booby. All but one were adult, whereas last month, farther west, all sightings were of immature birds. It's hard to explain the almost complete lack of Wedge-tailed Shearwaters, a widespread tropical seabird. This species was seen almost daily last month; on this cruise I've only seen two (not including 10 seen in a small feeding flock last week).

Highlights this week include two unidentified seabirds. During our transits eastward into Kiribati waters, three solitary black-and-white *Puffinus* shearwaters remained frustratingly well beyond the range required to identify species in this confusing group. The at-sea distributions of Newell's Shearwater and Tropical Shearwater, the likely candidates in this region, are poorly known. Another mystery was sightings of one, possibly three, Leach's Storm-Petrels which closely resembled the subspecies *Oceanodroma [leucorhoa] socorroensis*, a taxon many believe may represent a separate species, "Townsend's Storm-Petrel". It nests only on islets off the south end of Isla Guadalupe, Baja California, Mexico. Its pelagic distribution is somewhat of a mystery, but based on current knowledge is believed to range offshore in the eastern Pacific including the southern California Bight. There are no known sightings this far west.

Two unidentified beaked whales, seen only briefly, were likely Cuvier's Beaked Whales (*Ziphius cavirostris*).

	last week	this week
total effort (hours)	55.5	54.8
average daily effort (hours)	7.9	7.8
approx. trackline surveyed (km)	977.5	905.0
species	13	14
average species/day	5	7
total individuals	70	200
avg. # individuals/day	10	29
average wind speed (knots)	19	20
average Beaufort	5	5

Palmyra ECS RB16-01 Seabird Survey Effort Weekly Report 3
26 January to 1 February 2016

The results of the third week of the seabird strip transect survey essentially mirrors the previous two weeks. The trend of low diversity and abundance continues with Sunday standing out as a notable exception. Thirteen species of seabirds were seen that day, well exceeding the previous high count of nine on 21 January. To help put this in perspective, 13 species were seen during the first week of the survey. The first White-necked Petrel of the cruise was seen as well as a Bulwer's Petrel (only the fourth of the survey), and it was the first time both species of tropicbirds (Red-tailed and White-tailed) were seen on the same day. We were about 150 nautical miles southwest of Palmyra Atoll, raising the possibility that we were witnessing the influence of the North Equatorial Countercurrent (it was also a big day for flyingfish). Other than that, and lacking a detailed analysis of concurrent physical oceanographic data, it's difficult to draw any conclusions as to why the species count was so high. Red-footed Booby (45), White Tern (23) and Sooty Tern (11), all local breeders, comprised about 65% of the total birds seen this week. Each of the other fourteen species were represented by less than 10 individuals. The third frigatebird of the cruise finally approached close enough to be identified as an immature Great Frigatebird.

	Week 1	Week 2	this week
total effort (hours)	55.5	54.8	58.1
average daily effort (hours)	7.9	7.8	8.3
approx. trackline surveyed (km)	977.5	905.0	1002
species	13	14	17
average species/day	5	7	7
total individuals	70	200	121
avg. # individuals/day	10	29	17
average wind speed (knots)	19	20	19
average Beaufort	5	5	5

Palmyra ECS RB16-01 Seabird Survey Effort Final Weekly Report
2-8 February 2016

Seabird distribution and abundance data were collected using a standardised 300 metre strip transect while the NOAA ship *Ronald H. Brown* was underway. A single observer maintained a visual watch from either the bridge or flying bridge during daytime hours. All birds seen within a 300 metre arc on one side of the bow were identified to the highest possible taxon. Data were entered into a laptop using *SeeBird (vers 4.2),* a data logger program developed at the Southwest Fisheries Science Center, La Jolla, California. The laptop was connected to the ship's GPS data feed, providing a location and time stamp for every sighting event. The table below summarises total survey effort, both for the final week and for the entire survey.

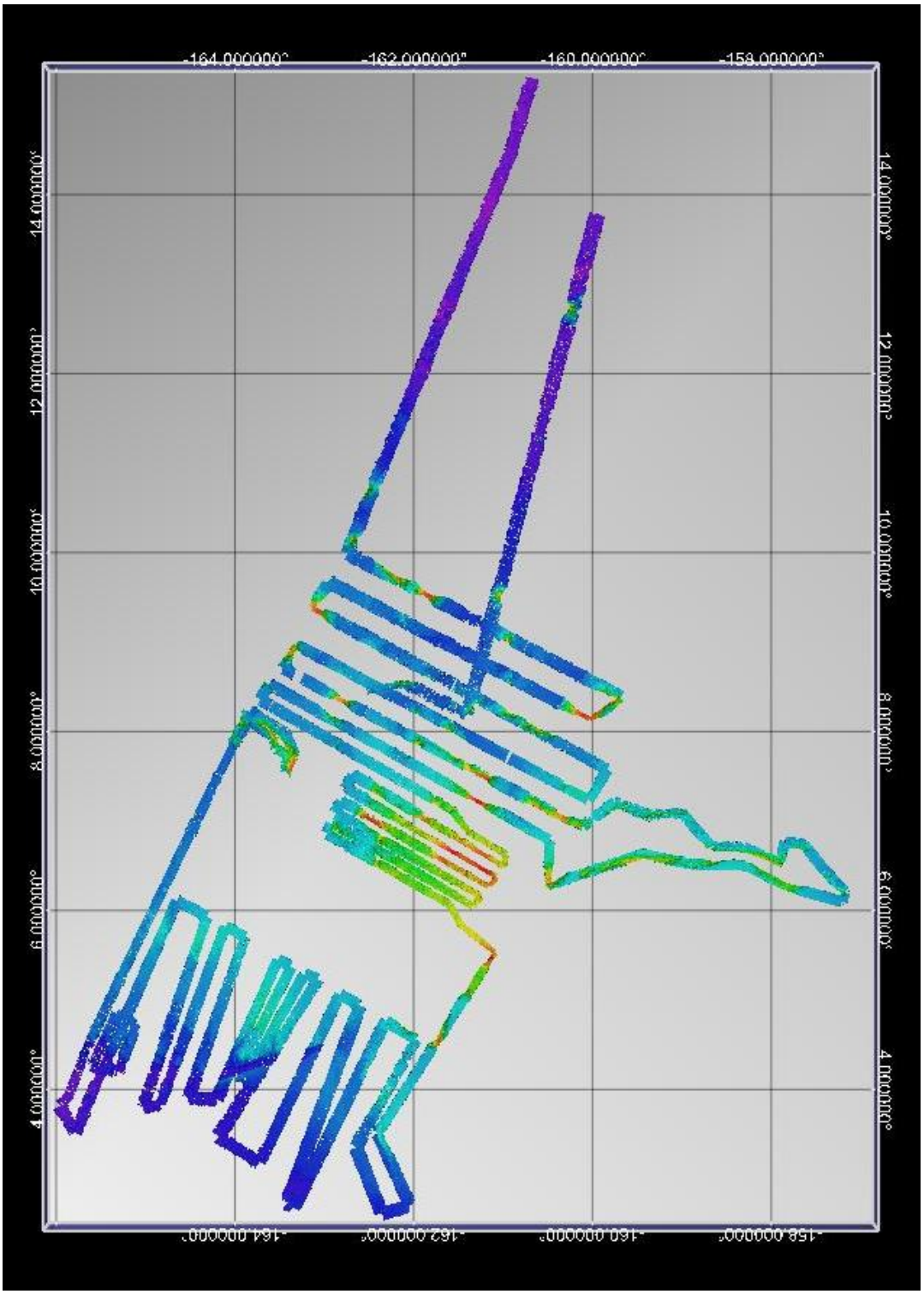
Increased diversity was obvious this week, particularly in the southwestern portion of the study area. Five species: single Collared and Cook's Petrels, Pomarine Jaeger, Christmas Shearwater and three Black-footed Albatross were noteworthy, not having been seen prior to this week. Overall, three species, Red-footed Booby, Sooty Tern, and White Tern comprised 61% of the total birds seen.

I would like to extend my appreciation to all who made this survey possible. Top mention goes to Beth Flint, at the USFWS Pacific Island Refuges and Monuments Office for financial assistance, and to Annette Henry, Cruise Coordinator, NOAA/SWFSC, for logistical support. Heartfelt thanks is due to the officers and crew of the *Ronald H. Brown* for exemplary support and affable camaraderie, and to Chief Scientist Andy Armstrong and his scientific staff. All present made for a very productive and memorable cruise.

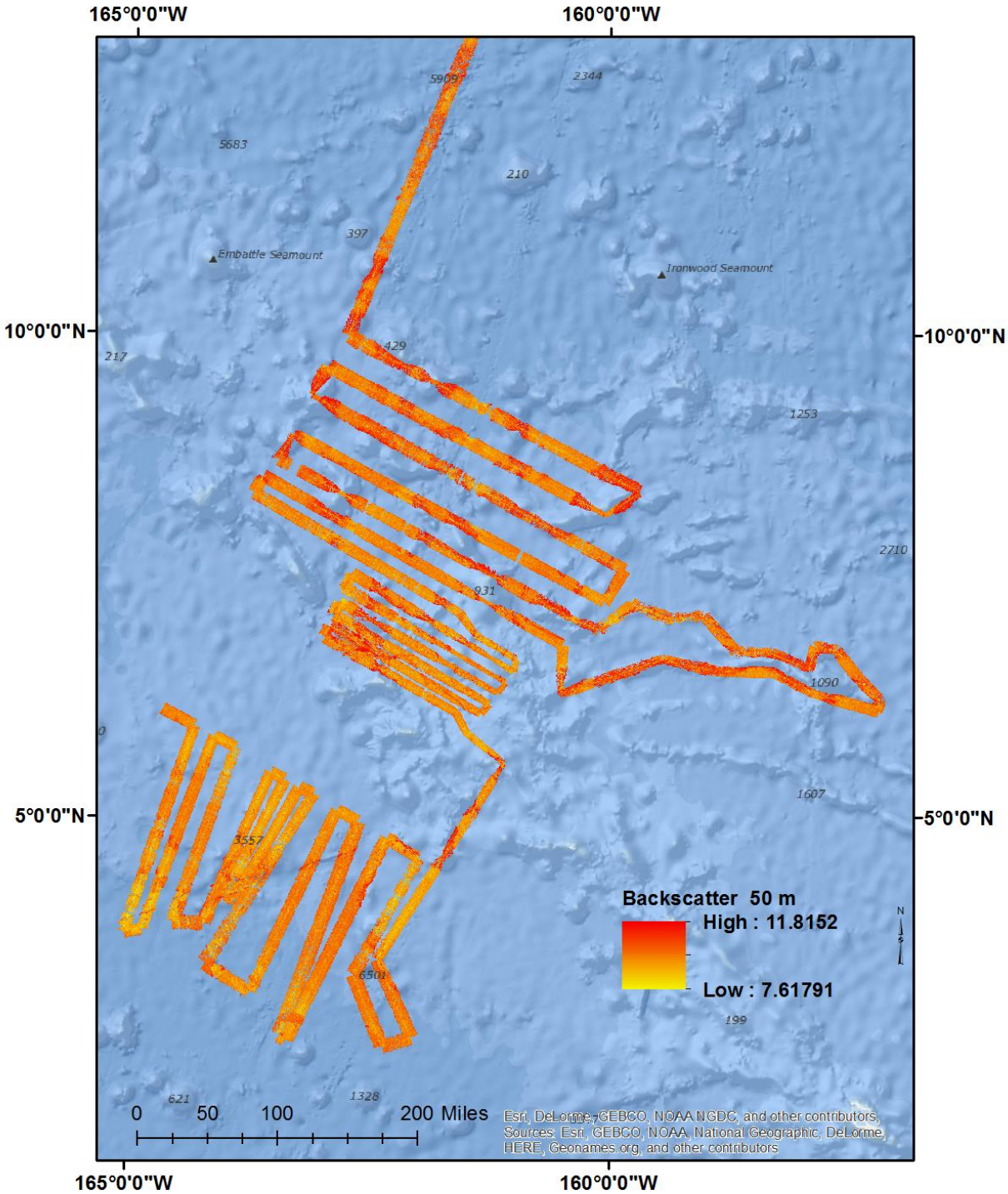
	Week 1	Week 2	Week 3	Week 4	Total
total effort (hours)	55.5	54.8	58.1	59.9	227.9
average daily effort (hours)	7.9	7.8	8.3	8.6	8.15
approx. trackline surveyed (km)	977.5	905.0	1002	1060.5	3944.5
species	13	14	17	20	23
average species/day	5	7	7	7	7
total individuals	70	200	121	197	588
avg. # individuals/day	10	29	17	28	21
average wind speed (knots)	19	20	19	22	20
average Beaufort	5	5	5	6	5

Appendix 5. Maps of Bathymetry and Acoustic Backscatter for Cruise.

Map of bathymetry



Map of acoustic backscatter



Appendix 6. Combined Kingman-Palmyra Post Cruise Cross-Swath Comparison

Introduction

Multibeam bathymetry (MBES) mapping in the U.S. Kingman Reef-Palmyra Atoll area was conducted in 2010, 2015 and 2016 on three dedicated cruises with two different ships totaling 89 days at sea. The cruises in 2010 and 2015 were conducted on the RV *Kilo Moana* equipped with a hull-mounted Kongsberg Maritime 12-kHz EM122 MBES, Knudsen 3260 CHIRP subbottom profiler and a Carson Gravity Meter & Instrument Co. model 6300 gravity meter. The cruise in 2016 was conducted on the NOAA Ship *Ronald H. Brown* equipped a hull-mounted Kongsberg Maritime 12-kHz EM122 MBES and a Knudsen 3260 CHIRP subbottom profiler. The ships and their associated multibeam, seismic and gravimeter systems are outlined in Table 1. The cruises' objective were to map the U.S. Kingman Reef-Palmyra Atoll area from shallower than the 2500 m isobath to the abyssal basin. Each cruise was planned and directed by a senior member of the University of New Hampshire's Center for Coastal & Ocean Mapping/Joint Hydrographic Office. Each ship was equipped with a Kongsberg Maritime MBES system that was interfaced with an inertial motion unit (IMU) and differential Global Position System (DGPS) receivers (Table 2). Details of the cruise and equipment, including the daily log, can be found in the cruise reports (Gardner and Calder, 2010; Calder and Masetti, 2015; Armstrong and Mosher, 2016).

A full Patch Test was performed prior to the commencement of mapping on each of the three cruises. Each Patch Test followed NOAA protocols. The Patch Test was performed to ensure that all of the IMU alignments and offsets were correct so as to eliminate artifacts and large uncertainties in both water depth and sounding position. The test began with a calibration of the XBT (expendable bathythermograph) system by a full-depth CTD (conductivity-temperature-depth) cast and then performing a comparison of the sound speed calculated from the CTD cast to that calculated from the XBT cast immediately after the CTD cast. The Patch Test began only after it was confirmed that sound speed calculated from the XBT data matched the sound speed calculated from the CTD data.

Sound speed in the water column during the cruise was measured at least once every six hours with a Sippican XBT and more frequently when the difference in sound speed at the transducer differed by more than 0.5 m/s. A total of 427 XBTs were cast during the 89 days of mapping. Water-column sound-speed profiles are necessary to account for refraction effects so that each sounding could be ray traced to its correct location on the seafloor.

An *a posteriori* analysis of cross swaths were run several times during each leg to determine the precision of the soundings across the multibeam swath. The analysis was performed using the Interactive Visualization System (now QPS) software *CrossCheck*. The analyses (Appendix 1) demonstrate that the MBES system was consistently acquiring depth soundings with a precision of better than 0.5% of water depth.

Table 1. Multibeam systems used for Keli and Karin gaps bathymetry mapping

Ship	MBES System	Subbottom Profiler	Gravimeter
RV *Kilo Moana*	Kongsberg EM122	Knudsen 3260	Carson 6300
NOAA Ship *Ron Brown*	Kongsberg EM122	Knudsen 3260	

Table 2. Inertial motion unit (IMU) and differential Global Position System (DGPS)

Ship	IMU	DGPS
RV *Kilo Moana*	Applanix POS/MV 320 v4	NovAtel OEM2-3151R
NOAA Ship *Ron Brown*	Applanix POS/MV v5	Fugro Marinestar

Data Processing and Uncertainty Analysis

The Kingman Reef-Palmyra Atoll area was subdivided into three regional areas for operational considerations because of the huge size of the area. The 2010 survey completed a 100% coverage of the central area of interest whereas the 2015 and 2016 surveys collected long profile lines leaving 30 to 50 km gaps of no data so as to obtain a regional view of the entire area. Each of the three areas was subdivided into subareas for processing at the highest resolution the data would allow. The subareas were then combined into small regional grids at their highest resolution as well as combined into a single 100-m resolution sounding grid for an overview of the entire Kingman Reef-Palmyra Atoll area.

The data from the 2010 cruise was processed by Dr. James V. Gardner, a marine geologist at the Center for Coastal & Ocean Mapping/Joint Hydrographic Center of the University of New Hampshire. He was also the Chief Scientist on the cruise. Data from the 2015 cruise was processed by Dr. Brian R. Calder, an electrical/ocean engineer at the Center for Coastal & Ocean Mapping/Joint Hydrographic Center of the University of New Hampshire. Dr. Calder was also the Chief Scientist on the 2015 cruise. Data from the 2016 cruise was processed by NOAA Lt. John Kidd, an experienced hydrographer with the National Ocean Survey, NOAA. Multibeam bathymetry and acoustic backscatter processing of the 2010 cruise utilized the University of New Brunswick Ocean Mapping Group's *SwathEd* software and QPS *FMGT* for processing backscatter. Data from the 2015 and 2016 cruises were processed using CARIS *HIPS* for bathymetry and QPS *FMGT* for backscatter.

The Subbottom Profiler data were processed using the Chesapeake Technology, Inc. *SonarWeb* and *SonarWiz5* software. Gravity data from the 2010 were processed by the University of Hawai'i Hawaii Mapping Research Group and by NSF's Rolling Deck to Repository (R2R) for the 2015 data. No gravity data was collected on the 2016 cruise.

Multibeam Bathymetry and Acoustic Backscatter Processing

Each Kongsberg *.all* file was collected by an onboard Kongsberg *SIS* (2008, 2012 and 2015) data-acquisition system. The acquisition software adjusted each sounding for (1) transducer draft, (2) static roll, pitch and gyro misalignments, (3) roll at reception, (4) refracted ray path and (5) beam steering at the transducer interface. Post-logging transformations included (1) transformation of navigation from antenna to transducer, (2) correction for positioning to sonar time shifts and (3) any unaccounted-for static attitude misalignments.

Once a line was completed, the *.all* file was copied to a server that could be accessed via a shipboard network. Each *.all* file was renamed from the system-generated file name to *KingmanPalmyra_line_n.all* so that later each file could be easily identified to the area. The line numbers commenced with *KingmanPalmyra_line_1* when the actual mapping began. Each *.all* file is composed of individual data packets of beam bathymetry (range and angle), beam average and full time-series acoustic backscatter, navigation, parameters, sound-speed profiles,

orientation and sound speed at the transducer. The first step in the processing (Fig. 1) separates each of these data packets into the individual files.

The second step in the processing plots the navigation file so that any bad fixes can be flagged. Once this step is completed, the validated navigation is merged with the bathymetry and acoustic backscatter files.

The third step involves editing (flagging) individual soundings that appear to be fliers, bad points, multipaths, side-lobe returns, etc. All of the files of soundings are viewed and edited in a sequence of steps through the file. Once the bathymetry file has been edited, the valid individual soundings are gridded into subarea DTM maps and the co-registered valid acoustic backscatter full-beam time series is assembled into a file and gridded into subarea mosaics. The complete data-processing workflow is shown on Figure 1.

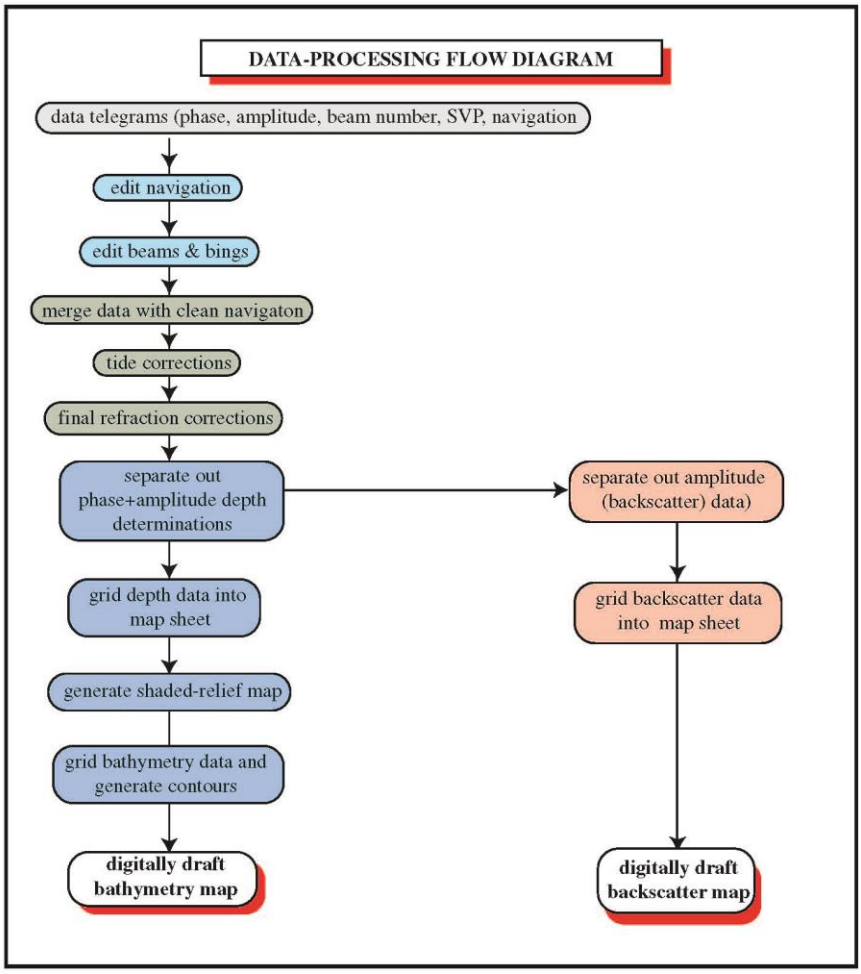


Figure 1. Steps in processing multibeam bathymetry and acoustic backscatter

The Kongsberg MBES system provides a backscatter-intensity time series for the bottom ensonification period for each of the individual receive apertures. The corrections applied by the shipboard recording system are listed in Table 3.

Table 3. Corrections applied to each beam for backscatter.

• source power adjustments. • spherical spreading compensation. • attenuation compensation (using operator entered 30 dB per km.). • TVG adjustments. • designed beam-pattern compensation. • calculation of insonified area (assuming a flat seafloor at the nadir depth). • application of a Lambertian model using flat seafloor equivalent grazing angles) to reduce the dynamic range of the data (stored at 8 bit (0= -128dB, 255 = 0 dB.).

A set of required backscatter data transformations is performed by the University of New Brunswick *SwathEd* and QPS *FMGT* software. The transformations include conversion of each beam backscatter time series to a horizontal range equivalent, splicing the individual beam traces together to produce one full slant-range corrected trace and removal of residual beam-pattern effects.

The processing approach for backscatter was to stack several thousand pings to view the angular variation of received backscatter intensity as a function of beam angle. Inherent in this function is both transmit and receive sensitivities, as well as the mean angular response of the seafloor. This function is then inverted to minimize the beam pattern and angular variations.

The Kongsberg MBES systems use a variable gain within 15° of vertical to reduce logged dynamic range at nadir and near-nadir. The backscatter data at this stage have had a Lambertian response removed and the beam pattern has been corrected with respect to the vertical and all receive beams have been roll stabilized. Consequently, corrections have been made for variations in the beam-forming amplifiers but not variations in the stave sensitivities of the physical array. Additional transformations were required to produce calibrated backscatter measurements. These include (1) removal of Lambertian model, (2) true seafloor slope correction, (3) refracted ray-path correction, (4) residual beam-pattern correction, and (5) aspherical-spreading corrections.

Morphologic features in the derived 3.6 arc-second (~100 m) cell-size bathymetric and curvature grids have an expected horizontal accuracy of less than one grid cell (100 m), and a vertical accuracy of 0.5% of water depth.

Navigational Uncertainty

Table 2 identifies the inertial motion units and differential Global Position Systems used for each of the ships. The IMU provides a real-time readout of x, y, z position accuracy as determined by the DGPS and IMU systems. Because all cruises used a commercial subscription service for instantaneous differential correctors to the DGPS solutions, the navigational uncertainty for the U.S. Kingman Reef-Palmyra Atoll surveys is on the order of 1 m or less for the 2010, 2015 and 2016 cruises.

Subbottom Profiler Processing

All of the subbottom profiler data for each cruise was collected in standard SEG-Y format. Very little processing was performed on individual files; only reading in each SEG-Y file and generating a JPEG output image of each file. All of the phase changes were compensated by the

Chesapeake Technology, Inc. *SonarWeb* and *SonarWiz5* software. Each processed line was also converted to a QPS *Fledermaus* SD file so that the subbottom data curtain could be visualized in a 3D view and overlaid on a DTM surface.

Bathymetry uncertainty

The CLCS Guidelines indicate that an *a priori* or *a posteriori* analysis can be conducted to ascertain the uncertainty of the bathymetric database used to derive the various formulae and limit lines used for a submission. When considering an *a priori* analysis, the Guidelines further specify that the International Hydrographic Organization (IHO) Standards for Hydrographic Surveys, Special Publication No. 44, 4th Edition (1998) may be followed to assess the bathymetry uncertainty, noting that S.44 provides required limits on the total uncertainty of soundings at the 95% confidence level as opposed to simply the precision of the soundings. For water depths greater than 200 m, S.44 indicates that Order 3 survey is appropriate, and hence that the maximum allowable bathymetric uncertainty at the 95% confidence level is the quadratic sum of a 5 m fixed vertical uncertainty, plus a variable uncertainty that grows as 2.3% of the indicated water depth.

Given the depths involved, the fixed vertical uncertainty is insignificant with respect to the variable portion (approximately 1%), and, therefore, the target uncertainty should be understood to be 2.3% of water depth at 95% confidence (69 m at 3000 m depth, or approximately 35 m standard deviation assuming Gaussian distribution of observations). Vertical correctors such as waterline variations (loading), draft, dynamic draft, and tides that all affect the overall uncertainty are also an insignificant component of the overall uncertainty budget in deep water, and may safely be ignored. Therefore, it can be concluded that the principal component of uncertainty in deep water is reflected in the precision of the data observed, which includes effects of motion and sound-speed variability, and should have precision better than 2.3% of water depth in order to meet the vertical requirements of S.44 (4th Edition) in deep water. Note that this is an upper limit of allowed uncertainty, rather than an estimate of the achievable uncertainty of the systems used for this mapping effort.

An *a posteriori* analysis of precision was conducted throughout the U.S. Kingman Reef-Palmyra Atoll area mapping by performing cross-swath analysis checks between the survey lines and specifically collected cross-lines. Cross-swath (Figure 2; Appendix 1) show that the precision achieved during the bathymetry mapping was approximately 0.5% of water depth, out-performing the maximum allowed uncertainty as determined by *a priori* analysis. Effects that would be common to both survey lines in each pair used for cross-swath analyses would not be reflected in this total, and, therefore, this number should be considered as a lower-bound on the achievable uncertainty of the data. However, such effects (e.g., from loading, draft, or dynamic draft) are expected to be small in proportion to the overall uncertainty in the water depths considered and would, therefore, be unlikely to significantly impact the overall assessment. In addition, because the cross-lines and main survey lines were collected by design at significantly different times, any persistent biases that were not being appropriately corrected would be reflected in higher uncertainties being estimated, or in significant spikes in the overall distribution of cross-check errors. No such effects were observed.

Therefore, it is concluded that the true uncertainty of the bathymetric database for these Atlantic margin surveys is in the range 0.5-2.3% of water depth at the 95% level, with a distribution strongly skewed to the lower end of the range.

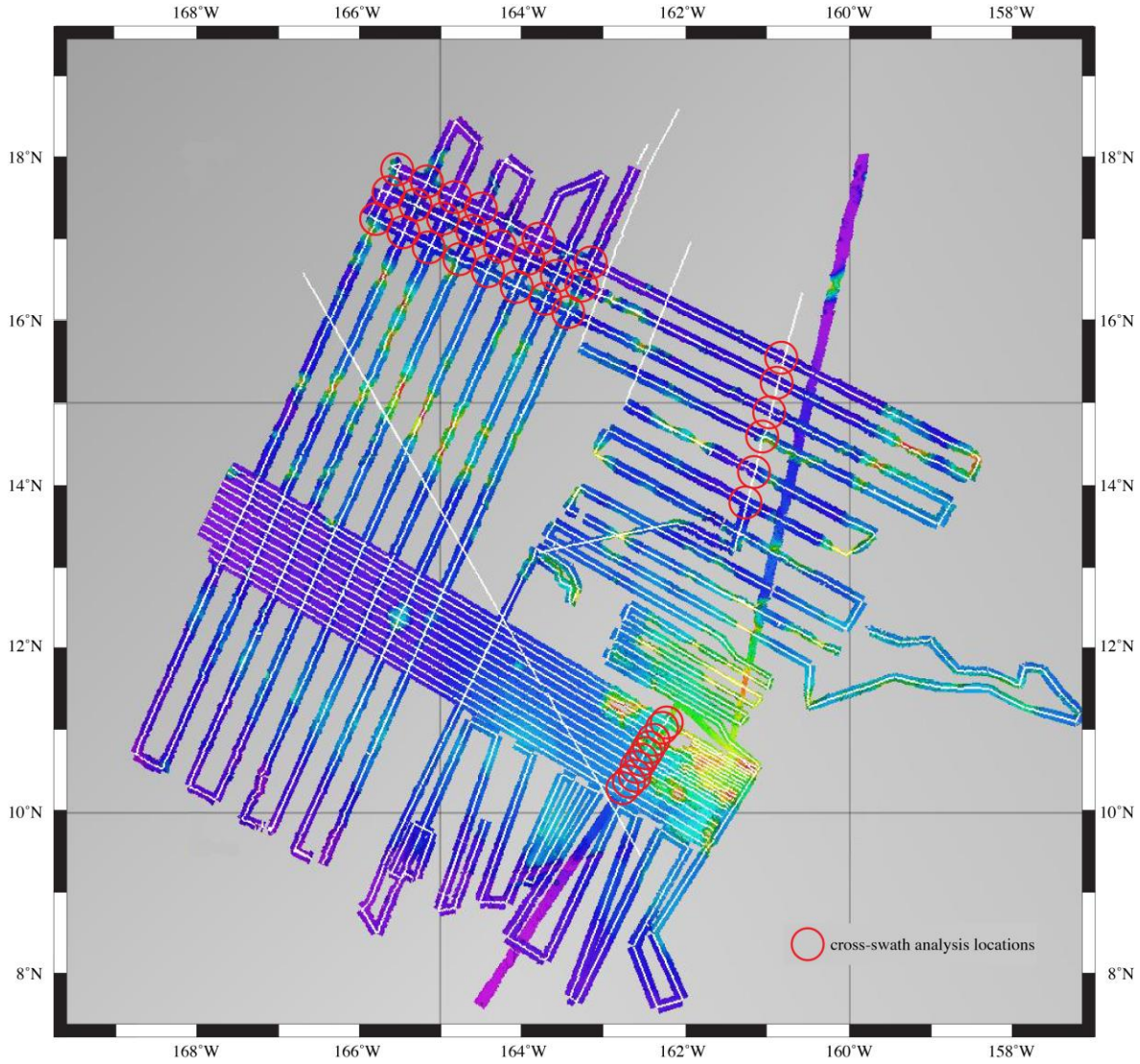
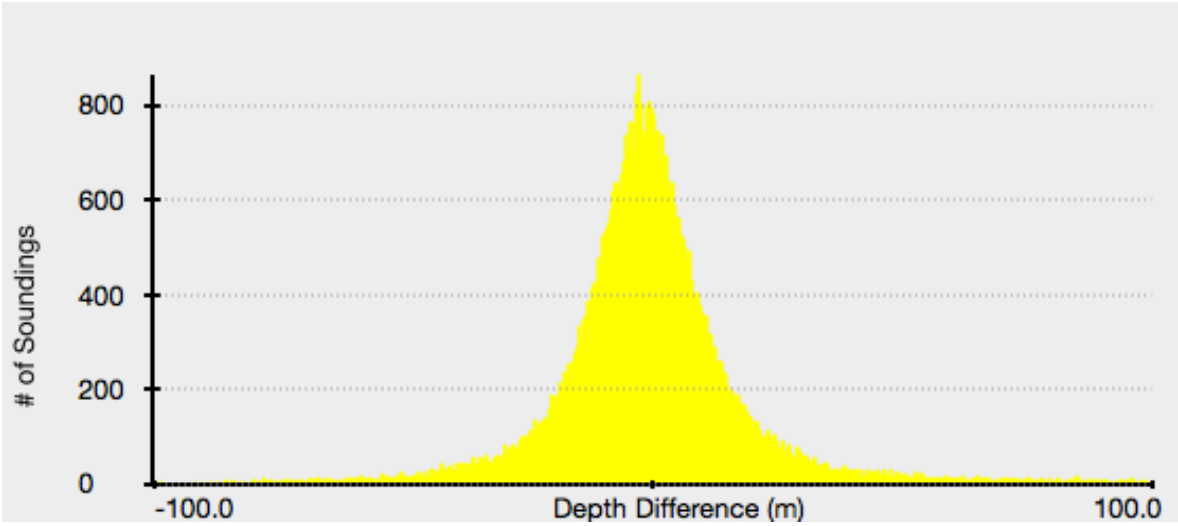


Figure 2. Locations of cross-swath analyses for the Kingman Reef-Palmyra Atoll area.

