NOAA *Okeanos Explorer* Program

MAPPING DATA REPORT

CRUISE EX1004 Leg 3

Exploration, Indonesia

July 21 to August 7, 2010

Bitung to Bitung

Report Contributors:

PS Meme Lobecker, LT Nicola VerPlanck, SST Elaine Stuart, SST Colleen Peters,

Joel DeMello,Tom Kok, Karl McLetchie

NOAA Office of Ocean Exploration and Research
1315 East-West Hwy, SSMC3, #10210
Silver Spring, MD 20910

1. Introduction

The *Okeanos Explorer* Program

Commissioned in August 2008, the NOAA Ship *Okeanos Explorer* is the nation's only federal vessel dedicated to ocean exploration. With 95% of the world's oceans left unexplored, the ship's combination of scientific and technological tools uniquely positions it to systematically explore new areas of our largely unknown ocean. These exploration cruises are explicitly designed to generate hypotheses and lead to further investigations by the wider scientific community.

Using a high-resolution multibeam sonar with water column capabilities, a deep water remotely operated vehicle, and telepresence technology, *Okeanos Explorer* provides NOAA the ability to foster scientific discoveries by identifying new targets in real time, diving on those targets shortly after initial detection, and then sending this information back to shore for immediate near-real-time collaboration with scientists and experts at Exploration Command Centers around the world. The subsequent transparent and rapid dissemination of information-rich products to the scientific community ensures that discoveries are immediately available to experts in relevant disciplines for research and analysis

Through the *Okeanos Explorer* Program, NOAA's Office of Ocean Exploration and Research (OER) provides the nation with unparalleled capacity to discover and investigate new oceanic regions and phenomena, conduct the basic research required to document discoveries, and seamlessly disseminate data and information-rich products to a multitude of users. The program strives to develop technological solutions and innovative applications to critical problems in undersea exploration and to provide resources for developing, testing, and transitioning solutions to meet these needs.

Okeanos Explorer Management – a unique partnership within NOAA

The *Okeanos Explorer* Program combines the capabilities of the NOAA Ship *Okeanos Explorer* with shore-based high speed networks and infrastructure for systematic telepresence-enabled exploration of the world ocean. The ship is operated, managed and maintained by NOAA's Office of Marine and Aviation Operations, which includes commissioned officers of the NOAA Corps and civilian wage mariners. OER owns and is responsible for operating and managing the cutting-edge ocean exploration systems on the vessel (ROV, mapping and telepresence) and ashore including Exploration Command Centers and terrestrial high speed networks. The ship and shore-based infrastructure combine to be the only federal program dedicated to systematic telepresence-enabled exploration of the planet's largely unknown ocean.

Table of Contents

2. Report Purpose

The purpose of this report is to briefly describe the data acquisition and processing for EX1004 Leg 3 data, without going into a very detailed description of the multibeam and ancillary sensor setup. For details about setup of the various equipment/sensors, please refer appendix D and the ship's readiness report, which can be obtained by contacting the ships operations officer (ops.explorer@noaa.gov). Also, please note that this report covers only the EM302 multibeam mapping activities conducted during this cruise. Considerable other activities including Remotely Operated Vehicles (ROV) dives, Conductivity Temperature Depth (CTD) casts and education and outreach activities, were conducted which may be referred to in this report.

The talented and patient crew of the NOAA Ship *Okeanos Explorer* is greatly appreciated for their efforts in helping make the INDEX-SATAL 2010 mission a success.

3. Cruise Objectives

This cruise was the second and final cruise conducted in cooperation between the US and Indonesia governments in 2010. The purpose of the INDEX-SATAL 2010 expedition (Indonesia Exploration – Sangihe Talaud region) is the exploration of the area specifically approved by the Indonesia government north of Sulawesi, Indonesia, shown in Figure 1. The area extends from 2°N to 6° 24'N, and 124° 45' E to 128°E, covering an area of the seafloor approximately 80,000 square kilometers in size. The coordinates of INDEX-SATAL 2010 are provided in Table 1.

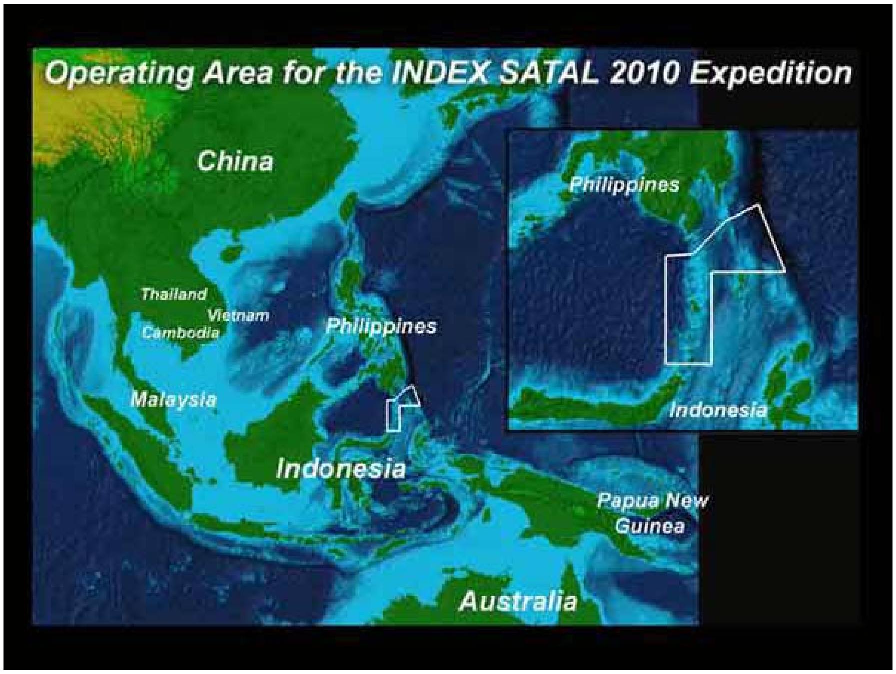


Figure 1. Operating area for INDEX-SATAL 2010 Expedition outlined in white. Image credit: NOAA.

Table 1. Coordinates of INDEX-SATAL 2010 exploration area as depicted in Figure 1.

Point ID	Latitude (N)	Longitude (E)
1	2°	126°
2	2°	124° 45’ 36”
3	4° 30’	126°
4	4° 30’	128°
5	6° 24’	127° 17’ 59.99”
6	5° 54’	126° 24’
7	5°	125° 30’
8	4° 57’	124° 45’

Remote Science: A new paradigm

Equipped with a high speed internet connection, the NOAA Ship *Okeanos Explorer* is capable of streaming live video and data to shore, commonly referred to as telepresence. This capability, along with shore based Exploration Command Centers (ECCs), allow shorebased scientists to talk directly with shipboard personnel. This partnership allows for realtime collaboration between shore side and ship-based participants to make decisions on where to ask the ship to focus its efforts, i.e. on areas and targets of particular interest.

Tim Shank (WHOI) acted as chief scientist for this cruise and was based at the Jakarta ECC. Santiago Herrera (MIT/WHOI)), and Rainer Troa (Indonesian scientist for BRKP) participated in this cruise as onboard science representatives. Data and information were made available to shore through a host of collaboration tools including designated FTP servers, and live broadcast of ROV video and computer screens. Mapping products were provided to shore on a daily basis to facilitate ROV dive site discussions.

4. Participating Personnel

NAME	ROLE	AFFILIATION
CDR Joseph Pica	Commanding Officer	NOAA Corps
Kelley Elliott	Expedition Coordinator	NOAA OER
LT Nicola VerPlanck	Field Operations Officer	NOAA Corps
Dr. Timothy Shank	Designated Chief Scientist (Jakarta ECC)	Woods Hole Oceanographic Institution (WHOI)
Elaine Stuart	Senior Survey Technician	NOAA OMAO
Colleen Peters	Senior Survey Technician	NOAA OMAO
Joel DeMello	Mapping Watchstander	NOAA OER/UCAR Intern
Tom Kok	Mapping Watchstander	NOAA OER/UCAR Intern
Karl McLetchie	Mapping Watchstander	NOAA OER/UCAR Intern
Meme Lobecker	Mapping Team Lead	NOAA OER (ERT, Inc.)
Santiago Herrera	Onboard US Science Lead	Massachusetts Institute of Technology /(MIT) Woods Hole Oceanographic Institution (WHOI)
Rainer Troa	Onboard Indonesian Science Lead	Indonesia Agency for Marine and Fisheries Research (BRKP)
Dion Adrianto	Indonesian Navy Observer	Indonesian Navy (TNI)

5. Mapping Statistics

Cruise Dates	July 21 – August 7, 2010
Weather delays days	0
Line kilometers surveyed	2618
Square kilometers mapped	15,339
Number of partial mapping days	15
Number of multibeam files	163
Number of XBT casts	21
Number of CTD casts	7
Number of ROV dives	14
Beginning draft 7/22/10	FWD: 14’6”; AFT: 13’11.75”
Ending draft 8/14/10	FWD: 14’3”; AFT: 14’2.5”

6. Mapping Sonar Setup

The NOAA Ship *Okeanos Explorer* (EX) is equipped with a 30 kHz Kongsberg EM 302 multibeam sonar. During this cruise, EM 302 bottom bathymetric and backscatter data were continuously collected. Water column backscatter data was also collected when water column anomalies were detected.

The ship used a POS MV version 4 to record and correct the multibeam data for any vessel motion. The C-NAV GPS system provided DGPS correctors with positional accuracy expected to be better than 2.0 m.

All corrections (motion, sound speed profile, sound speed at sonar head, draft, sensor offsets) were applied during real time data acquisition. Expendable bathythermograph (XBT) casts (Deep Blue, max depth 760 m) were applied every six hours and/or as necessary to correct for sound speed. The XBT cast data were converted to SIS compliant format using NOAA Velowicin or Velocipy (see SVP Log Appendix C). The CTD casts collected while the ROV was ascending at the end of its dive were processed using Velocipy. See Appendix A for a complete list of software used for data processing.

7. Data Acquisition Summary

Table 2 lists the transducer and attitude sensor offsets determined during the 2010 Sea Acceptance Testing. For complete processing unit setup utilized for the cruise, please refer to Appendix B.

	Roll	Pitch	Heading
TX Transducer	0.0	0.0	359.98
RX Transducer	0.0	0.0	0.03
Attitude	0	-0.8	0.0

Table 2. Angular offsets for Transmit (TX) and Receive (TX) transducer and attitude sensor

A note on time zone changes: all multibeam and associated data are time stamped with UTC time. The daily cruise log included this report is recorded with ship time, which was eight hours ahead of UTC.

The TX36 LC board in slot #16 of the EM302 transmit-receive unit remained in failed status throughout the cruise. An earlier attempt (during EX1004 Leg2) to replace the board showed that slot #16 was still destroying transmit boards. Kongsberg engineers are aware of the problem and are working with the mapping department to troubleshoot. Built In System Tests (BIST) were generally conducted daily to monitor transmit board status and RX noise levels. All BISTs were recorded in a BIST log, including survey and weather conditions present during testing. All RX noise levels were normal and no additional boards failed.

Engineering department activities, such as welding and major equipment cycling, were monitored to determine any possible effect on data quality. No effects were determined.

8. Multibeam Data Processing and Archival Procedures

Field Data Processing

For quality control purposes, all raw multibeam data was imported, cleaned and gridded (50 meter cell size) in CARIS 6.1 at sea in near real time. Gridded data were exported to ASCII xyz text files. These xyz's were then used to generate Fledermaus v.6 *.sd objects. Each *.sd object was then exported to a georeferenced image (embedded geotiff). Each of these data products were generated on a daily basis using cumulative data from within the cruise and were uploaded to the Okeanos Explorer FTP for daily science planning and collaboration purposes. Throughout the cruise, the SD objects and geotiffs were utilized by science participants on shore and on the ship, mainly to choose ROV dive locations.

At the request of onshore science participants, two additional daily products were developed:

1. Georeferenced tiff showing all cumulative multibeam data from EX1004 Legs 2 and 3 was produced on a daily basis and posted on the FTP. A color scale bar indicating depths displayed in the EX1004 Legs 2 and 3 geotiff was also provided.
2. A screenshot of gridded multibeam data with the most recently mapped area clearly marked with a polygon.

A "ReadMe.txt" file was provided each day to briefly describe each of the daily multibeam products provided on the Okeanos Explorer FTP site, including geographic referencing information and data resolution.

Shoreside Data Processing and Data Archiving

All field cleaning and processing was reviewed shoreside after the cruise was completed. Each bathymetry file was then exported to ASCII xyz text file, which contained every accepted sounding. These text files were then gridded (50 meter cell size) in Fledermaus DMagic, and an .sd object was generated. The .sd object was then exported to geotiff.

All raw and processed multibeam data will be archived with NGDC with individual metadata records. All processed data products are in latitude/longitude coordinates, WGS84 datum. All raw and processed multibeam data products will be accessible via www.ngdc.noaa.gov.

Archived multibeam products include:

1) Level 00
   a) Raw multibeam bathymetry files. (*.all)
2) Level 01
   a) ASCII xyz text file of each multibeam bathymetry line file, cleaned, not gridded. (*.txt)
3) Level 02
   a) ASCII xyz text file of all multibeam bathymetry gridded at 50 meter cell size. (*.xyz)
   b) Fledermaus v. 6 .sd object of 50 meter bathymetry grid. (*.sd)
   c) Georeferenced (geotiff) image of 50 meter bathymetry grid (*.tif)

9. Data Quality Assessment

During previous cruises in the 2010 field season, side lobe detection was a significant data quality concern. Side lobe detection increased after upgrading the TX36 boards to the TX36 LC version. It was determined during EX1004 Leg 2 that disabling the penetration filter in SIS virtually eliminated the side lobe detection problems. This remained consistent during EX1004 Leg 3.

Swath coverage and data quality was excellent throughout the cruise. This was largely due to excellent survey conditions, including calm seas and a generally highly acoustically reflective seafloor.

