Multibeam Bathymetry Survey Rangiroa, French Polynesia

SPC Applied Geoscience and Technology Division (SOPAC)

September 2013

Salesh Kumar, Jens Kruger, Zulfikar Begg, Eileen Handerson, & Manoël Alvis

SPC SOPAC TECHNICAL REPORT (PR106)

Ocean and Islands Programme

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SECRETARIAT OF THE PACIFIC COMMUNITY
SECRÉTARIAT GÉNÉRAL DE LA COMMUNAUTÉ DU PACIFIQUE

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The SPC Applied Geoscience and Technology (SOPAC) Division undertook the work in collaboration with 'Service de l'Urbanisme' of French Polynesia

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EXECUTIVE SUMMARY

This report describes a multibeam bathymetric survey of Rangiroa Lagoon and nearshore areas around the atoll rim, from the northwest (near Tivaru) to the northeast (near Ataiaheo motu). The survey was a component of the Supporting Disaster Risk Reduction in Pacific Overseas Countries and Territories project, conducted by the Secretariat of the Pacific Community Applied Geoscience Division, in collaboration with the Urban planning Department, and the Lighthouses and Beacons Service. This project component called for an investigation of the nearshore and lagoon seabed of Rangiroa Atoll. The survey was carried out using a multibeam echosounder over a period of six months (July to December 2011).

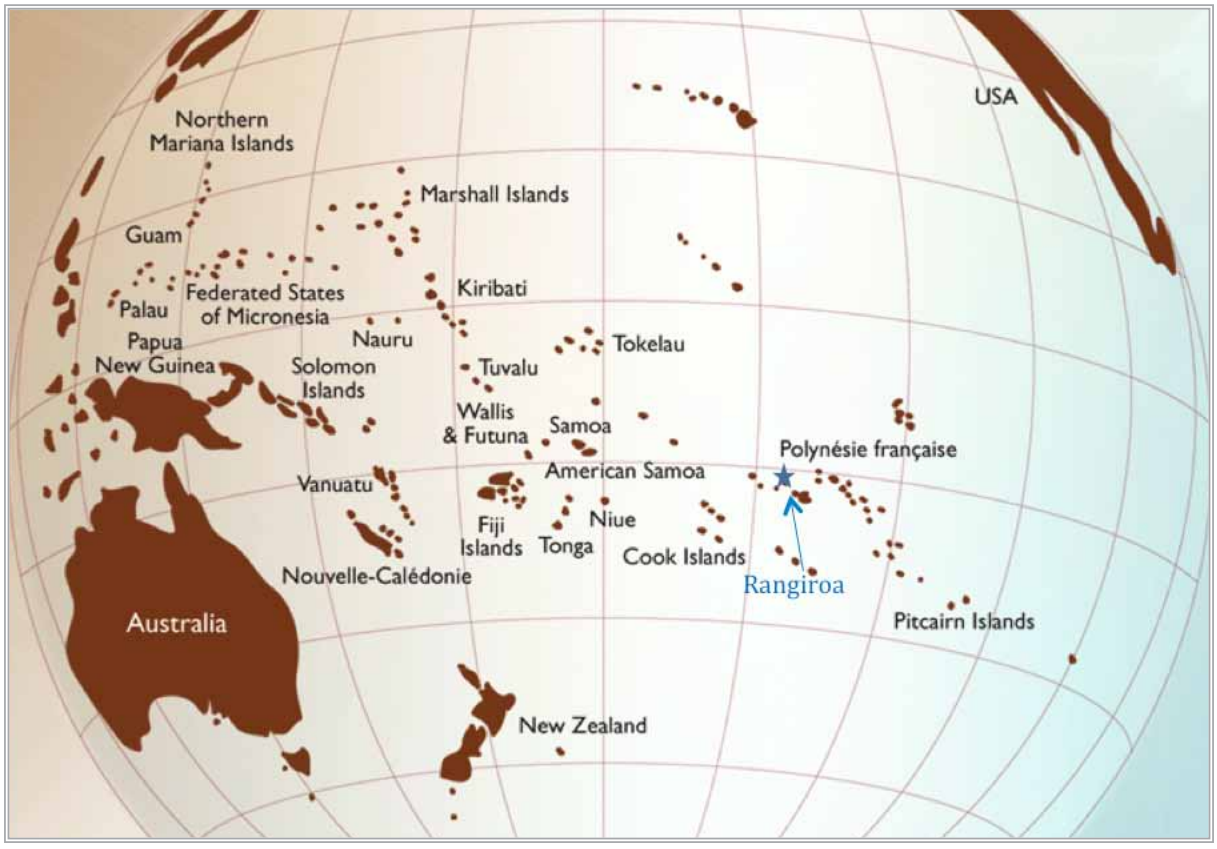


Figure 1. Location of Rangiroa Atoll, French Polynesia.

1 INTRODUCTION

1.1 Background

French Polynesia experiences a variety of major natural hazards, some of which are potentially very damaging to human life, the economy and infrastructure. In response, the country has introduced a risk-prevention policy that regulates development activities, and thereby increases protection for people and property against natural disaster hazards. The partnership programme between the Secretariat of the Pacific Community (SPC) and French Polynesia aims to assess the storm surge hazard in the Tuamotu Archipelago at the atoll scale, so that this hazard can be accurately addressed in future land-use plans.

This programme was jointly implemented by the Service de l'Urbanisme of French Polynesia and the Applied Geoscience Division (SOPAC) of SPC. Under this programme SOPAC carried out a multibeam echosounder (MBES) bathymetry survey of Rangiroa Lagoon and the outer reef slope to a depth of around 300 meters (m).

The objective was to investigate the seabed and provide information about water depths in the lagoon and nearshore areas of Rangiroa Atoll to assist French Polynesia in deriving coastal-related information to underpin and inform storm surge hazard mitigation in the Tuamotu Islands.

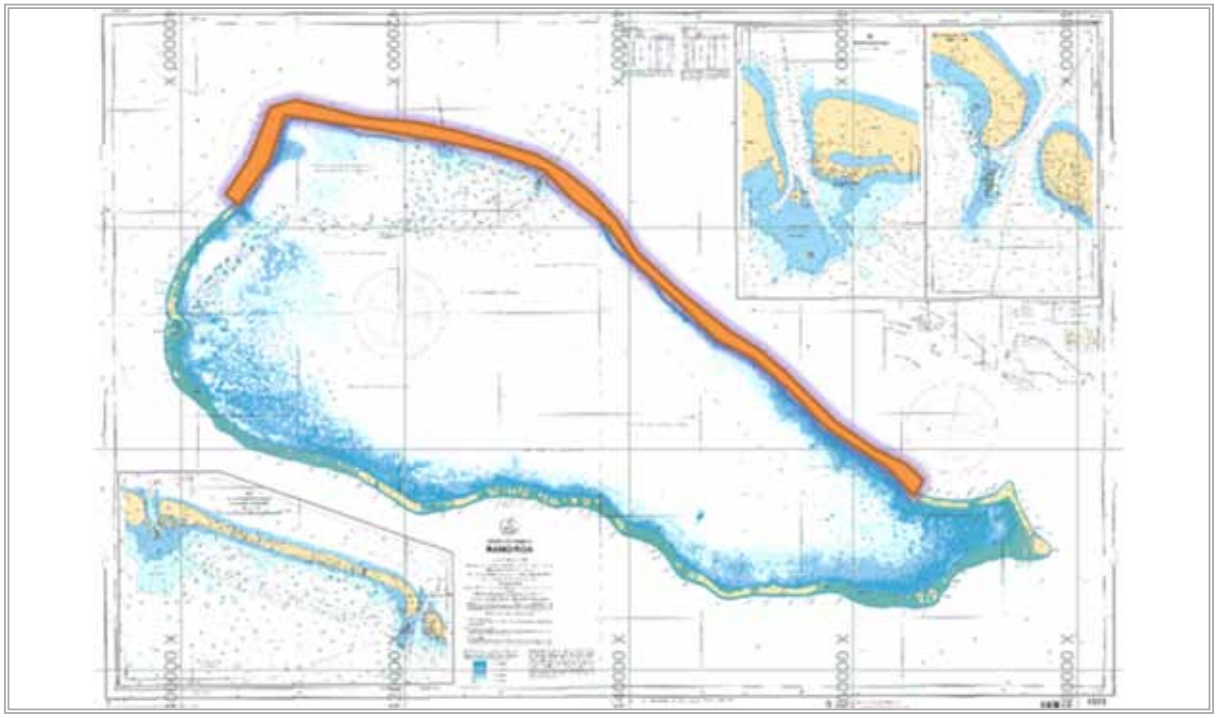


Figure 2. Chart of Rangiroa Atoll, showing the location of the offshore survey areas (excerpt from the Service Hydrographique et Oceanographique de la Marine; publication 1997, edition no. 2, 2002 chart 7373 of Archipel de Tuamotu, Rangiroa).

1.2 Geography

Rangiroa is the largest atoll in the Tuamotus, and one of the largest atolls in the world. It is located about 335 kilometres (km) northeast of Tahiti; the nearest atoll is Tikihau, located 12 km to the west. The main town on Rangiroa is Avatoru, in the northwestern part of the atoll (Figure 3). The atoll consists of about 415 motus, islets and sandbars, with a total land area of about 170 km^2. There are approximately one hundred narrow passages in the fringing reef (called *hoa*). The atoll has a flattened elliptical shape, and is 80 km long and 5–32 km wide. The width of the land is 300–500 m, with a circumference of about 200 km. The lagoon has a maximum depth of 38 m, and a surface area of 1446 km^2.

Only two islands, located on the northern end of the atoll, are permanently inhabited. In 2007, the island had a population of 2,473. The main villages are Avatoru, Tiputa, Ohutu, Taeo'o, Fenuaroa, Otepipi and Tivaru. Avatoru and Tiputa are on neighbouring islands, separated by Tiputa pass, one of the atoll's two major passes (the other is Avatoru pass, immediately to the west of the island of Avatoru).

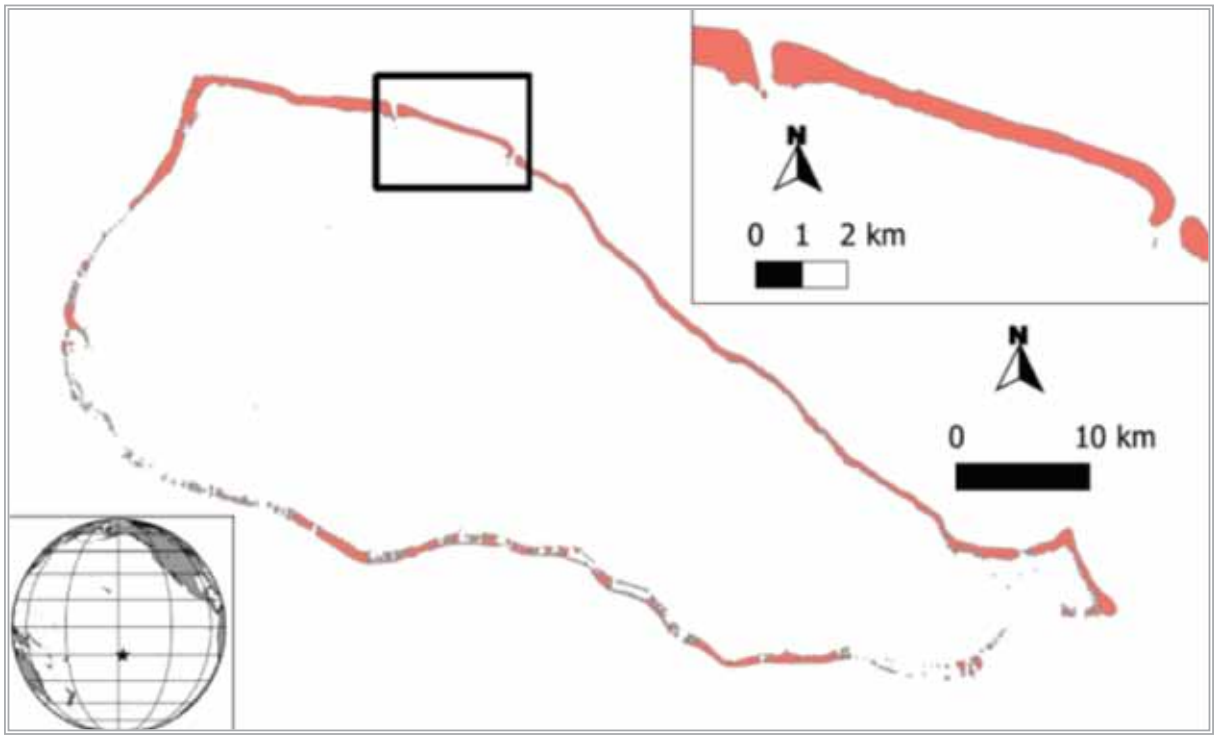


Figure 3. Avatoru, in the northwestern part of Rangiroa Atoll. The islet of Avatoru is bounded by Avatoru pass to the west and Tiputa pass to the east.

Table 1: Summary of the geography of Rangiroa Atoll.

Summary of the geography of Rangiroa Atoll	
Location	Pacific Ocean: 15.12° S 147.64° W
Land Area	The shape of the atoll is a flattened ellipse, extending 80 km from east to west and 32 km from north to south, with an approximate land area of 79 km^2.
Coastline	The lagoon is enclosed by an almost continuous reef flat, with approximately 100 narrow passages in the fringing reefs. The main villages are Avatoru and Tiputa. Avatoru and Tiputa are built on neighbouring islands that are 2.5 km and 4 km in length, respectively, and separated by Tiputa pass, one of the atoll's two major passes (the other is Avatoru pass, immediately to the west of the island of Avatoru). The lagoon has a surface area of about 1,446 km^2 and a maximum depth of 38 m.
Tides	Tides are semi-diurnal with pronounced diurnal inequalities (i.e. two tidal cycles per day of unequal tidal range). Predicted mean range at Rangiroa Atoll is 0.52 m, with a mean spring range of 0.64 m. (Source: tidesandcurrents.noaa.gov/tides10/tab2wc3.html).
Climate	Rangiroa has a humid tropical climate, with two relatively distinct seasons (a wet season from December to March, and a dry season from July to October). Rainfall is lower than would be recorded on a high island in the same location due to the lack of relief. The atoll is influenced by the easterly trade winds. The mean temperature ranges around 25°C, with a daily temperature range of approximately 4°C. The mean temperature is 27°C.

2 RESULTS AND DISCUSSION

2.1 Multibeam bathymetry

In total, 2,118 km of survey lines were run over the 141 days that the vessel was mobilised. A breakdown of data acquisition versus down time is summarised in Figure 5 below, showing that 39% of the time was spent on the acquisition of bathymetric data. The coverage achieved during that time is shown in Figure 5. Further details on line runs can be found in the log sheets attached as Appendix B.

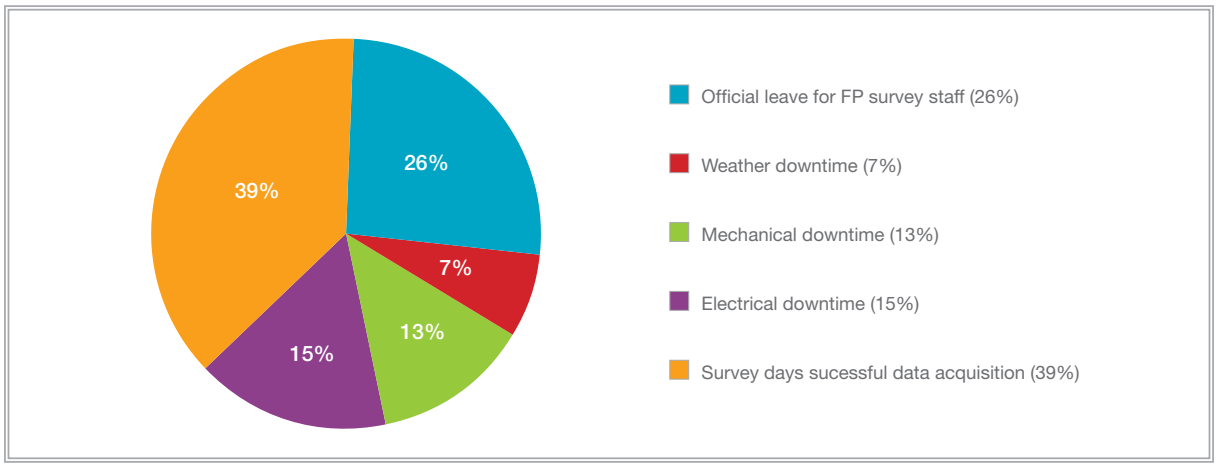


Figure 4: Summary of vessel activity during mobilisation period. The survey vessel Toa Nui was mobilised for a total of 141 days. Data was acquired during 54 survey days (39% of the time). The remainder of the time was spent as official leave for French Polynesia survey staff (26%); weather downtime (7%); mechanical downtime (13%); and electrical downtime (15%).

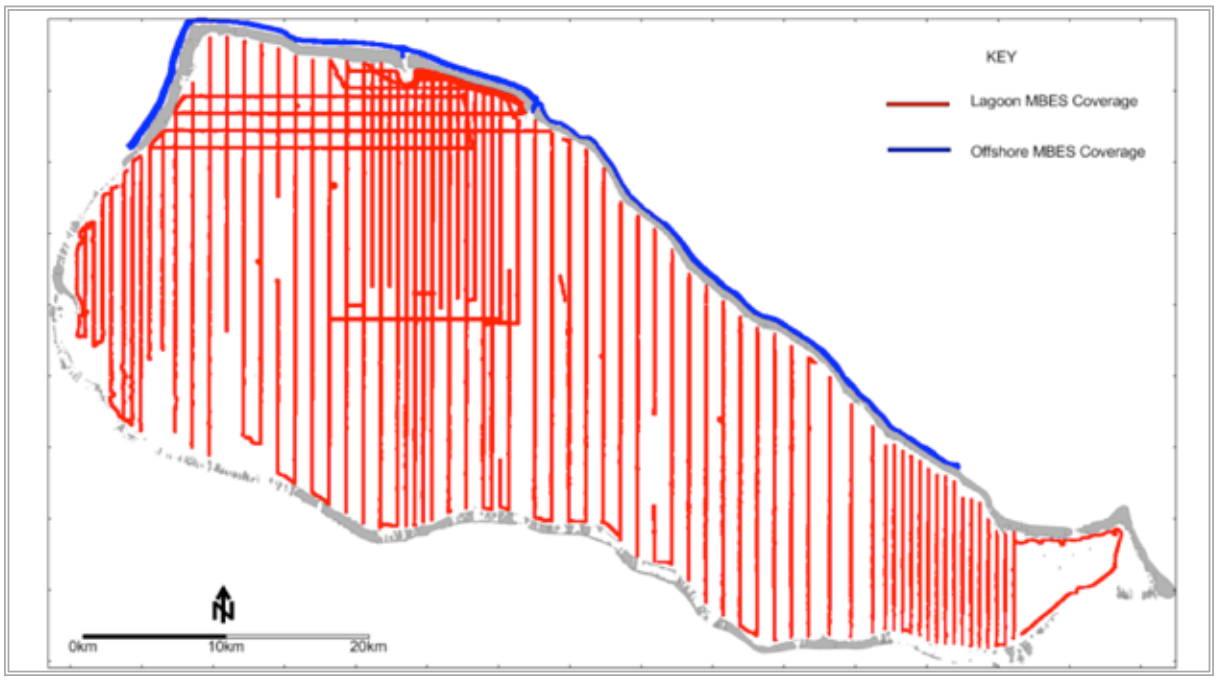


Figure 5: Survey coverage map. Survey lines run inside the lagoon are shown in red, and lines run on the oceanside to the north are shown in blue.

The MBES bathymetry acquired during this study is shown on a chart at a scale of 1:100,000, with contour intervals of 5 m in the lagoon, and 50 m on the nearshore slope. The original chart is drawn to fit an A0 paper size, with a reduced version shown in Figure 6.

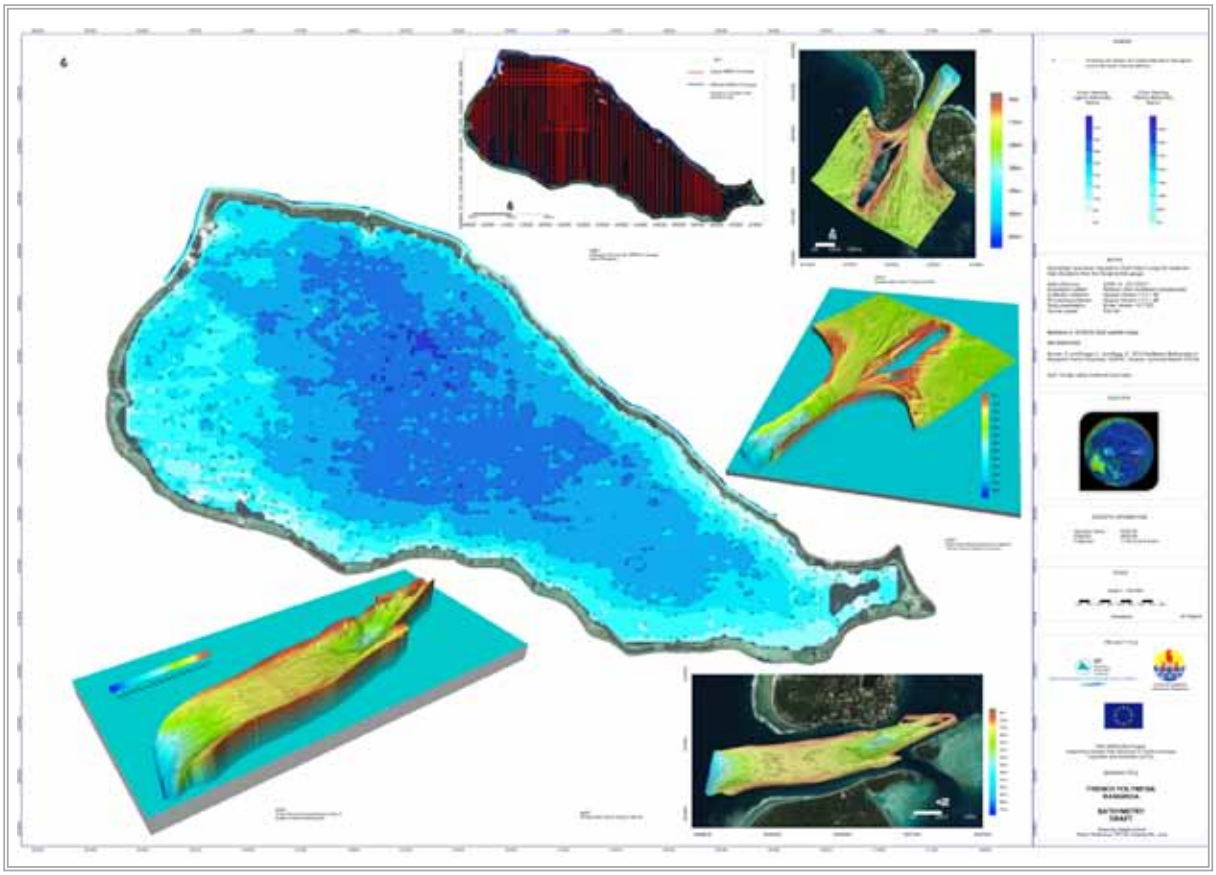


Figure 6: Final bathymetric chart of Rangiroa Atoll (scale 1:100,000 printed at A0).

The nearshore survey area on the ocean side of the reef slope extended from the coast to a water depth of approximately 300 m. Minimum water depths were measured near the coast on the outer slope of the fringing reef, with depths increasing in a general seaward direction at a mean slope angle of 31° toward the offshore limits of the survey area. As expected, the seabed is quite irregular locally, with highly variable slope angles ranging from 0° to 83°.

Bathymetric data provide information on the depth and morphology of the seafloor, as well as the shape and size of submarine features. Bathymetric derivatives (shaded relief maps, and three-dimensional rendered surfaces) can be used in addition to the high resolution bathymetry to aid visual interpretation of the seabed morphology (Figure 7 to Figure 10).

Table 2. Bathymetric derivatives.

Bathymetric derivatives	
Shaded relief	Shaded relief maps use shades of grey to indicate the local orientation of the seafloor relative to a user-defined light source direction. The light source can be thought of as the sun shining on a topographic surface, much like artificial hill shading that illuminates bathymetric roughness. Portions of the surface that face away from the light source reflect less light toward the viewer, and thus appear darker.
Three-dimensional surface	For three-dimensional surfaces, the height of the surface corresponds to the depth of the seafloor.

Figure 7: Shaded relief map of Tiputa channel. Sun illumination angle from the northwest.

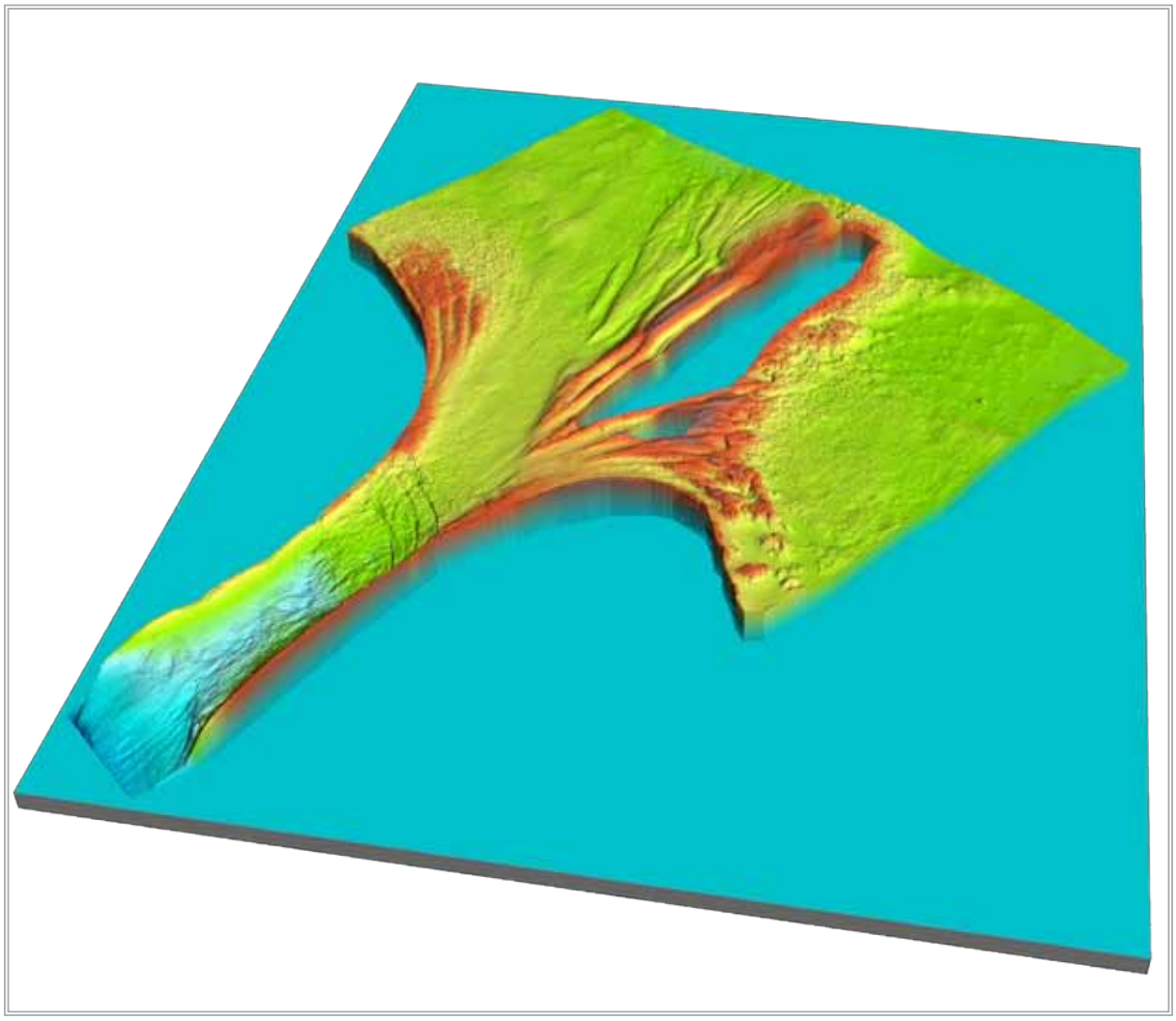


Figure 8: Three-dimensional perspective image of Tiputa channel, looking toward the southeast. Depths shallow (red) to deep (blue), 4x vertical exaggeration.

Figure 9: Shaded relief map of Tiputa channel. Sun illumination angle from the northwest.

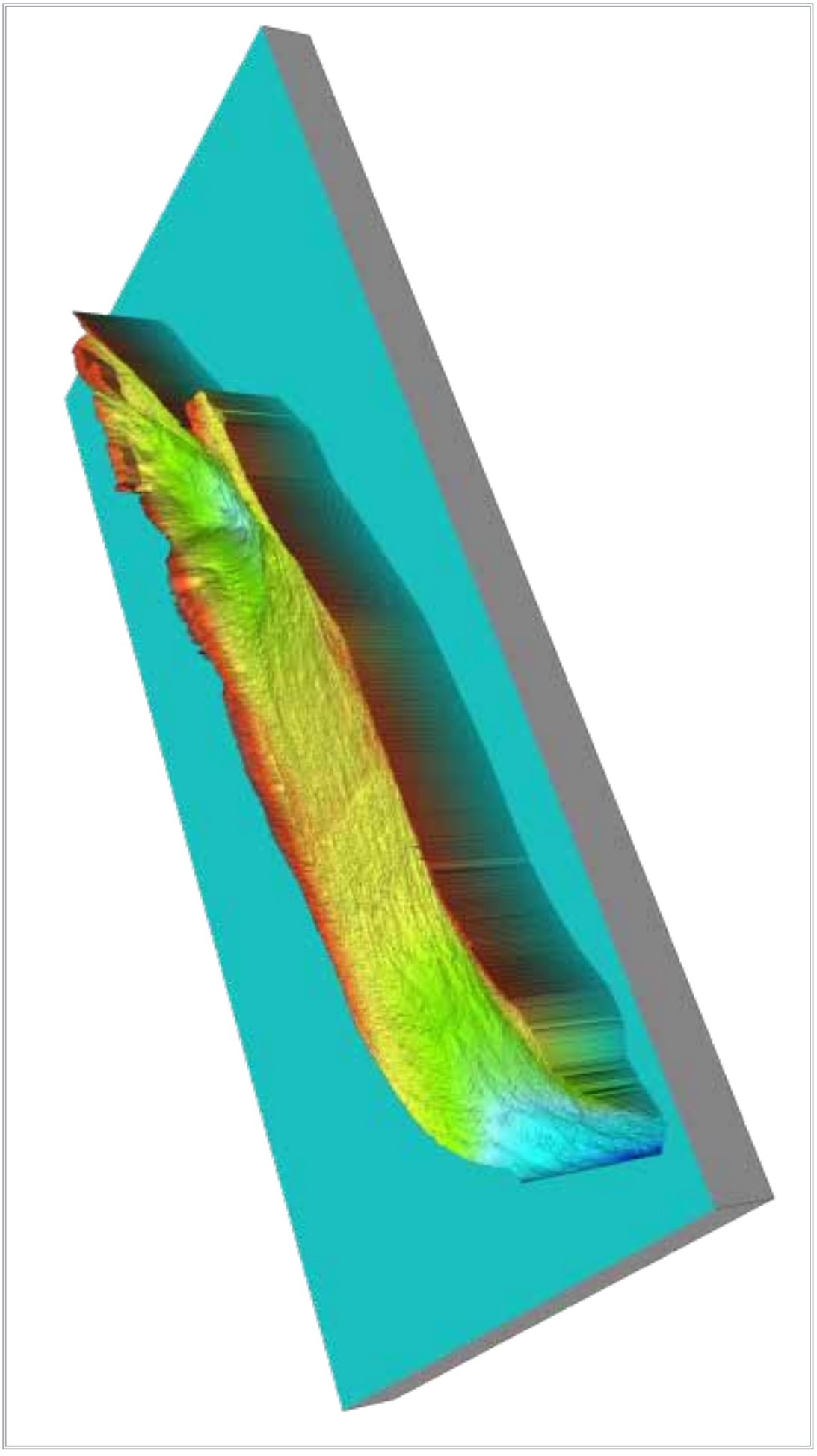


Figure 10: Three-dimensional perspective image of Avatoru channel, looking toward the southeast. Depths shallow (red) to deep (blue), 4x vertical exaggeration.