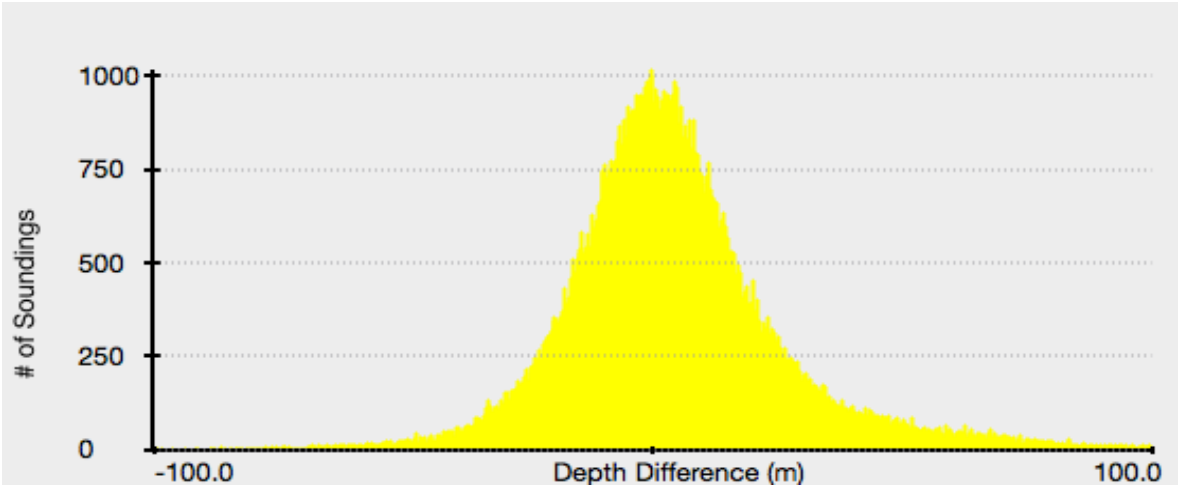
Appendix 1. Cross-swath analyses at U.S. Kingman Reef-Palmyra Atoll area



Histogram of sounding-depth differences from cross-line check of Line 44 and dipline 37 (fairly rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

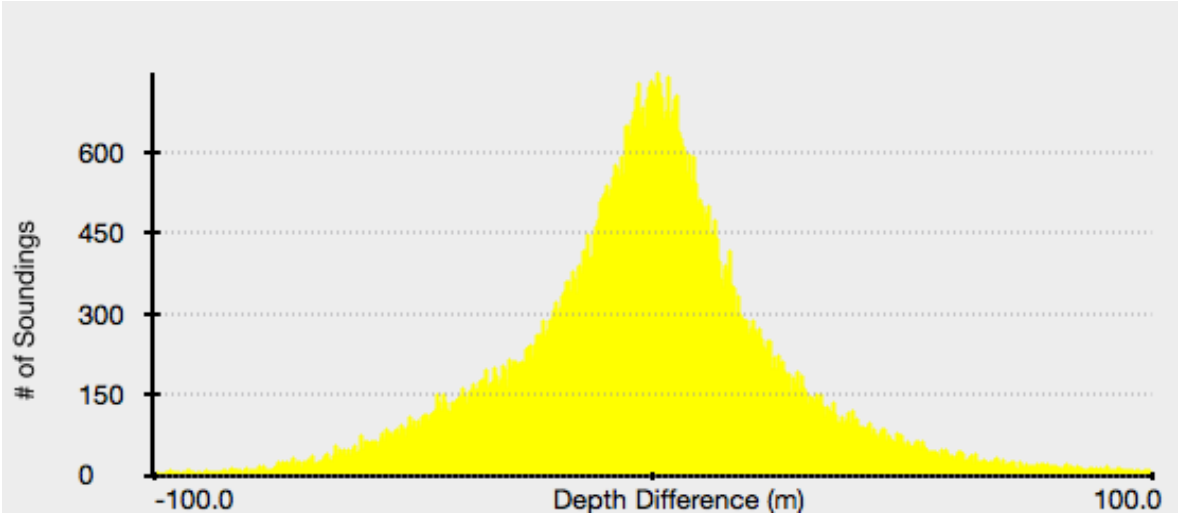
Line 44 vs dipline 37	Mean water depth	3543 m
	Mean Z difference	-0.62 m
	Standard deviation	19.96 m
	Number of samples	56,494
	Percent of water depth	1.0% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 55 and dipline 37 (fairly rough bathymetry). Kongsberg Maritime EM122..

Cross check statistics for the above lines.

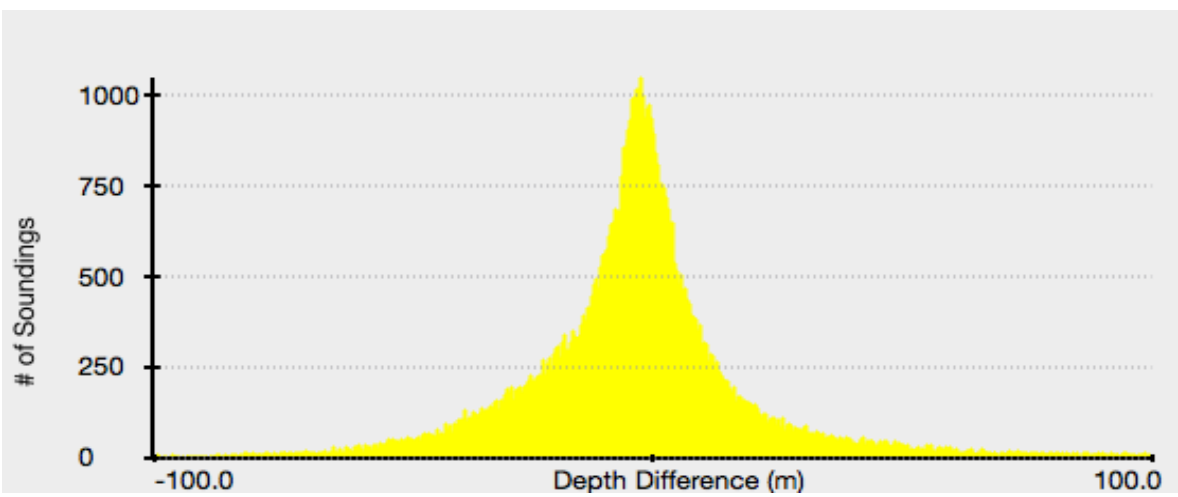
Line 55 vs dipline 37	Mean water depth	3570
	Mean Z difference	4.01 m
	Standard deviation	22.49 m
	Number of samples	99,974
	Percent of water depth	1.4% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 67 and dipline 37 (fairly rough bathymetry). Kongsberg Maritime EM122..

Cross check statistics for the above lines.

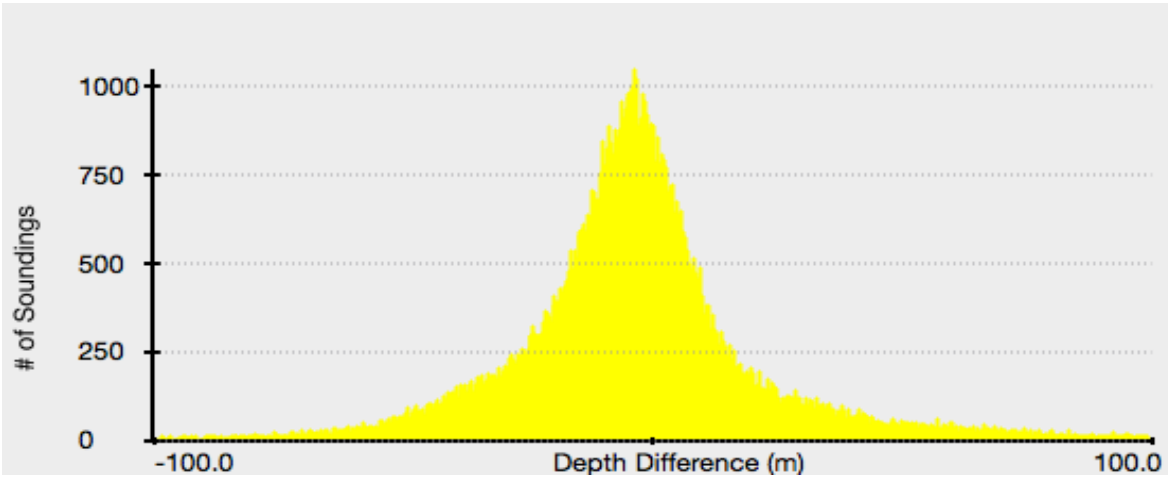
Line 67 vs dipline 37	Mean water depth	3351 m
	Mean Z difference	-1.06 m
	Standard deviation	27.25 m
	Number of samples	82,440
	Percent of water depth	1.6% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 74 and dipline 37(somewhat rough bathymetry). Kongsberg Maritime EM122..

Cross check statistics for the above lines.

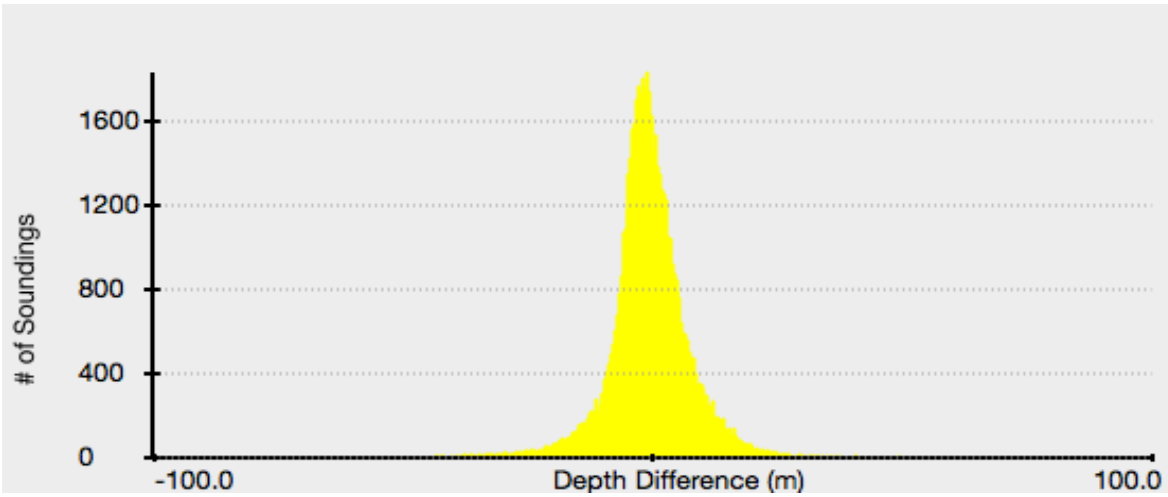
Line 74 vs dipline 37	Mean water depth	3437 m
	Mean Z difference	-3.30 m
	Standard deviation	23.82 m
	Number of samples	70,482
	Percent of water depth	1.3% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 86 and dipline 37 (somewhat rough bathymetry). Kongsberg Maritime EM122..

Cross check statistics for the above lines.

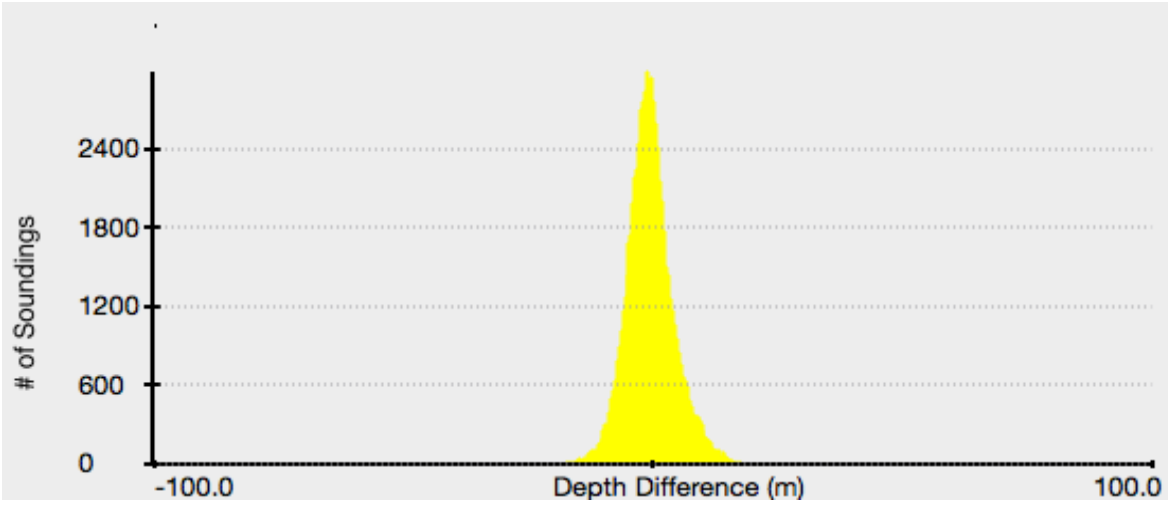
Line 86 vs dipline 37	Mean water depth	3864 m
	Mean Z difference	-3.32 m
	Standard deviation	25.86 m
	Number of samples	89,187
	Percent of water depth	1.2% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 88 and dipline 37 (somewhat rough bathymetry). Kongsberg Maritime EM122..

Cross check statistics for the above lines.

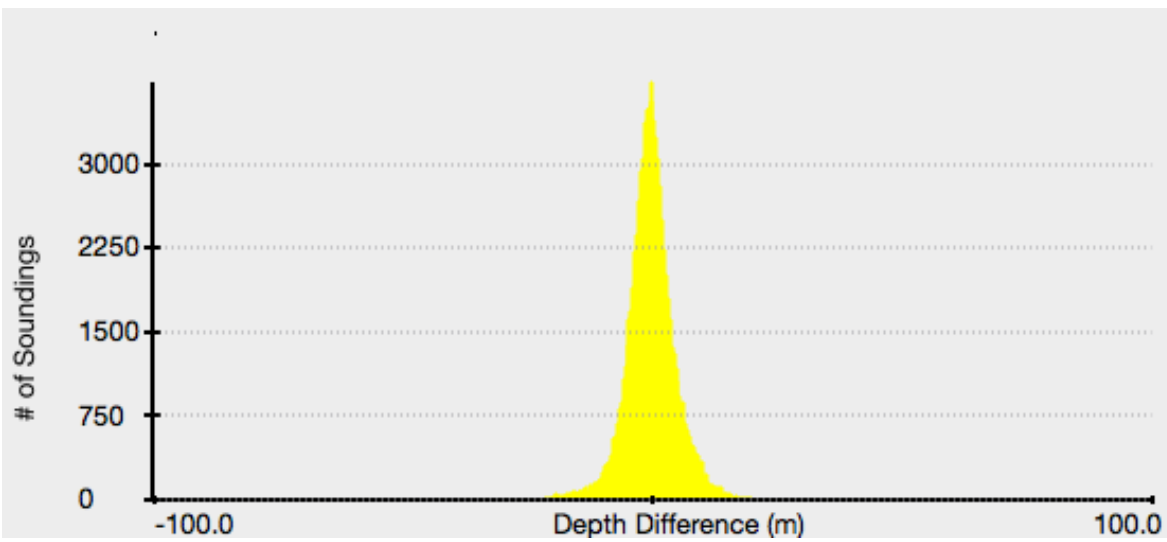
Line 88 vs dipline 37	Mean water depth	4279 m
	Mean Z difference	-0.76 m
	Standard deviation	9.93 m
	Number of samples	61,852
	Percent of water depth	0.9% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 99 and dipline 37 (smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

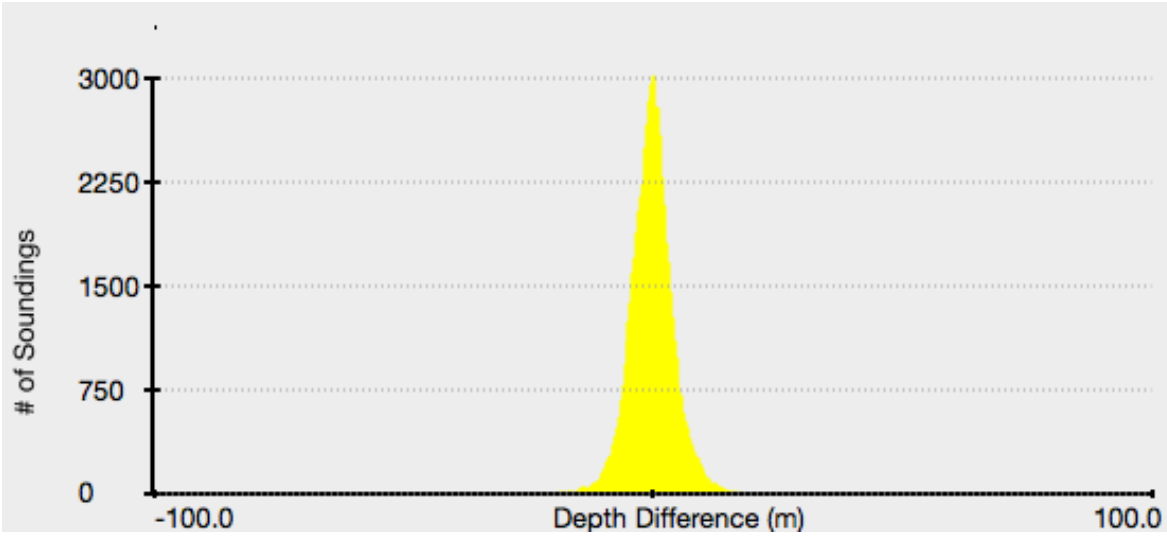
Line 99 vs dipline 37	Mean water depth	4359 m
	Mean Z difference	-0.45 m
	Standard deviation	4.72 m
	Number of samples	72,988
	Percent of water depth	0.2% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 102 and dipline 37 (smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

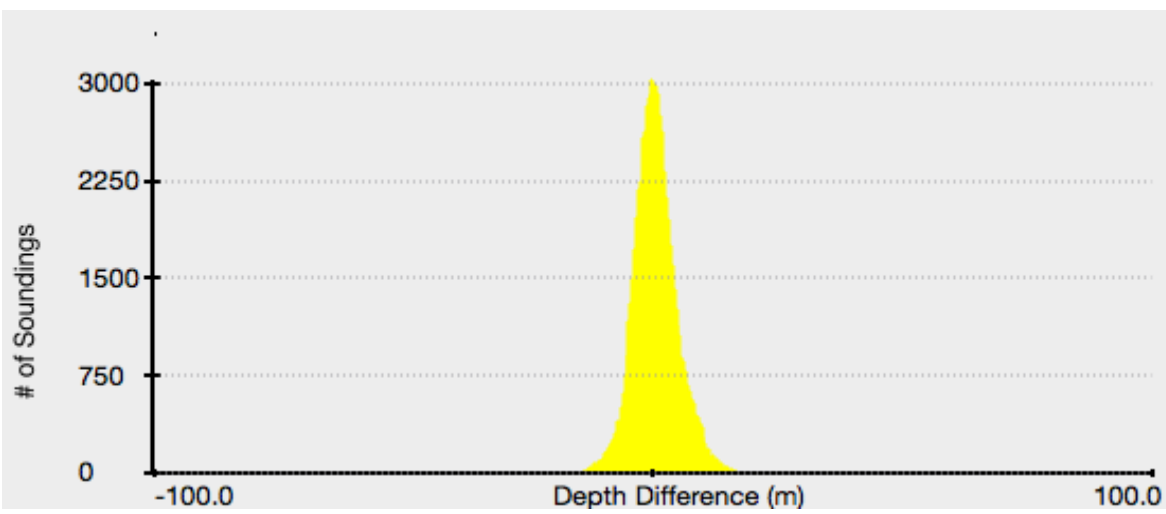
Line 102 vs dipline 37	Mean water depth	4381 m
	Mean Z difference	-0.28 m
	Standard deviation	5.01 m
	Number of samples	83,741
	Percent of water depth	0.2% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 115 and dipline 37 (smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

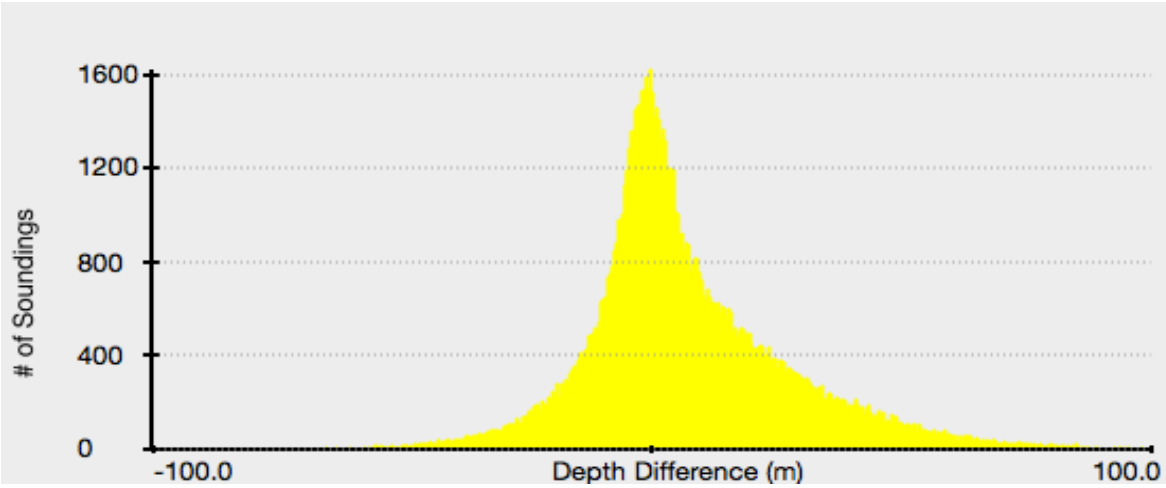
Line 115 vs dipline 37	Mean water depth	4390 m
	Mean Z difference	-0.14 m
	Standard deviation	4.31 m
	Number of samples	66,081
	Percent of water depth	0.2% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 118 and dipline 37 (smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

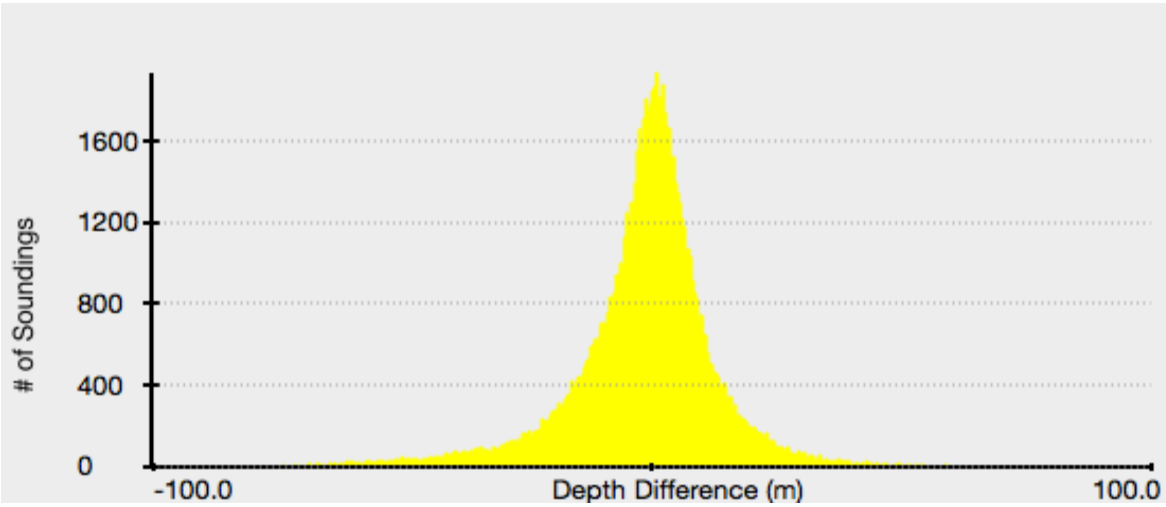
Line 118 vs dipline 37	Mean water depth	4410 m
	Mean Z difference	0.62 m
	Standard deviation	4.30 m
	Number of samples	71,727
	Percent of water depth	0.2% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 311 and dipline 309 (fairly smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

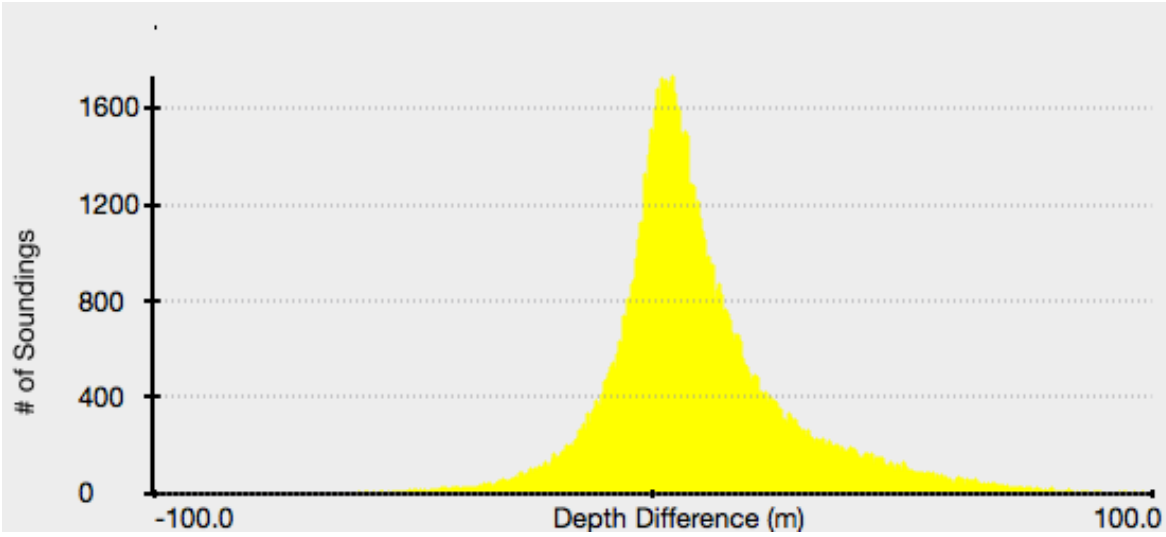
Line 311 vs dipline 309	Mean water depth	5031 m
	Mean Z difference	6.90 m
	Standard deviation	20.42 m
	Number of samples	111,238
	Percent of water depth	0.9% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 326 and dipline 309 (mostly smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

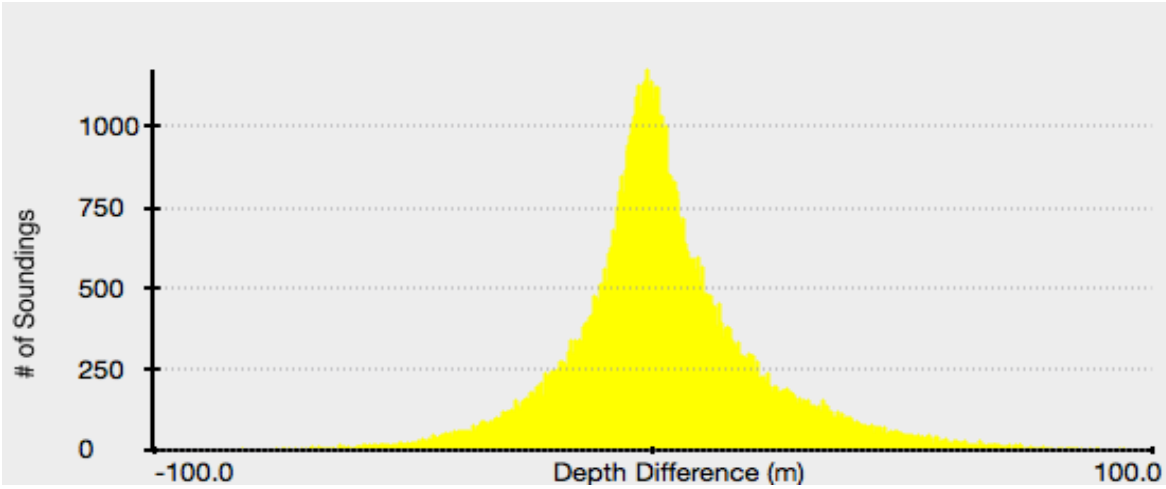
Line 326 vs dipline 309	Mean water depth	5294 m
	Mean Z difference	-1.46 m
	Standard deviation	14.93 m
	Number of samples	99,890
	Percent of water depth	0.5% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 328 and dipline 309 (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

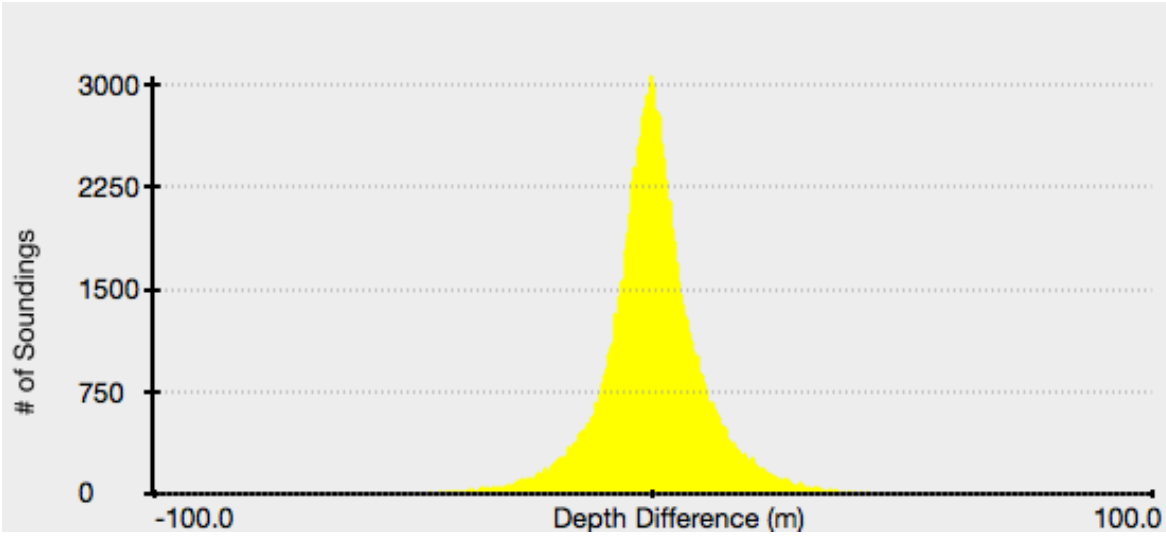
Line 328 vs dipline 309	Mean water depth	4670 m
	Mean Z difference	8.95 m
	Standard deviation	18.87 m
	Number of samples	111,847
	Percent of water depth	1.5% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 326 and dipline 295 (irregular bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