Crossline Analysis – July 28

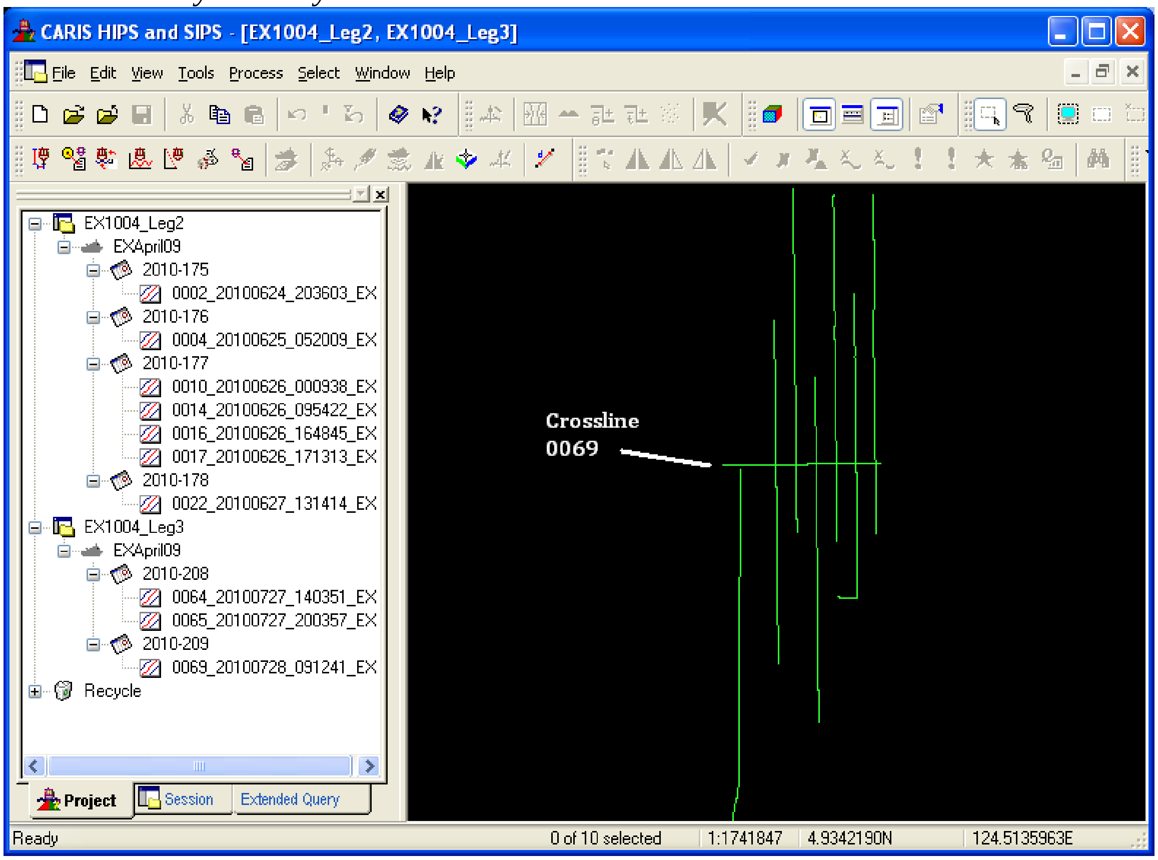


Figure 3. Screengrab taken in CARIS showing crossline 0069 crossing mainscheme lines.

A 37 kilometer crossline (Figure 3) was run on July 28 at a heading of 279°, and collected in Line 0069. The crossline spanned depths from 1460 to 5200 meters. The line crossed nine mainscheme survey lines collected during EX1004 Legs 2 and 3, specifically:

1. 0002_20100624_203603_EX.all (Leg 2)
2. 0004_20100625_052009_EX.all (Leg 2)
3. 0010_20100626_000938_EX.all (Leg 2)
4. 0014_20100626_095422_EX.all (Leg 2)
5. 0016_20100709_164845_EX.all (Leg 2)
6. 0017_20100626_171313_EX.all (Leg 2)
7. 0022_20100627_131414_EX.all (Leg 2)
8. 0064_20100727_140351_EX.all (Leg 3)
9. 0065_20100727_200357_EX.all (Leg 3)

Two crossline analysis routines were conducted.

1) The crossline was compared to the mainscheme lines visually using Subset Editor in CARIS. No significant offsets were observed. See Figure 4.

Figure 4. CARIS Subset Editor comparison showing crossline 0069 to mainscheme lines 0002 and 0004.

2) Analysis of the crossline was conducted using the Crosscheck extension of Fledermaus v.7. In this analysis, a 50 meter SD object of the mainscheme lines was compared to the raw line file 0069_20100728_091241_EX.all. The resulting statistics are shown in Table 2.

Table 2. 0069 crossline statistics.

Number of Points of Comparison	292390
Data Mean Water Depth	-4131.67
Reference Mean Water Depth	-4127.69
Difference Mean	-3.9814
Difference Median	-2.9979
Std. Deviation	10.591
Data Depth Range	-5262.54 to 1442.77
Reference Depth Range	-5216.18 to 1435.1
Difference Depth Range	-506.80 to 215.91
# Mean + 2*stddev	25.162654
# Median + 2*stddev	24.179135

The source of the larger errors is believed to be twofold. First, cutoff angles are not utilized during data collection, allowing for large fliers in outer beams. Second, Fledermaus Crosscheck only reads .all files, which we currently cannot edit in their original format, so fliers are included in crossline analysis. This problem is in the process of being addressed.

Crossline Analysis – August 4

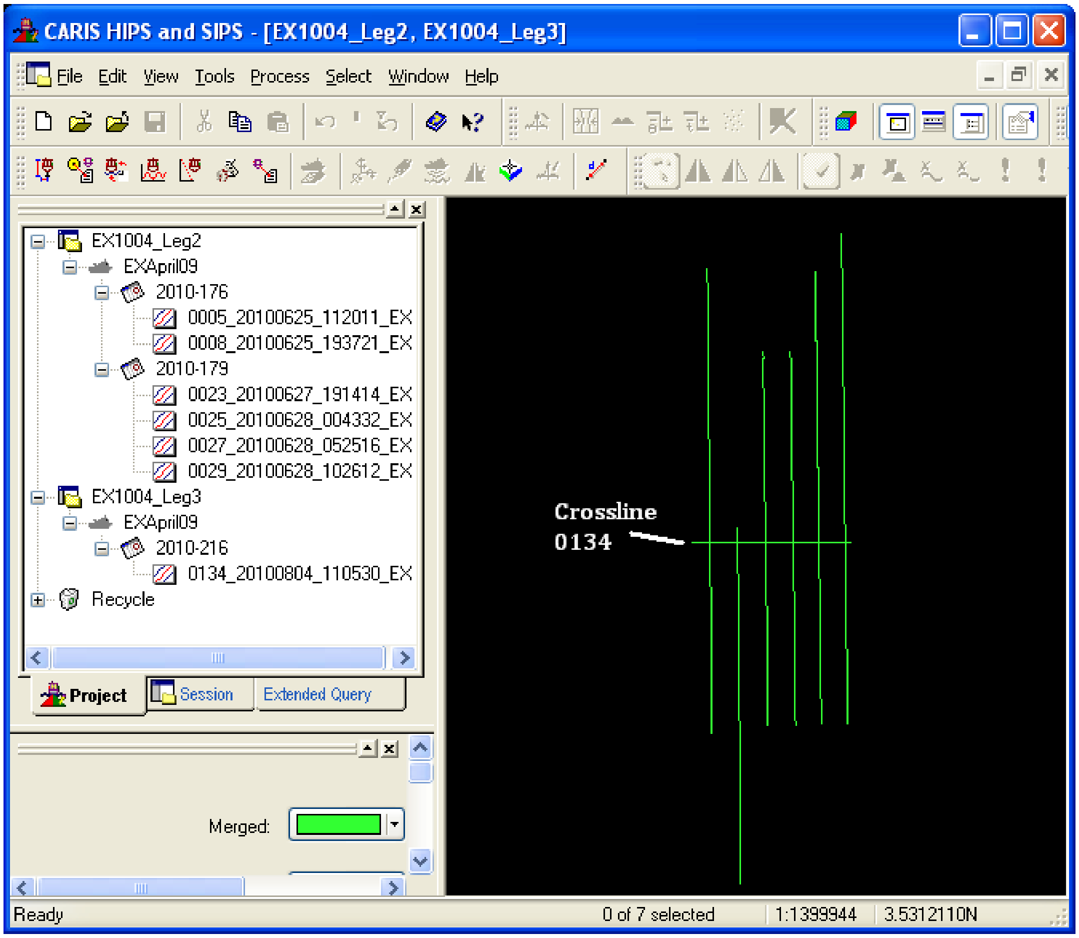


Figure 5. Screengrab taken in CARIS showing crossline 0134 crossing mainscheme lines.

A 32 kilometer long crossline (Figure 5was run on August 4 at a heading of 85°, and collected as Line 0134_20100804_110530_EX.all. The crossline spanned depths from 2755 meters to 4749 meters. Line 0134 crossed six mainscheme lines collected during EX1004 Leg 2, specifically:

1. 0005_20100625_112011_EX.all
2. 0008_20100625_193721_EX.all
3. 0023_20100627_131414_EX.all
4. 0025_20100628_004332_EX.all
5. 0027_20100628_052516_EX.all
6. 0029_20100628_102612_EX.all

1) The crossline was compared to the mainscheme lines visually using Subset Editor in CARIS. No significant offsets were observed. See Figure 6.

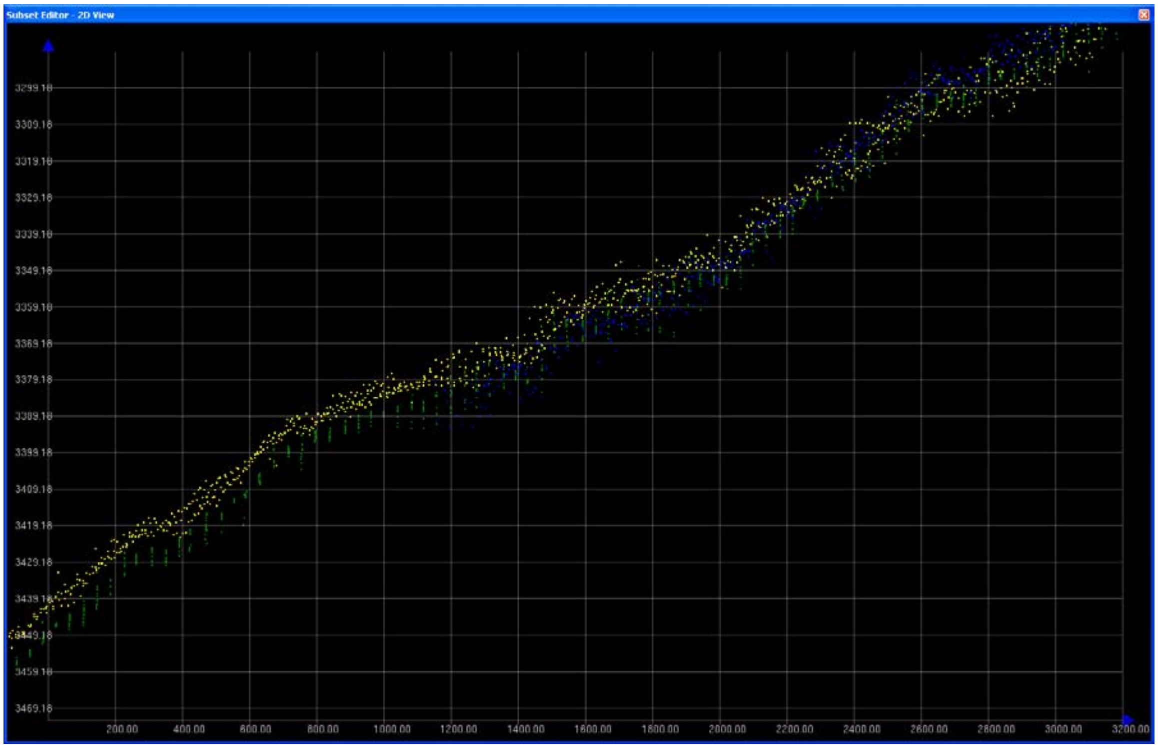


Figure 6. CARIS Subset Editor comparison showing crossline 0134 to mainscheme lines 0023 and 0029.

2) Analysis of the crossline was conducted using the CrossCheck extension of Fledermaus v.7. In this analysis, a 50 meter SD object of the mainscheme lines was compared to the raw line file 0134_20100804_110530_EX.all. The resulting statistics are shown in Table 3.

Table 3. 0134 crossline statistics.

Number of Points of Comparison	315324
Data Mean Water Depth	-3934.81
Data Depth Range	-4935.03 to -2754.04
Reference Mean Water Depth	-3922.22
Reference Depth Range	-4734.73 to -2742.5
Difference Mean	-12.589
Difference Median	-11.376
Difference Std. Deviation	11.425
Difference Depth Range	-355.84 to 191.71
# Mean + 2*stddev	35.438998
# Median + 2*stddev	34.22584
Percent water depth	0.319939209

10. Cruise Calendar

For a more detailed account of daily events, see *Daily Cruise Log in section 11.*

July 2010						
Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
		21 Sailing delayed due to Indonesian TNI representative delayed arrival.	22 Depart Port of Bitung, North Sulawesi, 0745. Mapped overnight after crossing working grounds boundary.	23 Mapped in morning and overnight. ROV dove on site K.	24 Mapped in morning and overnight. CTD and ROV dove on site T.	25 Mapped in morning and overnight. ROV dove on site G.
26 Mapped in morning and overnight. ROV dove on te G.	27 Mapped in morning and overnight. ROV dove on site K.	28 Mapped in morning and overnight. ROV dove near site 7.	29 Mapped in morning and overnight. ROV dove on Kawio Barat.	30 Mapped in morning and overnight. ROV dove on shallow ridge in NE.	31 Mapping operations 24 hrs. No ROV dive.	