3 ACQUISITION AND PROCESSING

3.1 Fieldwork summary

Table 3: Survey particulars.

Survey particulars	
Survey vessel	Toa Nui
Fieldwork period	01/08/2011 to 13/12/2011
Equipment used	R2Sonic 2024 multibeam

All dates and times in this report are given in local Tahiti time (Coordinated Universal Time –10).

3.2 Field personnel

Table 4: Personnel

SOPAC	
Jens Kruger	Physical Oceanographer
Salesh Kumar	Senior Technical Assistant
Zulfikar Begg	Senior Technical Assistant
Peni Musunamasi	Electronics Engineer
Avitesh Ram	Electronics Techinician
Maleli Turangabeci	Electronics Techinician
French Polynesia	
Eileen Handerson	Hydrographic Surveyor
Manoël Alvis	Captain

3.3 Geodetic reference system

Survey results were mapped in terms of the following geodetic reference system.

Table 5: Geodetic reference system

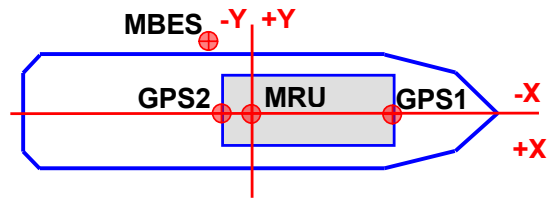
Geodetic reference system		
Geodetic datum	Universal Transverse Mercator Zone 6 South	
Ellipsoid	WGS 84	
	semi-major axis	6378137.000
	flattening (1/f)	298.257223563
	eccentricity sq. (e^2)	
Projection	UTM Zone 6 South	
	projection type	Transverse Mercator
	Central meridian	147 00 00.000W
	Reference latitude	00 00 00.000N
	False easting	500000.000
	False northing	1000000.000

Geodetic reference system		
	Scale factor	0.9996000000
	grid unit	metres
Geodetic transformation	from WGS 84 (GPS satellite datum) to UTM 6 South	
	source coordinate system	WGS 84
	target coordinate system	UTM 6 South
	transformation parameters	
	dX	0.00
	dY	0.00
	dZ	0.00
	rX	0.00000
	rY	0.00000
	rZ	0.00000
	scale	0.00000

3.4 Vessel description and static offsets

Table 6: Vessel description and static offsets

Vessel description and static offsets				
Sensor	X (m)	Y (m)	Z (m)	Not to scale
Reference point at water level	0.00	0.00	0.00	
Motion reference unit (MRU)	0.00	0.00	-0.115	
Positioning antenna (GPS1)	0.00	3.188	2.610	
Multibeam echosounder (MBES)	-1.875	-1.728	0.685	
Vessel				
Name	Toa Nui			
Length overall	9.90 m			
Beam (mid)	3.10 m			
Draft (mid)	0.75 m			
Displacement	3.95 T			
Port of registry	Tahiti			
Radio call sign	FGD7522			
Classification	Motor yacht			



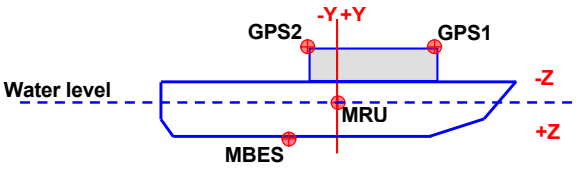


Figure 11: The survey vessel Toa Nui.

3.5 Positioning control and heading

The vessel's origin is the reference by which all devices and tracking points are positioned on the vessel. Each sensor is referenced to the origin based on the distance in survey units. It is starboard (X-direction), forward (Y-direction) and vertical (Z-direction). Vessel offsets are measured from the static water line, and are positive downward (Table 6).

Positioning was by the MarineSTAR 9200 G2H DGNSS dual frequency positioning equipment. The addition of the G2 service provided an accuracy of 0.2 m. The patch test was conducted in Tahiti and again in Rangiroa at the start and end of the survey. The MarineSTAR also provided heading information by use of a second antenna (see GPS2 in diagram of Table 6).

3.6 Survey computer

The survey computer was a Windows XP PC, running Hypack 11.0.1.49. This computer was used for continuous online data logging and computation of positioning and digital bathymetry. The package also provided a line control display for the helm. The online operator continuously monitored a range of quality control parameters.

An off-line Hypack 11.0.1.49 package was used in the office for replaying and post-processing of track data and bathymetry. An A0 plotter was available for the production of charts.

3.7 Multibeam echosounder

A R2Sonic 2024 wideband multibeam echosounder system was temporarily installed on Toa Nui, and used to provide swath bathymetry data. An MBES provided high resolution information about the depth of water from the surface to the seafloor in a water body. The main instrumental and operating parameters are listed below.

Table 7: Multibeam echosounder parameters.

Multibeam echosounder parameters	
Instrumentation	
Multibeam echosounder	R2Sonic 2024
Transducer mount	Port side-mounted
Motion reference unit	TSS DMS 2-05 Dynamic Motion Sensor
Sound velocity probe at transducer	Valeport Mini SV
R2Sonic 2024 System Specification	
Frequency	400 kHz/200 kHz
Beamwidth - across track	0.5° @ 400 kHz / 1.0° @ 200 kHz
Beamwidth - along track	1.0° @ 400 kHz / 2.0° @ 200 kHz
Number of beams	256
Swath sector	10° to 160° (user selectable)
Maximum slant range	500 meters
Pulse length	15 µsec - 1000 µsec
Pulse type	Shaped Continuous Wave (CW)
Depth rating	100 meters
Operating temperature	0° C to 40° C
Dynamic offset calibration	Rangiroa 01 August 2011
Roll correction	-2.09
Pitch correction	0.25
Yaw correction	-2.0
GPS latency correction	0.0

3.8 Multibeam echosounder data processing

Hypack 11.0.1.49 software was used for post-processing the MBES survey data. The production of contour maps was done using Surfer 10.7.972 software. The processing and gridding sequences are listed below.

Table 8: Data processing.

Data processing	
Post-processing sequence	
Phase 1	Tide (water level) and sound velocity corrections.
Phase 2	Search and filter options are used for editing the data. Removed poor-quality beams (quality <3) and outliers from individual survey lines.
Phase 3	Applied 4th standard deviation filter to remove outliers from median depth. Further manual cleaning of outliers.
Output	ASCII XYZ file using actual positions of median sounding depths in the project coordinate system.
Map Production Sequence	
Input	XYZ output data from Hypack reduced to 1 mm at charting scale (e.g. 50 m-grid size for a chart at 1:50 000).
Surface model	XYZ output data were gridded using the Kriging method in Surfer 10.7.972. Data gaps were interpolated using three times the survey line spacing.
Output	DXF contours, PDF chart, backdrop images, and DTM model in the project coordinate system. See Appendix C

Various levels of smoothing were applied to the contours and digital terrain model (DTM) to give a more realistic impression of the seabed without removing any real features from the dataset. However, due to the fact that the majority of survey lines were oriented from north to south, some striping can be observed on the final gridded and interpolated dataset.

3.9 Tidal information

Observed soundings were reduced to the chart datum using the observed tidal elevations from the Rangiroa tide gauge. The table below details the station metadata.

Table 9: Tidal station metadata.

Tidal station metadata	
Code	rangi
Country	France
Location	Rangiroa Atoll (Tuamotu, French Polynesia)
Status	Operational
Local contact	University of French Polynesia (France)
Other contact	Service Hydrographique et Océanographique de la Marine (France)
Latitude	-14.945834667°
Longitude	-147.706037917°
Connection	GTS message
GTS message type	SEHI40
Sensor 1	
Type of sensor	Pressure
Sampling rate (min)	2
Sensor 2	
Type of sensor	Radar
Sampling rate (min)	2

The tide data were obtained from the Intergovernmental Oceanographic Commission website (www.ioc-sealevelmonitoring.org). Data on this website are not reduced to chart datum and a correction of -5.945 m was, therefore, applied to the pressure sensor values (Marie Protat, Service Hydrographique et Océanographique de la Marine, pers. comm.).

3.10 Sound velocity profiling

The accuracy of the depth soundings depends in part on the variation of the speed of sound with water depth. Sound velocity profiles are, therefore, required in order to find the correct depth and location of water depth soundings. The speed of sound in seawater varies with temperature, salinity and depth, and was determined by measuring the conductivity, temperature and depth (CTD) through the water column. The main instrumental, operational, and processing parameters are listed below.

Table 10: Sound velocity profiling.

Sound velocity profiling	
CTD instrumentation	
Make	SeaBird Electronics
Model	SeaCat 19 (self-powered, self-contained)
Serial number	2795
Depth rating	3,000 m
Operating parameters	
Sample rate	1 scan every 0.5 s
Maximum depth	Limited to 200 m due to rope length
Data recorded	Profiles of conductivity, temperature, and pressure

Sound velocity profiling	
Data processing	
Positioning	The profile position was taken at the GPS attenna near the start of the downcast. No allowance was made for instrument or vessel drift over the duration of the profile, which may be significant (>50 m).
Data conversion	Convert raw data (.hex) to a .cnv file. The following values are output from the recorded data: • Pressure, dbar • Depth, m (derived using salt water at local latitude) • Temperature, °C (ITS-90) • Salinity, psu (derived) • Density, kg m^{-3} (derived) • Sound velocity, m s^{-1} (derived using Chen and Millero 1977)
Bin average	Average data into 1 m depth bins. No filtering was applied.
Output	Processed data is saved in ASCII text format with the date_bin.cnv.

The CTD profile details are listed below, with locations plotted in Figure 12. Summaries of the CTD profile data in graphical form are shown in Appendix A.

Table 11: CTD profile details.

CTD profile details					
CTD casts	Date	Time	Easting	Northing	Depth (m)
CTD cast 1	03/08/2011	12:43	426531.13	8340621.39	33
CTD cast 2	04/08/2011	09:55	425275.8	8331685.1	36
CTD cast 3	05/08/2011	10:21	420512.09	8330968.56	28
CTD cast 4	07/08/2011	09:22	432057.4	8329436.6	30
CTD cast 5	09/08/2011	14:11	431340.36	8344030.48	24
CTD cast 6	10/08/2011	10:32	409312.33	8345559.75	21
CTD cast 7	11/08/2011	12:36	420998.66	8343142.51	26.5
CTD cast 8	12/08/2011	11:29	427526.12	8316849.16	30
CTD cast 9	14/08/2011	11:11	432533.56	8324540.37	29
CTD cast 10	15/08/2011	13:02	434920.94	8330379.36	28
CTD cast 11	16/08/2011	13:20	437263.4	8327419.46	30
CTD cast 12	17/08/2011	12:19	437217.61	8331051.16	28
CTD cast 13	18/08/2011	11:40	424091.38	8323799.33	32
CTD cast 14	21/08/2011	12:57	428359.4	8337199.26	35
CTD cast 15	23/08/2011	11:36	421610.51	8326826.94	28
CTD cast 16	24/08/2011	14:18	418133.35	8329982.81	26
CTD cast 17	29/08/2011	11:14	422875.24	8331083.36	34
CTD cast 18	30/08/2011	12:15	415776.73	8339525.67	30
CTD cast 19	31/08/2011	12:56	424817.61	8317423.33	23
CTD cast 20	02/09/2011	12:26	413363.27	8340145.3	28
CTD cast 21	06/09/2011	15:08	408572.34	8331638.08	18
CTD cast 22	07/09/2011	13:46	404925.64	8330558.14	18
CTD cast 23	12/09/2011	14:52	413311.2	8326739.73	29
CTD cast 24	13/09/2011	15:08	403635.08	8338633.92	20
CTD cast 25	14/09/2011	14:15	424126.64	8323178.7	33
CTD cast 26	15/09/2011	15:00	405023.4	8332326.78	19
CTD cast 27	16/09/2011	14:12	428969.21	8329763.81	30
CTD cast 28	27/09/2011	12:23	440949.31	8316954.74	26

CTD profile details					
CTD casts	Date	Time	Easting	Northing	Depth (m)
CTD cast 29	28/09/2011	13:18	443324.1	8320040.9	28
CTD cast 30	29/09/2011	14:10	444518.64	8324167.72	26
CTD cast 31	30/09/2011	12:30	430061.84	8320207.8	24
CTD cast 32	02/10/2011	13:45	466090.56	8312398.3	18
CTD cast 33	03/10/2011	14:08	464903.84	8310158.54	20
CTD cast 34	04/10/2011	12:32	463123.96	8310708.03	21
CTD cast 35	05/10/2011	13:02	446952.08	8319763.98	30
CTD cast 36	06/10/2011	13:30	449327.49	8318668.29	21
CTD cast 37	21/10/2011	12:12	451430.21	8310854.65	22
CTD cast 38	24/10/2011	10:50	462446.17	8314483.54	20
CTD cast 39	25/10/2011	13:26	460758.87	8313003.51	20
CTD cast 40	26/10/2011	13:02	459519.88	8312249.52	25
CTD cast 41	17/11/2011	10:30	421152.22	8332210.94	29
CTD cast 42	21/11/2011	13:53	457106.55	8312252.72	25
CTD cast 43	02/12/2011	13:28	430742.37	8342447.75	28
CTD cast 44	04/12/2011	13:20	432240.72	8343765.42	21
CTD cast 45	05/12/2011	13:55	453208.77	8317452.41	27
CTD cast 46	06/12/2011	13:28	406060.54	8344844.12	97
CTD cast 47	07/12/2011	13:20	406463.13	8336766.05	25
CTD cast 48	08/12/2011	12:30	462331.51	8319638.97	196
CTD cast 49	09/12/2011	13:35	426616.45	8347802.18	113
CTD cast 50	09/12/2011	13:20	431428.95	8344416.16	24
CTD cast 51	11/12/2011	13:28	427385.84	8346591.48	18
CTD cast 52	12/12/2011	10:53	427394.9	8346604.19	18

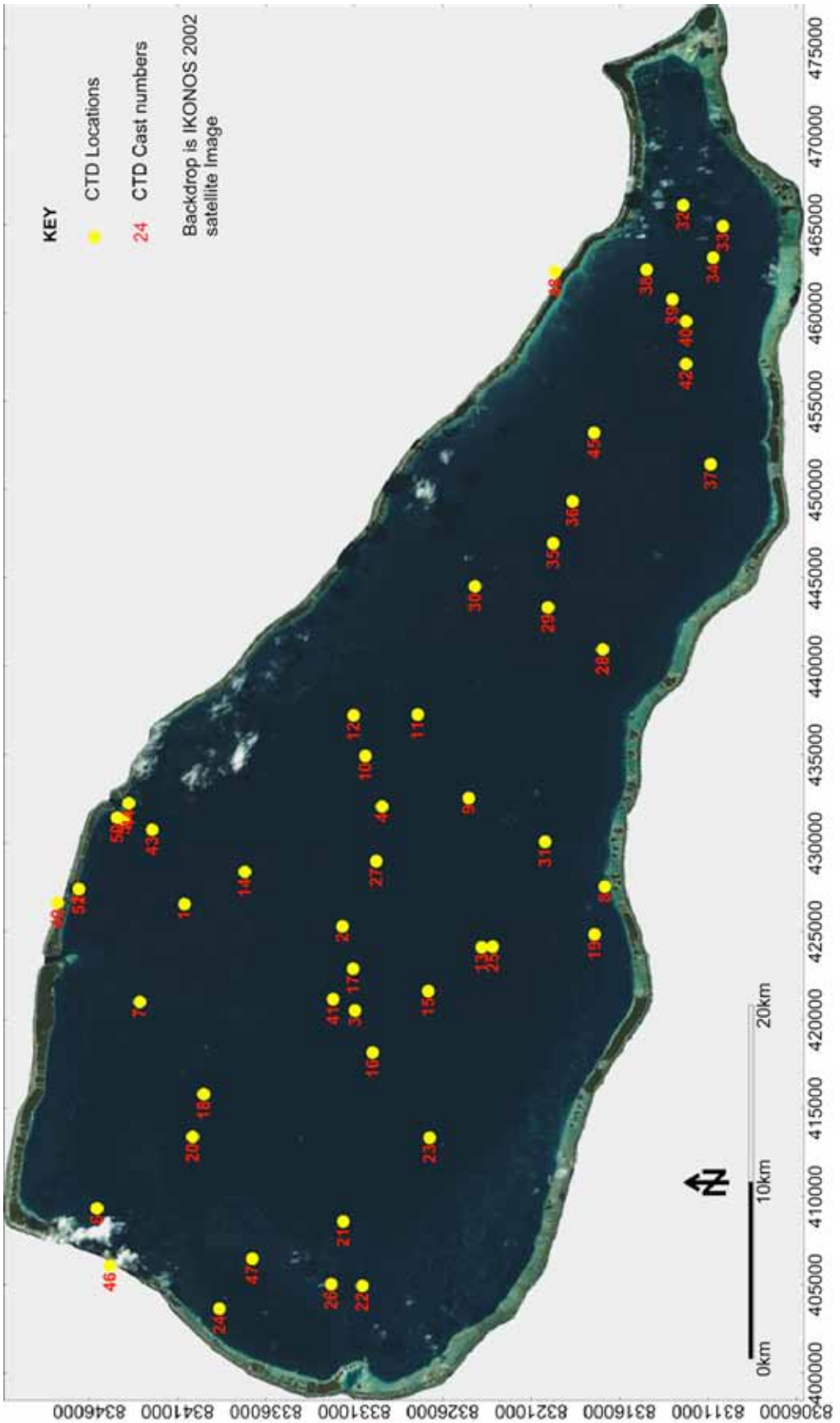


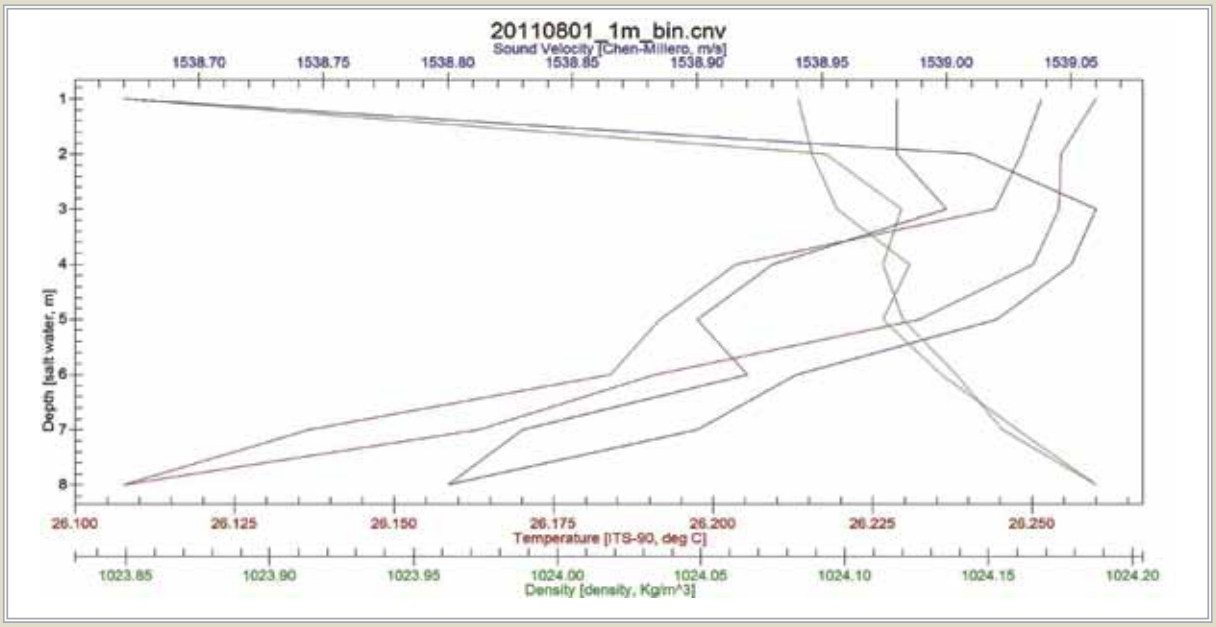
Figure 12: Location of conductivity, temperature and depth (CTD) profiles for Rangiroa Atoll. Locations of CTD casts are shown by yellow circles and the cast number is indicated by the red number. The backdrop is a 2002 IKONOS satellite image.

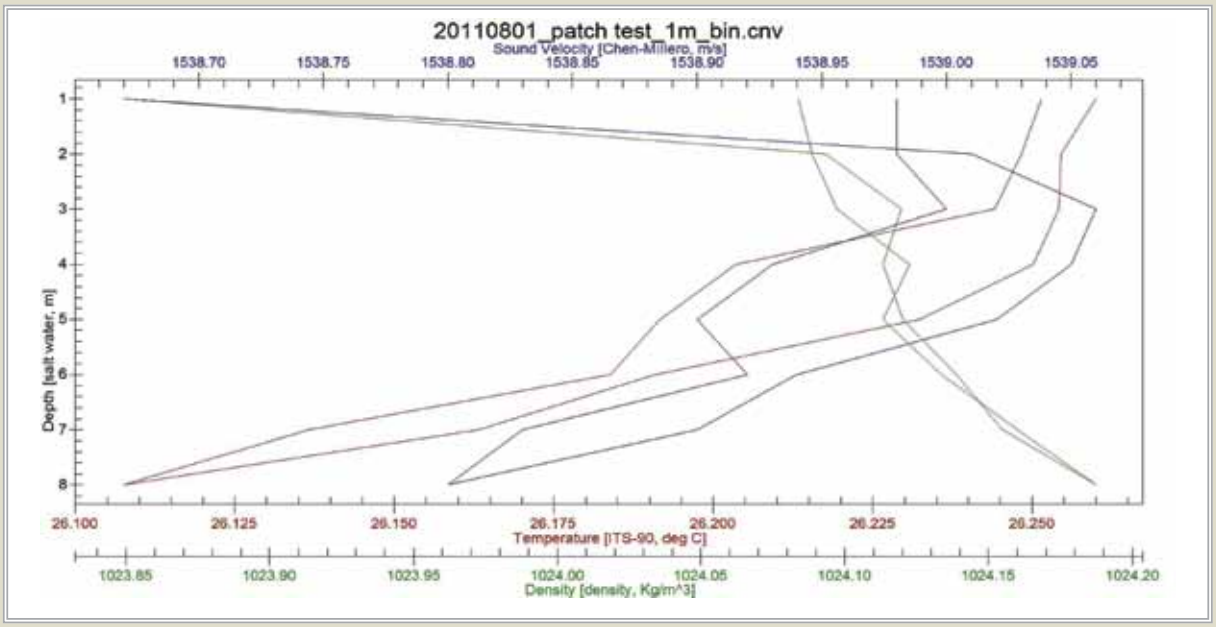
4 APPENDICES

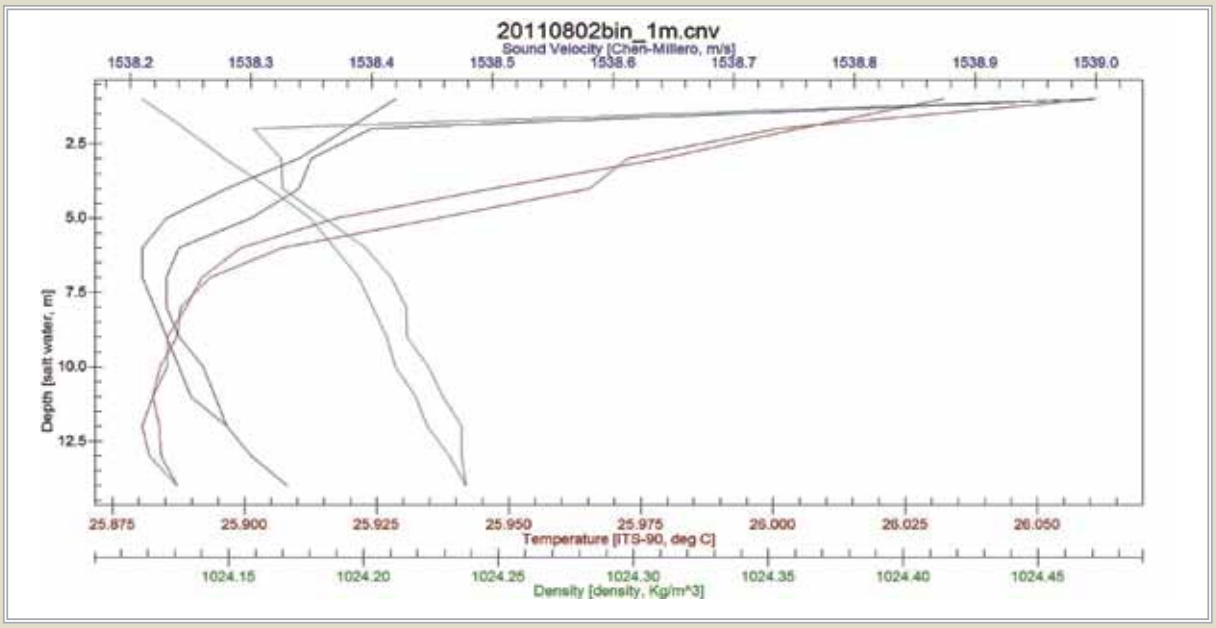
Appendix A: Conductivity, Temperature and Depth (CTD) profiles

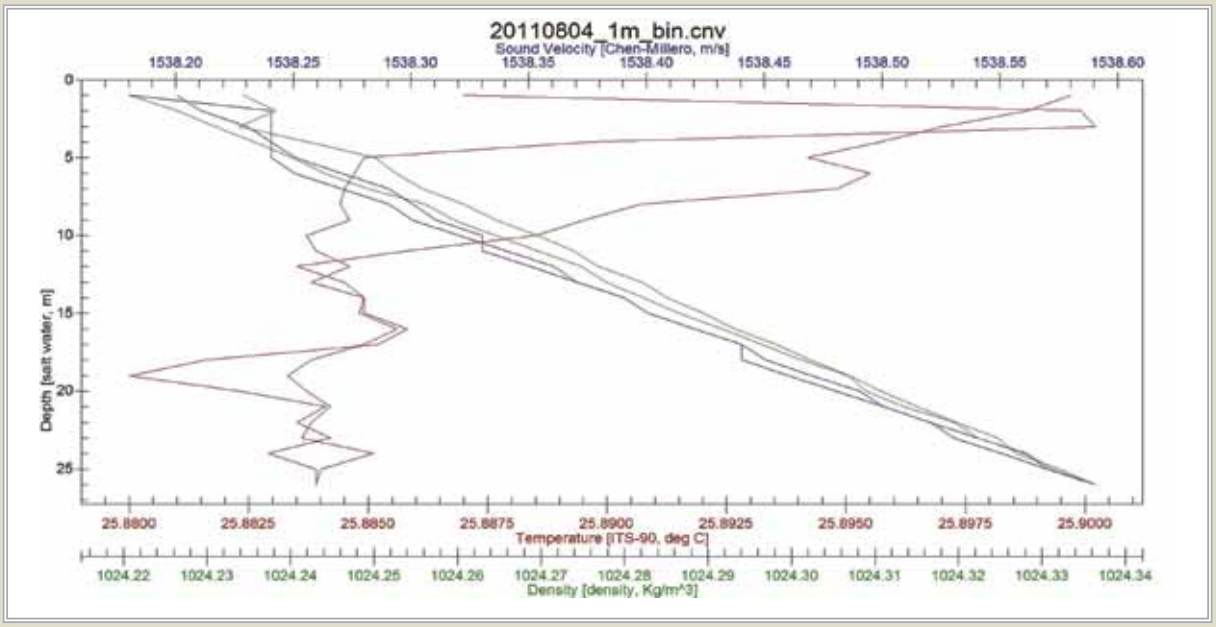
This appendix shows plots of the CTD profiles. Both downcast and upcast are shown. The title of each plot indicates the date on which the cast was done year, month, and date format (yyyymmdd). Please refer to Table 11 and Figure 12 for numbering and locations.

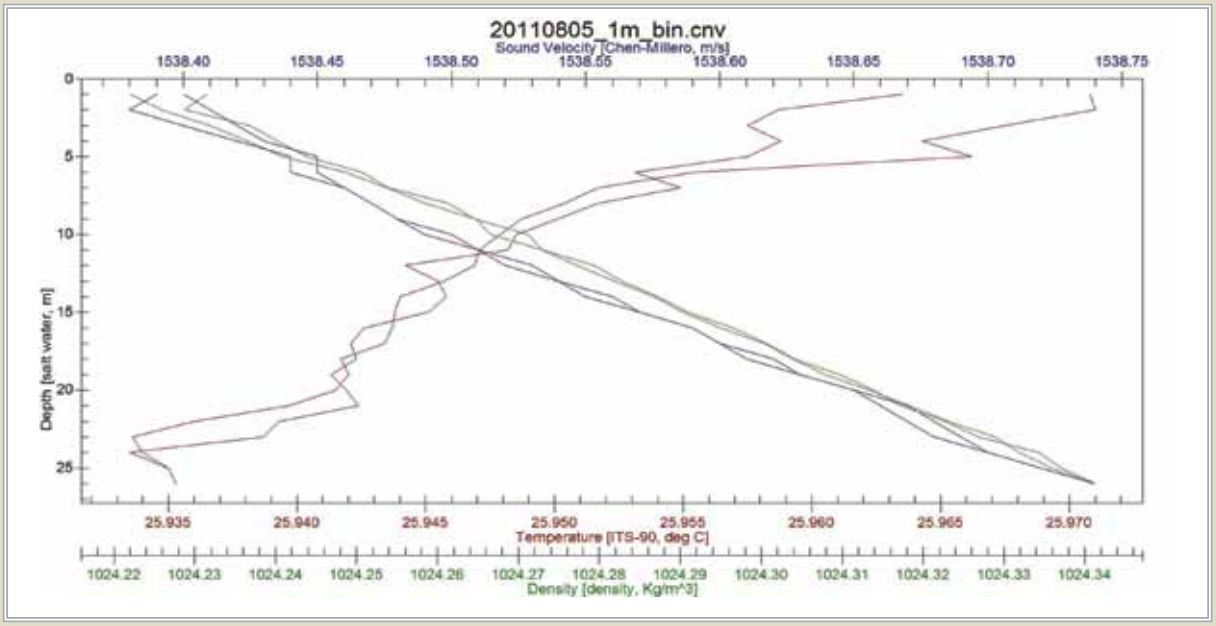
The plots consist of three x-axis and one y-axis. The y-axis shows depth in metres. The different x-axis show sound velocity, temperature and density as follows: the first x-axis at the top of the plot shows sound velocity in m/s (blue labels and line); the second x-axis under the plot shows temperature in degrees Celcius (red labels and line); and the third x-axis at the bottom of the plot shows Density in kg/m^3 (green labels and line).