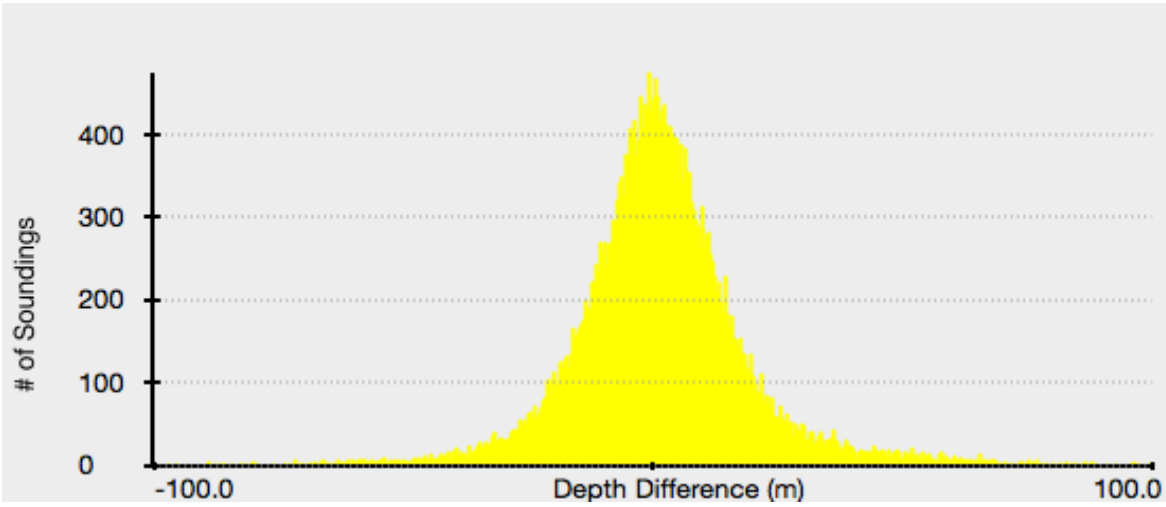
Line 326 vs dipline 295	Mean water depth	5088 m
	Mean Z difference	2.17 m
	Standard deviation	19.94 m
	Number of samples	81,265
	Percent of water depth	0.9% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 329 and dipline 295 (smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

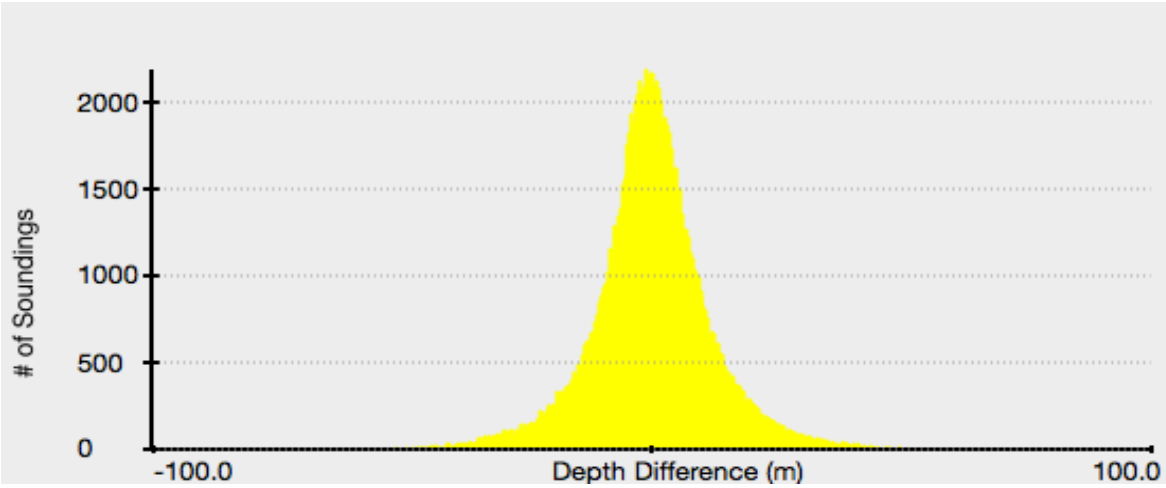
Line 329 vs dipline 295	Mean water depth	5193 m
	Mean Z difference	0.11 m
	Standard deviation	10.26 m
	Number of samples	125,545
	Percent of water depth	0.4% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 325 and dipline 291 (fairly bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

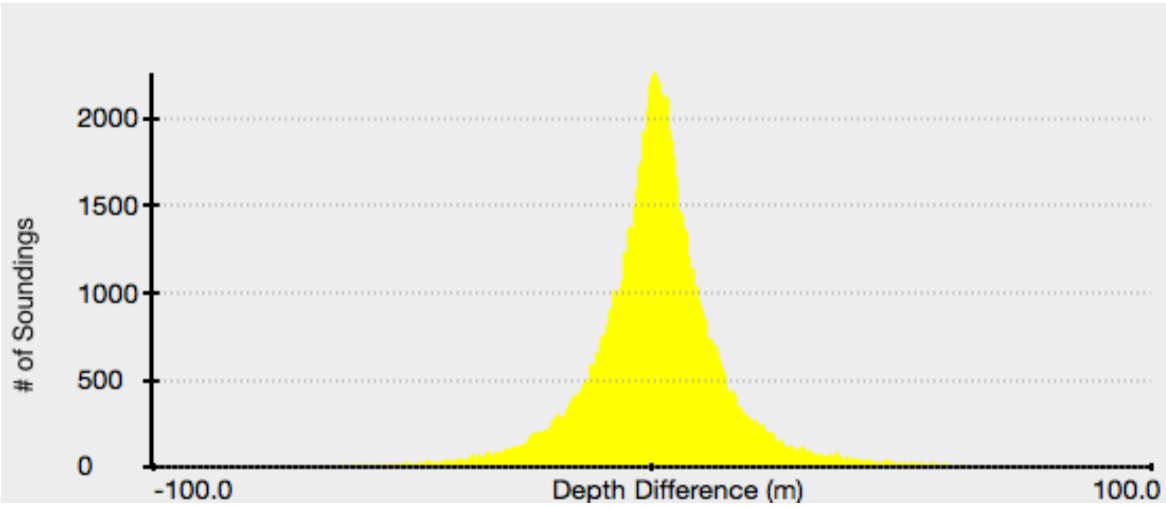
Line 325 vs dipline 291	Mean water depth	5153 m
	Mean Z difference	1.53 m
	Standard deviation	18.13 m
	Number of samples	34,181
	Percent of water depth	0.9% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 329 and dipline 291 (smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

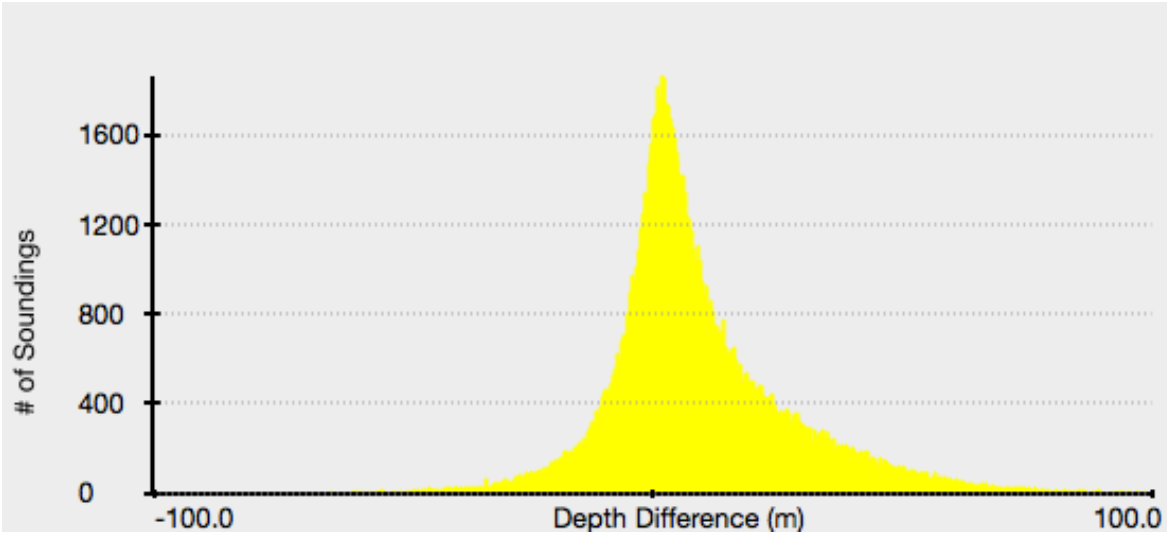
Line 329 vs dipline 291	Mean water depth	5094 m
	Mean Z difference	0.08 m
	Standard deviation	12.13 m
	Number of samples	118,393
	Percent of water depth	0.5% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 311 and dipline 292 (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

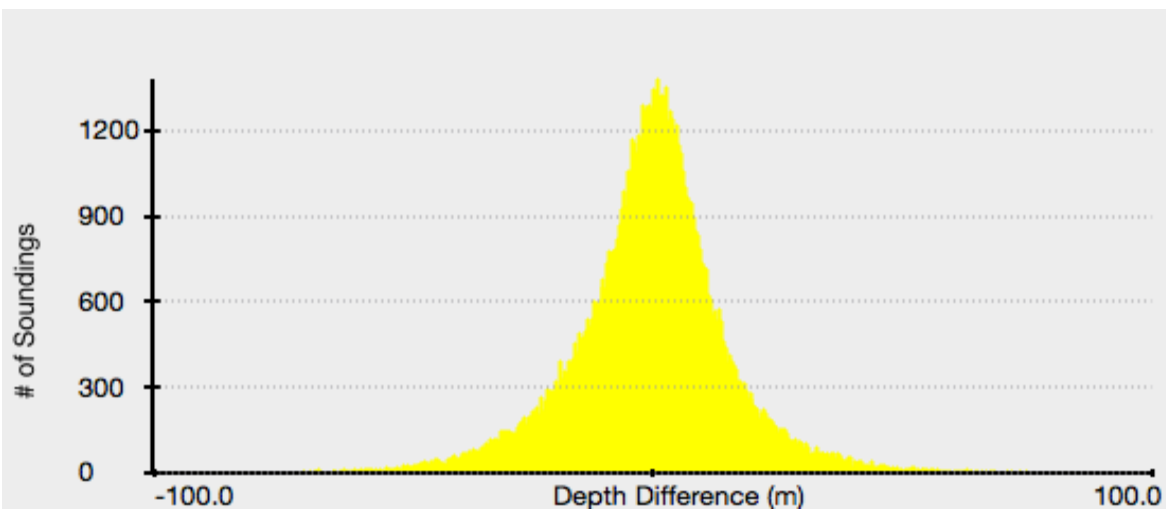
Line 311 vs dipline 292	Mean water depth	4719 m
	Mean Z difference	9.16 m
	Standard deviation	19.36 m
	Number of samples	111,334
	Percent of water depth	1.0% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 329 and dipline 277 (somewhat rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

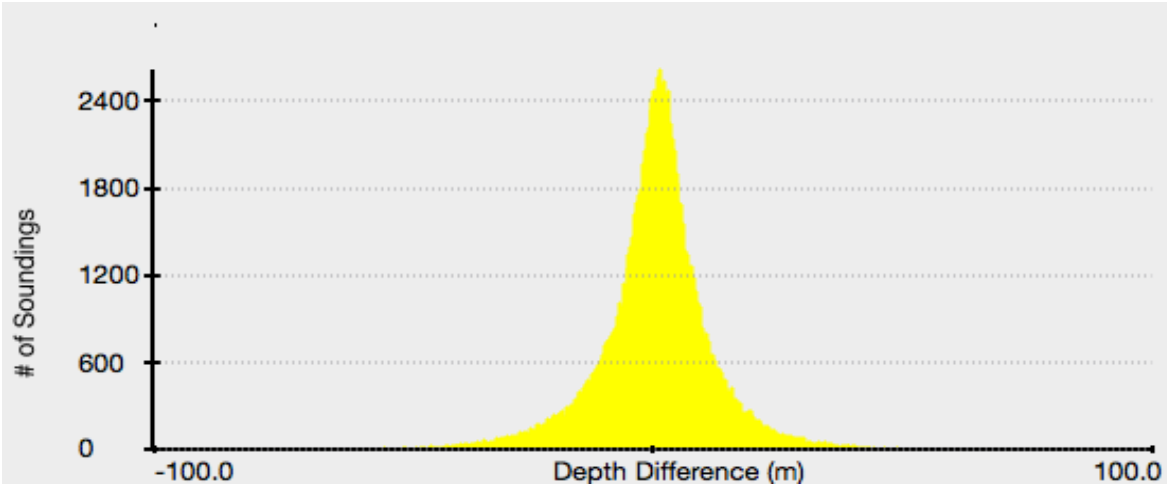
Line 329 vs dipline 277	Mean water depth	5031 m
	Mean Z difference	6.90 m
	Standard deviation	20.42 m
	Number of samples	111,238
	Percent of water depth	1.0% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 325 and dipline 277 (smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

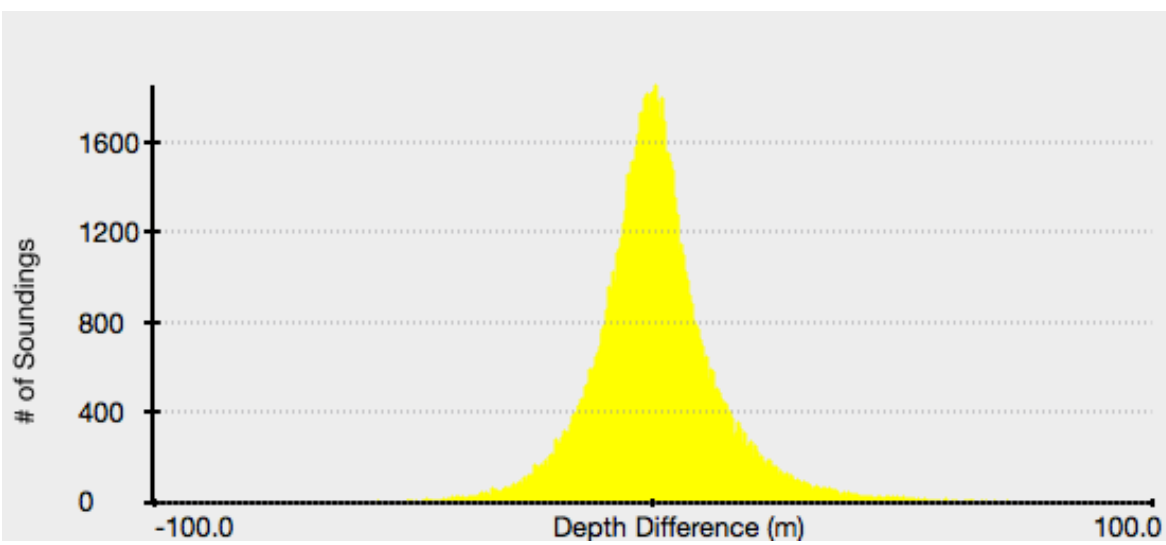
Line 277 vs dipline 277	Mean water depth	5089 m
	Mean Z difference	-0.30 m
	Standard deviation	16.21 m
	Number of samples	93,292
	Percent of water depth	0.6% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 311 and dipline 277 (smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

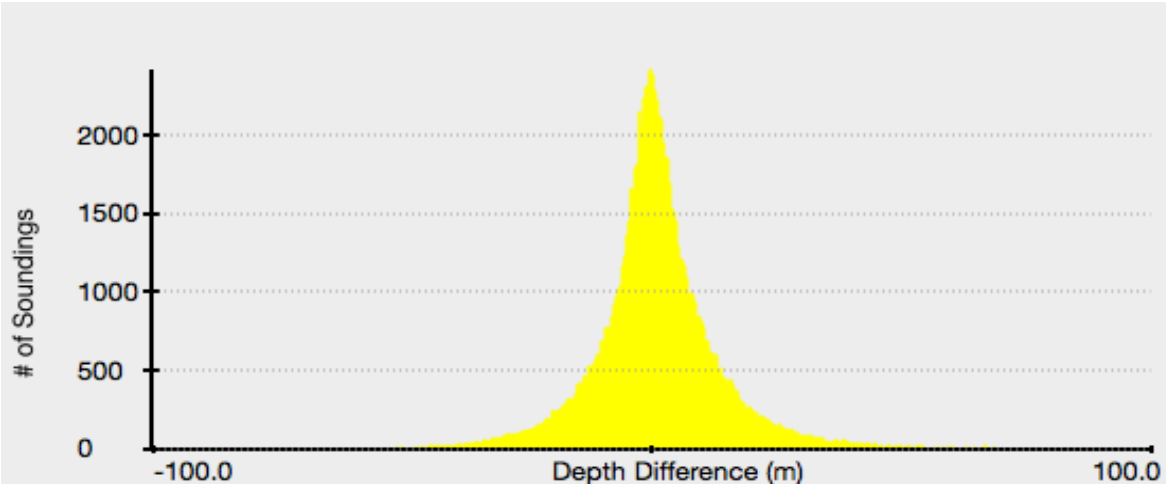
Line 311 vs dipline 277	Mean water depth	5312 m
	Mean Z difference	0.59 m
	Standard deviation	11.67 m
	Number of samples	113,016
	Percent of water depth	0.4% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 325 and dipline 273 (fairly smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

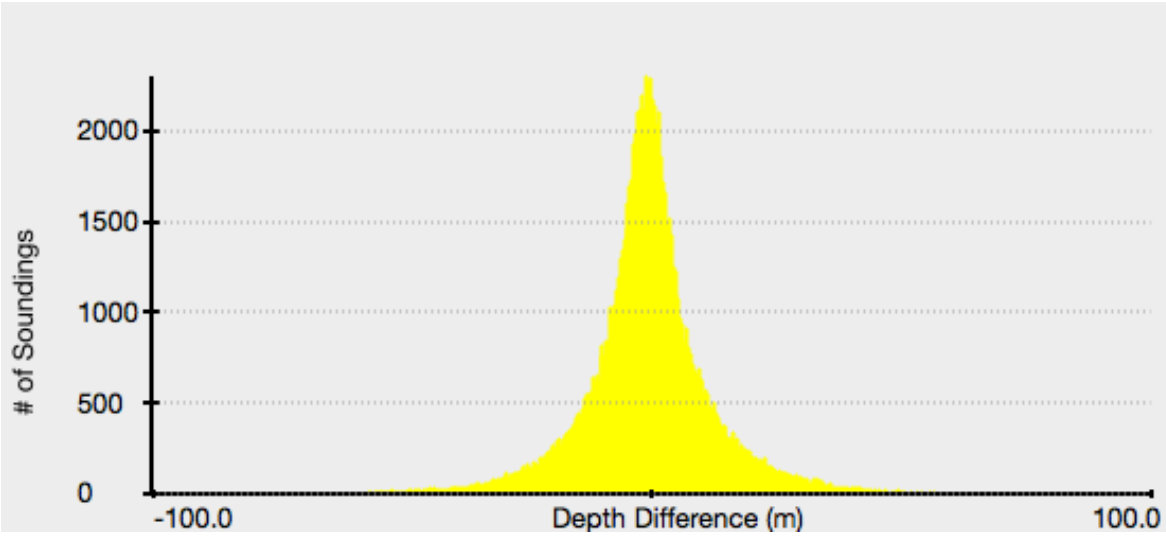
Line 325 vs dipline 273	Mean water depth	5336 m
	Mean Z difference	0.61 m
	Standard deviation	13.69 m
	Number of samples	100,214
	Percent of water depth	0.5% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 330 and dipline 273 (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

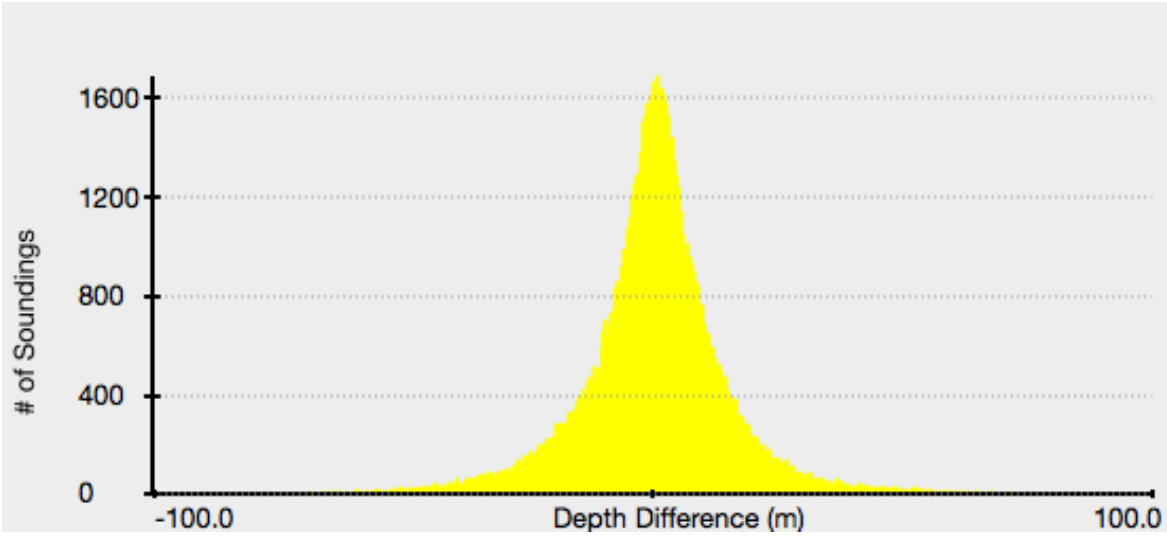
Line 330 vs dipline 273	Mean water depth	4953 m
	Mean Z difference	1.21 m
	Standard deviation	13.43 m
	Number of samples	107,938
	Percent of water depth	0.6% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 330 and dipline 252 (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

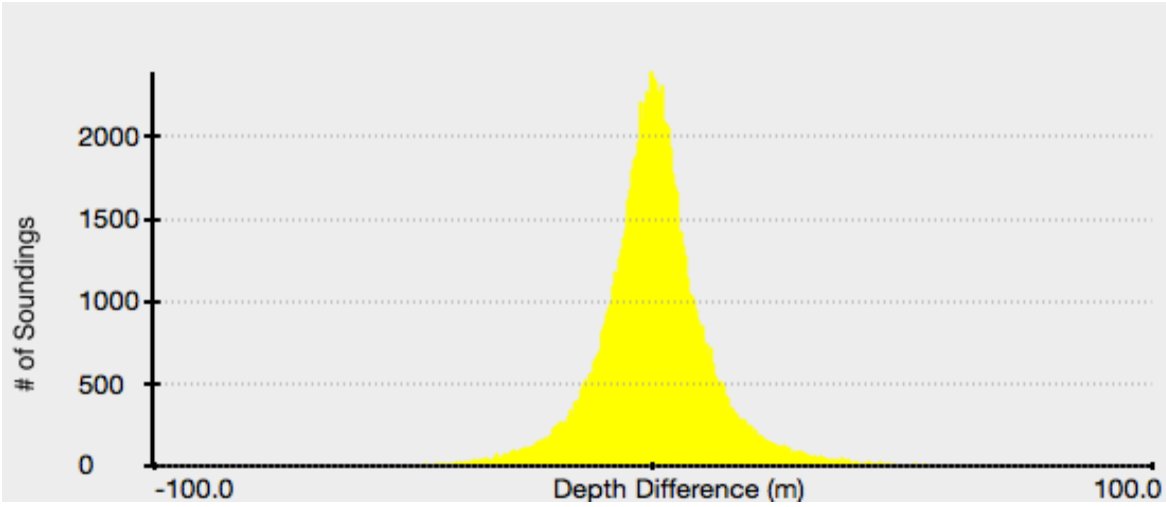
Line 330 vs dipline 252	Mean water depth	4928 m
	Mean Z difference	-0.70 m
	Standard deviation	13.13 m
	Number of samples	104,365
	Percent of water depth	0.5% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 324 and dipline 252 (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

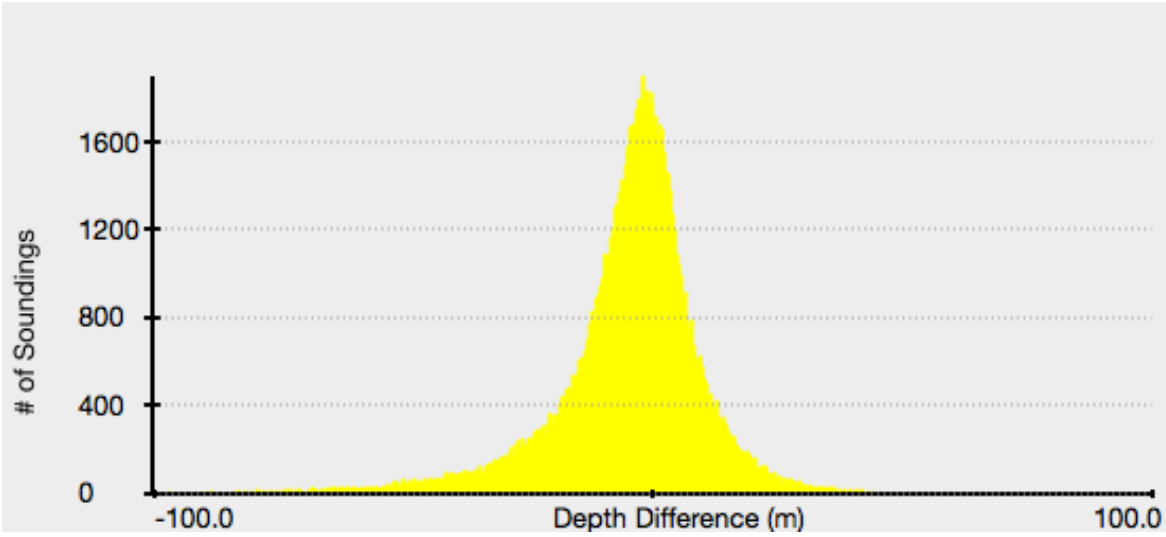
Line 324 vs dipline 252	Mean water depth	5238 m
	Mean Z difference	0.31 m
	Standard deviation	15.01 m
	Number of samples	93,470
	Percent of water depth	0.6% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 331 and dipline 252 (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

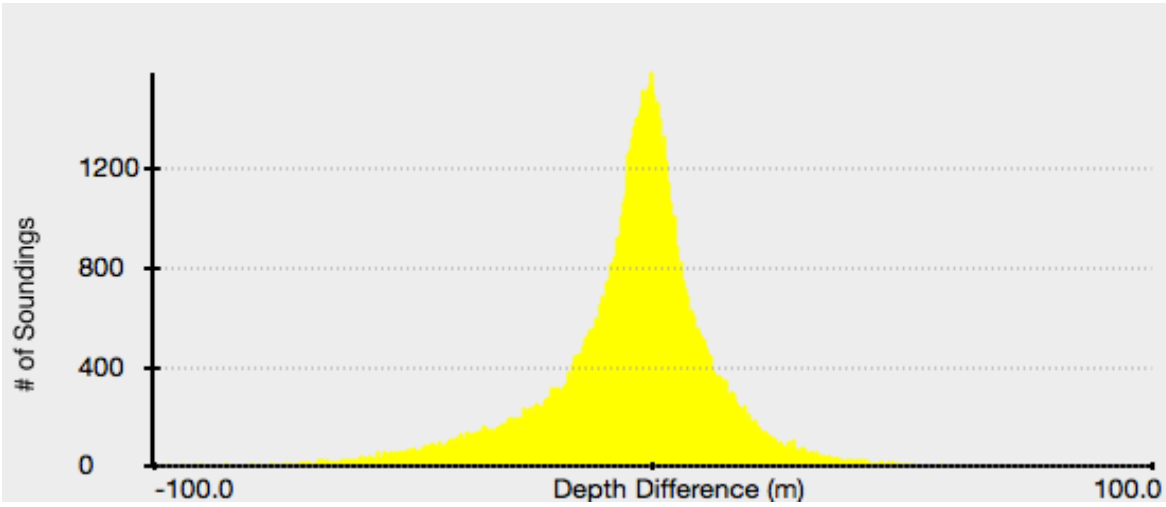
Line 331vs dipline 252	Mean water depth	5465 m
	Mean Z difference	0.35 m
	Standard deviation	11.47 m
	Number of samples	112,622
	Percent of water depth	0.4% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 311 and dipline 231 (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

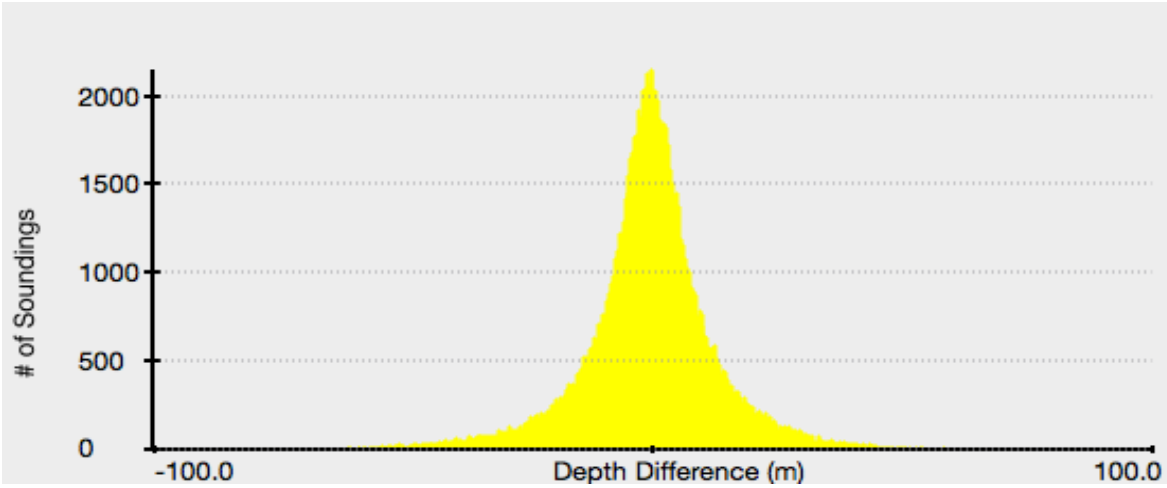
Line 311 vs dipline 231	Mean water depth	4825 m
	Mean Z difference	-4.92 m
	Standard deviation	15.49 m
	Number of samples	106,804
	Percent of water depth	0.5% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 324 and dipline 231 (mostly smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

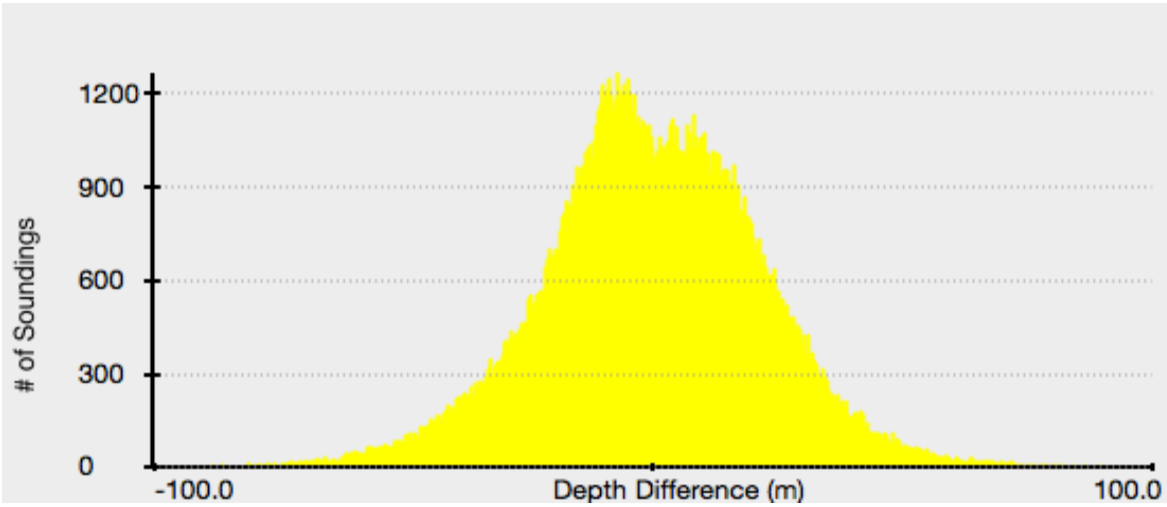
Line 311 vs dipline 324	Mean water depth	4980 m
	Mean Z difference	-4.47 m
	Standard deviation	17.24 m
	Number of samples	90,137
	Percent of water depth	0.6% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 314 and dipline 231 (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

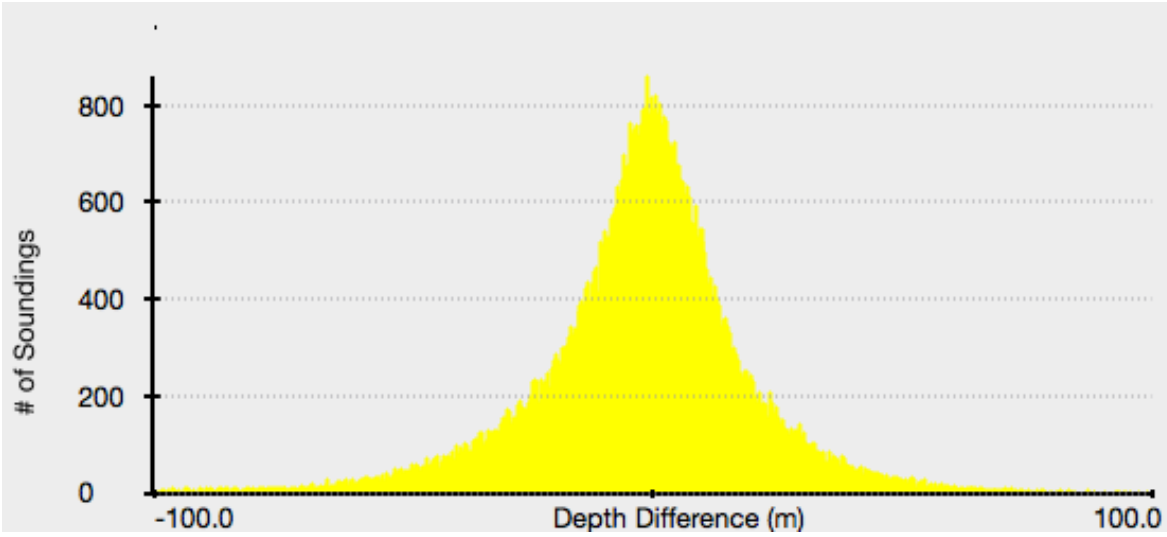
Line 314 vs dipline 231	Mean water depth	5270 m
	Mean Z difference	-0.62 m
	Standard deviation	13.63 m
	Number of samples	108,344
	Percent of water depth	0.5% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 413 and dipline 560tran (mostly smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