August 2010						
Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
						1 Mapped in morning and overnight. ROV dove on BJIV target near North Talaud.
2 Mapped in morning and overnight. ROV dove on BJIV shallow target in 300 m near North Talaud.	3 Mapped in morning and overnight. ROV dove on Kawio Barat for high level event with Silver Spring. 2 CTDs collected in evening over Kawai Barat.	4 Mapped in morning and overnight. ROV dove on Memeridge site.	5 Mapped in morning and overnight. ROV dove on seamount found by BJIV near Siau Island.	6 Mapped in morning and evening until 2300. ROV dove on seamount found by BJIV. Overnight transit to Bitung. Secured all sensors while travelling outside approved INDEX-SATAL 2010 exploration area.	7 Arrive port of Bitung, North Sulawesi, 0830.	

11. Daily Cruise Log

ALL DATES AND TIMES IN SHIP TIME, which was eight hours ahead of UTC. All ROV dive site names referred to were for field operation purposes only. Actual dive site name subject to change.

July 21, 2010
The ship was delayed in leaving the port of Bitung today due to awaiting the arrival of the Indonesian TNI official before sailing commences.

July 22, 2010
Departed the dock for the survey working grounds at 0745. We crossed into the approved Indonesia survey box at 0330. An XBT was taken and applied, and multibeam survey was commenced. We ran up the southeastern side of the working grounds and veered westward at 125.66E, 2.45N, to transit through the islands of Tahulandang and Siau towards ROV dive site K (approx 2.846N ,125.066E. Two short mapping lines (24 km each) to the east of dive site K were run overnight, and the TRU was shut down at 0325 on 23 July. The data quality is high, with excellent swath coverage and no side lobe detection. The ship stood by at site K for the July 23 0400 ROV launch in preparation for the telepresence event with Silver Spring, members of Congress, White House staff and the NOAA administration staff in the early morning of 23 July.

A software update to Velocipy has rendered it non-functional for the time being, so we will revert to processing XBT and CTD casts in Velociwin for the beginning of this cruise.

July 23, 2010
The ROV dove on the potential water column target at site K (Figures 7, 8, 9). The water column target, previously identified during EX1004 Leg 2, was not observed by the ROV cameras during this dive.

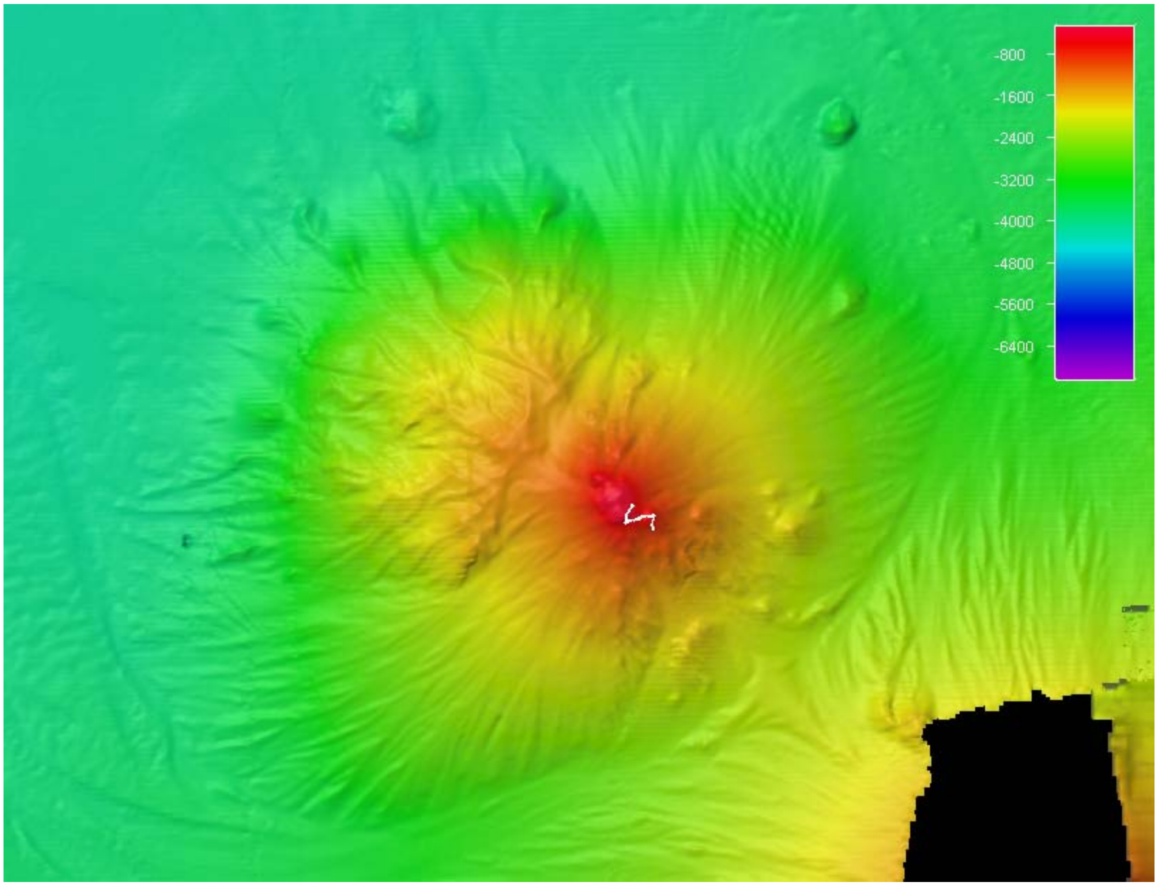


Figure 7. Site K seamount, site of July23 ROV dive (shown in white). Color scale bar showing bathymetry depths in meters, as collected by the Okeanos Explorer during EX1004 Leg 2. Image created in Fledermaus.

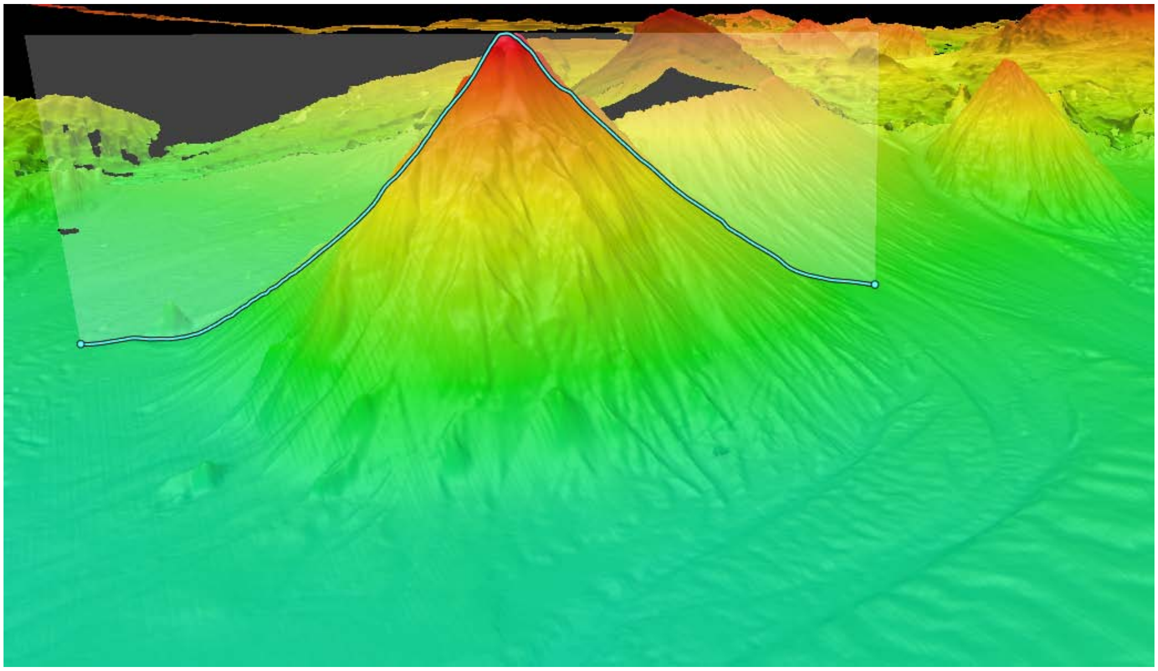


Figure 8. Landscape view of site K. Image created in Fledermaus with vertical exaggeration of 3.

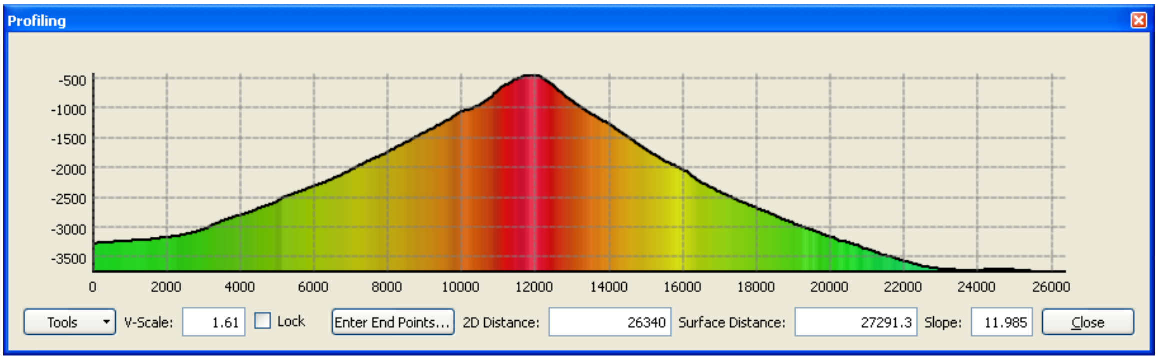


Figure 9. Profile of site K depths (meters). Image created in Fledermaus.

Resumed mapping at 1509. Ran one more line east of ROV dive site K, then transited south through the islands of Makalehi and Siau. We added one more line to the eastern side of our previous coverage in the southern portion of the overall Indonesian working grounds, then moved west, adding one more line to the south of our previous coverage in the area. The final mapping lines for the night were run over ROV dive site T (approx. 2.136N, 124.901E,). TRU was secured at 0541 so the ship could conduct a CTD over the summit of dive site T. Bathy data was quickly converted to products for the ROV team and science parties in Jakarta and Seattle.

July 24, 2010
ROV dove at site T. CTD and mapping operations conducted overnight and into morning of 25 July. Mapping operations focused on holidays in the southwestern section of the approved working grounds.

July 25, 2010
ROV dove on site G (approx. 2.267N , 124.835E). Resumed mapping overnight and into next morning.

July 26, 2010
ROV dove on site G. Mapped overnight and into the morning up the western edge of previous coverage, between G and K.

July 27, 2010
ROV dove on site K. Ran regularly scheduled BIST after logging for several hours. Most tests failed. Possibly because ROV start-up was occurring at the same time. Restarted TRU and BISTs passed. Similar to BIST failures we saw during EX1003. This will be reported to Kongsberg. Mapped overnight up the western edge of previous coverage, between sites K and 7.

July 28, 2010
ROV dove on site 7. Collected crossline in evening on way to mapping lines up to Kawio Barat volcano for tomorrow's dive.

July 29, 2010
ROV dove on Kawio Barat (Figures 10, 11, 12).

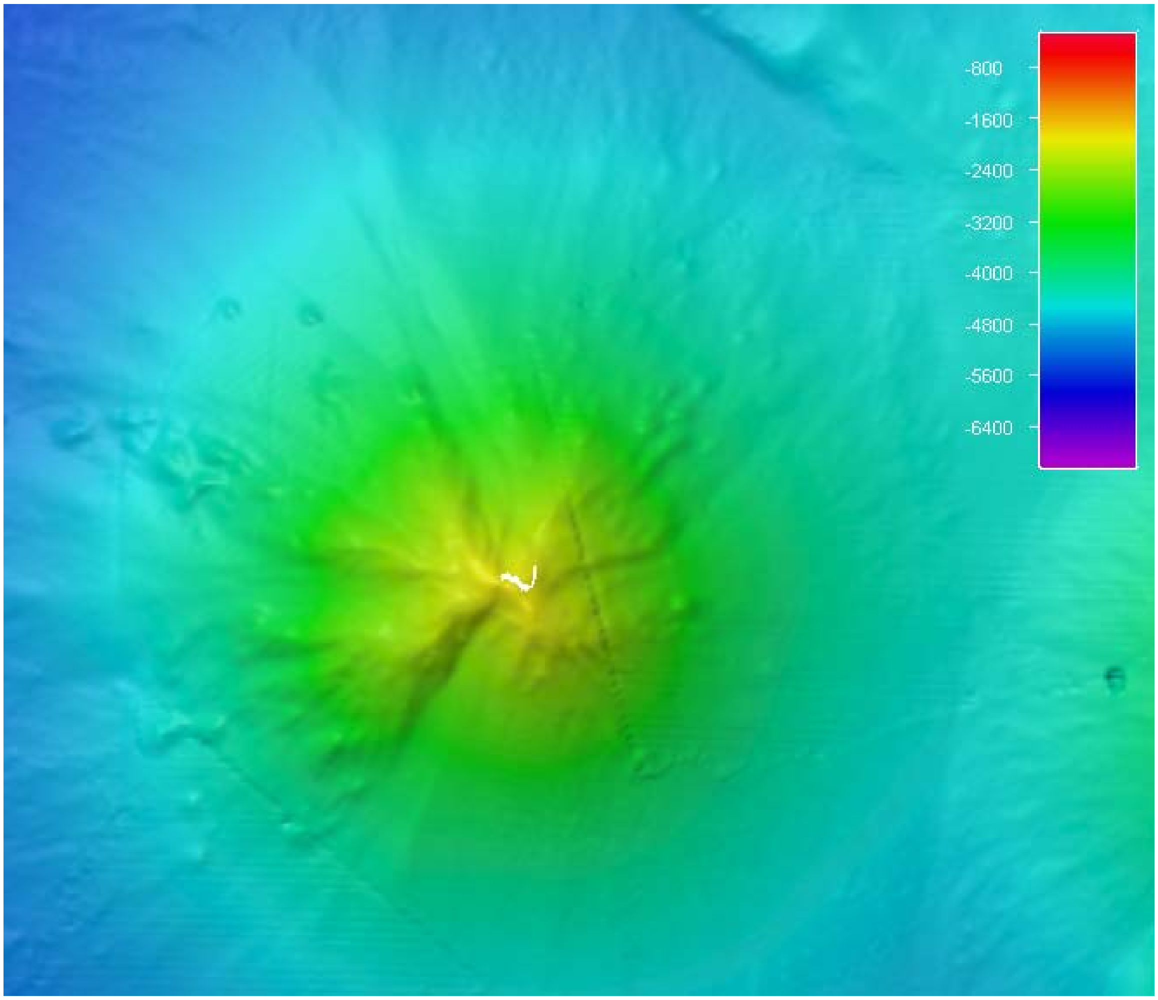


Figure 10. Kawio Barat submarine volcano, site of July 29 ROV dive (shown in white). Color scale bar showing bathymetry depths in meters, as collected by the Okeanos Explorer during EX1004 Leg 2. Image created in Fledermaus.