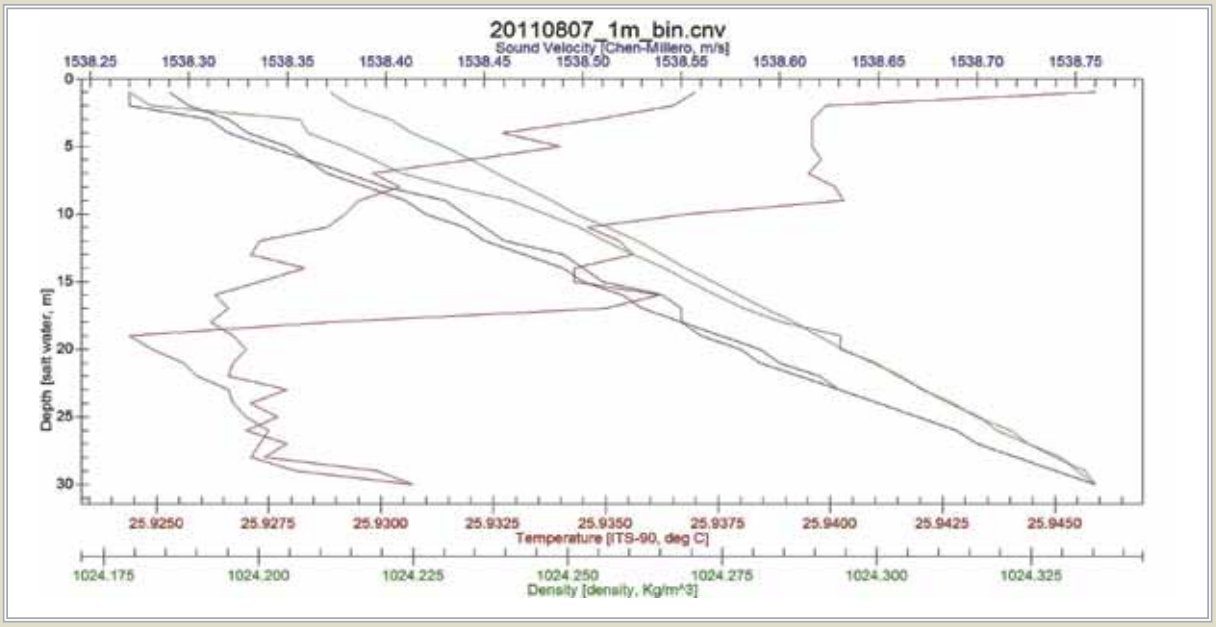

20110801_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.70
1538.75
1538.80
1538.85
1538.90
1538.95
1539.00
1539.05
Depth [salt water, m]
1
2
3
4
5
6
7
8
26.100
26.125
26.150
26.175
26.200
26.225
26.250
Temperature [ITS-90, deg C]
1023.85
1023.90
1023.95
1024.00
1024.05
1024.10
1024.15
1024.20
Density [density, Kg/m^3]

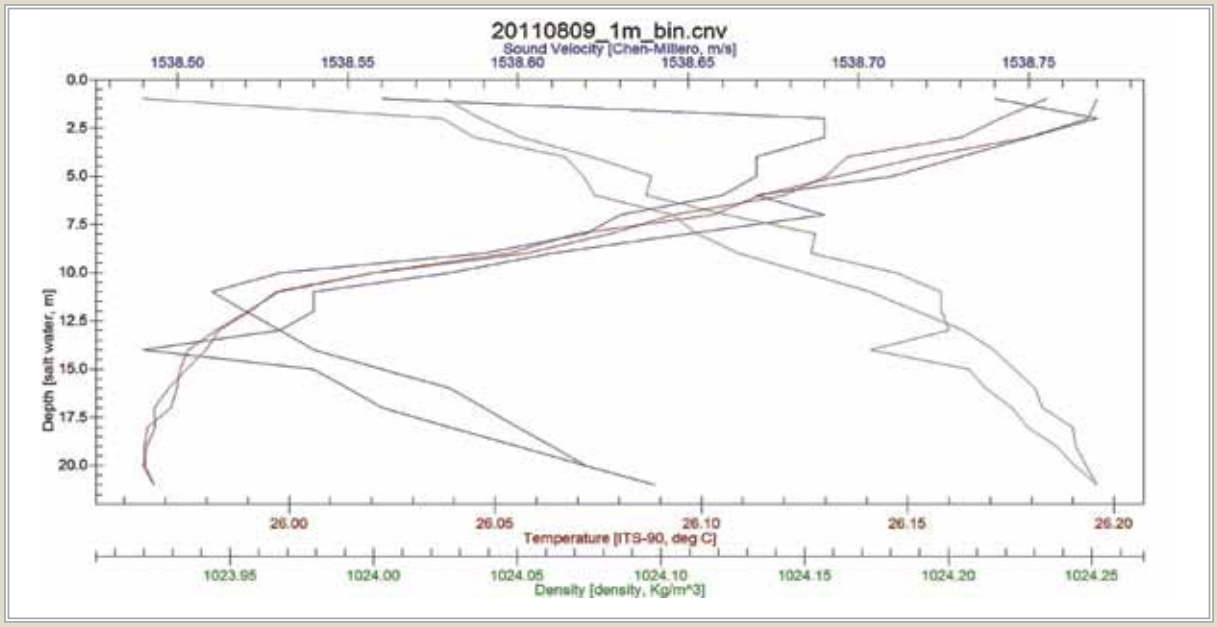

20110801_patch test_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.70
1538.75
1538.80
1538.85
1538.90
1538.95
1539.00
1539.05
Depth [salt water, m]
1
2
3
4
5
6
7
8
26.100
26.125
26.150
26.175
26.200
26.225
26.250
Temperature [ITS-90, deg C]
1023.85
1023.90
1023.95
1024.00
1024.05
1024.10
1024.15
1024.20
Density [density, Kg/m^3]

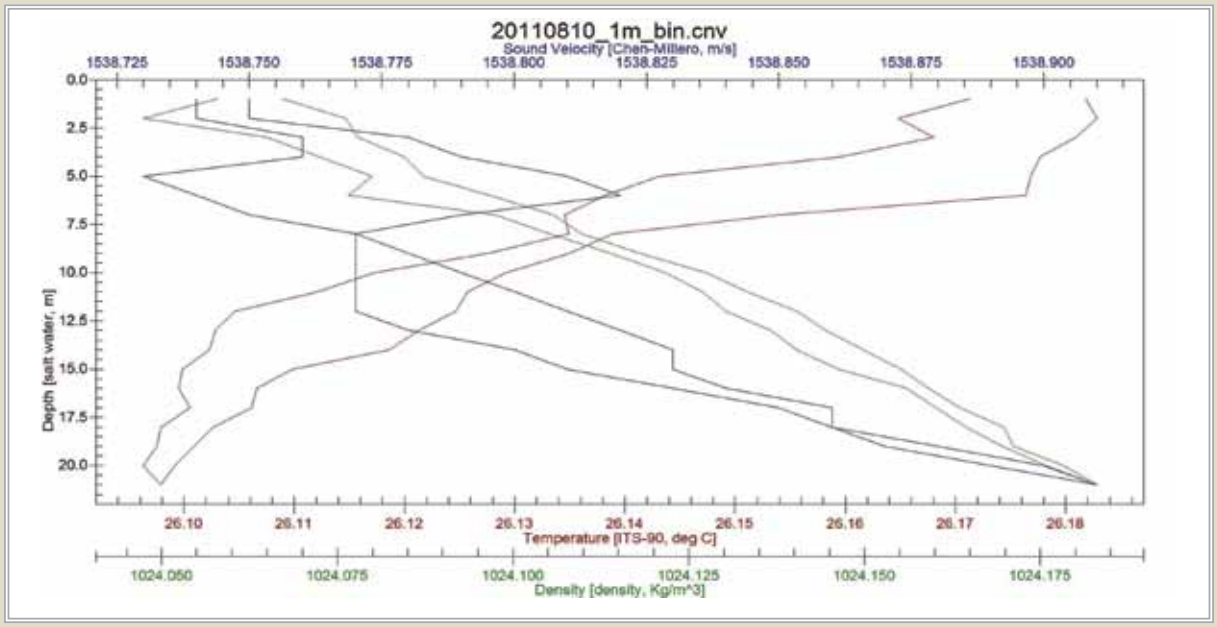

20110802bin_1m.cnv
Sound Velocity [Chen-Millero, m/s]
1538.2
1538.3
1538.4
1538.5
1538.6
1538.7
1538.8
1538.9
1539.0
Depth [salt water, m]
2.5
5.0
7.5
10.0
12.5
25.875
25.900
25.925
25.950
25.975
26.000
26.025
26.050
Temperature [ITS-90, deg C]
1024.15
1024.20
1024.25
1024.30
1024.35
1024.40
1024.45
Density [density, Kg/m^3]

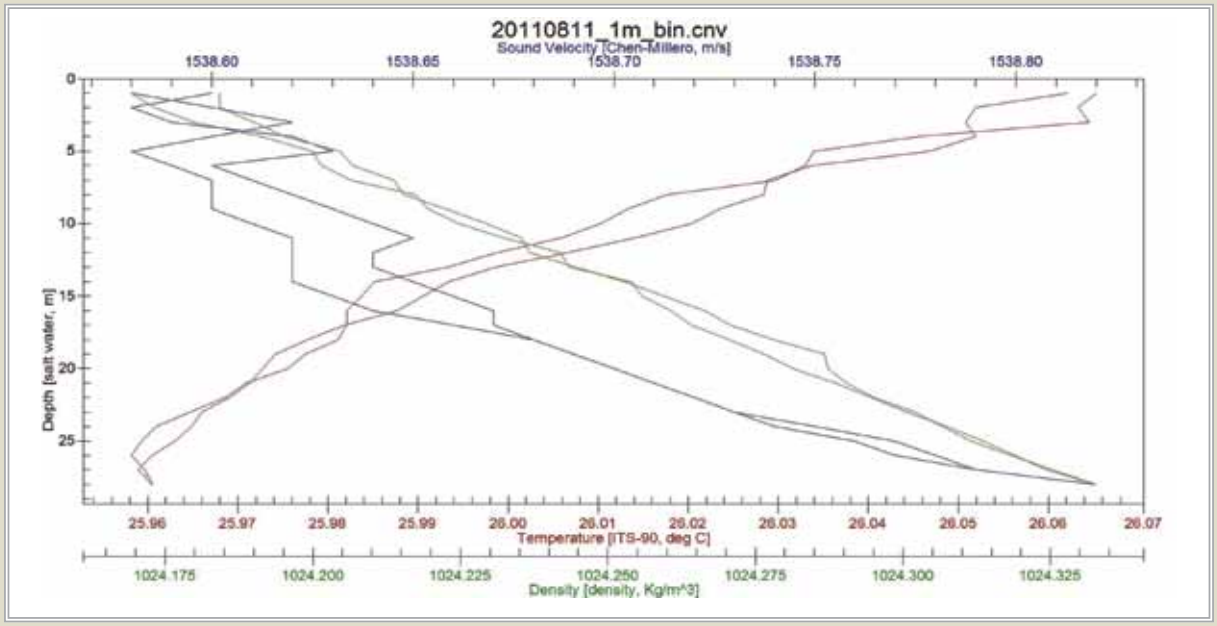

20110804_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.20 1538.25 1538.30 1538.35 1538.40 1538.45 1538.50 1538.55 1538.60
Depth [salt water, m]
0 5 10 15 20 25
25.8800 25.8825 25.8850 25.8875 25.8900 25.8925 25.8950 25.8975 25.9000
Temperature [ITS-90, deg C]
1024.22 1024.23 1024.24 1024.25 1024.26 1024.27 1024.28 1024.29 1024.30 1024.31 1024.32 1024.33 1024.34
Density [density, Kg/m^3]

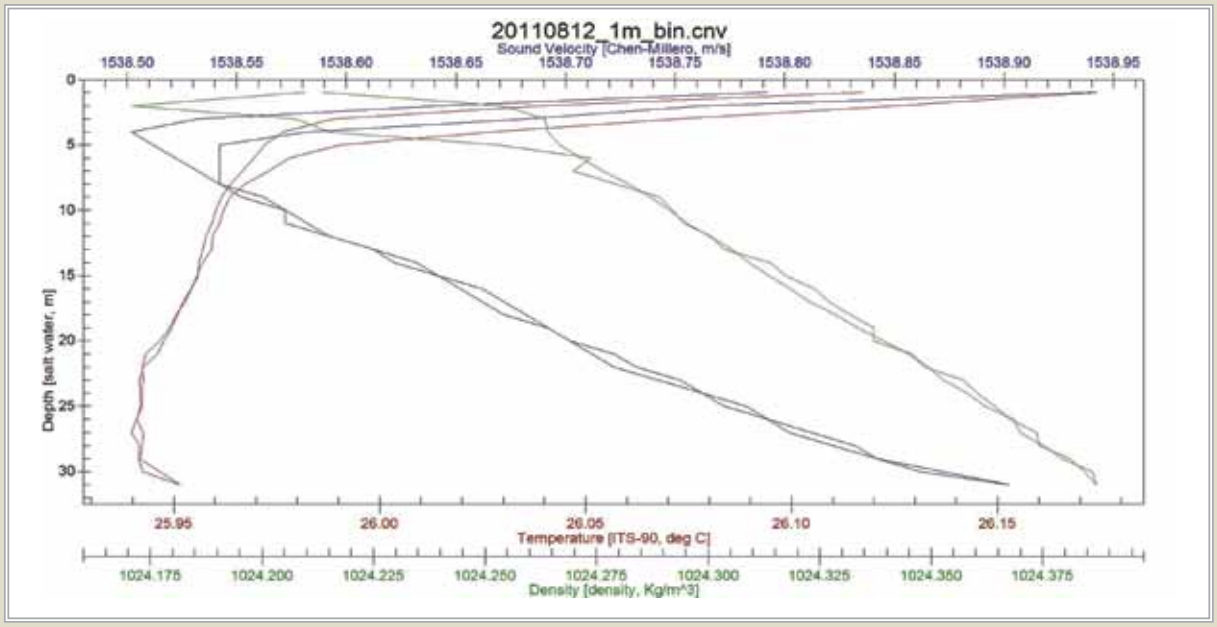

20110805_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.40 1538.45 1538.50 1538.55 1538.60 1538.65 1538.70 1538.75
Depth [salt water, m]
0 5 10 15 20 25
25.935 25.940 25.945 25.950 25.955 25.960 25.965 25.970
Temperature [ITS-90, deg C]
1024.22 1024.23 1024.24 1024.25 1024.26 1024.27 1024.28 1024.29 1024.30 1024.31 1024.32 1024.33 1024.34
Density [density, Kg/m^3]

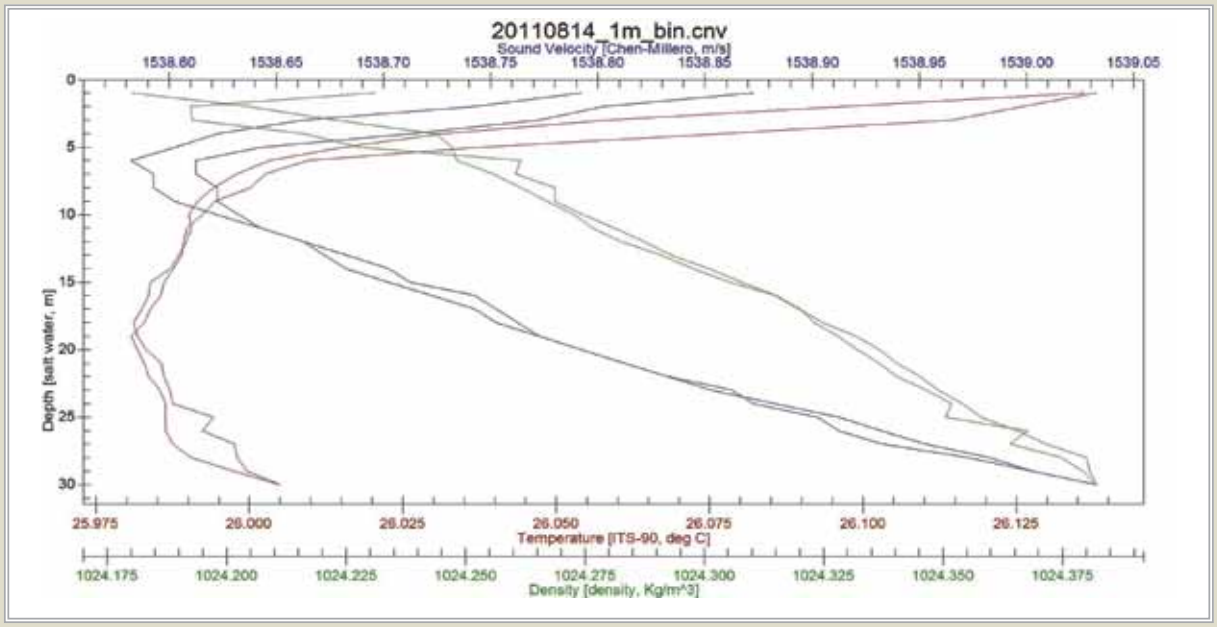

20110807_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.25 1538.30 1538.35 1538.40 1538.45 1538.50 1538.55 1538.60 1538.65 1538.70 1538.75
Depth [salt water, m]
0 5 10 15 20 25 30
25.9250 25.9275 25.9300 25.9325 25.9350 25.9375 25.9400 25.9425 25.9450
Temperature [ITS-90, deg C]
1024.175 1024.200 1024.225 1024.250 1024.275 1024.300 1024.325
Density [density, Kg/m^3]

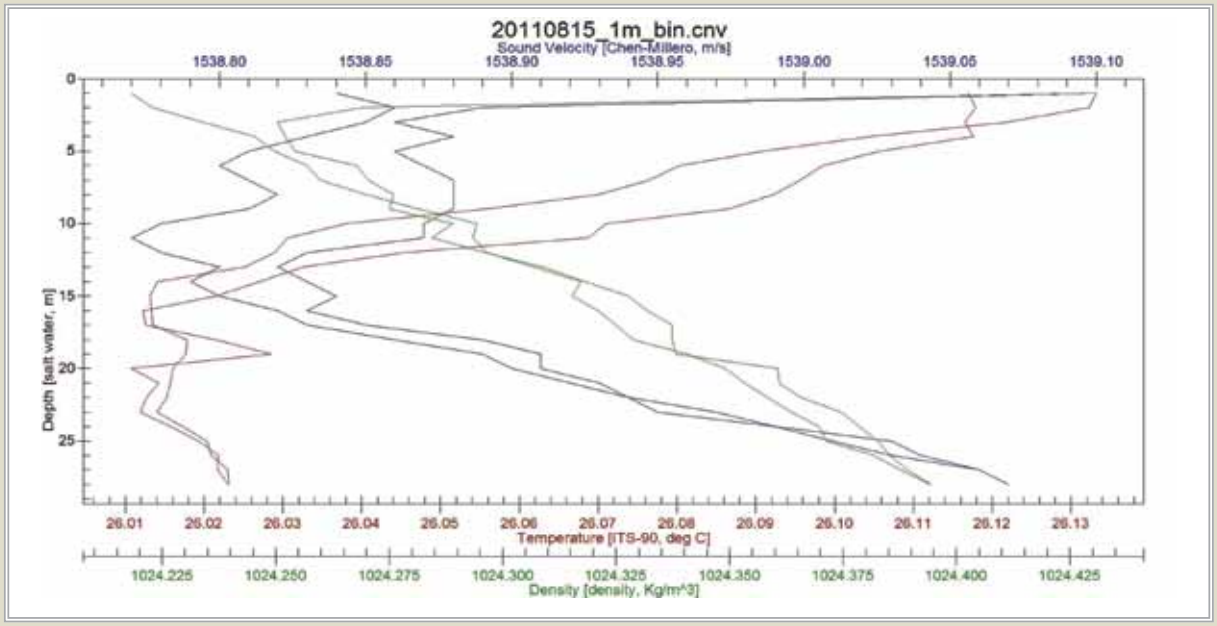

20110809_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.50
1538.55
1538.60
1538.65
1538.70
1538.75
Depth [salt water, m]
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
26.00
26.05
26.10
26.15
26.20
Temperature [ITS-90, deg C]
1023.95
1024.00
1024.05
1024.10
1024.15
1024.20
1024.25
Density [density, Kg/m^3]

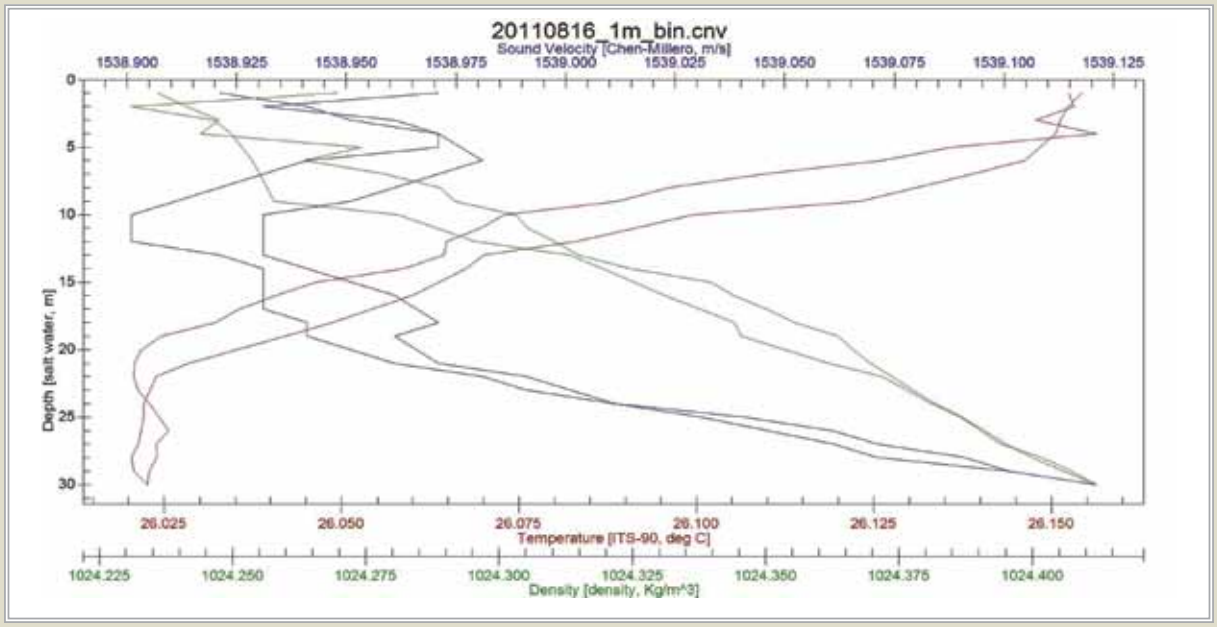

20110810_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.725
1538.750
1538.775
1538.800
1538.825
1538.850
1538.875
1538.900
Depth [salt water, m]
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
26.10
26.11
26.12
26.13
26.14
26.15
26.16
26.17
26.18
Temperature [ITS-90, deg C]
1024.050
1024.075
1024.100
1024.125
1024.150
1024.175
Density [density, Kg/m^3]

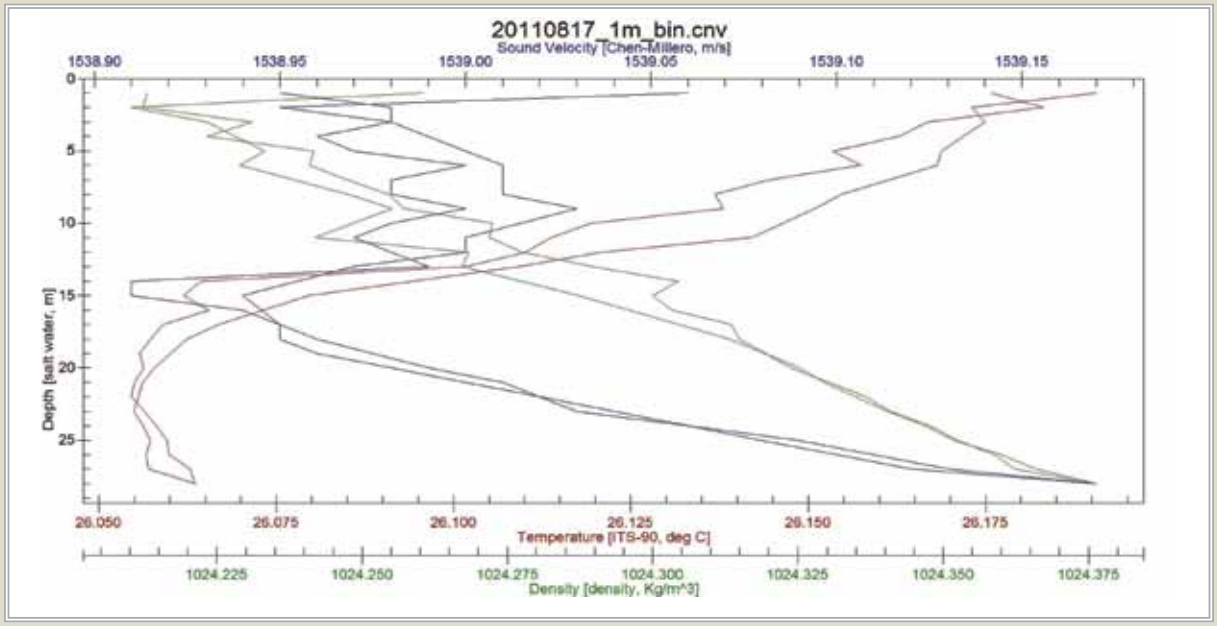

20110811_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.60
1538.65
1538.70
1538.75
1538.80
Depth [salt water, m]
0
5
10
15
20
25
25.96
25.97
25.98
25.99
26.00
26.01
26.02
26.03
26.04
26.05
26.06
26.07
Temperature [ITS-90, deg C]
1024.175
1024.200
1024.225
1024.250
1024.275
1024.300
1024.325
Density [density, Kg/m^3]

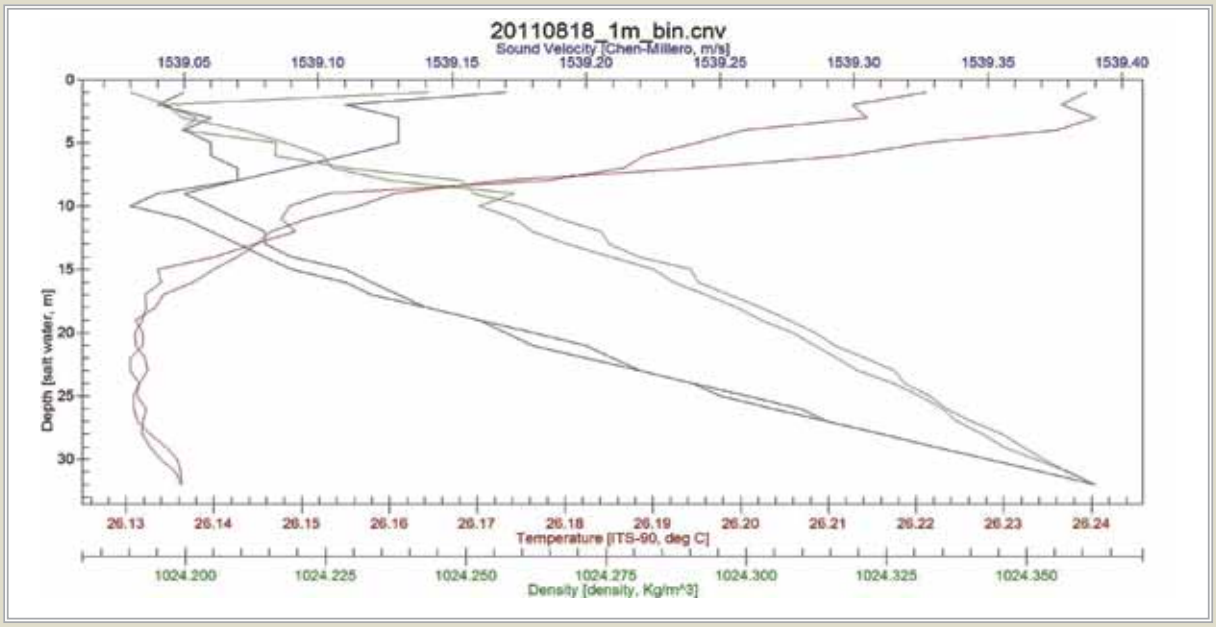

20110812_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.50 1538.55 1538.60 1538.65 1538.70 1538.75 1538.80 1538.85 1538.90 1538.95
Depth [salt water, m]
0 5 10 15 20 25 30
25.95 26.00 26.05 26.10 26.15
Temperature [ITS-90, deg C]
1024.175 1024.200 1024.225 1024.250 1024.275 1024.300 1024.325 1024.350 1024.375
Density [density, Kg/m^3]

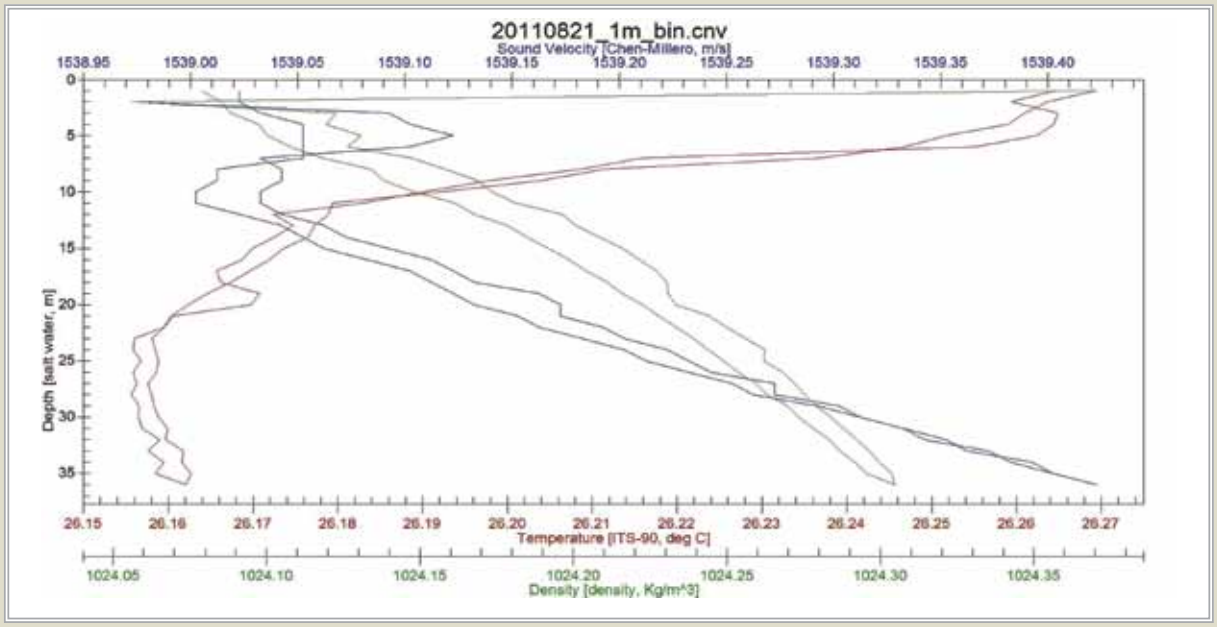

20110814_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.60 1538.65 1538.70 1538.75 1538.80 1538.85 1538.90 1538.95 1539.00 1539.05
Depth [salt water, m]
0 5 10 15 20 25 30
25.975 26.000 26.025 26.050 26.075 26.100 26.125
Temperature [ITS-90, deg C]
1024.175 1024.200 1024.225 1024.250 1024.275 1024.300 1024.325 1024.350 1024.375
Density [density, Kg/m^3]