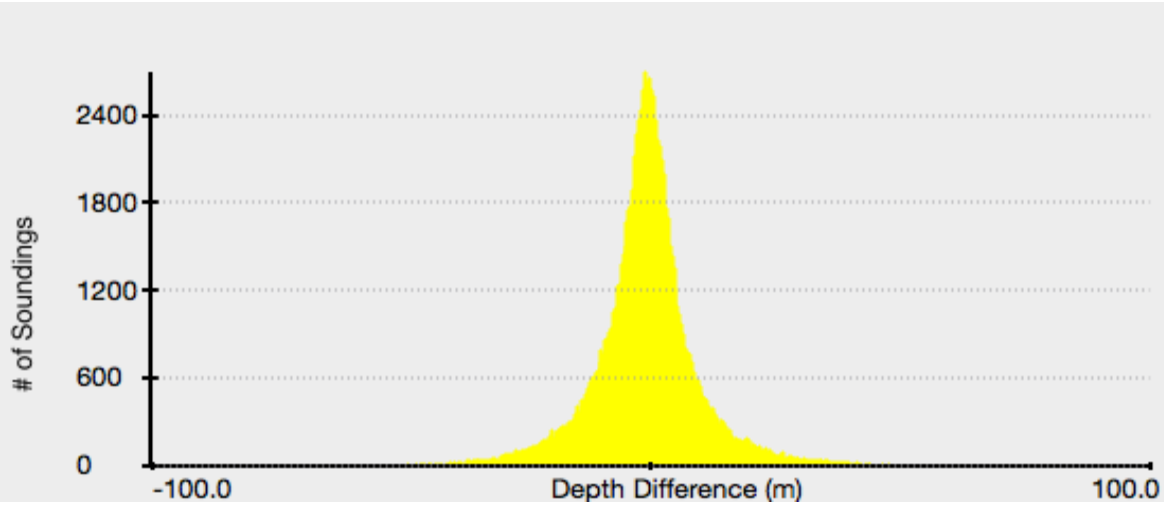
Line 413 vs dipline 560tran	Mean water depth	4962 m
	Mean Z difference	-0.14 m
	Standard deviation	22.01 m
	Number of samples	156,662
	Percent of water depth	0.9% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 339 and dipline560tran (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

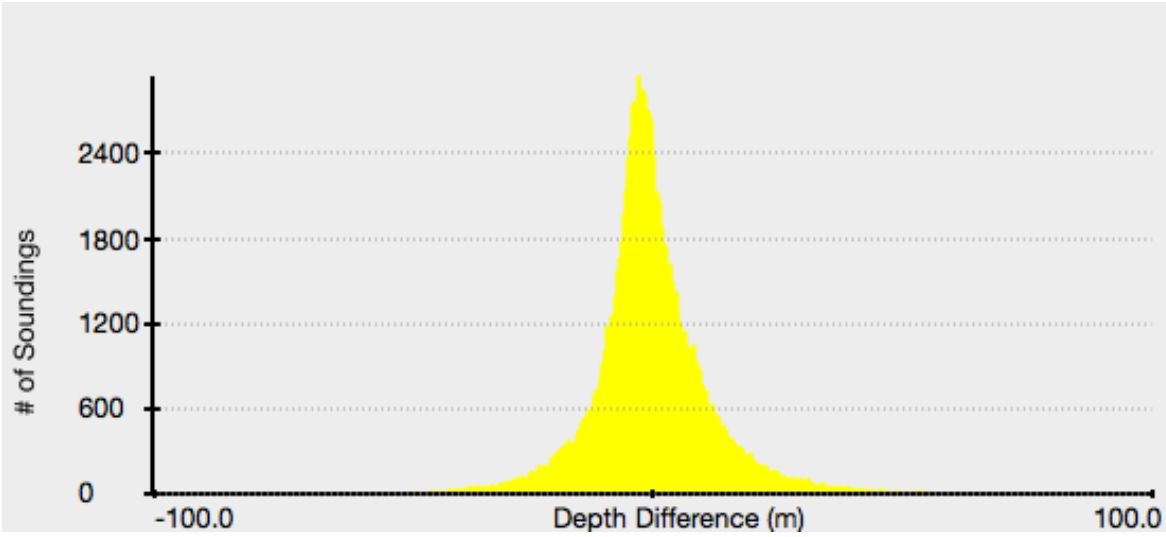
Line 339 vs dipline 560tran	Mean water depth	4152 m
	Mean Z difference	-1.97 m
	Standard deviation	22.24 m
	Number of samples	72,838
	Percent of water depth	1.0% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 322 and dipline 561tran (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

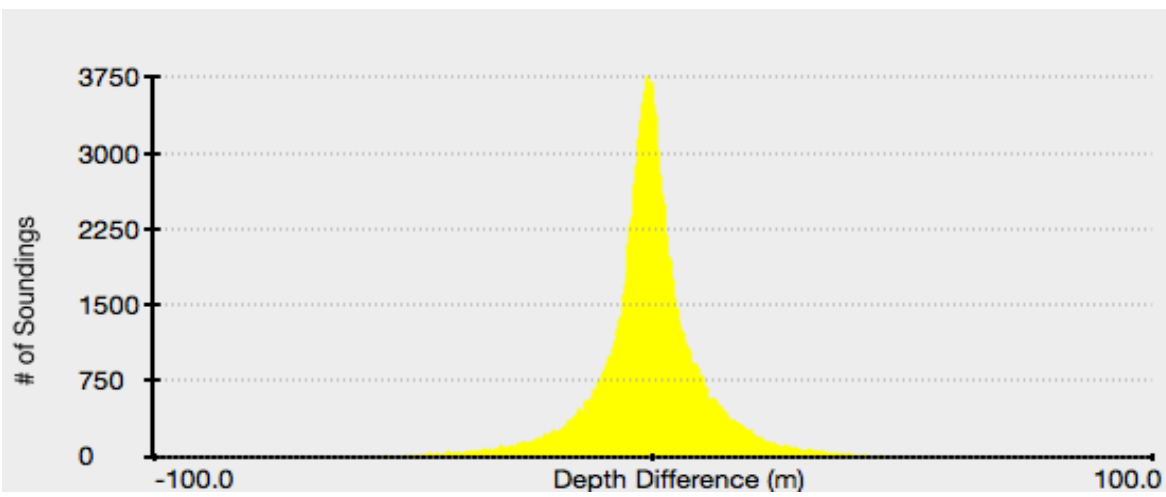
Line 322 vs dipline 561tran	Mean water depth	5214 m
	Mean Z difference	-0.89 m
	Standard deviation	11.08 m
	Number of samples	103,850
	Percent of water depth	0.4% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 316 and dipline 561tran (rough bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

Line 316 vs dipline 561tran	Mean water depth	5249 m
	Mean Z difference	-0.30 m
	Standard deviation	12.08 m
	Number of samples	124,682
	Percent of water depth	0.4% at 2σ



Histogram of sounding-depth differences from cross-line check of Line 333 and dipline 561tran (smooth bathymetry). Kongsberg Maritime EM122.

Cross check statistics for the above lines.

Line 333 vs dipline 561tran	Mean water depth	5182 m
	Mean Z difference	-0.66 m
	Standard deviation	11.59 m
	Number of samples	132,953
	Percent of water depth	0.4% at 2σ

Appendix 8. Ron Brown Ancillary Scientific Equipment Document

Scientific Equipment

The ***Ronald H. Brown*** supports a large suite of sensors for meteorological and oceanographic data acquisition. This sensor suite is supported by 2 high-powered Servers (primary and backup). A well-developed ethernet computer network integrates nearly all of the shipboard computers, including servers and workstations, along with other specialized computer platforms.

The shipboard network and computer systems are one of the ***Ronald H. Brown***'s greatest assets. Intranet services support many network applications. The three basic categories of shipboard computers are science, mission and public. The ship provides a public wifi connection for devices to connect to the internet. The Commanding Officer must approve all wireless devices before being connected. All users of the ship's network must comply with the NOAA IT Security protocols.

Nearly all of the ship's scientific sensors are integrated into the Scientific Computing System (SCS). This allows for centralized data acquisition and logging from numerous sensors with different sampling rates. One central data set of all sensors is logged continuously, and user-specified subsets of sensor data and independent sampling rates may be logged simultaneously. All data are time stamped from the ship's high-precision UTC clock and GPS navigation parameters can be included within any data set. SCS data can be accessed with feature-rich software from workstations throughout the ship-wide network. Details for individual shipboard sensors and systems are provided below. Temporary installation of additional mission-specific sensors and systems within SCS is also possible.

Scientists should inquire before mounting an instrument as placement of a new instrumentation may interfere with the operation of existing sensors or ship operations.

Data Acquisition System

The Scientific Computer System (SCS) software was developed at NOAA Headquarters for the NOAA fleet. SCS is a data acquisition and processing system designed for oceanographic and fisheries applications. The C^{++} based software package is run through point and click menu bars. The SCS package utilizes Graphical User Interface (GUI) technology in the form of time series graphs and directly calls ArcView graphing capabilities.

SCS is networked throughout the ship and is capable of sending data displays to remote stations (SCS Client) on the ship. In addition, ASCII data strings can be sent via RS-232 cable or over the Ethernet. Data from every sensor in SCS can be sent to any available port/node on the network through wired serial connections or through a TCP broadcast. The SCS workstations provide time series graphs of all acquired data to monitor any changes. Several variables can be plotted against each other in real time X-Y plots. Data can be output in a wide variety of formats. Data output formats include:

- Raw data files in binary form
- Postprocessed compressed or merged data sets
- ASCII data for easy transfer to PC environment
- UNIX format

COMPUTERS, NETWORK AND SOFTWARE

Computers

The central components of the ***Ronald H. Brown's*** Scientific Computer System (SCS) are two (primary and backup) servers. The servers are identical in set-up and configuration. In the event of a failure of the

primary system, the backup system can resume scientific data acquisition with minimal data loss. The system operates in a Microsoft Windows environment.

The primary node is used for data acquisition from a suite of nearly one-hundred real time and derived scientific sensors. The primary function of this system is to run the Scientific Computer System (SCS) software. In addition to the servers, workstations are located throughout the ship including the Bridge, Main Lab, Hydro Lab, Bio Lab, and Computer Lab. If needed, the workstations can be relocated to better meet scientific requirements.

Network

The Ship maintains a Microsoft Windows based Local Area Network with copper, fiber and wireless connections available throughout the ship. Most of the PC's have dedicated functions for shipboard personnel but several are available for scientific parties on a shared basis. File sharing, data access, and Internet access is available for the scientific party's computers in accordance with NOAA and OMAO IT Policies.

Currently, large file transfers and real time data transmission, including VPN access to/from the ship while using the VSAT connection is not permitted. If the scientific party requests additional bandwidth or real time data streaming over the VSAT, shore side approval is required. The additional cost of bandwith and any hardware associated will be incurred by the scientific party.

Developed Software

Scientific Computer System (SCS) software

Commercial Software Packages

ArcGIS
Kongsberg Seafloor Information Systems Software

Caris Hips/Sips
MatLab
Microsoft Office Suite

BATHYMETRIC

Echo Sounder - Deep Water

The SyQwest Bathy 2010 is a flexible dual frequency (3.5K/12 KHz) bathymetric sub-bottom survey system. The 12 KHz deep/shallow bottom profiler provides single beam depth to 10,000 m for bottom profiling or for tracking acoustic pingers in the water column. The 3.5 KHz sub-bottom profiler uses an array of transducers to provide shallow sub-bottom penetration with a 35 degree beam in water depths to 10,000 m.

A Knudsen 12kHz Chirp3260 system is also installed utilizing the same array of transducers; therefore the Chirp and the Bathy 2010 cannot be operated at the same time.

The depth and signal strength of either the SyQwest and Knudsen data are logged to the ship's data acquisition system (SCS).

Echo Sounder - Shallow Water

A Furuno FE700 50/200 kHz system is installed on the bridge for navigational use. The system has a maximum depth range of 800m. The data is logged into SCS.

Kongsberg EM122 Deepwater Multibeam

The EM 122 is designed to perform seabed mapping to full ocean depth with an unsurpassed resolution, coverage, and accuracy operating at 12 kHz. The operating depth as recommended by the manufacturer is 20m -11,000m. The system is also capable of water column data display and recording. The Survey and Electronics Technicians maintain, operate and troubleshoot this system. Ship’s crew does not process or “clean” multibeam data; however, the use of shipboard computers is available for data processing. Requests for specific software for multibeam data processing should be outlined in the project instructions.
There are two Reson 70, Sound Velocity Profilers (SVP) located amidships feeding the Kongsberg EM-122. Both sensors are logged in SCS but only the STBD sensor is directly feeding the EM-122.

METEOROLOGICAL

Sensor Placement

The MET sensors on the forward mast are approximately 10 meters above the water line. Specific heights above the waterline are outlined in the metadata package provided to the chief scientist at the end of the project. Sensors on the forward mast are: wind speed and direction, rain gauge, air temp and relative humidity sensor. Upon request, additional sensors can be located on the forward mast by the scientific party. Climbing the mast is limited to individuals who have completed the proper fall protection training program and are deemed qualified to climb by the Commanding Officer and/or the shipboard Competent Fall Protection designee.

A set of Woods Hole manufactured IMET sensors are installed on the ship. The Air Temp/Relative Humidity sensor, precipitation sensors, and analog wind bird are also located on the forward mast in a position with as little ship interference as possible. The short wave and long wave radiation sensors are located on the bow in direct sunlight. The sea surface temperature sensor is located near the intake of the ships scientific seawater system. These sensors are calibrated annually. Their calibration values are incorporated on their onboard ROMs and the data that they output is in calibrated values. The data from the IMET sensors are recorded on SCS and are available for scientific use.

Barometer

The ships Survey Technicians maintain a calibrated digital barometer outputting in millibars which is connected to SCS and is available for scientific use. Annually, or opportunistically when the ship is in port, the barometer height above sea level correction is determined by a NOAA Port Meteorological Officer (PMO).

OCEANOGRAPHIC

Acoustic Doppler Current Profiler (ADCP)

The RD Instruments (RDI), Model Ocean Surveyor, 75 KHz narrow band acoustic doppler current profiler provides vertical profiles of ocean current, speed and direction to depths of approximately 600m. The system is run with the University of Hawaii DAS operating system.

NOTE: ***OMAO*** and the University of Hawaii have a formal agreement regarding ADCP ping data. This agreement is intended to allow us to monitor the quality of the data, thereby providing an assurance of continued high ADCP data quality on board. The data is available to the public via the website at: http://currents.soest.hawaii.edu/ron_brown.

Autosalinometer

The ship has a Guildline model 8400B auto salinometers for precision salinity calculation in a temperature controlled airlock style entry room. The room also is equipped with a deep sink and a small desk.

CTD

Seabird Electronics Model 9/11+ CTD system in a 12-position rosette frame with a seabird SBE-32 submersible array firing assembly. The SBE 9+ underwater assembly has a depth capacity of 6800 meters and a dual conductivity/temperature sensor pair. The computer is running Seabird data collection software. The ***Ronald H. Brown*** has one primary SBE9+CTD and one back up to be used as a spare unit. The ship maintains a single conductivity and temperature sensor as back up. The CTD system is capable of interfacing through either of the two ship's hydrographic winches.

Fluorometer

Installed inline Turner Fluorometer with its data output to SCS and is available for scientific use.

Thermosalinograph (TSG)

Seabird Electronics SBE-21 thermosalinograph is plumbed in at the bow and capable of measuring the conductivity and temperature of the water from 5.6 meters below the water line. This data is recorded on SCS and is available for scientific use. A SBE-45 thermosalinograph is also located in the hydrographic lab measuring sea surface conductivity, temperature, salinity and sound velocity.

Expendable Bathythermograph (XBT)

A Sippican MK-12 XBT system with a portable launcher is installed in the Wet Lab that is available for scientific use. The user must supply XBT probes.

MISCELLANEOUS

Speed Log

Raytheon model DSN-450 dual axis, four beam, pulsed doppler sonar at a frequency of 200 KHz. Each of the four beams is 5 degrees conical and 30 degrees from the vertical. The output of the speed log is routed to remote displays located on the bridge, aft bridge and the computer lab.

Winch Systems

The ship's Survey and Electronic Technicians maintain two Markey DESH-5 hydrographic winches and a traction winch. The hydrographic winches are equipped with at least 8,000m of .322 conducting cable. The data is routed through slip rings and terminates in the computer lab. The winches provide data for wire-out in meters, line-out rate in meters per minute, and wire tension in pounds. These readings are also output to SCS for archival and are available for scientific use.

Appendix 8. Leg 1 Cruise Report

CRUISE REPORT

NOAA Ship *Ronald H. Brown*

System Test Cruise off Honolulu, Hawaii

CRUISE RB-16-01 Leg 1

January 5, to January 8, 2016

Honolulu, HI to Honolulu, HI

Andrew A. Armstrong and James V. Gardner

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

January 15, 2016

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Introduction

The objectives for cruise RHB16-01 are to calibrate the multibeam system, integrate the Knudsen subbottom profiler and Sippican XBT/XSV system to the Kongsberg SIS, confirm that the former problems with the POS/MV IMU have been fixed and insure that the hull-mounted sound-speed profiler is working. The NOAA-funded test cruise was conducted at the University of Hawaii's deep-water calibration site located NW of Honolulu, HI. All of these objectives have to be met to be confident that the *Ron Brown's* multibeam system and subsystems are properly configured and calibrated for the mid-January 2016 Kingman Reef-Palmyra Atoll Law of the Sea cruise.

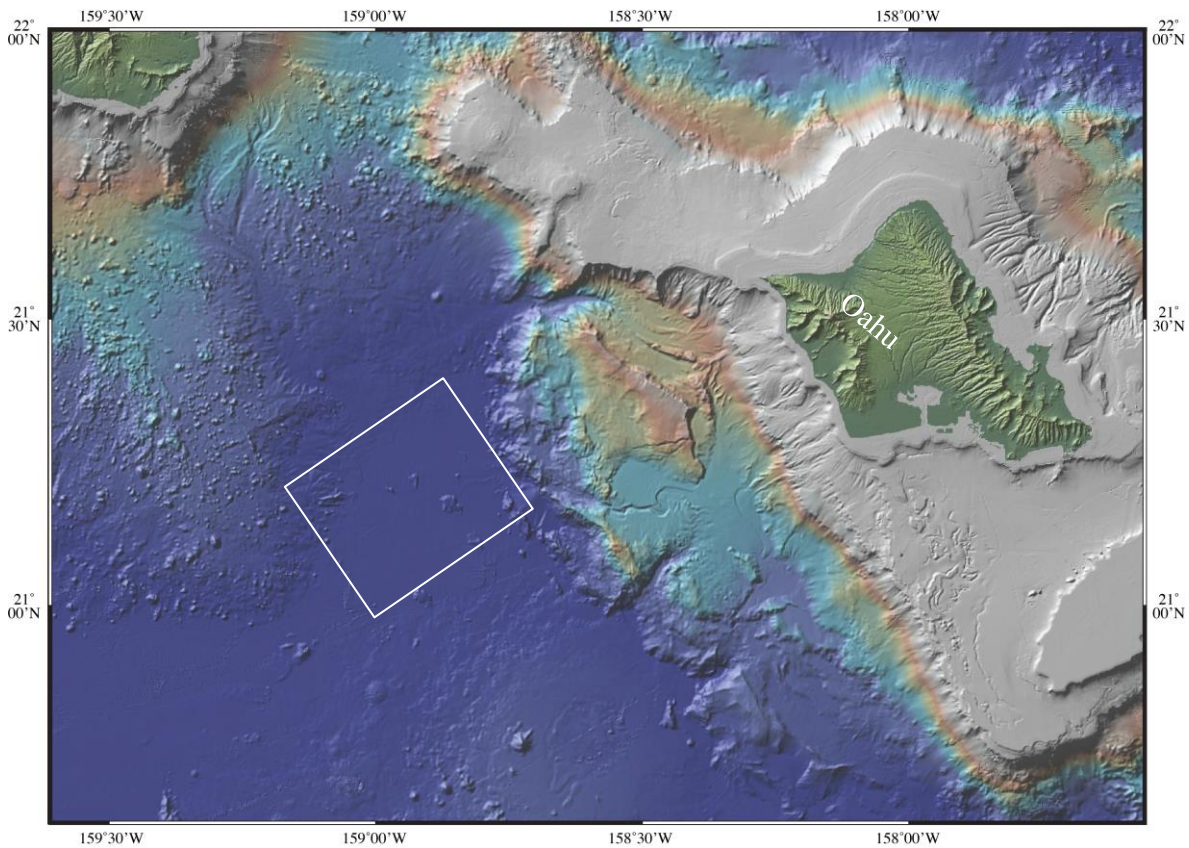


Figure 1. Location of the University of Hawaii deep-water calibration site (white box) where the patch test and MBES calibrations were run.

Table 1. Cruise Statistics

Julian days	JD005 to JD008
Dates	January 5 to January 8, 2016
Total days	4 days
Ports	Pearly Harbor, HI to Pearl Harbor, HI

Figure 2. NOAA Ship *Ronald H. Brown*

The Multibeam Echosounder System and Associated Systems

Kongsberg EM122

The NOAA Ship *Ronald H. Brown* (Fig. 2) has a gondola-mounted (Fig. 3) Kongsberg Maritime EM122 12-kHz multibeam echosounder (MBES) system that transmits a 1˚ wide (fore-aft) acoustic pulse and then generates 432-2˚ receive apertures ("beams") over a 150˚ swath. The system can automatically adjust the pointing angles of the receive beams to maximize the achievable coverage or a maximum aperture can be defined by the operator. The transmit cycle can be rapidly duplicated to provide two swaths per ping, each transmitted with a small along-track offset that compensates for water depths and ship speed to generate a constant sounding spacing in the along-track direction. This mode can provide as many as 864 soundings per transmit cycle swath (432 soundings per swath) in the high-density dual-swath mode. With more than one sounding generated per beam in the high-density mode, the horizontal resolution is increased and is almost constant over the entire swath when run in the equidistant mode. The MBES system can incorporate transmit beam steering up to ±10˚ from vertical, roll compensation up to ±10˚ and can perform yaw corrections as well. In addition, the receive beams can be steered as much as 10° forward or aft to reduce the effects of specular reflection at nadir and near-nadir angles.

Figure 3. The multibeam gondola on the NOAA Ship *Ronald H. Brown*.

The EM122 uses both continuous wave (CW) and frequency modulation (FM) pulses with pulse compression on reception to increase the signal-to-noise ratio. The transmit pulse is split into several independently steered sectors to compensate for vessel yaw. The system is pitch, yaw and roll stabilized to compensate for vehicle motion during transmission. Kongsberg Maritime states that, at the 10-ms pulse length used during this survey (deep mode), the system is capable of depth accuracies of 0.3 to 0.5% of water depth. The Kongsberg Maritime EM122 Product Description should be consulted for the full details of the MBES system. The installed software versions used on the Seafloor Information System (SIS) and the transmit-receive unit (TRU) systems are given in Table 2.

The EM122 beam forming during this cruise used the high-density equidistant mode with FM enabled and Automatic mode. For receive beams at near-normal incidence, the depth values are determined by center-of-gravity amplitude detection, but for most of the beams, the depth is determined by split-beam phase detection.

Table 2. Kongsberg software version numbers.

System	Software Version
Seafloor Information System	Version 4.2.1 build 33 Sept. 2015
TRU CPU	1.3.6b 160105
TRU DDS	3.5.10 140106
TRU BSP Master	2.2.3 090702
TRU BSP Slave	2.2.3 090702
TRU RX version	Feb. 18, 2010 Rev 1.11
TRU TX LC version	May 7, 2013 Rev 1.11

Kongsberg SIS Data Acquisition System

The EM 122 MBES is controlled by the Seafloor Information System (SIS) version 4.2.1 software operated from a workstation in the ship's computer lab. Initial and post-patch test sensor and angular offset values are provided in Tables 3 and 4.

Table 3. Initial system sensor offsets

Location Offsets				Angular Offsets		
Sensor	**Forward**	**Stbd**	**Down**	**Roll**	**Pitch**	**Heading**
POS 1	0.00	0.00	0.00	–	–	–
POS 2	0.00	0.00	0.00	–	–	–
POS 3	0.00	0.00	0.00	–	–	–
Tx tdr	6.1256	-0.9352	06.0856	-0.0314	-0.0144	359.9793
Rx tdr	10.6904	-0.4064	6.1618	0.1992	0.1775	0.07906
Attitude 1	0.00	0.00	0.00	-0.54	0.05	0.30
Attitude 2	0.00	0.00	0.00	0.00	0.00	0.00

Hull-mounted Reson sound-speed sensor depth 5.6 m

Table 4. Offset corrections determined by Patch Test

Offset	Value
roll	-0.54*°
pitch	-0.037°
yaw	0.3°
latency	0

* initially determined to be -0.50° and later added an additional -0.04°

NOAA assigned the cruise designator *RB16-01-Leg 1* to the test cruise. All raw MBES files were initially labeled with a unique Kongsberg file designator but the files were renamed to RonBrown2016Test_line_X, where X is a consecutive line number starting with 1 (see Appendix 1). The Leg 1 (test cruise) lines were given line numbers suffixed with "test" and patch test lines were prefixed with "patch. The renaming of MBES and Knudsen lines was done to be consistent with the other Kingman-Palmyra cruise line-naming convention.

Ancillary Systems

Positioning and Attitude

An Applanix POS/MV V5 s/n 7277 with integral Marinestar subscription satellite differential corrections and an IMU 7 model inertial motion unit (IMU) s/n 3221 provides position fixes with an accuracy of ~0.5 m. The IMU provides roll, pitch and yaw at accuracies of better than 0.1˚ at 1 Hz. All horizontal positions were georeferenced to the WGS84 ellipsoid and vertical referencing was to instantaneous sea level.

Transducer Sound Speed

A gondola-mounted Teledyne Reson SVP 70 sound-speed sensor (port S/N 0614179) was used during the cruise to measure the sound speed at the MBES array for accurate beam forming. The backup sound-speed sensor at the transducer depth was a Sea Bird Electronics SBE45 thermosalinograph (TSG). The TSG was tested again the SVP 70 and the derived sound speed with within 0.06 m/s.

Sippican XBT/XSV System

Sound-speed profiles of the water column were calculated from measurements of temperature versus depth using Sippican Deep Blue expendable bathythermographs (XBT). The data were processed with a Sippican MK21 unit (S/N 0126). The calculations were made using Sound Speed Manager v. 0.1.4 software developed by UNH, with a patch written by Glen Rice, and fed directly into the MBES SIS system.

The derived sound-speed profiles from XBT casts (see Appendix 2) were used to raytrace each MBES receive signal to the seafloor and back to the receiver to compensate for the refraction effects within the water column. A calibration of the XBT system was performed after the Applanix POS/MV tests were completed. The ship transited to deep water and the calibration was performed. First, a Deep Blue XBT cast was made to 850 m followed by a Sea-Bird SBE 9 CTD cast. The two derived sound-speed profiles did not match (Fig. 4); however, a constant salinity value of 30 ppt (considerably lower than surface salinity in these tropical waters) was used to derive sound speed. An XSV-01 cast was then made to compare with the calculated sound-speed profile from the CTD measurements. The sound-speed profiles from the CTD and XSV matched. It was concluded that the XBT cast was not initially valid because of the invalid salinity; when the XBT temperature was combined with the World Ocean Atlas (2009) salinity profile from this latitude, the sound-speed profile matched the CTD and XSV profiles providing confidence that XBT casts adjusted with WOA salinity would provide suitable sound speed profiles for the MBES.

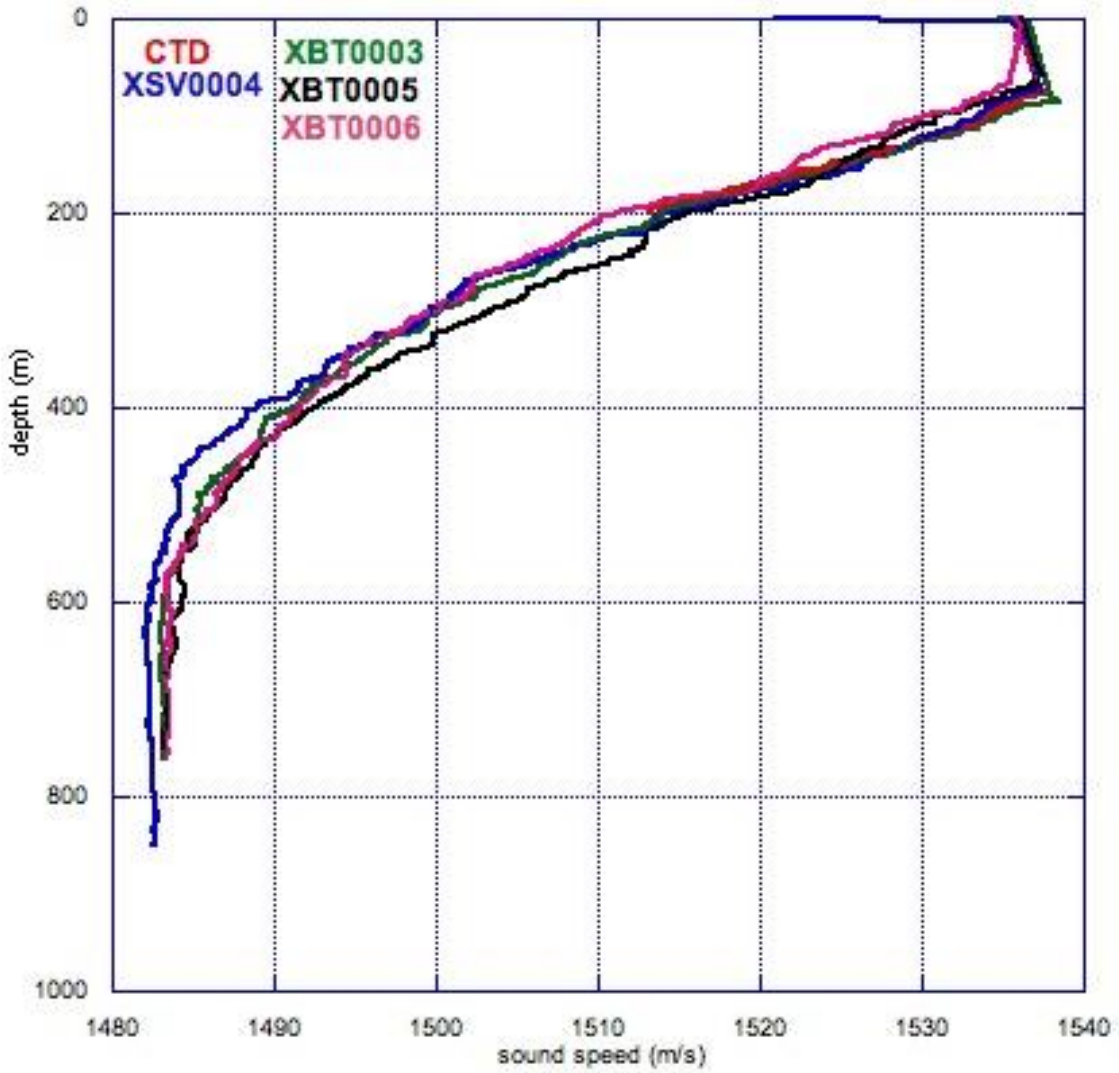


Figure 4. Comparison of sound speeds calculated from XSV (red), CTD (green) and XBT (blue).