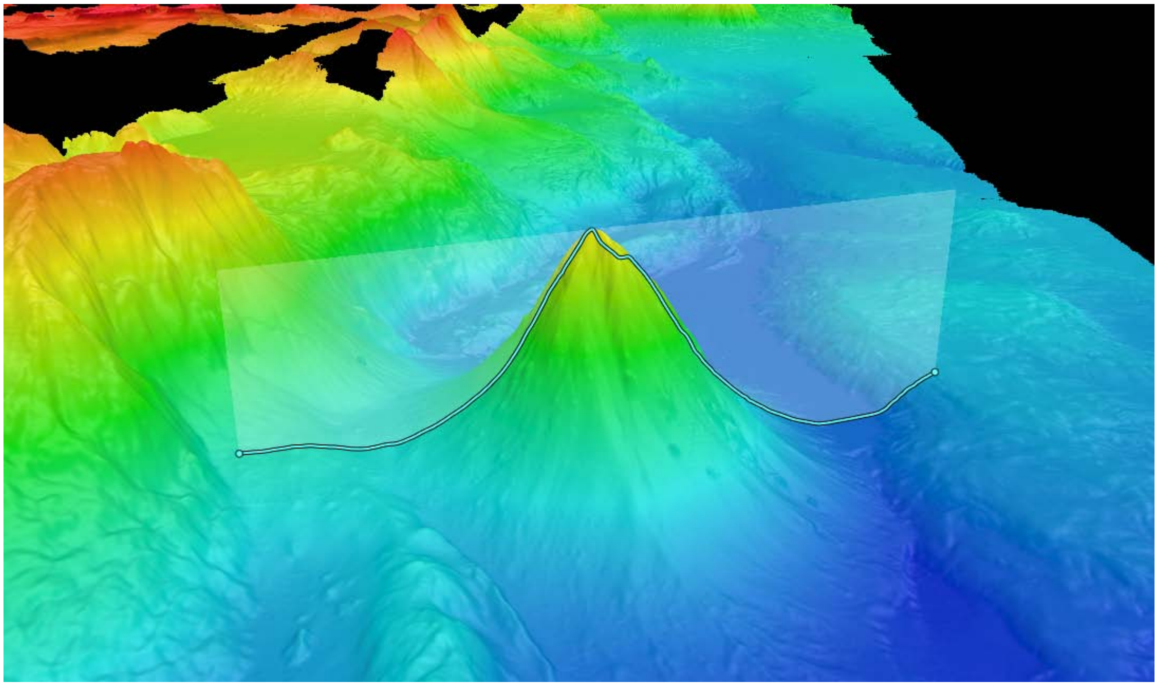


Figure 11. Landscape view of Kawio Barat. Image created in Fledermaus with vertical exaggeration of 3.

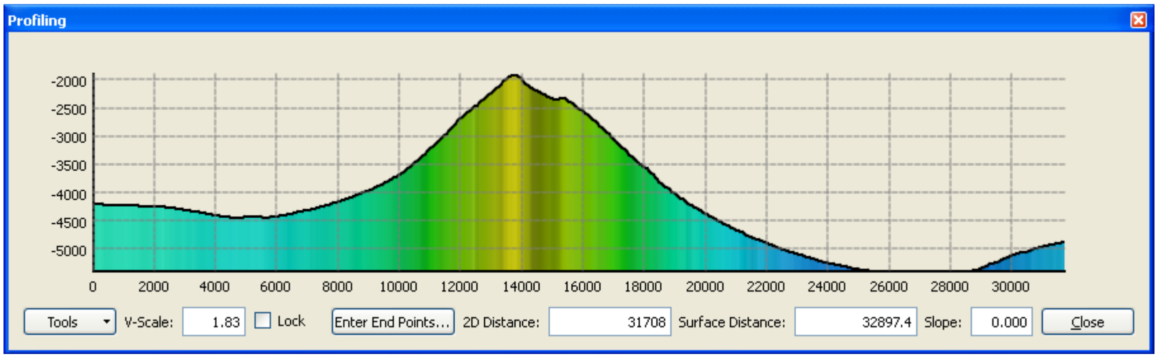


Figure 12. Profile of Kawio Barat depths (meters). Image created in Fledermaus.

Collected multibeam during transit to site 21. Collected two survey lines over ridge located at 5.48N , 126.29E, for use in determination of ROV targets in next few days. Will continue survey over this ridge tomorrow night.

July 30, 2010

Mapping operations continued through 0900. Arrived onsite at ROV dive location at 0900. Mapping resumed at 1700 and focused on ridge located at approx 5.48N, 126.29E. It is expected that members of the science team will use this data for additional ROV target identification.

The weather picked up a bit today, with seas coming up to 3-4 feet from 190 degrees, 14 knots from 190 degrees, and heavy rain throughout the day. Swath width was not noticeably affected.

Abandon ship and fire security drills were conducted.

July 31, 2010

ROV did not dive today. Mapping continued throughout the day, focusing on the ridges in the northeastern section of the survey working grounds (approx 5.48N , 126.29E). Overnight the ship transited to the ROV site near 4.6735N, 126.87E, filling a few small holidays on the way. The ROV target had been previously suggested by the Baruna Jaya IV as a potential site of interest.

Brought RPMs up from 150 to 170 to increase speed. Previously this had caused the UPS to go on battery for too long. Today, however, there was a momentary fluctuation in the UPS, but then it stabilized. The theory is that we should not be at 170 RPMs when there are a lot of power draw fluctuations going on, such as when switching from ROV to MB ops and associated engineering power changes. We should stay at 150 RPM such times, then increase to 170 RPM when we have settled into steady mapping ops.

August 1, 2010

Arrived at the ROV dive site at 0300. Surveyed a single 10 kilometer line over the survey site suggested by the Baruna Jaya IV, processed the data in CARIS and Fledermaus, and sent it ashore for scientist collaboration and dive target refinement. The ROV dove on the target for the rest of the day.

Resumed survey in the evening, starting with three lines over the dive site for tomorrow, then adding to eastern edge of the Baruna Jaya IV data in the area, then running two parallel lines to add to the previous *Okeanos Explorer* data in the northeast. The ship will return in the early morning on August 2 to tomorrows dive site, skirting along the eastern edge of the previous BJIV coverage.

August 2, 2010

Arrived back at the dive site north of Talaud at 0500. The ROV dove at 0600, on another target initially chosen by science partners using Baruna Jaya IV data, close to yesterday's dive. Mapping resumed at 1330, and commenced transit over to Kawai Barat for tomorrow's dive, planned for the high level telepresence event with Silver Spring.

August 3, 2010

The ROV dove on Kawio Barat for the high level telepresence event with Silver Spring today. The ship then mapped in the evening on the way down to the tomorrow's ROV site.

August 4, 2010

The ship mapped on the way to the ROV dive site for tomorrow, a new small seamount found and mapped by the Baruna Jaya IV. Reports are that bubbles have been observed at the surface, and during a recent nearshore snorkeling trip nearby conducted by the crew of the Baruna Jaya IV. There are also rumored to be underwater hot springs in the vicinity.

The weather has picked up to 3-5 foot seas. Swath width decreased slightly but overall data quality remains high. This is the first "bad weather" testing we have been able to do since Hawaii.

We collected another crossline, and also logged true heave with the POSMV to see if artifacts seen in the previous crossline are reduced.

August 5, 2010

In the morning we mapped two lines over the seamount to provide high resolution data for today's ROV dive, and watched for water column targets. We had planned to transit briefly over to site K, where a potential water column target was previously detected on July 11 and July 13 during EX104 Leg 2, however the weather picked up and we were not able to make it over to the site and still be back in time for the ROV dive (Figures 13, 14, 15). .

In the evening we mapped in the southeast section of the approved working grounds.

Weather picked up last night, resulting in a few hundred meters decrease in expected swath. Overall data quality remained high.

August 6, 2010

In the morning we continued mapping in the southeast section of the approved working grounds. The ROV dive again on the seamount discovered by the Baruna Jaya IV (Figures 13, 14, 15).

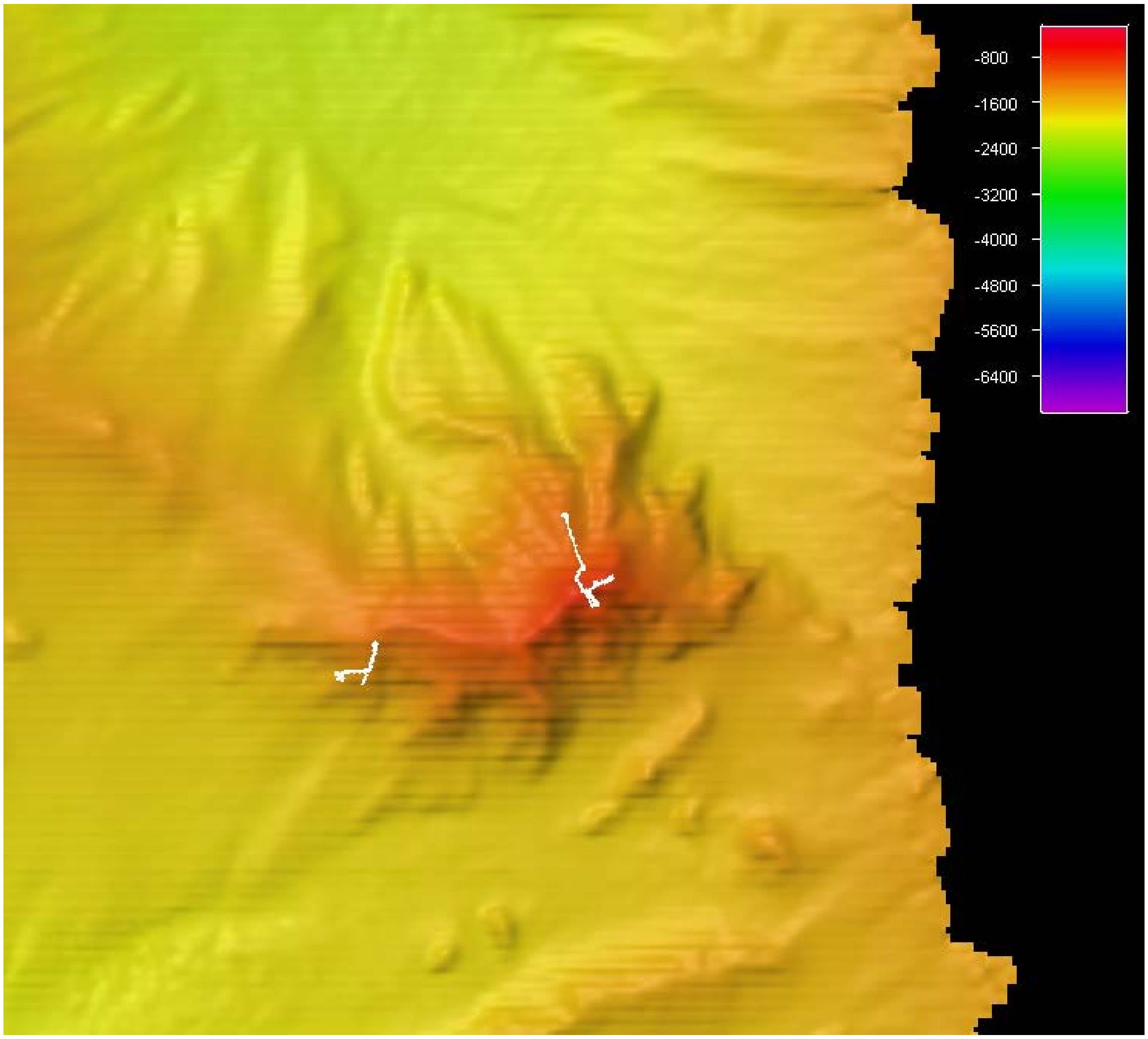


Figure 13. Seamount discovered by the Baruna Jaya IV, site of August 5 (east track) and 6 (west track) ROV dives (shown in white). Color scale bar showing bathymetry depths in meters, as collected by the Okeanos Explorer during EX1004 Leg 3. Image created in Fledermaus.