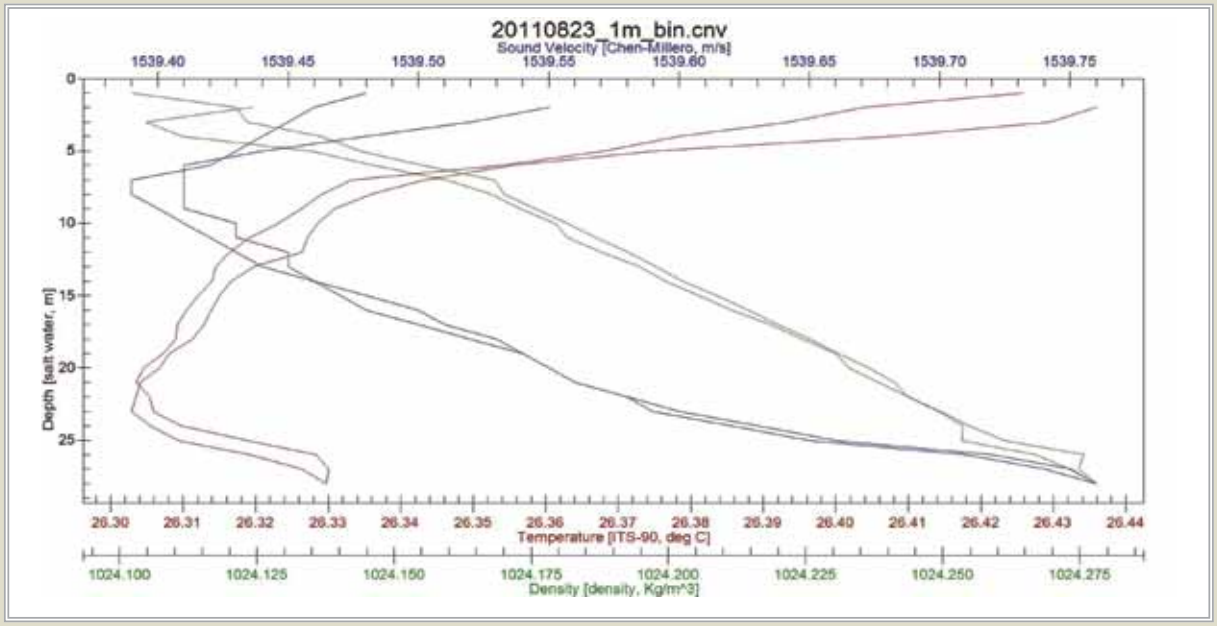

20110815_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.80 1538.85 1538.90 1538.95 1539.00 1539.05 1539.10
Depth [salt water, m]
0 5 10 15 20 25
26.01 26.02 26.03 26.04 26.05 26.06 26.07 26.08 26.09 26.10 26.11 26.12 26.13
Temperature [ITS-90, deg C]
1024.225 1024.250 1024.275 1024.300 1024.325 1024.350 1024.375 1024.400 1024.425
Density [density, Kg/m^3]

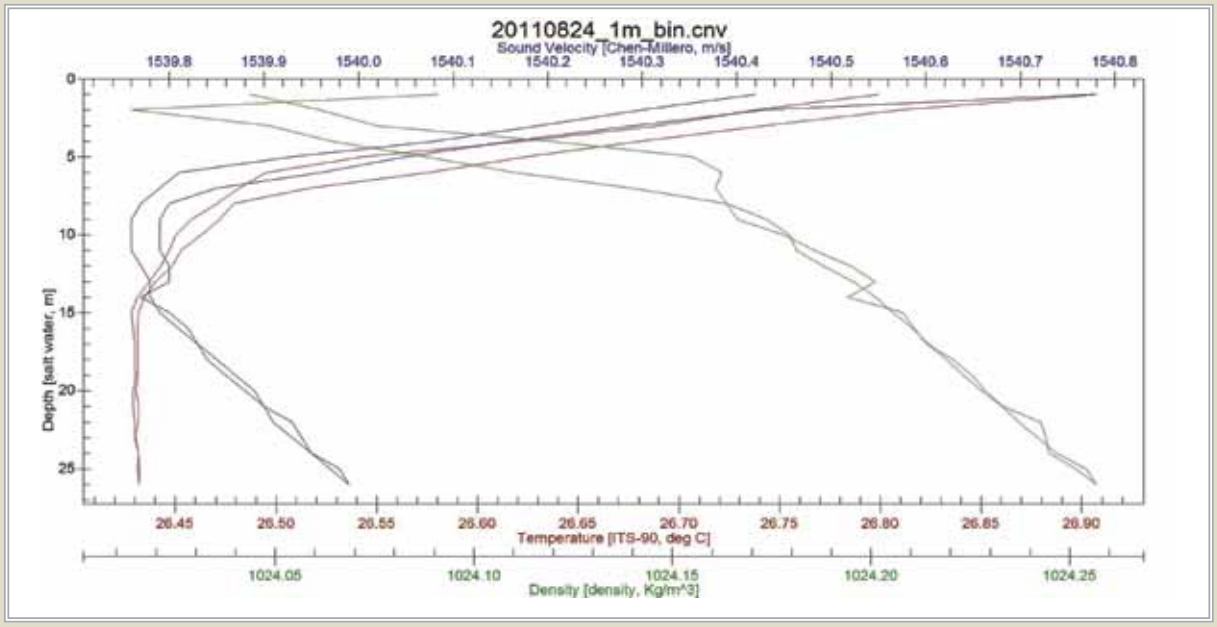

20110816_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.900
1538.925
1538.950
1538.975
1539.000
1539.025
1539.050
1539.075
1539.100
1539.125
Depth [salt water, m]
0
5
10
15
20
25
30
26.025
26.050
26.075
26.100
26.125
26.150
Temperature [ITS-90, deg C]
1024.225
1024.250
1024.275
1024.300
1024.325
1024.350
1024.375
1024.400
Density [density, Kg/m^3]

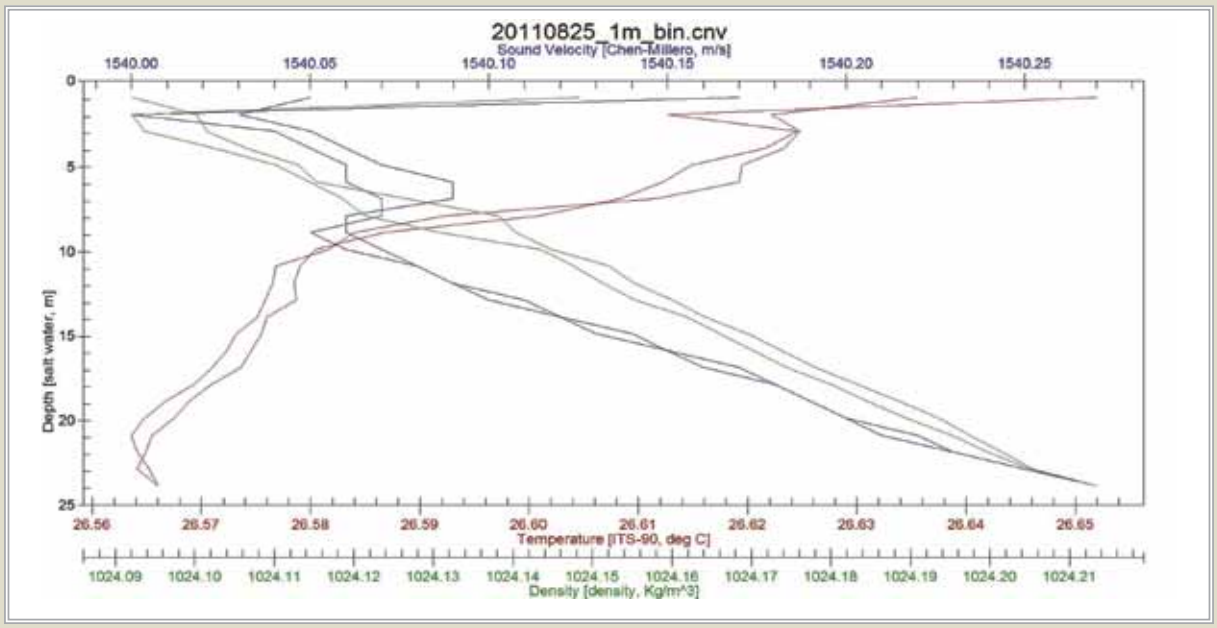

20110817_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.90
1538.95
1539.00
1539.05
1539.10
1539.15
Depth [salt water, m]
0
5
10
15
20
25
26.050
26.075
26.100
26.125
26.150
26.175
Temperature [ITS-90, deg C]
1024.225
1024.250
1024.275
1024.300
1024.325
1024.350
1024.375
Density [density, Kg/m^3]

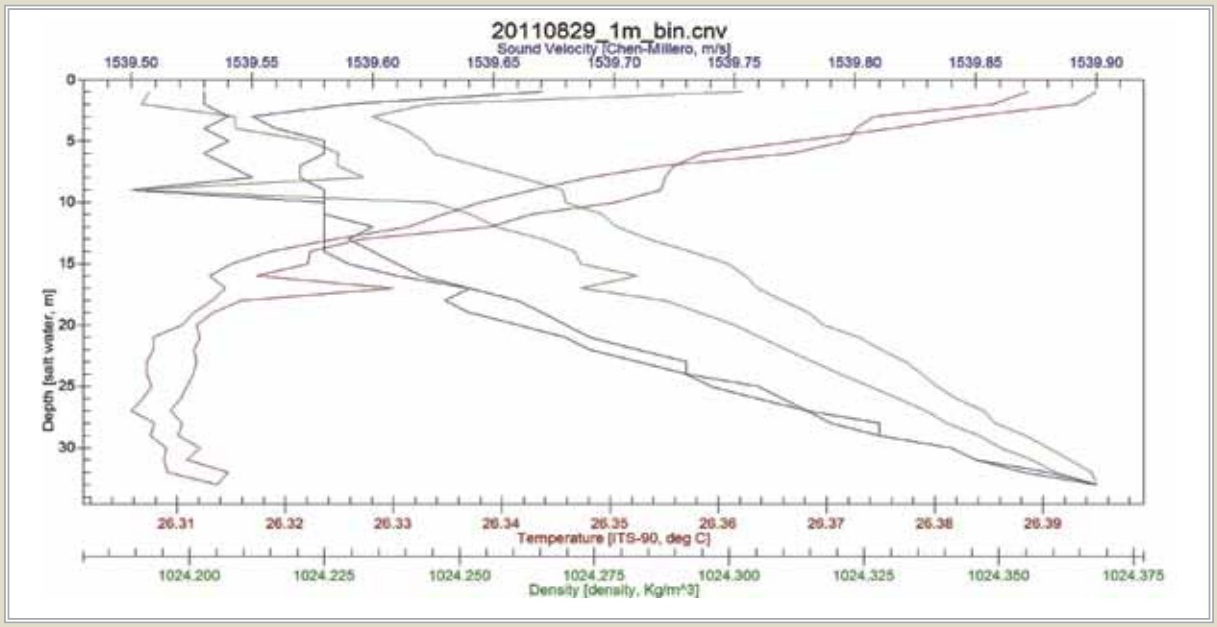

20110818_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.05
1539.10
1539.15
1539.20
1539.25
1539.30
1539.35
1539.40
Depth [salt water, m]
0
5
10
15
20
25
30
26.13
26.14
26.15
26.16
26.17
26.18
26.19
26.20
26.21
26.22
26.23
26.24
Temperature [ITS-90, deg C]
1024.200
1024.225
1024.250
1024.275
1024.300
1024.325
1024.350
Density [density, Kg/m^3]

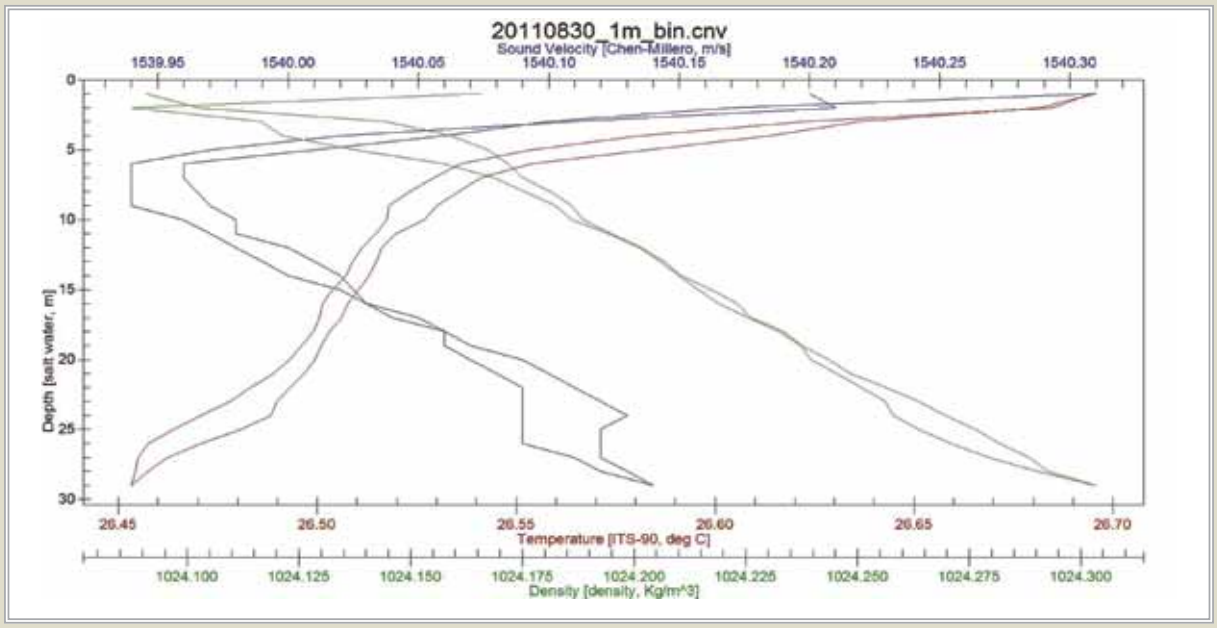

20110821_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.95 1539.00 1539.05 1539.10 1539.15 1539.20 1539.25 1539.30 1539.35 1539.40
Depth [salt water, m]
0 5 10 15 20 25 30 35
26.15 26.16 26.17 26.18 26.19 26.20 26.21 26.22 26.23 26.24 26.25 26.26 26.27
Temperature [ITS-90, deg C]
1024.05 1024.10 1024.15 1024.20 1024.25 1024.30 1024.35
Density [density, Kg/m^3]

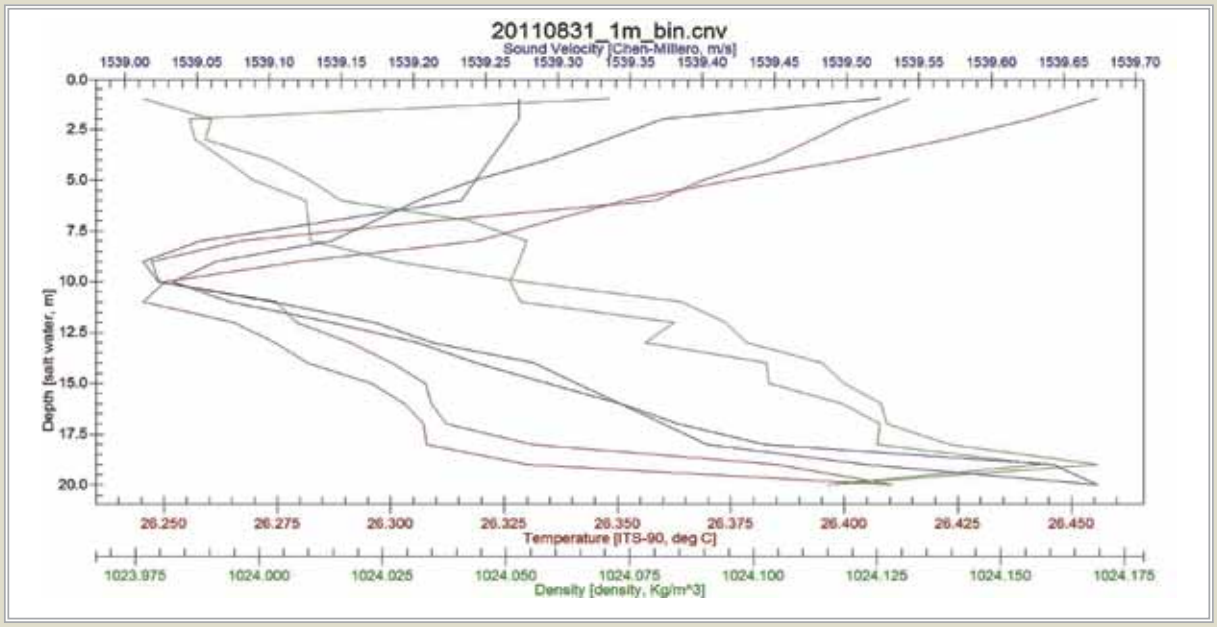

20110823_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.40 1539.45 1539.50 1539.55 1539.60 1539.65 1539.70 1539.75
Depth [salt water, m]
0 5 10 15 20 25
26.30 26.31 26.32 26.33 26.34 26.35 26.36 26.37 26.38 26.39 26.40 26.41 26.42 26.43 26.44
Temperature [ITS-90, deg C]
1024.100 1024.125 1024.150 1024.175 1024.200 1024.225 1024.250 1024.275
Density [density, Kg/m^3]

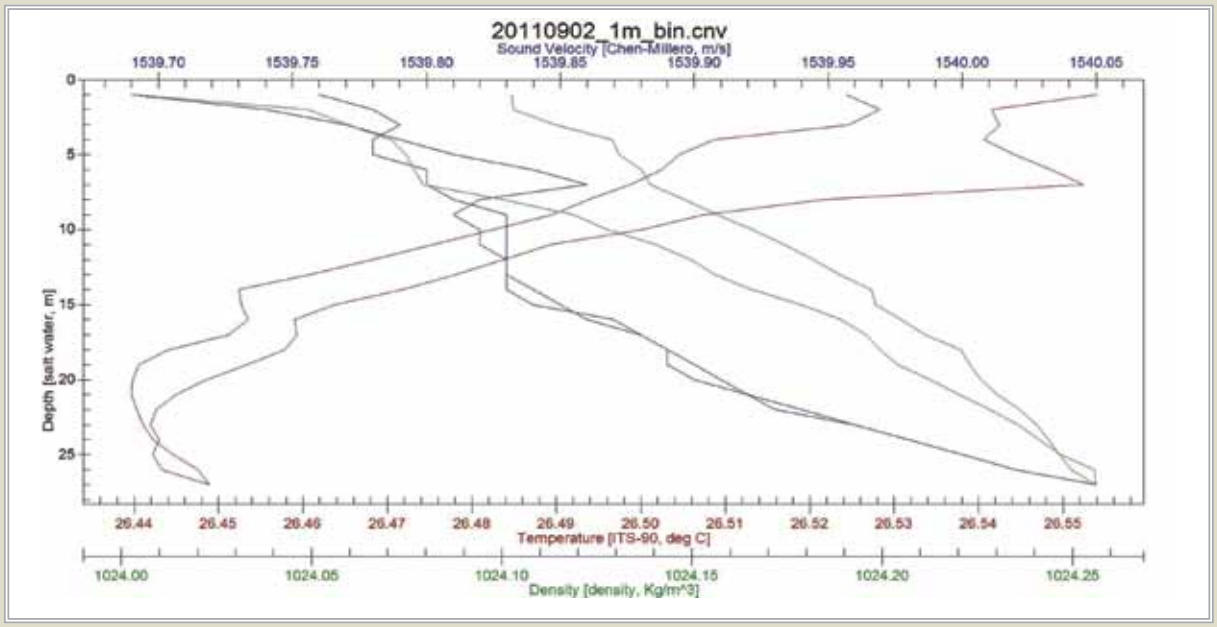

20110824_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.8 1539.9 1540.0 1540.1 1540.2 1540.3 1540.4 1540.5 1540.6 1540.7 1540.8
Depth [salt water, m]
0 5 10 15 20 25
26.45 26.50 26.55 26.60 26.65 26.70 26.75 26.80 26.85 26.90
Temperature [ITS-90, deg C]
1024.05 1024.10 1024.15 1024.20 1024.25
Density [density, Kg/m^3]

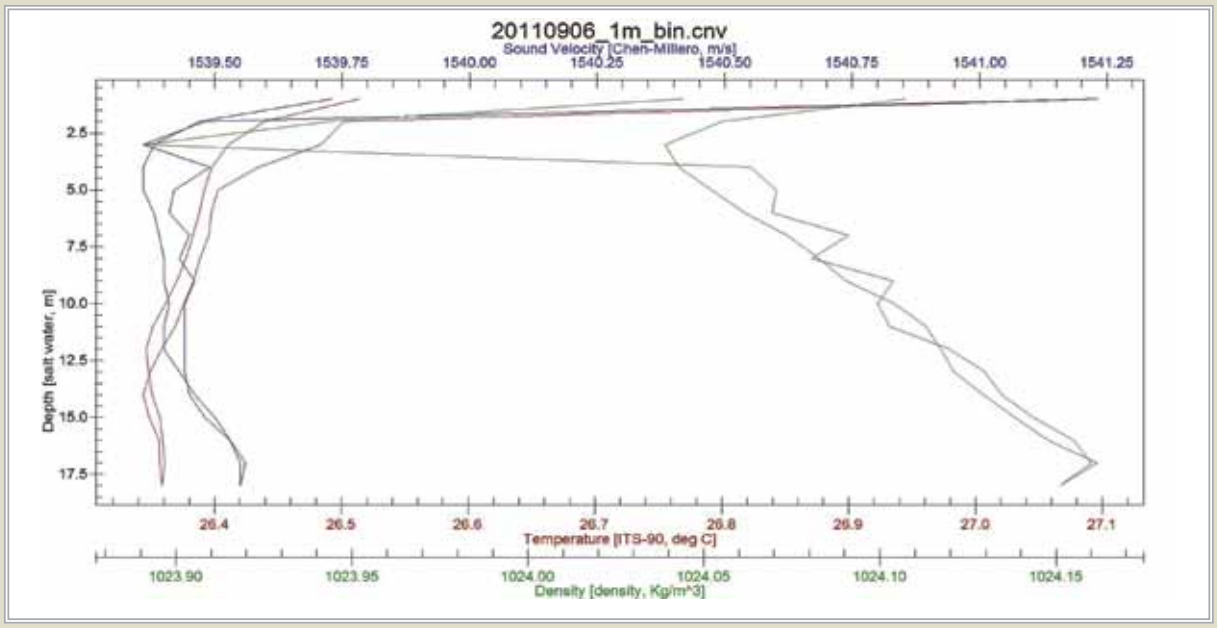

20110825_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1540.00
1540.05
1540.10
1540.15
1540.20
1540.25
Depth [salt water, m]
0
5
10
15
20
25
26.56
26.57
26.58
26.59
26.60
26.61
26.62
26.63
26.64
26.65
Temperature [ITS-90, deg C]
1024.09
1024.10
1024.11
1024.12
1024.13
1024.14
1024.15
1024.16
1024.17
1024.18
1024.19
1024.20
1024.21
Density [density, Kg/m^3]

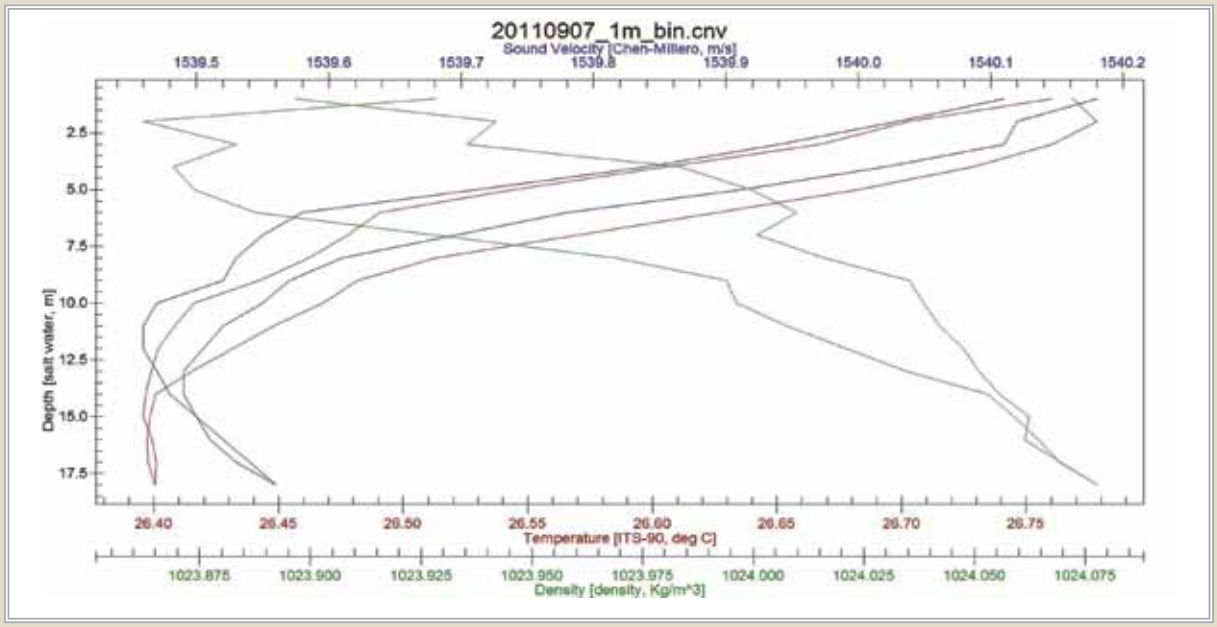

20110829_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.50
1539.55
1539.60
1539.65
1539.70
1539.75
1539.80
1539.85
1539.90
Depth [salt water, m]
0
5
10
15
20
25
30
26.31
26.32
26.33
26.34
26.35
26.36
26.37
26.38
26.39
Temperature [ITS-90, deg C]
1024.200
1024.225
1024.250
1024.275
1024.300
1024.325
1024.350
1024.375
Density [density, Kg/m^3]

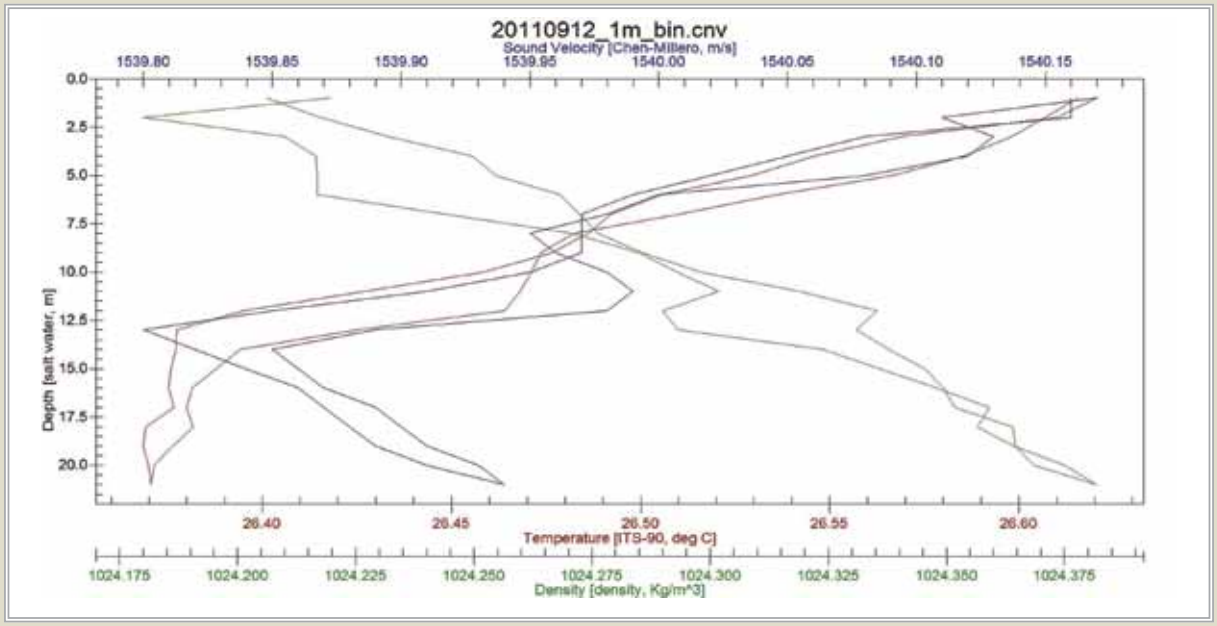

20110830_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.95
1540.00
1540.05
1540.10
1540.15
1540.20
1540.25
1540.30
Depth [salt water, m]
0
5
10
15
20
25
30
26.45
26.50
26.55
26.60
26.65
26.70
Temperature [ITS-90, deg C]
1024.100
1024.125
1024.150
1024.175
1024.200
1024.225
1024.250
1024.275
1024.300
Density [density, Kg/m^3]

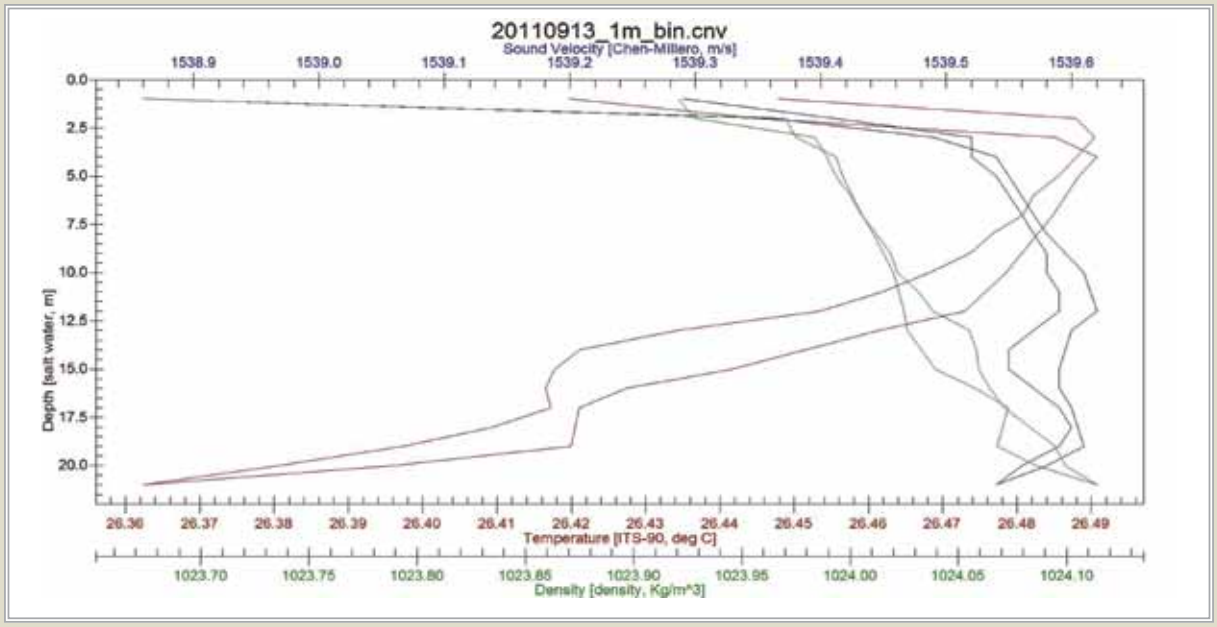

20110831_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.00 1539.05 1539.10 1539.15 1539.20 1539.25 1539.30 1539.35 1539.40 1539.45 1539.50 1539.55 1539.60 1539.65 1539.70
Depth [salt water, m]
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0
26.250 26.275 26.300 26.325 26.350 26.375 26.400 26.425 26.450
Temperature [ITS-90, deg C]
1023.975 1024.000 1024.025 1024.050 1024.075 1024.100 1024.125 1024.150 1024.175
Density [density, Kg/m^3]