MBES Data Processing

The processing of multibeam data for the patch test was performed using CARIS HIPS, QPS Qimera and UNB SwathEd software. In addition, almost all of the multibeam data collected (bathymetry and acoustic backscatter) was processed during the cruise using SwathEd version 20140429. Each Kongsberg .all file was collected by the onboard Kongsberg SIS data-acquisition system. Once a line was completed, the .all file was copied to a server that could be accessed by the UNH computer via the shipboard network. Each .all file was renamed from the Kongsberg-generated file name to *RonBrown2016Test_x.all* (see Appendix 1). The line numbers commenced with *RonBrown2016Test_line0001.all* for the transit to the map area and then commenced to *RonBrown2016Test_line_XXpatch.all* for the patch test lines. Each .all file is composed of individual data packets of beam bathymetry (range and angle), beam average and full time-series acoustic backscatter, navigation, parameters, sound-speed profiles, orientation

and sound speed at the transducer. The first step in the processing separates each of these data packets into the individual files then the navigation is merged with the bathymetry and acoustic backscatter files.

The second step involves flagging individual soundings that appear to be fliers, bad points, multipaths, etc. The entire file of soundings is viewed and edited in a sequence of steps through the file. Once the bathymetry file has been edited, the valid individual soundings are gridded into a DTM map and the co-registered valid acoustic backscatter full beam time series is assembled into a file and gridded into a subarea mosaic that is draped over the DTM.

Knudsen CHIRP 3260 subbottom profiler

A Knudsen CHIRP 3260 subbottom profiler (S/N D229-04331) was deployed throughout the cruise. The system is a ~3.5-kHz system with a hull-mounted 4 x 4 transducer array that produces an FM signal with a 1-kHz bandwidth. The system has adjustable pulse lengths, power and gain settings allowing it to acquire good bottom detection and subbottom resolution to about 50 m of sediment thickness. The digital data were recorded in SEG-Y format and processed with Chesapeake Technologies, Inc. SonarWeb software. The Knudsen system was synchronized with the EM122 MBES so that it did not interfere with the multibeam data.

Daily Log (local time, GMT-10)

JD 004 (Tuesday, January 5, 2016)

Arrived at the ship at 1630 L and set up computers, networking, etc.

JD 005 (Tuesday, January 5, 2016)

The ship departed the Ford Island pier in Pearl Harbor at 0900 L (1900 GMT) and headed to sea. The first order of business was to check out the POS/MV. An Applanix technician was aboard for the day to check out the system. The entire morning was spent in the lee of Oahu calibrating the POS/MV with multiple turns. The EM122 was pinging but not recording during the testing.

The Applanix technician decreed the POS/MV in fine working order and we transited back to the buoy at the entrance to Pearl Harbor for him to be picked up by a water taxi. Once he was off the ship and on his way at 1540 L, we departed the sea buoy and transited to a deep-water location (lines 0002, 0003 and 0004) to calibrate the XBT with an XSV and CTD casts (see Fig. 1 for location).

The Deep Blue XBT, XSV-01 and CTD (Sea-Bird SBE 9) calibration was completed (see discussion above) and the patch test was begun at 2245 L. The patch test was run over a sharp ridge at the base of the island platform in 4200 to 4800 m water depths. The EM122 swath was narrowed to ±15˚ to generate a dense narrow grid of data and the ship speed was set at 6 knts.

JD 006 (Wednesday, January 6, 2016)

The patch test was completed during the night and demonstrated that there was a 037˚ pitch error, a -0.49˚ roll error and a +0.3 heading error. We then headed to the reference surface at 9 knts.

The accuracy test (line0001acc.all) was started at 1045L running north at 6 knts on a flat seafloor 4719 m deep. The POS/MV crashed for unknown reasons, but perhaps because our course was 000˚. We changed course to 045˚ and GAMS recovered and the POS/MV was all green. That lasted only about 20 minutes before the POS/MV lost heading on 045˚. So, it is not the course that is causing the heading problems. Just to be certain, we set a course for 180˚ to see is the POS/MV again complains about GAMS heading. We learned that previous cruises on the *Ron Bro*wn had the same problems and the problems were suspected to correlate with the use of the Iridium phone. A test was run whereby all Iridium communication was stopped and the POS/MV was brought online with all green. Then one 7-minute Iridium phone call was made and the POS/MV starting having GAMS heading problems. Tests continued through the afternoon to determine whether, in fact, Iridium traffic was interfering with the heading sensors of the navigation systems.

Several problems occurred throughout the early hours and morning with the SIS gridding engine. The SIS display seemed to be limited to a fixed number of pings in grid, leaving no trail of gridded data. SIS was rebooted, new projects were created and nothing seemed to make the limitation go away. The entire MBES was powered down mid-morning but the problem continued. By mid-afternoon the problem seemed to go away and a full trail of gridded data stayed on the SIS display. However, during the day, our course circled around a small area with short lines and various turns. This may have allowed the SIS gridding engine to deal only with a small geographic area in the display grid, thus not exceeding some memory limit; however, the SIS have >6 GB of memory available.

Also, during the afternoon, the Knudsen 31260 subbottom profiler was turned on and collected very respectable data. The SEG-Y files were processed and the system seems ready for the mapping ahead.

An additional test of whether or not Iridium transmissions were interfering with the navigation systems was conducted in the mid afternoon and found that, regardless of course, Iridium transmissions knocked out the heading on the navigation systems. It was then decided to change out the POS/MV antennas and replace them with new antennas that are supposed to have RF shielding that will eliminate any radio-frequency interference. The test proved the Iridium transmissions had been corrupting the Fugro MarineSTAR navigation system. The newly installed RF-shielded antennas seem to have solved the problem and the navigations system has been running fine even with multiple Iridium transmissions.

We continued mapping on the reference surface throughout the evening with the Knudsen turned off. The POS/MV performed without any errors and was deemed ready for Leg 2.

JD 007 (Thursday, January 7, 2016)

The POS/MV ran throughout the night without interruption as the ship ran a track with headings of 000˚ and 180˚. Neither of the courses or the tight turns caused any problems. The plan continued with the deep-water accuracy (~4750 m water depth) and backscatter correlations

(DeepAccBScorr). An addition roll bias was determined so a -0.04˚ to bring the total roll correction to -0.54˚. Noise testing continued throughout the morning, mostly dead in the water. The TSG was connected to the network so that, if needed as the backup to the SVP, sound speed calculated by the TSG could be fed directly into SIS.

Noise tests were continued in the afternoon at various ship speeds and while dead in the water to determine the noise spectrum of the ship.

The noise tests were completed in the late afternoon and we transited to a shallow-water location for wobble tests. We arrived in the location of the wobble test at 2115 L and took an XBT cast. The wobble test was underway by 2130 L in water depths of ~500 m.

JD 008 (Friday, January 8, 2016)

The wobble test was completed and then a shallow-water backscatter test consumed the final 6 hours. The scheduled arrival at the NOAA dock at Pearl Harbor Fuel Dock was 0800 L.

Table 5. Cruise Personnel

Capt. Robert Kamphaus .....Ship's Master
Lt. Adrienne Hopper.....Operations Officer
Mr. Andrew A. Armstrong.....NOAA Chief Scientist
Dr. James V. Gardner.....UNH Co-Chief Scientist
Mr. Paul Johnson.....UNH Scientist
Mr. Glen Rice .....NOAA Scientist
Mr. Jeff Hill.....NOAA Lead Technician
Mr. Darren Billard..... Applanix Technician

Table 6. Cruise Calendar

January 2016

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4 board ship at Ford Island, Pearl Harbor, Honolulu	5 sailed at 0900 L patch test	6 noise testing backscatter testing	7 speed/noise testing and wobble test	8 arrive at Fuel Dock 0800 L	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Appendix 1. Conversion table of Kongsberg SIS-assigned .all file names to UNH file names by Julian Day

JD	Data Folder	Kongsberg file name RB.all	UNH file name .all	Notes
006	**160106**	0001_20160106_012641	RonBrown2016Test_line_0001	Transit to patch
		0002_20160106_015643	RonBrown2016Test_line_0002	Transit to patch
		0003_20160106_022641	RonBrown2016Test_line_0003	Transit to patch
		0004_20160106_023121	RonBrown2016Test_line_0004	Transit to patch
		0005_20160106_030123	RonBrown2016Test_line_0005	Transit to patch
		0006_20160106_033125	RonBrown2016Test_line_0006	Transit to patch
		0007_20160106_040127	RonBrown2016Test_line_0007	Transit to patch
		0008_20160106_204839	RonBrown2016Test_line_0008	Transit to patch
		0000_20160106_083937	RonBrown2016Test_line_0000patch	Patch test-pitch
		0001_20160106_094024	RonBrown2016Test_line_0001patch	Patch test-pitch
		0002_20160106_113003	RonBrown2016Test_line_0002patch	Patch test-roll
		0003_20160106_121025	RonBrown2016Test_line_0003patch	Patch test-roll
		0004_20160106_132113	RonBrown2016Test_line_0004patch	Patch test-yaw
		0005_20160106_141406	RonBrown2016Test_line_0005patch	Patch test-yaw
		0006_20160106_152754	RonBrown2016Test_line_0006patch	Patch test-yaw
		0000_20160106_202457	RonBrown2016Test_line_0000acc	DeepAccBScorr
		0001_20160106_203255	RonBrown2016Test_line_0001acc	DeepAccBScorr
		0002_20160106_205957	RonBrown2016Test_line_0002acc	DeepAccBScorr
		0003_20160106_215605	RonBrown2016Test_line_0003acc	DeepAccBScorr
		0004_20160106_220843	RonBrown2016Test_line_0004acc	DeepAccBScorr
		0000_20160106_202457	RonBrown2016Test_line_0004acc	DeepAccBScorr
007	**160107**	0001_20160107_004806	RonBrown2016Test_line_0001Aacc	DeepAccBScorr
		0000_20160107_041840	RonBrown2016Test_line_0000AAa	DeepAccBScorr
		0001_20160107_053602	RonBrown2016Test_line_0001Bacc	DeepAccBScorr
		0002_20160107_070111	RonBrown2016Test_line_0002Cacc	DeepAccBScorr
		0003_20160107_082728	RonBrown2016Test_line_0003Dacc	DeepAccBScorr
		0004_20160107_095620	RonBrown2016Test_line_0004Eacc	DeepAccBScorr
		0005_20160107_113715	RonBrown2016Test_line_0005Facc	DeepAccBScorr
		0006_20160107_130645	RonBrown2016Test_line_0006Gacc	DeepAccBScorr
		0007_20160107_143707	RonBrown2016Test_line_0007Hacc	DeepAccBScorr
		0008_20160107_155913	RonBrown2016Test_line_0008Iacc	DeepAccBScorr
		2		
008	**160108**	0000_20160108_012118	RonBrown2016Test_line_0009tran	Transit to wobble
		0001_20160108_044613	RonBrown2016Test_line_0010tran	Transit to wobble
		0000_20160108_074731	RonBrown2016Test_line_0000mo	Motion test
		0000_20160108_093554	RonBrown2016Test_line_0000AccBS	AccBScorr2
		0001_20160108_103627	RonBrown2016Test_line_0001AccBS	AccBScorr2
		0002_20160108_105654	RonBrown2016Test_line_0002AccBS	AccBScorr2
		0003_20160108_112630	RonBrown2016Test_line_0003AccBS	AccBScorr2
		0004_20160108_120113	RonBrown2016Test_line_0004AccBS	AccBScorr2
		0005_20160108_101613	RonBrown2016Test_line_0005AccBS	AccBScorr2
		0005_20160108_122843	RonBrown2016Test_line_0005aAccBS	AccBScorr2
		0006_20160108_125809	RonBrown2016Test_line_0006AccBS	AccBScorr2
		0007_20160108_133543	RonBrown2016Test_line_0007AccBS	AccBScorr2
		0008_20160108_140024	RonBrown2016Test_line_0008AccBS	AccBScorr2
		0009_20160108_142931	RonBrown2016Test_line_0009AccBS	AccBScorr2
		0010_20160108_145846	RonBrown2016Test_line_0010AccBS	AccBScorr2

008	**160108**	0011_20160108_153050	RonBrown2016Test_line_0011AccBS	AccBScorr2
		0012_20160108_155835	RonBrown2016Test_line_0012AccBS	AccBScorr2
		END OF CRUISE	**END OF CRUISE**	

Appendix 2. Location of XBT/XSV/XCTD casts

probe number	Longitude	Latitude	Serial Number	TYPE
3	-158.627522	21.132950	Not recorded	XBT
4	-158.627522	21.132950	Not recorded	XSV
5	-158.627522	21.132950	Sea-Bird SBE 9	CTD
6	-158.941438	21.030819	01244676	XBT
7	-158.962833	21.174638	01244675	XBT
8	-158.961833	21.046737	01244677	XBT
9	-158.961865	21.026916	01244677	XBT
10	-157.851172	21.158097	01244679	XBT
11	-157.856152	21.196126	01244680	XBT
12	-157.824609	21.157943	01244684	XBT
13	-157.816147	21.124434	01244683	XBT

Appendix 3. Kongsberg EM122 BIST Test Results

BIST test at Honolulu dock on December 20, 2015 after upgrade just prior to departure

```
Saved: 2015.12.20 01:29:07
Sounder Type:  122, Serial no.:  116
Date       Time          Ser. No.    BIST      Result
-------------------------------------------------------------------------------------
2015.12.19 23:22:54.024  116         0         OK
Number of BSP67B boards: 2
BSP 1 Master 2.2.3 090702 4.3 070913 4.3 070913
BSP 1 Slave 2.2.3 090702 6.0 080902
BSP 1 RXI FPGA 3.6 080821
BSP 1 DSP FPGA A 4.0 070531
BSP 1 DSP FPGA B 4.0 070531
BSP 1 DSP FPGA C 4.0 070531
BSP 1 DSP FPGA D 4.0 070531
BSP 1 PCI TO SLAVE A1 FIFO: ok
BSP 1 PCI TO SLAVE A2 FIFO: ok
BSP 1 PCI TO SLAVE A3 FIFO: ok
BSP 1 PCI TO SLAVE B1 FIFO: ok
BSP 1 PCI TO SLAVE B2 FIFO: ok
BSP 1 PCI TO SLAVE B3 FIFO: ok
BSP 1 PCI TO SLAVE C1 FIFO: ok
BSP 1 PCI TO SLAVE C2 FIFO: ok
BSP 1 PCI TO SLAVE C3 FIFO: ok
BSP 1 PCI TO SLAVE D1 FIFO: ok
BSP 1 PCI TO SLAVE D2 FIFO: ok
BSP 1 PCI TO SLAVE D3 FIFO: ok
BSP 1 PCI TO MASTER A HPI: ok
BSP 1 PCI TO MASTER B HPI: ok
BSP 1 PCI TO MASTER C HPI: ok
BSP 1 PCI TO MASTER D HPI: ok
BSP 1 PCI TO SLAVE A1 HPI: ok
BSP 1 PCI TO SLAVE A2 HPI: ok
BSP 1 PCI TO SLAVE A3 HPI: ok
BSP 1 PCI TO SLAVE B1 HPI: ok
BSP 1 PCI TO SLAVE B2 HPI: ok
BSP 1 PCI TO SLAVE B3 HPI: ok
BSP 1 PCI TO SLAVE C1 HPI: ok
BSP 1 PCI TO SLAVE C2 HPI: ok
BSP 1 PCI TO SLAVE C3 HPI: ok
BSP 1 PCI TO SLAVE D1 HPI: ok
BSP 1 PCI TO SLAVE D2 HPI: ok
BSP 1 PCI TO SLAVE D3 HPI: ok
BSP 2 Master 2.2.3 090702 4.3 070913 4.3 070913
BSP 2 Slave 2.2.3 090702 6.0 080902
```

BSP 2 RXI FPGA 3.6 080821
BSP 2 DSP FPGA A 4.0 070531
BSP 2 DSP FPGA B 4.0 070531
BSP 2 DSP FPGA C 4.0 070531
BSP 2 DSP FPGA D 4.0 070531
BSP 2 PCI TO SLAVE A1 FIFO: ok
BSP 2 PCI TO SLAVE A2 FIFO: ok
BSP 2 PCI TO SLAVE A3 FIFO: ok
BSP 2 PCI TO SLAVE B1 FIFO: ok
BSP 2 PCI TO SLAVE B2 FIFO: ok
BSP 2 PCI TO SLAVE B3 FIFO: ok
BSP 2 PCI TO SLAVE C1 FIFO: ok
BSP 2 PCI TO SLAVE C2 FIFO: ok
BSP 2 PCI TO SLAVE C3 FIFO: ok
BSP 2 PCI TO SLAVE D1 FIFO: ok
BSP 2 PCI TO SLAVE D2 FIFO: ok
BSP 2 PCI TO SLAVE D3 FIFO: ok
BSP 2 PCI TO MASTER A HPI: ok
BSP 2 PCI TO MASTER B HPI: ok
BSP 2 PCI TO MASTER C HPI: ok
BSP 2 PCI TO MASTER D HPI: ok
BSP 2 PCI TO SLAVE A1 HPI: ok
BSP 2 PCI TO SLAVE A2 HPI: ok
BSP 2 PCI TO SLAVE A3 HPI: ok
BSP 2 PCI TO SLAVE B1 HPI: ok
BSP 2 PCI TO SLAVE B2 HPI: ok
BSP 2 PCI TO SLAVE B3 HPI: ok
BSP 2 PCI TO SLAVE C1 HPI: ok
BSP 2 PCI TO SLAVE C2 HPI: ok
BSP 2 PCI TO SLAVE C3 HPI: ok
BSP 2 PCI TO SLAVE D1 HPI: ok
BSP 2 PCI TO SLAVE D2 HPI: ok
BSP 2 PCI TO SLAVE D3 HPI: ok

Summary:
BSP 1: OK
BSP 2: OK

2015.12.19 23:22:56.891 116 1 OK
High Voltage Br. 1

TX36 Spec: 108.0 - 132.0
0-1 119.7
0-2 119.7
0-3 119.3
0-4 119.7

0-5 119.7
0-6 118.8
0-7 119.3
0-8 119.7
0-9 119.7
0-10 119.3
0-11 119.7
0-12 120.1
0-13 119.3
0-14 119.3
0-15 119.3
0-16 120.5
0-17 119.7
0-18 119.7
0-19 119.7
0-20 119.7
0-21 119.7
0-22 120.5
0-23 119.7
0-24 119.7

High Voltage Br. 2

TX36 Spec: 108.0 - 132.0
0-1 120.5
0-2 119.7
0-3 119.3
0-4 119.7
0-5 119.7
0-6 119.7
0-7 119.3
0-8 120.5
0-9 119.3
0-10 119.3
0-11 120.1
0-12 119.7
0-13 119.3
0-14 119.7
0-15 119.3
0-16 120.5
0-17 119.7
0-18 119.3
0-19 119.7
0-20 119.7
0-21 119.7
0-22 120.1

0-23 120.1
0-24 119.3

Input voltage 12V

TX36 Spec: 11.0 - 13.0
0-1 11.9
0-2 11.9
0-3 11.8
0-4 11.9
0-5 11.9
0-6 11.8
0-7 11.9
0-8 11.9
0-9 11.9
0-10 11.8
0-11 11.9
0-12 11.9
0-13 11.8
0-14 11.9
0-15 11.8
0-16 11.9
0-17 11.9
0-18 11.9
0-19 11.9
0-20 11.9
0-21 11.9
0-22 11.9
0-23 11.9
0-24 11.8

Digital 3.3V

TX36 Spec: 2.8 - 3.5
0-1 3.3
0-2 3.3
0-3 3.3
0-4 3.3
0-5 3.3
0-6 3.3
0-7 3.3
0-8 3.3
0-9 3.3
0-10 3.3
0-11 3.3
0-12 3.3

0-13 3.3
0-14 3.3
0-15 3.3
0-16 3.3
0-17 3.3
0-18 3.3
0-19 3.3
0-20 3.3
0-21 3.3
0-22 3.3
0-23 3.3
0-24 3.3

Digital 2.5V

TX36 Spec: 2.4 - 2.6
0-1 2.5
0-2 2.5
0-3 2.5
0-4 2.5
0-5 2.5
0-6 2.5
0-7 2.5
0-8 2.5
0-9 2.5
0-10 2.5
0-11 2.5
0-12 2.5
0-13 2.5
0-14 2.5
0-15 2.5
0-16 2.5
0-17 2.5
0-18 2.5
0-19 2.5
0-20 2.5
0-21 2.5
0-22 2.5
0-23 2.5
0-24 2.5

Digital 1.5V

TX36 Spec: 1.4 - 1.6
0-1 1.5
0-2 1.5

0-3 1.5
0-4 1.5
0-5 1.5
0-6 1.5
0-7 1.5
0-8 1.5
0-9 1.5
0-10 1.5
0-11 1.5
0-12 1.5
0-13 1.5
0-14 1.5
0-15 1.5
0-16 1.5
0-17 1.5
0-18 1.5
0-19 1.5
0-20 1.5
0-21 1.5
0-22 1.5
0-23 1.5
0-24 1.5

Temperature

TX36 Spec: 15.0 - 75.0
0-1 31.6
0-2 30.4
0-3 29.6
0-4 28.4
0-5 29.6
0-6 28.8
0-7 28.8
0-8 29.2
0-9 28.8
0-10 27.6
0-11 29.2
0-12 28.4
0-13 28.4
0-14 28.8
0-15 28.4
0-16 30.0
0-17 31.2
0-18 31.2
0-19 30.8
0-20 30.8

0-21 30.4
0-22 31.2
0-23 29.2
0-24 29.6

Input Current 12V

TX36 Spec: 0.3 - 1.5
0-1 0.6
0-2 0.5
0-3 0.5
0-4 0.6
0-5 0.5
0-6 0.5
0-7 0.5
0-8 0.5
0-9 0.5
0-10 0.5
0-11 0.5
0-12 0.6
0-13 0.6
0-14 0.6
0-15 0.5
0-16 0.5
0-17 0.6
0-18 0.5
0-19 0.5
0-20 0.5
0-21 0.5
0-22 0.5
0-23 0.5
0-24 0.6

TX36 power test passed

IO TX PPC Embedded PPC Download
2.11 1.14 Mar 5 2007/1.07 May 7 2013/1.11

TX36 unique firmware test OK

2015.12.19 23:22:57.174 116 2 OK

Input voltage 12V

RX32 Spec: 11.0 - 13.0
7-1 11.8

7-2 11.8
7-3 11.7
7-4 11.8

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

Digital 3.3V

RX32 Spec: 2.8 - 3.5
7-1 3.3
7-2 3.3
7-3 3.3
7-4 3.3

Digital 2.5V

RX32 Spec: 2.4 - 2.6
7-1 2.5
7-2 2.5
7-3 2.5
7-4 2.5

Digital 1.5V

RX32 Spec: 1.4 - 1.6
7-1 1.5
7-2 1.5
7-3 1.5
7-4 1.5

Temperature

RX32 Spec: 15.0 - 75.0
7-1 30.0
7-2 33.0
7-3 30.0
7-4 28.0

Input Current 12V

RX32 Spec: 0.4 - 1.5
7-1 0.6
7-2 0.6
7-3 0.6
7-4 0.6

Input Current 6V

RX32 Spec: 2.4 - 3.3
7-1 2.8
7-2 2.8
7-3 2.8
7-4 2.9

RX32 power test passed

IO RX MB Embedded PPC Embedded PPC Download
1.12 1.14 May 5 2006/1.06 May 5 2006/1.07 Feb 18 2010/1.11

RX32 unique firmware test OK

2015.12.19 23:22:57.307 116 3 OK

High Voltage Br. 1

TX36 Spec: 108.0 - 132.0
0-1 119.7
0-2 119.7
0-3 119.3
0-4 119.7
0-5 119.7
0-6 118.8
0-7 119.3
0-8 120.1
0-9 119.7
0-10 119.3
0-11 119.7
0-12 120.1
0-13 119.3
0-14 119.3
0-15 118.8
0-16 120.5
0-17 120.1
0-18 119.7

0-19 119.7
0-20 119.7
0-21 119.7
0-22 120.5
0-23 119.3
0-24 119.7

High Voltage Br. 2

TX36 Spec: 108.0 - 132.0
0-1 120.5
0-2 119.7
0-3 119.3
0-4 119.7
0-5 119.7
0-6 119.7
0-7 119.3
0-8 120.5
0-9 119.7
0-10 119.3
0-11 120.1
0-12 119.7
0-13 119.3
0-14 119.7
0-15 119.3
0-16 120.5
0-17 119.7
0-18 119.3
0-19 119.7
0-20 119.7
0-21 119.7
0-22 120.1
0-23 119.7
0-24 119.3

Input voltage 12V

TX36 Spec: 11.0 - 13.0
0-1 11.9
0-2 11.9
0-3 11.8
0-4 11.9
0-5 11.9
0-6 11.8
0-7 11.9
0-8 11.9

0-9 11.9
0-10 11.8
0-11 11.9
0-12 11.9
0-13 11.8
0-14 11.9
0-15 11.8
0-16 11.9
0-17 11.9
0-18 11.9
0-19 11.9
0-20 11.9
0-21 11.9
0-22 11.9
0-23 11.9
0-24 11.8

RX32 Spec: 11.0 - 13.0
7-1 11.8
7-2 11.8
7-3 11.7
7-4 11.8

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

TRU power test passed

2015.12.19 23:22:57.441 116 4 OK

EM 122 High Voltage Ramp Test
Test Voltage:20.00 Measured Voltage: 18.00 PASSED
Test Voltage:60.00 Measured Voltage: 59.00 PASSED
Test Voltage:100.00 Measured Voltage: 100.00 PASSED
Test Voltage:120.00 Measured Voltage: 121.00 PASSED
Test Voltage:80.00 Measured Voltage: 85.00 PASSED
Test Voltage:40.00 Measured Voltage: 45.00 PASSED

6 of 6 tests OK

2015.12.19 23:25:21.389 116 5 OK

BSP 1 RXI TO RAW FIFO: ok
BSP 2 RXI TO RAW FIFO: ok

2015.12.19 23:25:28.305 116 6 OK

Receiver impedance limits [350.0 700.0] ohm

Board	1	2	3	4
1:	632.4	563.3	536.0	543.0
2:	625.7	570.7	564.8	549.3
3:	603.7	543.8	525.9	545.9
4:	595.2	560.1	484.1	568.7
5:	632.4	541.0	557.3	576.9
6:	586.7	541.7	534.6	579.6
7:	545.1	553.6	547.0	548.1
8:	633.1	558.9	536.1	530.9
9:	551.0	530.4	523.1	556.4
10:	619.7	576.3	535.9	524.9
11:	604.2	558.8	568.9	537.2
12:	615.0	573.5	525.2	529.3
13:	554.2	575.8	569.6	528.6
14:	578.7	566.4	579.2	576.7
15:	627.3	552.9	519.1	541.1
16:	632.5	562.4	564.9	537.5
17:	565.6	584.3	565.3	569.0
18:	618.7	586.1	585.6	551.8
19:	603.1	556.5	562.4	513.2
20:	604.2	565.0	570.4	559.5
21:	612.5	548.6	555.5	570.6
22:	631.1	561.3	545.8	580.6
23:	606.2	531.1	524.5	553.5
24:	586.8	543.1	590.1	564.7
25:	627.1	549.5	561.4	527.2
26:	526.6	518.7	554.1	572.7
27:	600.6	569.1	531.4	529.5
28:	619.7	545.1	543.2	543.2
29:	601.8	575.7	577.1	553.3
30:	576.0	547.0	565.1	560.4
31:	625.3	560.5	581.3	563.0
32:	566.3	563.5	567.8	550.3

Receiver Phase limits [-20.0 20.0] deg

Board	1	2	3	4
1:	-3.1	-0.5	1.9	0.7
2:	-1.9	-1.1	-1.3	0.3
3:	-1.0	1.1	1.8	0.3
4:	-0.4	0.3	5.4	-2.0
5:	-2.4	1.3	-0.4	-2.0
6:	1.7	1.8	0.5	-2.6
7:	5.1	0.5	0.1	-0.5
8:	-2.4	-0.2	1.2	1.9
9:	3.8	1.4	2.7	0.2
10:	-0.5	-2.3	1.4	1.5
11:	-0.7	-1.1	-1.4	1.6
12:	-1.9	-1.5	2.7	2.3
13:	4.2	-2.2	-1.6	1.9
14:	1.2	-0.4	-2.3	-2.4
15:	-2.2	1.3	2.8	1.2
16:	-2.4	-0.7	-1.1	1.3
17:	2.7	-2.3	-1.8	-1.7
18:	-1.6	-2.5	-3.2	0.2
19:	-0.8	-0.2	-0.8	2.9
20:	-1.0	-0.1	-1.9	0.0
21:	-0.6	0.9	0.3	-1.5
22:	-2.5	-0.1	0.4	-2.8
23:	-0.9	2.4	2.1	-0.3
24:	1.5	1.6	-3.0	-0.6
25:	-2.0	0.3	-0.7	1.6
26:	5.7	3.0	0.0	-2.0
27:	0.4	-1.2	2.0	1.3
28:	-1.5	0.9	1.0	0.1
29:	0.7	-1.4	-2.2	0.9
30:	1.5	1.5	-1.3	-1.2
31:	-1.9	-0.3	-2.5	-0.4
32:	3.5	-0.1	-0.9	0.0

Rx Channels test passed

2015.12.19 23:26:02.838 116 7 Error

No High Voltage

** Tx Channels test failed **

2015.12.19 23:28:44.803 116 8 OK

RX NOISE LEVEL

Board No:	1	2	3	4	
0:	79.7	74.0	77.9	78.4	dB
1:	79.8	74.3	78.0	78.2	dB
2:	79.8	78.6	78.3	78.7	dB
3:	78.6	78.1	78.8	77.5	dB
4:	79.8	77.3	78.7	77.5	dB
5:	79.2	78.2	78.3	77.9	dB
6:	79.8	79.1	78.3	77.9	dB
7:	78.4	77.4	77.2	76.5	dB
8:	78.8	77.4	76.0	77.5	dB
9:	79.3	78.8	78.2	78.1	dB
10:	78.8	78.4	78.1	79.2	dB
11:	78.8	78.9	78.2	78.7	dB
12:	78.5	79.2	78.4	78.9	dB
13:	78.8	78.8	79.2	78.0	dB
14:	78.5	78.3	79.3	79.0	dB
15:	78.1	77.0	77.3	76.2	dB
16:	79.1	78.8	77.8	76.2	dB
17:	78.2	77.4	77.7	76.2	dB
18:	79.3	79.1	78.5	78.0	dB
19:	78.2	78.9	78.2	76.8	dB
20:	79.8	80.0	78.2	76.9	dB
21:	78.3	79.2	77.9	77.4	dB
22:	79.3	79.4	77.7	77.2	dB
23:	77.5	76.1	78.0	76.9	dB
24:	77.6	78.9	77.4	78.4	dB
25:	78.9	78.0	76.3	77.4	dB
26:	79.0	79.4	79.0	77.7	dB
27:	77.1	78.5	78.4	77.2	dB
28:	78.1	78.9	78.6	77.8	dB
29:	78.2	78.1	77.9	77.1	dB
30:	78.8	78.7	79.1	76.3	dB
31:	78.2	76.7	77.5	77.1	dB

Maximum noise at Board 2 Channel 20 Level: 80.0 dB

Broadband noise test

Average noise at Board 1 78.8 dB OK
Average noise at Board 2 78.3 dB OK
Average noise at Board 3 78.1 dB OK
Average noise at Board 4 77.7 dB OK

2015.12.19 23:28:53.203 116 9 OK

RX NOISE SPECTRUM

Board No:	1	2	3	4	
10.0 kHz:	75.4	75.3	74.3	73.8	dB
10.2 kHz:	76.5	75.8	75.7	75.1	dB
10.3 kHz:	77.4	77.4	76.8	76.5	dB
10.4 kHz:	78.3	77.6	77.1	76.6	dB
10.6 kHz:	78.5	77.8	77.8	76.8	dB
10.7 kHz:	78.6	78.7	78.5	77.6	dB
10.9 kHz:	79.3	78.8	78.9	77.7	dB
11.0 kHz:	79.1	78.2	78.3	77.8	dB
11.2 kHz:	79.4	78.4	78.1	77.9	dB
11.3 kHz:	78.9	78.8	78.2	77.4	dB
11.4 kHz:	78.8	78.2	78.1	77.3	dB
11.6 kHz:	78.2	78.0	77.8	77.5	dB
11.7 kHz:	78.6	77.5	77.8	76.9	dB
11.9 kHz:	77.8	77.1	77.2	76.9	dB
12.0 kHz:	77.7	76.6	76.6	76.4	dB
12.1 kHz:	78.0	76.8	76.1	76.1	dB
12.3 kHz:	77.6	76.5	76.0	75.6	dB
12.4 kHz:	77.2	75.9	75.7	74.9	dB
12.6 kHz:	75.8	75.5	75.2	75.7	dB
12.7 kHz:	75.5	75.2	74.7	75.1	dB
12.9 kHz:	75.7	74.4	73.9	74.2	dB
13.0 kHz:	75.2	73.8	73.5	74.0	dB