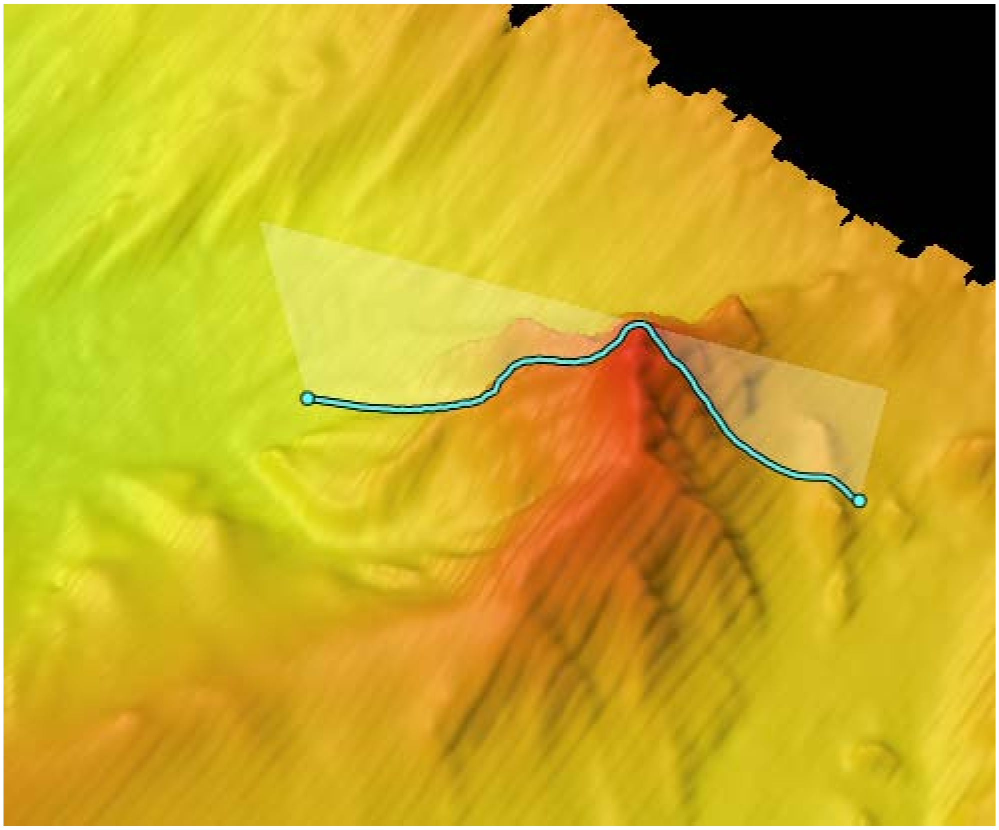


Figure 14. Landscape view of seamount discovered by the Baruna Jaya IV. Image created in Fledermaus with vertical exaggeration of 3.

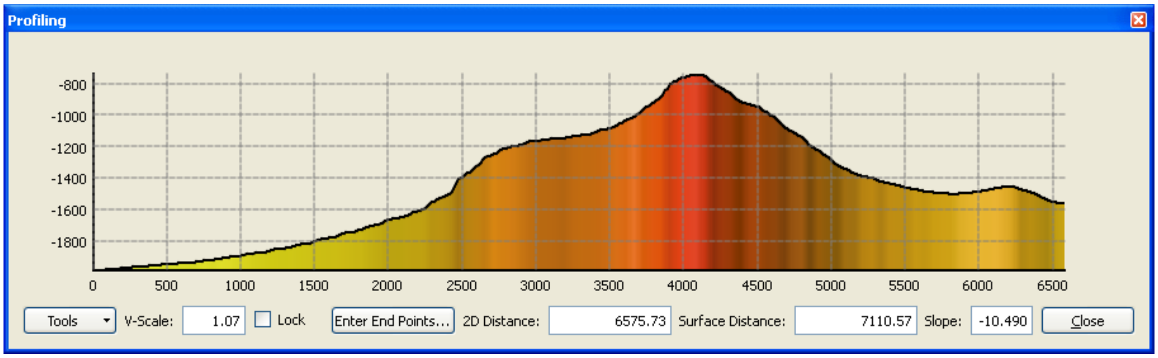


Figure 15. Profile of seamount depths (meters). Image created in Fledermaus.

The ship conducted emergency drills, including abandon ship and helicopter medical evacuation.

In the evening we mapped on the transit through the southeast section of the working grounds. The multibeam was secured at 2300, prior to exiting the approved survey working grounds.

Note: the following information is provided for long-term multibeam system performance tracking purposes. A final regularly scheduled BIST (#19) was run after multibeam data collection ceased, and several tests failed, similar to on July 27 of this cruise. There was again no detected data quality problem, and there was no indication that BISTs would fail. The TRU was restarted, BIST (#20) was rerun, and same tests failed. Restarted TRU & SIS a third time. Found

EM302 after several rescans. Ran BIST 080610_21_end_of_survey. 1,2,3,7 failed, all else passed. Reran each failed test separately. Same results. Restart TRU remotely & SIS. Reran full BIST (#23). Only tests 1,3,7 failed (normal with partially failed TX36 LC board #16). System appears to be normal again. Further testing not allowed as we are nearing edge of approved survey working grounds. Will have to test further in US EEZ on the transit to Guam.

Last day of survey, heading to port of Bitung.

August 7, 2010
The ship tied up at the port of Bitung at 0830.

12. References

1) John McDonough, Captain Michael Devany, Catalina Martinez, Cruise Instructions EX1004 Legs 1, 2, and 3.

2) T F McConachy, H. Permana, R A Binns, I Zulkarnain, J M Parr, C J Yeats, N D Hananto, B Priadi, S Burhannuddine and E P Utomo, Recent investigations of Submarine Hydrothermal Activity in Indonesia, PACRIIM 2004, Adelaide, SA 19-22 September, 2004.

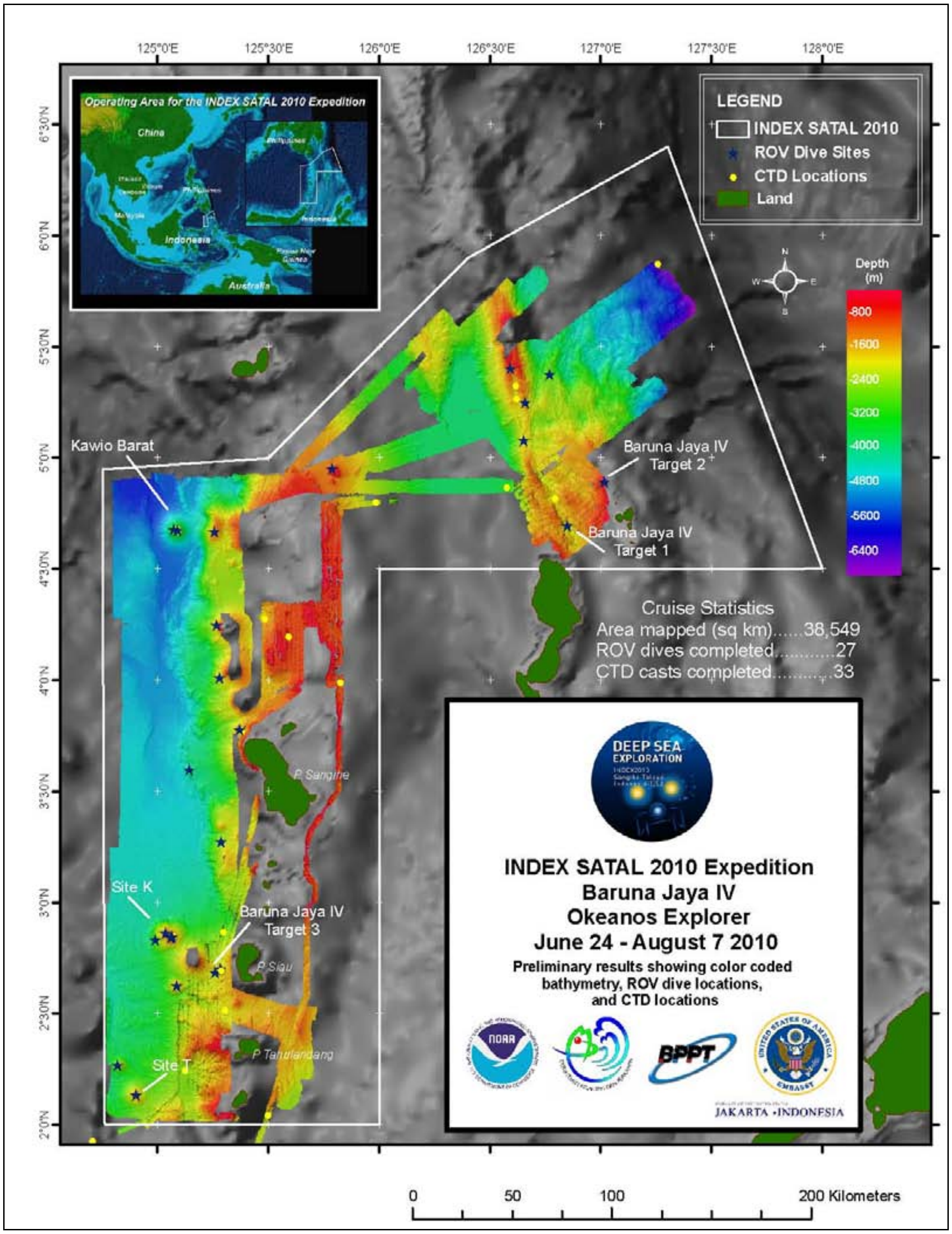
3) NOAA Ship Okeanos Explorer Mapping Readiness Report, 2010. Available on request from the ship. Email contact: ops.explorer@noaa.gov.

4) D. Smith, W. H. F., and D. T. Sandwell, Global seafloor topography from satellite altimetry and ship depth soundings, Science, v. 277, p. 1957-1962, 26 Sept., 1997.

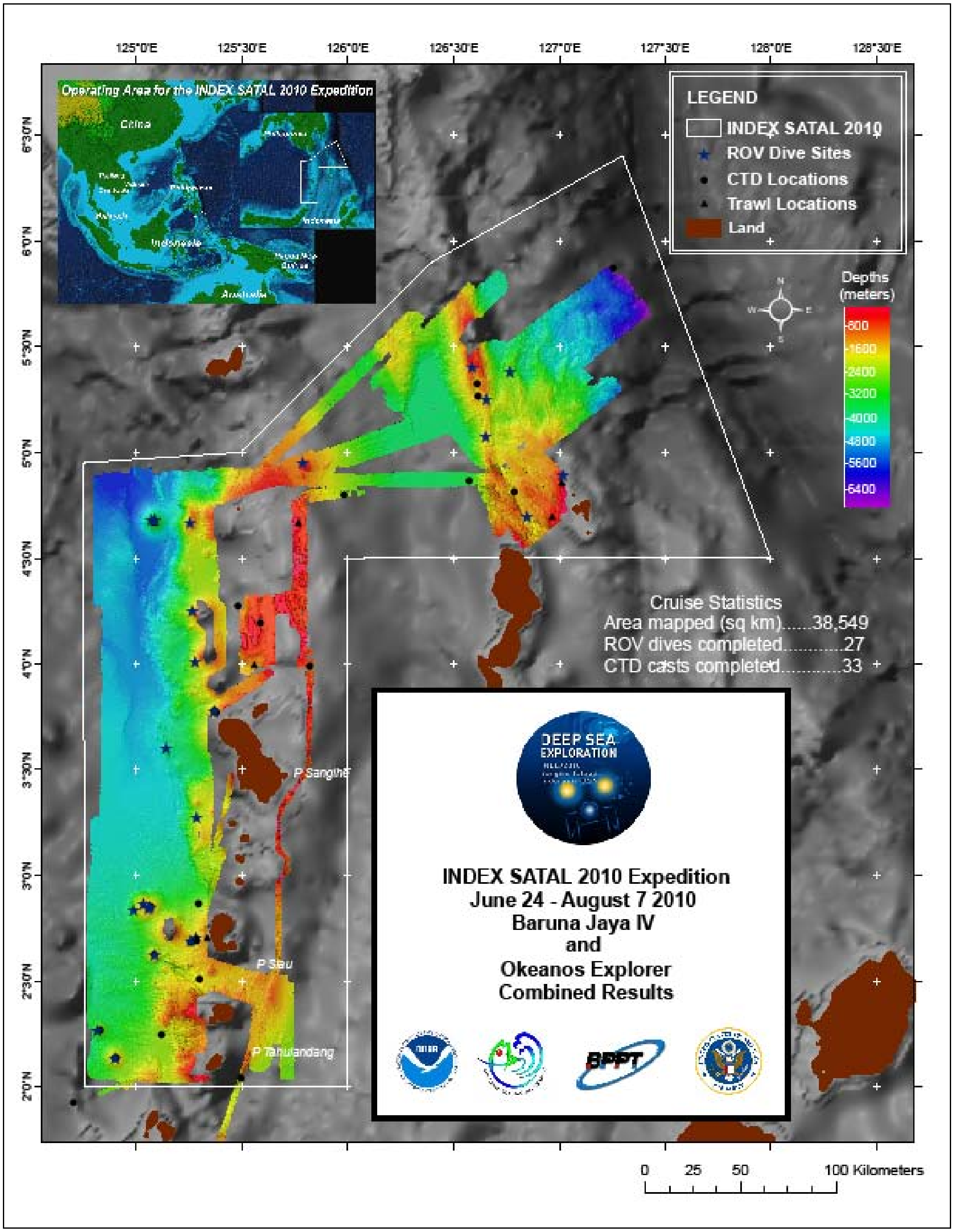
13. Appendices

Appendix A: Field Products

Poster developed for August 8, 2010 closing event Bitung, North Sulawesi, Indonesia, including bathymetry from the Baruna Jaya IV and the Okeanos Explorer.



Poster showing cumulative results for INDEX-SATAL 2010, including bathymetry from the Baruna Jaya IV and the Okeanos Explorer.