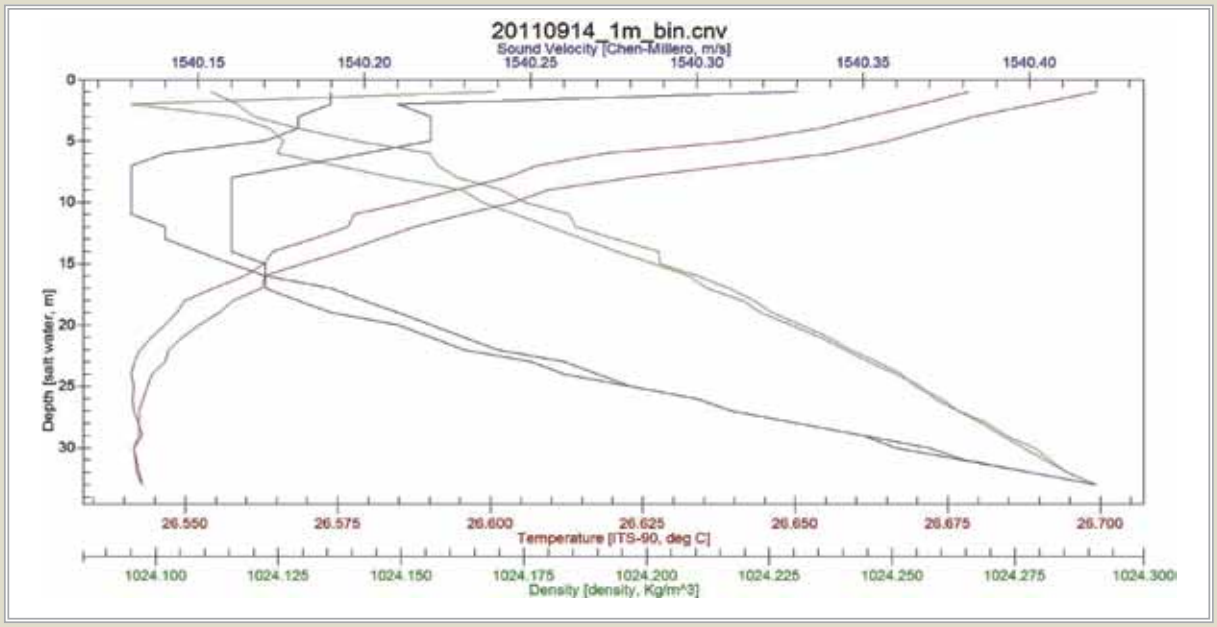

20110902_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.70 1539.75 1539.80 1539.85 1539.90 1539.95 1540.00 1540.05
Depth [salt water, m]
0 5 10 15 20 25
26.44 26.45 26.46 26.47 26.48 26.49 26.50 26.51 26.52 26.53 26.54 26.55
Temperature [ITS-90, deg C]
1024.00 1024.05 1024.10 1024.15 1024.20 1024.25
Density [density, Kg/m^3]

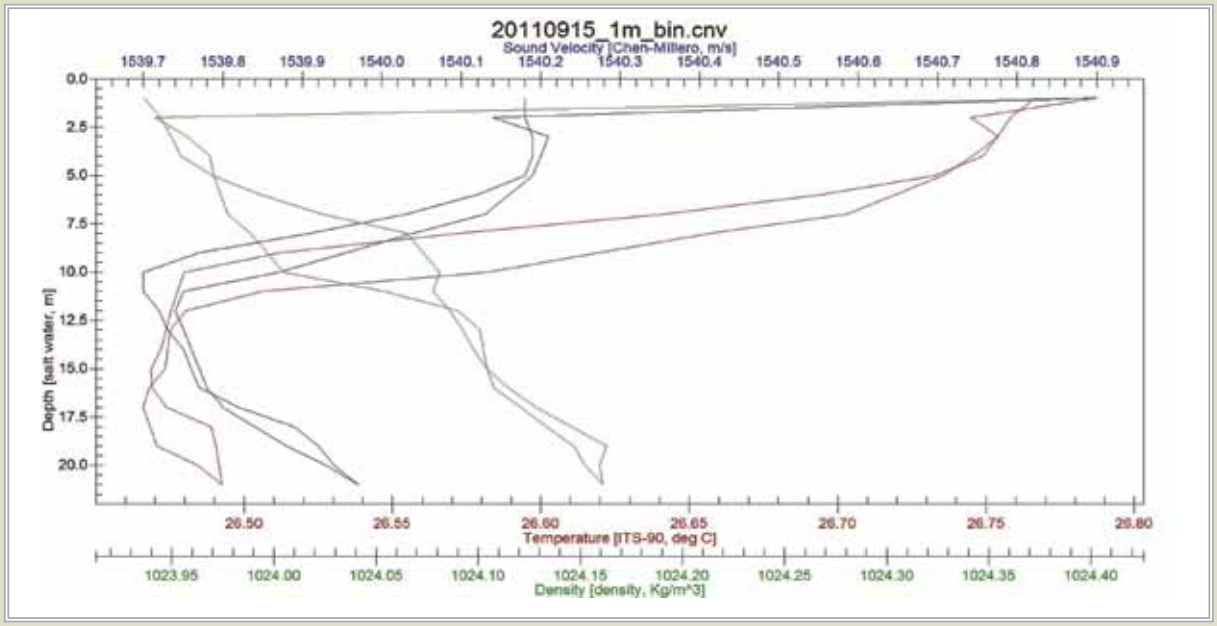

20110906_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.50 1539.75 1540.00 1540.25 1540.50 1540.75 1541.00 1541.25
Depth [salt water, m]
2.5 5.0 7.5 10.0 12.5 15.0 17.5
26.4 26.5 26.6 26.7 26.8 26.9 27.0 27.1
Temperature [ITS-90, deg C]
1023.90 1023.95 1024.00 1024.05 1024.10 1024.15
Density [density, Kg/m^3]

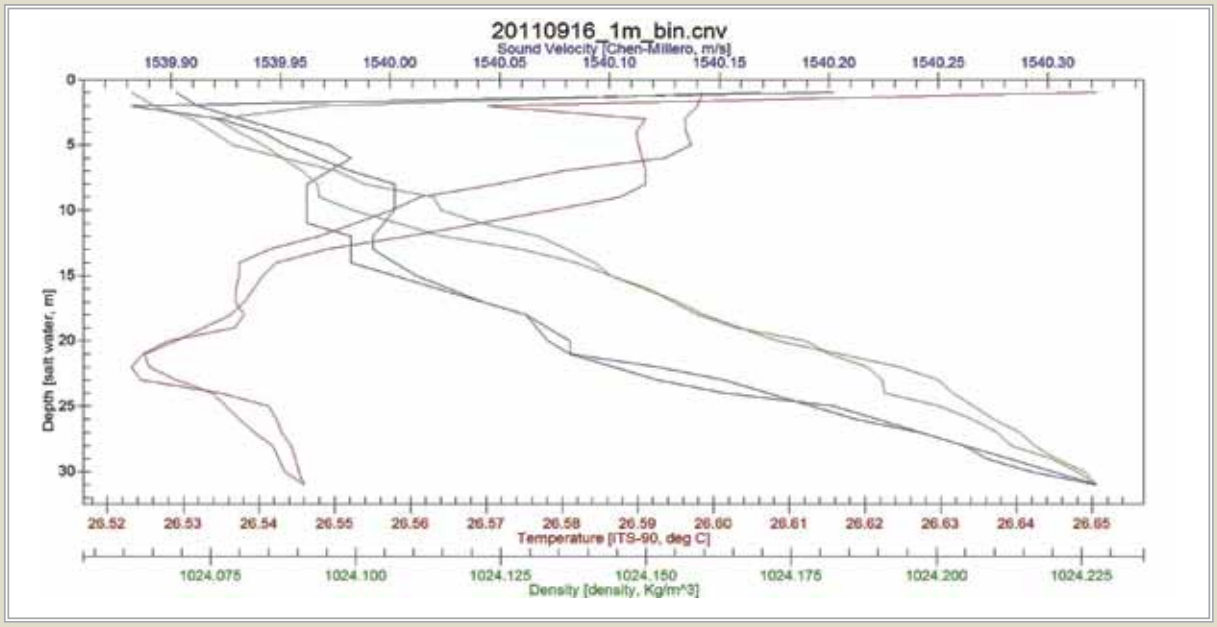

20110907_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.5
1539.6
1539.7
1539.8
1539.9
1540.0
1540.1
1540.2
Depth [salt water, m]
2.5
5.0
7.5
10.0
12.5
15.0
17.5
26.40
26.45
26.50
26.55
26.60
26.65
26.70
26.75
Temperature [ITS-90, deg C]
1023.875
1023.900
1023.925
1023.950
1023.975
1024.000
1024.025
1024.050
1024.075
Density [density, Kg/m^3]

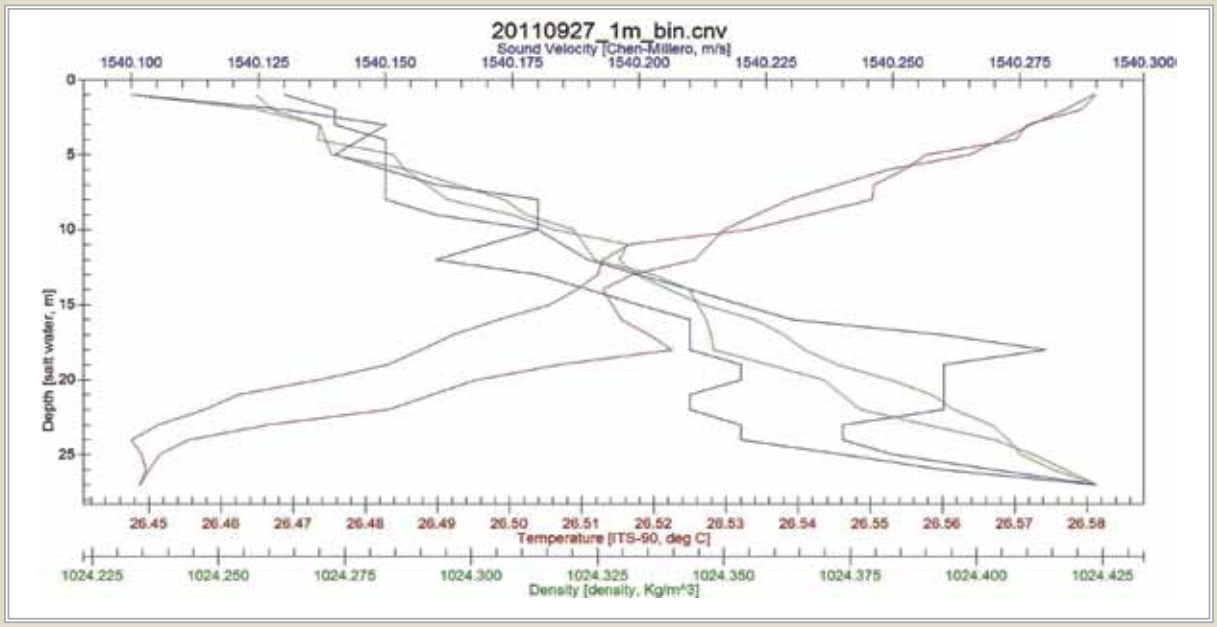

20110912_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.80
1539.85
1539.90
1539.95
1540.00
1540.05
1540.10
1540.15
Depth [salt water, m]
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
26.40
26.45
26.50
26.55
26.60
Temperature [ITS-90, deg C]
1024.175
1024.200
1024.225
1024.250
1024.275
1024.300
1024.325
1024.350
1024.375
Density [density, Kg/m^3]

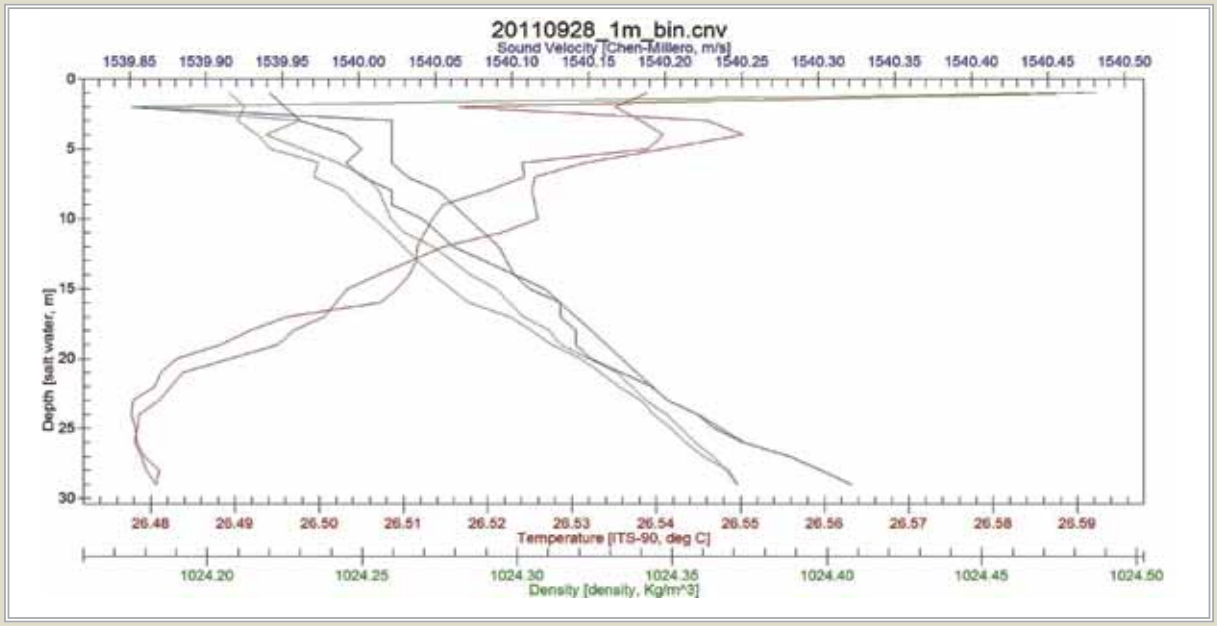

20110913_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1538.9
1539.0
1539.1
1539.2
1539.3
1539.4
1539.5
1539.6
Depth [salt water, m]
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
26.36
26.37
26.38
26.39
26.40
26.41
26.42
26.43
26.44
26.45
26.46
26.47
26.48
26.49
Temperature [ITS-90, deg C]
1023.70
1023.75
1023.80
1023.85
1023.90
1023.95
1024.00
1024.05
1024.10
Density [density, Kg/m^3]

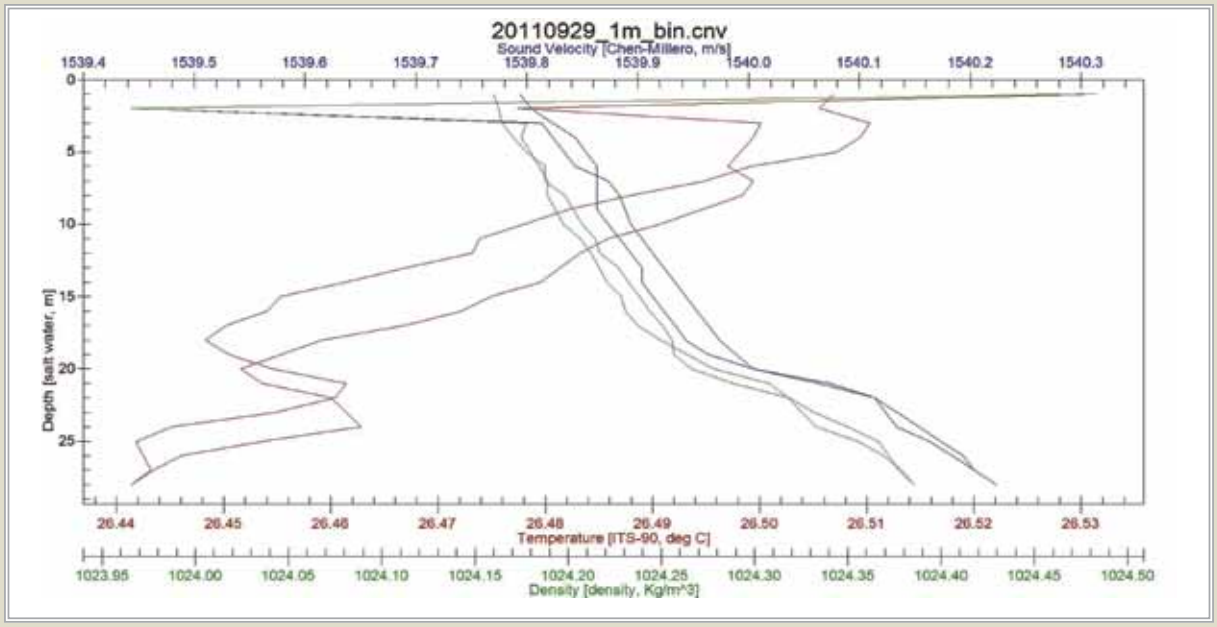

20110914_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1540.15
1540.20
1540.25
1540.30
1540.35
1540.40
Depth [salt water, m]
0
5
10
15
20
25
30
26.550
26.575
26.600
26.625
26.650
26.675
26.700
Temperature [ITS-90, deg C]
1024.100
1024.125
1024.150
1024.175
1024.200
1024.225
1024.250
1024.275
1024.300
Density [density, Kg/m^3]

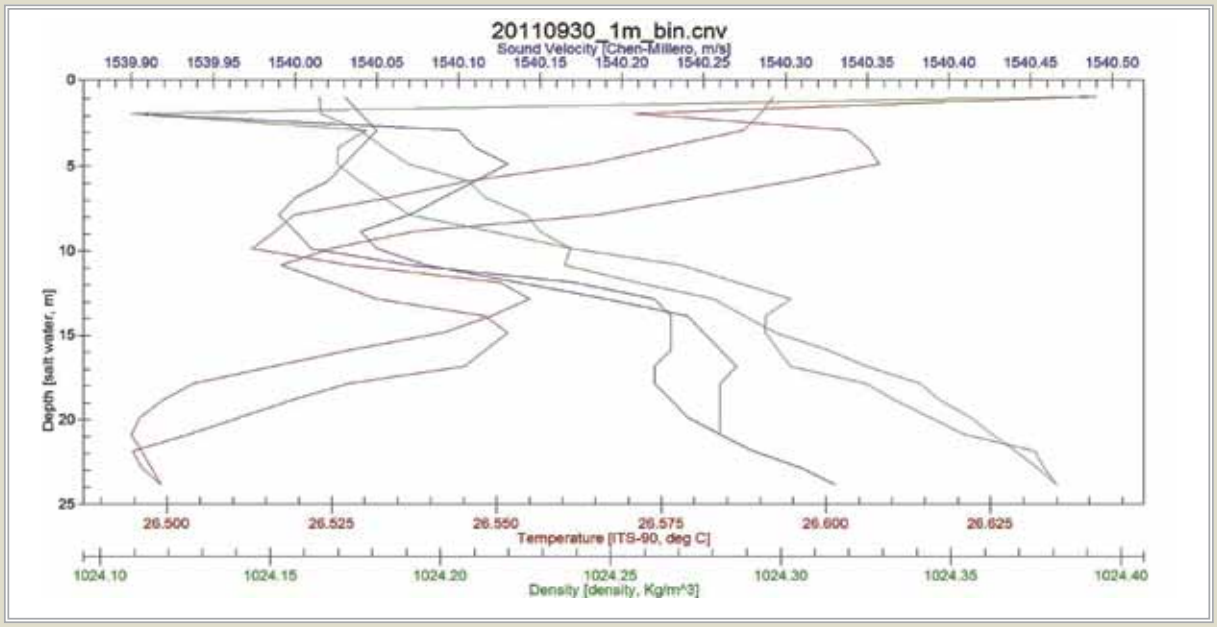

20110915_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.7
1539.8
1539.9
1540.0
1540.1
1540.2
1540.3
1540.4
1540.5
1540.6
1540.7
1540.8
1540.9
Depth [salt water, m]
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
26.50
26.55
26.60
26.65
26.70
26.75
26.80
Temperature [ITS-90, deg C]
1023.95
1024.00
1024.05
1024.10
1024.15
1024.20
1024.25
1024.30
1024.35
1024.40
Density [density, Kg/m^3]

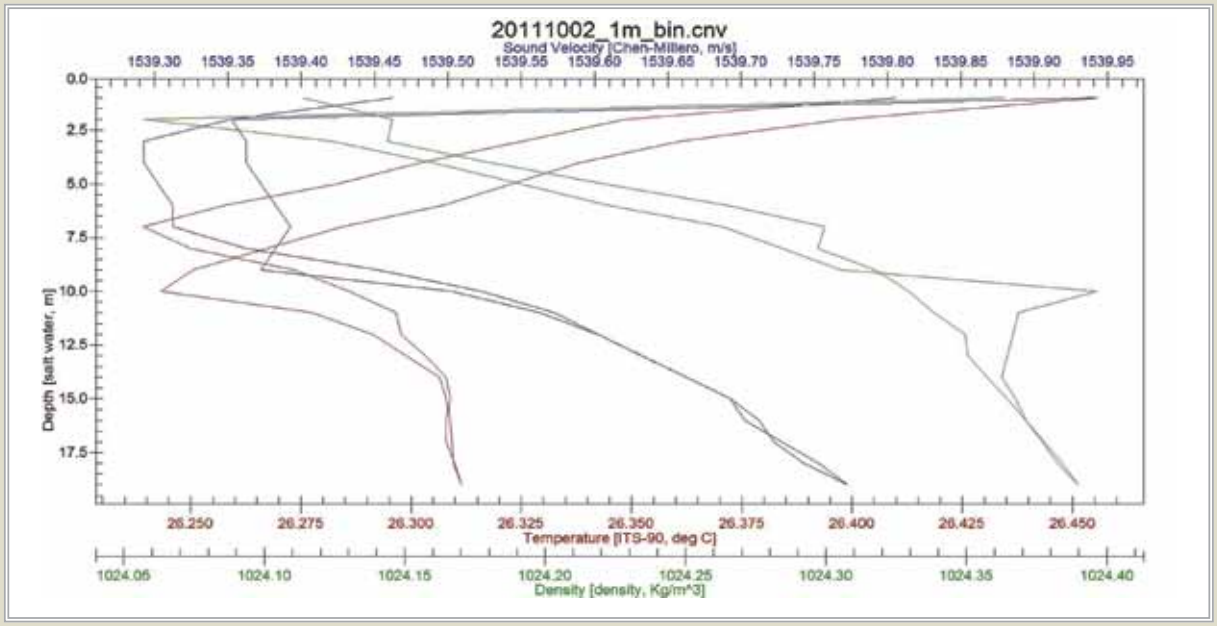

20110916_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.90
1539.95
1540.00
1540.05
1540.10
1540.15
1540.20
1540.25
1540.30
Depth [salt water, m]
0
5
10
15
20
25
30
26.52
26.53
26.54
26.55
26.56
26.57
26.58
26.59
26.60
26.61
26.62
26.63
26.64
26.65
Temperature [ITS-90, deg C]
1024.075
1024.100
1024.125
1024.150
1024.175
1024.200
1024.225
Density [density, Kg/m^3]

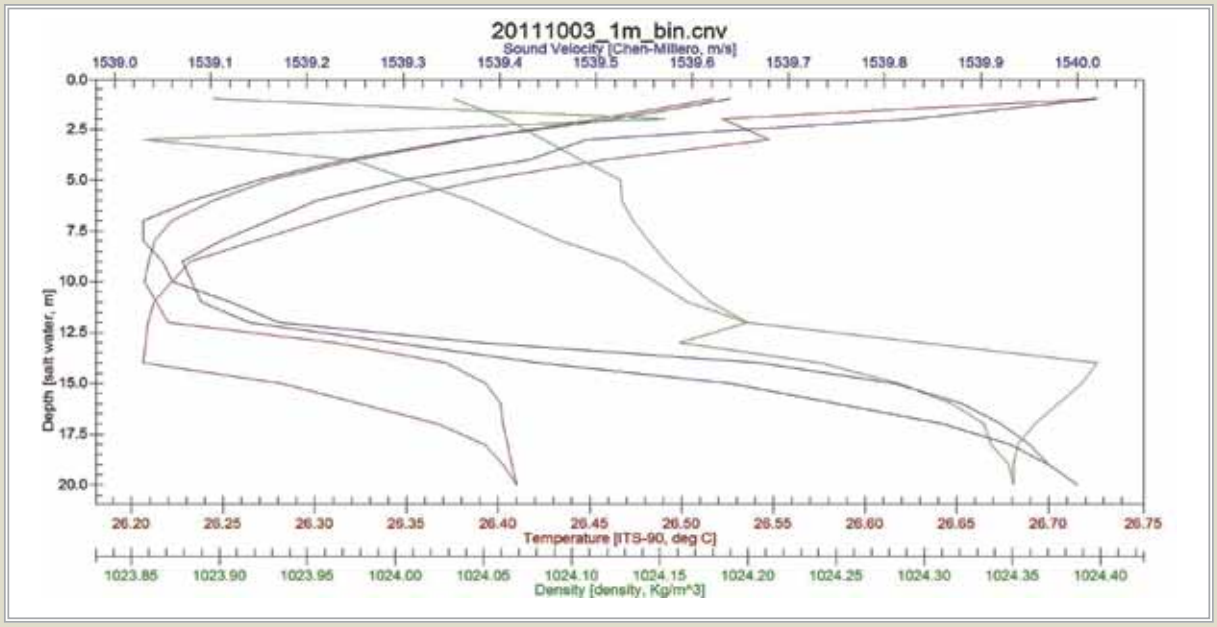

20110927_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1540.100 1540.125 1540.150 1540.175 1540.200 1540.225 1540.250 1540.275 1540.300
Depth [salt water, m]
0 5 10 15 20 25
26.45 26.46 26.47 26.48 26.49 26.50 26.51 26.52 26.53 26.54 26.55 26.56 26.57 26.58
Temperature [ITS-90, deg C]
1024.225 1024.250 1024.275 1024.300 1024.325 1024.350 1024.375 1024.400 1024.425
Density [density, Kg/m^3]

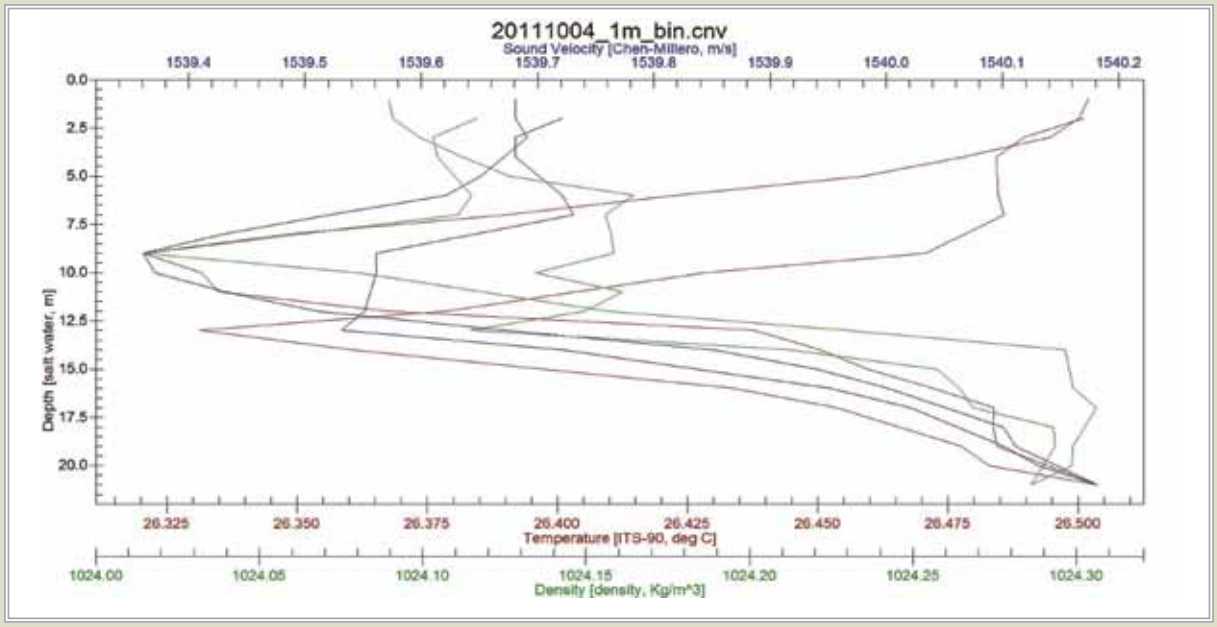

20110928_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.85 1539.90 1539.95 1540.00 1540.05 1540.10 1540.15 1540.20 1540.25 1540.30 1540.35 1540.40 1540.45 1540.50
Depth [salt water, m]
0 5 10 15 20 25 30
26.48 26.49 26.50 26.51 26.52 26.53 26.54 26.55 26.56 26.57 26.58 26.59
Temperature [ITS-90, deg C]
1024.20 1024.25 1024.30 1024.35 1024.40 1024.45 1024.50
Density [density, Kg/m^3]

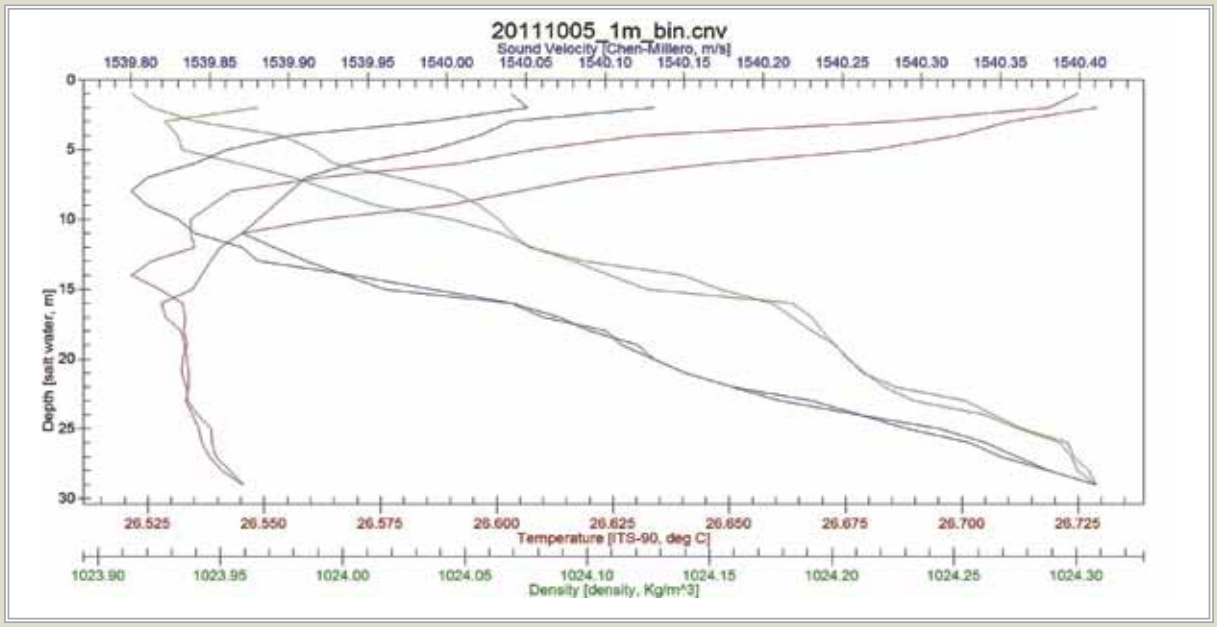

20110929_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.4 1539.5 1539.6 1539.7 1539.8 1539.9 1540.0 1540.1 1540.2 1540.3
Depth [salt water, m]
0 5 10 15 20 25
26.44 26.45 26.46 26.47 26.48 26.49 26.50 26.51 26.52 26.53
Temperature [ITS-90, deg C]
1023.95 1024.00 1024.05 1024.10 1024.15 1024.20 1024.25 1024.30 1024.35 1024.40 1024.45 1024.50
Density [density, Kg/m^3]