Maximum noise at Board 1 Frequency 11.2 kHz Level: 79.4 dB

Spectral noise test

Average noise at Board 1 77.8 dB OK
Average noise at Board 2 77.1 dB OK
Average noise at Board 3 76.9 dB OK
Average noise at Board 4 76.4 dB OK

2015.12.19 23:29:01.603 116 10 OK

CPU: PP 432/05x PENTIUM4

Clock 1500 MHz
Die 40 oC (peak: 42 oC @ 2015-12-19 - 23:04:21)
Board 38 oC (peak: 38 oC @ 2015-12-19 - 23:24:34)
Core 0.96 V
3V3 3.27 V
12V 11.99 V
-12V -11.99 V
Primary network: 157.237.14.60:0xffff0000
Secondary network: 129.100.1.233:0xffffff00

2015.12.19 23:29:01.670 116 15 OK

EM 122

BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.3.5 150812
DDS: 3.5.10 140106
DSV: 3.1.8 141125
RX32 version : Feb 18 2010 Rev 1.11
TX36 LC version : May 7 2013 Rev 1.11
VxWorks 5.5.1 Build V1.19-01 Oct 8 2009, 13:31:43

BIST Test at dock on January 5, 2016 after upgrades
Saved: 2016.01.05 02:18:59

Sounder Type: 122, Serial no.: 116

Date Time Ser. No. BIST Result

2016.01.04 23:56:11.797 116 0 OK

Number of BSP67B boards: 2
BSP 1 Master 2.2.3 090702 4.3 070913 4.3 070913
BSP 1 Slave 2.2.3 090702 6.0 080902
BSP 1 RXI FPGA 3.6 080821
BSP 1 DSP FPGA A 4.0 070531
BSP 1 DSP FPGA B 4.0 070531
BSP 1 DSP FPGA C 4.0 070531
BSP 1 DSP FPGA D 4.0 070531
BSP 1 PCI TO SLAVE A1 FIFO: ok
BSP 1 PCI TO SLAVE A2 FIFO: ok
BSP 1 PCI TO SLAVE A3 FIFO: ok
BSP 1 PCI TO SLAVE B1 FIFO: ok
BSP 1 PCI TO SLAVE B2 FIFO: ok
BSP 1 PCI TO SLAVE B3 FIFO: ok
BSP 1 PCI TO SLAVE C1 FIFO: ok
BSP 1 PCI TO SLAVE C2 FIFO: ok
BSP 1 PCI TO SLAVE C3 FIFO: ok
BSP 1 PCI TO SLAVE D1 FIFO: ok
BSP 1 PCI TO SLAVE D2 FIFO: ok
BSP 1 PCI TO SLAVE D3 FIFO: ok
BSP 1 PCI TO MASTER A HPI: ok
BSP 1 PCI TO MASTER B HPI: ok
BSP 1 PCI TO MASTER C HPI: ok
BSP 1 PCI TO MASTER D HPI: ok
BSP 1 PCI TO SLAVE A1 HPI: ok
BSP 1 PCI TO SLAVE A2 HPI: ok
BSP 1 PCI TO SLAVE A3 HPI: ok
BSP 1 PCI TO SLAVE B1 HPI: ok
BSP 1 PCI TO SLAVE B2 HPI: ok
BSP 1 PCI TO SLAVE B3 HPI: ok
BSP 1 PCI TO SLAVE C1 HPI: ok
BSP 1 PCI TO SLAVE C2 HPI: ok
BSP 1 PCI TO SLAVE C3 HPI: ok
BSP 1 PCI TO SLAVE D1 HPI: ok
BSP 1 PCI TO SLAVE D2 HPI: ok

BSP 1 PCI TO SLAVE D3 HPI: ok
BSP 2 Master 2.2.3 090702 4.3 070913 4.3 070913
BSP 2 Slave 2.2.3 090702 6.0 080902
BSP 2 RXI FPGA 3.6 080821
BSP 2 DSP FPGA A 4.0 070531
BSP 2 DSP FPGA B 4.0 070531
BSP 2 DSP FPGA C 4.0 070531
BSP 2 DSP FPGA D 4.0 070531
BSP 2 PCI TO SLAVE A1 FIFO: ok
BSP 2 PCI TO SLAVE A2 FIFO: ok
BSP 2 PCI TO SLAVE A3 FIFO: ok
BSP 2 PCI TO SLAVE B1 FIFO: ok
BSP 2 PCI TO SLAVE B2 FIFO: ok
BSP 2 PCI TO SLAVE B3 FIFO: ok
BSP 2 PCI TO SLAVE C1 FIFO: ok
BSP 2 PCI TO SLAVE C2 FIFO: ok
BSP 2 PCI TO SLAVE C3 FIFO: ok
BSP 2 PCI TO SLAVE D1 FIFO: ok
BSP 2 PCI TO SLAVE D2 FIFO: ok
BSP 2 PCI TO SLAVE D3 FIFO: ok
BSP 2 PCI TO MASTER A HPI: ok
BSP 2 PCI TO MASTER B HPI: ok
BSP 2 PCI TO MASTER C HPI: ok
BSP 2 PCI TO MASTER D HPI: ok
BSP 2 PCI TO SLAVE A1 HPI: ok
BSP 2 PCI TO SLAVE A2 HPI: ok
BSP 2 PCI TO SLAVE A3 HPI: ok
BSP 2 PCI TO SLAVE B1 HPI: ok
BSP 2 PCI TO SLAVE B2 HPI: ok
BSP 2 PCI TO SLAVE B3 HPI: ok
BSP 2 PCI TO SLAVE C1 HPI: ok
BSP 2 PCI TO SLAVE C2 HPI: ok
BSP 2 PCI TO SLAVE C3 HPI: ok
BSP 2 PCI TO SLAVE D1 HPI: ok
BSP 2 PCI TO SLAVE D2 HPI: ok
BSP 2 PCI TO SLAVE D3 HPI: ok

Summary:
BSP 1: OK
BSP 2: OK

2016.01.04 23:56:14.630 116 1 OK

High Voltage Br. 1

TX36 Spec: 108.0 - 132.0
0-1 121.3
0-2 121.3
0-3 121.3
0-4 121.7
0-5 121.7
0-6 120.5
0-7 121.3
0-8 121.7
0-9 121.7
0-10 120.9
0-11 121.3
0-12 121.7
0-13 120.9
0-14 121.3
0-15 120.9
0-16 122.6
0-17 121.7
0-18 121.7
0-19 121.7
0-20 121.3
0-21 121.3
0-22 122.1
0-23 121.3
0-24 121.7

High Voltage Br. 2

TX36 Spec: 108.0 - 132.0
0-1 122.2
0-2 121.3
0-3 120.9
0-4 121.7
0-5 121.3
0-6 121.3
0-7 120.9
0-8 122.2
0-9 121.3
0-10 120.9
0-11 121.7
0-12 121.3
0-13 121.3
0-14 121.7
0-15 120.9
0-16 122.6

0-17 121.7
0-18 121.3
0-19 121.7
0-20 121.3
0-21 121.7
0-22 122.2
0-23 121.7
0-24 121.3

Input voltage 12V

TX36 Spec: 11.0 - 13.0
0-1 11.9
0-2 11.9
0-3 11.8
0-4 11.9
0-5 11.9
0-6 11.8
0-7 11.9
0-8 11.9
0-9 11.9
0-10 11.8
0-11 11.9
0-12 11.9
0-13 11.8
0-14 11.9
0-15 11.8
0-16 11.9
0-17 11.9
0-18 11.9
0-19 11.9
0-20 11.9
0-21 11.9
0-22 11.9
0-23 11.9
0-24 11.8

Digital 3.3V

TX36 Spec: 2.8 - 3.5
0-1 3.3
0-2 3.3
0-3 3.3
0-4 3.3
0-5 3.3
0-6 3.3

0-7 3.3
0-8 3.3
0-9 3.3
0-10 3.3
0-11 3.3
0-12 3.3
0-13 3.3
0-14 3.3
0-15 3.3
0-16 3.3
0-17 3.3
0-18 3.3
0-19 3.3
0-20 3.3
0-21 3.3
0-22 3.3
0-23 3.3
0-24 3.3

Digital 2.5V

TX36 Spec: 2.4 - 2.6
0-1 2.5
0-2 2.5
0-3 2.5
0-4 2.5
0-5 2.5
0-6 2.5
0-7 2.5
0-8 2.5
0-9 2.5
0-10 2.5
0-11 2.5
0-12 2.5
0-13 2.5
0-14 2.5
0-15 2.5
0-16 2.5
0-17 2.5
0-18 2.5
0-19 2.5
0-20 2.5
0-21 2.5
0-22 2.5
0-23 2.5
0-24 2.5

Digital 1.5V

TX36 Spec: 1.4 - 1.6
0-1 1.5
0-2 1.5
0-3 1.5
0-4 1.5
0-5 1.5
0-6 1.5
0-7 1.5
0-8 1.5
0-9 1.5
0-10 1.5
0-11 1.5
0-12 1.5
0-13 1.5
0-14 1.5
0-15 1.5
0-16 1.5
0-17 1.5
0-18 1.5
0-19 1.5
0-20 1.5
0-21 1.5
0-22 1.5
0-23 1.5
0-24 1.5

Temperature

TX36 Spec: 15.0 - 75.0
0-1 30.8
0-2 30.0
0-3 29.2
0-4 28.0
0-5 29.2
0-6 28.4
0-7 28.4
0-8 28.4
0-9 28.0
0-10 27.2
0-11 28.4
0-12 27.6
0-13 27.6
0-14 28.0

0-15 28.0
0-16 29.2
0-17 30.4
0-18 30.0
0-19 29.6
0-20 29.6
0-21 29.6
0-22 30.0
0-23 28.4
0-24 28.8

Input Current 12V

TX36 Spec: 0.3 - 1.5
0-1 0.6
0-2 0.5
0-3 0.5
0-4 0.6
0-5 0.5
0-6 0.5
0-7 0.5
0-8 0.5
0-9 0.5
0-10 0.5
0-11 0.5
0-12 0.5
0-13 0.6
0-14 0.6
0-15 0.5
0-16 0.5
0-17 0.6
0-18 0.5
0-19 0.5
0-20 0.5
0-21 0.5
0-22 0.5
0-23 0.5
0-24 0.6

TX36 power test passed

IO TX PPC Embedded PPC Download
2.11 1.14 Mar 5 2007/1.07 May 7 2013/1.11

TX36 unique firmware test OK

2016.01.04 23:56:14.880 116 2 OK

Input voltage 12V

RX32 Spec: 11.0 - 13.0
7-1 11.8
7-2 11.8
7-3 11.7
7-4 11.8

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

Digital 3.3V

RX32 Spec: 2.8 - 3.5
7-1 3.3
7-2 3.3
7-3 3.3
7-4 3.3

Digital 2.5V

RX32 Spec: 2.4 - 2.6
7-1 2.5
7-2 2.5
7-3 2.5
7-4 2.5

Digital 1.5V

RX32 Spec: 1.4 - 1.6
7-1 1.5
7-2 1.5
7-3 1.5
7-4 1.5

Temperature

RX32 Spec: 15.0 - 75.0
7-1 29.0
7-2 32.0
7-3 30.0
7-4 27.0

Input Current 12V

RX32 Spec: 0.4 - 1.5
7-1 0.6
7-2 0.6
7-3 0.6
7-4 0.6

Input Current 6V

RX32 Spec: 2.4 - 3.3
7-1 2.8
7-2 2.8
7-3 2.8
7-4 2.9

RX32 power test passed

IO RX MB Embedded PPC Embedded PPC Download
1.12 1.14 May 5 2006/1.06 May 5 2006/1.07 Feb 18 2010/1.11

RX32 unique firmware test OK

2016.01.04 23:56:14.980 116 3 OK

High Voltage Br. 1

TX36 Spec: 108.0 - 132.0
0-1 121.3
0-2 121.3
0-3 120.9
0-4 121.3
0-5 121.7
0-6 120.5
0-7 121.3
0-8 121.7
0-9 121.7
0-10 120.9

0-11 121.3
0-12 121.7
0-13 120.9
0-14 121.3
0-15 120.9
0-16 122.6
0-17 121.7
0-18 121.7
0-19 121.7
0-20 121.3
0-21 121.3
0-22 122.1
0-23 121.3
0-24 121.7

High Voltage Br. 2

TX36 Spec: 108.0 - 132.0
0-1 122.2
0-2 121.3
0-3 121.3
0-4 121.7
0-5 121.3
0-6 121.3
0-7 120.9
0-8 122.2
0-9 121.3
0-10 120.9
0-11 121.7
0-12 121.7
0-13 121.3
0-14 121.7
0-15 120.9
0-16 122.6
0-17 121.7
0-18 121.3
0-19 121.7
0-20 121.7
0-21 121.7
0-22 122.2
0-23 121.7
0-24 121.3

Input voltage 12V

TX36 Spec: 11.0 - 13.0

0-1 11.9
0-2 11.9
0-3 11.8
0-4 11.9
0-5 11.9
0-6 11.8
0-7 11.9
0-8 11.9
0-9 11.9
0-10 11.8
0-11 11.9
0-12 11.9
0-13 11.8
0-14 11.9
0-15 11.8
0-16 11.9
0-17 11.9
0-18 11.9
0-19 11.9
0-20 11.9
0-21 11.9
0-22 11.9
0-23 11.9
0-24 11.8

RX32 Spec: 11.0 - 13.0
7-1 11.8
7-2 11.8
7-3 11.7
7-4 11.8

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

TRU power test passed

2016.01.04 23:56:15.113 116 4 OK

EM 122 High Voltage Ramp Test

Test Voltage:20.00 Measured Voltage: 18.00 PASSED
Test Voltage:60.00 Measured Voltage: 59.00 PASSED
Test Voltage:100.00 Measured Voltage: 100.00 PASSED
Test Voltage:120.00 Measured Voltage: 121.00 PASSED
Test Voltage:80.00 Measured Voltage: 85.00 PASSED
Test Voltage:40.00 Measured Voltage: 45.00 PASSED

6 of 6 tests OK

2016.01.04 23:58:39.061 116 5 OK

BSP 1 RXI TO RAW FIFO: ok
BSP 2 RXI TO RAW FIFO: ok

2016.01.04 23:58:46.161 116 6 OK

Receiver impedance limits [350.0 700.0] ohm

Board	1	2	3	4
1:	638.8	570.1	542.3	549.1
2:	630.8	579.7	571.7	555.4
3:	609.1	549.8	532.9	552.9
4:	600.8	566.2	489.1	575.6
5:	637.9	548.1	564.0	586.4
6:	592.2	546.8	540.4	586.1
7:	550.0	560.1	552.3	554.4
8:	638.6	565.4	541.6	536.4
9:	556.5	537.7	529.1	563.4
10:	627.0	583.0	541.4	533.6
11:	611.3	569.9	575.6	543.5
12:	621.6	581.4	530.4	535.1
13:	558.8	583.5	577.3	534.4
14:	585.3	573.5	585.9	586.0
15:	633.7	558.7	525.1	546.7
16:	640.1	570.4	573.3	543.2
17:	571.3	591.0	571.9	576.8
18:	625.0	592.9	592.2	556.7
19:	608.1	562.6	570.3	517.4
20:	609.9	570.4	577.3	564.4
21:	618.4	554.7	561.2	575.4
22:	637.7	565.0	552.3	587.9
23:	611.5	536.1	530.4	559.1
24:	591.1	546.9	597.2	568.9

25:	634.5	556.2	567.2	532.5
26:	531.5	525.4	561.4	580.5
27:	606.9	576.1	537.4	534.8
28:	625.8	549.8	549.6	548.9
29:	608.7	582.3	585.0	559.8
30:	581.7	552.0	570.8	565.8
31:	629.4	566.2	587.5	569.0
32:	571.1	566.5	571.6	555.6

Receiver Phase limits [-20.0 20.0] deg

Board	1	2	3	4
1:	-3.1	-0.6	1.8	0.8
2:	-2.0	-1.3	-1.4	0.2
3:	-1.0	1.1	1.8	0.4
4:	-0.4	0.2	5.5	-2.0
5:	-2.5	1.3	-0.4	-2.3
6:	1.8	2.0	0.5	-2.7
7:	5.2	0.6	0.1	-0.6
8:	-2.4	-0.2	1.4	1.9
9:	3.9	1.4	2.7	0.1
10:	-0.8	-2.3	1.5	1.2
11:	-0.9	-1.4	-1.5	1.6
12:	-2.0	-1.7	2.8	2.3
13:	4.3	-2.2	-1.9	1.9
14:	1.1	-0.6	-2.5	-2.6
15:	-2.3	1.2	3.0	1.1
16:	-2.7	-0.7	-1.1	1.3
17:	2.8	-2.4	-1.8	-1.8
18:	-1.6	-2.6	-3.2	0.3
19:	-0.8	-0.3	-1.0	3.1
20:	-1.0	-0.1	-1.9	0.0
21:	-0.7	1.0	0.5	-1.4
22:	-2.5	0.1	0.3	-2.7
23:	-0.8	2.5	2.2	-0.3
24:	1.6	1.9	-3.1	-0.5
25:	-2.0	0.2	-0.6	1.7
26:	5.9	3.0	0.0	-2.2
27:	0.4	-1.4	2.2	1.4
28:	-1.6	1.1	1.1	0.2
29:	0.7	-1.4	-2.3	0.8
30:	1.5	1.6	-1.3	-1.2
31:	-1.8	-0.3	-2.6	-0.2
32:	3.6	0.2	-0.7	0.2

Rx Channels test passed

2016.01.04 23:59:20.894 116 7 OK

Tx Channels test passed

2016.01.05 00:02:03.042 116 8 OK

RX NOISE LEVEL

Board No:	1	2	3	4	
0:	79.1	74.0	76.8	77.5	dB
1:	79.3	73.0	76.9	77.1	dB
2:	79.3	78.2	77.0	77.8	dB
3:	78.3	77.2	77.2	77.1	dB
4:	79.1	76.4	77.9	76.4	dB
5:	78.7	77.2	77.2	76.6	dB
6:	79.1	78.7	76.8	76.6	dB
7:	77.8	76.1	76.2	75.1	dB
8:	77.8	77.1	75.1	76.8	dB
9:	77.7	77.8	77.3	77.5	dB
10:	77.8	77.3	77.3	78.8	dB
11:	77.8	78.7	76.9	77.4	dB
12:	77.7	78.8	77.4	77.9	dB
13:	77.6	77.7	78.3	77.1	dB
14:	77.5	77.3	78.4	78.1	dB
15:	77.1	76.3	76.5	75.6	dB
16:	78.1	77.8	77.1	75.7	dB
17:	77.5	77.1	76.8	76.0	dB
18:	78.4	78.1	77.2	76.5	dB
19:	77.4	77.5	77.3	76.1	dB
20:	79.3	78.7	77.0	75.8	dB
21:	77.5	77.8	76.8	76.4	dB
22:	78.6	78.2	76.6	76.4	dB
23:	76.5	74.6	76.8	76.4	dB
24:	77.3	77.7	76.6	77.0	dB
25:	78.4	77.3	75.4	77.5	dB
26:	78.2	78.4	77.9	76.5	dB
27:	76.2	77.4	77.4	76.6	dB
28:	77.7	77.9	77.5	77.2	dB
29:	77.7	76.5	77.3	76.1	dB
30:	77.6	77.8	78.1	76.2	dB
31:	77.3	75.5	76.5	75.9	dB

Maximum noise at Board 1 Channel 2 Level: 79.3 dB

Broadband noise test

Average noise at Board 1 78.1 dB OK
Average noise at Board 2 77.4 dB OK
Average noise at Board 3 77.1 dB OK
Average noise at Board 4 76.8 dB OK

2016.01.05 00:02:11.626 116 9 OK

RX NOISE SPECTRUM

Board No:	1	2	3	4	
10.0 kHz:	76.4	75.2	74.8	74.6	dB
10.2 kHz:	76.9	76.2	75.7	75.3	dB
10.3 kHz:	78.0	76.8	77.2	76.2	dB
10.4 kHz:	78.3	77.7	78.2	76.6	dB
10.6 kHz:	79.6	78.6	78.3	77.6	dB
10.7 kHz:	79.7	79.0	78.7	77.9	dB
10.9 kHz:	79.7	78.5	78.1	78.5	dB
11.0 kHz:	79.3	78.8	78.4	78.4	dB
11.2 kHz:	79.3	78.2	78.4	77.4	dB
11.3 kHz:	78.7	78.3	77.8	77.2	dB
11.4 kHz:	78.3	77.5	77.1	77.1	dB
11.6 kHz:	77.9	77.8	77.1	76.7	dB
11.7 kHz:	77.9	77.7	76.3	76.0	dB
11.9 kHz:	77.2	76.7	76.4	76.0	dB
12.0 kHz:	77.1	76.1	75.8	75.4	dB
12.1 kHz:	75.9	75.6	75.3	74.9	dB
12.3 kHz:	75.7	75.0	75.1	74.4	dB
12.4 kHz:	75.4	74.6	74.7	74.5	dB
12.6 kHz:	75.3	74.3	74.0	74.1	dB
12.7 kHz:	74.6	73.9	73.8	73.6	dB
12.9 kHz:	74.1	74.1	73.3	73.0	dB
13.0 kHz:	73.4	73.5	73.0	73.1	dB

Maximum noise at Board 1 Frequency 10.9 kHz Level: 79.7 dB

Spectral noise test

Average noise at Board 1 77.6 dB OK
Average noise at Board 2 76.9 dB OK
Average noise at Board 3 76.6 dB OK

Average noise at Board 4 76.1 dB OK

2016.01.05 00:02:20.209 116 10 OK

CPU: PP 432/05x PENTIUM4
Clock 1500 MHz
Die 39 oC (peak: 41 oC @ 2016-01-04 - 23:53:36)
Board 37 oC (peak: 37 oC @ 2016-01-04 - 23:52:47)
Core 0.95 V
3V3 3.27 V
12V 11.99 V
-12V -11.99 V
Primary network: 157.237.14.60:0xffff0000
Secondary network: 129.100.1.233:0xffffff00

2016.01.05 00:02:20.276 116 15 OK

EM 122

BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.3.5 150812
DDS: 3.5.10 140106
DSV: 3.1.8 141125
RX32 version : Feb 18 2010 Rev 1.11
TX36 LC version : May 7 2013 Rev 1.11
VxWorks 5.5.1 Build V1.19-01 Oct 8 2009, 13:31:43

BIST Test for QAT while underway after upgrades
January 8, 2016
Saved: 2016.01.08 02:56:34
Sounder Type: 122, Serial no.: 116

Date	Time	Ser. No.	BIST	Result
2016.01.08	00:52:24.598	116	0	OK

Number of BSP67B boards: 2
BSP 1 Master 2.2.3 090702 4.3 070913 4.3 070913
BSP 1 Slave 2.2.3 090702 6.0 080902
BSP 1 RXI FPGA 3.6 080821
BSP 1 DSP FPGA A 4.0 070531
BSP 1 DSP FPGA B 4.0 070531
BSP 1 DSP FPGA C 4.0 070531
BSP 1 DSP FPGA D 4.0 070531
BSP 1 PCI TO SLAVE A1 FIFO: ok
BSP 1 PCI TO SLAVE A2 FIFO: ok
BSP 1 PCI TO SLAVE A3 FIFO: ok
BSP 1 PCI TO SLAVE B1 FIFO: ok
BSP 1 PCI TO SLAVE B2 FIFO: ok
BSP 1 PCI TO SLAVE B3 FIFO: ok
BSP 1 PCI TO SLAVE C1 FIFO: ok
BSP 1 PCI TO SLAVE C2 FIFO: ok
BSP 1 PCI TO SLAVE C3 FIFO: ok
BSP 1 PCI TO SLAVE D1 FIFO: ok
BSP 1 PCI TO SLAVE D2 FIFO: ok
BSP 1 PCI TO SLAVE D3 FIFO: ok
BSP 1 PCI TO MASTER A HPI: ok
BSP 1 PCI TO MASTER B HPI: ok
BSP 1 PCI TO MASTER C HPI: ok
BSP 1 PCI TO MASTER D HPI: ok
BSP 1 PCI TO SLAVE A1 HPI: ok
BSP 1 PCI TO SLAVE A2 HPI: ok
BSP 1 PCI TO SLAVE A3 HPI: ok
BSP 1 PCI TO SLAVE B1 HPI: ok
BSP 1 PCI TO SLAVE B2 HPI: ok
BSP 1 PCI TO SLAVE B3 HPI: ok
BSP 1 PCI TO SLAVE C1 HPI: ok
BSP 1 PCI TO SLAVE C2 HPI: ok
BSP 1 PCI TO SLAVE C3 HPI: ok
BSP 1 PCI TO SLAVE D1 HPI: ok
BSP 1 PCI TO SLAVE D2 HPI: ok
BSP 1 PCI TO SLAVE D3 HPI: ok

BSP 2 Master 2.2.3 090702 4.3 070913 4.3 070913
BSP 2 Slave 2.2.3 090702 6.0 080902
BSP 2 RXI FPGA 3.6 080821
BSP 2 DSP FPGA A 4.0 070531
BSP 2 DSP FPGA B 4.0 070531
BSP 2 DSP FPGA C 4.0 070531
BSP 2 DSP FPGA D 4.0 070531
BSP 2 PCI TO SLAVE A1 FIFO: ok
BSP 2 PCI TO SLAVE A2 FIFO: ok
BSP 2 PCI TO SLAVE A3 FIFO: ok
BSP 2 PCI TO SLAVE B1 FIFO: ok
BSP 2 PCI TO SLAVE B2 FIFO: ok
BSP 2 PCI TO SLAVE B3 FIFO: ok
BSP 2 PCI TO SLAVE C1 FIFO: ok
BSP 2 PCI TO SLAVE C2 FIFO: ok
BSP 2 PCI TO SLAVE C3 FIFO: ok
BSP 2 PCI TO SLAVE D1 FIFO: ok
BSP 2 PCI TO SLAVE D2 FIFO: ok
BSP 2 PCI TO SLAVE D3 FIFO: ok
BSP 2 PCI TO MASTER A HPI: ok
BSP 2 PCI TO MASTER B HPI: ok
BSP 2 PCI TO MASTER C HPI: ok
BSP 2 PCI TO MASTER D HPI: ok
BSP 2 PCI TO SLAVE A1 HPI: ok
BSP 2 PCI TO SLAVE A2 HPI: ok
BSP 2 PCI TO SLAVE A3 HPI: ok
BSP 2 PCI TO SLAVE B1 HPI: ok
BSP 2 PCI TO SLAVE B2 HPI: ok
BSP 2 PCI TO SLAVE B3 HPI: ok
BSP 2 PCI TO SLAVE C1 HPI: ok
BSP 2 PCI TO SLAVE C2 HPI: ok
BSP 2 PCI TO SLAVE C3 HPI: ok
BSP 2 PCI TO SLAVE D1 HPI: ok
BSP 2 PCI TO SLAVE D2 HPI: ok
BSP 2 PCI TO SLAVE D3 HPI: ok

Summary:
BSP 1: OK
BSP 2: OK

2016.01.08 00:52:27.464 116 1 OK

High Voltage Br. 1

TX36 Spec: 108.0 - 132.0
0-1 123.0
0-2 123.0
0-3 122.6
0-4 123.0
0-5 123.0
0-6 121.7
0-7 122.6
0-8 123.0
0-9 123.0
0-10 122.6
0-11 122.6
0-12 123.0
0-13 122.1
0-14 122.6
0-15 122.1
0-16 123.8
0-17 123.0
0-18 123.0
0-19 122.6
0-20 122.6
0-21 122.6
0-22 123.4
0-23 122.6
0-24 123.0

High Voltage Br. 2

TX36 Spec: 108.0 - 132.0
0-1 123.4
0-2 122.6
0-3 122.6
0-4 123.0
0-5 123.0
0-6 123.0
0-7 122.6
0-8 123.8
0-9 123.0
0-10 122.6
0-11 123.4
0-12 123.0
0-13 122.6
0-14 123.0
0-15 122.2
0-16 123.8
0-17 123.0

0-18 122.6
0-19 123.0
0-20 123.0
0-21 123.0
0-22 123.4
0-23 123.0
0-24 122.6

Input voltage 12V

TX36 Spec: 11.0 - 13.0
0-1 11.9
0-2 11.9
0-3 11.8
0-4 11.9
0-5 11.9
0-6 11.8
0-7 11.9
0-8 11.9
0-9 11.9
0-10 11.8
0-11 11.9
0-12 11.9
0-13 11.8
0-14 11.9
0-15 11.8
0-16 11.9
0-17 11.9
0-18 11.9
0-19 11.9
0-20 11.9
0-21 11.9
0-22 11.9
0-23 11.9
0-24 11.8

Digital 3.3V

TX36 Spec: 2.8 - 3.5
0-1 3.3
0-2 3.3
0-3 3.3
0-4 3.3
0-5 3.3
0-6 3.3
0-7 3.3

0-8 3.3
0-9 3.3
0-10 3.3
0-11 3.3
0-12 3.3
0-13 3.3
0-14 3.3
0-15 3.3
0-16 3.3
0-17 3.3
0-18 3.3
0-19 3.3
0-20 3.3
0-21 3.3
0-22 3.3
0-23 3.3
0-24 3.3

Digital 2.5V

TX36 Spec: 2.4 - 2.6
0-1 2.5
0-2 2.5
0-3 2.5
0-4 2.5
0-5 2.5
0-6 2.5
0-7 2.5
0-8 2.5
0-9 2.5
0-10 2.5
0-11 2.5
0-12 2.5
0-13 2.5
0-14 2.5
0-15 2.5
0-16 2.5
0-17 2.5
0-18 2.5
0-19 2.5
0-20 2.5
0-21 2.5
0-22 2.5
0-23 2.5
0-24 2.5

Digital 1.5V

TX36 Spec: 1.4 - 1.6
0-1 1.5
0-2 1.5
0-3 1.5
0-4 1.5
0-5 1.5
0-6 1.5
0-7 1.5
0-8 1.5
0-9 1.5
0-10 1.5
0-11 1.5
0-12 1.5
0-13 1.5
0-14 1.5
0-15 1.5
0-16 1.5
0-17 1.5
0-18 1.5
0-19 1.5
0-20 1.5
0-21 1.5
0-22 1.5
0-23 1.5
0-24 1.5

Temperature

TX36 Spec: 15.0 - 75.0
0-1 37.6
0-2 36.4
0-3 35.6
0-4 34.0
0-5 35.6
0-6 34.8
0-7 34.8
0-8 34.8
0-9 34.4
0-10 33.6
0-11 34.8
0-12 34.0
0-13 34.0
0-14 34.4
0-15 34.4

0-16 36.0
0-17 37.6
0-18 37.6
0-19 36.8
0-20 37.2
0-21 36.4
0-22 37.2
0-23 35.2
0-24 35.6

Input Current 12V

TX36 Spec: 0.3 - 1.5
0-1 0.6
0-2 0.5
0-3 0.5
0-4 0.6
0-5 0.5
0-6 0.5
0-7 0.5
0-8 0.6
0-9 0.5
0-10 0.6
0-11 0.5
0-12 0.6
0-13 0.6
0-14 0.6
0-15 0.5
0-16 0.5
0-17 0.6
0-18 0.5
0-19 0.5
0-20 0.5
0-21 0.5
0-22 0.5
0-23 0.5
0-24 0.5

TX36 power test passed

IO TX PPC Embedded PPC Download
2.11 1.14 Mar 5 2007/1.07 May 7 2013/1.11

TX36 unique firmware test OK

2016.01.08 00:52:27.714 116 2 OK

Input voltage 12V

RX32 Spec: 11.0 - 13.0
7-1 11.8
7-2 11.8
7-3 11.7
7-4 11.8

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

Digital 3.3V

RX32 Spec: 2.8 - 3.5
7-1 3.3
7-2 3.3
7-3 3.3
7-4 3.3

Digital 2.5V

RX32 Spec: 2.4 - 2.6
7-1 2.5
7-2 2.5
7-3 2.5
7-4 2.5

Digital 1.5V

RX32 Spec: 1.4 - 1.6
7-1 1.5
7-2 1.5
7-3 1.5
7-4 1.5

Temperature

RX32 Spec: 15.0 - 75.0

7-1 37.0
7-2 41.0
7-3 38.0
7-4 35.0

Input Current 12V

RX32 Spec: 0.4 - 1.5
7-1 0.6
7-2 0.6
7-3 0.6
7-4 0.6

Input Current 6V

RX32 Spec: 2.4 - 3.3
7-1 2.8
7-2 2.8
7-3 2.8
7-4 2.9

RX32 power test passed

IO RX MB Embedded PPC Embedded PPC Download
1.12 1.14 May 5 2006/1.06 May 5 2006/1.07 Feb 18 2010/1.11