Appendix B: Tables of Data Files

EX1004 LEG 3 EM302 MULTIBEAM BATHYMETRY FILE LOG			
MULTIBEAM FILE NAME	**DATE (GMT)**	**SURVEY AREA NAME**	**NOTES**
0000_20100722_080911_EX.all	7/22/10	EX1004_Leg3_50m_LL_WGS84	FIRST MB LINE OF EX1004 LEG3. TRANSIT TO ROV DIVE SITE K.
0001_20100722_095848_EX.all	7/22/10	EX1004_Leg3_50m_LL_WGS84	
0002_20100722_141126_EX.all	7/22/10	EX1004_Leg3_50m_LL_WGS84	
0003_20100722_141649_EX.all	7/22/10	EX1004_Leg3_50m_LL_WGS84	
0004_20100722_145733_EX.all	7/22/10	EX1004_Leg3_50m_LL_WGS84	
0005_20100722_152255_EX.all	7/22/10	EX1004_Leg3_50m_LL_WGS84	
0006_20100722_155303_EX.all	7/22/10	EX1004_Leg3_50m_LL_WGS84	
0007_20100722_155538_EX.all	7/22/10	EX1004_Leg3_50m_LL_WGS84	
0008_20100722_170816_EX.all	7/22/10	EX1004_Leg3_50m_LL_WGS84	
0009_20100722_172313_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0010_20100723_070824_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0011_20100723_081512_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0012_20100723_081820_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0013_20100723_093219_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0014_20100723_100903_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0015_20100723_101213_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0015_20100723_123957_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	SIS CRASHED AND RESTARTED WITH SAME LINE NUMBER
0016_20100723_133711_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0017_20100723_135957_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0018_20100723_145459_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0019_20100723_152932_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0020_20100723_153128_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0021_20100723_183118_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0022_20100723_183616_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0023_20100723_190118_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0024_20100723_195644_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0025_20100723_201140_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0026_20100723_205913_EX.all	7/23/10	EX1004_Leg3_50m_LL_WGS84	
0027_20100724_092801_EX.all	7/24/2010	EX1004_Leg3_50m_LL_WGS84	
0028_20100724_094454_EX.all	7/24/2010	EX1004_Leg3_50m_LL_WGS84	
0029_20100724_094713_EX.all	7/24/2010	EX1004_Leg3_50m_LL_WGS84	
0030_20100724_121916_EX.all	7/24/2010	N/A	DNP - TURN
0031_20100724_124534_EX.all	7/24/2010	EX1004_Leg3_50m_LL_WGS84	
0032_20100724_132048_EX.all	7/24/2010	EX1004_Leg3_50m_LL_WGS84	
0033_20100724_144511_EX.all	7/24/2010	EX1004_Leg3_50m_LL_WGS84	
0034_20100724_151022_EX.all	7/24/2010	EX1004_Leg3_50m_LL_WGS84	TRANSIT TO CTD. PREVIOUS EX

			COVERAGE.
0035, FILE SKIPPED BY SIS	0035, FILE SKIPPED BY SIS	N/A	0035, FILE SKIPPED BY SIS
0036_20100724_184632_EX.all	7/24/2010	N/A	NO DATA
0037_20100724_185138_EX.all	7/24/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0038_20100725_091439_EX.all	7/25/2010	EX1004_Leg3_50m_LL_WGS84	
0039_20100725_135638_EX.all	7/25/2010	EX1004_Leg3_50m_LL_WGS84	
0040_20100725_141942_EX.all	7/25/2010	EX1004_Leg3_50m_LL_WGS84	
0041_20100725_155954_EX.all	7/25/2010	EX1004_Leg3_50m_LL_WGS84	
0042_20100725_162011_EX.all	7/25/2010	EX1004_Leg3_50m_LL_WGS84	
0043_20100725_180027_EX.all	7/25/2010	EX1004_Leg3_50m_LL_WGS84	
0044_20100725_182013_EX.all	7/25/2010	EX1004_Leg3_50m_LL_WGS84	
0045_20100725_192830_EX.all	7/25/2010	N/A	NO DATA
0046_20100726_090955_EX.all	7/26/2010	N/A	DNP - RPM TESTING
0047_20100726_115516_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	
0048_20100726_132509_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	
0049_20100726_152313_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	TURN
0050_20100726_154608_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	
0051_20100726_173708_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	TURN
0052_20100726_180115_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	
0053_20100726_193742_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	TURN
0054_20100726_200022_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	
0055_20100726_214812_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0056_20100726_225258_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	
0057_20100726_231233_EX.all	7/26/2010	EX1004_Leg3_50m_LL_WGS84	
0058_20100726_232611_EX.all	7/26/2010	N/A	DNP - TURN
0059_20100727_094413_EX.all	7/27/2010	N/A	DNP - TURN
0060_20100727_094551_EX.all	7/27/2010	EX1004_Leg3_50m_LL_WGS84	
0061_20100727_101509_EX.all	7/27/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0062_20100727_110717_EX.all	7/27/2010	EX1004_Leg3_50m_LL_WGS84	
0063_20100727_132707_EX.all	7/27/2010	N/A	DNP - TURN
0064_20100727_140351_EX.all	7/27/2010	EX1004_Leg3_50m_LL_WGS84	
0065_20100727_200357_EX.all	7/27/2010	EX1004_Leg3_50m_LL_WGS84	
0066_20100727_203809_EX.all	7/27/2010	N/A	DNP - TURN
0067_20100727_230254_EX.all	7/27/2010	EX1004_Leg3_50m_LL_WGS84	
0068_20100727_232406_EX.all	7/27/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0069_20100728_091241_EX.all	7/28/2010	EX1004_Leg3_50m_LL_WGS84	
0070_20100728_112357_EX.all	7/28/2010	N/A	DNP - TURN
0071_20100728_112926_EX.all	7/28/2010	EX1004_Leg3_50m_LL_WGS84	
0072_20100728_160803_EX.all	7/28/2010	EX1004_Leg3_50m_LL_WGS84	
0073_20100728_201514_EX.all	7/28/2010	N/A	DNP - TURN
0074_20100728_202022_EX.all	7/28/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0075_20100728_220311_EX.all	7/28/2010	EX1004_Leg3_50m_LL_WGS84	
0076_20100729_085823_EX.all	7/29/2010	EX1004_Leg3_50m_LL_WGS84	
0077_20100729_125709_EX.all	7/29/2010	EX1004_Leg3_50m_LL_WGS84	
0078_20100729_185706_EX.all	7/29/2010	EX1004_Leg3_50m_LL_WGS84	
0079_20100729_200813_EX.all	7/29/2010	EX1004_Leg3_50m_LL_WGS84	TURN
0080_20100729_202850_EX.all	7/29/2010	N/A	DNP - TURN
0081_20100729_203202_EX.all	7/29/2010	EX1004_Leg3_50m_LL_WGS84	
0082_20100729_214836_EX.all	7/29/2010	N/A	DNP - TURN
0083_20100729_215456_EX.all	7/29/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0084_20100730_000128_EX.all	7/30/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0085_20100730_095320_EX.all	7/30/2010	EX1004_Leg3_50m_LL_WGS84	
0086_20100730_112745_EX.all	7/30/2010	EX1004_Leg3_50m_LL_WGS84	

0087_20100730_121419_EX.all	7/30/2010	EX1004_Leg3_50m_LL_WGS84	
0088_20100730_150656_EX.all	7/30/2010	EX1004_Leg3_50m_LL_WGS84	
0089_20100730_153119_EX.all	7/30/2010	EX1004_Leg3_50m_LL_WGS84	
0090_20100730_180618_EX.all	7/30/2010	EX1004_Leg3_50m_LL_WGS84	
0091_20100730_182627_EX.all	7/30/2010	EX1004_Leg3_50m_LL_WGS84	
0092_20100730_205845_EX.all	7/30/2010	EX1004_Leg3_50m_LL_WGS84	
0093_20100730_212054_EX.all	7/30/2010	EX1004_Leg3_50m_LL_WGS84	
0094_20100731_022047_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	
0095_20100731_023732_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	
0096_20100731_024034_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	
0097_20100731_065441_EX.all	7/31/2010	N/A	DNP - TURN
0098_20100731_070640_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	
0099_20100731_071526_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	
0100_20100731_112401_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	TURN
0101_20100731_120133_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	
0102_20100731_125815_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0103_20100731_140530_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	
0104_20100731_144539_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX & BJIV COVERAGE
0105_20100731_192141_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	
0106_20100731_200445_EX.all	7/31/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS BJIV COVERAGE
0107_20100801_091425_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS BJIV COVERAGE
0108_20100801_104112_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	
0109_20100801_105906_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	
0110_20100801_110221_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	
0111_20100801_111308_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	TURN
0112_20100801_111833_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	
0113_20100801_113103_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	TURN
0114_20100801_113525_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	
0115_20100801_123741_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	
0116_20100801_160956_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	TURN
0117_20100801_162838_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	
0118_20100801_195742_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	TURN
0119_20100801_202005_EX.all	8/1/2010	EX1004_Leg3_50m_LL_WGS84	
0120_20100802_060154_EX.all	8/2/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS BJIV COVERAGE
0121_20100802_081151_EX.all	8/2/2010	EX1004_Leg3_50m_LL_WGS84	
0122_20100802_133711_EX.all	8/2/2010	EX1004_Leg3_50m_LL_WGS84	
0123_20100802_160511_EX.all	8/2/2010	EX1004_Leg3_50m_LL_WGS84	
0124_20100802_163333_EX.all	8/2/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0125_20100802_165337_EX.all	8/2/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0126_20100803_112024_EX.all	8/3/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0127_20100803_114213_EX.all	8/3/2010	EX1004_Leg3_50m_LL_WGS84	
0128_20100803_120803_EX.all	8/3/2010	N/A	DNP - RPM TESTING
0129_20100803_140933_EX.all	8/3/2010	EX1004_Leg3_50m_LL_WGS84	
0130_20100803_142810_EX.all	8/3/2010	EX1004_Leg3_50m_LL_WGS84	
0131_20100803_202812_EX.all	8/3/2010	EX1004_Leg3_50m_LL_WGS84	
0132_20100803_204516_EX.all	8/3/2010	N/A	DNP - TURN
0133_20100804_104238_EX.all	8/4/2010	EX1004_Leg3_50m_LL_WGS84	
0134_20100804_110530_EX.all	8/4/2010	EX1004_Leg3_50m_LL_WGS84	
0135_20100804_125932_EX.all	8/4/2010	EX1004_Leg3_50m_LL_WGS84	
0136_20100804_130458_EX.all	8/4/2010	EX1004_Leg3_50m_LL_WGS84	

0137_20100804_182015_EX.all	8/4/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0138_20100804_185504_EX.all	8/4/2010	EX1004_Leg3_50m_LL_WGS84	
0139_20100804_192553_EX.all	8/4/2010	EX1004_Leg3_50m_LL_WGS84	
0140_20100804_193934_EX.all	8/4/2010	EX1004_Leg3_50m_LL_WGS84	
0141_20100804_200655_EX.all	8/4/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0142_20100804_212622_EX.all	8/4/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0143_20100805_090410_EX.all	8/5/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0144_20100805_100359_EX.all	8/5/2010	EX1004_Leg3_50m_LL_WGS84	
0145_20100805_121017_EX.all	8/5/2010	EX1004_Leg3_50m_LL_WGS84	
0146_20100805_123034_EX.all	8/5/2010	EX1004_Leg3_50m_LL_WGS84	
0147_20100805_150221_EX.all	8/5/2010	EX1004_Leg3_50m_LL_WGS84	
0148_20100805_152545_EX.all	8/5/2010	EX1004_Leg3_50m_LL_WGS84	
0149_20100805_173416_EX.all	8/5/2010	N/A	DNP - TURN
0150_20100805_175313_EX.all	8/5/2010	EX1004_Leg3_50m_LL_WGS84	
0151_20100805_195536_EX.all	8/5/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0152_20100806_081605_EX.all	8/6/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0153_20100806_090614_EX.all	8/6/2010	N/A	DNP - TURN
0154_20100806_090838_EX.all	8/6/2010	EX1004_Leg3_50m_LL_WGS84	PREVIOUS EX COVERAGE
0155_20100806_102357_EX.all	8/6/2010	EX1004_Leg3_50m_LL_WGS84	
0156_20100806_113851_EX.all	8/6/2010	N/A	DNP - TURN
0157_20100806_114723_EX.all	8/6/2010	EX1004_Leg3_50m_LL_WGS84	LAST MB LINE OF EX1004 LEG3. TRANSIT TO EDGE OF SURVEY BOUNDARY. JUMPS IN NAV DATA.

EX1004 LEG 3 EM302 MULTIBEAM WATER COLUMN FILE LOG	
DATE (GMT)	**EM302 FILE NAME**
7/22/2010	0009_20100722_172313_EX.wcd
7/23/2010	0015_20100723_101213_EX.wcd
7/23/2010	0018_20100723_145459_EX.wcd
7/23/2010	0019_20100723_152932_EX.wcd
7/23/2010	0026_20100723_205913_EX.wcd

EX1004 LEG 3 SVP LOG				
DATE (GMT)	**TIME (GMT)**	**XBT/CTD FILE NAME**	**LAT/LONG (WGS84)**	**Notes**
7/22/2010	08:03	XBT_072210_01.asvp	2.1925 N 125.2317 E	Processed in Velociwin
7/22/2010	16:14	XBT_072310_02.asvp	2.911275 N 125.158756 E	Processed in Velociwin

7/23/2010	06:55	XBT_072310_03.asvp	2.834514 N 125.087500 E	Processed in Velociwin
7/23/2010	16:24:37	XBT_072310_04.asvp	2.05674133 N 125.10120567 E	Processed in Velociwin
7/24/2010	09:16	XBT_072410_05.asvp	2.147275N 124.896533E	Processed in Velociwin
7/25/2010	00:20	ROV_072510_03.asvp	2.270883N 124.830667E	Processed in Velociwin
7/26/2010	16:25	XBT_072610_06.asvp	2.742310 N 124.895068 E	Processed in Velocipy
7/26/2010	00:14	ROV_072610_04.asvp	2.273233 N 124.830400 E	Processed in Velocipy
7/26/2010	16:28	XBT_072710_07.asvp	3.147557 N 124.906136 E	Processed in Velocipy
7/27/2010	00:15	ROV_072710_05.asvp	2.83085N 124.989433E	Processed in Velocipy
7/28/2010	16:23	XBT_072810_08.asvp	3.588428N 124.911703E	Processed in Velocipy
7/28/2010	00:28	ROV_072810_06.asvp	4.247300N 125.272933E	Processed in Velocipy
7/29/2010	16:26	XBT_072910_09.asvp	4.854375 N 124.822868 E	Processed in Velocipy
7/29/2010	0034	ROV_072910_07.asvp	4.679283 N 125.090733 E	Processed in Velocipy
7/29/2010	1624	XBT_073010_10.asvp	5.279130 N 125.946029 E	Processed in Velocipy
7/30/2010	1:14:00	ROV_073010_08.asvp	5.402N 126.593833E	Processed in Velocipy
7/30/2010	16:27:00	XBT_073110_11.asvp	5.296215N 126.375000E	Processed in Velocipy
7/30/2010	22:40:00	XBT_073110_12.asvp	5.404341N 126.350228E	Processed in Velocipy
7/31/2010	5:13:00	XBT_073110_13.asvp	5.523546 N 126.399854E	Processed in Velocipy
7/31/2010	10:47:00	XBT_073110_14.asvp	5.721923N 126.537256E	Processed in Velocipy
7/31/2010	16:33	XBT_080110_15.asvp	5.169772N 126.728646E	Processed in Velocipy
8/1/2010	0:19:00	ROV_080110_09.asvp	4.685817N 126.853000E	Processed in Velocipy