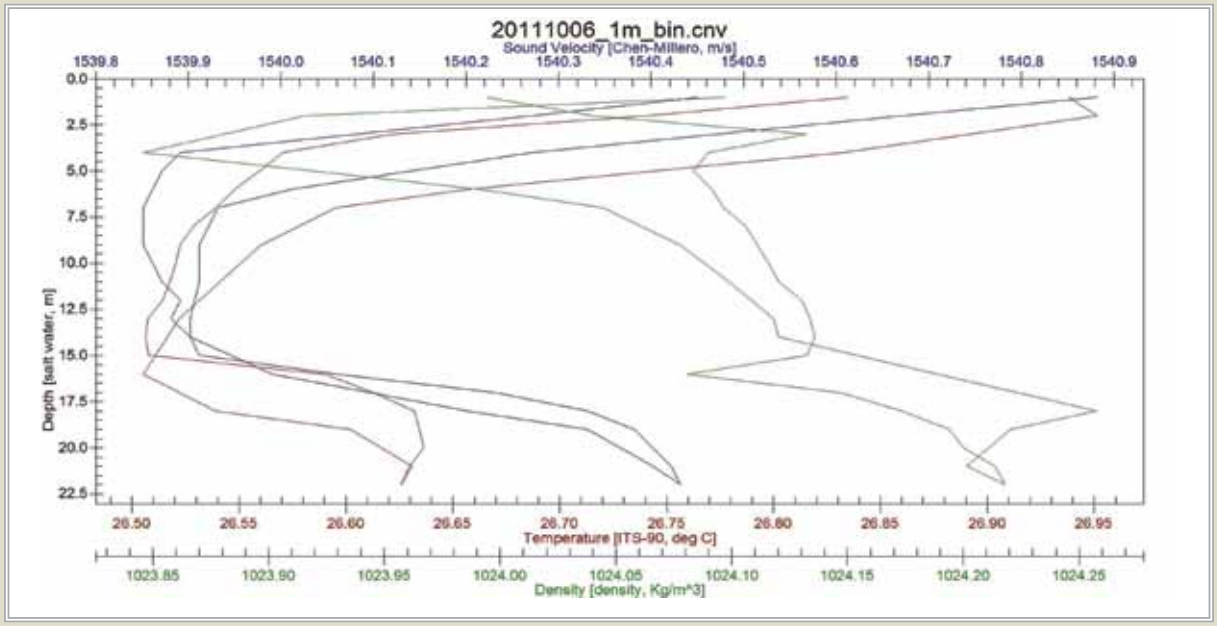

20110930_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.90 1539.95 1540.00 1540.05 1540.10 1540.15 1540.20 1540.25 1540.30 1540.35 1540.40 1540.45 1540.50
Depth [salt water, m]
0 5 10 15 20 25
26.500 26.525 26.550 26.575 26.600 26.625
Temperature [ITS-90, deg C]
1024.10 1024.15 1024.20 1024.25 1024.30 1024.35 1024.40
Density [density, Kg/m^3]

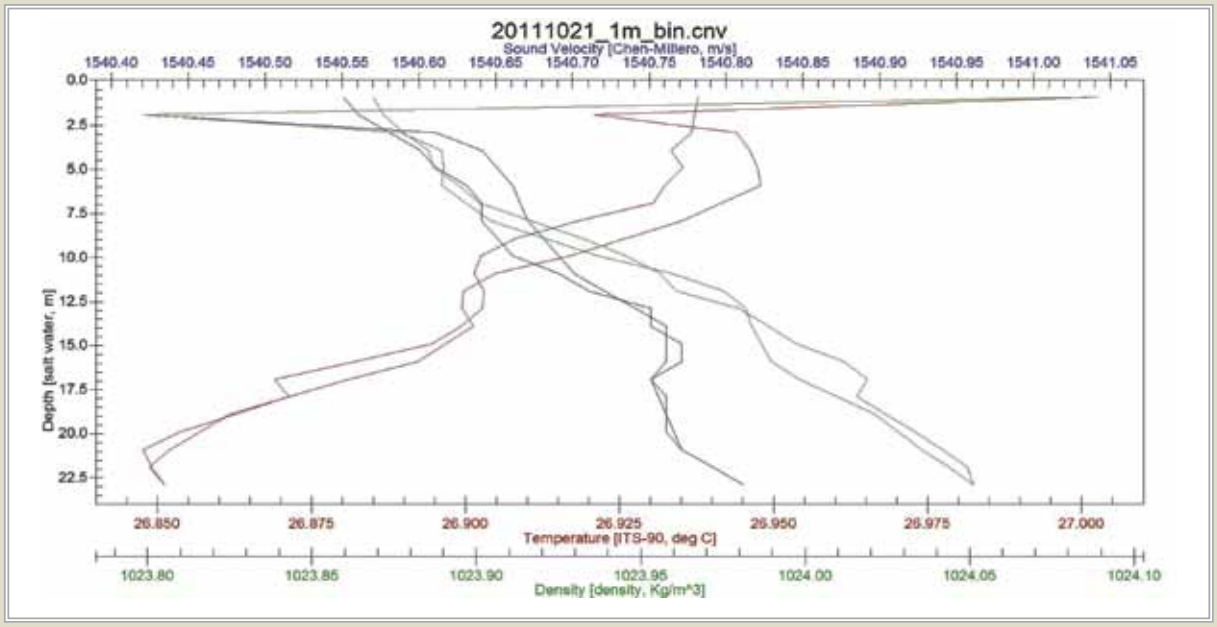

20111002_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.30 1539.35 1539.40 1539.45 1539.50 1539.55 1539.60 1539.65 1539.70 1539.75 1539.80 1539.85 1539.90 1539.95
Depth [salt water, m]
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5
26.250 26.275 26.300 26.325 26.350 26.375 26.400 26.425 26.450
Temperature [ITS-90, deg C]
1024.05 1024.10 1024.15 1024.20 1024.25 1024.30 1024.35 1024.40
Density [density, Kg/m^3]

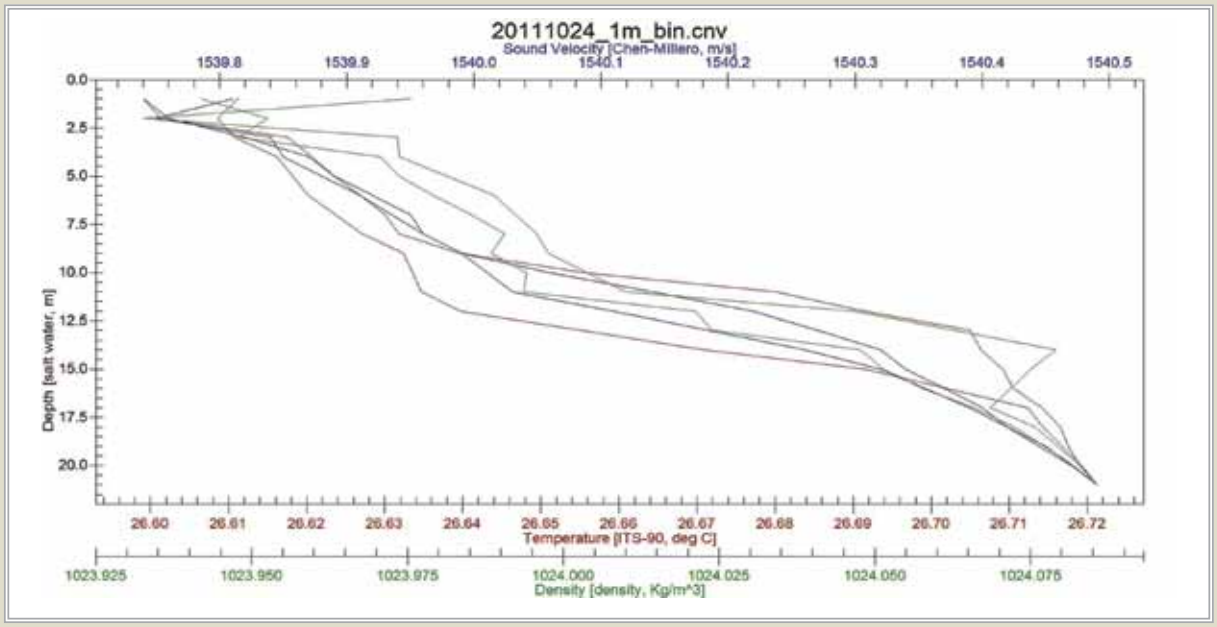

20111003_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.0 1539.1 1539.2 1539.3 1539.4 1539.5 1539.6 1539.7 1539.8 1539.9 1540.0
Depth [salt water, m]
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0
26.20 26.25 26.30 26.35 26.40 26.45 26.50 26.55 26.60 26.65 26.70 26.75
Temperature [ITS-90, deg C]
1023.85 1023.90 1023.95 1024.00 1024.05 1024.10 1024.15 1024.20 1024.25 1024.30 1024.35 1024.40
Density [density, Kg/m^3]

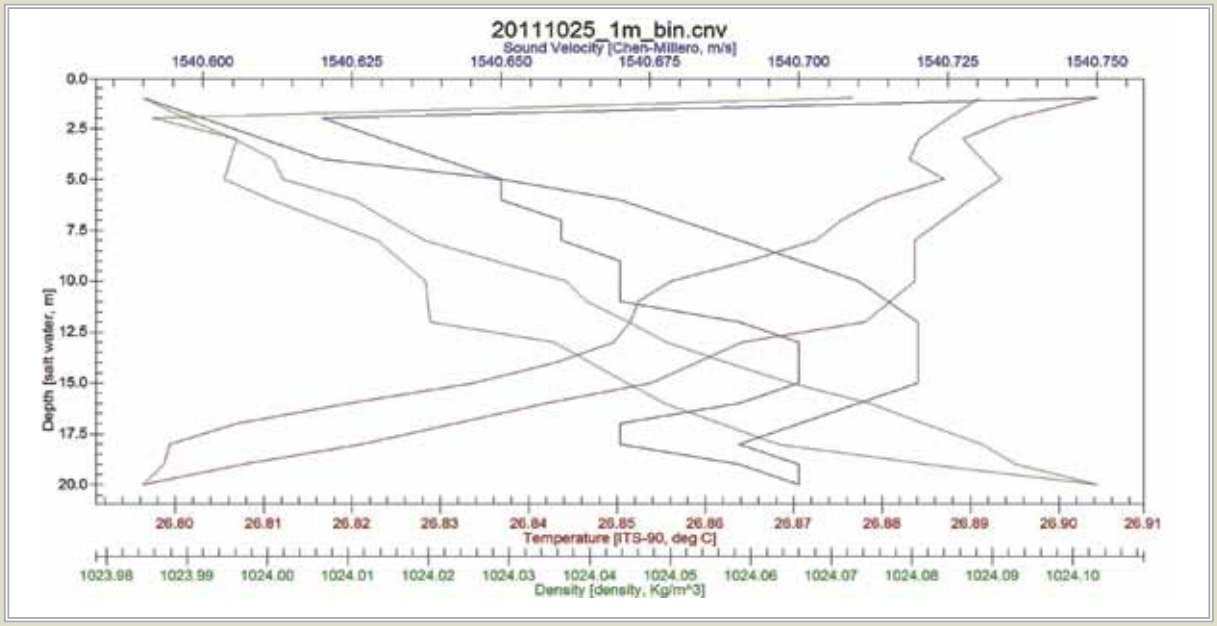

20111004_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.4 1539.5 1539.6 1539.7 1539.8 1539.9 1540.0 1540.1 1540.2
Depth [salt water, m]
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0
26.325 26.350 26.375 26.400 26.425 26.450 26.475 26.500
Temperature [ITS-90, deg C]
1024.00 1024.05 1024.10 1024.15 1024.20 1024.25 1024.30
Density [density, Kg/m^3]

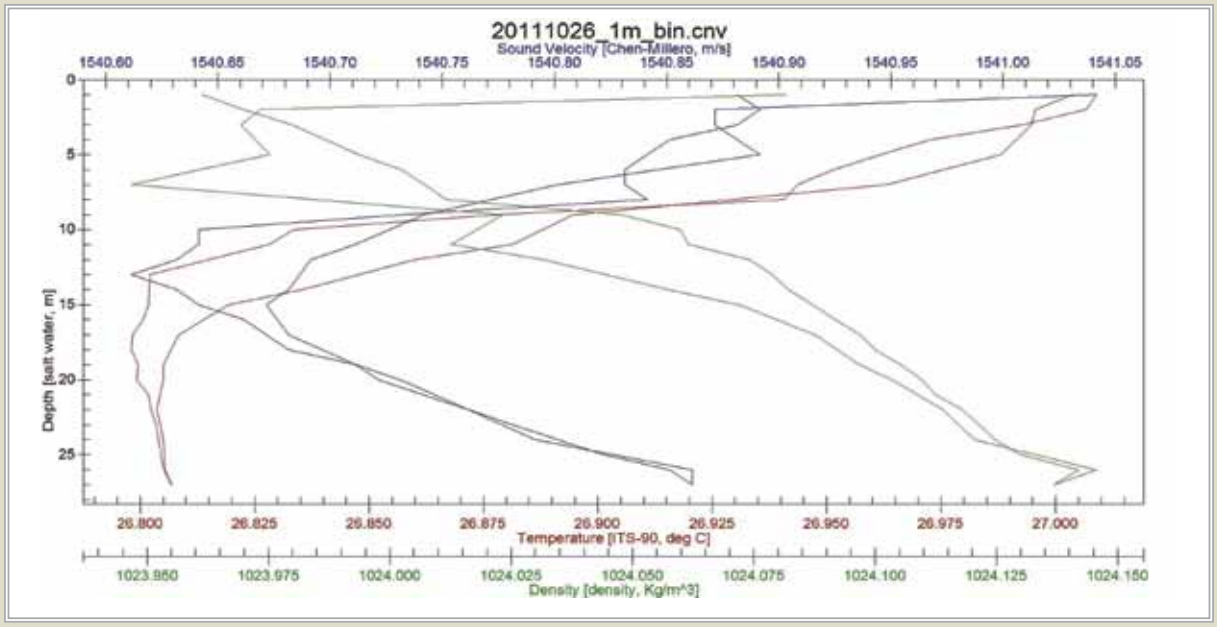

20111005_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.80 1539.85 1539.90 1539.95 1540.00 1540.05 1540.10 1540.15 1540.20 1540.25 1540.30 1540.35 1540.40
Depth [salt water, m]
0 5 10 15 20 25 30
26.525 26.550 26.575 26.600 26.625 26.650 26.675 26.700 26.725
Temperature [ITS-90, deg C]
1023.90 1023.95 1024.00 1024.05 1024.10 1024.15 1024.20 1024.25 1024.30
Density [density, Kg/m^3]

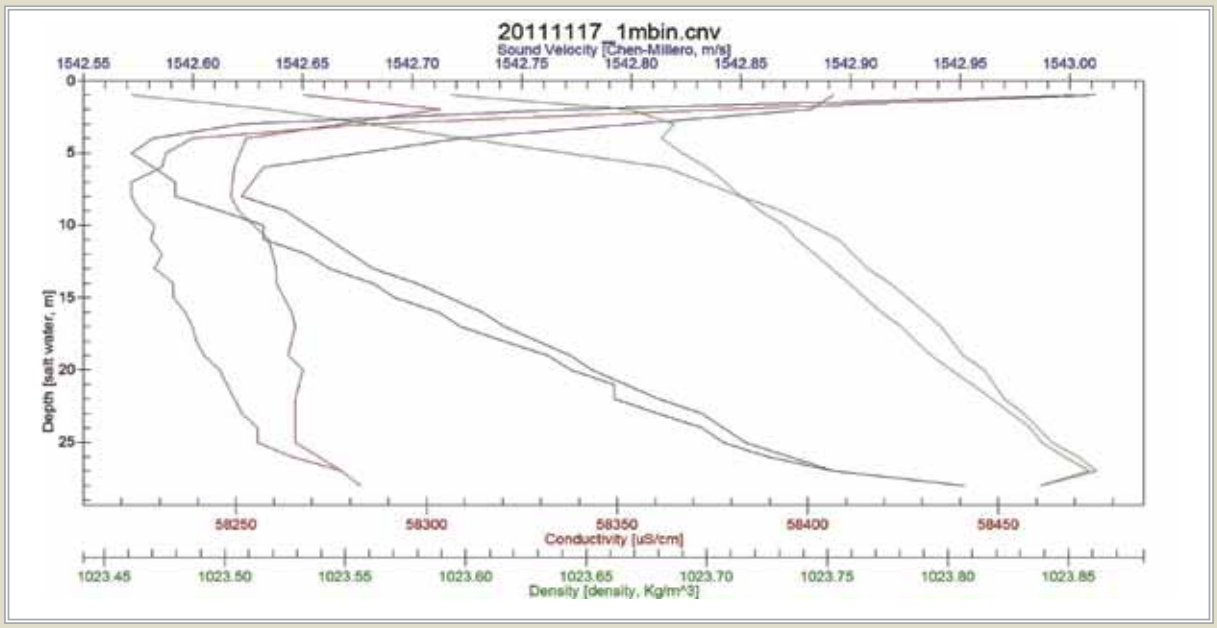

20111006_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.8 1539.9 1540.0 1540.1 1540.2 1540.3 1540.4 1540.5 1540.6 1540.7 1540.8 1540.9
Depth [salt water, m]
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5
26.50 26.55 26.60 26.65 26.70 26.75 26.80 26.85 26.90 26.95
Temperature [ITS-90, deg C]
1023.85 1023.90 1023.95 1024.00 1024.05 1024.10 1024.15 1024.20 1024.25
Density [density, Kg/m^3]

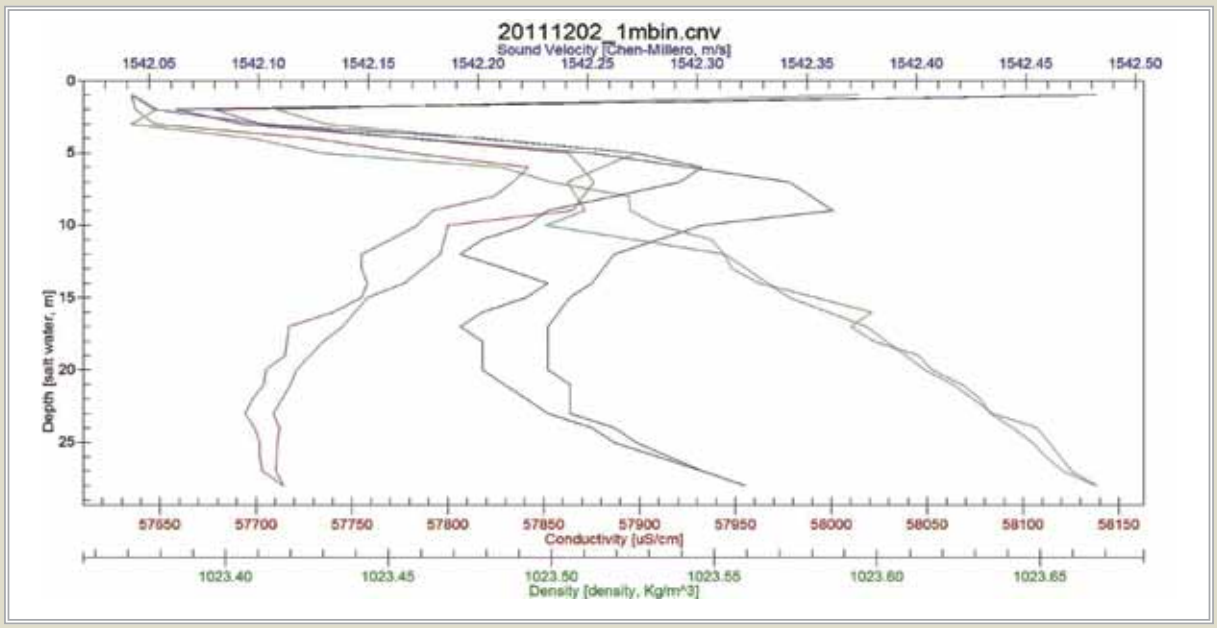

20111021_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1540.40 1540.45 1540.50 1540.55 1540.60 1540.65 1540.70 1540.75 1540.80 1540.85 1540.90 1540.95 1541.00 1541.05
Depth [salt water, m]
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5
26.850 26.875 26.900 26.925 26.950 26.975 27.000
Temperature [ITS-90, deg C]
1023.80 1023.85 1023.90 1023.95 1024.00 1024.05 1024.10
Density [density, Kg/m^3]

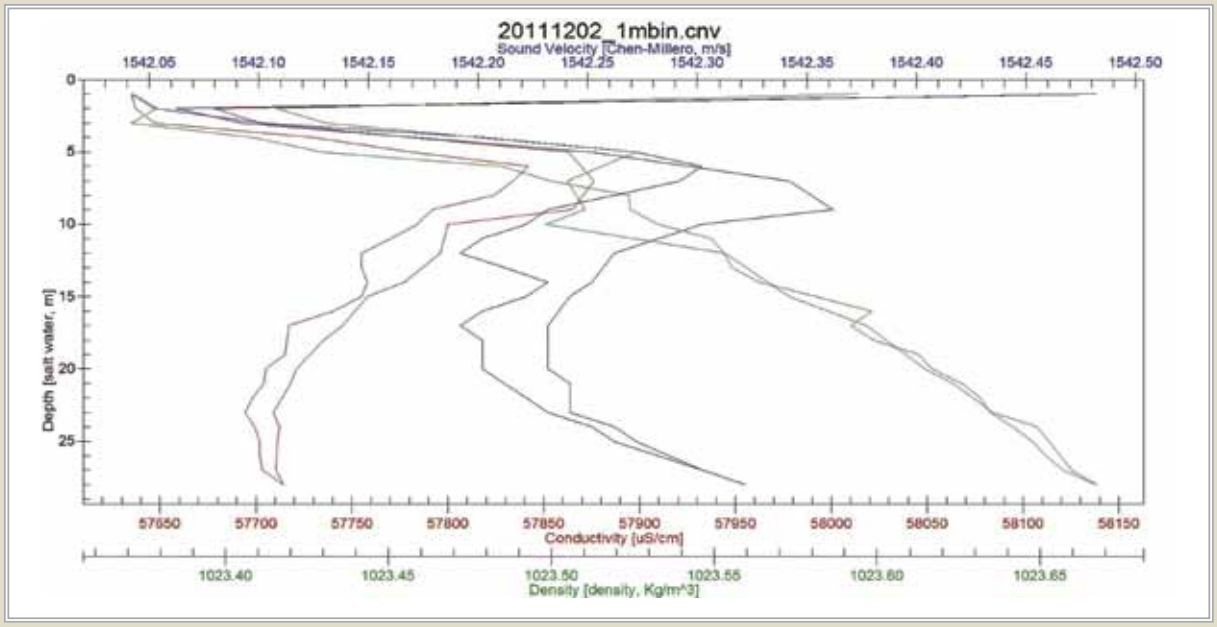

20111024_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.8 1539.9 1540.0 1540.1 1540.2 1540.3 1540.4 1540.5
Depth [salt water, m]
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0
26.60 26.61 26.62 26.63 26.64 26.65 26.66 26.67 26.68 26.69 26.70 26.71 26.72
Temperature [ITS-90, deg C]
1023.925 1023.950 1023.975 1024.000 1024.025 1024.050 1024.075
Density [density, Kg/m^3]

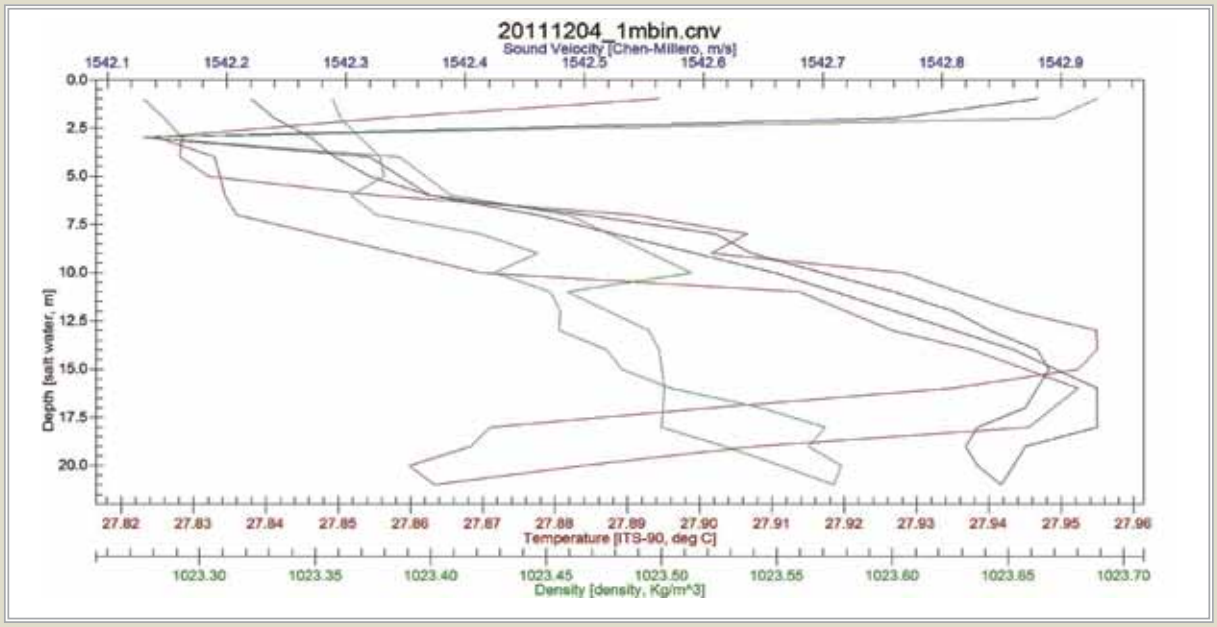

20111025_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1540.600 1540.625 1540.650 1540.675 1540.700 1540.725 1540.750
Depth [salt water, m]
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0
26.80 26.81 26.82 26.83 26.84 26.85 26.86 26.87 26.88 26.89 26.90 26.91
Temperature [ITS-90, deg C]
1023.98 1023.99 1024.00 1024.01 1024.02 1024.03 1024.04 1024.05 1024.06 1024.07 1024.08 1024.09 1024.10
Density [density, Kg/m^3]

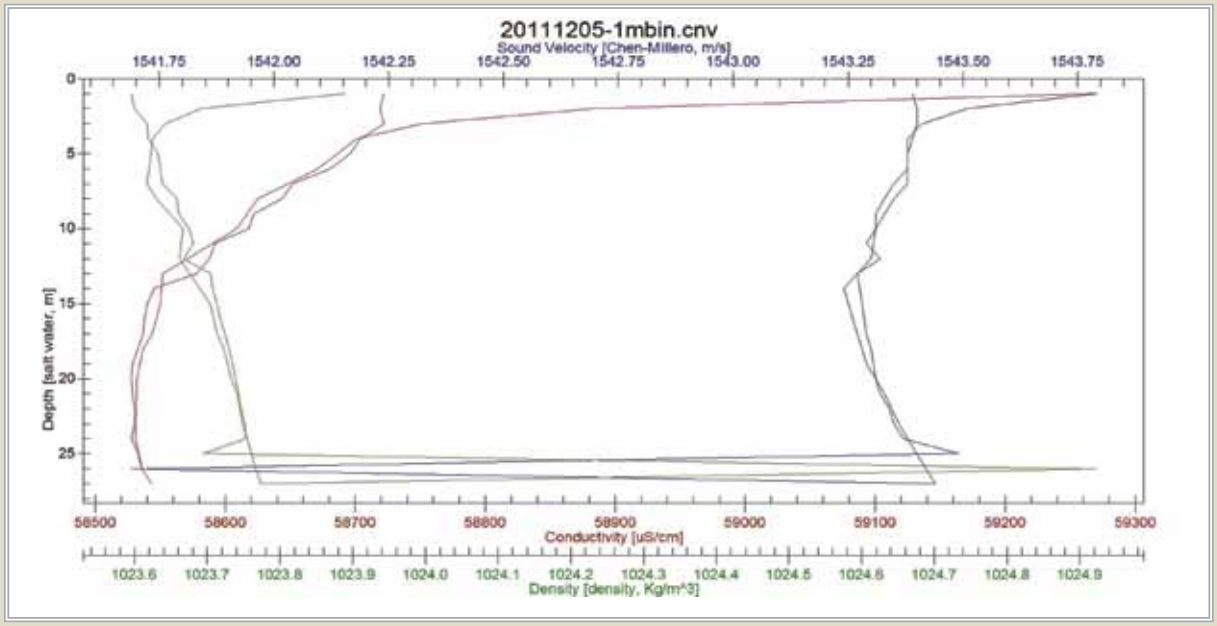

20111026_1m_bin.cnv
Sound Velocity [Chen-Millero, m/s]
1540.60 1540.65 1540.70 1540.75 1540.80 1540.85 1540.90 1540.95 1541.00 1541.05
Depth [salt water, m]
0 5 10 15 20 25
26.800 26.825 26.850 26.875 26.900 26.925 26.950 26.975 27.000
Temperature [ITS-90, deg C]
1023.950 1023.975 1024.000 1024.025 1024.050 1024.075 1024.100 1024.125 1024.150
Density [density, Kg/m^3]

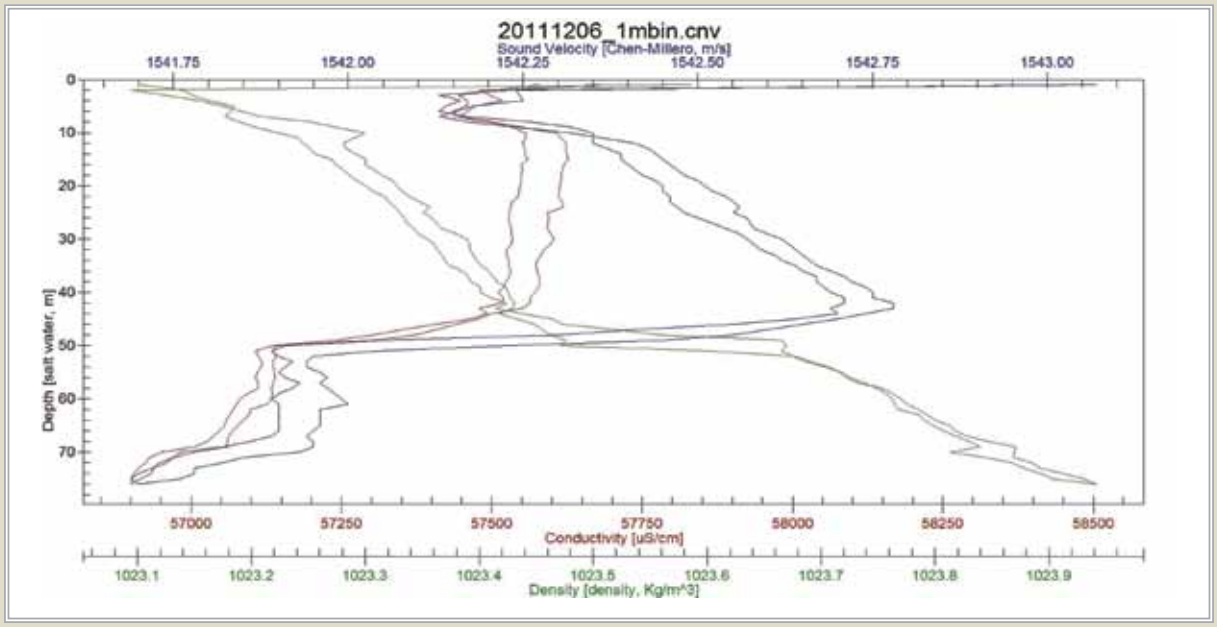

20111117_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1542.55 1542.60 1542.65 1542.70 1542.75 1542.80 1542.85 1542.90 1542.95 1543.00
Depth [salt water, m]
0 5 10 15 20 25
58250 58300 58350 58400 58450
Conductivity [uS/cm]
1023.45 1023.50 1023.55 1023.60 1023.65 1023.70 1023.75 1023.80 1023.85
Density [density, Kg/m^3]