RX32 unique firmware test OK

2016.01.08 00:52:27.814 116 3 OK

High Voltage Br. 1

TX36 Spec: 108.0 - 132.0
0-1 123.0
0-2 123.0
0-3 122.1
0-4 123.0
0-5 123.0
0-6 121.7
0-7 122.6
0-8 123.0
0-9 123.0
0-10 122.6
0-11 122.6

0-12 123.0
0-13 122.1
0-14 122.6
0-15 122.1
0-16 123.8
0-17 123.0
0-18 123.0
0-19 123.0
0-20 122.6
0-21 122.6
0-22 123.4
0-23 122.6
0-24 123.0

High Voltage Br. 2

TX36 Spec: 108.0 - 132.0
0-1 123.4
0-2 122.6
0-3 122.6
0-4 123.0
0-5 122.6
0-6 122.6
0-7 122.6
0-8 123.4
0-9 122.6
0-10 122.6
0-11 123.4
0-12 123.0
0-13 122.6
0-14 123.0
0-15 122.6
0-16 123.8
0-17 123.0
0-18 122.6
0-19 123.0
0-20 123.0
0-21 123.0
0-22 123.4
0-23 123.4
0-24 122.6

Input voltage 12V

TX36 Spec: 11.0 - 13.0
0-1 11.9

0-2 11.9
0-3 11.8
0-4 11.9
0-5 11.9
0-6 11.8
0-7 11.9
0-8 11.9
0-9 11.9
0-10 11.8
0-11 11.9
0-12 11.9
0-13 11.8
0-14 11.9
0-15 11.8
0-16 11.9
0-17 11.9
0-18 11.9
0-19 11.9
0-20 11.9
0-21 11.9
0-22 11.9
0-23 11.9
0-24 11.8

RX32 Spec: 11.0 - 13.0
7-1 11.8
7-2 11.8
7-3 11.7
7-4 11.8

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

TRU power test passed

2016.01.08 00:52:27.948 116 4 OK

EM 122 High Voltage Ramp Test
Test Voltage:20.00 Measured Voltage: 19.00 PASSED

Test Voltage:60.00 Measured Voltage: 59.00 PASSED
Test Voltage:100.00 Measured Voltage: 100.00 PASSED
Test Voltage:120.00 Measured Voltage: 121.00 PASSED
Test Voltage:80.00 Measured Voltage: 85.00 PASSED
Test Voltage:40.00 Measured Voltage: 45.00 PASSED

6 of 6 tests OK

2016.01.08 00:54:51.896 116 5 OK

BSP 1 RXI TO RAW FIFO: ok
BSP 2 RXI TO RAW FIFO: ok

2016.01.08 00:54:58.996 116 6 OK

Receiver impedance limits [350.0 700.0] ohm

Board	1	2	3	4
1:	622.2	550.8	530.0	535.1
2:	615.4	554.7	552.0	541.0
3:	589.6	530.8	515.6	537.4
4:	583.2	552.7	476.5	552.1
5:	618.2	529.5	543.8	559.2
6:	575.9	535.1	521.5	560.1
7:	537.3	541.3	539.4	542.0
8:	620.4	547.7	530.1	525.5
9:	541.0	518.6	513.4	546.9
10:	604.6	560.7	523.6	510.8
11:	590.2	540.8	553.7	529.5
12:	601.1	558.0	517.5	521.6
13:	544.1	558.8	551.2	519.9
14:	566.2	550.0	561.7	556.6
15:	616.6	543.9	512.7	533.7
16:	618.5	546.0	552.6	528.8
17:	555.2	569.7	551.3	552.6
18:	607.0	571.6	569.3	543.4
19:	591.9	541.1	547.9	507.1
20:	592.5	552.8	556.3	552.8
21:	601.9	538.6	550.2	564.6
22:	619.5	554.3	533.7	564.1
23:	595.0	520.5	513.3	546.1
24:	577.6	540.7	573.2	558.9
25:	613.7	535.1	549.3	519.7

26:	517.5	508.4	539.6	554.4
27:	588.3	553.4	524.0	520.3
28:	606.1	538.5	534.1	537.7
29:	588.4	560.1	561.4	544.3
30:	565.1	540.6	551.9	547.0
31:	613.9	545.1	567.0	556.3
32:	554.7	560.3	561.7	543.8

Receiver Phase limits [-20.0 20.0] deg

Board	1	2	3	4
1:	-3.0	-0.5	1.4	0.6
2:	-2.1	-0.7	-1.2	0.1
3:	-0.9	1.2	1.6	0.3
4:	-0.3	-0.1	5.0	-1.4
5:	-2.2	1.2	-0.3	-1.4
6:	1.6	1.4	0.6	-1.8
7:	4.6	0.6	-0.2	-0.9
8:	-2.3	-0.3	0.8	1.5
9:	3.6	1.4	2.5	0.1
10:	-0.3	-1.9	1.3	1.8
11:	-0.6	-0.5	-1.2	1.4
12:	-1.6	-1.3	2.3	2.0
13:	3.9	-1.7	-1.1	1.7
14:	1.2	-0.1	-1.9	-1.6
15:	-2.2	0.9	2.4	0.8
16:	-2.2	-0.3	-1.0	1.1
17:	2.7	-2.0	-1.6	-1.2
18:	-1.6	-2.3	-2.8	0.1
19:	-0.9	0.0	-0.7	2.5
20:	-1.1	-0.1	-1.6	-0.3
21:	-0.8	0.8	-0.1	-1.8
22:	-2.4	-0.5	0.3	-2.2
23:	-0.8	2.2	2.0	-0.5
24:	1.2	0.8	-2.6	-1.0
25:	-1.7	0.4	-0.6	1.5
26:	5.4	2.9	0.2	-1.3
27:	0.5	-1.0	1.8	1.1
28:	-1.4	0.5	0.9	-0.3
29:	0.8	-1.1	-1.7	0.7
30:	1.4	1.0	-1.1	-0.9
31:	-2.0	0.0	-2.3	-0.6
32:	3.4	-0.8	-1.3	-0.2

Rx Channels test passed

2016.01.08 00:55:33.713 116 7 OK

Tx Channels test passed

2016.01.08 00:58:15.861 116 8 OK

RX NOISE LEVEL

Board No:	1	2	3	4	
0:	68.3	59.4	60.6	60.9	dB
1:	67.7	60.2	59.0	62.9	dB
2:	64.6	60.5	61.3	64.6	dB
3:	62.6	61.9	60.8	64.0	dB
4:	62.6	64.6	60.5	63.2	dB
5:	61.9	60.2	59.8	60.5	dB
6:	61.8	69.3	59.7	60.0	dB
7:	60.9	59.1	60.8	62.4	dB
8:	61.8	62.9	59.9	60.9	dB
9:	61.0	57.9	61.2	60.8	dB
10:	61.3	58.5	63.8	63.4	dB
11:	61.2	61.0	60.7	61.1	dB
12:	61.6	60.5	60.9	61.8	dB
13:	60.8	58.3	61.5	60.6	dB
14:	60.5	59.0	60.8	61.3	dB
15:	60.5	59.2	60.7	63.3	dB
16:	63.5	58.6	62.3	62.5	dB
17:	62.1	57.8	61.4	60.0	dB
18:	62.1	57.2	67.0	59.7	dB
19:	61.9	56.9	60.4	62.3	dB
20:	65.9	58.3	61.4	60.8	dB
21:	64.2	57.0	61.1	62.2	dB
22:	61.8	57.3	61.6	61.2	dB
23:	62.0	55.2	61.6	61.8	dB
24:	65.8	58.5	61.8	62.8	dB
25:	63.2	59.3	62.6	63.7	dB
26:	62.2	59.7	61.2	61.8	dB
27:	61.3	59.0	60.1	62.6	dB
28:	66.0	58.7	60.6	64.0	dB
29:	61.1	57.8	60.2	64.8	dB
30:	59.4	59.6	61.0	66.5	dB
31:	61.2	58.1	60.1	68.9	dB

Maximum noise at Board 2 Channel 6 Level: 69.3 dB

Broadband noise test

Average noise at Board 1 63.2 dB OK
Average noise at Board 2 60.6 dB OK
Average noise at Board 3 61.4 dB OK
Average noise at Board 4 62.9 dB OK

2016.01.08 00:58:24.444 116 9 OK

RX NOISE SPECTRUM

Board No:	1	2	3	4	
10.0 kHz:	62.0	57.6	58.9	61.4	dB
10.2 kHz:	63.1	58.4	60.3	62.8	dB
10.3 kHz:	63.3	59.5	60.5	62.3	dB
10.4 kHz:	64.1	60.0	61.2	63.5	dB
10.6 kHz:	63.5	60.0	61.7	64.1	dB
10.7 kHz:	63.7	60.4	62.3	64.4	dB
10.9 kHz:	64.5	60.2	62.7	64.4	dB
11.0 kHz:	64.5	60.6	62.0	65.0	dB
11.2 kHz:	63.6	60.4	61.9	64.4	dB
11.3 kHz:	63.9	59.7	61.6	64.1	dB
11.4 kHz:	64.1	60.0	61.8	64.3	dB
11.6 kHz:	64.7	60.4	61.2	65.0	dB
11.7 kHz:	63.6	59.2	60.4	64.1	dB
11.9 kHz:	63.1	59.4	60.5	64.0	dB
12.0 kHz:	63.0	58.2	59.6	63.0	dB
12.1 kHz:	62.5	59.1	60.0	62.9	dB
12.3 kHz:	62.3	57.9	58.8	62.8	dB
12.4 kHz:	62.9	58.7	59.0	62.1	dB
12.6 kHz:	62.7	57.9	58.0	62.2	dB
12.7 kHz:	62.1	57.9	57.5	61.8	dB
12.9 kHz:	60.9	56.2	57.4	61.2	dB
13.0 kHz:	59.7	55.5	56.6	60.9	dB

Maximum noise at Board 4 Frequency 11.6 kHz Level: 65.0 dB

Spectral noise test

Average noise at Board 1 63.2 dB OK
Average noise at Board 2 59.2 dB OK
Average noise at Board 3 60.5 dB OK

Average noise at Board 4 63.4 dB OK

2016.01.08 00:58:33.027 116 10 OK

CPU: PP 432/05x PENTIUM4
Clock 1500 MHz
Die 46 oC (peak: 55 oC @ 2016-01-07 - 20:17:37)
Board 44 oC (peak: 50 oC @ 2016-01-07 - 20:21:07)
Core 0.95 V
3V3 3.27 V
12V 11.99 V
-12V -11.99 V
Primary network: 157.237.14.60:0xffff0000
Secondary network: 129.100.1.233:0xffffff00

2016.01.08 00:58:33.127 116 15 OK

EM 122

BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.3.6b 160105
DDS: 3.5.10 140106
DSV: 3.1.8 141125
RX32 version : Feb 18 2010 Rev 1.11
TX36 LC version : May 7 2013 Rev 1.11
VxWorks 5.5.1 Build V1.19-01 Oct 8 2009, 13:31:43

Appendix 4. System Reports

System report on December 19, 2015

CPU: PP 432/05x PENTIUM4
Clock 1500 MHz
Die 38 oC (peak: 42 oC @ 2015-12-19 - 23:04:21)
Board 37 oC (peak: 37 oC @ 2015-12-19 - 23:04:21)
Core 0.95 V
3V3 3.27 V
12V 11.99 V
-12V -11.99 V
Primary network: 157.237.14.60:0xffff0000
Secondary network: 129.100.1.233:0xffffff00
Software versions

BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.3.5 150812
DDS: 3.5.10 140106
DSV: 3.1.8 141125

VxWorks 5.5.1 Build V1.19-01 Oct 8 2009, 13:31:43
RX boards :
Rack, Slot, SerialNo, IOFPGA, RXFPGA, MB Emedded, PPC Embedded, PPC Download
7, 0, RX32, 411375, 1.12, 1.14, 1.06 /May 5 2006, 1.07 /May 5 2006, 1.11 /Feb 18 2010
7, 1, RX32, 411377, 1.12, 1.14, 1.06 /May 5 2006, 1.07 /May 5 2006, 1.11 /Feb 18 2010
7, 2, RX32, 411370, 1.12, 1.14, 1.06 /May 5 2006, 1.07 /May 5 2006, 1.11 /Feb 18 2010
7, 3, RX32, 409222, 1.12, 1.14, 1.06 /May 5 2006, 1.07 /May 5 2006, 1.11 /Feb 18 2010
TX boards :
Rack, Slot, SerialNo, IOFPGA, TXFPGA, PPC Embedded, PPC Download
0, 0, TX36, 397838, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 1, TX36, 385189, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 2, TX36, 385143, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 3, TX36, 211274, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 4, TX36, 210768, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 5, TX36, 210706, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 6, TX36, 210734, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 7, TX36, 210698, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 8, TX36, 210699, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 9, TX36, 210758, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 10, TX36, 210772, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 11, TX36, 210701, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 12, TX36, 210691, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 13, TX36, 210765, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 14, TX36, 210774, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013

0, 15, TX36, 210682, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 16, TX36, 210776, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 17, TX36, 210681, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 18, TX36, 398444, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 19, TX36, 398450, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 20, TX36, 210716, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 21, TX36, 210710, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 22, TX36, 210700, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013
0, 23, TX36, 210760, 2.11, 1.14, 1.07 /Mar 5 2007, 1.11 /May 7 2013

BIST test while underway on January 7 2016 after upgrades
Saved: 2016.01.08 02:56:3**4**

Sounder Type: 122, Serial no.: 116

Date	Time	Ser. No.	BIST	Result
2016.01.08	00:52:24.598	116	0	OK

Number of BSP67B boards: 2
BSP 1 Master 2.2.3 090702 4.3 070913 4.3 070913
BSP 1 Slave 2.2.3 090702 6.0 080902
BSP 1 RXI FPGA 3.6 080821
BSP 1 DSP FPGA A 4.0 070531
BSP 1 DSP FPGA B 4.0 070531
BSP 1 DSP FPGA C 4.0 070531
BSP 1 DSP FPGA D 4.0 070531
BSP 1 PCI TO SLAVE A1 FIFO: ok
BSP 1 PCI TO SLAVE A2 FIFO: ok
BSP 1 PCI TO SLAVE A3 FIFO: ok
BSP 1 PCI TO SLAVE B1 FIFO: ok
BSP 1 PCI TO SLAVE B2 FIFO: ok
BSP 1 PCI TO SLAVE B3 FIFO: ok
BSP 1 PCI TO SLAVE C1 FIFO: ok
BSP 1 PCI TO SLAVE C2 FIFO: ok
BSP 1 PCI TO SLAVE C3 FIFO: ok
BSP 1 PCI TO SLAVE D1 FIFO: ok
BSP 1 PCI TO SLAVE D2 FIFO: ok
BSP 1 PCI TO SLAVE D3 FIFO: ok
BSP 1 PCI TO MASTER A HPI: ok
BSP 1 PCI TO MASTER B HPI: ok
BSP 1 PCI TO MASTER C HPI: ok
BSP 1 PCI TO MASTER D HPI: ok
BSP 1 PCI TO SLAVE A1 HPI: ok
BSP 1 PCI TO SLAVE A2 HPI: ok
BSP 1 PCI TO SLAVE A3 HPI: ok
BSP 1 PCI TO SLAVE B1 HPI: ok
BSP 1 PCI TO SLAVE B2 HPI: ok
BSP 1 PCI TO SLAVE B3 HPI: ok
BSP 1 PCI TO SLAVE C1 HPI: ok
BSP 1 PCI TO SLAVE C2 HPI: ok
BSP 1 PCI TO SLAVE C3 HPI: ok
BSP 1 PCI TO SLAVE D1 HPI: ok
BSP 1 PCI TO SLAVE D2 HPI: ok
BSP 1 PCI TO SLAVE D3 HPI: ok

BSP 2 Master 2.2.3 090702 4.3 070913 4.3 070913
BSP 2 Slave 2.2.3 090702 6.0 080902
BSP 2 RXI FPGA 3.6 080821
BSP 2 DSP FPGA A 4.0 070531
BSP 2 DSP FPGA B 4.0 070531
BSP 2 DSP FPGA C 4.0 070531
BSP 2 DSP FPGA D 4.0 070531
BSP 2 PCI TO SLAVE A1 FIFO: ok
BSP 2 PCI TO SLAVE A2 FIFO: ok
BSP 2 PCI TO SLAVE A3 FIFO: ok
BSP 2 PCI TO SLAVE B1 FIFO: ok
BSP 2 PCI TO SLAVE B2 FIFO: ok
BSP 2 PCI TO SLAVE B3 FIFO: ok
BSP 2 PCI TO SLAVE C1 FIFO: ok
BSP 2 PCI TO SLAVE C2 FIFO: ok
BSP 2 PCI TO SLAVE C3 FIFO: ok
BSP 2 PCI TO SLAVE D1 FIFO: ok
BSP 2 PCI TO SLAVE D2 FIFO: ok
BSP 2 PCI TO SLAVE D3 FIFO: ok
BSP 2 PCI TO MASTER A HPI: ok
BSP 2 PCI TO MASTER B HPI: ok
BSP 2 PCI TO MASTER C HPI: ok
BSP 2 PCI TO MASTER D HPI: ok
BSP 2 PCI TO SLAVE A1 HPI: ok
BSP 2 PCI TO SLAVE A2 HPI: ok
BSP 2 PCI TO SLAVE A3 HPI: ok
BSP 2 PCI TO SLAVE B1 HPI: ok
BSP 2 PCI TO SLAVE B2 HPI: ok
BSP 2 PCI TO SLAVE B3 HPI: ok
BSP 2 PCI TO SLAVE C1 HPI: ok
BSP 2 PCI TO SLAVE C2 HPI: ok
BSP 2 PCI TO SLAVE C3 HPI: ok
BSP 2 PCI TO SLAVE D1 HPI: ok
BSP 2 PCI TO SLAVE D2 HPI: ok
BSP 2 PCI TO SLAVE D3 HPI: ok

Summary:
BSP 1: OK
BSP 2: OK

2016.01.08 00:52:27.464 116 1 OK

High Voltage Br. 1

TX36 Spec: 108.0 - 132.0
0-1 123.0
0-2 123.0
0-3 122.6
0-4 123.0
0-5 123.0
0-6 121.7
0-7 122.6
0-8 123.0
0-9 123.0
0-10 122.6
0-11 122.6
0-12 123.0
0-13 122.1
0-14 122.6
0-15 122.1
0-16 123.8
0-17 123.0
0-18 123.0
0-19 122.6
0-20 122.6
0-21 122.6
0-22 123.4
0-23 122.6
0-24 123.0

High Voltage Br. 2

TX36 Spec: 108.0 - 132.0
0-1 123.4
0-2 122.6
0-3 122.6
0-4 123.0
0-5 123.0
0-6 123.0
0-7 122.6
0-8 123.8
0-9 123.0
0-10 122.6
0-11 123.4
0-12 123.0
0-13 122.6
0-14 123.0
0-15 122.2
0-16 123.8
0-17 123.0

0-18 122.6
0-19 123.0
0-20 123.0
0-21 123.0
0-22 123.4
0-23 123.0
0-24 122.6

Input voltage 12V

TX36 Spec: 11.0 - 13.0
0-1 11.9
0-2 11.9
0-3 11.8
0-4 11.9
0-5 11.9
0-6 11.8
0-7 11.9
0-8 11.9
0-9 11.9
0-10 11.8
0-11 11.9
0-12 11.9
0-13 11.8
0-14 11.9
0-15 11.8
0-16 11.9
0-17 11.9
0-19 11.9
0-20 11.9
0-21 11.9
0-22 11.9
0-23 11.9
0-24 11.8

Digital 3.3V

TX36 Spec: 2.8 - 3.5
0-1 3.3
0-2 3.3
0-3 3.3
0-4 3.3
0-5 3.3
0-6 3.3
0-7 3.3
0-8 3.3

0-9 3.3
0-10 3.3
0-11 3.3
0-12 3.3
0-13 3.3
0-14 3.3
0-15 3.3
0-16 3.3
0-17 3.3
0-18 3.3
0-19 3.3
0-20 3.3
0-21 3.3
0-22 3.3
0-23 3.3
0-24 3.3

Digital 2.5V

TX36 Spec: 2.4 - 2.6
0-1 2.5
0-2 2.5
0-3 2.5
0-4 2.5
0-5 2.5
0-6 2.5
0-7 2.5
0-8 2.5
0-9 2.5
0-10 2.5
0-11 2.5
0-12 2.5
0-13 2.5
0-14 2.5
0-15 2.5
0-16 2.5
0-17 2.5
0-18 2.5
0-19 2.5
0-20 2.5
0-21 2.5
0-22 2.5
0-23 2.5
0-24 2.5

Digital 1.5V

TX36 Spec: 1.4 - 1.6
0-1 1.5
0-2 1.5
0-3 1.5
0-4 1.5
0-5 1.5
0-6 1.5
0-7 1.5
0-8 1.5
0-9 1.5
0-10 1.5
0-11 1.5
0-12 1.5
0-13 1.5
0-14 1.5
0-15 1.5
0-16 1.5
0-17 1.5
0-18 1.5
0-19 1.5
0-20 1.5
0-21 1.5
0-22 1.5
0-23 1.5
0-24 1.5

Temperature

TX36 Spec: 15.0 - 75.0
0-1 37.6
0-2 36.4
0-3 35.6
0-4 34.0
0-5 35.6
0-6 34.8
0-7 34.8
0-8 34.8
0-9 34.4
0-10 33.6
0-11 34.8
0-12 34.0
0-13 34.0
0-14 34.4
0-15 34.4
0-16 36.0

0-17 37.6
0-18 37.6
0-19 36.8
0-20 37.2
0-21 36.4
0-22 37.2
0-23 35.2
0-24 35.6

Input Current 12V

TX36 Spec: 0.3 - 1.5
0-1 0.6
0-2 0.5
0-3 0.5
0-4 0.6
0-5 0.5
0-6 0.5
0-7 0.5
0-8 0.6
0-9 0.5
0-10 0.6
0-11 0.5
0-12 0.6
0-13 0.6
0-14 0.6
0-15 0.5
0-16 0.5
0-17 0.6
0-18 0.5
0-19 0.5
0-20 0.5
0-21 0.5
0-22 0.5
0-23 0.5
0-24 0.5

TX36 power test passed

IO TX PPC Embedded PPC Download
2.11 1.14 Mar 5 2007/1.07 May 7 2013/1.11

TX36 unique firmware test OK

2016.01.08 00:52:27.714 116 2 OK

Input voltage 12V

RX32 Spec: 11.0 - 13.0
7-1 11.8
7-2 11.8
7-3 11.7
7-4 11.8

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

Digital 3.3V

RX32 Spec: 2.8 - 3.5
7-1 3.3
7-2 3.3
7-3 3.3
7-4 3.3

Digital 2.5V

RX32 Spec: 2.4 - 2.6
7-1 2.5
7-2 2.5
7-3 2.5
7-4 2.5

Digital 1.5V

RX32 Spec: 1.4 - 1.6
7-1 1.5
7-2 1.5
7-3 1.5
7-4 1.5

Temperature

RX32 Spec: 15.0 - 75.0
7-1 37.0

7-2 41.0
7-3 38.0
7-4 35.0

Input Current 12V

RX32 Spec: 0.4 - 1.5
7-1 0.6
7-2 0.6
7-3 0.6
7-4 0.6

Input Current 6V

RX32 Spec: 2.4 - 3.3
7-1 2.8
7-2 2.8
7-3 2.8
7-4 2.9

RX32 power test passed

IO RX MB Embedded PPC Embedded PPC Download
1.12 1.14 May 5 2006/1.06 May 5 2006/1.07 Feb 18 2010/1.11

RX32 unique firmware test OK

2016.01.08 00:52:27.814 116 3 OK

High Voltage Br. 1

TX36 Spec: 108.0 - 132.0
0-1 123.0
0-2 123.0
0-3 122.1
0-4 123.0
0-5 123.0
0-6 121.7
0-7 122.6
0-8 123.0
0-9 123.0
0-10 122.6
0-11 122.6
0-12 123.0

0-13 122.1
0-14 122.6
0-15 122.1
0-16 123.8
0-17 123.0
0-18 123.0
0-19 123.0
0-20 122.6
0-21 122.6
0-22 123.4
0-23 122.6
0-24 123.0

High Voltage Br. 2

TX36 Spec: 108.0 - 132.0
0-1 123.4
0-2 122.6
0-3 122.6
0-4 123.0
0-5 122.6
0-6 122.6
0-7 122.6
0-8 123.4
0-9 122.6
0-10 122.6
0-11 123.4
0-12 123.0
0-13 122.6
0-14 123.0
0-15 122.6
0-16 123.8
0-17 123.0
0-18 122.6
0-19 123.0
0-20 123.0
0-21 123.0
0-22 123.4
0-23 123.4
0-24 122.6

Input voltage 12V

TX36 Spec: 11.0 - 13.0
0-1 11.9
0-2 11.9

0-3 11.8
0-4 11.9
0-5 11.9
0-6 11.8
0-7 11.9
0-8 11.9
0-9 11.9
0-10 11.8
0-11 11.9
0-12 11.9
0-13 11.8
0-14 11.9
0-15 11.8
0-16 11.9
0-17 11.9
0-18 11.9
0-19 11.9
0-20 11.9
0-21 11.9
0-22 11.9
0-23 11.9
0-24 11.8

RX32 Spec: 11.0 - 13.0
7-1 11.8
7-2 11.8
7-3 11.7
7-4 11.8

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

TRU power test passed

2016.01.08 00:52:27.948 116 4 OK

EM 122 High Voltage Ramp Test
Test Voltage:20.00 Measured Voltage: 19.00 PASSED
Test Voltage:60.00 Measured Voltage: 59.00 PASSED

Test Voltage:100.00 Measured Voltage: 100.00 PASSED
Test Voltage:120.00 Measured Voltage: 121.00 PASSED
Test Voltage:80.00 Measured Voltage: 85.00 PASSED
Test Voltage:40.00 Measured Voltage: 45.00 PASSED

6 of 6 tests OK

2016.01.08 00:54:51.896 116 5 OK

BSP 1 RXI TO RAW FIFO: ok
BSP 2 RXI TO RAW FIFO: ok

2016.01.08 00:54:58.996 116 6 OK

Receiver impedance limits [350.0 700.0] ohm

Board	1	2	3	4
1:	622.2	550.8	530.0	535.1
2:	615.4	554.7	552.0	541.0
3:	589.6	530.8	515.6	537.4
4:	583.2	552.7	476.5	552.1
5:	618.2	529.5	543.8	559.2
6:	575.9	535.1	521.5	560.1
7:	537.3	541.3	539.4	542.0
8:	620.4	547.7	530.1	525.5
9:	541.0	518.6	513.4	546.9
10:	604.6	560.7	523.6	510.8
11:	590.2	540.8	553.7	529.5
12:	601.1	558.0	517.5	521.6
13:	544.1	558.8	551.2	519.9
14:	566.2	550.0	561.7	556.6
15:	616.6	543.9	512.7	533.7
16:	618.5	546.0	552.6	528.8
17:	555.2	569.7	551.3	552.6
18:	607.0	571.6	569.3	543.4
19:	591.9	541.1	547.9	507.1
20:	592.5	552.8	556.3	552.8
21:	601.9	538.6	550.2	564.6
22:	619.5	554.3	533.7	564.1
23:	595.0	520.5	513.3	546.1
24:	577.6	540.7	573.2	558.9
25:	613.7	535.1	549.3	519.7
26:	517.5	508.4	539.6	554.4

27: 588.3 553.4 524.0 520.3
28: 606.1 538.5 534.1 537.7
29: 588.4 560.1 561.4 544.3
30: 565.1 540.6 551.9 547.0
31: 613.9 545.1 567.0 556.3
32: 554.7 560.3 561.7 543.8

Receiver Phase limits [-20.0 20.0] deg

Board	1	2	3	4
1:	-3.0	-0.5	1.4	0.6
2:	-2.1	-0.7	-1.2	0.1
3:	-0.9	1.2	1.6	0.3
4:	-0.3	-0.1	5.0	-1.4
5:	-2.2	1.2	-0.3	-1.4
6:	1.6	1.4	0.6	-1.8
7:	4.6	0.6	-0.2	-0.9
8:	-2.3	-0.3	0.8	1.5
9:	3.6	1.4	2.5	0.1
10:	-0.3	-1.9	1.3	1.8
11:	-0.6	-0.5	-1.2	1.4
12:	-1.6	-1.3	2.3	2.0
13:	3.9	-1.7	-1.1	1.7
14:	1.2	-0.1	-1.9	-1.6
15:	-2.2	0.9	2.4	0.8
16:	-2.2	-0.3	-1.0	1.1
17:	2.7	-2.0	-1.6	-1.2
18:	-1.6	-2.3	-2.8	0.1
19:	-0.9	0.0	-0.7	2.5
20:	-1.1	-0.1	-1.6	-0.3
21:	-0.8	0.8	-0.1	-1.8
22:	-2.4	-0.5	0.3	-2.2
23:	-0.8	2.2	2.0	-0.5
24:	1.2	0.8	-2.6	-1.0
25:	-1.7	0.4	-0.6	1.5
26:	5.4	2.9	0.2	-1.3
27:	0.5	-1.0	1.8	1.1
28:	-1.4	0.5	0.9	-0.3
29:	0.8	-1.1	-1.7	0.7
30:	1.4	1.0	-1.1	-0.9
31:	-2.0	0.0	-2.3	-0.6
32:	3.4	-0.8	-1.3	-0.2

Rx Channels test passed

2016.01.08 00:55:33.713 116 7 OK

Tx Channels test passed

2016.01.08 00:58:15.861 116 8 OK

RX NOISE LEVEL

Board No:	1	2	3	4	
0:	68.3	59.4	60.6	60.9	dB
1:	67.7	60.2	59.0	62.9	dB
2:	64.6	60.5	61.3	64.6	dB
3:	62.6	61.9	60.8	64.0	dB
4:	62.6	64.6	60.5	63.2	dB
5:	61.9	60.2	59.8	60.5	dB
6:	61.8	69.3	59.7	60.0	dB
7:	60.9	59.1	60.8	62.4	dB
8:	61.8	62.9	59.9	60.9	dB
9:	61.0	57.9	61.2	60.8	dB
10:	61.3	58.5	63.8	63.4	dB
11:	61.2	61.0	60.7	61.1	dB
12:	61.6	60.5	60.9	61.8	dB
13:	60.8	58.3	61.5	60.6	dB
14:	60.5	59.0	60.8	61.3	dB
15:	60.5	59.2	60.7	63.3	dB
16:	63.5	58.6	62.3	62.5	dB
17:	62.1	57.8	61.4	60.0	dB
18:	62.1	57.2	67.0	59.7	dB
19:	61.9	56.9	60.4	62.3	dB
20:	65.9	58.3	61.4	60.8	dB
21:	64.2	57.0	61.1	62.2	dB
22:	61.8	57.3	61.6	61.2	dB
23:	62.0	55.2	61.6	61.8	dB
24:	65.8	58.5	61.8	62.8	dB
25:	63.2	59.3	62.6	63.7	dB
26:	62.2	59.7	61.2	61.8	dB
27:	61.3	59.0	60.1	62.6	dB
28:	66.0	58.7	60.6	64.0	dB
29:	61.1	57.8	60.2	64.8	dB
30:	59.4	59.6	61.0	66.5	dB
31:	61.2	58.1	60.1	68.9	dB

Maximum noise at Board 2 Channel 6 Level: 69.3 dB

Broadband noise test

Average noise at Board 1 63.2 dB OK
Average noise at Board 2 60.6 dB OK
Average noise at Board 3 61.4 dB OK
Average noise at Board 4 62.9 dB OK

2016.01.08 00:58:24.444 116 9 OK

RX NOISE SPECTRUM

Board No:	1	2	3	4	
10.0 kHz:	62.0	57.6	58.9	61.4	dB
10.2 kHz:	63.1	58.4	60.3	62.8	dB
10.3 kHz:	63.3	59.5	60.5	62.3	dB
10.4 kHz:	64.1	60.0	61.2	63.5	dB
10.6 kHz:	63.5	60.0	61.7	64.1	dB
10.7 kHz:	63.7	60.4	62.3	64.4	dB
10.9 kHz:	64.5	60.2	62.7	64.4	dB
11.0 kHz:	64.5	60.6	62.0	65.0	dB
11.2 kHz:	63.6	60.4	61.9	64.4	dB
11.3 kHz:	63.9	59.7	61.6	64.1	dB
11.4 kHz:	64.1	60.0	61.8	64.3	dB
11.6 kHz:	64.7	60.4	61.2	65.0	dB
11.7 kHz:	63.6	59.2	60.4	64.1	dB
11.9 kHz:	63.1	59.4	60.5	64.0	dB
12.0 kHz:	63.0	58.2	59.6	63.0	dB
12.1 kHz:	62.5	59.1	60.0	62.9	dB
12.3 kHz:	62.3	57.9	58.8	62.8	dB
12.4 kHz:	62.9	58.7	59.0	62.1	dB
12.6 kHz:	62.7	57.9	58.0	62.2	dB
12.7 kHz:	62.1	57.9	57.5	61.8	dB
12.9 kHz:	60.9	56.2	57.4	61.2	dB
13.0 kHz:	59.7	55.5	56.6	60.9	dB