8/2/2010	0:30:00	XBT_080110_16.asvp	5.295154N 127.263053E	Processed in Velocipy
8/2/2010	5:37:00	XBT_080210_17.asvp	4.881469 N 127.000864 E	Processed in Velocipy
8/2/2010	16:24	XBT_080310_18.asvp	4.792311N 125.401042E	Processed in Velocipy
8/2/2010	19:58:00	ROV_080310_11.asvp	4.666667N 125.083333E	Processed in Velocipy
8/4/2010	16:27	XBT_080410_19.asvp	3.882703N 124.865804E	Processed in Velocipy
8/4/2010	0:46	ROV_080410_12.asvp	3.587283N 125.131200E	Processed in Velocipy
8/5/2010	16:27	XBT_080510_20.asvp	3.078257 N 125.317774 E	Processed in Velocipy
8/5/2010	0:16:00	ROV_080510_13.asvp	2.70325N 125.282050E	Processed in Velocipy
8/5/2010	16:24:00	XBT_080610_21.asvp	2.254627N 125.568164E	Processed in Velocipy
8/6/2010	0:13:00	ROV_080610_14.asvp	2.68435N 125.260367E	Processed in Velocipy

Appendix C: List of acronyms

BPPT - Badan Pengkajian Dan Penerapan Teknologi (Indonesian Agency for the Assessment and Application Technology)

BIST – Built In System Test

BJIV – Baruna Jaya IV

BRKP - Indonesia Agency for Marine and Fisheries Research

CDR – Commander

CO – Commanding Officer

CIMS – Cruise Information Management System

CTD – conductivity temperature and depth

CW – continuous wave

dB – decibels

DGPS –Differential Global Positioning System

DTM – digital terrain model

ECS – Extended Continental Shelf

EEZ –Exclusive Economic Zone

ET – Electronics Technician

EX – NOAA Ship *Okeanos Explorer*

FM – frequency modulation

FOO – Field Operations Officer

INDEX-SATAL – Indonesia Exploration–Sangihe Talaud Region

kHz - kilohertz

Km – kilometers

KM – Kongsberg Maritime AS

Kt(s) – knots

LT – Lieutenant

Ma – megaannum

MBES – multibeam echosounder

NCDDC – National Coastal Data Development Center

NGDC – National Geophysical Data Center

NOAA – National Oceanic and Atmospheric Administration

NODC – National Oceanographic Data Center

OER – Office of Ocean Exploration and Research

OMAO – Office of Marine and Aviation Operations

PMEL – Pacific Marine Environmental Laboratory

ROV – Remotely Operated Vehicle

RX – receive

SST – Senior Survey Technician

SV – sound velocity

TNI –Tentara Nasional Indonesia (Indonesian Navy)

TRU – transmit and receive unit

TSG - thermosalinograph

TX – transmit

UNCLOS – United Nations Convention on the Law of the Sea

UNH-CCOM/JHC – University of New Hampshire Center for Coastal and Ocean Mapping / Joint Hydrographic Center

UPS – uninterruptable power supply

USBL – ultra-short base line

WD – water depth

WHOI – Woods Hole Oceanographic Institution

XBT – expendable bathythermograph

Appendix D: EM302 description and operational specs

EM 302: Ideal for Ocean Exploration

There are several features of the Okeanos Explorer's 30 kHz multibeam that make it an excellent tool for ocean exploration. The following is a brief description of these features.

Depth Range

The system is designed to map the seafloor in water depths of 10 to 7000 meters. This leaves only the deepest parts of the deeper ocean trenches out of the EM 302's reach. Moreover, operational experience on the *Okeanos Explorer* has shown consistent EM 302 bottom detection at depth ranges in excess of 8000m.

High Density Data

In multibeam data, the denser the data, the finer resolution maps you can produce. The system can operate in dual swath, or multiping mode, which results in increased along track data density. This is achieved by detecting two swaths per ping cycle, resulting in up to 864 beams per ping.

The Okeanos Explorer mapping team typically operates the multibeam in high density equidistant ping mode, which results in up to 864 soundings on the seafloor per ping.

Full Suite of Data Types Collected

The system collects seafloor backscatter data, which provides information about the character of the seafloor in terms of bottom type.

The system also collects water column backscatter data, which has the ability to detect gaseous plumes in the water column. The full value of this feature is still being realized.

FM chirp mode is utilized in water depths greater than 1000 meters, and allows for the detection of the bottom further out from nadir than with previous 30 kHz systems.

Multibeam Primer

The area of the seafloor covered, or ensonified, by a single beam within a pulse of sound, or ping, is called the beam footprint. This beam footprint is defined in terms of the across track and along track values. Both of these values are dependent on water depth and the beam width at which the sound pulse is transmitted and received. The across track beam width value is also dependent on the receive angle, or "listening" angle, of the system, and the angle from nadir which it is received from. The receive angle for the receive transducer on the Okeanos Explorer EM302 is 1°, which is the smallest possible angle currently available for the EM302 system. The further out from nadir a sounding occurs, the larger the footprint will be. For example, as seen in Table 1 below, in 2000 meters of water, a beam footprint will have a radius of 18 meters at nadir but 25 meters by the time it hits the seafloor at an angle 140 degrees out from nadir.

Calculated acrosstrack acoustic beam footprint for EM 302 (high density ping mode, 432 soundings/profile)				
Water depth (m)	**Angle from nadir**			
50	1 deg RX center	90 deg	120 deg	140 deg
100	1	0.5	1	1
200	2	1	2	3
400	4	2	3	5
1000	7	4	6	10
2000	18	9	16	25
4000	35	19	32	-
6000	70	37	-	-
7000	105	56	-	-

Table 4. Calculated across track EM 302 beam footprint. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 17.

Calculated acrosstrack sounding density for EM 302 (high density ping mode, 432 soundings/profile)			
Water depth (m)	**Swath Width**		
50	90 deg	120 deg	140 deg
100	0.2	0.4	0.9
200	0.5	0.8	1.7
400	0.9	1.6	3.5
1000	1.9	3.2	6.9
2000	4.6	8.1	17.4
4000	9.3	16.2	-

Table 5. Calculated across track EM 302 sounding density. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 17.

Acrosstrack sounding density describes the spacing between individual soundings on the seafloor in the acrosstrack direction. The maximum swath of the EM 302 is 150 degrees. At this swath, the sounding density will be the least dense, since the beams will be spread out over a larger horizontal distance over the seafloor. As the swath angle (width) is decreased, the sounding density will increase, as the same number of beams are now spread out over a smaller horizontal distance over the seafloor.

Calculated ping rate and alongtrack resolution for EM 302			
140 deg swath, one profile per ping			
			Alongtrack distance between

			profiles (m)		
Water depth (m)	**Swath Width (m)**	**Ping Rate (pings/second)**	**@4 kts**	**@8 kts**	**@12 kts**
50	275	3.2	0.7	1.2	1.9
100	550	1.8	1.1	2.2	3.3
200	1100	1	2.1	4.2	6.3
400	2200	0.5	4.1	8.2	12.2
1000	5500	0.2	10	20	30
2000	8000	0.1	15.2	30.5	45.7
4000	8000	0.06	19.2	38.5	57.7
6000	8000	0.04	24.5	49	73.4

Table 6. Calculated ping rate and along track EM 302 sounding density, one profile per ping. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 15.

Calculated ping rate and alongtrack resolution for EM 302					
140 deg swath, two profiles per ping					
Water depth (m)	**Swath Width (m)**	**Ping Rate**	**Alongtrack distance between profiles (m)**		
			@4 kts	**@8 kts**	**@12 kts**
50	275	3.2	0.3	0.6	0.9
100	550	1.8	0.6	1.1	1.7
200	1100	1	1.1	2.1	3.2
400	2200	0.5	2	4.1	6.1
1000	5500	0.2	5	10	15
2000	8000	0.1	7.6	15.2	22.8

Table 7. Calculated ping rate and along track EM 302 sounding density, two profiles per ping. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 15.

Reference: Kongsberg Product Description: EM 302 multibeam echosounder

Appendix E: EM302 PU Parameters in use during EX1004 Leg 3

#// Database Parameters

#// Seafloor Information System
#// Kongsberg Maritime AS
#// Saved: 2010.08.06 15:34:49

#// Build info:
#* SIS: [Version: 3.6.4, Build: 174 , DBVersion 16.0 CD generated: Mon Mar 30 2009 14:00:00]
[Fox ver = 1.6.29]
[db ver = 16, proc = 16.0]
[OTL = 4.0.-95]
[ACE ver = 5.5]
[Coin ver = 2.4.4]
[Simage ver = 1.6.2a]
[Dime ver = DIME v0.9]
[STLPort ver = 513]
[FreeType ver = 2.1.9]
[TIFF ver = 3.8.2]
[GeoTIFF ver = 1230]
[GridEngine ver = 2.3.0]

#* Language [3] #// Current language, 1-Norwegian, 2-German,3-English, 4-Spanish

#* Type [302]
#* Serial no. [101]
#* Number of heads [2]
#* System descriptor [50331648]
#// 03000000

#// ***
#// Installation parameters

#{ Input Setup #// All Input setup parameters

#{ COM1 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#* Baud rate: [9600]
#* Data bits [8]
#* Stop bits: [1]
#* Parity: [NONE]
#} Com. settings

#{ Position #// Position input settings.
#* None [1] [0]
#* GGK [1] [0]
#* GGA [1] [1]
#* GGA_RTK [1] [0]
#* SIMRAD90 [1] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [1] [1]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} COM1

#{ COM2 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#* Baud rate: [19200]
#* Data bits [8]
#* Stop bits: [1]
#* Parity: [NONE]
#} Com. settings

#{ Position #// Position input settings.
#* None [0] [1]
#* GGK [0] [0]
#* GGA [0] [0]
#* GGA_RTK [0] [0]
#* SIMRAD90 [0] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [1] [1]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [0] [0]
#* DBT Depth [0] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [0] [0]
#* Height, special purp [0] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} COM2

#{ COM3 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#* Baud rate: [4800]
#* Data bits [8]
#* Stop bits: [1]
#* Parity: [NONE]
#} Com. settings

#{ Position #// Position input settings.
#* None [1] [1]
#* GGK [1] [0]
#* GGA [1] [0]
#* GGA_RTK [1] [0]
#* SIMRAD90 [1] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [1] [1]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} COM3

#{ COM4 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#* Baud rate: [9600]
#* Data bits [8]
#* Stop bits: [1]
#* Parity: [NONE]
#} Com. settings

#{ Position #// Position input settings.
#* None [1] [1]
#* GGK [1] [0]
#* GGA [1] [0]
#* GGA_RTK [1] [0]
#* SIMRAD90 [1] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} COM4

#{ UDP2 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#// N/A
#} Com. settings

#{ Position #// Position input settings.
#* None [1] [1]
#* GGK [1] [0]
#* GGA [1] [0]
#* GGA_RTK [1] [0]
#* SIMRAD90 [1] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [0] [0]
#* DBT Depth [0] [0]
#* EA500 Depth [1] [0]
#* ROV. depth [0] [0]
#* Height, special purp [0] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} UDP2

#{ UDP3 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#// N/A
#} Com. settings

#{ Position #// Position input settings.
#* None [0] [1]
#* GGK [0] [0]
#* GGA [0] [0]
#* GGA_RTK [0] [0]
#* SIMRAD90 [0] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [1] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]

#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} UDP3

#{ UDP4 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#// N/A
#} Com. settings

#{ Position #// Position input settings.
#* None [0] [1]
#* GGK [0] [0]
#* GGA [0] [0]
#* GGA_RTK [0] [0]
#* SIMRAD90 [0] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [1] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [1] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} UDP4

#{ UDP5 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#// N/A
#} Com. settings

#{ Position #// Position input settings.
#* None [0] [0]
#* GGK [0] [0]
#* GGA [0] [0]
#* GGA_RTK [0] [0]
#* SIMRAD90 [0] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [0] [0]
#* DBT Depth [0] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [0] [0]
#* Height, special purp [0] [0]
#* Ethernet AttVel [1] [1]
#} Input Formats

#{ Attitude Velocity settings #// Only relevant for UDP5 on EM122, EM302 and EM710, currently
#* Attitude 1 [1] [1]
#* Attitude 2 [1] [0]
#* Use Ethernet 2 [1] [1]
#* Port: [5602]
#* IP addr.: [192.168.2.20]
#* Net mask: [255.255.255.0]
#} Attitude Velocity settings

#} UDP5

#{ Misc. #// Misc. input settings.
#* External Trigger [1] [0]
#} Misc.