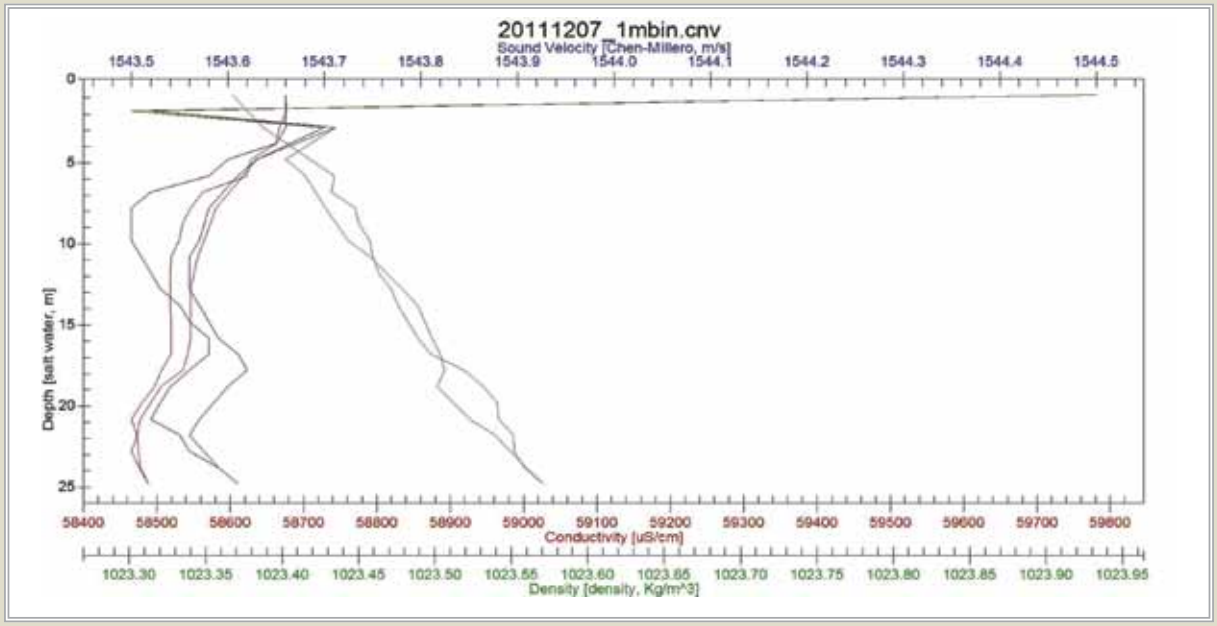

20111202_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1542.05 1542.10 1542.15 1542.20 1542.25 1542.30 1542.35 1542.40 1542.45 1542.50
Depth [salt water, m]
0 5 10 15 20 25
57650 57700 57750 57800 57850 57900 57950 58000 58050 58100 58150
Conductivity [uS/cm]
1023.40 1023.45 1023.50 1023.55 1023.60 1023.65
Density [density, Kg/m^3]

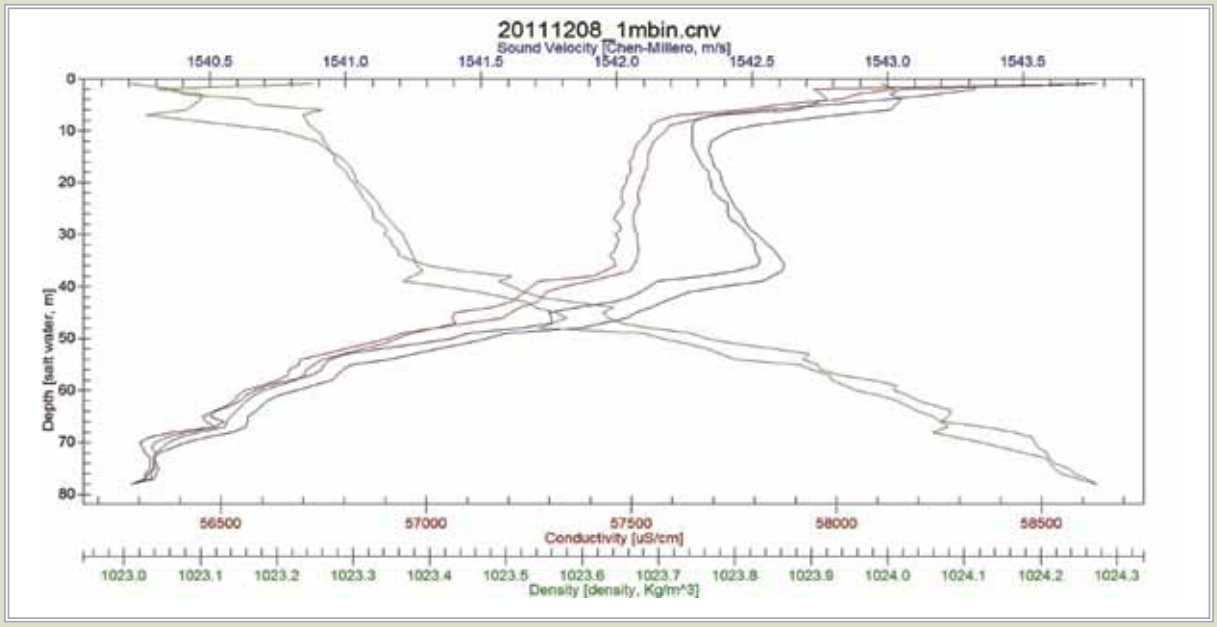

20111202_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1542.05 1542.10 1542.15 1542.20 1542.25 1542.30 1542.35 1542.40 1542.45 1542.50
Depth [salt water, m]
0 5 10 15 20 25
57650 57700 57750 57800 57850 57900 57950 58000 58050 58100 58150
Conductivity [uS/cm]
1023.40 1023.45 1023.50 1023.55 1023.60 1023.65
Density [density, Kg/m^3]

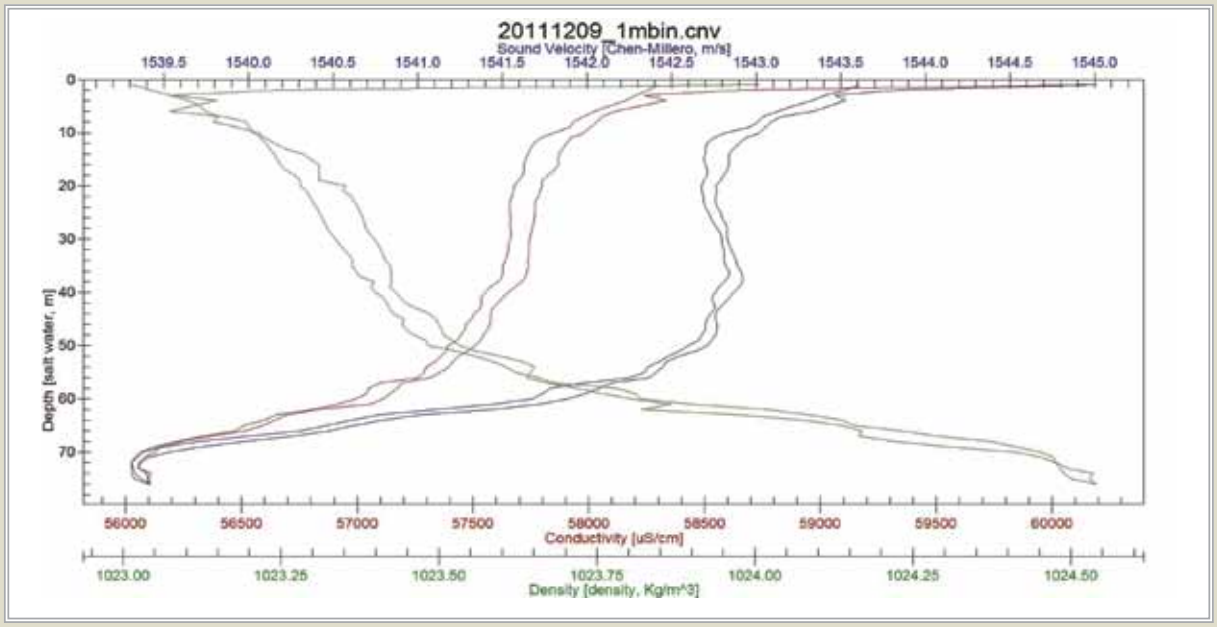

20111204_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1542.1 1542.2 1542.3 1542.4 1542.5 1542.6 1542.7 1542.8 1542.9
Depth [salt water, m]
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0
27.82 27.83 27.84 27.85 27.86 27.87 27.88 27.89 27.90 27.91 27.92 27.93 27.94 27.95 27.96
Temperature [ITS-90, deg C]
1023.30 1023.35 1023.40 1023.45 1023.50 1023.55 1023.60 1023.65 1023.70
Density [density, Kg/m^3]

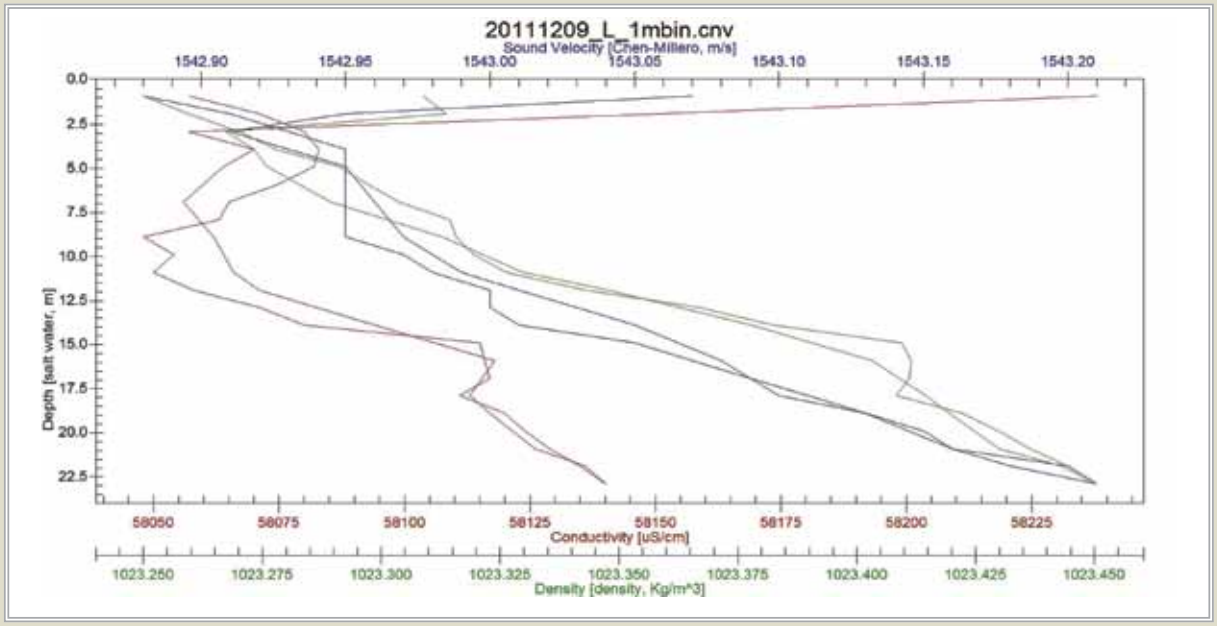

20111205-1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1541.75 1542.00 1542.25 1542.50 1542.75 1543.00 1543.25 1543.50 1543.75
Depth [salt water, m]
0 5 10 15 20 25
58500 58600 58700 58800 58900 59000 59100 59200 59300
Conductivity [uS/cm]
1023.6 1023.7 1023.8 1023.9 1024.0 1024.1 1024.2 1024.3 1024.4 1024.5 1024.6 1024.7 1024.8 1024.9
Density [density, Kg/m^3]

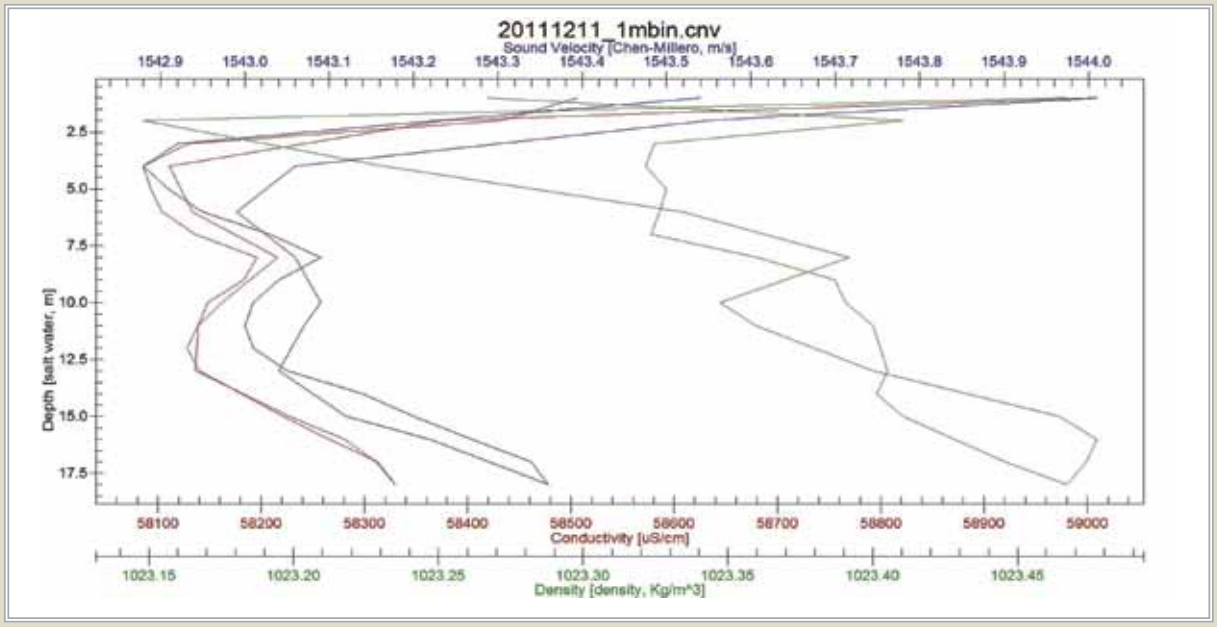

20111206_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1541.75
1542.00
1542.25
1542.50
1542.75
1543.00
Depth [salt water, m]
0
10
20
30
40
50
60
70
57000
57250
57500
57750
58000
58250
58500
Conductivity [uS/cm]
1023.1
1023.2
1023.3
1023.4
1023.5
1023.6
1023.7
1023.8
1023.9
Density [density, Kg/m^3]

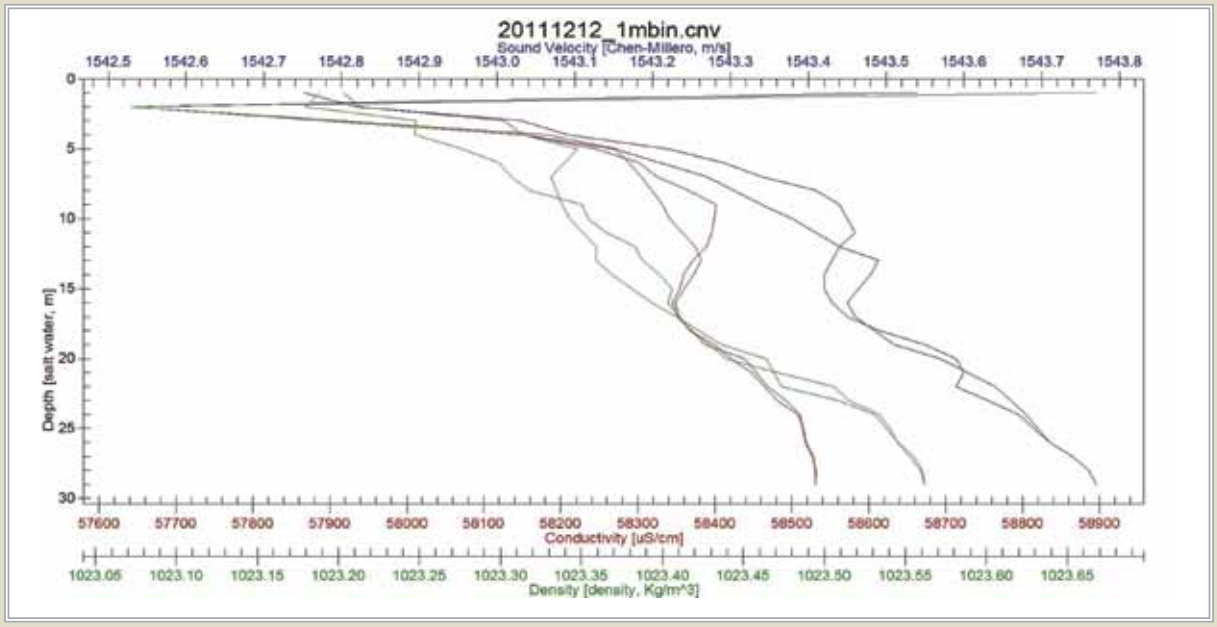

20111207_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1543.5
1543.6
1543.7
1543.8
1543.9
1544.0
1544.1
1544.2
1544.3
1544.4
1544.5
Depth [salt water, m]
0
5
10
15
20
25
58400
58500
58600
58700
58800
58900
59000
59100
59200
59300
59400
59500
59600
59700
59800
Conductivity [uS/cm]
1023.30
1023.35
1023.40
1023.45
1023.50
1023.55
1023.60
1023.65
1023.70
1023.75
1023.80
1023.85
1023.90
1023.95
Density [density, Kg/m^3]

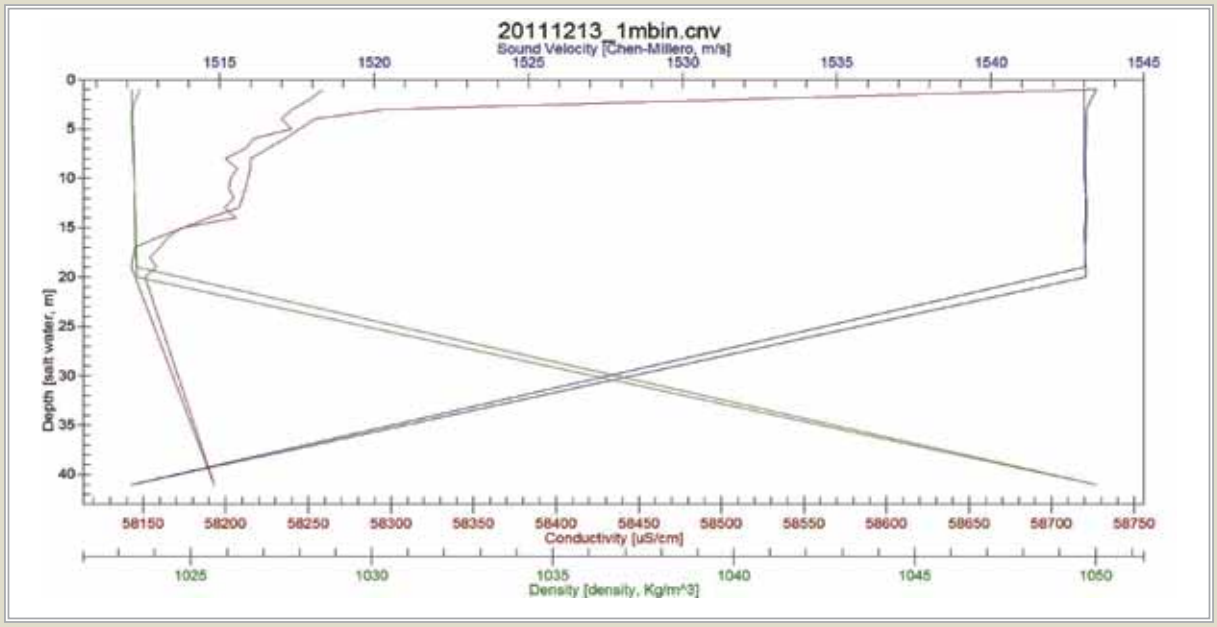

20111208_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1540.5
1541.0
1541.5
1542.0
1542.5
1543.0
1543.5
Depth [salt water, m]
0
10
20
30
40
50
60
70
80
56500
57000
57500
58000
58500
Conductivity [uS/cm]
1023.0
1023.1
1023.2
1023.3
1023.4
1023.5
1023.6
1023.7
1023.8
1023.9
1024.0
1024.1
1024.2
1024.3
Density [density, Kg/m^3]


20111209_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1539.5 1540.0 1540.5 1541.0 1541.5 1542.0 1542.5 1543.0 1543.5 1544.0 1544.5 1545.0
Depth [salt water, m]
0 10 20 30 40 50 60 70
56000 56500 57000 57500 58000 58500 59000 59500 60000
Conductivity [uS/cm]
1023.00 1023.25 1023.50 1023.75 1024.00 1024.25 1024.50
Density [density, Kg/m^3]


20111209_L_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1542.90 1542.95 1543.00 1543.05 1543.10 1543.15 1543.20
Depth [salt water, m]
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5
58050 58075 58100 58125 58150 58175 58200 58225
Conductivity [uS/cm]
1023.250 1023.275 1023.300 1023.325 1023.350 1023.375 1023.400 1023.425 1023.450
Density [density, Kg/m^3]


20111211_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1542.9 1543.0 1543.1 1543.2 1543.3 1543.4 1543.5 1543.6 1543.7 1543.8 1543.9 1544.0
Depth [salt water, m]
2.5 5.0 7.5 10.0 12.5 15.0 17.5
58100 58200 58300 58400 58500 58600 58700 58800 58900 59000
Conductivity [uS/cm]
1023.15 1023.20 1023.25 1023.30 1023.35 1023.40 1023.45
Density [density, Kg/m^3]


20111212_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1542.5 1542.6 1542.7 1542.8 1542.9 1543.0 1543.1 1543.2 1543.3 1543.4 1543.5 1543.6 1543.7 1543.8
Depth [salt water, m]
0 5 10 15 20 25 30
57600 57700 57800 57900 58000 58100 58200 58300 58400 58500 58600 58700 58800 58900
Conductivity [uS/cm]
1023.05 1023.10 1023.15 1023.20 1023.25 1023.30 1023.35 1023.40 1023.45 1023.50 1023.55 1023.60 1023.65
Density [density, Kg/m^3]

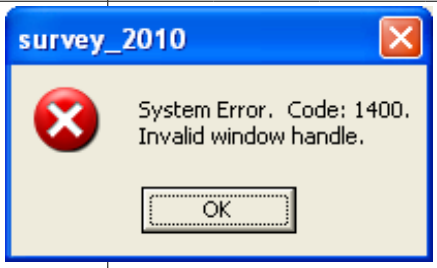

20111213_1mbin.cnv
Sound Velocity [Chen-Millero, m/s]
1515 1520 1525 1530 1535 1540 1545
Depth [salt water, m]
0 5 10 15 20 25 30 35 40
58150 58200 58250 58300 58350 58400 58450 58500 58550 58600 58650 58700 58750
Conductivity [uS/cm]
1025 1030 1035 1040 1045 1050
Density [density, Kg/m^3]

Appendix B: Multibeam log sheets

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024		
Static Offsets		Hypack Project Name: PF_Rangiroa
GPS: X = 0.0; Y = 3.188; Z = 2.610		Country: French Polynesia
MRU: X = 0.00; Y = 0.00; Z =- 0.115		Area: Rangiroa
MBES Head: X = -1.875; Y = -1.728.4; Z = 0.685		Vessel: Toa Nui
Dynamic Offsets		MBES System: R2SONIC 2024
Yaw = -2.0; Pitch = 0.25; Roll = -2.09; Latency = 0.00		Positioning: MarineStar

Date	Location	Line No.	Time		Fix		HDG	SPD	Filename (.HSX)	Log File (.LOG)		Line QC	Comments / Online changes
			SOL	EOL	SOL	EOL							
1/08/2011	RANGIROA LAGOON	20	14:12				315	3.6	020_1412				Patch Test Lines
		19					136	3.1	019_1418				
		18					324	4	018_1423				
		17					127	3	017_1426				
		16					321	4.7	016_1431				
		9					131	3.8	009_1434				
		8					336	3.9	008_1439				
		7					118	3.5	007_1442				
		7					315	4	007_1446				
		8					132	3	008_1450				
		9					320	4.8	009_1454				
		16					123	3.1	016_1457				
		17					311	5	017_1502				
		18					126	4.2	018_1505				
		19					332	5.1	019_1509				
		20					145	4.3	020_1512				
		21					130	3.7	021_1516				

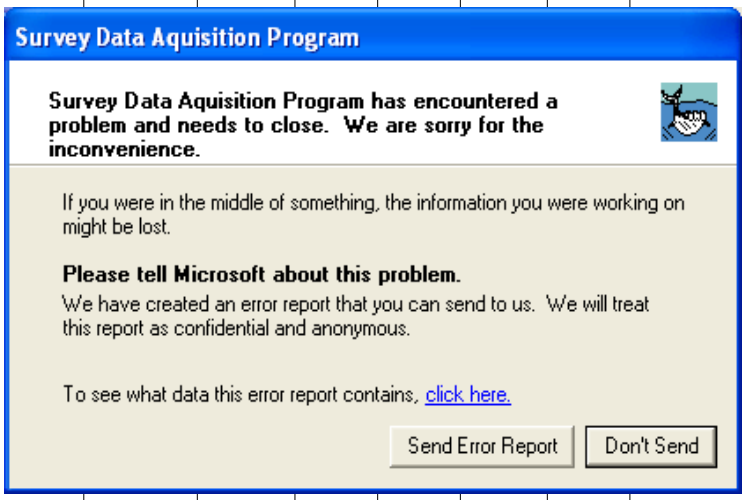
SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024																	
		18					134	7	018_1522								
2/08/2011		1					132	3.7	001_0910								
		6					320	4.2	006_0914								
		2					133	3.9	002_0916								
		3					326	4.6	003_0920								
		4					146	4.4	004_0922								
		5					307	4.6	005_0925								
		5					134	3.7	005_0929								
		4					311	4.6	004_0931								
		3					134	4.4	003_0934								
		2					320	4.6	002_0936								
		6					141	3.1	006_0939								
		1					305	4.7	001_0924								
		4					137	7.3	004_0948								
		9					31	3.5	009_0957								
		8					223	4.8	008_1000								
		5					113	6.5	005_1010			Line To Tiputa Wharf					
3/08/2011	rangiroa laggon	160	7:50	8:50	1	70	189	5.8	160_00750								
		160	8:50	9;50	71	126	180	2.85	160_0850								
		160	9:50	10;35	127		151	2.94	160_0950								
		164	10:36	11:18		152	216	5	164_1036			Stop line (Hypack problem)					
		164	11:18	11:53	217	250	16	5	164_1118								
		164	11:53	12:45	251	315	357	5.4	164_1153			End line E 314, continue shore parallel to wharf					
4/08/2011	Rangiroa Lagoon	168	6:49	7:49	316	357	269	5	168_0649			Start of survey, heading towards line 168					
		168	7:49	8:49	358	414	184	3	168_0749								
		168	8:49	9:46	415	467	179	3	168 _0849								

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
		172	9:57	10:57	468	534	280	4.8	172_0957			
		172	10:57	11:57	534	619	28	4.5	172_1057			
		172	11:57	0:00	620	625	16	5.2	172_1157			End of line
		176	0:14	12:27	626	634	626	2.7	176_1201			Going across shore, and then end of line.
5/08/2011	Rangiroa Lagoon	184	6:51	7:51	635	643	307	4.5	184_0651			Heading towards line 184
		184	7:51	8:51	643	699	171	3.5	184_0751			
		184	8:51	9:51	700	764	165	3.7	184_0851			
		184	9:51	10:20	765	797	166	3.9	184_0951			End of line 184
		188	10:28	11:28	798	864	291	3.18	188_1028			Heading towards line 188
		188	11:28	12:28	865	945	21	4.4	188_1128			
		188	12:28	12:44	946	970	6.1	4.5	188_1228			End of line 188
		184	12:50	13:26	973	980	184	3.2	184_1250			Heading to line 12 west–east.
		12	12:58	13:58	982	13.54	49	3.4	12_1258			Line 12 west–east, end of line 12 survey
		13	13:55	13:57	1031	1032	146	2.8	13_1355			Heading to line 13 west–east
		14	13:58	14:24	1031	1066	178	4.3	14_1358			Heading to line 14, end of line going to wharf
7/08/2011	Rangiroa Lagoon	152	7:09	8:09	1067	1136	113	5	152_0709		ZB	Heading to start of line 152, E1075 starting line
		152	8:09	9:09	1137	1223	160	4.8	152_0809		ZB	E1146, E1147 problem in Hypack navigation
		152	9:09	9:18	1224	1237	189	5.6	152_0909		ZB	E1149 problem in Hypack navigation
		156	9:34		1239		336	4.8	156_0934		ZB	E1193 error, E1206 error, Heading to Line 156
												
												Hypack error

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
		70	9:48	10:48	1241	1356	264	7	70_0948		ZB	Start line 70
		70	10:48	10;53	1357	1363	273	6	70_1048		SK	
		192	10:56	11:56	1365	1454	4	5	192_1056		SK	NS line
		192	11:56	12:53	1455	1548	19	6	192_1156		SK	End of line
		16	12:56	13:56	1548	1628	170	3	16_1548		ZB	EW heading to line 16 start
		16	13:56	14:27	1629	1659	84	4.9	16_1356		ZB	End of survey
9/08/2011		156	9:38	10:38	1660	1726	79.9	5	156_0938		ZB	Heading to line 156
		156	10:38	11:38	1727	1798	161	4.3	156_1038		ZB	1.5 to 2 m waves
		156	11:38	12:03	1799	1830	171	5	156_1138		SK	
		148	12:04	12:23	1831	1834	63	4.9	148_1204		SK	Heading to line 148
		148	12:23	13:00	1834	1884	14	4.1	148_1223		SK	r2 sonic time sync error
		148	13:04	14:04	1885	1971	9	5	148_1304		ZB	
		148	14:04	14:16	1972	1981	5	4.3	148_1404		ZB	Network receive error R2sonic, end of line 148
10/08/2011		18	8:44	9:44	2000	2107	277	5	18_0844		ZB	Start line 18, going west
		18	9:44	10:24	2108	2184	272	4.9	18_0944		ZB	NMEA gyro bad data error
		18	10:37	10:46	2186	2200	281	4	18_1037		ZB	E2188-gyro error, end of line 18
		22	10:51	11:51	2201	2241	243	5	22_1051		SK	Heading to start line 22
		22	11:51	12:51	2242	2297	109	4	22_1151		SK	
		22	12:51	13:51	2297	2363	90	3.2	22_1251		ZB	
		22	13:51	14:36	2364	2439	87	4.2	22_1351		ZB	E2373 hysweep interface error, end of line
11/08/2011		30	8:21	8:44	2440	2441	163	5	30_0821		ZB	Heading towards line 30 west
		30	8:45	9:45	2442	2549	319	4.8	30_0845		ZB	Start line 30
		30	9:45	10:45	2550	2661	280	5.4	30_0945		ZB	
		30	10:45	10:52	2662	2669	275	5.4	30_1045		ZB	End line
		26	10:54	11:05	2671	2682	21	2	26_1054		ZB	Heading to line 26
		26	11:05	12:05	2683	2777	54	4	26_1105		SK	Start line 26
		26	12:05	12:34	2778	2827	91	5	26_1105		SK	Stop line for CTD