Maximum noise at Board 4 Frequency 11.6 kHz Level: 65.0 dB

Spectral noise test

Average noise at Board 1 63.2 dB OK
Average noise at Board 2 59.2 dB OK

Average noise at Board 3 60.5 dB OK
Average noise at Board 4 63.4 dB OK

2016.01.08 00:58:33.027 116 10 OK

CPU: PP 432/05x PENTIUM4
Clock 1500 MHz
Die 46 oC (peak: 55 oC @ 2016-01-07 - 20:17:37)
Board 44 oC (peak: 50 oC @ 2016-01-07 - 20:21:07)
Core 0.95 V
3V3 3.27 V
12V 11.99 V
-12V -11.99 V
Primary network: 157.237.14.60:0xffff0000
Secondary network: 129.100.1.233:0xffffff00

2016.01.08 00:58:33.127 116 15 OK

EM 122

BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.3.6b 160105
DDS: 3.5.10 140106
DSV: 3.1.8 141125
RX32 version : Feb 18 2010 Rev 1.11
TX36 LC version : May 7 2013 Rev 1.11
VxWorks 5.5.1 Build V1.19-01 Oct 8 2009, 13:31:43

Appendix 4 Calibration Sheets

Hull-mounted sound-speed sensor

TELEDYNE RESON
Everywhereyoulook™

SVP Test and Calibration certificate

SVP Type :	SVP70
SVP Serial No.	0614179

Date of issue : 04-06-2014

Temperature Calibration :	Hart 1504 s/n A6B554 & Thermistor s/n 3014
Point 1:	4.6 °C
Point 2:	16.5 °C
Point 3:	25.5 °C
Pressure Calibration :	Custom Built Tank (TestUnit ASF150 Ser# 41-10-0007-R03)
Point 1:	0 Bar
Point 2:	300 Bar
Point 3:	600.1 Bar

	RMS Speed of Sound Errors
Temperature Validation :	0.0205 m/s
Pressure Validation :	0.1165 m/s

Calibration & Final Function Test : Sign : Find Petersen

QA Signature : Inits : Oskar
2014 06.11

TELEDYNE RESON
Everywhereyoulook™
TELEDYNE-RESON A/S, Fabriksvangen 13, DK-3550 Slangerup
Fax: +45 4738 0066, Phone: +45 4738 0022

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0489
CALIBRATION DATE: 29-Sep-15

SBE 9plus PRESSURE CALIBRATION DATA
FSR: 10000 psia S/N 67264

DIGIQUARTZ COEFFICIENTS:

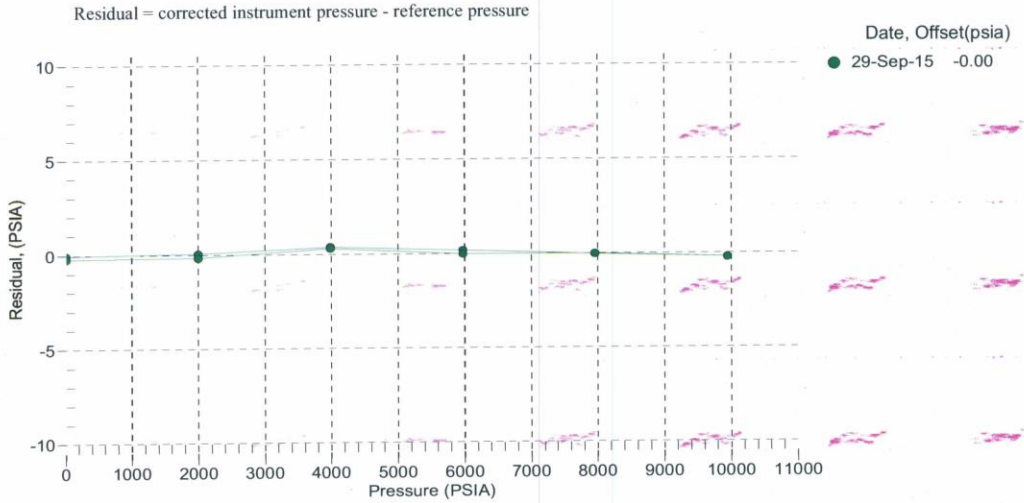
```
C1 =  -4.834104e+004
C2 =  -2.870371e-002
C3 =   1.520660e-002
D1 =   3.859400e-002
D2 =   0.000000e+000
T1 =   3.018636e+001
T2 =  -3.267612e-004
T3 =   3.968100e-006
T4 =   4.221960e-009
T5 =   0.000000e+000
```

AD590M, AD590B, SLOPE AND OFFSET:

```
AD590M =   1.28576e-002
AD590B =  -8.87871e+000
Slope  =   0.99993
Offset =  -0.7516 (dbars)
```

PRESSURE (PSIA)	INST OUTPUT (Hz)	INST TEMP (C)	INST OUTPUT (PSIA)	CORRECTED INST OUTPUT (PSIA)	RESIDUAL (PSIA)
14.576	33138.80	23.1	15.616	14.526	-0.050
2000.939	33811.70	23.2	2002.200	2000.970	0.031
3987.957	34469.70	23.3	3989.689	3988.318	0.361
5974.967	35113.20	23.3	5976.643	5975.132	0.165
7962.102	35743.20	23.3	7963.695	7962.045	-0.057
9949.226	36360.40	23.4	9950.787	9948.996	-0.230
7962.056	35743.20	23.4	7963.664	7962.013	-0.043
5974.787	35113.10	23.4	5976.268	5974.758	-0.029
3987.931	34469.70	23.4	3989.592	3988.222	0.291
2001.041	33811.70	23.5	2002.076	2000.846	-0.195
14.573	33138.80	23.6	15.418	14.328	-0.245

Residual = corrected instrument pressure - reference pressure



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SENSOR SERIAL NUMBER: 0833
CALIBRATION DATE: 06-Oct-15

SBE 21 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g =  -4.19426078e+000
h =   5.00643727e-001
i =   1.19742696e-003
j =  -3.69709428e-005
```

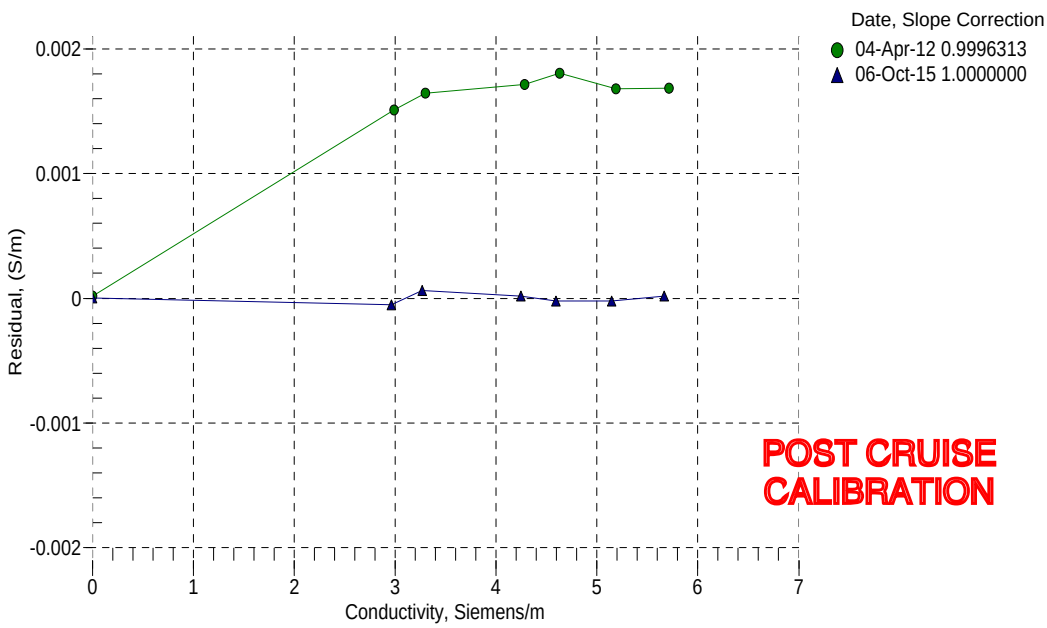
```
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88538	0.00000	0.00000
1.0000	34.6749	2.96503	8.16261	2.96498	-0.00005
4.5000	34.6544	3.27095	8.52197	3.27101	0.00006
14.9999	34.6106	4.24903	9.57981	4.24905	0.00002
18.5000	34.5993	4.59268	9.92455	4.59266	-0.00002
24.0000	34.5851	5.14802	10.45759	5.14800	-0.00002
29.0000	34.5735	5.66701	10.93220	5.66703	0.00002
32.5000	34.5695	6.03780	11.25916	6.03803	0.00023

Conductivity = $(g + h * f^2 + i * f^3 + j * f^4) / [10 * (1 + d * t + e * p)]$ Siemens / meter

t = temperatur e[°C)]; p = pressure[decibars]; d = CTcor; e = CPcor;

Residual = instrument conductivity - bath conductivity



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SENSOR SERIAL NUMBER: 0833
CALIBRATION DATE: 06-Oct-15

SBE 21 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

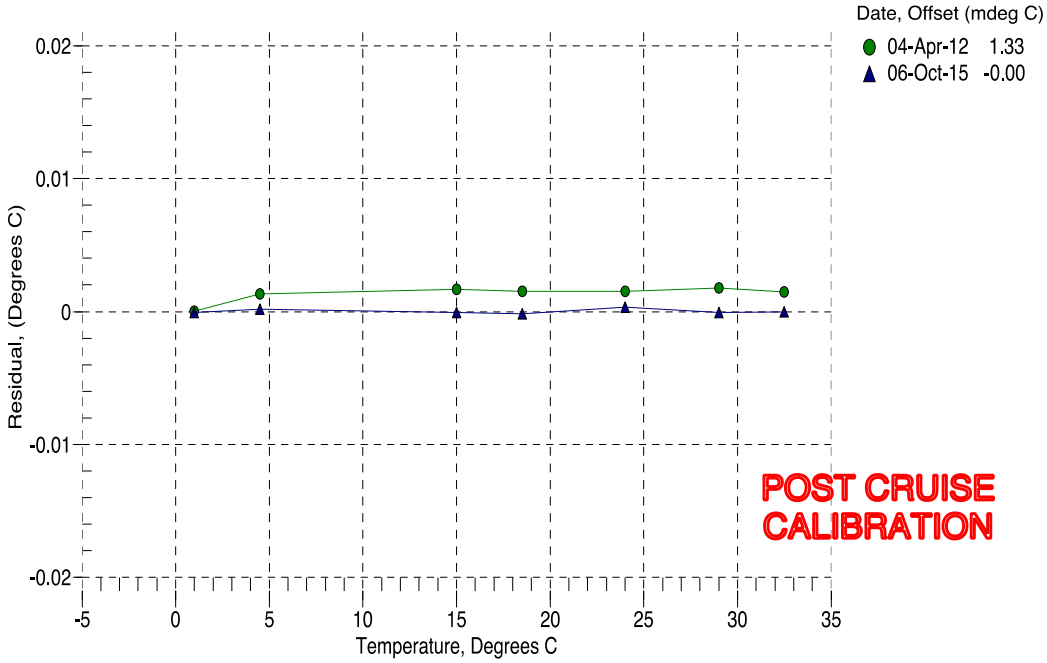
ITS-90 COEFFICIENTS:

```
g =  4.22878450e-003
h =  6.06434131e-004
i =  6.90239860e-006
j = -1.19810761e-006
f0 =  1000.0
```

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	2640.146	0.9999	-0.00010
4.5000	2854.596	4.5002	0.00018
14.9999	3571.760	14.9998	-0.00008
18.5000	3836.620	18.4998	-0.00020
24.0000	4280.234	24.0003	0.00031
29.0000	4713.439	28.9999	-0.00009
32.5000	5034.251	32.5000	-0.00002

Temperature ITS-90 = $1/\{ g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 0833
CALIBRATION DATE: 06-Oct-15

SBE 21 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS:

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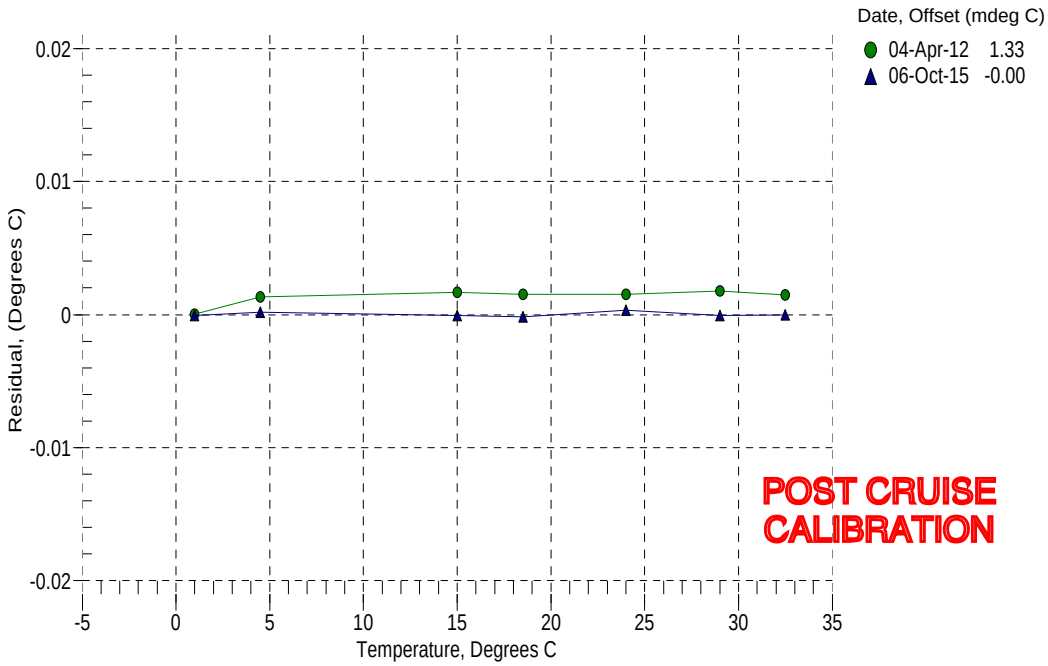
g =  4.22878450e-003
h =  6.06434131e-004
i =  6.90239860e-006
j = -1.19810761e-006
f0 =  1000.0
```

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	2640.146	0.9999	-0.00010
4.5000	2854.596	4.5002	0.00018
14.9999	3571.760	14.9998	-0.00008
18.5000	3836.620	18.4998	-0.00020
24.0000	4280.234	24.0003	0.00031
29.0000	4713.439	28.9999	-0.00009
32.5000	5034.251	32.5000	-0.00002

Temperature ITS-90 = $1/\{ g + h[\ln(f_0/f)] + i[\ln^2(f_0/f)] + j[\ln^3(f_0/f)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



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Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0492
CALIBRATION DATE: 09-Oct-15

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -9.948402e-001                    CPcor = -9.5700e-008
h =  1.744315e-001                    CTcor =  3.2500e-006
i = -2.671153e-004                    WBOTC =  2.4401e-007
j =  5.222874e-005
```

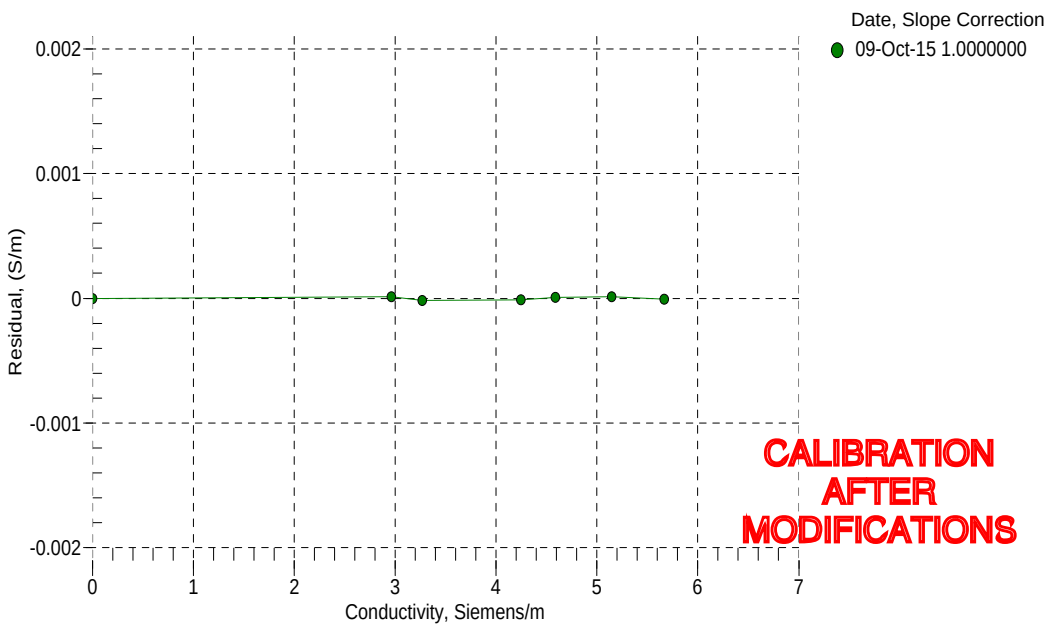
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2390.49	0.00000	0.00000
1.0000	34.6537	2.96339	4764.83	2.96340	0.00001
4.4999	34.6335	3.26916	4944.84	3.26915	-0.00002
15.0000	34.5892	4.24669	5480.17	4.24668	-0.00001
18.5000	34.5779	4.59014	5656.00	4.59015	0.00001
23.9999	34.5638	5.14519	5928.88	5.14520	0.00001
29.0000	34.5577	5.66471	6173.07	5.66470	-0.00001
32.5000	34.5541	6.03542	6341.30	6.03516	-0.00025

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductiv ity = $(g + h * f^2 + i * f^3 + j * f^4) / (1 + d * t + e * p)$ Siemens / meter

t = temperatur e[°C)]; p = pressure[decibars]; d = CTcor; e = CPcor;

Residual = instrument conductivity - bath conductivity



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SENSOR SERIAL NUMBER: 0492
CALIBRATION DATE: 30-Sep-15

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -9.946242e-001                    CPcor = -9.5700e-008
h =  1.747708e-001                    CTcor =  3.2500e-006
i = -6.776997e-004                    WBOTC =  2.4401e-007
j =  7.865801e-005
```

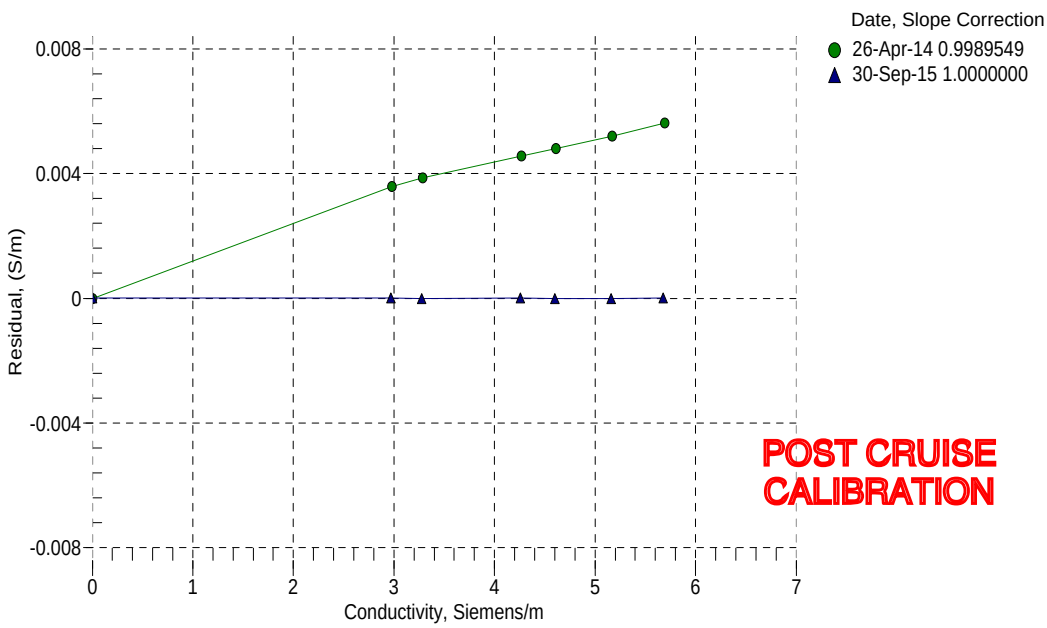
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2393.61	0.00000	0.00000
1.0000	34.7520	2.97099	4783.22	2.97100	0.00000
4.5000	34.7315	3.27751	4964.42	3.27750	-0.00001
14.9999	34.6856	4.25726	5503.16	4.25728	0.00001
18.5000	34.6740	4.60152	5680.09	4.60151	-0.00001
23.9999	34.6589	5.15778	5954.63	5.15778	-0.00000
29.0000	34.6482	5.67788	6200.04	5.67788	0.00000
32.5001	34.6391	6.04859	6369.05	6.04869	0.00010

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductiv ity = $(g + h * f^2 + i * f^3 + j * f^4) / (1 + d * t + e * p)$ Siemens / meter

t = temperatur e[°C)]; p = pressure[decibars]; d = CTcor; e = CPcor;

Residual = instrument conductivity - bath conductivity



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Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0492
CALIBRATION DATE: 09-Oct-15

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

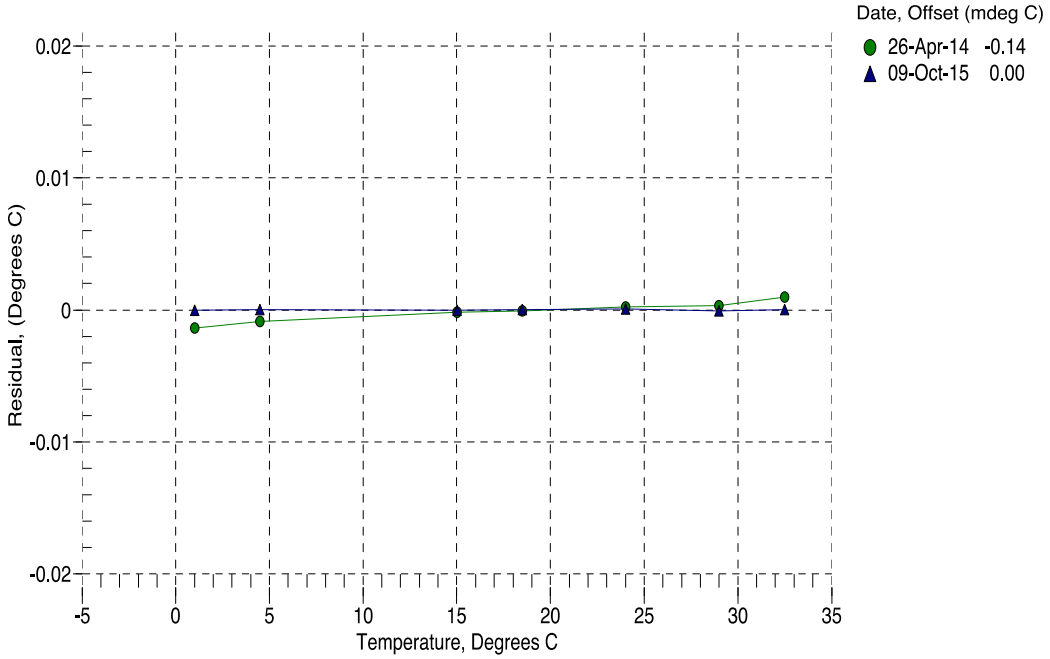
```
a0 = -1.684314e-006
a1 =  2.787926e-004
a2 = -2.831399e-006
a3 =  1.609755e-007
```

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	743577.6	1.0000	-0.0000
4.4999	634524.1	4.4999	0.0000
15.0000	402112.0	15.0000	-0.0000
18.5000	347556.2	18.5000	0.0000
23.9999	278048.5	24.0000	0.0001
29.0000	228391.5	28.9999	-0.0001
32.5000	199672.3	32.5000	0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature

n = instrument output



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SENSOR SERIAL NUMBER: 0492
CALIBRATION DATE: 09-Oct-15

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

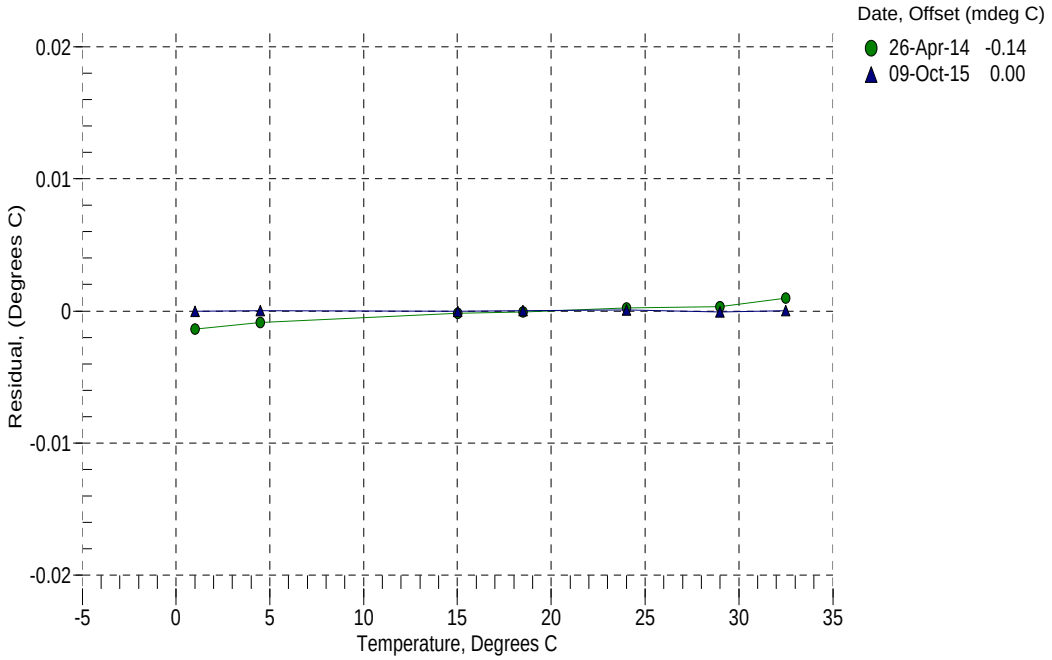
```
a0 = -1.684314e-006
a1 =  2.787926e-004
a2 = -2.831399e-006
a3 =  1.609755e-007
```

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	743577.6	1.0000	-0.0000
4.4999	634524.1	4.4999	0.0000
15.0000	402112.0	15.0000	-0.0000
18.5000	347556.2	18.5000	0.0000
23.9999	278048.5	24.0000	0.0001
29.0000	228391.5	28.9999	-0.0001
32.5000	199672.3	32.5000	0.0000

Temperature ITS-90 = 1/{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]} - 273.15 (°C)

Residual = instrument temperature - bath temperature

n = instrument output



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SENSOR SERIAL NUMBER: 0492
CALIBRATION DATE: 30-Sep-15

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

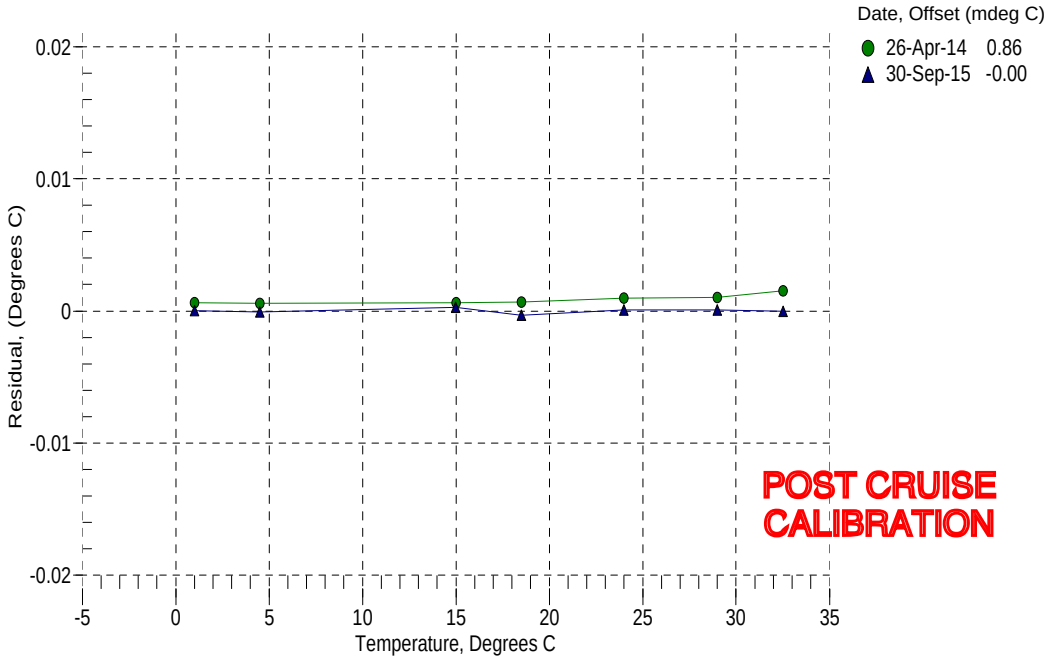
```
a0 =  4.276159e-005
a1 =  2.682301e-004
a2 = -1.994655e-006
a3 =  1.388759e-007
```

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	743644.4	1.0000	0.0000
4.5000	634565.4	4.4999	-0.0001
14.9999	402122.2	15.0002	0.0003
18.5000	347571.7	18.4997	-0.0003
23.9999	278056.6	24.0000	0.0001
29.0000	228396.2	29.0001	0.0001
32.5001	199676.4	32.5001	-0.0000

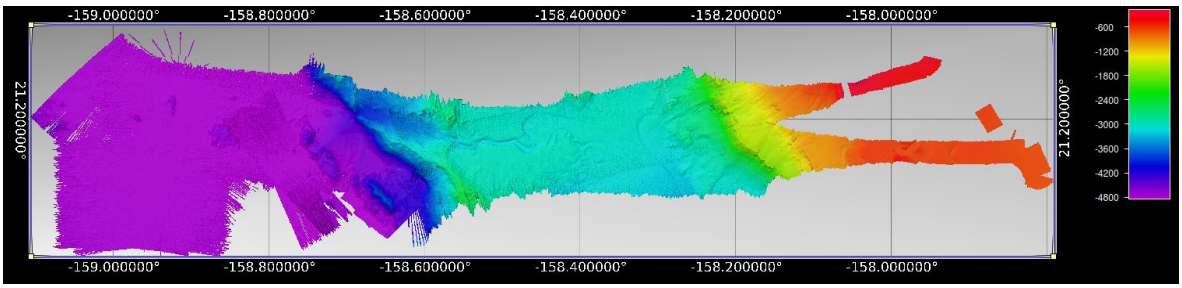
Temperature ITS-90 = 1/{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]} - 273.15 (°C)

Residual = instrument temperature - bath temperature

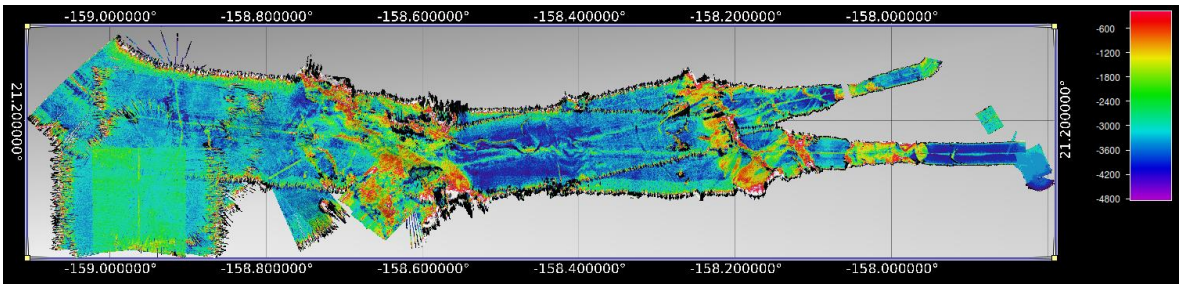
n = instrument output



Appendix 5. Maps of Bathymetry and Acoustic Backscatter for Cruise.



Map of bathymetry



Map of acoustic backscatter