#} Input Setup

#{ Output Setup #// All Output setup parameters

#* PU broadcast enable [1] [1]
#* Log watercolumn to s [1] [1]

#{ Host UDP1 #// Host UDP1 Port: 16100

#{ Datagram subscription #//
#* Depth [0] [0]
#* Raw range and beam a [0] [0]
#* Seabed Image [0] [0]
#* Central Beams [0] [0]
#* Position [0] [0]
#* Attitude [0] [0]
#* Heading [0] [0]
#* Height [0] [0]
#* Clock [0] [0]
#* Single beam echosoun [0] [0]
#* Sound Speed Profile [0] [1]
#* Runtime Parameters [0] [1]
#* Installation Paramet [0] [1]
#* BIST Reply [0] [1]
#* Status parameters [0] [1]
#* PU Broadcast [0] [0]
#* Stave Display [0] [0]
#* Water Column [0] [0]
#* Internal, Range Data [0] [0]
#* Internal, Scope Data [0] [0]
#} Datagram subscription

#} Host UDP1

#{ Host UDP2 #// Host UDP2 Port: 16101

#{ Datagram subscription #//
#* Depth [1] [1]
#* Raw range and beam a [1] [1]
#* Seabed Image [1] [1]
#* Central Beams [1] [0]
#* Position [1] [1]
#* Attitude [1] [1]
#* Heading [1] [1]
#* Height [1] [1]
#* Clock [1] [1]
#* Single beam echosoun [1] [1]
#* Sound Speed Profile [0] [1]
#* Runtime Parameters [0] [1]
#* Installation Paramet [0] [1]
#* BIST Reply [1] [1]
#* Status parameters [0] [1]
#* PU Broadcast [1] [0]
#* Stave Display [0] [1]
#* Water Column [0] [1]
#* Internal, Range Data [1] [0]
#* Internal, Scope Data [1] [0]
#} Datagram subscription

#} Host UDP2

#{ Host UDP3 #// Host UDP3 Port: 16102

#{ Datagram subscription #//
#* Depth [0] [1]
#* Raw range and beam a [0] [0]
#* Seabed Image [0] [0]
#* Central Beams [0] [0]
#* Position [0] [0]
#* Attitude [0] [1]
#* Heading [0] [0]
#* Height [0] [1]
#* Clock [0] [0]
#* Single beam echosoun [0] [1]
#* Sound Speed Profile [0] [1]
#* Runtime Parameters [0] [0]
#* Installation Paramet [0] [1]
#* BIST Reply [0] [0]
#* Status parameters [0] [0]
#* PU Broadcast [0] [0]
#* Stave Display [0] [0]
#* Water Column [0] [0]
#* Internal, Range Data [0] [0]
#* Internal, Scope Data [0] [1]
#} Datagram subscription

#} Host UDP3

#{ Host UDP4 #// Host UDP4 Port 16103

#{ Datagram subscription #//
#* Depth [1] [1]
#* Raw range and beam a [1] [0]
#* Seabed Image [1] [0]
#* Central Beams [1] [0]
#* Position [1] [0]
#* Attitude [1] [0]
#* Heading [1] [0]

#* Height [1] [0]
#* Clock [1] [0]
#* Single beam echosoun [1] [0]
#* Sound Speed Profile [1] [0]
#* Runtime Parameters [1] [0]
#* Installation Paramet [1] [0]
#* BIST Reply [1] [0]
#* Status parameters [1] [0]
#* PU Broadcast [1] [0]
#* Stave Display [1] [0]
#* Water Column [1] [0]
#* Internal, Range Data [1] [0]
#* Internal, Scope Data [1] [0]
#} Datagram subscription

#} Host UDP4

#{ Watercolumn #// Host UDP4 Port 16103

#{ Datagram subscription #//
#* Depth [1] [1]
#* Raw range and beam a [1] [1]
#* Seabed Image [1] [1]
#* Central Beams [1] [0]
#* Position [1] [1]
#* Attitude [1] [1]
#* Heading [1] [1]
#* Height [1] [1]
#* Clock [1] [1]
#* Single beam echosoun [1] [1]
#* Sound Speed Profile [1] [1]
#* Runtime Parameters [1] [1]
#* Installation Paramet [1] [1]
#* BIST Reply [1] [1]
#* Status parameters [1] [1]
#* PU Broadcast [1] [0]
#* Stave Display [1] [0]
#* Water Column [1] [1]
#* Internal, Range Data [1] [0]
#* Internal, Scope Data [1] [0]
#} Datagram subscription

#} Watercolumn

#} Output Setup

#{ Clock Setup #// All Clock setup parameters

#{ Clock #// All clock settings.
#* Source: [1] #// External ZDA Clock
#* 1PPS Clock Synch. [1] [1]
#* Offset (sec.): [0]
#} Clock

#} Clock Setup

#{ Settings #// Sensor setup parameters

#{ Positioning System Settings #// Position related settings.

#{ COM1 #// Positioning System Ports:
#* P1T [0] #// System
#* P1M [0] #// Enable position motion correction
#* P1D [0.000] #// Position delay (sec.):
#* P1G [WGS84] #// Datum:
#* P1Q [1] #// Enable
#* Pos. qual. indicator [] #//
#} COM1

#} Positioning System Settings

#{ Motion Sensor Settings #// Motion related settings.

#{ COM2 #// Motion Sensor Ports:
#* MRP [RP] #// Rotation (POSMV/MRU)
#* MSD [0] #// Motion Delay (msec.):
#* MAS [1.00] #// Motion Sensor Roll Scaling:
#} COM2

#} Motion Sensor Settings

#{ Active Sensors #//
#* APS [0] [COM1] #// Position:
#* ARO [2] [COM2] #// Motion:
#* AHE [2] [COM2] #// Motion:
#* AHS [3] [COM3] #// Heading:
#} Active Sensors

#} Settings

#{ Locations #// All location parameters

#{ Location offset (m) #//

#{ Pos, COM1: #//
#* P1X [0.00] #// Forward (X)
#* P1Y [0.00] #// Starboard (Y)
#* P1Z [0.00] #// Downward (Z)
#} Pos, COM1:

#{ Pos, COM3: #//
#* P2X [0.00] #// Forward (X)
#* P2Y [0.00] #// Starboard (Y)
#* P2Z [0.00] #// Downward (Z)
#} Pos, COM3:

#{ Pos, COM4/UDP2: #//
#* P3X [0.00] #// Forward (X)
#* P3Y [0.00] #// Starboard (Y)
#* P3Z [0.00] #// Downward (Z)
#} Pos, COM4/UDP2:

#{ TX Transducer: #//
#* S1X [6.147] #// Forward (X)
#* S1Y [1.822] #// Starboard (Y)
#* S1Z [6.796] #// Downward (Z)
#} TX Transducer:

#{ RX Transducer: #//
#* S2X [2.497] #// Forward (X)
#* S2Y [2.481] #// Starboard (Y)
#* S2Z [6.790] #// Downward (Z)
#} RX Transducer:

#{ Attitude 1, COM2: #//
#* MSX [0.00] #// Forward (X)
#* MSY [0.00] #// Starboard (Y)
#* MSZ [0.00] #// Downward (Z)
#} Attitude 1, COM2:

#{ Attitude 2, COM3: #//
#* NSX [0.00] #// Forward (X)
#* NSY [0.00] #// Starboard (Y)
#* NSZ [0.00] #// Downward (Z)
#} Attitude 2, COM3:

#{ Waterline: #//
#* WLZ [1.838] #// Downward (Z)
#} Waterline:

#} Location offset (m)

#} Locations

#{ Angular Offsets #// All angular offset parameters

#{ Offset angles (deg.) #//

#{ TX Transducer: #//
#* S1R [0.00] #// Roll
#* S1P [0.00] #// Pitch
#* S1H [359.98] #// Heading
#} TX Transducer:

#{ RX Transducer: #//

#* S2R [0.00] #// Roll
#* S2P [0.00] #// Pitch
#* S2H [0.03] #// Heading
#} RX Transducer:

#{ Attitude 1, COM2: #//
#* MSR [0.00] #// Roll
#* MSP [-0.80] #// Pitch
#* MSG [0.00] #// Heading
#} Attitude 1, COM2:

#{ Attitude 2, COM3: #//
#* NSR [0.00] #// Roll
#* NSP [0.00] #// Pitch
#* NSG [0.00] #// Heading
#} Attitude 2, COM3:

#{ Stand-alone Heading: #//
#* GCG [0.00] #// Heading
#} Stand-alone Heading:

#} Offset angles (deg.)

#} Angular Offsets

#{ ROV. Specific #// All ROV specific parameters

#{ Depth/Pressure Sensor #//
#* DSF [1.00] #// Scaling:
#* DSO [0.00] #// Offset:
#* DSD [0.00] #// Delay:
#* DSH [NI] #// Disable Heave Sensor
#} Depth/Pressure Sensor

#} ROV. Specific

#{ System Parameters #// All system parameters

#{ System Gain Offset #//
#* GO1 [0.0] #// BS Offset (dB)
#} System Gain Offset

#{ Opening angles #//
#* S1S [0] #// TX Opening angle:
#* S2S [1] #// RX Opening angle:
#} Opening angles

#} System Parameters

#// **
#// Runtime parameters

#{ Sounder Main #//

#{ Sector Coverage #//

#{ Max. angle (deg.): #//
#* MPA [75] #// Port
#* MSA [75] #// Starboard
#} Max. angle (deg.):

#{ Max. Coverage (m): #//
#* MPC [5000] #// Port
#* MSC [5000] #// Starboard
#} Max. Coverage (m):

#* ACM [1] #// Angular Coverage mode: AUTO
#* BSP [2] #// Beam Spacing: HIDENS EQDIST

#} Sector Coverage

#{ Depth Settings #//
#* FDE [4500] #// Force Depth (m)
#* MID [50] #// Min. Depth (m):
#* MAD [7000] #// Max. Depth (m):
#* DSM [0] #// Dual swath mode: OFF
#* PMO [0] #// Ping Mode: AUTO
#* FME [1] #// FM enable
#} Depth Settings

#{ Stabilization #//
#* YPS [1] #// Pitch stabilization
#* TXA [-2] #// Along Direction (deg.):

#{ Yaw Stabilization #//
#* YSM [2] #// Mode: REL. MEAN HEADING
#* YMA [300] #// Heading:
#* HFI [1] #// Heading filter: MEDIUM
#} Yaw Stabilization

#} Stabilization
#} Sounder Main

#{ Sound Speed #//

#{ Sound Speed at Transducer #//
#* SHS [0] #// Source SENSOR
#* SST [15000] #// Sound Speed (dm/sec.):
#* Sensor Offset (m/sec [0] #//
#* Filter (sec.): [5] #//
#} Sound Speed at Transducer

#} Sound Speed

#{ Filter and Gains #//

#{ Filtering #//
#* SFS [2] #// Spike Filter Strength: MEDIUM
#* PEF [0] #// Penetration Filter Strength: OFF
#* RGS [0] #// Range Gate: SMALL
#* SLF [1] #// Slope
#* AEF [1] #// Aeration
#* STF [1] #// Sector Tracking
#* IFF [1] #// Interference
#} Filtering

#{ Absorption Coefficient #//
#* ABC [6.279] #// 31.5 kHz
#} Absorption Coefficient

#{ Normal incidence sector #//
#* TCA [6] #// Angle from nadir (deg.):
#} Normal incidence sector

#{ Mammal protection #//
#* TXP [0] #// TX power level (dB): Max.
#* SSR [0] #// Soft startup ramp time (min.):
#} Mammal protection
#} Filter and Gains

#{ Data Cleaning #//
#* Active rule: [STANDARD] #//
#{ STANDARD #//
#* PingProc.maxPingCountRadius [10]
#* PingProc.radiusFactor [0.050000]
#* PingProc.medianFactor [1.500000]
#* PingProc.beamNumberRadius [3]
#* PingProc.sufficientPointCount [40]
#* PingProc.neighborhoodType [Elliptical]
#* PingProc.timeRule.use [false]
#* PingProc.overhangRule.use [false]

#* PingProc.medianRule.use [false]
#* PingProc.medianRule.depthFactor [0.050000]
#* PingProc.medianRule.minPointCount [6]
#* PingProc.quantileRule.use [false]
#* PingProc.quantileRule.quantile [0.100000]
#* PingProc.quantileRule.scaleFactor [6.000000]
#* PingProc.quantileRule.minPointCount [40]
#* GridProc.minPoints [8]
#* GridProc.depthFactor [0.200000]
#* GridProc.removeTooFewPoints [false]
#* GridProc.surfaceFitting.surfaceDegree [1]
#* GridProc.surfaceFitting.tukeyConstant [6.000000]
#* GridProc.surfaceFitting.maxIteration [10]
#* GridProc.surfaceFitting.convCriterion [0.010000]
#* GridProc.surfaceDistanceDepthRule.use [false]
#* GridProc.surfaceDistanceDepthRule.depthFactor [0.050000]
#* GridProc.surfaceDistancePointRule.use [false]
#* GridProc.surfaceDistancePointRule.scaleFactor [1.000000]
#* GridProc.surfaceDistanceUnitRule.use [false]
#* GridProc.surfaceDistanceUnitRule.scaleFactor [1.000000]
#* GridProc.surfaceDistanceStDevRule.use [false]
#* GridProc.surfaceDistanceStDevRule.scaleFactor [2.000000]
#* GridProc.surfaceAngleRule.use [false]
#* GridProc.surfaceAngleRule.minAngle [20.000000]
#* SonarProc.use [false]
#* SonarProc.gridSizeFactor [4]
#* SonarProc.mergerType [Average]
#* SonarProc.interpolatorType [TopHat]
#* SonarProc.interpolatorRadius [1]
#* SonarProc.fillInOnly [true]
#} STANDARD

#{ Seabed Image Processing #//
#* Seabed Image Process [1] [0]
#} Seabed Image Processing
#} Data Cleaning

#{ Advanced param. #//
#} Advanced param.

Appendix F: Software versions in use during EX1004 Leg 3

Software	**Version**	**Purpose**
CARIS HIPS and SIPS	6.1 Service Pack 2	Multibeam processing
ECDIS		Ship line keeping
ESRI – ArcMap	9.3	Map products
Fledermaus	6.7.0h Build 419 Professional	Multibeam QC, Line planning
Fledermaus	7.2.0 Build 411 Professional, 32 bit Edition	
Hypack	9.0.0.22	Survey planning
Hypack	9.0.4.0	Realtime monitoring
Kongsberg SIS (installed 2/12/10)	3.6.4 build 174	EM302 data acquisition
Velocipy (NOAA)	10.7	XBT, ROV CTD processing
Velociwin (NOAA)	8.92	XBT processing