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
		26	12:41	13:41	2828	2914	75	2	26_1241		ZB	
		26	13:41	14:01	2915	2957	93	6.5	26_1341		ZB	End line
12/08/2011		160	8:19	9:01	2959	3035	177	5	160_0819		ZB	Start line 160 middle of lagoon, going south, calm sea, R2sonic error
		160	9:10	9:59	3036	3125	96	2	160_0910		ZB	R2sonic netwrok receive error, end of line 160
		164	10:32	11:28	3126	3222	235	5.2	164_1032		ZB	Heading to line 164
		164	11:38	12:07	3223	3280	354	3.6	164_1138		ZB	
		162	12:11	13:11	3281	3395	18	6	162_1211		ZB	Starting line 162
		162	13:11	13:31	3396	3435	3	6	162_1311		ZB	Line end
14/08/2011		140	7:22	7:27	3436	3441	116	8	140_0722		ZB	Heading to line 140
		140	7:48	8:48	3443	3560	157	3	140_0748		ZB	Start line 140
		140	8:48	9:48	3561	3673	185	6.21	140_0848		ZB	
		140	9:48	10:11	3674	3715	180	603	140_0948		SK	End of line, Utoto
		144	10:15	11:11	3716	3803	311	4.6	144_1015		ZB	Heading to line 144, E3718 line 144 starts
		144	11:47	12:47	3805	3912	345	4.8	144_1147		SK	
		144	12:47	13:32	3913	4000	347	5.18	144_1247			
		6	13:35	13:55	4002	4018	27	2	6_1335			Tiputa Pass
15/08/2011		132	8:39	9:39	4020	4133	174	6	132_0839		ZB	Start line 132, heading south
		132	9:39	10:39	4134	4218	179	5	132_0939		ZB	1m waves, SE winds
		132	10:39	11:20	4219	4281	179	4	132_1039		SK	
		136	11:20	11:29	4282	4282	283	4	136_1120		SK	Heading to start line 136
		136	11:29	12:29	4285	4381	19	5	136_1129		ZB	
		136	12:29	12:59	4382	4429	6	5	136_1229		ZB	Error Hypack navigation
		136	13:26	13:34	4432	4441	9	5	136_1326			Error Hypack navigation
		136	13:35	13:35	4442	4443			136_1335			DNP
		136	13:45	13:52	4443	4461	8.7		136_1345			Testing Hypack,,,DNP

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
16/08/2011		124	9:02	10:02	4462	4556	173	3	124_0902		ZB	Start line 124 heading south, rough seas
		124	10:02	11:02	4557	4644	180	4	124_1002		ZB	
		124	11:02	11:44	4645	4700	178	4	124_1102		ZB	
		128	11:47	12:47	4701	4782	321	6	128_1147		ZB	Heading to line 128, E4711 start line
		128	12:47	13:16	4783	4828	24	4	128_1247		ZB	
		128	13:28	13:33	4829	4844	124	5	128_1328		ZB	
17/08/2011		136	9:14	10:14	4845	4928	121	4	136_0914		ZB	Start line 136 heading south
		136	10:14	10:56	4929	4980	169	4	136_1014		ZB	Rough seas with rain, R2sonic network error
		136	10:57		4981		216	4	136_1057			Error
		136	11:08	11:37	4983	5020	102	4	136_1108		SK	End line
		128	11:58	12:13	5022	5048	15	5	128_1158		SK	Hypack veritime sync error
		128	12:25	13:19	5050	5144	6	6	128_1225		SK	
18/08/2011		168	8:48	9:48	5147	5243	178	5	168_0848		SK	Eastly winds , 1m waves
		168	9:48	10:31	5144	5308	171	5	168_0948		SK	
		172	10:42	11:39	5310	5393	28	5	172_1042		SK	
		172	11:48	12:26	5394		4	5	172_1148		SK	
		172	12:34								SK	DNP error
		172	12:41		5460		354	5	172_1241		SK	DNP Hypack navigation error
		172	12:55	13:09	5467	5488	7	5	172_1255		SK	

21/08/2011												
												Error returned to wharf to check everything
												Error with the NW matrix, therefore created new nw matrix
												ZB
		166	10:03	11:03	5491	5574	230	3	166_1003		ZB	Very rough seas
		166	11:03	12:00	5575	5654	150	3	166_1103		ZB	End line
		158	12:16	12:57	5657	5716	86	3	158_1216		ZB	Heading to line 158
		158	13:05	13:59	5717	5810	7	5	158_1305		ZB	End line
23/08/2011		176	8:12	9:12	5812	5900	175	5	176_0812		ZB	Start line, rough seas
		176	9:12	10:06	5901	5984	175	4	176_0912		ZB	
		180	10:08	10:33	5985	6006	253	3	180:1008		ZB	Heading to line 180, error
		180	10:34		6007		6	6	180_1034		ZB	Error-R2sonic network
		180	10:36	11:29	6010	6104	14	3	180_1036		ZB	Stopped for CTD
		180	11:38	12:38	6105	6209	338	4	180_1138		ZB	
		180	12:38	13:31	6210	6317	358	6	180_1238		ZB	End of line
24/08/2011		204	8:54	9:54	6318	6438	181	7	204_0854		ZB	Start line 204 going south
		204	9:54	10:03	6438	6454	1713	5	204_0954		ZB	End of line
		200	10:04	10:20	6455	6467	101	5	200_1004		ZB	Heading to line 200

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
		200	10:22	11:22	6459	6594	12	4	200_1022		ZB	End of line
		196	11:30	12:30	6596	6712	175	5	196_1130		ZB	Start line 196 going south
		196	12:30	12:48	6713	6746	178	5	196_1230		ZB	End of line
		192	12:48	12:57	6747	6748	138	6	192_1248		ZB	Heading to line 192,E6747 start line, stopped for fueling-100L filled
		192	13:14	13:58	6750	6846	11	5	192_1314		ZB	
		192	14:00	14:17	6847	6881	14	5	192_1400		ZB	End of line
25/08/2011		220	10:40	11:40	6882	6966	175	5	220_1040		ZB	Start line-very rough seas
		220	11:40	12:05	6967	7005	171	5	220_1140		ZB	End of line
		216	12:05	13:05	7006	7097	163	5	216_1205		ZB	Heading to line 216, E7007 start line
		216	13:05	13:29	7098		17	6	216_1305		ZB	Hypack crashed closed
		216	13:31	13:51	7136	7175	160	5	216_1331			End of survey
29/08/2011		196	8:43	9:43	7177	7270	176	4	196_0843		ZB	Start line
		196	9:43		7271		195	4	196_0943		ZB	End of line-error survey acquisition
		176	11:20	12:20	7334	7426	21	3	176_1120		ZB	
		176	12:20	13:02	7427	7497	4.7	6.19	176_1220		ZB	End of line
30/08/2011		204	9:51	10:51	7501	7602	171	4.6	204_0951		ZB	Start line 204
		204	10:51	11:29	7603	7667	178	5	204_1051		ZB	End of line
		200	11:34	12:14	7668	7740	348	3	200_1134		ZB	Start line 200
		200	12:20	13:14	7742	7833	358	5	200_1220		ZB	End of line
31/08/2011		170	8:59	9:59	7834	7918	155	3	170_0859		ZB	Start line
		170	9:59	10:59	7919	8002	176	5	170_0959		ZB	
		170	10:59	11:59	8002	8088	171	5	170_1059		ZB	
		170	11:59	12:38	8089	8143	196	4	170_1159		ZB	ERROR, bad data from Gyro
		170	12:40	12:46	8144	8153	181	4	170_1240		ZB	End of line

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
2/09/2011		212	8:57	9:57	8157	8238	168	3	212_0857		ZB	Start line
		212	9:57	10:57	8239	8304	181	4.5	212_0957		ZB	
		212	10:57	11:15	8305	8329	183	3	212_1057		ZB	End of line
		208	11:31	12:26	8333	8412	18	4	208_1131		ZB	
		208	12:32	13:32	8413	8503	7	3	208_1232		ZB	
		208	13:32	13:33	8503	8506	14	5	208_1332		ZB	End of line
6/09/2011		220	8:51	8:52	8507	8510	164	3.9	220_0851		ZB	Start line 220 heading south, calm seas
		220	8:55	9:55	8511	8625	168	4	220_0855		ZB	
		220	9:55	10:22	8626	8684	183	6	220_0955		ZB	
		224	10:28	11:28	8685	8793	354	4	224_1028		ZB	Start line 224
		224	11:28	11:47	8794	8829	5	6	224_1128		ZB	
		228	11:58	12:58	8830	8959	185	4.33	228_1158		ZB	
		228	12:58	13:30	5960	9032	181	6.6	228_1258		ZB	
		228	13:32	13:50	9033	9060	191	2	228_1332		ZB	End of line
		224	14:04	15:04	9061	9162	10	4	224_1404		ZB	
		224	15:04	15:06	9163	9168	2	7	224_1504		ZB	CTD,
		224	15:12	15:15	9170	9177	4	5	224_1512		ZB	End of line
7/09/2011		240	9:51	10:51	9179	9269	209	3.96	240_0951		ZB	Start line 240 heading south rough seas
		240	10:51	11:51	9270	9353	160	4	240_1051		ZB	End of line
		236	11:53	12:13	9354	9355	115	3	236_1153		ZB	Heading to line 236
		236	12:38	12:53	9356	9376	18.1	5	236_1238		ZB	
		236	12:57	13:13	9377	9400	55	3	236_1257		ZB	
		236	13:16	13:44	9401	9446	324	4	236_1316		ZB	CTD
		236	13:50	14:02	9448	9468	4	5	236_1350		ZB	End of line
12/09/2011		216	9:09	10:09	9470	9581	178	5	216_0909		SK	
		216	10:09	10:50	9582	9644	180	6	216_1009		SK	
		212	11:01	12:01	9645	9744	181	6	212_1101		SK	

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
		212	12:01	12:05	9745	9751	180	6	212_1201		SK	
		208	12:06	12:16	9752	9753	115	2	208_1206		SK	Heading to line 208
		208	12:16	12;50	9754	9810	14	5	208_1216		SK	
		208	13:01		9811		11	5	208_1301		SK	DNP
		208	13:08	13:16	9814	9825	13	5	208_1308		SK	
		208	13:27	13;53	9827	9872	1	5	208_1327		SK	
		196	14:15	14:52	9873	9941	10	5	196_1415		SK	
13/09/2011		251	10:12	10:16	9942	9947	279	7	251_1012		SK	r2 sonic problem
		251	10:32	11:28	9948	23	198	4	251_1032		SK	
		249	11:30	11:52	9961	9965	82	4	249_1130		SK	Event reset
		249	11:52	12:04	9966		11	4	249_1151		SK	
		249	12:07								SK	DNP
		249	12:08	12:44	9981	9991	3	4	249_1208		SK	
		247	12:44	13:45	9992	50	177	4	247_1244		SK	Events reset to 1 after 9999
		245	13:45	13:57	51	65	69	4	245_1345		SK	SVP sync error
		245	14:02	14:58	66	159	2	5	245_1402		SK	
		243	14:59	15:02	160	161	36	5	243_1459		SK	
14/09/2011		174	9:53	10:50	163	259	180	5	174_0953		SK	
		174	10:53	11:02	261	273	180	5	174_1053		SK	SVP error
		174	11:06	11:11	275	281	180	5	174_11061		SK	SVP error
		174	11:15	11:25	283	300	180	5	174_1115		SK	SVP error
		174	11:42	12;42	301	388	180	5	174_1142		SK	
		174	12:42	13:39	389	485	180	5	174_1242		SK	
		172	14:39	15:10	490	558	9	6	172_1439		SK	
15/09/2011		243	9:59	10:50	560	655	180	5	243_0959		SK	
		243	10:59	11:40	656	714	170	5	243_1059		SK	

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
		238	11:40	12:12	715	744	123	5	238_1140		SK	
		238	12:15	12;27	745	759	213	5	238_1215		SK	SVP error
		238	12:29	12:08	760	820	761	5	238_1229		SK	
		238	13:11	13:50	821	887	8	5	238_1311		SK	Gyro error
		238	13:53	14:09	888	909	10	5	238_1353		SK	
		236	14:08	15:00	910	1000	180	5	236_1408		SK	
16/09/2011		154	8:12	8:55	1002	1059	180	4	154_0812		SK	Ctrl.dll error
		154	9:09	9:17	1060	1069	180	4	154_0909		SK	SVP error
		154	9:22	10:22	1071	1146	180	4	154_0922		SK	1.5 to 2-m waves, SE winds around 15 kt
		154	10:22	11:12	1147	1208	180	4	154_1022		SK	
		154	11:14	12:13	1208	1282	180	4	154_1114		SK	
		154	12:16	12:32	1283	2842	180	4	154_1216		SK	
		156	12:32	13:32	2843	1388	180	4	156_1232		SK	
		156	13:32	14:08	1389		12	4	156_1332		SK	
26/09/2011	Avatoru pass	6	9:56		1440	1470	6	4	006_0956		SK	
		8	10:21		1471	1487	152	2	008_1021		SK	
		7	10:36	10:50	1488	1488	347	3	007_1036		SK	
		5	10:51	11:06	1489	1509	125	3	005_1051		SK	
		4	11:07	11:22	1510	1529	333	4	004_1107		SK	
		3	11:22	11:32	1530	1549	152	5	003_1122		SK	
		2	11:33		1550						SK	DNP
		9	11:37	11:53	1553	1569	323	4	009_1137		SK	
		15	11:55	12:06	1570	1587	149	4	015_1155		SK	
		10	12:12	12:21	1589	1599	342	3	010_1212		SK	
		10	12:26	12:33	1600	1607	358	3	010_12266		SK	
		2	12:34	12:48	1608	1625	112	4	002_1234		SK	

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
27/09/2011	east lagoon	116	8:59	9:59	1627	1725	149	5	116_0859		SK	1 to 1.5-m waves
		116	9:59	10:18	1727	1756	176	5	116_0959		SK	
		116	10:56		1758		179	5	116_1056		SK	DNP
		116	11:16	12:03	1762	1829	146	5	116_1116		SK	SVP error
		116	12:30	12:35	1830	1836	142	4	116_1230		SK	
		116	12:41	12;49	1837	1847	161	4	116_1241		SK	
		116	12:53	12:56	1848	1853	164	4	116_1253		SK	SVP error
		116	12:58	13:14	1856	1876	164	5	116_1258		SK	
		112	13:16	14:16	1877	1890	64	6	112_1316		SK	Line to start 112
		112	14:16	15:14	1891	2097	13	6	112_14:16		SK	
28/09/2011	east lagoon	120	9:13	10:13	2099	2184	169	4	120_0913		SK	8.4 PR @ 28 m
		120	10:13	11;13	2185	2266	191	4	120_1013		SK	1-m waves, SE winds
		120	11:13	12:03	2267	2338	162	4	120_1113		SK	
		108	12:22	12:16	2339	2423	28	5	108_1222		SK	
		108	13:24	14:24	2424	2525	6	5	108_1324		SK	
		108	14:24	14:41	2526	2557	6	5	108_1424		SK	
29/09/2011	east lagoon	100	9:34	10:34	2558	2633	165	5	100_0934		SK	1 to 1.5-m waves, SE winds
		100	10:34	11:34	2634	2706	167	5	100_1037		SK	
		100	11:34	11:50	2707	2733	190	5	100_1134		SK	
		100	11:53	12:25	2735	2782	181	5	100_1153		SK	
		104	12:38	13:38	2783	2871	13	5	104_1238		SK	
		104	13:38	14:10	2872	2924	8	5	104_1338		SK	
		104	14:16	15:06	2925	3007	3	5	104_1416		SK	
30/09/2011	near the airport east end	152	8:10	9:02	3009	3090	182	5	152_0810		SK	3 whales seen to the west
		152	9:42	10:09	3091	3132	180	5	152_0942		SK	This line done previously
		150	10:12	11:01	3134	3209	168	5	150_1012		SK	NMEA error, bad data from device
		150	11:03	12:03	3210	3299	180	5	150_1103		SK	

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
		150	12:03	12:05	3300	3304		4	150_1203		SK	
		152	12:05	12:29	3306	3342	6	5	152_1205		SK	
2/10/2011	eastern most end	30	10:49	11:47	3343	3358	?	6	030_1049		SK	Around the eastern end of lagoon
		32	11:58	12:42	3360	3410	?	6	032_1158		SK	Around the eastern end of lagoon
		32	13:19	13;45	3412	3459	8	6	032_1319		SK	
		32	13:49	14:05	3460	3488	10	6	032_1349		SK	
3/10/2011	eastern lagoon	34	11:31	12:09	3489	3568	178	6	034_1131		SK	Very calm seas
		36	12:09	12:12	3569				034_1209		SK	
		36	12:13	12:56	3570	3651	2.8	6	034_1213		SK	
		38	13:04	13:54	3652	3743	175	6	036_1304		SK	
4/10/2011	eastern lagoon	40	11:05	12:00	3744	3845	178	6	040_1105		SK	0.5 to 1-m waves, NW winds
		42	12:04	12:32	3846	3883	7	6	042_1204		SK	
		42	12:36	13:23	3885	3952	4	4	042_1236		SK	
		44	1352	14:30	3953	4011	177	4	044_1352		SK	
5/10/2011	eastern lagoon	92	10:08	11:08	4012	4121	173	6	092_1008		SK	SSE winds, calm seas
		92	11:08	12:04	4122	4227	180	7	092_1108		SK	
		96	12:04	13:01	4228	4341	1	6	096_1204		SK	0.5-m waves
		96	13:09	14:01	4343	4436	3	5	096_1309		SK	
		96	14:04	14:11	4437	4448	2	5	096_1404		SK	
6/10/2011	eastern lagoon	84	10:07	11:07	4450	4563	186	6	084_1007		SK	Calm seas, winds from the south
		84	11:07	11:58	4564	4655	180	6	084_1107		SK	
		88	12:34	13:29	4656	4768	360	6	088_1234		SK	
		88	13:36	14:27	4770	4873	350	6	088_1336		SK	

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
21/10/2011		80	9:36	10:36	4874	5063	304	5.8	080_0936		ZB	Start line 80, rough seas
		80	10:36	11:36	5064	5249	193	5	080_1036		ZB	
		80	11:36	11:40	5250	5268	170	5	080_1136		ZB	End of line
24/10/2011		44	10:55	11:35	5270	5341	166.3	5.76	044_1055		ZB	Rough seas, end of line
		46	11:41	12:41	5342	5442	1.2	5.13	046_1141		ZB	Start line 46 from south
		46	12:41	12:48	5443	5456	358	5.8	046_1241		ZB	End line
25/10/2011		48	11:35	11:46	5457	5477	188.6	4.96	048_1135		ZB	Start line 48 from northeast, rough seas
		48	11:49	12:44	5478	5578	229	5	048_1149		ZB	Data sync out error, end of line
		50	12:50	13:24	5579	5637	14	5	050_1250		ZB	Start line 50 from southeast, R2sonic sync out error
		50	13:31	14:07	5638	5699	25.4	4	050_1331		ZB	End of survey
26/10/2011		52	10:39	10:47	5701	5715	182	5.31	52_1039		ZB	Start line, rough seas, SE winds, R2sonic error
		52	11:19	11:37	5716	5746	174	6	52_1119		ZB	Sync out error
		52	11:40	12:33	5747	5825	180	4	52_1140		ZB	End of line
		54	12:37	13:02	5826	5871	329	3	54_1237		ZB	
		54	13:12	13:57	5872	5951	20.3	5	54_1312		ZB	End of line
27/10/2011		56	11:01	11:03	5952	5953	171	5.78	56_1101		ZB	Start line 56, northeast, sync out error
		56	11:05	11:21	5956	5979	144	4	56_1105		ZB	Sync out error
		56	11:25	11:29	5981	5988	177	5	56_1125		ZB	Simbox error
		56	11:34	11:46	5989	6006	165	5	56_1134		ZB	SVP error, simbox error
17/11/2011		182	9:04	9:59	6008	6115	192	5.78	182_0904		ZB	Heading south, calm seas
		182	10:03	10:28	6116	6167	175	5	182_1003		ZB	
		188	10:42	11:42	6169	6296	176.9	7	188_1042		ZB	
		188	11:42	11:57	6297	6329	178	6.8	188_1142		ZB	End of line
		184	12:04	13:04	6330	6457	42.9	4	184_1204		ZB	

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
		184	13:04	13:22	6458	6497	2.8	7.04	184_1304		ZB	
		178	13:30	14:30	6498	6619	4.3	5	178_1330		ZB	
		178	14:30	14:45	6620	6650	358	6.34	178_1430		ZB	End of line
21/11/2011		56	9:52	10:17	6651	6703	160	4	56_0952		ZB	Start line- heading south east
		56	10:19	10:56	6704	6778	177	6.3	56_1019		ZB	
		58	10:57		6779				58_1057		SK	
		58	11:03	11:10	6782	6786	356	6	58_1103		SK	
		58	11:12	12;07	6797	6911	13.2	6	58_1112		SK	
		60	12:26	13:26	6912	7034	174	5	60_1226		ZB	
		60	13:26	13:30	7035	7043	168	7	60_1326		ZB	
		62	13:33	13:53	7045	7085	356	7	62_1333		SK	
		62	13:58	14:41	7087	7176	357	7	62_1358		SK	
2/12/2011	habitat	1	8:54		7178		180	5	001_0854		SK	Restarted, matrix problem
	habitat	21	9:14	9:21	7193	7203	88	5	021_0914		SK	
	habitat	20	9:23		7204		312	5	020_0923		SK	
	habitat	19	9:53	10:02	7228	7239	72	5	019_0953		SK	
	habitat	18	10:04	10:12	7241	7252	315	5	018_1004		SK	
	habitat	17	10:15	10:23	7253	7264	79	5	017_1015		SK	
	habitat	16	10:25	10;30	7265	7276	292	5	016_1024		SK	
	habitat	15	10:33	10:41	7278	7289	78	5	015_1033		SK	
	habitat	14	10:43	10:48	7291	7302	294	5	014_1042		SK	
	habitat	13	10:50	10:58	7304	7315	73	5	013_1050		SK	
	habitat	12	10:59	11:06	7316	7327	300	5	012_1059		SK	
	habitat	11	11:07	11:15	7328	7339	105	5	011_1107		SK	
	habitat	10	11:16	11:23	7340	7351	286	5	010_1116		SK	
	habitat	9	11:26	11:33	7352	7363	85	5	090_1126		SK	
	habitat	8	11:35	11:40	7365	7376	284	5	008_1135		SK	

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024																
	habitat	7	11:41	11:48	7377	7388	92	5	007_1141		SK					
	tiputa pass	4	11:54	12:05	7390	7408	15	5	004_1154		SK					
	tiputa pass	3	12:06	12:19	7409	7430	206	5	003_1205		SK	On line 5				
	habitat	6	12:25	12:31	7436	7447	279	5	006_1225		SK					
	habitat	5	12:32	12:40	7449	7460	80	5	005_1232		SK					
	habitat	4	12:54	13:00	7462	7473	270	5	004_1254		SK					
	habitat	3	13:01	######	7475	7488	82	5	003_1301		SK					
	habitat	2	13:10	13:16	7488	7499	279	5	002_1310		SK					
	habitat	1	13:19	13:25	7500	7501	184	7	001_1319		SK	Cross line				
4/12/2011	Tiputa pass	1	7:08	7:25	7502	7522	133	5	001_0708		SK					
	Tiputa pass	7	7:25	7:38	7502		168	5	007_725		SK					
	Tiputa pass	1	7;49		7532				001_749		SK					
	Tiputa pass	7							007_0806		SK					
	Avatoru offshore	1	8:27	9:27	7564	7662	281	5	001_0827		SK					
	Avatoru offshore	1	009:27	9:38	7663	7679	280	5	001_0927		SK					
	Avatoru offshore	2	9:43	10:43	7680	7761	101	5	002_0943		SK					
	Avatoru offshore	2	10:43	11:01	7762		119	5	002_1043		SK					
	Avatoru offshore	2	11:08	11:14	7796	7803	145	5	002_1108		SK					
	Tiputa pass	1	11:48	12:00	7807	7830	214	5	001_1148		SK					
	Tiputa pass	6	12:00	12:17	7830	7844	30	5	006_1200		SK					
	Tiputa pass	6	12:19	12:22	7846	7852	202	5	006_1219		SK					
	Tiputa pass	15	12:27	12:27	7853	7865	35	5	015_1227		SK					
	Tiputa pass	17	12:39	12:45	7866	7879	154	5	017_1239		SK					
	Tiputa pass	19	12:47		7880		60	5	019_1247		SK	Data fill				

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024																
	Tiputa pass	21				7898			021_1310			SK	V feature jetty			
5/12/2011	eastern lagoon	65	9:58	10:58	7900	8016	180	5	065_0958			SK				
		65	10:58	11:16	8017	8044	178	5	065_1058			SK				
		70	11:25	12:25	8045	8064	9	5	070_1125			SK				
		70	12:25	13:01	8064	8078	5	6	070_1225			SK				
		75	13:14	13:55	8079	8097	178	5	075_1314			SK				
		75	14;14	15:06	8099	8119	174	6	075_1414			SK				
6/12/2011	offshore northwest	1	8:02	9;02	8121	8220	350	6	001_0802			SK				
		1	9:02	10:02	8221	8324	279	6	001_0902			SK				
		1	10:02	10:34	8325	8388	210	6	001_1002			SK				
		4	10:36	11:25	8408	8517	47	7	004_1036			SK				
		6	11;27	12:22	8518	8636	203	6	006_1127			SK	Freq 200 abs 89 Pr 1.5 pulse 500			
		2	12;26		8642		54	6	002_1226			SK	Data fill			
		2	12:58	13:23	8680	8702	20	7	002_1257			SK				
		4	13:31	14:31	8719	8820	86	4	004_1431			SK				
		4	14:31	15:31	8820	8897	95	4	004_1431			SK				
		4	15:32			8899			004_1532			SK	Channel			
7/12/2011	west	234	9:24	10:24	8900	8993	180	5	0234_0924			SK				
		234	10:24	11:07	8994	9051	166	5	234_1024			SK				
		231	11:24	12:18	9053	9142	350	5	231_1124			SK				
		231	12:25	13:05	9143	9208	30	5	231_1225			SK				
8/12/2011	northeast offshore	11	8:36	9:36	9209	9299	107	5	011_0836			SK				
		11	9:36	10:36	9300	9411	157	5	011_0936			SK				
		11	10:36	11:36	9412	9532	136	5	011_1036			SK				
		11	11:36	12:24	9533	9648	139	7	011_1136			SK				

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
		9	12:34	13:10	9691	284	298	5	009_1234		SK	
		10	13;09	13:51	284	374	311	6	010_1309		SK	
		9	13:54	14;54	400		304	5	009_1354		SK	
		9	14;54	15:54	540	660	321	5	009_1454		SK	
		9	15:54	15:59	666	671	321	5	009_1554		SK	
9/12/2011	Tiputa pass	21	8;05	8:14	672	680	34	5	021_0805		SK	
	Tiputa pass	23	8:17	8:25	681	690	36	5	023_0817		SK	
	Tiputa pass	25	8:29	8:42	691	701	36	5	025_0829		SK	
	Tiputa pass	1	8:53	9:00	702	713	28	5	001_0853		SK	
	Tiputa pass	29	9:01	9:08	714	725	28	5	029_0901		SK	
	Tiputa pass	31	9:09	9:15	726	738	26	5	031_0909		SK	
	Tiputa pass	33	9:17	9:25	739	749	150	5	033_0917		SK	
	Tiputa pass	35	9:27	9:38	751	761	25	5	035_0927		SK	
	Tiputa pass	36	9:40	9:46	762	771	46	5	036_0940		SK	
	Tiputa pass	36	9:47	10:47	772	775	322	3	036_0947		SK	Data fill
	Tiputa pass	36	10:47	10:50	773	776	320	3	036_1047		SK	Data fill
	Avatoru offshore	4	10:59	11:59	777	876	280	5	004_1059		SK	
	Avatoru offshore	4	11:59	12:11	877	894	280	5	004_1159		SK	
11/12/2011	Tiputa pass	1	8:48		896		29	5	001_0848		SK	
		1	9:04	9:51	927	1015	90	5	001A_0927		SK	
	Avatoru shoreparallel	2	9:54	10:09	1016	1045	300	5	002_0954		SK	
	Avatoru shoreparallel	2	10:18	11:05	1057	1150	320	5	002_1018		SK	
	Avatoru shoreparallel	5	11:05	11:39	1151	1221	90	5	005_1150		SK	
	Avatoru shoreparallel	5	11:51	12:09	1237	1247	320	5	005_1151		SK	
	Avatoru shoreparallel	8	12:10	12:52	1248	1328	236	5	008_12:10		SK	

SOPAC MULTIBEAM ONLINE LINE LOG R2 SONIC 2024												
	Avatoru shoreparallel	8	12:57	13:08	1334	1340	75	5	008_1256		SK	
	Avatoru shoreparallel	4	13:08	13:27	1340	1382	154	5	004_1308		SK	
12/12/2011	patch test Dec	1	9:21	9:25	1386	1396	275	5	001_0921		SK	
	patch test Dec	3	9:27	9:32	1400	1416	97	5	003_0927		SK	
	patch test Dec	5	9:34	9:38	1419	1427	259	5	005_0933		SK	
	patch test Dec	7	9:39	9:44	1428	1436	88	5	007_0939		SK	
	patch test Dec	9	9:45	9:50	1438	1446	268	5	009_0945		SK	
	patch test Dec	11	9:51	9:56	1448	1456	96	5	011_0951		SK	
	patch test Dec	11	9:57	10:02	1458	1466	259	5	011_0957		SK	
	patch test Dec	9	10:04	10:09	1468	1476	97	5	009_1004		SK	
	patch test Dec	7	10:10	10:14	1477	1485	273	5	007_1010		SK	
	patch test Dec	5	10:15	10:20	1486	1494	83	5	005_1015		SK	
	patch test Dec	3	10:21	10:26	1496	1504	273	5	003_1021		SK	
	patch test Dec	1	10:27	10:32	1506	1514	80	5	001_1027		SK	
	patch test Dec	3	10:33	10:41	1516	1523	280	3	003_1033		SK	Latency
	patch test Dec	3	10:46	10:49	1525	1533	276	7	003_1046		SK	Latency
											SK	
	Avatoru shoreparallel	3	11:12	12:02	1534	1640	41	5	003_1112		SK	
		6	12:02	12:55	1640	1745	192	5	006_1202		SK	
		4	12:57	13:10	1747	1792	56	5	004_1257		SK	
		4	13:13	13:29	1792	1825	289	5	004_1313		SK	
13/12/2011	Avatoru shoreparallel	9	8:34	08"51	1834	1865	120	3	009_0834			

Multibeam Bathymetry Survey Rangiroa, French Polynesia

SPC CPS

SECRETARIAT OF THE PACIFIC COMMUNITY

SECRÉTARIAT GÉNÉRAL DE LA COMMUNAUTÉ DU PACIFIQUE